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T 011 789 7170 E info@eims.co.za W www.eims.co.za

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

PROPOSED AFRICA OIL SOUTH AFRICA CORP BLOCK 3B/4B EXPLORATION RIGHT

PASA/DMRE REFERENCE: 12/3/339

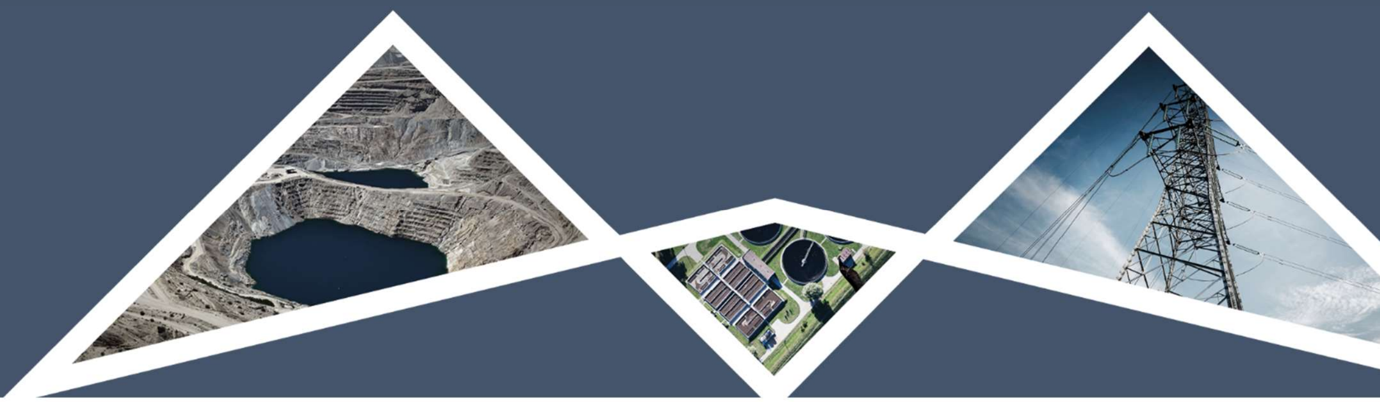

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Table of Contents

List of Figures

List of Tables

Appendices

ACRONYMS AND ABBREVIATIONS

2D	two-dimensional
3D	three-dimensional
ABNJ	Areas Beyond National Jurisdiction
ADZ	Aquaculture Development Zones
AEL	Atmospheric Emission Licence
AFOLU	Agriculture, Forestry and Other Land Use
AIS	Automatic Identification System
AOI	Area of Interest
AOSAC	Africa Oil South Africa Corp
API	Area Specific Gravity
APPA	Air Pollution Prevention Act (Act No. 45 of 1965)
AQSR	Air Quality Sensitive Receptors
AR	Assessment Report
ASA	Acoustical Society of America
AVO	Amplitude Versus Offset
BAT	Best Available Technology
Bbl	Barrel of Oil
BCC	Benguela Current Commission
BCLME	Benguela Current Large Marine Ecosystem
BOCP	Blow-out Contingency Plan
BOD	Biological Oxygen Demand
BOP	Blow-out Preventor
BOPD	Barrels of Oil Per Day
BTEX	Benzene, toluene, ethylbenzene, and xylene
CAPP	Canadian Association of Petroleum Producers
CBA	Critical Biodiversity Area
CBD	Central Business District
CCRA	Climate Change Risk Assessment
CCS	Carbon Capture and Storage
CHIA	Cultural Heritage Impact Assessment
CI	Cumulative Impact
CITES	Convention on International Trade in Endangered Species
CMS	Conservation of Migratory Species
COLREGS	Convention dealing with safety at sea
COP	Conference of the Parties
CPUE	Catch per unit effort
CR	Critically Endangered

CSIR	Council for Scientific and Industrial Research
CTS	Cool Temperate Sardine
CUD	cumulative utilization distribution
CVI	Coastline Vulnerability Index
DAFF	Department of Agriculture, Forestry and Fisheries
DD	Data Deficient
DEA	Department of Environmental Affairs
DEAT	Department of Environmental Affairs and Tourism
DEFF	Department of Agriculture, Forestry and Fisheries
DFA	Development Facilitation Act (Act No. 67 of 1995)
DFFE	Department of Forestry, Fisheries and the Environment
DM	District Municipality
DMRE	Department of Mineral Resources and Energy
DNA	Deoxyribonucleic acid
DPME	Department of Planning, Monitoring and Evaluation
DSI	Department of Science and Innovation
DUG	Down Under Geophysical
DWH	Deep Water Horizon
EA	Environmental Authorisation
EAP	Economically Active Population
EBRD	European Bank for Reconstruction and Development
EBSA	Ecologically and Biologically Significant Area
ECA	Environment Conservation Act (Act No. 73 of 1989)
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIMS	Environmental Impact Management Services (Pty) Ltd
EMEP	European Monitoring and Evaluation Programme
EMPr	Environmental Management Programme
EN	Endangered
ENSO	El Niño Southern Oscillation
EOI	Expressions of Interest
EPA	Environmental Protection Agency
ER	Exploration Right
ERP	Emergency Response Plan
ESA	Ecological Support Area
ESAs	Ecological Support Areas
ESIA	Environmental and Social Impact Assessment

EU	European Union
EWP	Exploration Works Programme
FAMDA	Fishing and Mariculture Development Association
FAO	Food and Agricultural Organisation of the United Nations
FOLU	Forestry and Other Land Use
FPL	Food Poverty Line
FRAP	Fishery Rights Allocation Process
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GHGIP	Greenhouse Gas Improvement Programme
GHS	General Household Survey
GIS	Geographical Information System
GN	Government Notice
GPG	Good Practice Guidance
GPS	Global Positioning System
GRT	Gross Registered Tonnage
GVA	Gross Value Added
GWA	Global Wind Atlas
GWP	Global Warming Potential
HABs	Harmful Algal Blooms
HF	High Frequency
HWS	High Water Spring
I&APs	Interested and Affected Parties
IBA	Important Bird Area
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICH	Intangible Cultural Heritage
ICHC	Convention for the Safeguarding of the Intangible Cultural Heritage
IDP	Integrated Development Plan
IDZ	Industrial Development Zone
IEM	Integrated Environmental Management
IFC	International Finance Corporation
IGR	Intergovernmental Relations
IMMA	Important Marine Mammal Areas
IMO	International Maritime Organization
IOGP	International Association of Oil and Gas Producers
IOTC	Indian Ocean Tuna Commission
IP	Implementation Plan
IPCC	Intergovernmental Panel on Climate Change

IPPU	Industrial Process and Product Use
IRP	Integrated Resource Plan, 2019
ISPPC	International Sewage Pollution Prevention Certificate
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for the Conservation of Nature
IUU	Illegal, Unreported and Unregulated
IWC	International Whaling Commission
IWWMP	Integrated Waste and Water Plan
KCL	Potassium Chloride
kts	knots
KZN	Kwa-Zulu Natal
LBPL	Lower Bound Poverty Line
LC	Least Concern
LF	Low Frequency
LFPR	labour force participation rate
LM	Local Municipality
LMP	Linefish Management Protocol
LR	Loss of Resources
LSA	Later Stone Age
LWD	Logging While Drilling
MARISMA	Marine Spatial Management and Governance Programme
MARPOL	International Convention for the Prevention of Pollution from Ships, 1973/1978
MBES	Multibeam Echosounder
MEC	Member of the Executive Committee
MES	Minimum Emission Standards
MFMR	Ministry of Fisheries and Marine Resources
MFO	Mixed Function Oxygenase
MLRA	Marine Living Resources Act (Act No. 18 of 1998)
MMO	Marine Mammal Observer
MPA	Marine Protected Area
MPRDA	Minerals and Petroleum Resources Development Act (Act No. 28 of 2002)
MSC	Marine Stewardship Council
MSP	Marine Spatial Planning
Mt	Mega tonne
NAAQS	National Ambient Air Quality Standards
NADF	Non-Aqueous Drilling Fluid
NBA	National Biodiversity Assessment
NCEP	National Centres for Environmental Prediction

NDC	Nationally Determined Contributions
NDM	Namakwa District Municipality
NDP	National Development Plan
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NEMAQA	National Environmental Management: Air Quality Act (Act No. 39 of 2004), as amended
NEMBA	National Environmental Management: Biodiversity Act (Act 10 of 2004)
NEMPAA	National Environmental Management Protected Areas Act (Act No. 57 of 2003)
NGER	National Greenhouse Gas Emission Reporting Regulations
NGOs	Non-Governmental Organisations
NHC	National Heritage Council
NHRA	National Heritage Resources Act (Act No. 25 of 1999)
NMFS	National Marine Fisheries Services
NMVOC	Non-methane volatile organic compound
NOAA	National Oceanic and Atmospheric Organisation\
NOSCP	National Oil Spill Contingency Plan
NRC	National Research Council
NRF	National Research Foundation
NSO	Nitrogen-Sulfur-Oxygen
NT	Near Threatened
OCIMS	Oceans and Coastal Information Management System
OCW	Other Marine Carnivores in Water
OOC	Oil on Cutting
OSCP	Oil Spill Contingency Plan
OSRL	Oil Spill Response Limited
OWCP	Oiled Wildlife Contingency Plan
PAH	Polycyclic Aromatic Hydrocarbons
PAJA	Promotion of Administrative Justice Act (Act No. 3 of 2000)
PAM	Passive Acoustic Monitoring
PASA	Petroleum Agency of South Africa
PCAD	Population Consequences Of Acoustic Disturbance
PCW	Phocid Carnivores in Water
PF	Priority Factor
PIM	Particulate Inorganic Matter
PM	Particulate Matter
PNSF	Port Nolloth Sea Farms
POM	Particulate Organic Matter
PPP	Public Participation Process
PPR	Public Participation Report

psi	Pounds per Square Inch
PTS	Permanent Threshold Shift
PV	Photovoltaic
RAS	Re-Circulating Aquaculture System
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
RMS	Root-Mean-Square
ROV	Remote Operating Vehicle
ROVs	Remote Operated Vehicles
S&EIA	Scoping and Environmental Impact Assessment
SA	South Africa(n)
SAAELIP	South African Atmospheric Emission Licensing and Inventory Portal
SAAQIS	South African Air Quality Information System
SACW	South Atlantic Central Water
SADSTIA	South African Deepsea Trawling Industry Association
SAGERS	South African Greenhouse Gas Emissions Reporting System
SAHLLA	South African Hake Longline Association
SAHRA	South African Heritage Resources Agency
SAIAB	South African Institute for Aquatic Biodiversity
SAMPI	South African Multidimensional Poverty Index
SAMSA	South African Maritime Safety Authority
SANBI	South African National Biodiversity Institute
SANHO	South African Navy Hydrographer
SAPFIA	South African Pelagic Fishing Industry Association
SAR	Synthetic Aperture Radar
SASSI	Southern African Sustainable Seafood Initiative
SAWHCA	South African World Heritage Convention (Act No. 49 of 1999)
SAWS	South African Weather Service
SC	South Coast
SD	Standard Deviation
SDF	Spatial Development Framework
SEL	Sound Exposure Level
SI	Sirenians
SIC	Standard Industrial Classification
SMME	Small, Micro and Medium Enterprises
SOLAS	Convention ensuring that vessels comply with minimum safety standards
SOPEP	Shipboard Oil Pollution Emergency Plan
SPL	Sound Pressure Level
SSDI	Subsea dispersant injection

SSF	Small Scale Fishing
SSFP	Smallscale Fisheries Policy
SSP	Shared Socioeconomic Pathway
SSVR	Sensitivity Verification Report
STLM	Sound Transmission Loss Modelling
TAC	Total Allowable Catch
TAE	Total Allowable Effort
TBT	Tributyltin
TCP	Technical Co-operation Permit
TEEPSA	Total Energies Exploration South Africa
TH	Tangible Heritage
TMNP	Table Mountain National Park
TOC	Total Organic Carbon
TOPS	Threatened and Endangered Species
TSPM	Total Suspended Particulate Matter
TSS	Total Suspended Solids
TTS	Temporary Threshold Shift
TVOC	Total Volatile Organic Compounds
UBPL	Upper Bound Poverty Line
UCH	Underwater Cultural Heritage
UNCLOS	United Nations Conference on the Law of the Sea
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USA	United States of America
VAT	Value Added Tax
VHF	Very High Frequency
VME	Vulnerable Marine Ecosystems
VMEs	Vulnerable Marine Ecosystems
VMS	Vessel Monitoring, Control and Surveillance
VOC	Volatile Organic Compounds
VSP	Vertical Seismic Profiling
VU	Vulnerable
WACS	West Africa Cable System
WBM	Water Based Mud
WC	Western Cape
WCCP	Well Control Contingency Plan

WCG	Western Cape Government
WESSA	Wildlife and Environment Society of South Africa
WHS	World Heritage Sites
WTS	Warm Temperate Sardine
WWF	World Wide Fund for Nature

EXECUTIVE SUMMARY

Africa Oil SA Corp, Ricocure (Pty) Ltd and Azinam Limited (a wholly owned subsidiary of Eco Atlantic) (the Joint Venture (JV) Partners – hereafter jointly referred to as the Applicant) are the holders of the Block 3B/4B Exploration Right (ER) in terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002 – MPRDA), as amended. The licence block covers an area of approximately 17 581 km^2, and is situated between latitudes 31°S and 33°S on the continental shelf in water depths ranging from 300 m to 2 600 m.

The area of primary interest is in the northern part of this block, but there is also significant exploration interest in the central part of the block. As part of the process of applying for the Exploration Right, the Applicant undertook and completed a 3D reprocessing project covering 2 000 km^2, which is a subset of the 10 000 km^2 BHP/Shell 3D seismic datasets, focussed primarily on the most northern portion of Block 3B/4B. Based on analysis of the reprocessed dataset, the Applicant is now proposing to drill an exploration well in the area of primary interest in order to appraise further the hydrocarbon potential of the geological structure or "prospect", with the option to drill up to four additional wells.

A full Scoping and Environmental Impact Assessment (S&EIA) process is being undertaken to accompany the existing ER for the EIA Listing Notices listed activities applicable to the project namely: Listing Notice 2: Activity 18. The locality of the proposed exploration area is shown in Figure 15.

DESCRIPTION AND SCOPE OF THE PROPOSED ACTIVITY

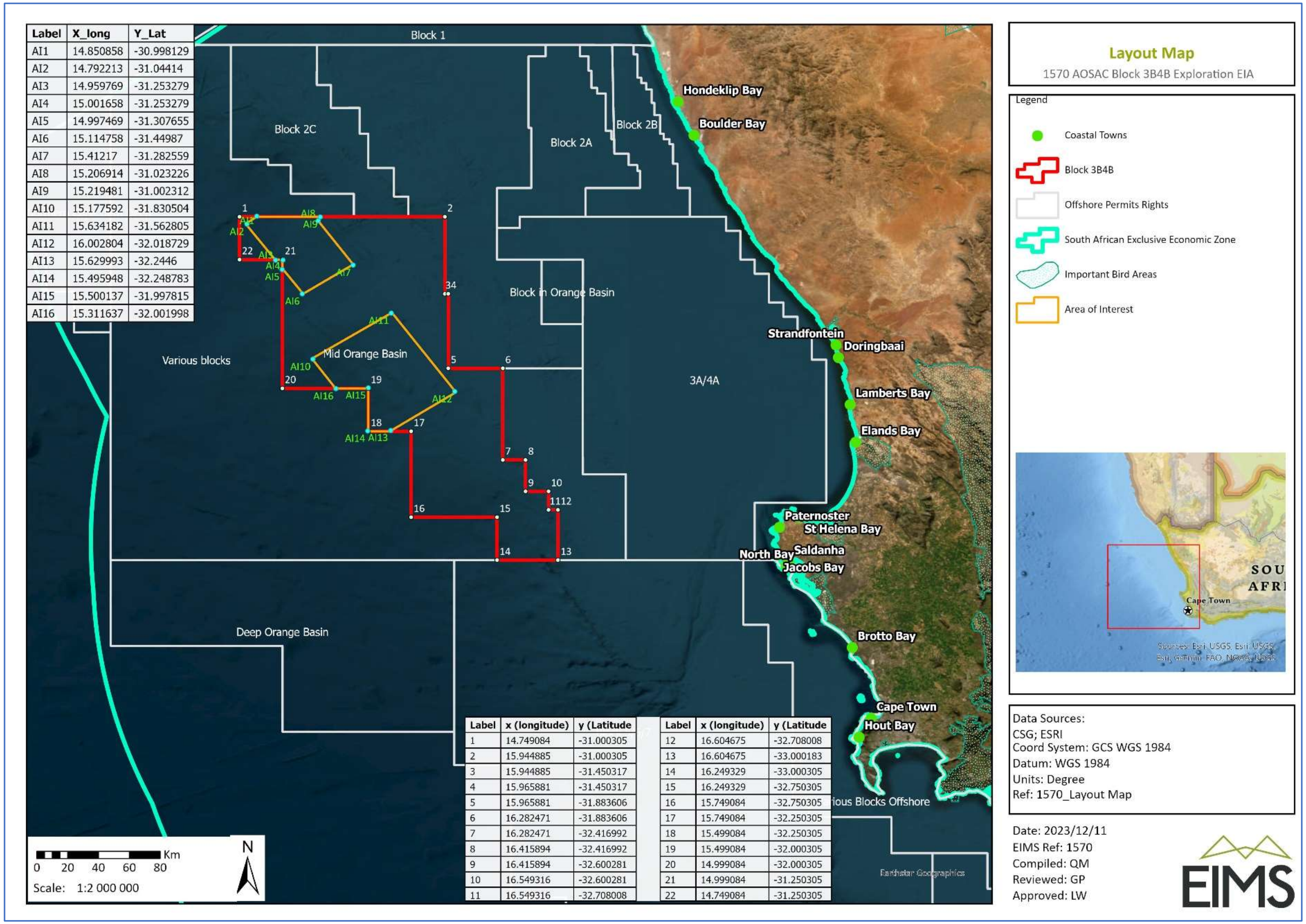
This section provides an overview of the proposed activity. A brief history of the Applicant's involvement in Block 3B/4B is provided followed by the proposed activities to be undertaken as part of this application.

PRIOR ADMINISTRATIVE DECISIONS

On 28 November 2018, the Minister granted an environmental authorisation to Ricocure (Pty) Ltd. Ricocure applied for and was granted an environmental authorisation on the basis of its final scoping report because the proposed work programme commitments were of a non-invasive nature in that it entailed only desktop studies. Accordingly, the results of the final scoping report were that there were no environmental or social impacts associated with the proposed desktop studies and therefore an environmental impact assessment and an environmental management programme was not required. The Minister granted the environmental authorisation accordingly on 28 November 2018 and on 4 December 2018 all registered I&APs were notified of this decision as is required under regulation 4(2) of the Environmental Impact Assessment Regulations, and on 27 March 2019 the Minister granted exploration right referenced 12/3/339 to Ricocure.

On 23 September 2022 the Director-General of the DMRE granted a renewal of the exploration right. As part of the renewal application, the Applicant requested a deferment of the 20% area relinquishment obligation until such time as the Marine Protected Areas within Block 3B/4B have been finalised at which stage an appropriate relinquishment would be made so as exclude such areas. The application for deferment of the relinquishment obligation was granted by the Director-General of the DMRE on 23 September 2022 as part of granting of the renewal of the exploration right.

It should be noted that the project described in this EIA Report, relates to exploration activities only. No production activities have been assessed as part of this Scoping and EIA Process – any production related activities would be subject to a separate production right application, including a new Scoping and EIA Process.



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5	15.965881	-31.883606	16	15.749084	-32.750305
6	16.282471	-31.883606	17	15.749084	-32.250305
7	16.282471	-32.416992	18	15.499084	-32.250305
8	16.415894	-32.416992	19	15.499084	-32.000305
9	16.415894	-32.600281	20	14.999084	-32.000305
10	16.549316	-32.600281	21	14.999084	-31.250305
11	16.549316	-32.708008	22	14.749084	-31.250305

Figure 1: Locality map.

PRE-DRILLING SURVEYS

Pre-drilling surveys may be undertaken prior to drilling in order to confirm baseline conditions at the drill site and to identify and delineate any seabed and sub-seabed geo-hazards that may impact the proposed exploration drilling operations. Pre-drilling surveys typically undertaken during the startup of drilling operations, may involve a combination of sonar surveys, sediment sampling, water sampling and ROV activities and may include the following:

- Sonar Surveys
- Echo Sounders
- Sub-bottom Profilers
- Seabed Sediment Coring
- Piston Coring
- Box Coring

WELL LOCATION AND DRILLING PROGRAMME

The Applicant is proposing to drill up to five exploration wells within an Area of Interest (AOI) within Block 3B/4B. The expected target drilling depth is not confirmed yet a notional well depth of up to a maximum depth of 3,750m below sea floor. Water depths in the prospect areas range from 500-1700m. It is expected that it would take approximately three to four months to complete the physical drilling and testing of each well (excluding mobilisation and demobilisation). The applicant's strategy for future drilling is that drilling could be undertaken throughout the year (i.e. not limited to a specific seasonal window period). The schedule for drilling the wells is not confirmed yet; however, the earliest anticipated date for commencement of drilling is quarter 1 to quarter 2 of 2025 and is expected to take approximately 90 days per well.

MAIN PROJECT COMPONENTS

DRILLING UNIT OPTIONS

Various types of drilling technology can be used to drill an exploration well (e.g. barges, jack-up rigs, semi-submersible drilling units (rigs) and drill-ships) depending on, inter alia, the water depth and marine operating conditions experienced at the well site. Based on the anticipated sea conditions, the Applicant is proposing to utilise a semi-submersible drilling unit or a drill-ship, both of which utilise dynamic positioning systems suitable for the harsh deep-water marine environment in the AOI. The final rig selection will be made depending upon availability and final design specifications.

A semi-submersible drilling unit (Figure 2, right) is essentially a drilling rig located on a floating structure of pontoons. When at the well location, the pontoons are partially flooded (or ballasted), with seawater, to submerge the pontoons to a pre-determined depth below the sea level where wave motion is minimised. This gives stability to the drilling vessel thereby facilitating drilling operations.

A drill-ship (Figure 2, left) is a fit for purpose built drilling vessel designed to operate in deep water conditions. The drilling “rig” is normally located towards the centre of the ship with support operations from both sides of the ship using fixed cranes. The advantages of a drill-ship over the majority of semi-submersible units are that a drill-ship has much greater storage capacity and is independently mobile, not requiring any towing and reduced requirement of support vessels.

Figure 2: Examples of drilling equipment.

SUPPORT VESSELS

The drilling unit would be supported / serviced by up to three support vessels, which would facilitate equipment, material and waste transfer between the drilling unit and onshore logistics base. A support vessel will always be on standby near the drilling unit to provide support for firefighting, oil containment / recovery, rescue in the unlikely event of an emergency and supply any additional equipment that may be required. Support vessels can also be used for medical evacuations or transfer of crew if needed.

HELICOPTERS

Transportation of personnel to and from the drilling unit would be provided by helicopter from Springbok Airport (fixed wing trip from Cape Town) using local providers. It is estimated that there may be up to four return flights per week between the drilling unit and the helicopter support base at Springbok (i.e. 17 weeks (~120 days) x 4 = 68 trips per well). The helicopters can also be used for medical evacuations from the drilling unit to shore (at day- or night-time), if required, in which case the flights are likely to be directly to Cape Town.

ONSHORE LOGISTICS BASE

The primary onshore logistics base will most likely be located at the Port of Cape Town (preferred option), but alternatively at the Port of Saldanha. The shore base would provide space for the storage of materials, consumables and equipment that would be shipped to the drilling unit and back to storage for onward international freight forwarding. The shore base would also be used for offices, waste management services, bunkering vessels, and stevedoring / customs clearance services.

MOBILISATION PHASE

The mobilisation phase will entail the required notifications and permitting, the establishment of the onshore base, appointment of local service providers, procurement and transportation of drilling equipment and materials from various ports and airports, accommodation arrangements and transit of the drilling unit and support vessels to the drilling area. The drilling unit and support vessels could sail directly to the well site from outside South African waters or from a South African port, depending on which drilling unit is selected, and where it was last used.

Core specialist and skilled personnel would arrive in South Africa onboard the drilling unit and the rest of the support personnel will be flown to Cape Town for crew change. Drilling materials, such as casings, mud components and other equipment and materials will be brought into the country on the drilling unit itself or imported via a container vessel directly to the onshore logistics base from where the support vessels will transfer it to the drilling unit. Cement and drilling chemicals will be sourced locally.

OPERATION PHASE

FINAL SITE SELECTION AND SEABED SURVEY

The selection of the specific well locations will be based on a number of factors, including further detailed analysis of the 3D seismic data and pre-drilling survey interpretation and the geological target. A Remote

Operating Vehicle (ROV) or other remote sensing equipment will typically be used to finalise the well position based on inter alia the presence of any seafloor obstacles or the presence of any sensitive features that may become evident.

WELL DRILLING OPERATION

The well will be created by drilling a hole into the seafloor with a drill bit attached to a rotating drill string, which crushes the rock into small particles, called "cuttings". After the hole is drilled, casings (sections of steel pipe), each slightly smaller in diameter, are placed in the hole and permanently cemented in place (cementing operations are described below). The hole diameter decreases with increasing depth.

The casings provide structural integrity to the newly drilled wellbore, in addition to isolating potentially dangerous high-pressure zones from each other and from the surface. With these zones safely isolated, and the formation protected by the casing, the well will be drilled deeper with a smaller drill bit, and also cased with a smaller sized casing. For the current project, it is anticipated that there will be five sets of consecutively smaller hole sizes drilled inside one another, each cemented with casing, except the last phase that will remain an open hole.

Drilling is undertaken in two stages, namely the riserless and risered drilling stages (Figure 3). The final well design depends upon factors such as planned depths, expected pore pressures and the location of the anticipated hydrocarbon-bearing formations. Several types of drilling fluids with different compositions and densities would be used for drilling operations. This may vary slightly depending on the contractor's selection and may be modified to suit operational needs.

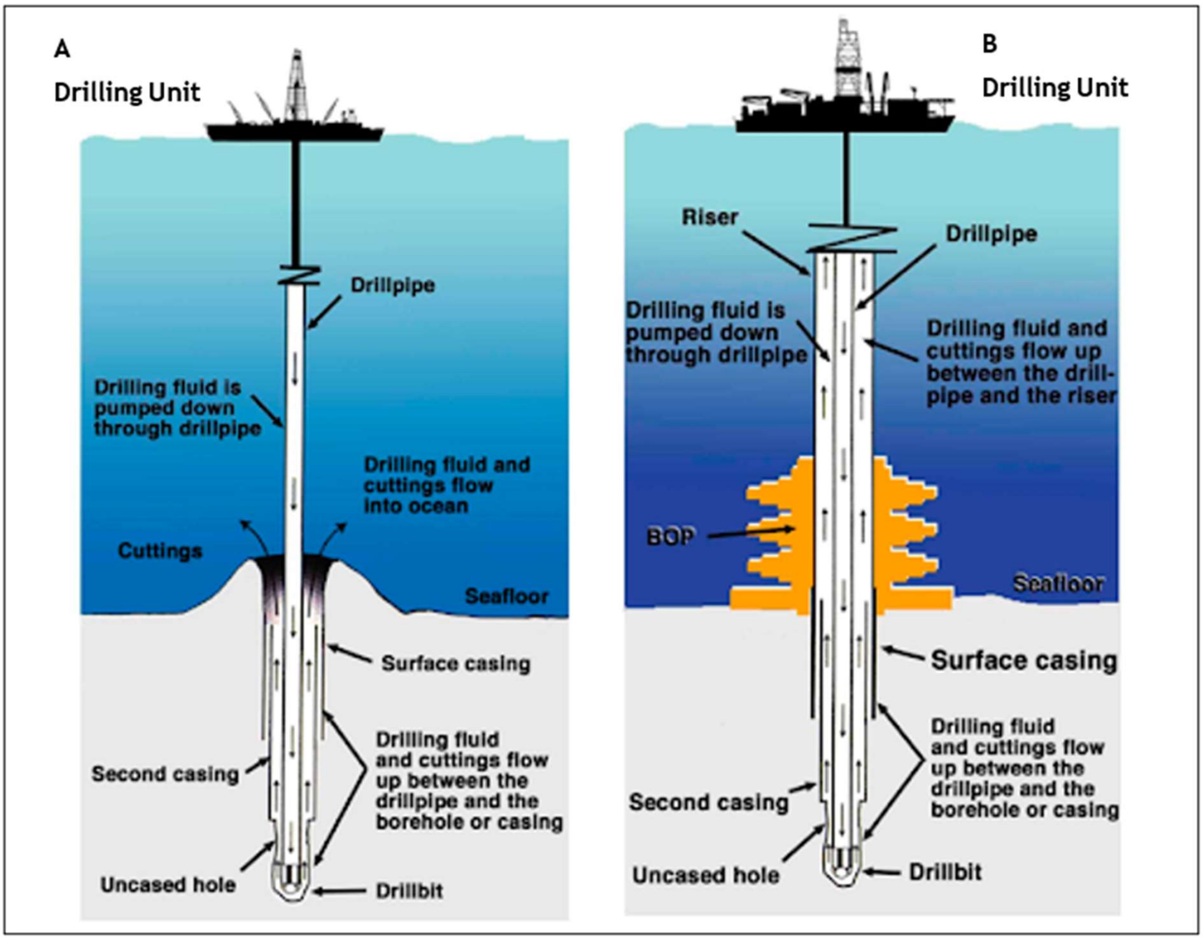


Figure 3: Drilling stages: (a) Riserless Drilling Stage; and (b) Risered Drilling Stage

INITIAL (RISERLESS) DRILLING STAGE

The process of preparing the first section of a well is referred to as "spudding." Sediments just below the seafloor are often very soft and loose, thus, to keep the well from caving in and to carry the weight of the wellhead, a 30- or 36-inch diameter structural conductor pipe is drilled, or in some cases jetted, and thereafter cemented into place or in some cases jetted.

For the proposed wells, the drill and cement option is preferred. It is usually implemented where the nature of the seafloor sediments (hard sediments) necessitate drilling. A hole of diameter 36 inches is planned, and the conductor pipe will be run into the hole and cemented into place. The cement returns exit the bottom of the conductor and travel up the annular space between the conductor and the hole with some cement being deposited on the seabed around the conductor pipe.

When the conductor pipe and low-pressure wellhead are at the correct depth, approximately 70 m deep (depending upon substrate strength), a new drilling assembly will be run inside the structural conductor pipe and the next hole section will be drilled by rotating the drill string and drill bit.

Below the conductor pipe, a hole of approximately 26 inches in diameter will be drilled to a depth of approximately 320 m below the seabed. The rotating drill string causes the drill bit to crush rock into small particles, called "cuttings". While the wellbore is being drilled, drilling fluid is pumped from the surface down through the inside of the drill pipe, the drilling fluid passes through holes in the drill bit and travels back to the seafloor through the space between the drill string and the walls of the hole, thereby removing the cuttings from the hole. At a planned depth the drilling is stopped and the bit and drill string is pulled out of the hole. A surface casing of 20 inch diameter is then placed into the hole and secured into place by pumping cement through the casing at the bottom of the hole and back up the annulus (the space between the casing and the borehole). The 20-inch casing will have a high-pressure wellhead on top; which provides the entry point to the subsurface and it is the connection point to the Blow-out Preventor (BOP).

These initial hole sections will be drilled using seawater (with viscous sweeps) and water-based mud (WBM). All cuttings and WBM from this initial drilling stage will be discharged directly onto the seafloor adjacent to the wellbore.

RISERED DRILLING STAGE

The risered drilling stage commences with the lowering of a BOP and installing it on the wellhead. The BOP is designed to seal the well and prevent any uncontrolled release of fluids from the well (a 'blow-out'). A lower marine riser package is installed on top of the BOP and the entire unit is lowered on riser joints. The riser isolates the drilling fluid and cuttings from the external environment, thereby creating a "closed loop system".

Drilling is continued by lowering the drill string through the riser, BOP and casing, and rotating the drill string. During the risered drilling stage, should the WBMs not be able to provide the necessary characteristics, a low toxicity Non-Aqueous Drilling Fluid (NADF's) will be used. The drilling fluid emerges through nozzles in the drill bit and then rises (carrying the rock cuttings with it) up the annular space between the sides of the hole to the drilling unit.

The cuttings are removed from the returned drill mud, sampled for analysis and the balance of the cuttings are discharged overboard. The rock cuttings are analysed and logged in terms of their depth and rock description, which forms the basis of building a stratigraphic record of the types of rocks penetrated. This information is used to build a stratigraphic column. Any fossils present in the rocks can be used to help establish a geologic age for the stratigraphic layers that are drilled. In instances where NADFs are used, cuttings will be treated to reduce oil content and discharged overboard.

The hole diameter decreases in steps with depth as progressively smaller diameter casings are inserted into the hole at various stages and cemented into place. The expected target drilling depth is not yet confirmed but the notional well depth is up to a maximum of approximately 3 750 m below the seafloor with a final hole diameter between of 8.5 and 12.25 inches and a casing diameter of between 7 and 9.6 inches.

CEMENTING OPERATION

Cementing is the process of pumping cement slurry through the drill pipe and / or cement stinger at the bottom of the hole and back up into the space between the casing and the borehole wall (annulus). Cement fills the annulus between the casing and the drilled hole to form an extremely strong, nearly impermeable seal, thereby permanently securing the casings in place. To separate the cement from the drilling fluid in order to minimise cement contamination a cementing plug and/or spacer fluids are used. The plug/ wiper is pushed by the drilling fluid to ensure the cement is placed outside the casing filling the annular space between the casing and the hole wall.

Cementing has four general purposes:

(i) it isolates formations, fluids and/or gases and segregates the casing seat for subsequent drilling;

(ii) it protects the casing from corrosion;

(iii) it provides structural support for the casing; and

(iv) it stabilises the formation.

To ensure effective cementing, an excess of cement is often used. Until the marine riser is set, excess cement from the first two casings emerges out of the top of the well onto the seafloor. This cement does not set and is slowly dissolved into the seawater.

Offshore drilling operations typically use Portland cements, defined as pulverised clinkers consisting of hydrated calcium silicates and usually containing one or more forms of calcium sulphate. The raw materials used are lime, silica, alumina and ferric oxide. The cement slurry used is specially designed for the exact well conditions encountered.

Additives can be used to adjust various properties in order to achieve the desired results. There are over 150 cementing additives available. The volumes of these additives generally make up only a small portion (<10%) of the overall amount of cement used for a typical well. Usually, there are three main additives used: retarders, fluid loss control agents and friction reducers. These additives are polymers generally made of organic material and are considered non-toxic.

Once the cement has set, a short section of new hole is drilled, then a pressure test is performed to ensure that the cement, casing and formation are able to withstand the higher pressures of fluids from deeper formations.

WELL LOGGING AND TESTING

Once the target depth is reached, the well would be logged and could be tested dependent on the drilling results. Well logging involves the evaluation of the physical and chemical properties of the sub-surface rocks, and their component minerals, including water, oil and gas to confirm the presence of hydrocarbons and the petrophysical characteristics of rocks. It is undertaken during the drilling operation using Wireline Logging or Logging While Drilling (LWD) to log core data from the well. Information from engineering and production logs, as well as mud logging, may also be used.

Depending on drilling results, a Vertical Seismic Profile (VSP) may be acquired. The VSP is an evaluation tool used to generate a high-resolution seismic image of the geology in the well's immediate vicinity and determine the accurate formation velocity. The VSP images are used for correlation with surface seismic images and for forward planning of the drill bit during drilling. VSP uses a small airgun array with a gun pressure of 450 per square inch (psi), which is operated from the drilling rig at a depth of between 7 m and 10 m of water. During VSP operations, four to five receivers are positioned in a section of the borehole and the airgun array is discharged approximately five times at 20 second intervals at each station. The generated sound pulses are reflected through the seabed and are recorded by the receivers to generate a profile along a 60 to 75 m section of the well. This process is repeated for different stations in the well and may take up to six hours to complete approximately 125 shots, depending on the well's depth and number of stations being profiled.

If potential hydrocarbon bearing zones are identified well or flow testing may be undertaken to determine the economic potential of the discovery before the well is either abandoned or suspended. One flow test per zone of interest would typically be undertaken for exploration or appraisal wells. Each test would take up to 7 days to complete (5 days of build-up and 2 days of flowing and flaring). For well flow-testing, hydrocarbons would be burned at the well site. A high-efficiency flare is used to maximise combustion of the hydrocarbons. Burner heads which have a high burning efficiency under a wide range of conditions will be used.

The volume of hydrocarbons (to be burned) and possible associated produced water from the reservoir which could be generated during well testing cannot be reliably predicted due to variations in gas composition, flow rates and water content. Burners are manufactured to ensure emissions are kept to a minimum. The estimated volume of hydrocarbons to be burned cannot be predicted with much accuracy because the actual test requirements can only be established after the penetration of a hydrocarbon-bearing reservoir. However, an estimated 10 000 bbl oil could be flared per test, i.e. up to 20 000 bbl over the two tests associated with an appraisal well. If produced water is generated during well testing, it will be separated from the hydrocarbons.

WELL SEALING AND PLUGGING

The purpose of well sealing and plugging is to isolate permeable and hydrocarbon bearing formations once drilling activities have been completed. Well sealing and plugging aims to restore the integrity of the formation that was penetrated by the wellbore. The principal technique applied to prevent cross flow between permeable formations is plugging of the well with cement, thus creating an impermeable barrier between two zones.

Once drilling and logging have been completed, the exploration wells will be sealed with cement plugs, tested for integrity and abandoned according to international best practices. Cement plugs will be set to isolate hydrocarbon bearing and / or permeable zones and cementing of perforated intervals (e.g. from well logging activities) will be evaluated where there is the possibility of undesirable cross flow. These cement plugs are set in stages from the bottom up. Up to three cement plugs would be installed: e.g. one each for isolation of the deep reservoir and the main reservoir; and a third as a second barrier for the main reservoir.

The integrity of cement plugs can be tested by a number of methods. The cement plugs will be tag tested (to validate plug position) and weight tested, and if achievable then a positive pressure test (to validate seal) and/or a negative pressure test will be performed. Additionally, a flow check may be performed to ensure sealing by the plug. Once the well is plugged, seawater will be displaced before disconnecting the riser and the BOP.

DEMOBILISATION PHASE

After wells have been plugged and tested for integrity, they may be abandoned with wellhead left in place on the seabed in line with industry practices worldwide. Where appropriate, 'over trawlable' protective equipment is applied to abandoned wellheads. The risk assessment criteria will consider factors such as the water depth and use of the area by other sectors (e.g., fishing). It is worth noting that irrespective of whether the wellhead and over trawlable protective equipment is retained the well bore itself will be plugged.

The operator may place monitoring equipment on wellheads for monitoring well properties and data collection to be used for future development scheme design and input.

With the exception of the over-trawlable protective equipment (if required) over abandoned wellheads and drilling discharges deposited on the seabed, no further physical remnants of the drilling operation will be left on the seafloor. A final clearance survey check will be undertaken using an ROV. The drilling unit and support vessels will demobilise from the offshore licence area and either mobilise to the following drilling location or relocate into port or a regional base for maintenance, repair or resupply.

DISCHARGES, WASTES AND EMISSIONS

The proposed drilling operations (including mobilisation and demobilisation) will result in various discharges to water, the generation of waste and emissions. All vessels will have equipment, systems and protocols in place for prevention of pollution by oil, sewage and garbage in accordance with International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL) requirements. Any oil spill related discharges would be managed by an Oil Spill Contingency Plan (OSCP). Onshore licenced waste disposal sites and waste management facilities will be identified, verified and approved prior to commencement of drilling operations.

DRILLING CUTTINGS AND MUDS

Drill cuttings, which range in size from clay to coarse gravel and reflect the types of sedimentary rocks penetrated by the drill bit, are the primary discharge during well drilling. Drilling discharges would be disposed at sea in line with accepted drilling practices as defined by the UK and Norway. This is in line with most countries (including South Africa) for early exploration development phases. The rationale for this is based on the low density of drilling operations in the vast offshore area and the high energy marine environment in these regions. As such, it is proposed to use the "offshore treatment and disposal" option for the drilling campaign. The same method was applied and approved for drilling other deep water exploration wells in Block 11B/12B (namely Brulpadda and Luiperd wells) off the South Coast of South Africa.

During the riserless drilling stage, all cuttings and Water Based Muds (WBM's) will be discharged directly onto the seafloor adjacent to the wellbore. Where NADFs are used (possibly during the risered drilling stage, if WBMs are not able to provide the necessary characteristics), these are sometimes treated onshore and disposed, treated to recover oil and disposed offshore and sometimes re-injected into wells. For the current project, in instances where NADFs are used, cuttings will be treated offshore to reduce oil content to <6% Oil on Cutting (OOC) and discharged overboard. During this drilling stage the circulated drilling fluid will be cleaned and the cuttings discharged into the sea at least 10 m below sea level. The drill cuttings will be treated to reduce their mud content using shakers and a centrifuge.

Cuttings released from the drilling unit during the risered drilling stage will be dispersed by the current and settle to the seafloor. The rate of cuttings discharge decreases with increasing well depth as the hole diameter becomes smaller and penetration rates decrease. Discharge is intermittent as actual drilling operations are not continuous while the drilling unit is on location. Discharge is 10 m below sea level and cuttings then settle on the seabed below.

Further drilling fluid will be released 1 m above the seafloor during well suspension and displacement (between drilling section 2 and 3). The expected fall and spatial extent of the deposition of discharged cuttings have been investigated in the Drilling Discharges Modelling Study (Livas 2023a), the results of which will inform the Marine Ecology and Fisheries Assessments.

CEMENT AND CEMENT ADDITIVES

Typically, cement and cement additives are not discharged during drilling. However, during the initial cementing operation (i.e. surface casing), excess cement emerges out of the top of the well and onto the seafloor in order to ensure that the conductor pipe is cemented all the way to the seafloor. During this operation a maximum of 150% of the required cement volume may be pumped into the space between the casing and the borehole wall (annulus, this is dependent on the hole size in the first section). In the worst-case scenario where the hole is very in gauge, approximately 50 m^3 of cement could be discharged onto the seafloor.

BLOW-OUT PREVENTER HYDRAULIC FLUID

As part of routine opening and closing operations the subsea BOP stack elements will vent some hydraulic fluid into the sea at the seafloor. It is anticipated that between approximately 500 and 1 000 litres of oil-based hydraulic emulsion fluid could be vented per month during the drilling of a well. BOP fluids are completely biodegraded in seawater within 28 days.

PRODUCED WATER

If water from the reservoir arises during well flow testing, these would be separated from the oily components and treated onboard to reduce the remaining hydrocarbons from these produced waters. The hydrocarbon component will be burned off via the flare booms, while the water is temporarily collected in a slop tank. The water is then either directed to:

- a settling tank prior to transfer to support vessel for onshore treatment and disposal; or
- a dedicated treatment unit on the rig where, after treatment, it is either:
    - discharged overboard if hydrocarbon content is < 30 mg/l; or

- subject to a second treatment or directed to tank prior to transfer to support vessel for onshore treatment and disposal if hydrocarbon content is > 30 mg/l.

VESSEL MACHINERY SPACES (BILGE WATER)

Vessels will occasionally discharge treated bilge water. Bilge water is drainage water that collects in a ship's bilge space (the bilge is the lowest compartment on a ship, below the waterline, where the two sides meet at the keel). In accordance with MARPOL Annex I, bilge water will be retained on board until it can be discharged to an approved reception facility, unless it is treated by an approved oily water separator to <15 ppm oil content and monitored before discharge. The residue from the onboard oil/water separator will be treated / disposed of onshore at a licenced hazardous landfill site.

DECK DRAINAGE

Deck drainage consists of liquid waste resulting from rainfall, deck and equipment washing (using water and a water-based detergent). Deck drainage will be variable depending on the vessel characteristics, deck activities and rainfall amounts.

In areas of the drilling unit where oil contamination of rainwater is more likely (i.e. the rig floor), drainage is routed to an oil / water separator for treatment before discharge in accordance with MARPOL Annex I (i.e. 15 ppm oil and grease maximum). There will be no discharge of free oil that could cause either a film, sheen or discolouration of the surface water or a sludge or emulsion to be deposited below the water's surface. Only non-oily water (i.e. <15 ppm oil and grease, maximum instantaneous oil discharge monitor reading) will be discharged overboard. If separation facilities are not available (due to overload or maintenance) the drainage water will be retained on board until it can be discharged to an approved reception facility. The oily residue from the onboard oil / water separator will be treated / disposed of onshore at an approved hazardous landfill site.

BRINE GENERATED FROM ONBOARD DESALINATION PLANT

The waste stream from the desalination plant is brine (concentrated salt), which is produced in the reverse osmosis process. The brine stream contains high concentration of salts and other concentrated impurities that may be found in seawater. Water chemical agents will not be used in the treatment of seawater and therefore the brine reject portion would be in a natural concentrated state. Based on previous well drilling operations, freshwater production amounts to approximately 40 m^3/day, which will result in approximately 35 g salt for each litre water produced (i.e. 1 400 kg salt/brine per day).

SEWAGE AND GREY WATER

Discharges of sewage (or black water) and grey water (i.e. wastewater from the kitchen, washing and laundry activities and non-oily water used for cleaning) will occur from vessels intermittently throughout the project and will vary according to the number of persons on board, estimated at an average of 200 litres per person. All sewage discharges will comply with MARPOL Annex IV. Sewage and grey water will be treated using a marine sanitation device.

FOOD (GALLEY) WASTES

The disposal into the sea of food waste is permitted, in terms of MARPOL Annex V, when it has been ground to particle sizes smaller than 25 mm and the vessel is en route more than 3 nautical miles (approximately 5.5 km) from land. Disposal overboard without macerating is permitted for moving vessels greater than 12 nautical miles (approximately 22 km) from the coast. On the drilling unit, all food waste will be macerated to particles sizes <25 mm and the daily discharge is typically about seven tonnes per month.

BALLAST WATER

Ballast water is used during routine operations to maintain safe operating conditions onboard a ship by reducing stress on the hull, providing stability, improving propulsion and manoeuvrability, and compensating for weight lost due to fuel and water consumption.

Ballast water is discharged subject to the requirements of the 2004 International Convention for the Control and Management of Ships' Ballast Water and Sediments. The Convention stipulates that all ships are required to implement a Ballast Water Management Plan and that all ships using ballast water exchange will do so at least 200 nautical miles (nm) (± 370 km) from nearest land in waters of at least 200 m deep when arriving from a different marine region. Where this is not feasible, the exchange should be as far from the nearest land as possible, and in all cases a minimum of 50 nm (±93 km) from the nearest land and preferably in water at least 200 m in depth. Project vessels will be required to comply with this requirement.

DETERGENTS

Detergents used for washing exposed marine deck spaces will be discharged overboard. Water-based detergents are low in toxicity and are preferred for use. Preferentially biodegradable detergents should be used. Detergents used on work deck space will be collected with the deck drainage and treated as described under deck drainage above.

NOISE EMISSIONS

The key sources generating underwater noise are vessel propellers (and positioning thrusters), with a contribution from the pontoons (e.g. noise originating from within the pontoons and on-deck machinery), support vessels and from drilling activities. This is expected to result in highly variable sound levels, being dependent on the operational mode of each vessel. The pre-drilling sonar surveys and VSP survey would generate a short-term noise, sonar acquisition takes 1.5 to 3 days to acquire with short bursts of the sound source and the VSP onboard between 4 to 6 hours dependent on the programme to complete, respectively.

The main sources of noise from these activities are as follows:

- Pre-drilling sonar surveys;
- Drilling noise;
- Propeller and positioning thrusters;
- Machinery noise;
- Well logging noise (VSP);
- Well testing noise;
- Equipment in water; and
- Helicopter noise.

The extent of project-related noise above the background noise level may vary considerably depending on the specific vessels used and the number of support vessels operating. It will also depend on the variation in the background noise level with weather and with the proximity of other vessel traffic (not associated with the project).

An Underwater Noise Modelling Study has been undertaken to determine the underwater noise transmission loss with distance from well site and compare results with threshold values for marine fauna to determine zones of impact. These modelling results were used in the assessment of impacts on marine fauna.

LIGHT EMISSIONS

Operational lighting will be required on the drilling unit and support vessels for safe operations and navigation purposes during the hours of darkness. Where feasible, operational lights will be shielded in such a way as to minimise their spill out to sea.

HEAT EMISSIONS

Flaring during well testing generates heat emissions from the combustion of hydrocarbons at the burner head.

UNPLANNED EVENTS – WELL BLOWOUT

The greatest environmental threat from offshore drilling operations is the risk of a major release of crude oil occurring either from a blow-out or loss of well control. A blow-out is the uncontrolled release of crude oil and/or natural gas from a well after pressure control systems have failed.

Oil released in the marine environment would have an immediate detrimental effect on water quality, with the toxic effects potentially resulting in mortality (e.g. suffocation and poisoning) of marine fauna or affecting faunal health (e.g. respiratory damage). If the spill reaches the coast, it can result in the smothering of sensitive coastal habitats (modelling indicates that in the event of an accidental release that the oil plume would dissipate a significant distance from the shore and would not reach the shore).

In the order of 47 wells have been drilled on the West Coast offshore environment to date and no well blow-outs have been recorded. Global data maintained by Lloyds Register indicates that frequency of a blow-out from normal exploration wells is in the order of 1.43×10^{-4} (0.000143) per well drilled. While the probability of a major spill happening is thus extremely small, the impact nonetheless needs to be considered as it could have devastating effects on the marine environment. Following the Deep Water Horizon (DWH) incident, however, Muehlenbachs et al. (2013) undertook an empirical analysis of performance indicators on offshore platforms in the Gulf of Mexico and identified that water depth played a statistically significant role in determining the probability of an incident.

In order to address the management of the risks associated with the highly unlikely scenario of a well blowout, the following project control measures will be required for implementation during the exploration activities in order to prevent or respond to an unplanned well blowout event:

- Compliance with COLREGS (the Convention dealing with safety at sea, particularly to reduce the risk of collisions at sea) and SOLAS (the Convention ensuring that vessels comply with minimum safety standards).
- A 500 m safety zones will be enforced around the drilling unit within which fishing and other vessels would be excluded.
- Regulation 37 of MARPOL Annex I will be applied, which requires that all ships of 400 gross tonnage and above carry an approved Shipboard Oil Pollution Emergency Plan (SOPEP). The purpose of a SOPEP is to assist personnel in dealing with unexpected discharge of oil, to set in motion the necessary actions to stop or minimise the discharge, and to mitigate its effects on the marine environment.
- As standard practice, an Emergency Response Plan (ERP) and an Oil Spill Contingency Plan (OSCP) will be prepared and available at all times during the drilling operation.
- Project vessels will be equipped with appropriate spill containment and clean-up equipment, e.g. booms, dispersants and absorbent materials. All relevant vessel crews will be trained in spill clean-up equipment use and routine spill clean-up exercises.
- The primary safeguard against a blow-out is the column of drilling fluid in the well, which exerts hydrostatic pressure on the wellbore. Under normal drilling conditions, this pressure should balance or exceed the natural rock formation pressure to help prevent an influx of gas or other formation fluids. As the formation pressures increase, the density of the drilling fluid is increased to help maintain a safe margin and prevent "blow-outs". However, if the density of the fluid becomes too heavy, the formation can break down. If drilling fluid is lost in the resultant fractures, a reduction of hydrostatic pressure occurs. Maintaining the appropriate fluid density for the wellbore pressure regime is therefore critical to safety and wellbore stability. Abnormal formation pressures are detected by primary well control equipment (pit level indicators, return mud-flow indicators and return mud gas detectors) on the drill unit. The drilling fluid is also tested frequently during drilling operations and its composition can be adjusted to account for changing downhole conditions. The likelihood of a blow-out is further minimised by installation of a blow-out preventer (BOP) on the wellhead at the start of the risered drilling stage. The BOP is a secondary control system, which contain a stack of independently-operated

cut-off mechanisms, to ensure redundancy in case of failure. The BOP is designed to close in the well to prevent the uncontrolled flow of hydrocarbons from the reservoir. A blow-out occurs in the highly unlikely event of these pressure control systems failing.

- If the BOP does not successfully shut off the flow from the well, the drilling rig would disconnect and move away from the well site while crews mobilise a capping system. The capping system would be lowered into place from its support barge and connected to the top of the BOP to stop the flow of oil or gas.
- Information provided by the Applicant for the Oil Spill Modelling Study has considered both condensate and crude oil as potential fluid types. In addition, the scenarios modelled the possibility of high blow rates representing what is considered well beyond expectations and representative of a 'worst case' scenario. Two release points were also modelled (i.e. a 'worst-case' of the potential five well locations identified); one in the northern and one in the central areas of interest (AOI).
- Oil Spill Response Limited (OSRL), the global oil spill response co-operative funded by more than 160 oil and energy companies, has a base in Saldanha Bay and another base in Aberdeen, which houses well capping equipment designed to shut-in an uncontrolled subsea well. The Saldanha based capping stack is available to oil and gas companies across the industry and provides for swift subsea incident response around the world. The equipment is maintained ready for immediate mobilisation and onward transportation by sea and/or air in the event of an incident. The operator must be a member of OSRL, at the point of commencing the project. This would significantly reduce the spill period. All of the wells must be designed to allow for capping.
- Other project controls include the preparation and implementation of plans that would include aspects related to Shipboard Oil Pollution Emergencies, Oil Spill Contingency and Well Control Contingency.

POLICY AND LEGISLATIVE CONTEXT

An overview of the governing legislation identified which relates to the proposed project is provided below:

- Constitution of the Republic of South Africa;
- The Mineral and Petroleum Resources Development Act;
- The National Environmental Management Act;
- The National Heritage Resources Act;
- National Environmental Management: Protected Areas Act;
- National Environmental Management: Air Quality Act:
    - National Ambient Air Quality Standards for Criteria Pollutants;
    - Inhalation Health Criteria for Non-criteria Pollutants; and
    - Atmospheric Emission Licence and other Authorisations.
- National Environmental Management: Integrated Coastal Management Act;
- Additional South African Legislation;
- National Policy and Planning Context:
    - Integrated Resource Plan 2019;
    - National Development Plan 2030;
    - White Paper on the Energy Policy of the Republic of South Africa (1998);
    - National Gas Infrastructure Plan (2005);
    - Paris Agreement – United Nations Framework Convention on Climate Change;

- National Climate Change Response White Paper;
  - South African National Climate Change Response Policy;
  - Nationally Determined Contribution;
  - National GHG Emissions Inventory;
  - GHG Emission Inventory for the Energy Sector;
  - GHG Monitoring and Reporting; and
  - Marine Spatial Planning Framework (2017).
- Provincial Policy and Planning Context:
  - Northern Cape Strategic Plan 2020-2035.
- Municipal Policy and Planning Context:
  - Namakwa District Municipality;
  - Richtersveld Local Municipality;
  - Nama Khoi Local Municipality;
  - Kamiesberg Local Municipality;
  - West Coast District Municipality;
  - Matzikama Local Municipality;
  - Cederberg Local Municipality;
  - Bergrivier Local Municipality;
  - Saldanha Bay Local Municipality; and
  - Swartland Local Municipality.
  - City of Cape Town Metropolitan Municipality
- International Legislation:
  - United Nations Convention on the Law of the Sea;
  - Convention for the Safeguarding of the Intangible Cultural Heritage;
  - International Regulations for Preventing Collisions at Sea; and
  - International Marine Conventions.

NEED AND DESIRABILITY OF THE PROPOSED ACTIVITY

South Africa's crude oil demand has increased steadily to over 600 000 barrels / day. Most of the crude oil consumed in South Africa is imported, as local oil and gas production is low, contributing towards a current account deficit. Producing more oil and gas within South Africa is expected to contribute towards a lower current account deficit, more stable prices, create new jobs and industries in the upstream and downstream oil and gas industry supply chain and sectors, and counter volatility related to instabilities in major oil producing regions. The services sector in the oil and gas industry is not mature in the upstream side and this could provide opportunities to invest in the sector.

The proposed project aims to identify oil and gas resources and does not include any production activities. The identification and assessment of impacts is therefore limited to the activities associated with the exploration for oil and gas.

According to the Integrated Resource Plan 2019 (IRP 2019), which is the country's electricity planning strategy, there is a need for gas in South Africa's energy mix in the future. This need is driven in part by the expectation that natural gas may act as a transition fuel, and assist in bridging the countries current power shortages, whilst other lower net carbon and greener technologies mature. According to the National DFFE, targets have been determined to achieve South Africa's national GHG Emissions commitments. These targets consider the likely GHG emissions outcome of the implementation of current South African policies including the IRP. The proposed exploration activities may be used to determine whether a viable gas or oil resource is present. The outcomes of this could provide insight into potential alternative supply options to inform the future energy planning and policy for South Africa. Considering this, and other new information on supply options, as well as the rapid technological advancements in the energy sector (and specifically in the low carbon alternatives), it is crucial that the energy planning for South Africa is continually reassessed and revised to ensure that the most suitable and sustainable strategy is defined. The 2021 NDC's are aligned with the IRP 2019. The GHG emissions and associated climate change impacts associated with the exploration activities have been assessed as part of the Scoping and EIA Process (refer to Section 9 of this report).

Considering that the life-cycle of the project would be limited to the exploration activities only (i.e. identification of resources only – and does not necessarily imply actual further production of oil and gas resources), there are limited GHG emissions directly related to the proposed activity and a very low climate change vulnerability risks, mainly since the project will be of limited duration.

The needs and desirability analysis component of the "Guideline on need and desirability in terms of the EIA Regulations (Notice 819 of 2014)" includes, but is not limited to, describing the linkages and dependencies between human well-being, livelihoods and ecosystem services applicable to the area in question, and how the proposed development's ecological impacts will result in socio-economic impacts (e.g. on livelihoods, loss of heritage site, opportunity costs, etc.).

PROJECT ALTERNATIVES

It should be noted that the exploration for oil and gas within the Block 3B/4B offshore area will be undertaken by the drilling of exploration wells focused mostly on north and central sections of the licence block (i.e. the Areas of Interest – AOI).

LOCATION ALTERNATIVES

It should be noted that the exploration for oil and gas within the Block 3B/4B offshore area will be undertaken by the drilling of exploration wells focused mostly on north and central of the exploration area. The sites which have been identified as AOI are located in the north where three (3) to four (4) exploration wells are currently proposed and at the central area where one (1) to two (2) wells are currently proposed within the 3B/4B exploration area. It is understood that prospects and leads outlines were depicted for the areas where drilling of exploration wells is proposed. Further to this, more mature prospects were depicted in the northern section of the block where the 3D volume data was reprocessed which now need to be further explored. As such no further location alternatives will be assessed in the study.

LAYOUT ALTERNATIVES

Though Block 3B/4B is in close proximity to the Child's Bank and Benguela Muds MPAs, the proposed AOIs which, should they be authorised, can only occur within Block 3B/4B and do not overlap with any proclaimed MPAs as the AOI already avoids these areas. Block 3B/4B overlaps to some extent with the Child's Bank Ecologically and Biologically Significant Area (EBSA). However, the proposed AOIs avoid all EBSAs. For oil and gas exploration activities, although vessels are permitted to sail through these areas, no invasive exploration activities are permitted in any proclaimed and Gazetted MPA. Under the currently issued exploration permit, no invasive exploration activities such as the proposed exploration drilling will take place in any proclaimed MPAs.

The AOIs do, however, overlap with some Critical Biodiversity Areas (CBA), and as such, the option of avoiding these CBAs within the AOI was assessed as a layout alternative during the EIA Phase. No other environmental sensitivities which require further avoidance were identified in the proposed AOI, and as such no further layout alternatives were considered feasible for further consideration. Please refer to Section 11.2 for further details on the preferred layout alternative recommended based on the impact assessment.

TECHNOLOGY ALTERNATIVES

Various types of drilling technology and equipment can be used to drill an exploration well (e.g. barges, jack-up rigs, semi-submersible drilling units (rigs) and drill-ships) depending on, inter alia, the water depth and marine operating conditions experienced at the well site. Based on the anticipated sea conditions and the depths, the Applicants are proposing to utilise a semi-submersible drilling unit or a drillship, both with dynamic positioning system suitable for the deep-water harsh marine environment. The final rig selection will be made depending upon availability and final well design specifications.

- A semi-submersible drilling unit is essentially a drilling rig located on a floating structure of pontoons. When at the well location, the pontoons are partially flooded (or ballasted), with seawater, to submerge the pontoons to a pre-determined depth below the sea level where wave motion is minimised. This gives stability to the drilling vessel thereby facilitating drilling operations.
- A drillship is a fit for purpose-built drilling vessel designed to operate in deep water conditions. The drilling "derrick" is normally located towards the centre of the ship with support operations from both sides of the ship using fixed cranes. The advantages of a drillship over the majority of semi-submersible units are that a drillship has much greater storage capacity and is independently mobile, not requiring any towing and reduced requirement of support vessels.

The activities proposed in this application require specialised technology and skills. The final technology selection will be made based on equipment availability and final design criteria/selection.

SCHEDULING ALTERNATIVES

Based on the findings of the Drill Cutting and Oil Spill Modelling, Acoustics, Marine Ecology and Fisheries recommendations, alternatives scheduling alternatives were considered as part of the environmental impact assessment in order to avoid/ minimise the impacts associated with exploration activities. These include considerations on:

- Avoid/ minimise impacts/ likelihood of well-blowout or other pollution events;
- Avoid sensitive areas and periods for some marine fauna: e.g. movement of migratory animals and feeding grounds; and
- Avoid periods of peak fishing activity.

NO GO ALTERNATIVE

The no go alternative would imply that no exploration activities are undertaken. As a result, the opportunity to identify potential oil and gas resources within the Block 3B/4B and proposed AOI would not exist. This will negate the potential negative and positive impacts associated with the proposed exploration activities. A no-go alternative assessment was undertaken during the EIA Phase.

STAKEHOLDER ENGAGEMENT

The Public Participation Process (PPP) is a requirement of several pieces of South African legislation and aims to ensure that all relevant Interested and Affected Parties (I&APs) are consulted, involved and their comments are considered, and a record included in the reports submitted to the Authorities. The process ensures that all stakeholders are provided this opportunity as part of a transparent process which allows for a robust and comprehensive environmental study. The PPP for the proposed project needs to be managed sensitively and according to best practises to ensure and promote:

- Compliance with international best practice options;
- Compliance with national legislation;
- Establishment and management of relationships with key stakeholder groups; and
- Involvement and participation in the environmental study and authorisation/approval process.

As such, the purpose of the PPP and stakeholder engagement process is to:

- Introduce the proposed project;
- Explain the authorisations required;
- Explain the environmental studies already completed and yet to be undertaken (where applicable);
- Solicit and record any issues, concerns, suggestions, and objections to the project;
- Provide opportunity for input and gathering of local knowledge;
- Establish and formalise lines of communication between the Interested and Affected Parties (I&APs) and the project team;
- Identify all significant issues for the project; and
- Identify possible mitigation measures or environmental management plans to minimise and/or prevent negative environmental impacts and maximize and/or promote positive environmental impacts associated with the project.

GENERAL APPROACH TO PUBLIC PARTICIPATION

The PPP for the proposed project has been undertaken in accordance with the requirements of the NEMA EIA Regulations (2014), and in line with the principles of IEM. IEM implies an open and transparent participatory process, whereby stakeholders and other I&APs are afforded an opportunity to comment on the project and have their views considered and included as part of project planning. The details of the approach and processes undertaken for public participation are outlined in the Public Participation Report (PPR), refer to Appendix 2. Table 1 provides a summary of the opportunities provided to I&APs for participation in the public participation process to date.

Table 1: Opportunities Provided for Public Participation

Action	Description	Publication/Place	Date
Initial Call to Register	Notification of landowners, occupiers, and other key I&APs.	Affected landowners and key I&APs were notified via email, fax, and/or post.	12 June 2023
	Placement of site notices.	One hundred and fifty (150) A1 Correx site notices (in English, Afrikaans and isiXhosa) placed at 150 locations along the West Coast.	12-17 June 2023
	Newspaper advertisement	Notices were placed in five (5) newspapers.	14-16 June 2023
	Radio Adverts	Four (4) radio adverts were aired.	12-16 June 2023
DSR Availability	Placement of DSR for Public Review	DSR placed at various libraries and locations along the west coast.	19 July – 21 August 2023
	Public Meetings and Focus Group Discussions	Several public meetings and focus group discussions held in key communities along the west coast.	31 July – 10 August 2023

Action	Description	Publication/Place	Date
DEIAR Availability	Placement of DEIAR for Public Review	DEIAR placed at various libraries and locations along the west coast.	8 January 2024
	Public Open Days	Several public open days held in key communities along the west coast.	22 January – 1 February 2024

RECORD OF ISSUES RAISED

The comments presented below are those that have been received and addressed from 15 June 2023 to date and will be updated during and following the public participation period. A high-level summary of the types of comments raised to date are presented below:

- I&AP registrations and de-registrations;
- Request for clarity regarding terminology such as the reprocessing of data;
- Request for clarity on the nature of the project;
- Request to be informed about updates of the project;
- Request for files related to the location and situation of the project site;
- Provision of information related to SAHRIS application procedure for the project;
- Acknowledgement of receipt of notifications from local municipality;
- Request for clarity on the geographical extent of initial notification;
- Enquiry on the status of the application;
- Current employment opportunities enquiry;
- Questions around the risks of a blow-out;
- Comment on opinion on Afrikaans translations of documentation;
- Mitigation measures currently in place to deal with spillage risks;
- Questions about the duration of the drilling activity;
- Comments on relating to Scoping Report;
    - Drilling operations (including fluids and cuttings discharge) damage the seafloor;
    - Pollution from drilling operations affecting health of marine life;
    - Potential disturbance to ecosystems;
    - Impacts on spawning of fish species as well as other marine species;
    - Potential of significant adverse residual environmental effect on marine biota populations;
    - Potential impacts on species should a species be displaced;
- Concerns around Increase in underwater noise levels;
- Concern around marine fauna behavioural changes;
- Concern around impact on fishing sector;
- Concern around cultural heritage;

- Number of concerns related to the construction and operation phases of the project:
    - Increased levels of *E. coli* in the water due to the presence of drilling rig and crew;
    - Fish aggregation and increased predator – prey interactions;
    - Light emissions in marine environment;
    - Potential effects of project contributing to the disorientation and mortality of seabirds;
    - Attraction of plankton through project activities and increased risk to fish, turtles and cetaceans;
- Comments related to Climate Change and Just Energy transition:
    - Reasons requested for the need for oil and gas exploration despite the Just transition and move away from carbon emissions;
    - Commitment of applicant to Just transition questioned;
    - Potential bearing of the project on Climate Change;
    - Future commitment and reassurance of applicant to the Just energy transition;
    - Questions around the potential impacts of oil and gas production should a discovery be made;
- Question on contributions of applicant to skills development;
- Future employment opportunities related to activities of the project;
- Enquiry on future contributions to be made by applicant;
- Effects of project activities of fisheries and fishermen;
- Effect of project activities on economic wellbeing of coastal communities;
- The accuracy of the data and findings of scoping report questioned;
- The reliability and relevance of any older data used as part of the scoping report;
- The impact of the project on snoek (*Thyrsites atun*) and snoek fishing as a seasonal and sensitive activity;
- Comment on the potential of the project to affect beaches and tourism;
- Effect of activities on livelihood of communities;
- New or novel approaches to the EIA process this project engages with;
- Questions on the extent of public participation to be employed throughout the process;
- Question on the extent of community engagement during the public participation process;
- Enquiry on previous information used to select potential drilling spots;
- Block 3B/4B's in relation to protected biodiversity areas;
- Potential of not proceeding with the project to avoid risks involved altogether; and
- Comment from SAHRIS relating to further heritage studies of the affected area.

All comments and/or queries received to date are included in the PPR in Appendix 2.

ENVIRONMENTAL ATTRIBUTES AND BASELINE ENVIRONMENT

MARINE ECOLOGY

Block 3B/4B falls into the Atlantic Offshore Bioregion. Although there is a lack of knowledge of the community structure and diversity of benthic macrofauna off the continental shelf edge, the South Atlantic unclassified slopes and unclassified abyssal unconsolidated habitat types have been rated as 'least threatened', reflecting the great extent of these habitats in the South African Exclusive Economic Zone (EEZ). Two geological features of note in the vicinity of the proposed area of interest are Child's Bank, situated ~50 km due east of the area of interest for exploration drilling at about 31°S, and Tripp Seamount situated at about 29°40'S, ~150 km north-northwest of the area of interest. Features such as banks and seamounts often host deepwater corals and boast an enrichment of bottom-associated communities relative to the otherwise low-profile homogenous seabed habitats.

Due to its offshore location, plankton abundance is expected to be low, with the major fish spawning and migration routes occurring further inshore on the shelf. The dominant fish in the area would include the migratory large pelagic species such as tunas, billfish and pelagic sharks. Seabirds will be dominated by the pelagic species such as albatross, petrels and shearwaters. Migrating turtles in the area would include the leatherback and loggerhead turtles. Marine mammals likely to occur offshore include a variety of baleen whales including humpbacks, Antarctic minke, fin and sei whales. Toothed whales will include sperm and killer whales, as well as a variety of beaked whales and dolphins. The licence area overlaps with the Childs Bank MPA and the Childs Bank and Shelf Edge EBSA. The Area of Interest for drilling, however, specifically avoids these areas.

The highest sensitivities to the proposed drilling activities are:

- Childs Bank, which is located ~50 km East of the Area of Interest block, that potentially supports vulnerable, long-lived benthic invertebrate species;
    - Numerous vulnerable and endangered pelagic shark species;
    - Leatherback turtles that migrate through the area;
    - Sperm whales, which occur in the area year-round;
    - Humpback and Fin whales, which migrate through the area between May and December; and
- The Orange Shelf Edge MPA, and the Orange Seamount and Canyon Complex EBSA.

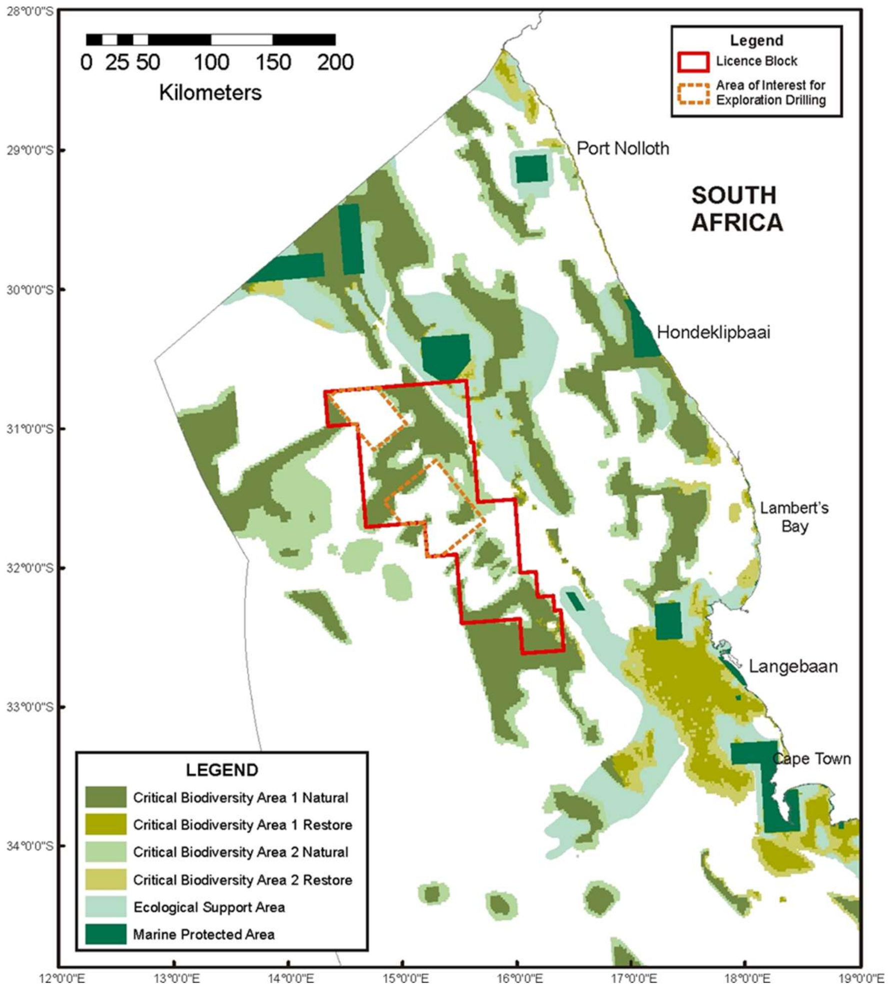


Figure 4: Block 3B/4B (red polygon) and the AOI for exploration drilling (orange dashed polygons) in relation to Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) (Version 1.2) (Harris et al. 2022).

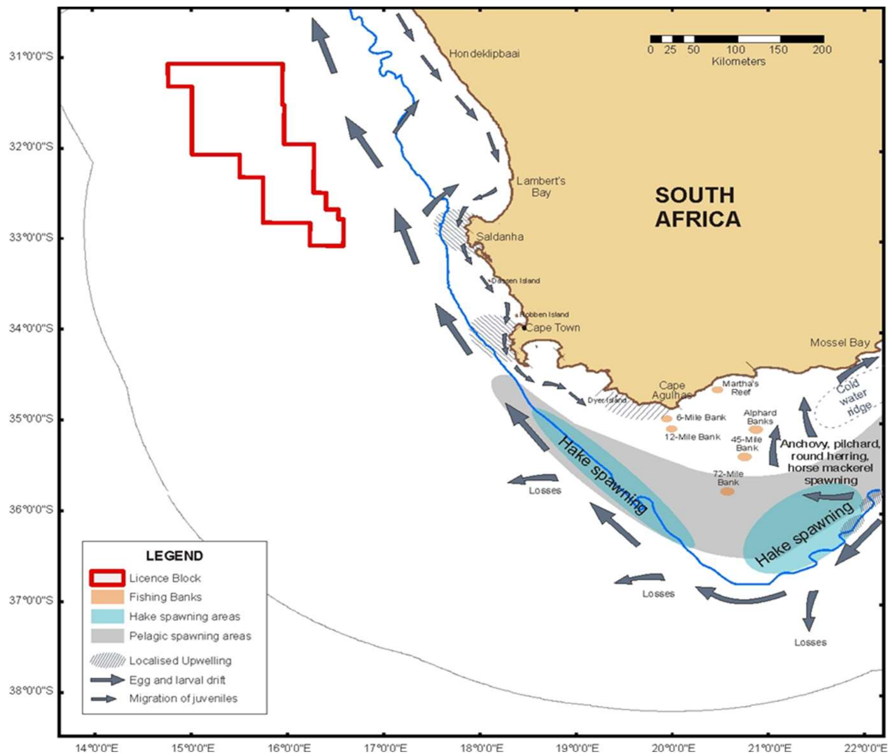


Figure 5: Block 3B/4B (red polygon) in relation to major spawning, recruitment and nursery areas in the southern Benguela region (adapted from Crawford et al. 1987; Hutchings 1994; Hutchings et al. 2002).

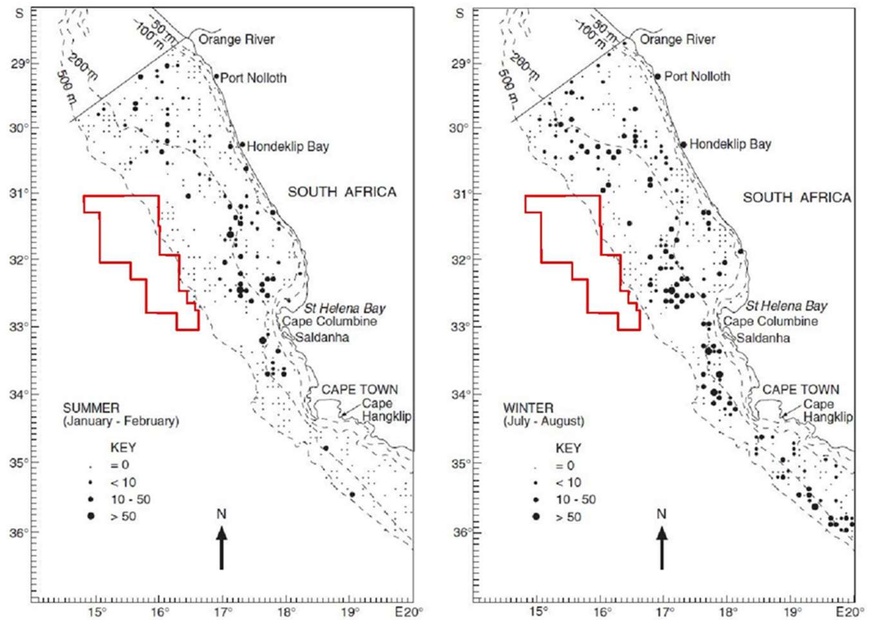


Figure 6: Mean number of snoek per demersal trawl per grid block (5 × 5 Nm) by season for (A) the west coast (July 1985–Jan 1991) and (B) the south coast in relation to Block 3B/4B (red polygon) (Pisces, 2023).

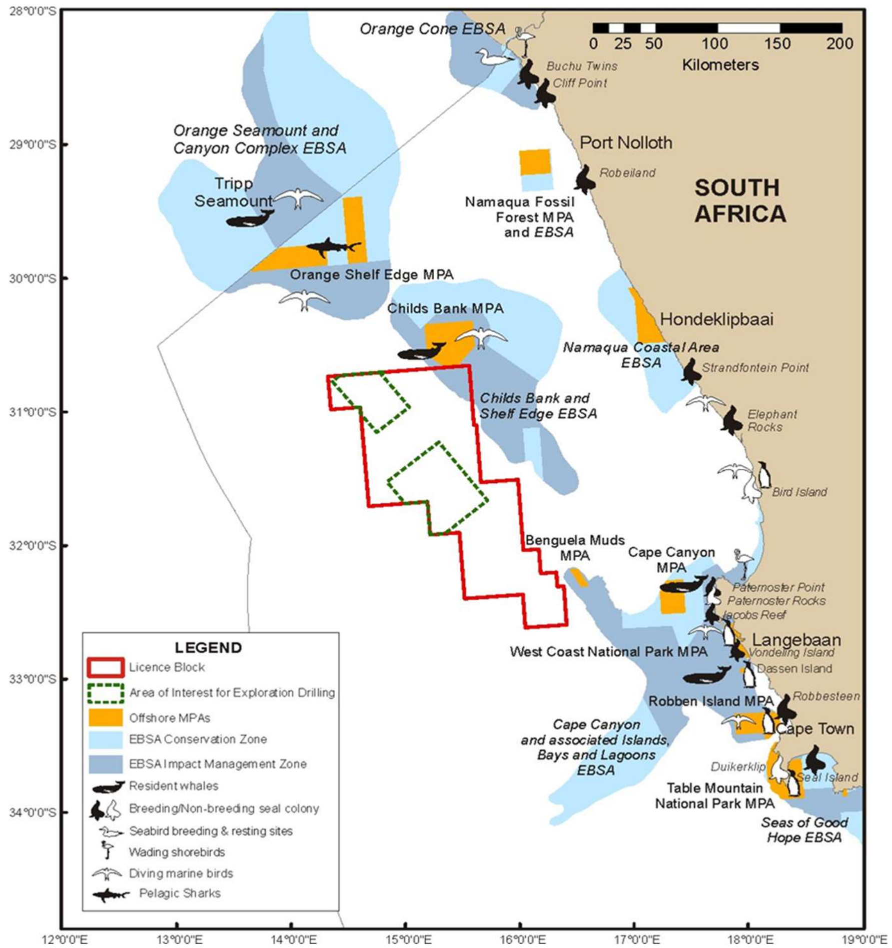


Figure 7: Block 3B/4B (red polygon) in relation to project – environment interaction points on the West Coast, illustrating the location of seabird and seal colonies and resident whale populations, Marine Protected Areas (MPAs) and Ecologically and Biologically Significant Areas (EBSAs) (Adapted from MARISMA Project 2020).

FISHERIES

Licence Block 3B/4B does overlap the spatial extent of demersal trawling ground whereas the northern and central AOI are situated 25 km and 10 km, respectively, from the trawl footprint. A 500 m safety zone around the drilling unit would therefore not coincide with trawl ground nor present an exclusion to fishing operations or loss of access to fishing ground. Refer to Figure 8 below which shows the location of demersal trawling grounds in relation to the AOI for well drilling.

Licence Block 3B/4B does overlap the spatial extent of the large pelagic longline ground. The fishery operates extensively within the South African EEZ, primarily along the continental shelf break and further offshore. Figure 9 below shows the spatial extent of pelagic longline fishing grounds in relation to the licence block and AOI for proposed drilling.

Figure 10 below shows the location of fishing activity in relation to the licence block and AOI for proposed drilling. Fishing records received from DFFE for the reporting period 2017 to 2019 show fishing within the licence block but no activity within the AOI.

OTHER USES

Other industrial uses of the marine environment include the intake of feed-water for mariculture, or diamond-gravel treatment, submarine telecommunications cables, ammunition dumps and hydrocarbon wellheads (Figure 11 below). None of these activities should in any way be affected by exploration drilling activities offshore.

There are a number of existing and proposed subsea fibreoptics cables that make landfall between Cape Town and Saldanha Bay (Figure 11 below), most of which pass to the west of Block 3B/4B. Of the ammunition dump sites off the West Coast, none fall within Block 3B/4B.

SOCIAL

Apart from the potential social impacts that will be created, there are also several social risks that must be considered before any activities are considered. The social risks include:

- Opposition to the project through appeals and court cases causing a significant delay in the process
- Damage to corporate reputation
- Lack of social license to operate
- Community protests and potential for civil unrest
- Stakeholder fatigue

In South Africa the environmental authorisation process is triggered by certain activities. As a result, a project may be required to go through several impact assessment processes during the different phases of the project. This Social Impact Assessment Report is only applicable to the drilling of a limited number of exploration wells (between 1 and 5). The activities will take place > 180 km off shore. As a result, direct social impacts of the activity are limited. Existing phenomena that causes impacts in the project area has been identified. These impacts relate to mining; the fishing industry; climate change; governance issues; and poverty, inequality, and unemployment and are discussed in Section 9.3 of the EIA Report. Any impact generated by the proposed exploration activities have to be considered in this context.

Potential impacts directly caused by the exploration activities relate to the impact of unplanned events on the livelihoods of the community, uncertainty and confusion about project phases and activities, and the impact on community cohesion.

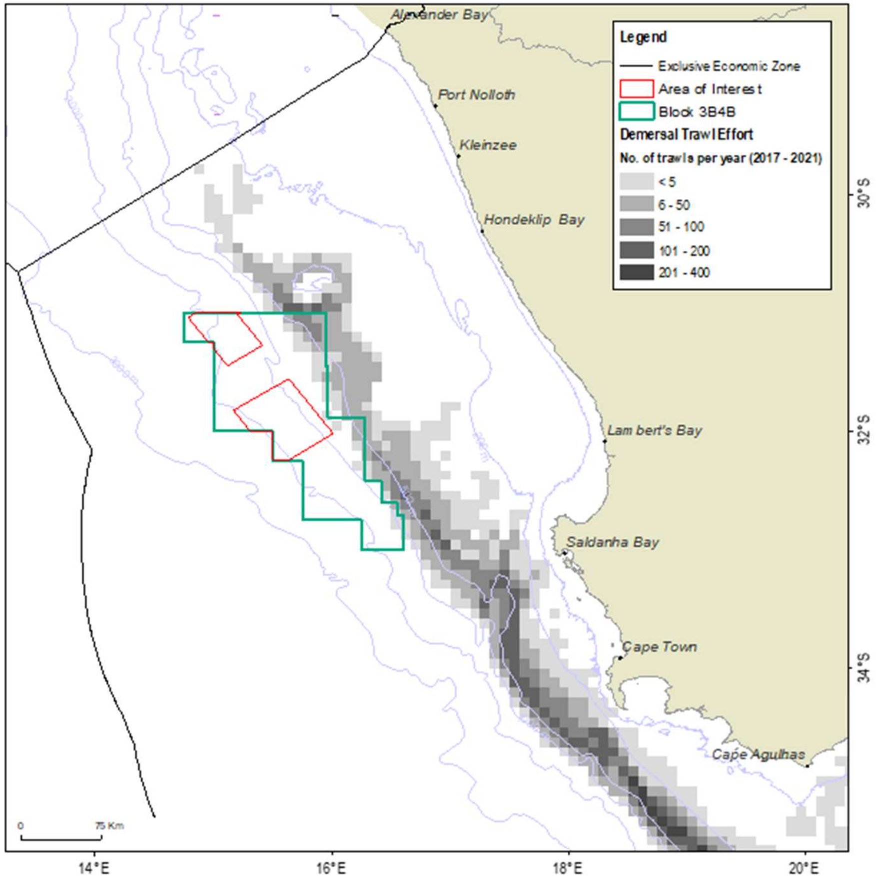


Figure 8: Overview of the spatial distribution of demersal trawl effort (2017 – 2021) in relation the licence block and AOI for proposed drilling.

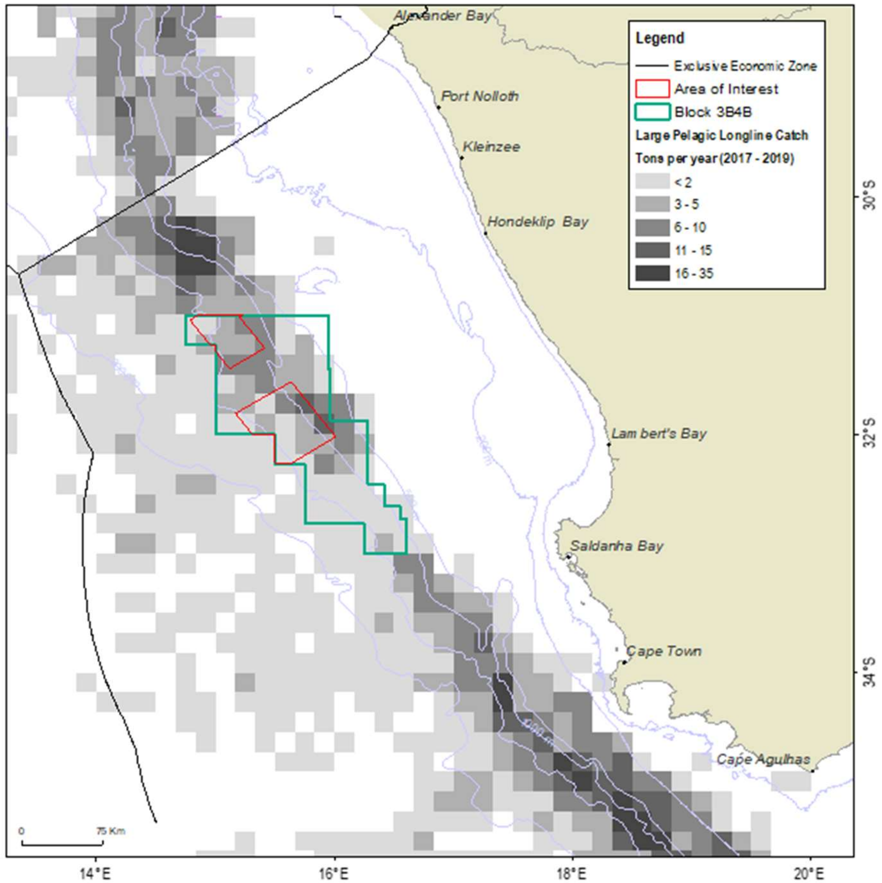


Figure 9: An overview of the spatial distribution of fishing effort expended by the longline sector targeting large pelagic fish species in relation to licence block 3B/4B (Green polygon) and AOI for proposed drilling (Red polygon).

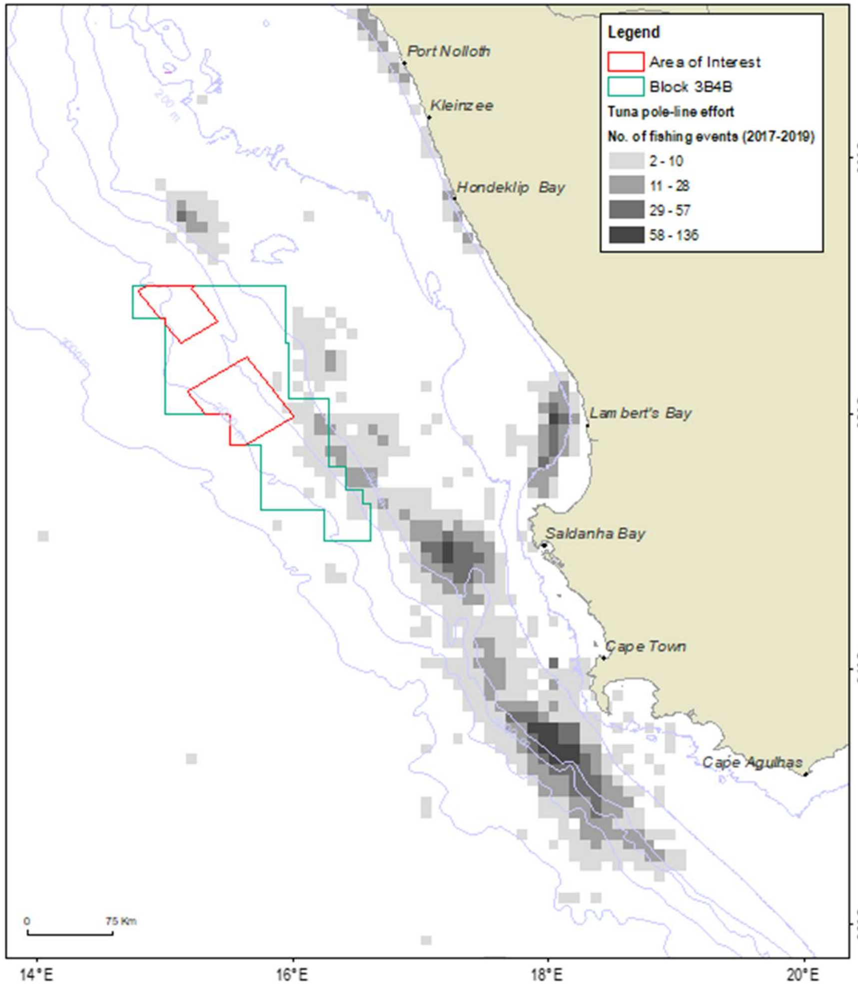


Figure 10: An overview of the spatial distribution of fishing effort expended by the pole- line sector targeting pelagic tuna (offshore areas) and snoek (inshore areas) in relation to the licence block 3B/4B (Green polygon) and AOI for proposed drilling (Red polygon).

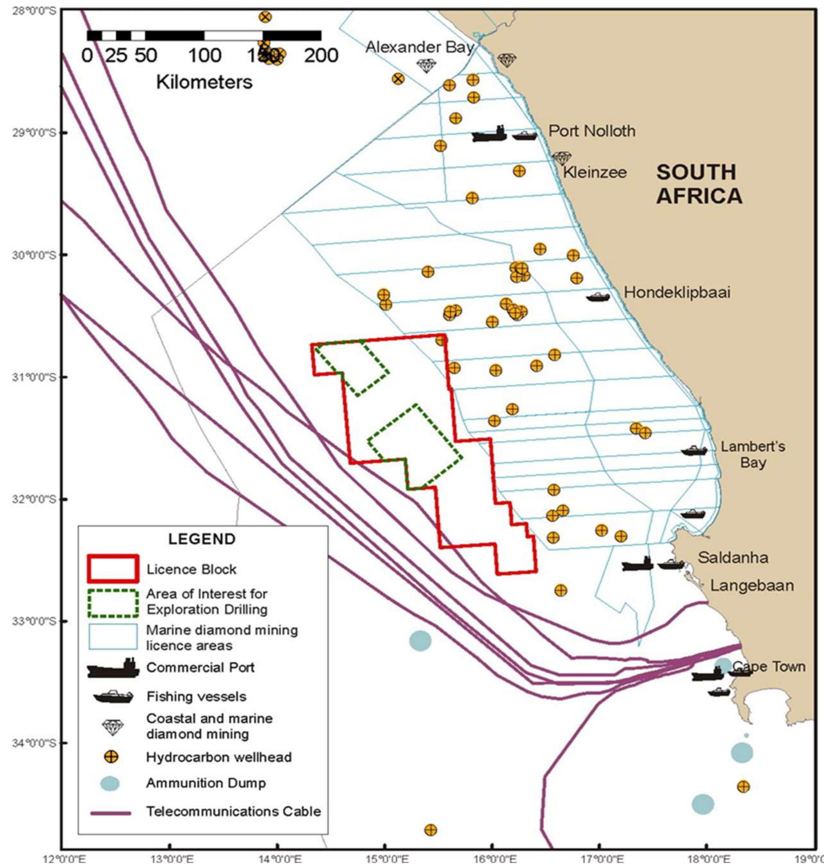


Figure 11: Block 3B/4B (red polygon) in relation to other marine infrastructure on the West Coast, illustrating the location of well heads, diamond mining concessions, submarine telecommunications cables and ammunition dumps.

ECONOMIC

The West Coast economy consists of ten sub-regional economies that represent the economic output region of the western coast of South Africa (not to be confused with the West Coast District economy). The receiving economy generated R153.0 billion in current prices Gross Value Added (GVA) in 2021 contributing approximately 2.7% to the National economy and 17.4% to the combined output of the Western and Northern Cape economies. The receiving economy's contribution to the National economy remained consistent between 2015 and 2021, fluctuating between a contribution of 2.74% and 2.77% per annum. The receiving economy's contribution to the combined economies of the Western and Northern Cape has continually increased, reaching 17.4% in 2021. The sub-regional economies of Blaauwberg and Table Bay (situated in the Cape Town Metropolitan Area) are the primary economic output generating regions of the receiving economy, contributing more than 68% to the total receiving economy's GVA. Furthermore, the Saldanha Bay, Swartland and Nama Khoi sub-regional economies represent secondary economic contributors.

Since 2011, all sub-regional economies have increased their proportional contribution to the receiving economy. The Table Bay sub-regional economy is the only exception, as it saw a decrease in its proportional share. The data suggests that two sub-regional economies, Table Bay and Kamiesberg, may have expanded at rates slower than other sub-regional economies. This could likely be due to a decline in economic activity in key sectors affected by, and recovering from, the effects of past and current macro-economic pressures.

The receiving economy is primarily tertiary economy orientated with the majority of economic output being generated by the business services and wholesale and retail trade sectors. Although almost all sub-regional economies have sizeable business services and wholesale and retail trade sectors, the bulk of these sectors' output is produced in the Table Bay and Blaauwberg sub-regional economies – Table Bay and Blaauwberg sub-regional economies represent nearly 69% of the total output produced by the receiving economy and, therefore, has a significant influence on the structure and functionality of the receiving economy.

Nevertheless, the tertiary economy is supported by a sizeable secondary and primary economy, where manufacturing, especially the production of food products, and agriculture, specifically land based farming and fishing, play vital roles in the output produced by the overarching economy. It is, however, important to note that although sub-regional economies such as Blaauwberg and Table Bay are the largest contributors to the total production of the receiving economy, these areas' influence is primarily concentrated in the tertiary (all sub-sectors) and secondary sectors (all sub-sectors except food production). West Coast sub-regional economies such as Bergrivier, Saldanha and Swartland play important roles in not only agricultural production and fishing industry output but are core locations where the bulk of food production output is concentrated.

CULTURAL HERITAGE

The intangible cultural heritage (ICH) of coastal communities in South Africa, particularly in the Northern Cape and Western Cape, and the potential impact of offshore exploration on these communities, was described. The following key findings were made:

- Strong connection to the sea: Small-scale fishers (SSF) have a deep cultural and spiritual connection to the ocean, viewing it as a living organism and part of a complex ecological system. They value the coast for fish spawning, subsistence, and ancestral connections.
- Concern about offshore exploration: Over 50% of SSF interviewed worry about the impact of offshore oil and gas activities on fish stocks and the environment.
- First Peoples' revivals: Indigenous communities are experiencing a revival of cultural identity and remembrance of coastal ICH, highlighting the cultural sensitivity of these coastal ecosystems.
- Holistic view of the sea: Indigenous communities have a distinct value system for the sea, viewing it as a cultural resource as well as an economic resource.
- Ancestral connections: The ocean is considered a resting place for ancestors, and interacting with it through rituals is significant for spiritual well-being.

- Khoisan and Nguni practices: These groups have specific practices drawing on fynbos and the sea for healing and connecting with the ancestral world.
- Impact of apartheid: Many people categorised as "Coloured" under apartheid are now reclaiming their Khoisan ancestry and cultural expressions denied to them previously.
- Environmental conservation: Maintaining ancestral beliefs and rituals requires the protection of flowing waters like the ocean, rivers, and estuaries.

The research emphasized the rich intangible cultural heritage of coastal communities in South Africa and the potential negative impacts of offshore exploration on their cultural and spiritual connection to the sea. It is important to recognise their holistic view of the ocean and consideration of their practices and beliefs in relevant project decisions.

SHIPPING DENSITY

A large number of vessels navigate the major shipping lanes along the South African Coastline. Approximately 96% of the country's exports are conveyed by sea through eight commercial ports. These ports are the conduits for trade between South Africa and its southern African partners as well as hubs for traffic to and from Europe, Asia, the Americas and the east and west coasts of Africa. Figure 12 provides an indication of the annual shipping density along the South African Coast. It can be observed that the shipping density is generally low to medium over the majority of the proposed exploration area within Block 3B/4B.

AIR QUALITY & CLIMATE CHANGE

Since the calculated maximum predicted ground level concentrations (under worst-case atmospheric conditions) are considerably lower than the NAAQS limit values, it is expected that the exposure to any significant concentration levels would be infrequent and insignificant when compared with the NAAQS. Such emissions are therefore unlikely to have a direct effect on any receptor or other activity, other than the project vessels themselves.

The assessment was based on Scope 1 greenhouse gas (GHG) emissions for the proposed exploration survey in a portion of Block 3B/4B. The calculated carbon dioxide equivalent (CO_2-e) emissions were estimated at a total of 31.87 kilotonne (kt). The GHG emissions were estimated using South African (SA) specific caloric values and densities for fuels (where available) and the Intergovernmental Panel on Climate Change (IPCC) emission factors.

Based on the published 2020 National GHG annual Inventory for South Africa, the maximum total CO_2-e emissions from the Project, assuming a maximum survey duration of 84 days, would contribute approximately 0.008% to the 2020 South African "energy" sector total of 379 505.2 kt CO_2-e and represent a contribution of 0.007% to the 2020 National GHG inventory total of 468 811.7 kt CO_2-e (excluding Forestry and Other Land Use (FOLU)).

GHG emissions are expected to be less than the Department of Forestry, Fisheries and the Environment (DFFE) Pollution Prevention Plan (PPP) requirement threshold of 100 kt CO_2-e. Given that, the negative impact is of low intensity, national extent, irreversible but of short duration, the environmental risk is low (due to its limited period of emission and future uptake by vegetation). Since the Project is of a temporary nature and expected to be completed in the near future, changes in meteorological parameters are not expected to have a significant impact on the Project.

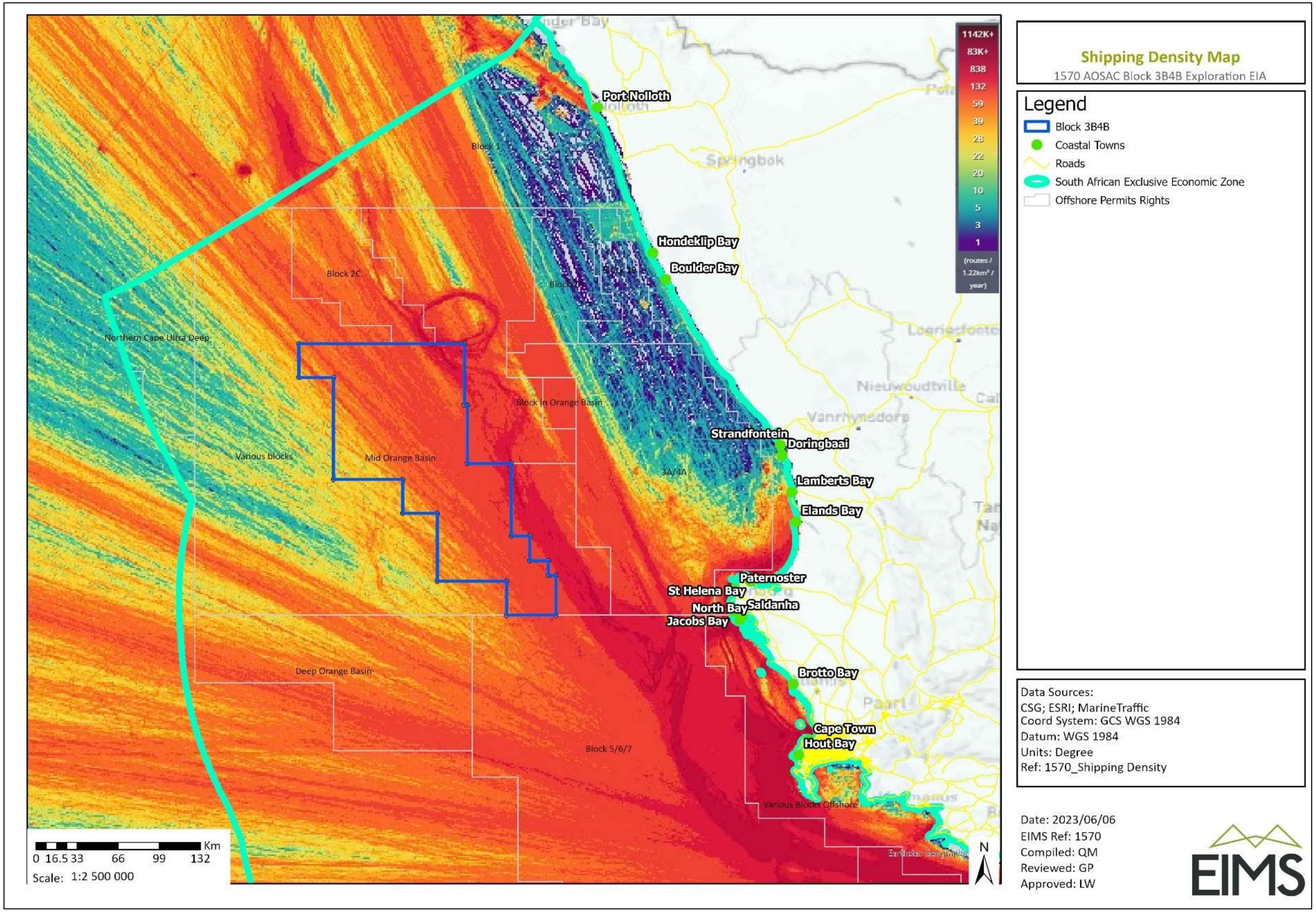


Figure 12: Annual shipping density along the South African Coast.

ENVIRONMENTAL IMPACT ASSESSMENT

The potential impacts that have been identified throughout the EIA are presented in the Table 2 below. It should be noted that this report will be made available to I&AP's for review and comment and their comments and concerns will be addressed in the final EIA Report submitted to the PASA/DMRE for adjudication. The results of the public consultation will be used to update the identified potential impacts, where required. These impacts were identified by the EAP, the appointed specialists, as well as the input from the public. Without proper mitigation measures and continual environmental management, most of the identified impacts may potentially become cumulative, affecting areas outside of their originally identified zone of impact. The potential cumulative impacts have been identified, evaluated, and mitigation measures suggested where appropriate.

As indicated in Table 2 and as summarised in Figure 13 below, the majority of the impacts identified can be reduced to be of low Environmental Risk (ER) and Final Significance (after impact prioritisation) with the implementation of mitigation measures.

Table 2: Identified Environmental Impacts

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
Marine Ecology	Mobilisation	**Alternative 1**	Routine Operational Discharges to Sea	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Routine Operational Discharges to Sea	Low Negative	Low Negative	Low Negative
	Decommissioning	**Alternative 1**	Routine Operational Discharges to Sea	Low Negative	Low Negative	Low Negative
	Mobilisation	**Alternative 1**	Discharge of Ballast Water from Vessels	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Noise from Helicopters	Low Negative	Low Negative	Low Negative
	Mobilisation	**Alternative 1**	Lighting from Drill Unit and Vessels	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Lighting from Drill Unit and Vessels	Low Negative	Low Negative	Low Negative
	Decommissioning	**Alternative 1**	Lighting from Drill Unit and Vessels	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Drilling and Placement of Infrastructure on the Seafloor	Low Negative	Low Negative	Low Negative
	Rehab and Closure	**Alternative 1**	Drilling and Placement of Infrastructure on the Seafloor	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Disturbance and/or Smothering of soft-sediment benthic communities due to drilling solids discharge	Medium Negative	Medium Negative	Medium Negative
	Operation	**Alternative 1**	Disturbance and/or Smothering of hardgrounds / deep-water reef communities due to drilling solids discharge	High Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Biochemical Impacts of residual WBMs, NADFs and cements additives on marine organisms in unconsolidated sediments	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Biochemical Impacts of residual WBMs, NADFs and cements additives on marine organisms on hard grounds	Low Negative	Low Negative	Low Negative

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
	Operation	**Alternative 1**	Biochemical Impacts of residual WBMs, NADFs and cements additives on marine organisms in the water column	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Increased Water Turbidity and reduced Light Penetration on marine ecology	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Reduced physiological functioning of marine organisms due to indirect biochemical effects in the sediments	Low Negative	Low Negative	Low Negative
	Mobilisation	**Alternative 1**	Disturbance, behavioural changes and avoidance of feeding and/or breeding areas in seabirds, seals, turtles and cetaceans due to drilling and vessel noise (continuous noise)	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Disturbance, behavioural changes and avoidance of feeding and/or breeding areas in seabirds, seals, turtles and cetaceans due to drilling and vessel noise (continuous noise)	Low Negative	Low Negative	Low Negative
	Decommissioning	**Alternative 1**	Disturbance, behavioural changes and avoidance of feeding and/or breeding areas in seabirds, seals, turtles and cetaceans due to drilling and vessel noise (continuous noise)	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Disturbance and behavioural changes in seabirds, seals, turtles and cetaceans due to Geophysical Surveys and Vertical Seismic Profiling (impulsive noise)	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Impacts of infrastructure and residual cement on marine biodiversity – Wellhead removal	Low Negative	Low Negative	Low Negative
	Decommissioning	**Alternative 1**	Impacts of infrastructure and residual cement on marine biodiversity – Wellhead removal	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 2**	Impacts of infrastructure and residual cement on marine biodiversity – Wellhead Abandonment	Low Negative	Low Negative	Low Negative
	Decommissioning	**Alternative 2**	Impacts of infrastructure and residual cement on marine biodiversity – Wellhead Abandonment	Low Negative	Low Negative	Low Negative

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
	Operation	**Alternative 1**	Impacts of flare lighting on marine fauna	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Impact on marine fauna from the discharge of treated produced water	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Impact on marine fauna from hydrocarbon 'drop-out'	Low Negative	Low Negative	Low Negative
	Mobilisation	**Unplanned**	Unplanned Collision of Vessels with Marine Fauna	Low Negative	Low Negative	Low Negative
	Operation	**Unplanned**	Unplanned Collision of Vessels with Marine Fauna	Low Negative	Low Negative	Low Negative
	Decommissioning	**Unplanned**	Unplanned Collision of Vessels with Marine Fauna	Low Negative	Low Negative	Low Negative
	Mobilisation	**Unplanned**	Unplanned Loss of Equipment	Low Negative	Low Negative	Low Negative
	Operation	**Unplanned**	Unplanned Loss of Equipment	Low Negative	Low Negative	Low Negative
	Decommissioning	**Unplanned**	Unplanned Loss of Equipment	Low Negative	Low Negative	Low Negative
	Mobilisation	**Unplanned**	Unplanned Oil release to the sea due to vessel collisions, bunkering accident and line / pipe rupture	Medium Negative	Low Negative	Low Negative
	Operation	**Unplanned**	Unplanned Oil release to the sea due to vessel collisions, bunkering accident and line / pipe rupture	Medium Negative	Low Negative	Low Negative
	Decommissioning	**Unplanned**	Unplanned Oil release to the sea due to vessel collisions, bunkering accident and line / pipe rupture	Medium Negative	Low Negative	Low Negative
	Operation	**Unplanned**	Unplanned Well Blow-out (condensate)	Medium Negative	Medium Negative	Medium Negative
	Operation	**Unplanned**	Unplanned Well Blow-out (crude oil)	High Negative	Medium Negative	Medium Negative

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
Fisheries	Operation	**Alternative 1**	Impacts on the fishing sector catch rates (tuna pole and large pelagic longline.	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Exclusion from Fishing Ground Due to Temporary Safety Zone around Vessels – Large Pelagic Longline	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Discharge of Drill Cuttings	Low Negative	Low Negative	Low Negative
	Mobilisation	**Alternative 1**	Vessel and Drilling Noise	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Vessel and Drilling Noise	Low Negative	Low Negative	Low Negative
	Decommissioning	**Alternative 1**	Vessel and Drilling Noise	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Vertical Seismic Profiling Noise	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Sonar Survey (MBES) Noise	Low Negative	Low Negative	Low Negative
	Operation	**Unplanned**	Impact on fisheries of small scale hydrocarbon spill	Medium Negative	Low Negative	Low Negative
	Operation	**Unplanned**	Impact on fisheries of large-scale hydrocarbon spill (condensate)	Medium Negative	Medium Negative	Medium Negative
	Operation	**Unplanned**	Impact on fisheries of large-scale hydrocarbon spill (crude oil)	High Negative	Medium Negative	Medium Negative
	Operation	**Unplanned**	Loss of Equipment	Low Negative	Low Negative	Low Negative
Maritime Heritage	Operation	**Alternative 1**	Damage to or Loss of Palaeontological Materials	Low Positive	Low Positive	Low Positive
	Operation	**Alternative 1**	Damage to or Loss of Maritime Archaeological Sites or Material	Medium Negative	Low Negative	Medium Negative

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
Cultural Heritage	Operation	**Alternative 1**	Cultural heritage impact of drilling – Normal Operations	Medium Negative	Low Negative	Medium Negative
	Operation	**Unplanned**	Cultural heritage impact of drilling – Unplanned Events	High Negative	Low Negative	Medium Negative
Social	Operation	**Unplanned**	Impact of oils spills or unplanned events on the livelihoods of the fishers	Medium Negative	Low Negative	Low Negative
	Operation	**Unplanned**	Impact of well blow out on the fishing industry (worst case scenario)	High Negative	Low Negative	Medium Negative
	Operation	**Alternative 1**	Uncertainty/Confusion related to different processes	Medium Negative	Low Negative	Medium Negative
	Operation	**Alternative 1**	Impact on the cohesion in the community	Medium Negative	Medium Negative	Medium Negative
Economic	Planning	**Alternative 1**	Stimulation of economic activity (additional business sales) throughout the exploration industry's value chain for the duration of the survey operations	Low Positive	Low Positive	Low Positive
	Planning	**Alternative 1**	Impact on commercial fishing operators targeting large pelagic longline fish species because of reduced fishing grounds and potential lowered catch potential	Low Negative	Low Negative	Low Negative
	Planning	**Alternative 1**	Impact on maritime logistics operations because of disrupted shipping routes to major ports along the South African coast. Alternate routes could impact on the economic efficiency of maritime logistics	Low Negative	Low Negative	Low Negative
	Mobilisation	**Alternative 1**	The establishment of the onshore logistics base will create temporary employment opportunities for skilled labour	Low Positive	Medium Positive	Medium Positive
	Mobilisation	**Alternative 1**	Employment opportunities created by the logistics base will provide compensation to employees that will contribute toward household livelihoods and their access to services and amenities	Low Positive	Low Positive	Low Positive

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
	Mobilisation	**Alternative 1**	The economic activity stimulated by the sourcing of inputs for exploration activities will increase the fiscus of government through fiscal benefits in the form of taxation (personal, business, production, product, imports, etc)	Medium Positive	Medium Positive	Medium Positive
	Mobilisation	**Alternative 1**	The sourcing of materials, equipment and associated services will generate additional business sales throughout the exploration industry's value chain – businesses providing inputs to the exploration industry will benefit from an increase in sales and economic output	Medium Positive	Medium Positive	Medium Positive
	Mobilisation	**Alternative 1**	Additional employment opportunities could be created throughout the exploration industry's value chain due to increased demand generated for goods and services	Low Positive	Low Positive	Low Positive
	Mobilisation	**Alternative 1**	The demand for bulk services contributes to the fiscus of the local authority or providing agent	Low Positive	Low Positive	Medium Positive
	Mobilisation	**Alternative 1**	The increased demand on bulk infrastructure requires additional investment to accommodate additional demand. Additional demand is accompanied by an increased maintenance burden	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	The operational phase of the exploration activity will generate demand for goods and services necessary to sustain operational activities. This sustained demand over the operational period of exploration could lead to additional business sales throughout the exploration industry's value chain (increased economic output, production and gross value added)	Medium Positive	Medium Positive	Medium Positive
	Operation	**Alternative 1**	New employment opportunities throughout the exploration industry's value chain could be stimulated as a result of the increased demand generated by the proposed exploration activity	Low Positive	Medium Positive	Medium Positive
	Operation	**Alternative 1**	The logistics base of the exploration activity sustains skilled employment opportunities for the duration of exploration activities	Low Positive	Medium Positive	Medium Positive
	Operation	**Alternative 1**	The employment opportunities created directly (i.e. through the projects logistics base) or indirectly (i.e. throughout the exploration industry's value chain) by the proposed exploration activity provides compensation to	Low Positive	Medium Positive	Medium Positive

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
			employees which in turn assists with maintaining household livelihoods (i.e. access to services and amenities)			
	Operation	**Alternative 1**	The exploration activity through its expenditure during its operation phase stimulates economic activity throughout its value chain and as a result increases the fiscal value (i.e. taxes) collected by government	Medium Positive	Medium Positive	Medium Positive
	Operation	**Alternative 1**	The exploration activity further contributes toward a basic sector of the economy and therefore assists with maintaining the economic functionality of the receiving economy by providing a basis from which SMME development could occur	Low Positive	Low Positive	Low Positive
	Operation	**Alternative 1**	The demand for bulk services contributes to the fiscus of the local authority or providing agent	Low Positive	Low Positive	Medium Positive
	Operation	**Alternative 1**	The increased demand on bulk infrastructure requires additional investment to accommodate additional demand. Additional demand is accompanied by an increased maintenance burden	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	The proposed exploration activity could lead to reduced fishing grounds and catch potential for the large pelagic longline fishing industry, which, in turn, may result in decreased economic productivity for the receiving economy's fishing industry. As a consequence, the demand for inputs to the fishing industry and the outputs from the industry may be impacted (limiting business sales, economic output and gross value added). The impact is viewed as a temporary impact given that exploration activities will not be a long-term sustained operation	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Due to the temporary decrease of economic productivity in the receiving economy's large pelagic longline fishing industry, the demand for employment throughout the industry's value chain could be lowered, affecting the availability of employment opportunities	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Due to the temporary decreased of economic productivity in the receiving economy's large pelagic longline fishing industry and the subsequent lowering of demand for employment in the industry, the compensation of	Low Negative	Low Negative	Low Negative

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
			employees and income of households dependent on the industry could be lowered, impacting on the capability of households to sustain livelihoods			
	Operation	**Alternative 1**	Due to the temporary decreased of economic productivity in the receiving economy's large pelagic longline fishing industry, the fiscal value that government receives (e.g. taxation of productions, production, businesses and employees) as a result of economic activity throughout the industry's value chain could be diminished	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	The temporary decrease of economic productivity in the receiving economy's large pelagic longline fishing industry could temporarily diminish the demand for new business (SMME) development due to limited scope with which business sales can be stimulated	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	The proposed exploration activities' area of interest overlaps with established and commonly used shipping routes. This overlap may result in disruptions to shipping operations, as vessels may need to use alternative routes. Such deviations can diminish operational efficiency and subsequently reduce the economic output (limiting business sales, economic output and gross value added) within the receiving economy's transport and storage industry. The impact is viewed as a temporary impact given that exploration activities will not be a long-term sustained operation	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Due to the temporary decrease of economic productivity in the receiving economy's transport and storage industry, the demand for employment throughout the industry's value chain could be lowered, affecting the availability of employment opportunities	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Due to the temporary decreased of economic productivity in the receiving economy's transport and storage industry and the subsequent lowering of demand for employment in the industry, the compensation of employees and income of households dependent on the industry could be lowered, impacting on the capability of households to sustain livelihoods	Low Negative	Low Negative	Low Negative
	Operation	**Alternative 1**	Due to the temporary decreased of economic productivity in the receiving economy's transport and storage industry, the fiscal value that government receives (e.g. taxation of productions, production, businesses and	Low Negative	Low Negative	Low Negative

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
			employees) as a result of economic activity throughout the industry's value chain could be diminished			
	Operation	**Alternative 1**	The temporary decrease of economic productivity in the receiving economy's transport and storage industry could temporarily diminish the demand for new business (SMME) development due to limited scope with which business sales can be stimulated	Low Negative	Low Negative	Low Negative
	Operation	**Unplanned**	The oil spill response activity could generate demand for goods and services necessary to sustain operational activities. This sustained demand over the response period of exploration could lead to additional business sales throughout the response industry's value chain (increased economic output, production and gross value added) (condensate)	Low Positive	Low Positive	Low Positive
	Operation	**Unplanned**	The oil spill response activity could generate demand for goods and services necessary to sustain operational activities. This sustained demand over the response period of exploration could lead to additional business sales throughout the response industry's value chain (increased economic output, production and gross value added) (crude oil)	Low Positive	Low Positive	Low Positive
	Operation	**Unplanned**	New employment opportunities throughout the response industry's value chain could be stimulated as a result of the increased demand generated by the response activity (condensate)	Low Positive	Low Positive	Low Positive
	Operation	**Unplanned**	New employment opportunities throughout the response industry's value chain could be stimulated as a result of the increased demand generated by the response activity (crude oil)	Low Positive	Low Positive	Low Positive
	Operation	**Unplanned**	The employment opportunities created directly or indirectly by the response activity provides compensation to employees which in turn assists with maintaining household livelihoods (i.e., access to services and amenities) (condensate)	Low Positive	Low Positive	Low Positive
	Operation	**Unplanned**	The employment opportunities created directly or indirectly by the response activity provides compensation to employees which in turn assists with	Low Positive	Low Positive	Low Positive

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
			maintaining household livelihoods (i.e., access to services and amenities) (crude oil)			
	Operation	**Unplanned**	A well blow-out event could lead to reduced fishing grounds and catch potential for the large pelagic longline fishing industry, which, in turn, may result in decreased economic productivity for the receiving economy's fishing industry. As a consequence, the demand for inputs to the fishing industry and the outputs from the industry may be impacted (limiting business sales, economic output and gross value added). The impact is viewed as a temporary impact given that the well blow-out event might not be a long-term sustained event (condensate)	Low Negative	Low Negative	Low Negative
	Operation	**Unplanned**	A well blow-out event could lead to reduced fishing grounds and catch potential for the large pelagic longline fishing industry, which, in turn, may result in decreased economic productivity for the receiving economy's fishing industry. As a consequence, the demand for inputs to the fishing industry and the outputs from the industry may be impacted (limiting business sales, economic output and gross value added). The impact is viewed as a temporary impact given that the well blow-out event might not be a long-term sustained event (crude oil)	Low Negative	Low Negative	Low Negative
	Operation	**Unplanned**	The potential area that is affected by a well blow-out event overlaps with established and commonly used shipping routes. This overlap may result in disruptions to shipping operations, as vessels may need to use alternative routes. Such deviations can diminish operational efficiency and subsequently reduce the economic output (limiting business sales, economic output and gross value added) within the receiving economy's transport and storage industry. The impact is viewed as a temporary impact given that exploration activities will not be a long-term sustained operation (condensate)	Low Negative	Low Negative	Low Negative
	Operation	**Unplanned**	The potential area that is affected by a well blow-out event overlaps with established and commonly used shipping routes. This overlap may result in disruptions to shipping operations, as vessels may need to use alternative routes. Such deviations can diminish operational efficiency and subsequently reduce the economic output (limiting business sales, economic output and gross value added) within the receiving economy's transport and storage	Low Negative	Low Negative	Low Negative

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
			industry. The impact is viewed as a temporary impact given that exploration activities will not be a long-term sustained operation (crude oil)			
	Operation	**Unplanned**	The potential area that is affected by a crude oil well blow-out event overlaps with established and commonly used cruise tourism routes. This overlap may result in disruptions to cruise line operations, as vessels may need to use alternative routes, or temporarily postpone trips along popular routes. Such deviations can diminish operational efficiency and subsequently affect economic activity (limiting business sales, economic output and gross value added) within the receiving economy's tourism and transport and storage industry. The impact is viewed as a temporary impact given that the majority of surface oil has evaporated, biodegraded and dispersed after 60 days thereby reducing the area affected by an oil spill event (crude oil)	Low Negative	Low Negative	Low Negative
Air Quality	Operation	**Alternative 1**	Atmospheric Emissions (routine)	Low Negative	Low Negative	Low Negative
Air Quality	Operation	**Alternative 1**	Atmospheric Emissions (upset)	Low Negative	Low Negative	Low Negative
Climate Change	Operation	**Alternative 1**	Climate Change (routine)	Low Negative	Low Negative	Low Negative
Climate Change	Operation	**Alternative 1**	Climate Change (upset)	Low Negative	Low Negative	Low Negative
No-Go	Operation	**No-Go**	No-Go Alternative	Low Negative	Low Negative	Low Negative

ENVIRONMENTAL IMPACT STATEMENT

The findings of the specialist studies conclude that there are no environmental fatal flaws that should prevent the proposed project from proceeding, provided that the recommended mitigation and management measures are implemented. Based on the nature and extent of the proposed project, the local level of disturbance predicted as a result of the activities, the findings of the specialist studies, and the understanding of the significance level of potential environmental impacts, it is the opinion of the EIA project team and the EAP that the significance levels of the majority of identified negative impacts can generally be reduced to an acceptable level by implementing the recommended mitigation measures and the project should be authorized. A final layout and sensitivity map is provided in Figure 14 below, which shows the final layout alternative. A summary showing the number of impacts and the post-mitigation significance of these identified impacts is provided in Figure 13 below.

Figure 13: Impact Summary showing number and significance of impacts post mitigation.

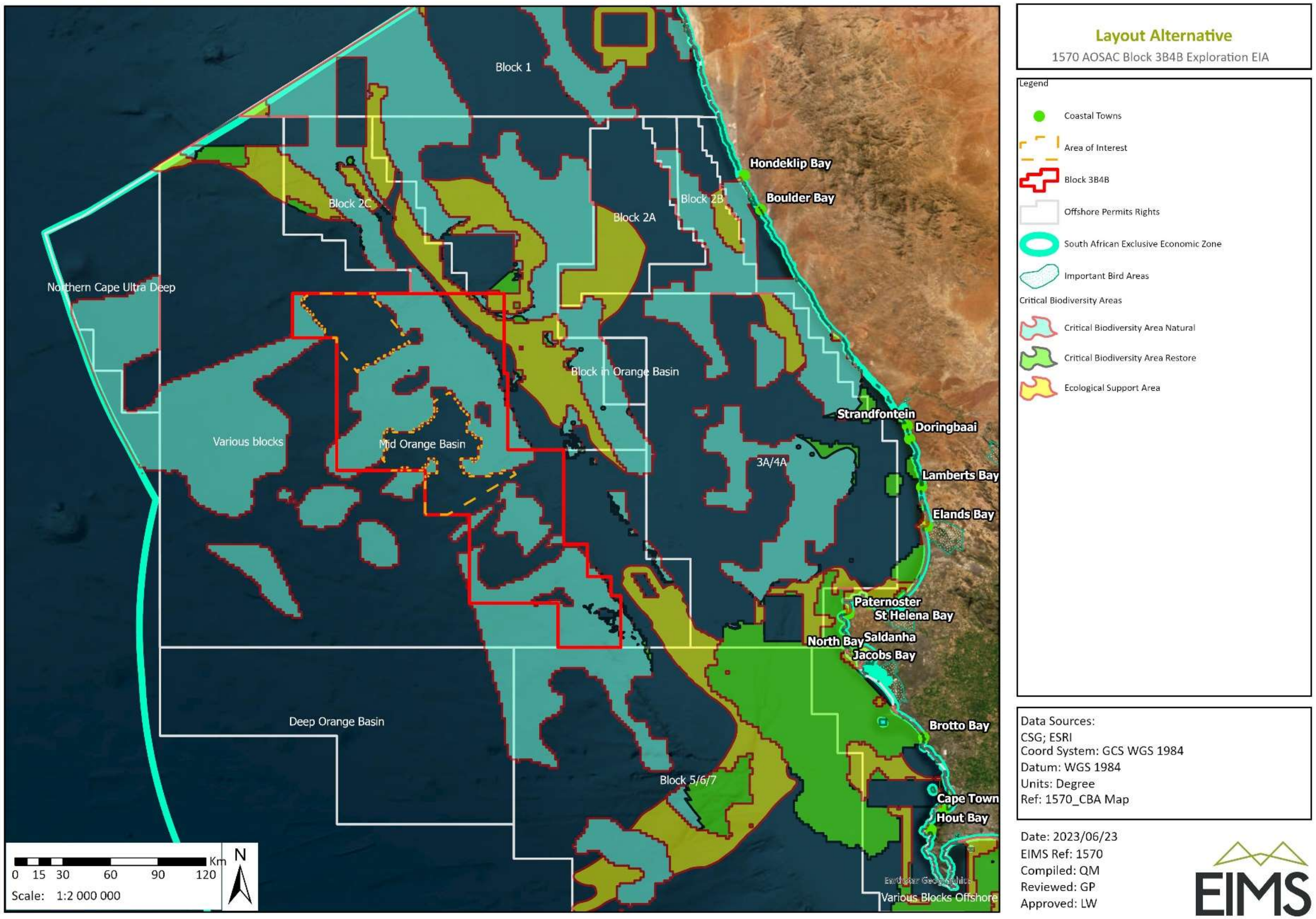


Figure 14: Final Composite Sensitivity Map

1 INTRODUCTION

Africa Oil SA Corp, Ricocure (Pty) Ltd and Azinam Limited (a wholly owned subsidiary of Eco Atlantic) (the Joint Venture (JV) Partners – hereafter jointly referred to as the Applicant) are the holders of the Block 3B/4B Exploration Right (ER) in terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002 – MPRDA), as amended. The licence block covers an area of approximately 17 581 km^2, and is situated between latitudes 31°S and 33°S on the continental shelf in water depths ranging from 300 m to 2 600 m.

The area of primary interest is in the northern part of this block, but there is also significant exploration interest in the central part of the block. As part of the process of applying for the Exploration Right, the Applicant undertook and completed a 3D reprocessing project covering 2 000 km^2, which is a subset of the 10 000 km^2 BHP/Shell 3D seismic datasets, focussed primarily on the most northern portion of Block 3B/4B. Based on analysis of the reprocessed dataset, the Applicant is now proposing to drill an exploration well in the area of primary interest in order to appraise further the hydrocarbon potential of the geological structure or "prospect", with the option to drill up to four additional wells.

A full Scoping and Environmental Impact Assessment (S&EIA) process is being undertaken to accompany the existing ER for the EIA Listing Notices listed activities applicable to the project namely: **Listing Notice 2: Activity 18**.

1.1 REPORT STRUCTURE

This report has been compiled in accordance with the NEMA EIA Regulations, 2014, as amended. A summary of the report structure, and the specific sections that correspond to the applicable regulations, is provided in Table 3 below.

Table 3: Report structure

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
Appendix 3(1)(a):	Details of – i. The Environmental Assessment Practitioner (EAP) who prepared the report; and ii. The expertise of the EAP, including a curriculum vitae;	1.2
Appendix 3(1)(b):	The location of the development footprint of the activity on the approved site as contemplated in the accepted scoping report, including:– i. the 21 digit Surveyor General code of each cadastral land parcel; ii. where available, the physical address and farm name; and iii. where the required information in items (i) and (ii) is not available, the coordinates of the boundary of the property or properties;	2
Appendix 3(1)I:	A plan which locates the proposed activity or activities applied for as well as the associated structures and infrastructure at an appropriate scale, or, if it is- i. a linear activity, a description and coordinates of the corridor in which the proposed activity or activities is to be undertaken; ii. on land where the property has not been defined, the coordinates within which the activity is to be undertaken;	2
Appendix 3(1)(d):	A description of the scope of the proposed activity, including- i. all listed and specified activities triggered and being applied for; and ii. a description of the associated structures and infrastructure related to the development;	3
Appendix 3(1)(e):	A description of the policy and legislative context within which the development is located and an explanation of how the proposed development complies with and responds to the legislation and policy context;	4
Appendix 3(1)(f):	A motivation for the need and desirability for the proposed development, including the need and desirability of the activity in the context of the preferred development footprint within the approved site as contemplated in the accepted scoping report;	5
Appendix 3(1)(g):	A motivation for the preferred development footprint within the approved site as contemplated in the accepted scoping report;	

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
Appendix 3(1)(h):	A full description of the process followed to reach the proposed development footprint within the approved site as contemplated in the accepted scoping report, including: i. details of the development footprint alternatives considered; ii. details of the public participation process undertaken in terms of Regulation 41 of the Regulations, including copies of the supporting documents and inputs; iii. a summary of the issues raised by interested and affected parties, and an indication of the manner in which the issues were incorporated, or the reasons for not including them; iv. the environmental attributes associated with the development footprint alternatives focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects; v. the impacts and risks identified including the nature, significance, consequence, extent, duration and probability of the impacts, including the degree to which these impacts- (aa) can be reversed; (bb) may cause irreplaceable loss of resources; and (cc) can be avoided, managed or mitigated; vi. the methodology used in determining and ranking the nature, significance, consequences, extent, duration and probability of potential environmental impacts and risks; vii. positive and negative impacts that the proposed activity and alternatives will have on the environment and on the community that may be affected focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects; viii. the possible mitigation measures that could be applied and level of residual risk; ix. if no alternative development footprints for the activity were investigated, the motivation for not considering such; and x. a concluding statement indicating the location of the preferred alternative development footprint within the approved site as contemplated in the accepted scoping report;	6, 7, 8 and 9
Appendix 3(1)(i):	A full description of the process undertaken to identify, assess and rank the impacts the activity and associated structures and infrastructure will impose on the preferred development footprint on the approved site as contemplated in the accepted scoping report through the life of the activity, including- i. a description of all environmental issues and risks that were identified during the environmental impact assessment process; and ii. an assessment of the significance of each issue and risk and an indication of the extent to which the issue and risk could be avoided or addressed by the adoption of mitigation measures;	9
Appendix 3(1)(j)	An assessment of each identified potentially significant impact and risk, including- i. cumulative impacts; ii. the nature, significance and consequences of the impact and risk;	9

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
	iii. the extent and duration of the impact and risk; iv. the probability of the impact and risk occurring; v. the degree to which the impact and risk can be reversed; vi. the degree to which the impact and risk may cause irreplaceable loss of resources; and (vii) the degree to which the impact and risk can be mitigated;	
Appendix 3(1)(k):	Where applicable, a summary of the findings and recommendations of any specialist report complying with Appendix 6 to these Regulations and an indication as to how these findings and recommendations have been included in the final assessment report;	11.1, 11.4
Appendix 3(1)(l):	An environmental impact statement which contains- i. a summary of the key findings of the environmental impact assessment: ii. a map at an appropriate scale which superimposes the proposed activity and its associated structures and infrastructure on the environmental sensitivities of the preferred development footprint on the approved site as contemplated in the accepted scoping report indicating any areas that should be avoided, including buffers; and iii. a summary of the positive and negative impacts and risks of the proposed activity and identified alternatives;	11.1, 11.2, 11.3
Appendix 3(1)(m):	Based on the assessment, and where applicable, recommendations from specialist reports, the recording of proposed impact management outcomes for the development for inclusion in the EMPr as well as for inclusion as conditions of authorisation;	9, 11.4
Appendix 3(1)(n):	The final proposed alternatives which respond to the impact management measures, avoidance, and mitigation measures identified through the assessment;	11.2
Appendix 3(1)(o):	Any aspects which were conditional to the findings of the assessment either by the EAP or specialist which are to be included as conditions of authorisation;	11.4
Appendix 3(1)(p):	A description of any assumptions, uncertainties and gaps in knowledge which relate to the assessment and mitigation measures proposed;	12
Appendix 3(1)(q):	A reasoned opinion as to whether the proposed activity should or should not be authorised, and if the opinion is that it should be authorised, any conditions that should be made in respect of that authorisation;	11.3
Appendix 3(1)(r):	Where the proposed activity does not include operational aspects, the period for which the environmental authorisation is required and the date on which the activity will be concluded and the post construction monitoring requirements finalised;	N/A
Appendix 3(1)(s):	An undertaking under oath or affirmation by the EAP in relation to-	13

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
	i. the correctness of the information provided in the reports; ii. the inclusion of comments and inputs from stakeholders and I&APs; iii. the inclusion of inputs and recommendations from the specialist reports where relevant; and iv. any information provided by the EAP to interested and affected parties and any responses by the EAP to comments or inputs made by interested or affected parties;	
Appendix 3(1)(u):	An indication of any deviation from the approved scoping report, including the plan of study, including- i. any deviation from the methodology used in determining the significance of potential environmental impacts and risks; and ii. a motivation for the deviation;	N/A
Appendix 3(1)(v):	Any specific information that may be required by the competent authority; and	N/A
Appendix 3(1)(w):	Any other matters required in terms of section 24(4)(a) and (b) of the Act.	N/A

1.2 DETAILS OF THE EAP

EIMS has been appointed by the Applicant as the independent Environmental Assessment Practitioner (EAP) to prepare and submit the EA application, Scoping and EIA Reports, and undertaking a Public Participation Process (PPP) to accompany the existing ER. The contact details of the EIMS consultant and EAP who compiled this Report are as follows:

Name of Practitioner	Mr G.P. Kriel (EAP)
Tel No.:	011 789 7170
E-mail:	block3b4b@eims.co.za

In terms of Regulation 13 of the EIA Regulations, 2014, as amended, an independent EAP, must be appointed by the applicant to manage the application. EIMS is compliant with the definition of an EAP as defined in Regulations 1 and 13 of the EIA Regulations, as well as Section 1 of the NEMA. This includes, inter alia, the requirement that EIMS is:

- Objective and independent;
- Has expertise in conducting EIA's;
- Comply with the NEMA, the environmental regulations and all other applicable legislation;
- Considers all relevant factors relating to the application; and
- Provides full disclosure to the applicant and the relevant environmental authority.

EIMS is a private and independent environmental management-consulting firm that was founded in 1993. EIMS has in excess of 29 years' experience in conducting EIA's. Please refer to the EIMS website (www.eims.co.za) for further details of expertise and experience.

Mr Gideon Petrus Kriel (GP) holds an M.Env.Sci (Water Sciences) Cum Laude from the North-West University (Potchefstroom Campus) and has been employed as an Environmental Consultant since 2007. GP is a Registered Professional Natural Scientist (South African Council for Natural and Scientific Professions) and a Registered Environmental Assessment Practitioner (Environmental Assessment Practitioner). He has delivered presentations locally and internationally concerning the use of bio-indicators for the determination of water quality, and has experience in a wide variety of environmental management projects including: Environmental Impact Assessments, Basic Assessments, Geographic Information Systems (GIS), Environmental Compliance Monitoring, Environmental Awareness Training, Aquatic Ecological Assessments, Drinking and Waste Water Treatment Process Audits, Wetland Delineation and Assessments, ISO 14001 Aspect Registers, Water Use Licence Applications, Waste Management Licence Applications and Integrated Waste and Water Management Plans (IWWMP).

The Curriculum Vitae of the EAP responsible for the compilation of this Report is included in Appendix 1.

2 DESCRIPTION OF THE PROJECT AREA

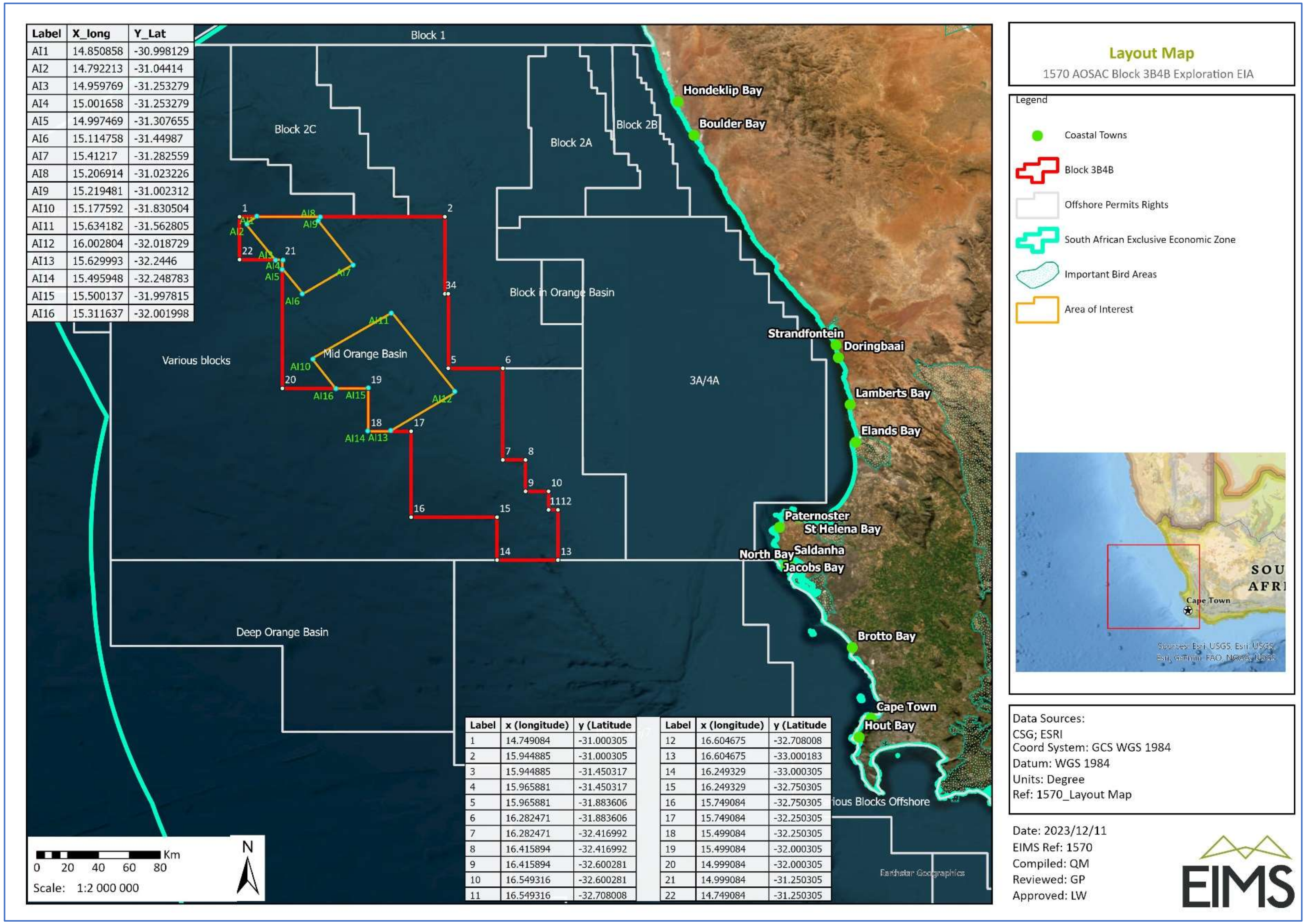
Table 4 indicates the details of the project area for the proposed project including details on the project location as well as the distance from the proposed project area to the nearest towns.

Table 4: Locality details

Project Area	Block 3B/4B off the West Coast of South Africa has an area of approximately 17 581 km^2. Two areas of interest (AOI) have been identified: • Northern AOI: Total Area: ~1637 km^2; and • Central AOI: Total Area: ~3069 km^2. The primary AOI for drilling is located in the northern portion of the licence area and covers ranging in water depths between 1 000 m and 2 600 m (Figure 15). The Applicant is proposing to drill 1 exploration well, with the option to drill up to four additional wells.
Application Area	Block 3B/4B Approximately 1 758 100 ha covers an area of approximately 17 581 km^2.
Magisterial District	Adjacent to the Namakwa and West Coast District Municipalities.
District Municipality	Adjacent to the Namakwa and West Coast District Municipalities.
Local Municipalities	Adjacent to the Kamiesberg; Richtersveld; Nama Khoi; Matzikama; Cederberg; Bergrivier; Saldanha Bay; Swartland; and City of Cape Town Local Municipalities.
Application area coordinates	The application area corner coordinate points are as follows:

Point	Latitude	Longitude	Point	Latitude	Longitude
1	-31.00030518	14.74908447	**12**	-32.70800781	16.60467529
2	-31.00030518	15.94488525	**13**	-33.00018311	16.60467529
3	-31.45031738	15.94488525	**14**	-33.00030518	16.24932861
4	-31.45031738	15.96588135	**15**	-32.75030518	16.24932861
5	-31.88360596	15.96588135	**16**	-32.75030518	15.74908447
6	-31.88360596	16.2824707	**17**	-32.25030518	15.74908447
7	-32.41699219	16.2824707	**18**	-32.25030518	15.49908447
8	-32.41699219	16.41589356	**19**	-32.00030518	15.49908447
9	-32.60028076	16.41589356	**20**	-32.00030518	14.99908447
10	-32.60028076	16.54931641	**21**	-31.25030518	14.99908447
11	-32.70800781	16.54931641	**22**	-31.25030518	14.74908447

The locality of the proposed exploration area is shown in Figure 15.



Label	X_long	Y_Lat
AI1	14.850858	-30.998129
AI2	14.792213	-31.04414
AI3	14.959769	-31.253279
AI4	15.001658	-31.253279
AI5	14.997469	-31.307655
AI6	15.114758	-31.44987
AI7	15.41217	-31.282559
AI8	15.206914	-31.023226
AI9	15.219481	-31.002312
AI10	15.177592	-31.830504
AI11	15.634182	-31.562805
AI12	16.002804	-32.018729
AI13	15.629993	-32.2446
AI14	15.495948	-32.248783
AI15	15.500137	-31.997815
AI16	15.311637	-32.001998

Label	x (longitude)	y (Latitude
1	14.749084	-31.000305
2	15.944885	-31.000305
3	15.944885	-31.450317
4	15.965881	-31.450317
5	15.965881	-31.883606
6	16.282471	-31.883606
7	16.282471	-32.416992
8	16.415894	-32.416992
9	16.415894	-32.600281
10	16.549316	-32.600281
11	16.549316	-32.708008

Label	x (longitude)	y (Latitude
12	16.604675	-32.708008
13	16.604675	-33.000183
14	16.249329	-33.000305
15	16.249329	-32.750305
16	15.749084	-32.750305
17	15.749084	-32.250305
18	15.499084	-32.250305
19	15.499084	-32.000305
20	14.999084	-32.000305
21	14.999084	-31.250305
22	14.749084	-31.250305

Figure 15: Locality map.

3 DESCRIPTION AND SCOPE OF THE PROPOSED ACTIVITY

This section provides an overview of the proposed activity. A brief history of the Applicant's involvement in Block 3B/4B is provided followed by the proposed activities to be undertaken as part of this application.

3.1 DESCRIPTION OF PREVIOUS ACTIVITIES UNDERTAKEN

A number of previous investigations and exploration activities have been undertaken within Block 3B/4B in the past. Approximately 14 000 linear km's of 2D seismic and 10 800 km^2 of 3D seismic data exists over Block 3B/4B. While a number of key 2D seismic lines have been acquired, the subsurface evaluation has largely utilized the extensive 3D seismic data that was acquired by PGS in 2013 for BHP Petroleum. This single 3D survey covers approximately 65% of the block and is joined in the northern part of the block by an overlapping 3D seismic survey acquired by Dolphin in 2013 for Shell. In 2022, a subset of the BHP survey plus a small portion of the Shell 3D was reprocessed by Down Under Geophysical (DUG) through Pre-Stack Depth Migration on behalf of the Applicant.

An ER for Block 3B/4B was granted to Ricocure (a company that is part of the JV Partners) by the Director-General of the Department of Mineral Resources and Energy (DMRE) duly delegated to act on behalf of the Minister of DMRE in terms of Section 80 of the Mineral and Petroleum Resources Development Act, 2002. The ER was signed on 9 May 2019 with an effective start date of the Initial Period of 27 March 2019 and recorded as file reference number 12/3/339. The ER/MPRDA allows for three additional renewal periods, each with a two-year duration. The work programme for each renewal period is negotiable. Clause 10 of the Block 3B/4B ER requires a 20% relinquishment upon completion of the Initial Exploration Period which equates to approximately 3,516 km^2. The Applicant applied for a deferment of this relinquishment obligation until such time as the Marine Protected Areas within Block 3B/4B have been finalised. The application for deferment of the relinquishment obligation was granted by the Director-General of the DMRE duly delegated to act on behalf of the Minister of DMRE and accordingly the Applicant did not relinquish at the end of the Initial Exploration Period.

The Initial three-year exploration period expired on 26 March 2022. The Initial work programme included the following:

- Regional interpretation and mapping of key horizons and faults;
- Detailed petrophysical analysis tying to neighbouring wells;
- Quantitative interpretation work of the physical properties;
- Basin model update Integrating the regional studies;
- Prospect maturation; and
- Prospect ranking and final report compilation.

During the Initial Exploration Period, the Applicant purchased and acquired digital copies of 2D and 3D seismic data, well data, and regional reports from the Petroleum Agency of South Africa (PASA). As part of the minimum work programme the Applicant performed regional mapping, basin modelling studies, well log interpretation, and quantitative rock physics and amplitude versus offset (AVO) seismic attribute analysis on legacy 2D and 3D seismic data. In 2022, the Applicant completed reprocessing 2,020 km^2 of legacy 3D seismic survey, therefore, exceeding the minimum work commitment for the exploration period.

The remaining work programme for that exploration period includes the interpretation of recently reprocessed 3D seismic, geologic studies to rank prospects, and recommendations for exploratory drilling candidates. The reprocessing effort was successful in terms of providing improved seismic imaging and further de-risking the existing prospect inventory and has helped the Applicant identify new prospects.

On expiry of the Initial Exploration Period of the ER the JV applied to enter into the First Renewal Period. On 23 September 2022 the Director-General of DMRE, duly delegated to act on behalf of the Minister of DMRE, granted the entry into the First Renewal Period. The PASA informed the JV of the aforementioned grant on 27 October

2022 and as such, the First Renewal Period commenced on 27 October 2022 and ends on 26 October 2024. The minimum work commitment includes the following:

- Reprocess 1,500 km^2 of 3D Seismic applying Pre-stack Depth Migration;
- Seismic Interpretation of the newly reprocessed seismic data in the Northern Area;
- Seismic AVO analysis of prospects identified on the newly re-processed seismic data;
- Update regional source rock and reservoir models developed during the Initial Exploration Phase with results from the recent wells in the Deepwater Orange Basin;
- Update Prospect Inventory (Volumes and Ranking); and
- Conduct commercial evaluation of high-graded prospects to determine the risked value, or the risk versus reward of the best prospects.

3.1.1 REGIONAL SETTING OF THE ORANGE BASIN

According to the literature and exploration activity associated with Block 3B/4B to date, it was reported that there is evidence and confirmation that several petroleum systems sourced from known source rocks are developed in the Orange Basin as shown in Figure 16 below. Evidence for Aptian source rocks has been reported by a number of authors and there is also evidence for the presence of an active Cenomanian/Turonian source rock. These oil and gas systems contain a number of exploration plays and several prospects and leads were identified, which have been evaluated and reviewed by a number of companies previously active in exploration in South Africa. The Albian stratigraphic structural play has been confirmed in several gas discoveries off South Africa, the best of which is the A-K1 (Ibhubesi gas field), as shown in Figure 17 below.

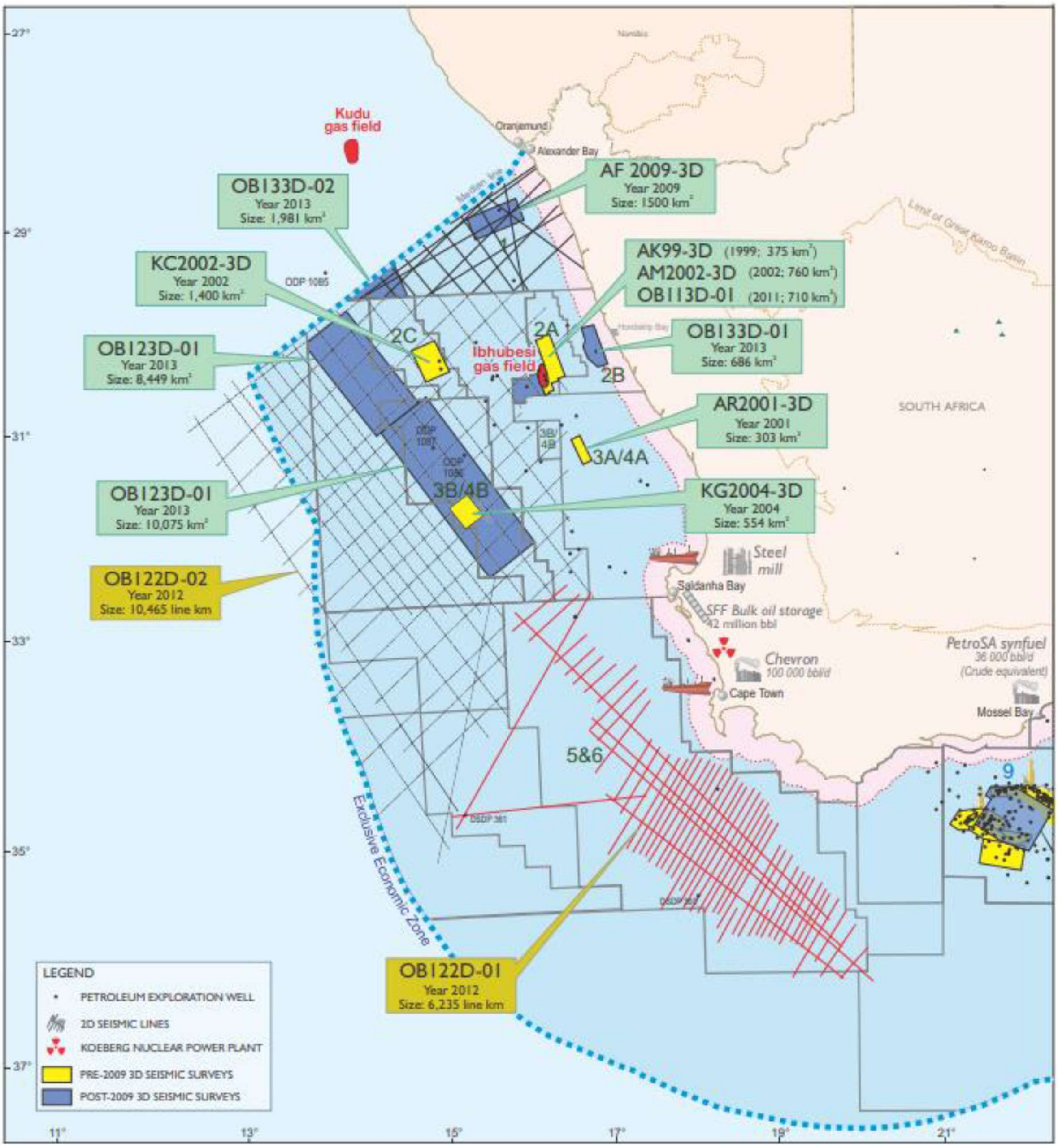


Figure 16: Regional setting highlighting a subset of the wells, seismic surveys, exploration wells and discoveries in the Orange Basin.

The A-F1 gas discovery confirmed the following key parameters:

- Tested approximately 32 MMscf/d;
- 17 m fluvial sandstone;
- Albian play;
- Porosities 20-26%; and
- Incised valley system.

Within the syn-rift succession, the only oil system confirmed to-date occurs in the isolated A-J half-graben (Figure 18 below). The oil is sourced from typically rich Hauterivian lacustrine shales within the half-graben and is trapped stratigraphically within lake shore-line sandstones interbedded with the source shales. The maximum flow rate reached whilst testing was approximately 200 barrels per day of oil.

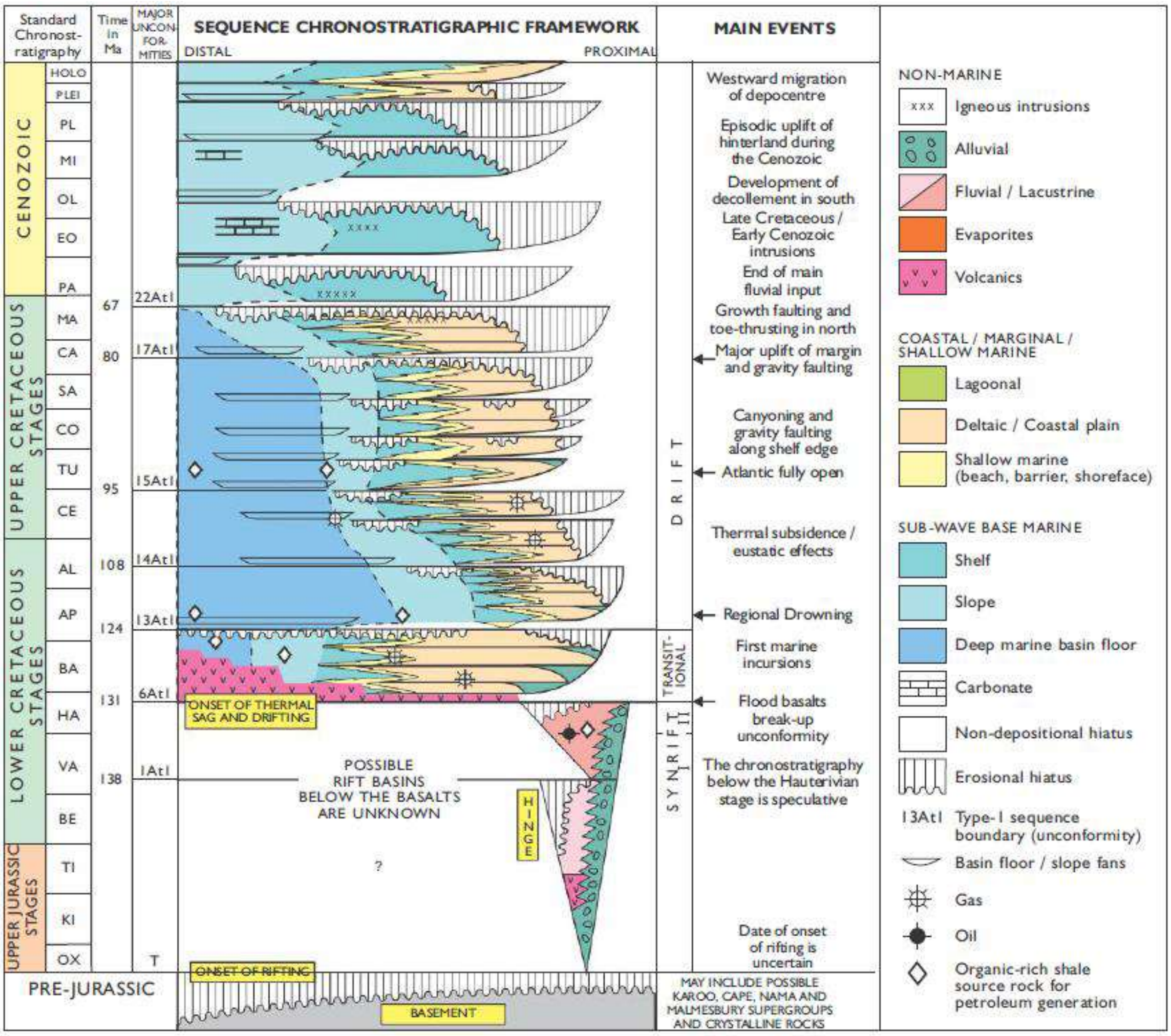


Figure 17: Generalised chronostratigraphic Geological Column of the Orange Basin.

It is anticipated that there is also significant potential in other syn-rift grabens to the north and south of the A-J Graben and there is potential for significant gas and light oil discoveries in the shallower sequences above the rift graben succession in the outboard areas of Block 3B/4B.

Two main source rock units are known to occur in the Orange Basin which includes:

- Late Hauterivian synrift source rock;
- Barremian-early Aptian source rock; and
- Indication of a regionally developed Cenomanian-Turonian source rock.

Each of these marine condensed sequences is associated with the three main phases of basin development in the Orange Basin, namely the rift, early drift, complete drift phases.

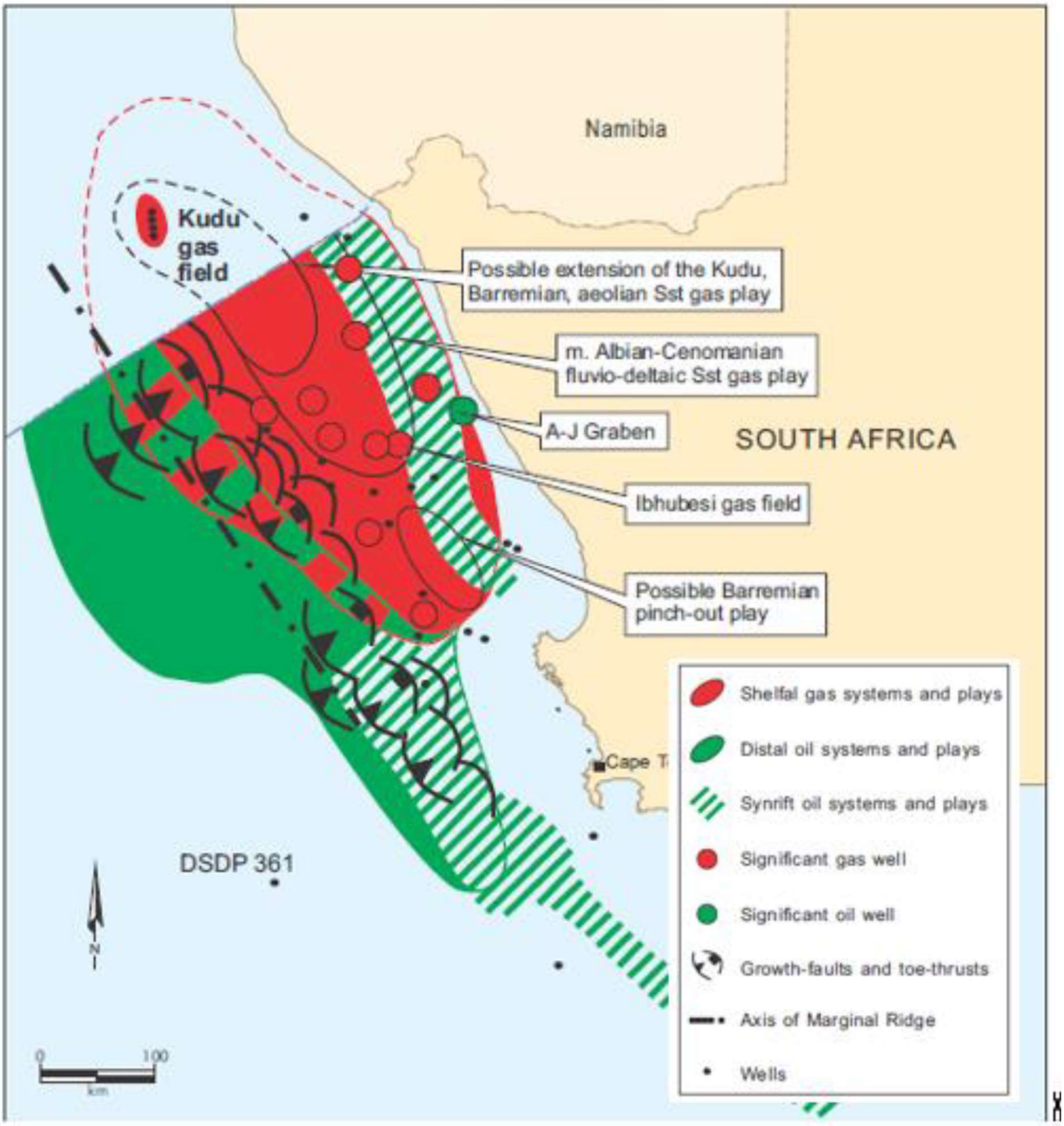


Figure 18: Main and postulated petroleum systems in the southern Orange Basin.

3.1.2 REGIONAL SETTING AND GEOLOGY ASSOCIATED WITH BLOCK 3B/4B

Exploration in the Orange Basin has historically targeted Cretaceous shelf sequences in shallow water areas, inboard of Block 3B/4B. Before the major Graff and Venus discoveries in 2022, very few discoveries had been made. Early exploration had focused mainly on targets in relatively shallow water, the most notable being the Kudu gas discovery in southern Namibia (in aeolian, shallow-marine Barremian reservoirs), the Ibhubesi gas discovery (in Aptian-Albian shallow-marine fluvio-deltaics) and the small A-J1 oil field (in Hauterivian syn-rift and lacustrine clastics).

In 2009, Shell was granted an Exploration Right to explore the deepwater area to the west in deep and ultra-deep water. Shell expanded their exploration activity into Namibia which has led to their recent light oil and gas discoveries in Cretaceous age turbidite reservoirs as encountered in the Graff-1, La Rana-1 and Jonkers-1 discovery wells in 2022 and 2023. Similarly, Total Energies have joined this activity and maintain a large position in the deep water and ultra-deepwater licenses of the Orange Basin. In Namibia, TotalEnergies and partners announced a significant light oil discovery in Cretaceous turbidite fans. These along with Luiperd and Brulpadda discoveries reportedly benefit from strong seismic amplitude, or AVO seismic signatures.

Prospects in Block 3B/4B will target turbidite fan deposits of similar age and seismic response to the discoveries made by both Total Energies and Shell. Traps are generally combination structural-stratigraphic traps, with siliciclastic reservoirs confined within channels, or deposited as turbidite fans fully encased in shales.

Block 3B/4B lies within the Orange Basin which extends from South Africa as far north as the Lüderitz Arch in Namibia. The basin formed from the breakup of the African and South American continents starting in Jurassic time. The early syn-rift basin fill consists of both siliciclastics, and carbonates deposited during the Late Jurassic and Early Cretaceous eras (Figure 17: Note multiple unconformities occur through the Upper Cretaceous transporting sands into the deepwater basin). This was followed by deposition of Aptian-Albian aged organic-rich shales deposited in a marine restricted environment. These regionally extensive marine shales are the primary source rock for the Orange Basin.

Following deposition of the Aptian-Albian marine source rocks, separation of the continents continued during what is referred to the 'drift' stage, where sediments from major proto rivers deposited large quantities of clastic sediments as fluvial-deltaic deposits in the nearshore areas. Further offshore, where Block 3B/4B is located, Cretaceous clastic sediments were deposited at the paleo shelf edge and slope as turbidites. Two ancient river systems provided sediments to the nearshore and offshore areas of Block 3B/4B during the Upper Cretaceous, the Orange River to the north, and the Olifants River located immediately east of Block 3B/4B.

The shelf areas of the Orange Basin east of Block 3B/4B have been explored with more than 38 wells, most of which were drilled in water depths of 500 m or less. While these wells did not target the same depositional environments that are being targeted in Block 3B/4B, the wells do provide information about the stratigraphy of the Upper Cretaceous sediments east of Block 3B/4B. For example, wells located on the shelf confirm the presence of sandstone input into the area, and also confirm the presence of Cretaceous source rocks that are key to a working petroleum system.

Sediments of Albian age were deposited in the shelfal areas by distributary meandering channels on the lower to middle shoreface of a delta front. Proportions of sand up to 63% are noted and a general trend of decreasing sand proportions across the shelf is observed, with approximately 60% sand in proximal wells such as A-K1 and P-Fl, and very low proportions sand (4% to 5%) deposited in distal wells such as A-C3 and K-A2. Where tested, these Albian sandstones have good porosity and permeability and produced good flow rates.

In the Ibhuhesi field, located east of Block 3B/4B, Albian deltaic sandstone reservoirs achieved rates greater than 30 MMscf/d from individual reservoir zones.

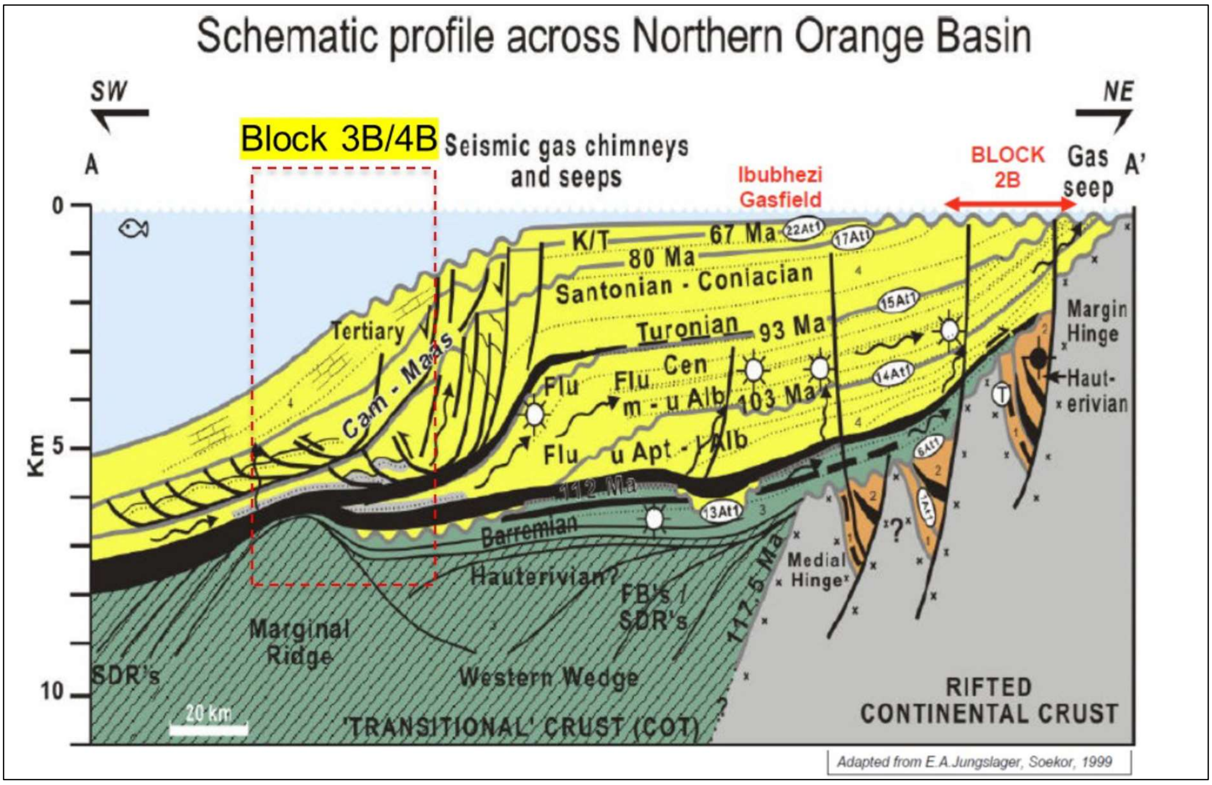


Figure 19: Schematic seismic profile showing location of Block 3B/4B within continental slope deposits.

Structural deformation, or faulting is not prominent in Cretaceous sediments of Block 3B/4B although some minor faulting and soft-sediment deformation has occurred in some rather limited intervals within the Cretaceous or Tertiary sections. However, a prominent topographic high referred to as the 'Outer Ridge' or 'Outer High' provides an important structural element for Block 3B/4B. This feature was a topographic high during deposition of the Aptian-Albian time and in some areas the key source rock interval is thin or absent over this Outer High (Figure 19 and Figure 20).

Similarly, the Outer High affected deposition of Albian turbidite fans which in some areas ponded, thinned, or pinched-out against this topographic feature. Lower areas or 'gaps' in the Outer High allowed turbidite sediments to more easily reach deepwater outboard areas. The Venus and Graff discoveries in Namibia are located seaward of one these 'gaps' in the Outer Ridge where sediments could more easily funnel through to more distant slope and deepwater areas. In Block 3B/4B one of the larger prospects in the inventory, 'Fan-S', is a turbidite fan that thins and truncates against the Outer High, forming a combination structural-stratigraphic trap. Further offshore, and in the area of Block 3B/4B, these Albian sandstones were deposited as turbidite channels and fans and form one of the principal reservoir targets.

Following deposition of Cretaceous sediments, Tertiary deposition continued with the development of an aggrading shelf margin with little or no deformation. Later phases of deposition during the Tertiary are characterized in some areas by instability resulting in development of a coupled growth fault and toe thrust system but these are not prominent in Block 3B/4B and have not been a focus for developing the prospect inventory. The current prospect inventory does not include any prospects of Tertiary age, but this shallow section could contain thermogenic gas generated deeper in the Cretaceous section. Tertiary deposition is most significant from the prospective of source maturation in Block 3B/4B, as it is the timing and thickness of Tertiary deposition that drives the maturation of Cretaceous source rocks in Block 3B/4B.

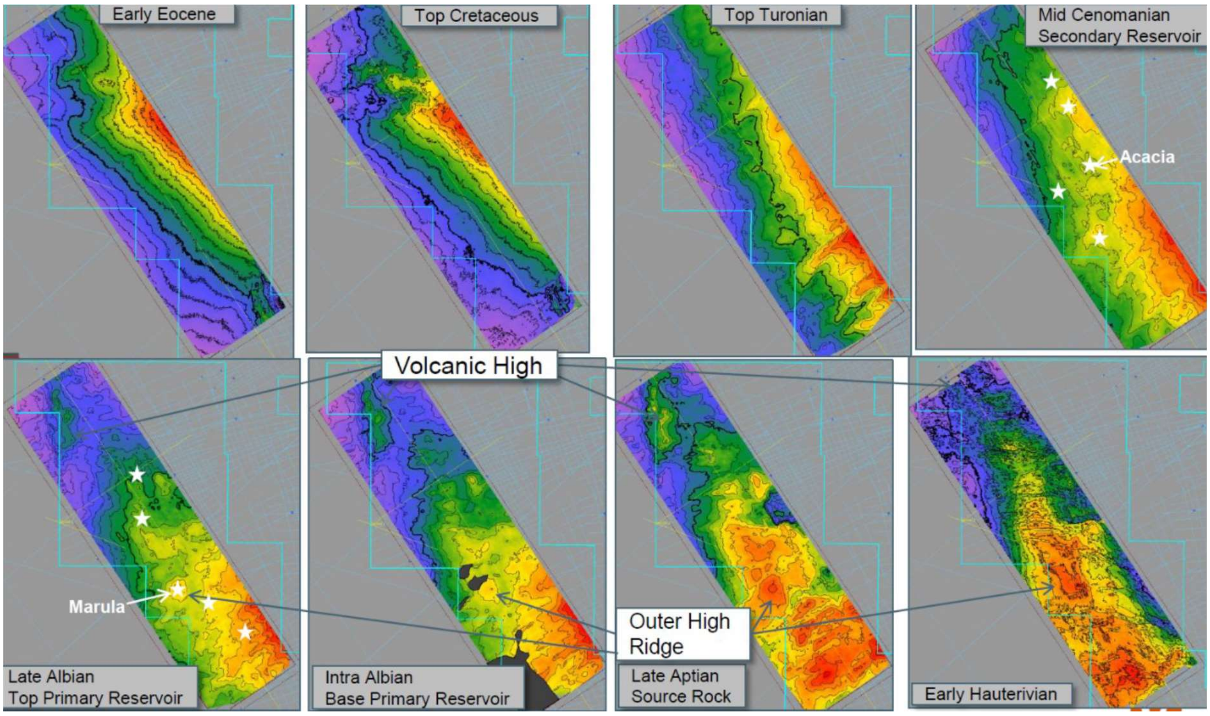


Figure 20: Blockwide structure maps from Early Cretaceous through Eocene time for Block 3B/4B.

Shelfal well K-D1, was used as a key well for well-ties into Block 3B/4B seismic because of the total depth of penetration (Figure 21). Unfortunately, well K-D1 did not penetrate the Late Cretaceous turbidite feeder channels that would have helped the correlation of sands in the deepwater section.

3.1.3 SOURCE ROCKS

Cretaceous Aptian-Albian and Barremian shales have been identified as the primary source rocks in the Orange basin. Wells located inboard and adjacent to Block 3B/4B provide key evidence for source rock quality and maturity. Potential source rocks of Aptian and or Albian age are penetrated in wells A-F1, A-E1, K-A2, A-C2, PA-1, 0-A1, and DSDP-360. These source rocks are generally characterized by modest total organic carbon (TOC)'s (2% to 3%) with kerogen types that are indicative of mixed oil and gas-prone source rocks. To the west of the Outer High, source rocks are expected to be more oil prone due both to their lower maturity and less terrigenous clastic input. This interpretation is based not only on the recent light oil and west gas discoveries by Shell and Total Energies, but by data provided by DSDP8-361 located southwest of Block 3B/4B which encountered Aptian organic-rich black shales with TOC content up to 25% with a thermal maturity capable of oil and wet gas generation.

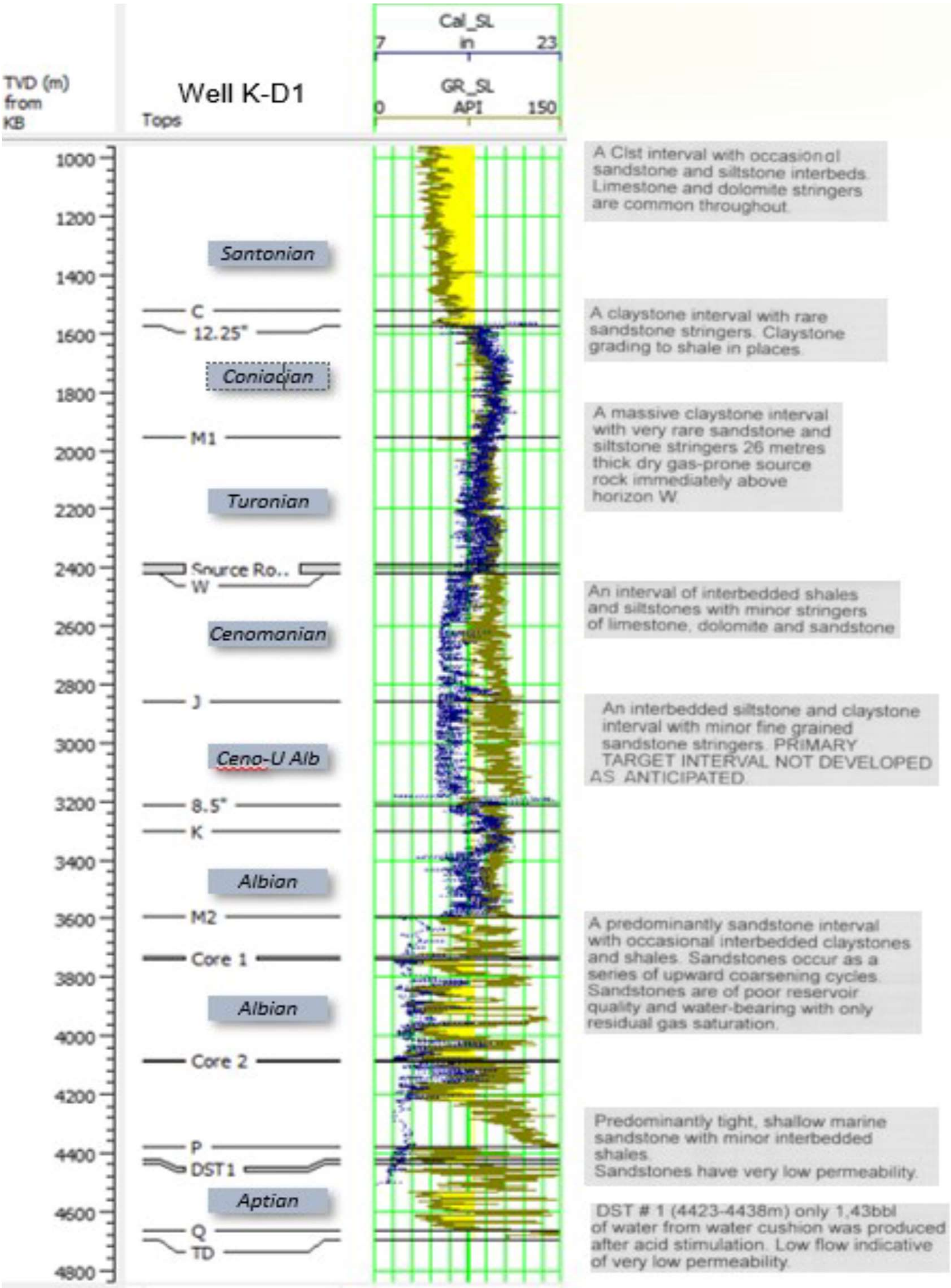


Figure 21: Summary log from the shelfal well K-D1, used as a key well for well-tie into Block 3B/4B seismic data.

Inboard of Block 3B/4B basin these source rocks are in the gas window as evidenced by the discoveries to date. However, Tertiary and Late Cretaceous overburden thins westwards towards Block 3B/4B, and basin models suggest that source rocks are less mature and in the oil window (Figure 22: Note absence of source rocks on Outer High). This Modelling prediction is supported by the recent light oil and wet gas discoveries by Shell and TotalEnergies along trend in Namibia.

Based on the source rock analysis in this outboard region of Block 3B/4B, it is interpreted that the hydrocarbon type that is expected to be found at the predicted reservoir level will be very similar to that discovered in the recent Brulpadda and Luiperd condensate discoveries where the primary Aptian source is oil prone however this interval has gone through the oil window and entered into the wet gas generating window. This results in substantial amounts of a very wet gas being generated which then migrates and accumulates in the primary reservoir sequence. When this hydrocarbon accumulation is produced to surface both condensate ("light oil") with an API of 42-25 degrees, and wet gas are recovered. Important in this play is that the formation temperature within the source sequence is controlled by the variable overburden which is very thick in the block thinning outboard towards the west into the Orange Basin.

In summary the expected hydrocarbon type to be discovered and produced is predicted to be condensate with significant associated wet gas. This is opposed to black oil which may be developed further outboard where the overburden is less and the Aptian source is within the mid oil window.

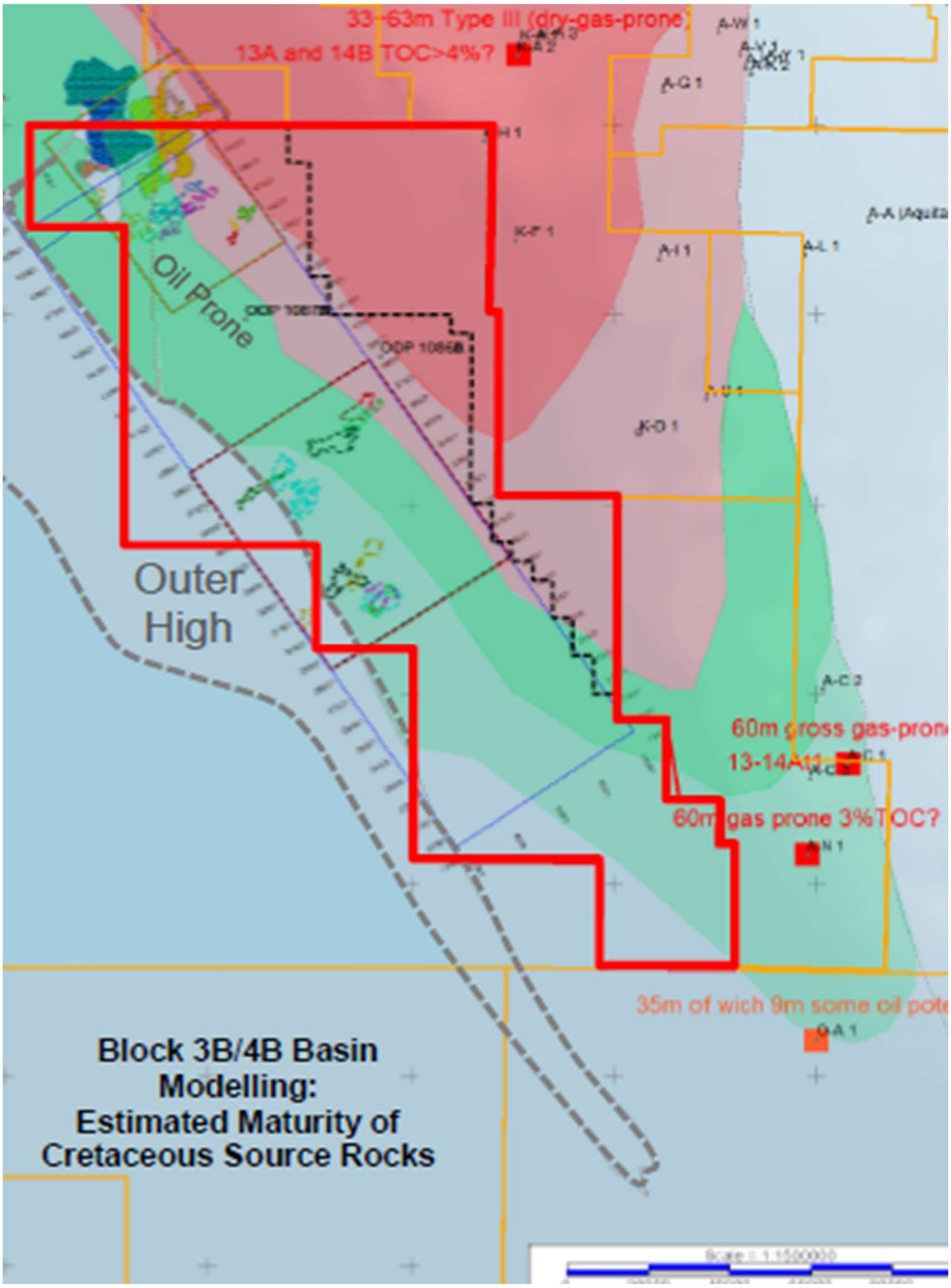


Figure 22: Source Rock maturity map for Aptian-Albian source rocks in the Southern Orange Basin.

3.1.4 RESERVOIRS

Expected porosity and permeability ranges for potential Cretaceous reservoirs in Block 3B/4B have been derived from depth versus porosity cross plots based on available well control, most of which are located to the east of Block 3B/4B. Since prospects in Block 3B/4B are targeting different facies (turbidite sandstones versus fluvial-deltaics), analog data from other deepwater discoveries has also been incorporated into estimates for reservoirs parameters. The work of Bjorkum *et al*. (1998) for example provides a useful reference for estimating porosity of Upper Cretaceous sandstones deposited in a turbidite setting and buried to depths of 3 km to 4 km with a temperature gradient of circa 30°C/ km.

Primary reservoir targets in Block 3B/4B are as follows:

- Santonian or 'Upper Cretaceous' age sandstones deposited in turbidite channel and fan systems at the slope margin.
- Cenomanian-Turonian age sandstones deposited in turbidite channel and fan systems at the slope margin and outer slope.
- Albian sandstones deposited as turbidites as basin floor fans.

Studies of analog reservoirs in the Orange Basin have shown that diagenetic alteration can reduce porosity and permeability by quartz overgrowth and authigenic chlorite precipitation. In some cases, the presence of chlorite has proven to inhibit quartz overgrowths, thereby preserving porosity. However, an abundance of chlorite can reduce permeability, which can also be improved or degraded by other factors such as sorting. For prospects in Block 3B/4B porosities are generally considered to have a P50 of 20%, increasing to 25% where reservoirs are shallower and thickest.

Permeabilities are expected to be in the 10's to 100's of millidarcies based on limited well penetrations and analog data. The expectation for low viscosity light oil is expected to offset lower permeabilities and flow rates above 10,000 barrels of oil per day (bopd) can be achieved based on analogue data from similar reservoirs, pressures, and fluid characteristics.

Seismic attributes and particularly AVO analysis has been a particularly good tool for identifying potential reservoir targets in the upper Cretaceous sequences of the Orange Basin. While calibration to well control is required for porosity and fluid prediction, in the absence of nearby well control and as a qualitive indicator, AVO analysis forms the most robust exploration tool for identifying sandstone turbidites in Block 3B/4B. Although seismic amplitude responses are non-unique, when AVO anomalies conform to depth this may be indicative of fluid contacts, which greatly increases the chance of encountering hydrocarbons. Several prospects within the Block 3B/4B prospect inventory exhibit some conformance to depth contours.

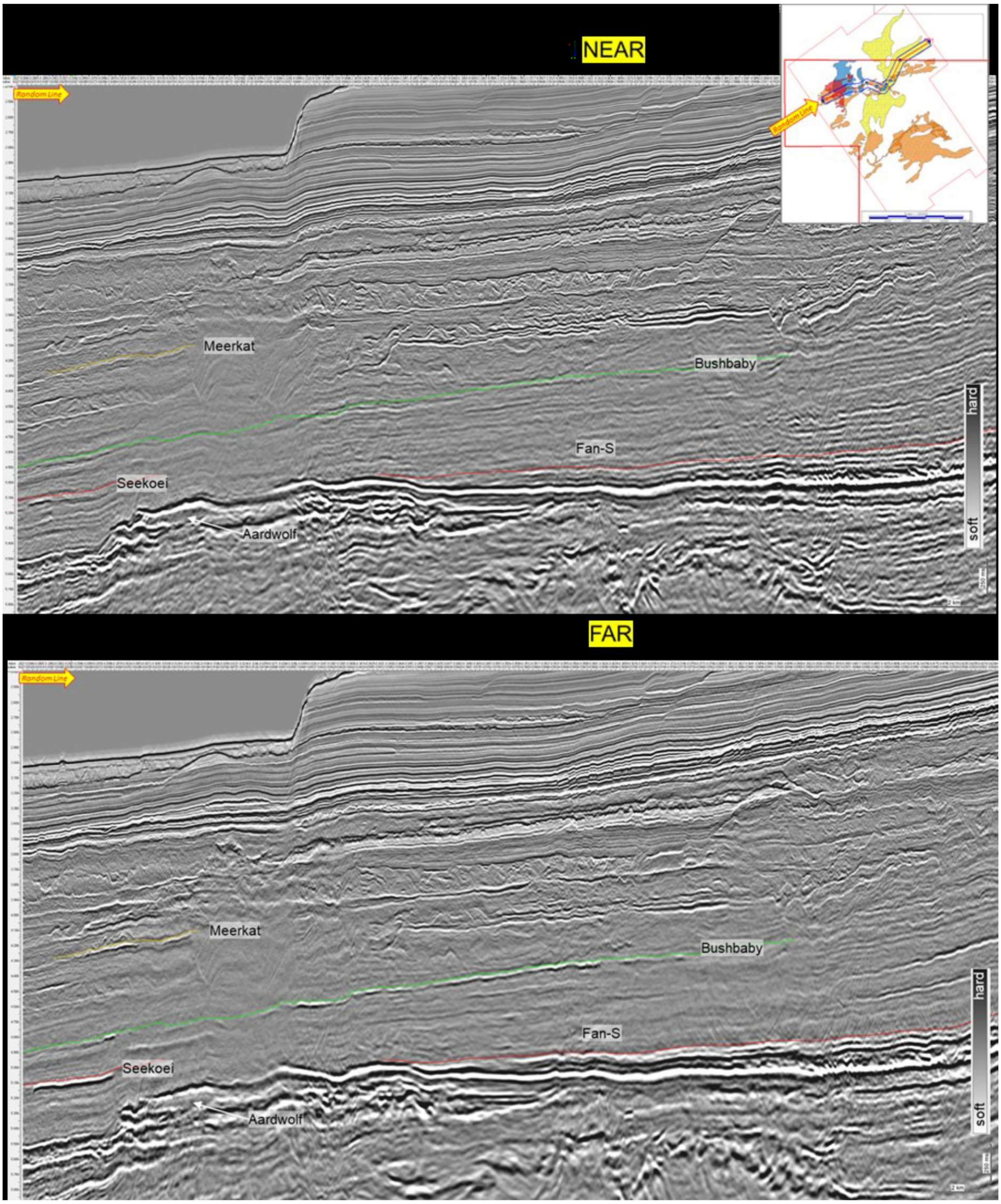


Figure 23: Examples of Near- and Far offset seismic data showing prospective reservoir targets in the Northern Area.

3.1.5 PLAY TYPES

Prospects within the Block 3B/4B inventory all target Cretaceous reservoirs that are expected to contain hydrocarbons sourced from Aptian-Albian source rocks below, and therefore all part of a single proven petroleum system. Inboard of Block 3B/4B, source rocks have more overburden and deeper burial has pushed source rocks into the gas window. Within Block 3B/4B and source rocks are generally in the oil, or wet gas window, becoming more oil prone to the west as overburden is thinner.

Within this proven petroleum system there are at least four general play types (Figure 24 and Figure 25). The first three are similar in that they all rely on stratigraphic trapping and the key tools for identifying prospects rely on seismic attributes. Sand bodies are identified based on amplitude, relative impedance, AVO characteristics, shear modulus, and cross plots of these various attributes to produce relationships such as 'Fluid Factor' that can provide insight to fluid composition within reservoir targets.

Prospects are high graded if they show evidence of an up-dip pinchout for trapping. AVO anomalies with strong increase in FAR angle gathers are ranked higher, and AVO anomalies that have conformance to depth, indicative of a possible fluid contact are ranked with the highest chance of success.

- Santonian or 'Upper Cretaceous' Turbidite Play - target reservoirs are turbidite sandstones deposited in an outer slope environment.
    - Reservoir: turbidite sandstones 10 m to 30 m thick, often stacked;
    - Reservoir Geometry: channelized, overbank, splays, and basin-floor fans;
    - Traps: stratigraphic or combination traps relying on up-dip truncation of feeder channels;
    - De-risking Elements: clear imaging of updip pinchout, strong AVO anomalies (Class II or III), conformance of AVO anomaly with depth contours.
    - Cenomanian-Turonian Turbidite Play - turbidite sandstones deposited in an outer slope environment; with the same prospecting characteristics as above.
    - Albian Basin Floor Fan - similar characteristics to Plays 1 and 2, except that sand bodies tend to be more widespread and fan-shaped due to their deposition on the basin floor. In these low gradient areas sand deposition is heavily influenced by subtle changes in topography, such as the Outer High.
    - Barremian-Aptian Carbonate Ramp Play - characterized by positive features of Albian age located in close association with the Outer High and interpreted as isolated carbonate platforms or ramps. Prospects often exhibit internal seismic reflections with clinoform geometry. Similar leads have been recognized along the Outer High and into Namibia. No carbonates have been encountered at this stratigraphic level in any of the inboard wells. The closest penetration of carbonates in the deepwater trend is Moosehead- 1 and reservoir risk is deemed high as a result.

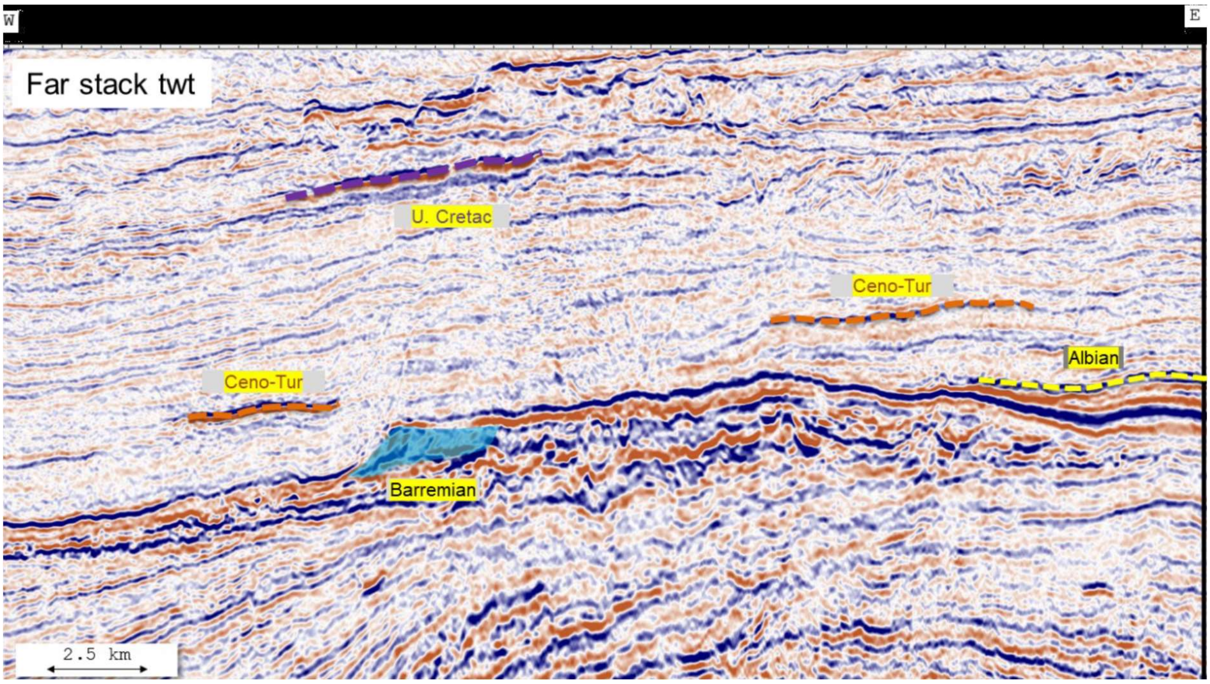


Figure 24: Examples of the 4 primary play types in Block 3B/4B.

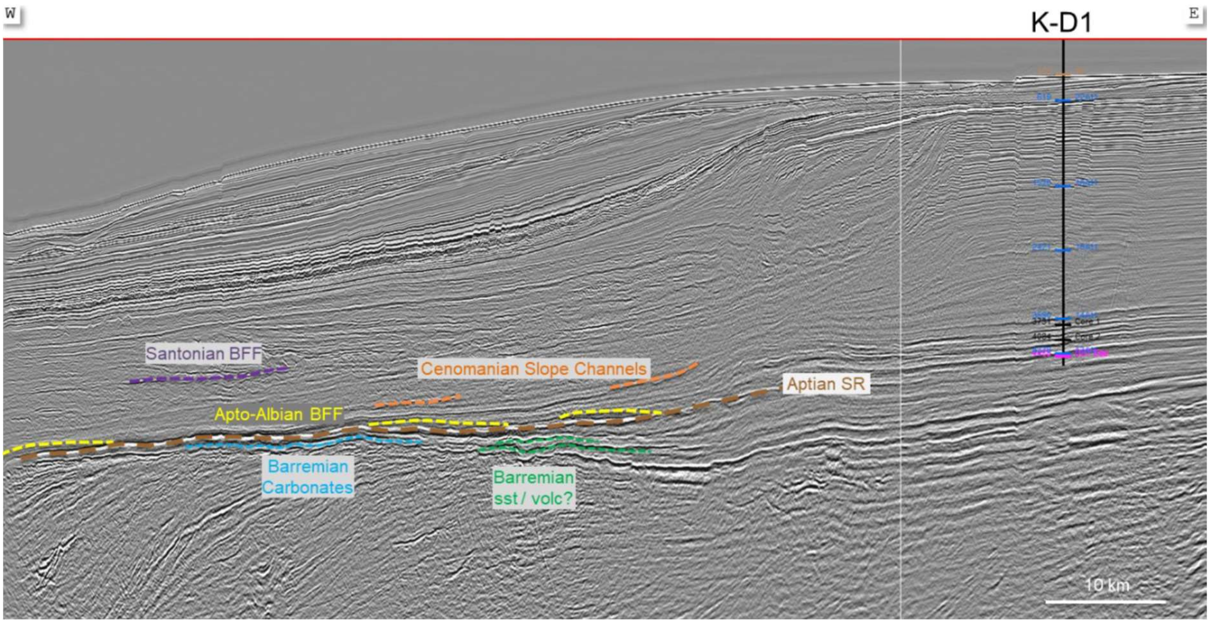


Figure 25: Examples of the four primary play types in Block 3B/4B, showing tie to well K-D1.

3.2 PRIOR ADMINISTRATIVE DECISIONS

On 28 November 2018, the Minister granted an environmental authorisation to Ricocure (Pty) Ltd. Ricocure applied for and was granted an environmental authorisation on the basis of its final scoping report because the proposed work programme commitments were of a non-invasive nature in that it entailed only desktop studies. Accordingly, the results of the final scoping report were that there were no environmental or social impacts associated with the proposed desktop studies and therefore an environmental impact assessment and an environmental management programme was not required. The Minister granted the environmental authorisation accordingly on 28 November 2018 and on 4 December 2018 all registered i&APs were notified of this decision as is required under regulation 4(2) of the Environmental Impact Assessment Regulations, and on 27 March 2019 the Minister granted exploration right referenced 12/3/339 to Ricocure.

On 23 September 2022 the Director-General of the DMRE granted a renewal of the exploration right. As part of the renewal application, the Applicant requested a deferment of the 20% area relinquishment obligation until such time as the Marine Protected Areas within Block 3B/4B have been finalised at which stage an appropriate relinquishment would be made so as exclude such areas. The application for deferment of the relinquishment obligation was granted by the Director-General of the DMRE on 23 September 2022 as part of granting of the renewal of the exploration right.

3.3 DESCRIPTION OF ACTIVITIES TO BE UNDERTAKEN

Hydrocarbon deposits occur in reservoirs in sedimentary rock layers. Being lighter than water they accumulate in traps where the sedimentary layers are arched or tilted by folding or faulting of the geological layers. Exploration drilling activities are one of the primary geophysical methods for locating such deposits. The below activities are expected to be undertaken as part of the proposed exploration for oil and gas. It should be noted that the project described in this EIA Report, relates to exploration activities only. No production activities have been assessed as part of this Scoping and EIA Process – any production related activities would be subject to a separate production right application, including a new Scoping and EIA Process.

3.3.1 PRE-DRILLING SURVEYS

Pre-drilling surveys may be undertaken prior to drilling in order to confirm baseline conditions at the drill site and to identify and delineate any seabed and sub-seabed geo-hazards that may impact the proposed exploration drilling operations. Pre-drilling surveys may involve a combination of sonar surveys, sediment sampling, water sampling and ROV activities.

3.3.1.1 **SONAR SURVEYS**

Pre-drilling sonar surveys may involve multi- and single beam echo sounding and sub-bottom profiling. These surveys would not be limited to a specific time of the year but would be of short duration (around 10 days per survey) and focused on selected areas of interest within the block. The interpretation of the survey would take up to four weeks to complete.

3.3.1.2 **ECHO SOUNDERS**

The majority of hydrographic depth/echo sounders are dual frequency, transmitting a low frequency pulse at the same time as a high frequency pulse. Dual frequency depth/echo sounding has the ability to identify a vegetation layer or a layer of soft mud on top of a layer of rock. it is proposed to utilise a single beam echo-sounder with a frequency range of 38 to 200 kHz. In addition, it is proposed to also utilise multibeam echo sounders (70 - 100 kHz range and 200 dB re 1µPa at 1m source level) that are capable of receiving many return "pings". This system produces a digital terrain model of the seafloor.

3.3.1.3 **SUB-BOTTOM PROFILERS**

Sub-bottom profilers are powerful low frequency echo-sounders that provide a profile of the upper layers of the ocean floor. Bottom profilers emit an acoustic pulse at frequencies ranging between 2 and 16 kHz, typically producing sound levels in the order of 200-230 db re 1µPa at 1m.

3.3.1.4 **SEABED SEDIMENT CORING**

Seabed sediment sampling may involve the collection of sediment samples in order to characterise the seafloor and for laboratory geochemical analyses in order to determine if there is any naturally occurring hydrocarbon seepage at the seabed or any other type of contamination prior to the commencement of drilling.

No specific target area has as yet been identified for the sediment sampling. It is currently anticipated that up to 20 samples could be taken across the entire area of interest (AOI) potentially removing a cumulative volume of ~ 35 m^3. The sediment sampling process would take between three to five weeks to complete, depending on weather conditions.

Piston and box coring (or grab samples) techniques may be used to collect the seabed sediment samples. These techniques are further described below.

3.3.1.5 **PISTON CORING**

Piston coring (or drop coring) is one of the more common methods used to collect seabed geochemical samples. The piston coring rig is comprised of a trigger assembly, the coring weight assembly, core barrels, tip assembly and piston. The core barrels are 6 - 9 m in lengths with a diameter of 10 cm.

The recovered cores are visually examined at the surface for indications of hydrocarbons (gas hydrate, gas parting or oil staining) and sub-samples retained for further geochemical analysis in an onshore laboratory.

3.3.1.6 **BOX CORING**

Box corers are lowered vertically to the seabed from a survey vessel by. At the seabed the instrument is triggered to collect a sample of seabed sediment. The recovered sample is completely enclosed thereby reducing the loss of finer materials during recovery. On recovery, the sample can be processed directly through the large access doors or via complete removal of the box and its associated cutting blade. The Applicant is proposing to take box core samples (50 cm x 50 cm) at a depth of less than 60 cm.

3.3.2 WELL LOCATION AND DRILLING PROGRAMME

The Applicant is proposing to drill 1 exploration well, with the option to drill up to four additional wells within an AOI within Block 3B/4B. The expected target drilling depth is not confirmed yet and a notional well depth of 3 750 m below sea floor (Water depth range 500 -1700m) is assumed at this stage. It is expected that it would take approximately three to four months to complete the physical drilling and testing of each well (excluding mobilisation and demobilisation). The applicant's strategy for future drilling is that drilling could be undertaken throughout the year (i.e. not limited to a specific seasonal window period).

The schedule for drilling the wells is not confirmed yet; however, the earliest anticipated date for commencement of drilling is third quarter of 2024 (Q3 2024) and is expected to take approximately 90 days per well.

3.3.3 MAIN PROJECT COMPONENTS

3.3.3.1 **DRILLING UNIT OPTIONS**

Various types of drilling technology can be used to drill an exploration well (e.g. barges, jack-up rigs, semi-submersible drilling units (rigs) and drill-ships) depending on, inter alia, the water depth and marine operating conditions experienced at the well site. Based on the anticipated sea conditions, the Applicant is proposing to utilise a semi-submersible drilling unit or a drill-ship, both of which utilise dynamic positioning systems suitable for the harsh deep-water marine environment in the AOI. The final rig selection will be made depending upon availability and final design specifications.

A semi-submersible drilling unit (Figure 26, right) is essentially a drilling rig located on a floating structure of pontoons. When at the well location, the pontoons are partially flooded (or ballasted), with seawater, to submerge the pontoons to a pre-determined depth below the sea level where wave motion is minimised. This gives stability to the drilling vessel thereby facilitating drilling operations.

A drill-ship (Figure 26, left) is a fit for purpose built drilling vessel designed to operate in deep water conditions. The drilling "rig" is normally located towards the centre of the ship with support operations from both sides of the ship using fixed cranes. The advantages of a drill-ship over the majority of semi-submersible units are that a drill-ship has much greater storage capacity and is independently mobile, not requiring any towing and reduced requirement of support vessels.

Figure 26: Examples of drilling equipment.

3.3.3.2 **SUPPORT VESSELS**

The drilling unit would be supported / serviced by up to three support vessels, which would facilitate equipment, material and waste transfer between the drilling unit and onshore logistics base. A support vessel will always be on standby near the drilling unit to provide support for firefighting, oil containment / recovery, rescue in the unlikely event of an emergency and supply any additional equipment that may be required. Support vessels can also be used for medical evacuations or transfer of crew if needed.

3.3.3.3 **HELICOPTERS**

Transportation of personnel to and from the drilling unit would be provided by helicopter from Springbok Airport (fixed wing trip from Cape Town) using local providers. It is estimated that there may be up to four return flights per week between the drilling unit and the helicopter support base at Springbok (i.e. 17 weeks (~120 days) x 4 = 68 trips per well). The helicopters can also be used for medical evacuations from the drilling unit to shore (at day- or night-time), if required, in which case the flights are likely to be directly to Cape Town.

3.3.3.4 **ONSHORE LOGISTICS BASE**

The primary onshore logistics base will most likely be located at the Port of Cape Town (preferred option), but alternatively at the Port of Saldanha. The shore base would provide space for the storage of materials, consumables and equipment that would be shipped to the drilling unit and back to storage for onward international freight forwarding. The shore base would also be used for offices, waste management services, bunkering vessels, and stevedoring / customs clearance services.

3.3.4 MOBILISATION PHASE

The mobilisation phase will entail the required notifications and permitting, the establishment of the onshore base, appointment of local service providers, procurement and transportation of drilling equipment and materials from various ports and airports, accommodation arrangements and transit of the drilling unit and support vessels to the drilling area. The drilling unit and support vessels could sail directly to the well site from outside South African waters or from a South African port, depending on which drilling unit is selected, and where it was last used.

Core specialist and skilled personnel would arrive in South Africa onboard the drilling unit and the rest of the support personnel will be flown to Cape Town for crew change. Drilling materials, such as casings, mud components and other equipment and materials will be brought into the country on the drilling unit itself or imported via a container vessel directly to the onshore logistics base from where the support vessels will transfer it to the drilling unit. Cement and drilling chemicals will be sourced locally, where available.

3.3.5 OPERATION PHASE

3.3.5.1 **FINAL SITE SELECTION AND SEABED SURVEY**

The selection of the specific well locations will be based on a number of factors, including further detailed analysis of the 3D seismic data and pre-drilling survey interpretation and the geological target. A Remote

Operating Vehicle (ROV) will be used to finalise the well position based on inter alia the presence of any seafloor obstacles or the presence of any sensitive features that may become evident.

3.3.5.2 WELL DRILLING OPERATION

The well will be created by drilling a hole into the seafloor with a drill bit attached to a rotating drill string, which crushes the rock into small particles, called “cuttings”. After the hole is drilled, casings (sections of steel pipe), each slightly smaller in diameter, are placed in the hole and permanently cemented in place (cementing operations are described below). The hole diameter decreases with increasing depth.

The casings provide structural integrity to the newly drilled wellbore, in addition to isolating potentially dangerous high-pressure zones from each other and from the surface. With these zones safely isolated, and the formation protected by the casing, the well will be drilled deeper with a smaller drill bit, and also cased with a smaller sized casing. For the current project, it is anticipated that there will be five sets of consecutively smaller hole sizes drilled inside one another, each cemented with casing, except the last phase that will remain an open hole.

Drilling is undertaken in two stages, namely the riserless and risered drilling stages (Figure 27). A typical well design is summarised in Table 5. The final well design depends upon factors such as planned depths, expected pore pressures and the location of the anticipated hydrocarbon-bearing formations. Several types of drilling fluids with different compositions and densities would be used for drilling operations. The composition of the muds is provided in Table 4. This may vary slightly depending on the contractor’s selection and may be modified to suit operational needs.

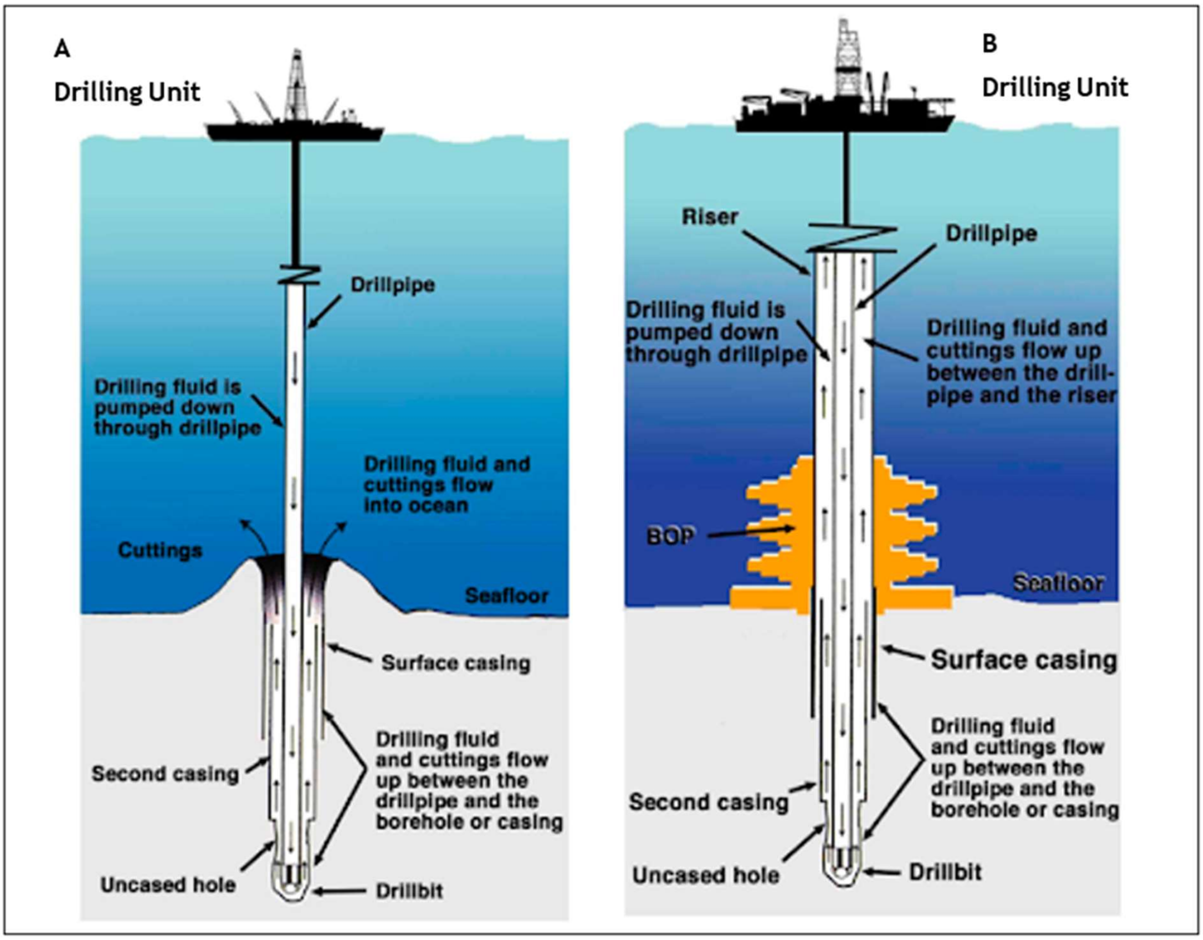


Figure 27: Drilling stages: (a) Riserless Drilling Stage; and (b) Risered Drilling Stage

Table 5: Cuttings and mud volumes per phase for notional base case well design and estimated drilling discharges.

Drill Section	Hole diameter (inches)	Depth of section (m)	Type of drilling fluid used	Mass of drilling fluid discharged (tonnes)	Volume of cuttings released (m^3)	Drilling fluid and cuttings discharge location
Riserless drilling stage						
1	36"	100	Seawater, viscous sweeps & WBM	338	160	At sea bottom
2	26"	775		541	879	
-	Suspension / Displacement before drilling Section 3	-	High Viscous Gel sweeps / KCl Polymer PAD mud	1 047	-	1 m above seabed
Total Riserless		875		1 926	1 039	
Risered drilling stage						
3	17.5"	800	NADF	57	411	10 m below mean sea level
4	12.25"	1 325		46	334	
5	8.5"	750		13	92	
Total Risered		**2 875**		**116**	**837**	
Total		**3 750**		**2 042**	**1 826**	-

Note: * Total quantity of mud discharged including Oil On Cuttings (OOC) @ 6% by weight of cuttings (metricT) + Other constituents.

3.3.5.2.1 INITIAL (RISERLESS) DRILLING STAGE

The process of preparing the first section of a well is referred to as "spudding." Sediments just below the seafloor are often very soft and loose, thus, to keep the well from caving in and to carry the weight of the wellhead, a 30- or 36-inch diameter structural conductor pipe is drilled, or in some cases jetted, and thereafter cemented into place or in some cases jetted.

For the proposed wells, the drill and cement option is preferred. It is usually implemented where the nature of the seafloor sediments (hard sediments) necessitate drilling. A hole of diameter 36 inches will be drilled, and the conductor pipe will be run into the hole and cemented into place. The cement returns exit the bottom of the conductor and travel up the annular space between the conductor and the hole with some cement being deposited on the seabed around the conductor pipe.

When the conductor pipe and low-pressure wellhead are at the correct depth (depending upon substrate strength), a new drilling assembly will be run inside the structural conductor pipe and the next hole section will be drilled by rotating the drill string and drill bit.

Below the conductor pipe, a hole of approximately 26 inches in diameter will be drilled. The rotating drill string causes the drill bit to crush rock into small particles, called "cuttings". While the wellbore is being drilled, drilling fluid is pumped from the surface down through the inside of the drill pipe, the drilling fluid passes through holes in the drill bit and travels back to the seafloor through the space between the drill string and the walls of the hole, thereby removing the cuttings from the hole. At a planned depth the drilling is stopped, and the bit and drill string is pulled out of the hole. A surface casing of 20 inch diameter is then placed into the hole and secured into place by pumping cement through the casing at the bottom of the hole and back up the annulus (the space between the casing and the borehole). The 20-inch casing will have a high-pressure wellhead on top; which provides the entry point to the subsurface and it is the connection point to the Blow-out Preventor (BOP).

These initial hole sections will be drilled using seawater (with viscous sweeps) and water-based mud (WBM). All cuttings and WBM from this initial drilling stage will be discharged directly onto the seafloor adjacent to the wellbore.

3.3.5.2.2 RISERED DRILLING STAGE

The risered drilling stage commences with the lowering of a BOP and installing it on the wellhead. The BOP is designed to seal the well and prevent any uncontrolled release of fluids from the well (a 'blow-out'). A lower marine riser package is installed on top of the BOP and the entire unit is lowered on riser joints. The riser isolates the drilling fluid and cuttings from the external environment, thereby creating a "closed loop system".

Drilling is continued by lowering the drill string through the riser, BOP and casing, and rotating the drill string. During the risered drilling stage, should the WBMs not be able to provide the necessary characteristics, a low toxicity Non-aqueous Drilling Fluid (NADF) will be used. Considering that the wells are planned to be drilled to a total depth of 3500-3750 m below the mud line, temperatures at the bottom of the well (BHST) are in the range of 140°C, with high Pore Pressures for downhole conditions, it is likely that only WBM's would not be suitable. The drilling fluid emerges through nozzles in the drill bit and then rises (carrying the rock cuttings with it) up the annular space between the sides of the hole to the drilling unit.

The cuttings are removed from the returned drill mud, sampled for analysis and the balance of the cuttings are discharged overboard. The rock cuttings are analysed and logged in terms of their depth and rock description, which forms the basis of building a stratigraphic record of the types of rocks penetrated. This information is used to build a stratigraphic column. Any fossils present in the rocks can be used to help establish a geologic age for the stratigraphic layers that are drilled. In instances where NADFs are used, cuttings will be treated to reduce oil content and discharged overboard. Operational discharges are discussed further in Section 3.3.7.1.

The hole diameter decreases in steps with depth as progressively smaller diameter casings are inserted into the hole at various stages and cemented into place. The expected target drilling depth is not yet confirmed but the notional well depth is approximately 3 750 m below the seafloor with a final hole diameter between of 8.5 and 12.25 inches and a casing diameter of between 7 and 9.6 inches.

3.3.5.2.3 CEMENTING OPERATION

Cementing is the process of pumping cement slurry through the drill pipe and / or cement stinger at the bottom of the hole and back up into the space between the casing and the borehole wall (annulus). Cement fills the annulus between the casing and the drilled hole to form an extremely strong, nearly impermeable seal, thereby permanently securing the casings in place. To separate the cement from the drilling fluid in order to minimise cement contamination a cementing plug and/or spacer fluids are used. The plug is pushed by the drilling fluid to ensure the cement is placed outside the casing filling the annular space between the casing and the hole wall.

Cementing has four general purposes:

(v) it isolates formations and segregates the casing seat for subsequent drilling;

(vi) it protects the casing from corrosion;

(vii) it provides structural support for the casing; and

(viii) it stabilises the formation.

To ensure effective cementing, an excess of cement is often used. Until the marine riser is set, excess cement from the first two casings emerges out of the top of the well onto the seafloor. This cement does not set and is slowly dissolved into the seawater.

Offshore drilling operations typically use Portland cements, defined as pulverised clinkers consisting of hydrated calcium silicates and usually containing one or more forms of calcium sulphate. The raw materials used are lime, silica, alumina and ferric oxide. The cement slurry used is specially designed for the exact well conditions encountered.

Additives can be used to adjust various properties in order to achieve the desired results. There are over 150 cementing additives available. The volumes of these additives generally make up only a small portion (<10%) of the overall amount of cement used for a typical well. Usually, there are three main additives used: retarders, fluid loss control agents and friction reducers. These additives are polymers generally made of organic material and are considered non-toxic.

Once the cement has set, a short section of new hole is drilled, then a pressure test is performed to ensure that the cement and formation are able to withstand the higher pressures of fluids from deeper formations.

3.3.5.3 WELL LOGGING AND TESTING

Once the target depth is reached, the well would be logged and could be tested dependent on the drilling results. Well logging involves the evaluation of the physical and chemical properties of the sub-surface rocks, and their component minerals, including water, oil and gas to confirm the presence of hydrocarbons and the petrophysical characteristics of rocks. It is undertaken during the drilling operation using Wireline Logging or Logging While Drilling (LWD) to log core data from the well. Information from engineering and production logs, as well as mud logging, may also be used.

Vertical Seismic Profiling (VSP) is an evaluation tool used to generate a high-resolution seismic image of the geology in the well's immediate vicinity and determine the accurate formation velocity. The VSP images are used for correlation with surface seismic images and for forward planning of the drill bit during drilling. VSP uses a small airgun array with a gun pressure of 450 per square inch (psi), which is operated from the drilling unit at a depth of between 7 m and 10 m. During VSP operations, four to five receivers are positioned in a section of the borehole and the airgun array is discharged approximately five times at 20 second intervals at each station. The generated sound pulses are reflected through the seabed and are recorded by the receivers to generate a profile along a 60 to 75 m section of the well. This process is repeated for different stations in the well and may take up to six hours to complete approximately 125 shots, depending on the well's depth and number of stations being profiled.

Well or flow testing is undertaken to determine the economic potential of the discovery before the well is either abandoned or suspended. One test would be undertaken per exploration well should a resource be discovered and up to two tests per appraisal well. Each test would take up to 7 days to complete (5 days of build-up and 2 days of flowing and flaring). For well flow-testing, hydrocarbons would be burned at the well site. A high-efficiency flare is used to maximise combustion of the hydrocarbons. Burner heads which have a high burning efficiency under a wide range of conditions will be used.

The volume of hydrocarbons (to be burned) and possible associated produced water from the reservoir which could be generated during well testing cannot be reliably predicted due to variations in gas composition, flow rates and water content. Burners are manufactured to ensure emissions are kept to a minimum. The estimated volume of hydrocarbons to be burned cannot be predicted with much accuracy because the actual test requirements can only be established after the penetration of a hydrocarbon-bearing reservoir. However, an estimated 10 000 bbl oil could be flared per test, i.e. up to 20 000 bbl over the two tests associated with an appraisal well. If produced water is generated during well testing, it will be separated from the hydrocarbons.

3.3.5.4 WELL SEALING AND PLUGGING

The purpose of well sealing and plugging is to isolate permeable and hydrocarbon bearing formations once drilling activities have been completed. Well sealing and plugging aims to restore the integrity of the formation that was penetrated by the wellbore. The principal technique applied to prevent cross flow between permeable formations is plugging of the well with cement, thus creating an impermeable barrier between two zones.

Once drilling and logging have been completed, the exploration wells will be sealed with cement plugs, tested for integrity and abandoned according to international best practices. Cement plugs will be set to isolate hydrocarbon bearing and / or permeable zones and cementing of perforated intervals (e.g. from well logging activities) will be evaluated where there is the possibility of undesirable cross flow. These cement plugs are set in stages from the bottom up. Up to three cement plugs would be installed: e.g. one each for isolation of the deep reservoir and the main reservoir; and a third as a second barrier for the main reservoir.

The integrity of cement plugs can be tested by a number of methods. The cement plugs will be tag tested (to validate plug position) and weight tested, and if achievable then a positive pressure test (to validate seal) and/or a negative pressure test will be performed. Additionally, a flow check may be performed to ensure sealing by the plug. Once the well is plugged, seawater will be displaced before disconnecting the riser and the BOP.

3.3.6 DEMOBILISATION PHASE

After wells have been plugged and tested for integrity, they may be abandoned with wellhead left in place on the seabed in line with industry practices worldwide. Where appropriate, 'over trawlable' protective equipment is applied to abandoned wellheads. The risk assessment criteria will consider factors such as the water depth and use of the area by other sectors (e.g., fishing). It is worth noting that irrespective of whether the wellhead and over trawlable protective equipment is retained the well bore itself will be plugged.

The operator may place monitoring equipment on wellheads for monitoring well properties and data collection to be used for future development scheme design and input.

With the exception of the over-trawlable protective equipment (if required) over abandoned wellheads and drilling discharges deposited on the seabed, no further physical remnants of the drilling operation will be left on the seafloor. A final clearance survey check will be undertaken using an ROV. The drilling unit and support vessels will demobilise from the offshore licence area and either mobilise to the following drilling location or relocate into port or a regional base for maintenance, repair or resupply.

3.3.7 DISCHARGES, WASTES AND EMISSIONS

The proposed drilling operations (including mobilisation and demobilisation) will result in various discharges to water, the generation of waste and emissions. All vessels will have equipment, systems and protocols in place for prevention of pollution by oil, sewage and garbage in accordance with International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL) requirements. Any oil spill related discharges would be managed by an Oil Spill Contingency Plan (OSCP). Onshore licenced waste disposal sites and waste management facilities will be identified, verified and approved prior to commencement of drilling operations.

3.3.7.1 **DISCHARGES TO SEA**

3.3.7.1.1 DRILLING CUTTINGS AND MUD

Drill cuttings, which range in size from clay to coarse gravel and reflect the types of sedimentary rocks penetrated by the drill bit, are the primary discharge during well drilling. Drilling discharges would be disposed at sea in line with accepted drilling practices as defined by the UK and Norway. This is in line with most countries (including South Africa) for early exploration development phases. The rationale for this is based on the low density of drilling operations in the vast offshore area and the high energy marine environment. As such, it is proposed to use the "offshore treatment and disposal" option for the drilling campaign. The same method was applied and approved for drilling other deep water exploration wells in Block 11B/12B (namely Brulpadda and Luiperd wells) off the South Coast of South Africa.

During the riserless drilling stage, all cuttings will be discharged directly onto the seafloor adjacent to the wellbore. Where NADFs are used (during the risered drilling stage, if WBMs are not able to provide the necessary characteristics), these are sometimes treated onshore and disposed, treated to recover oil and disposed offshore and sometimes re-injected into wells. For the current project, in instances where NADFs are used, cuttings will be treated offshore to reduce oil content to <6% Oil on Cutting (OOC) and discharged overboard. During this drilling stage the circulated drilling fluid will be cleaned and the cuttings discharged into the sea at least 10 m below sea level. The drill cuttings will be treated to reduce their mud content using shakers and a centrifuge. The assumed types and mass/volumes of discharges are detailed in Table 5 above.

Cuttings released from the drilling unit during the risered drilling stage will be dispersed by the current and settle to the seafloor. The rate of cuttings discharge decreases with increasing well depth as the hole diameter becomes smaller and penetration rates decrease. Discharge is intermittent as actual drilling operations are not continuous while the drilling unit is on location. Discharge is 10 m below sea level and cuttings then settle on the seabed below.

Further drilling fluid will be released 1 m above the seafloor during well suspension and displacement (between drilling section 2 and 3), as detailed in Table 5 above. The expected fall and spatial extent of the deposition of discharged cuttings have been investigated in the Drilling Discharges Modelling Study (Livas 2023a), the results of which will inform the Marine Ecology and Fisheries Assessments.

3.3.7.1.2 CEMENT AND CEMENT ADDITIVES

Typically, cement and cement additives are not discharged during drilling. However, during the initial cementing operation (i.e. surface casing), excess cement emerges out of the top of the well and onto the seafloor in order to ensure that the conductor pipe is cemented all the way to the seafloor. During this operation a maximum of 150% of the required cement volume may be pumped into the space between the casing and the borehole wall (annulus, this is dependent on the hole size in the first section). In the worst-case scenario where the hole is very in gauge, approximately 50 m^3 of cement could be discharged onto the seafloor.

3.3.7.1.3 BOP HYDRAULIC FLUID

As part of routine opening and closing operations the subsea BOP stack elements will vent some hydraulic fluid into the sea at the seafloor. It is anticipated that between approximately 500 and 1 000 litres of oil-based hydraulic emulsion fluid could be vented per month during the drilling of a well. BOP fluids are completely biodegraded in seawater within 28 days.

3.3.7.1.4 PRODUCED WATER

If water from the reservoir arises during well flow testing, these would be separated from the oily components and treated onboard to reduce the remaining hydrocarbons from these produced waters. The hydrocarbon component will be burned off via the flare booms, while the water is temporarily collected in a slop tank. The water is then either directed to:

- a settling tank prior to transfer to support vessel for onshore treatment and disposal; or
- a dedicated treatment unit on the rig where, after treatment, it is either:
    - discharged overboard if hydrocarbon content is < 30 mg/l; or
    - subject to a second treatment or directed to tank prior to transfer to support vessel for onshore treatment and disposal if hydrocarbon content is > 30 mg/l.

3.3.7.1.5 VESSEL MACHINERY SPACES (BILGE WATER)

Vessels will occasionally discharge treated bilge water. Bilge water is drainage water that collects in a ship's bilge space (the bilge is the lowest compartment on a ship, below the waterline, where the two sides meet at the keel). In accordance with MARPOL Annex I, bilge water will be retained on board until it can be discharged to an approved reception facility, unless it is treated by an approved oily water separator to <15 ppm oil content and monitored before discharge. The residue from the onboard oil/water separator will be treated / disposed of onshore at a licenced hazardous landfill site.

3.3.7.1.6 DECK DRAINAGE

Deck drainage consists of liquid waste resulting from rainfall, deck and equipment washing (using water and a water-based detergent). Deck drainage will be variable depending on the vessel characteristics, deck activities and rainfall amounts.

In areas of the drilling unit where oil contamination of rainwater is more likely (i.e. the rig floor), drainage is routed to an oil / water separator for treatment before discharge in accordance with MARPOL Annex I (i.e. 15 ppm oil and grease maximum). There will be no discharge of free oil that could cause either a film, sheen or discolouration of the surface water or a sludge or emulsion to be deposited below the water's surface. Only non-oily water (i.e. <15 ppm oil and grease, maximum instantaneous oil discharge monitor reading) will be discharged overboard. If separation facilities are not available (due to overload or maintenance) the drainage water will be retained on board until it can be discharged to an approved reception facility. The oily residue from the onboard oil / water separator will be treated / disposed of onshore at an approved hazardous landfill site.

3.3.7.1.7 BRINE GENERATED FROM ONBOARD DESALINATION PLANT

The waste stream from the desalination plant is brine (concentrated salt), which is produced in the reverse osmosis process. The brine stream contains high concentration of salts and other concentrated impurities that may be found in seawater. Water chemical agents will not be used in the treatment of seawater and therefore the brine reject portion would be in a natural concentrated state. Based on previous well drilling operations, freshwater production amounts to approximately 40 m^3/day, which will result in approximately 35 g salt for each litre water produced (i.e. approx. 1 400 kg salt/brine per day).

3.3.7.1.8 SEWAGE AND GREY WATER

Discharges of sewage (or black water) and grey water (i.e. wastewater from the kitchen, washing and laundry activities and non-oily water used for cleaning) will occur from vessels intermittently throughout the project and will vary according to the number of persons on board, estimated at an average of 200 litres per person. All sewage discharges will comply with MARPOL Annex IV.

Sewage and grey water will be treated using a marine sanitation device to produce an effluent with:

- A Biological Oxygen Demand (BOD) of <25 mg/l (if the treatment plant was installed after 1/1/2010) or <50 mg/l (if installed before this date);
- Minimal residual chlorine concentration of 0.5 mg/l; and
- No visible floating solids or oil and grease.

3.3.7.1.9 FOOD (GALLEY) WASTES

The disposal into the sea of food waste is permitted, in terms of MARPOL Annex V, when it has been comminuted or ground to particle sizes smaller than 25 mm and the vessel is *en route* more than 3 nautical miles (approximately 5.5 km) from land. Disposal overboard without macerating is permitted for moving vessels greater than 12 nautical miles (approximately 22 km) from the coast. On the drilling unit, all food waste will be macerated to particles sizes <25 mm and the daily discharge is typically about seven tonnes per month.

3.3.7.1.10 BALLAST WATER

Ballast water is used during routine operations to maintain safe operating conditions onboard a ship by reducing stress on the hull, providing stability, improving propulsion and manoeuvrability, and compensating for weight lost due to fuel and water consumption.

Ballast water is discharged subject to the requirements of the 2004 International Convention for the Control and Management of Ships' Ballast Water and Sediments. The Convention stipulates that all ships are required to implement a Ballast Water Management Plan and that all ships using ballast water exchange will do so at least 200 nautical miles (nm) (± 370 km) from nearest land in waters of at least 200 m deep when arriving from a different marine region. Where this is not feasible, the exchange should be as far from the nearest land as possible, and in all cases a minimum of 50 nm (±93 km) from the nearest land and preferably in water at least 200 m in depth. Project vessels will be required to comply with this requirement.

3.3.7.1.11 DETERGENTS

Detergents used for washing exposed marine deck spaces will be discharged overboard. Water-based detergents are low in toxicity and are preferred for use. Preferentially biodegradable detergents should be used. Detergents used on work deck space will be collected with the deck drainage and treated as described under deck drainage above.

3.3.7.1.12 NOISE EMISSIONS

The key sources generating underwater noise are vessel propellers (and positioning thrusters), with a contribution from the pontoons (e.g. noise originating from within the pontoons and on-deck machinery), support vessels and from drilling activities. This is expected to result in highly variable sound levels, being dependent on the operational mode of each vessel. The pre-drilling sonar surveys and VSP survey would generate a short-term noise, sonar acquisition takes 1.5 to 3 days to acquire with short bursts of the sound source and the VSP onboard between 4 to 6 hours dependent on the programme to complete, respectively.

The main sources of noise from these activities are categorised below.

- Pre-drilling sonar surveys may involve multi- and single beam echo sounding and sub-bottom profiling. These surveys would be undertaken between the 700 m and 1900 m depth ranges covering a survey area of approximately 50 km^2. Each wellsite survey would take up to 10 to 15 days to complete. A single beam echo-sounder operates within a frequency range of 38 to 200 kHz, whereas multibeam echo sounders operate in the 70 - 100 kHz range and have a 200dB re 1µPa at 1m source level. Sub-bottom profilers emit an acoustic pulse at frequencies ranging between 2 and 16 kHz, typically producing sound levels in the order of 200-230 db re 1µPa at 1m[1].
- Drilling noise: Drilling units generally produce underwater noise in the range of 10 Hz to 100 kHz (OSPAR commission, 2009) with major frequency components below 100 Hz and average source levels of up to 190 dB re 1 µPa at 1 m (rms) (the higher end of this range from use of bow thrusters). These noise levels will be assumed as indicative for the current project.
- Propeller and positioning thrusters: Noise from propellers and thrusters is predominately caused by cavitation around the blades whilst transiting at speed or operating thrusters under load in order to maintain a vessel's position. The noise produced by a drilling unit's dynamic positioning systems can be audible for many kilometres. Noise produced is typically broadband noise, with some low tonal peaks. The support vessels will also contribute to an overall propeller noise generation.
- Machinery noise: Machinery noise is often of low frequency and can become dominant for vessels when stationary or moving at low speeds. The source of this type of noise is from large machinery, such as large power generation units (diesel engines or gas turbines), compressors and fluid pumps. Sound is transmitted through different paths, i.e. structural (machine to hull/pontoons to water) and airborne (machine to air to hull to water) or a mixture of both. The nature of sound is dependent on a number of variables, such as the type and size of machinery operating; and the coupling between machinery and the vessel body. Machinery noise is typically tonal in nature. A ROV will be used to conduct a sweep of the drilling site to identify any debris; however, this is not expected to form a significant noise source.
- Well logging noise: If relevant, VSP will be undertaken in order to generate a high-resolution image of the geology in the well's immediate vicinity. It is expected to use a small dual airgun array, comprising a system of three 150 cubic inch airguns and three 150 cubic inch airguns with a total volume of 450 cubic inches of compressed nitrogen at about 2 000 psi. VSP source will generate a pulse noise level in the 5 to 1 000 Hz range. The volumes and the energy released into the marine environment are significantly smaller than what is required or generated during conventional seismic surveys. The airguns will be discharged approximately five times at 20 second intervals. This process is repeated, as required, for different sections of the well for a total of approximately 125 shots. A VSP is expected to take up to six hours per well to complete, depending on the well's depth and number of stations being profiled.
- Well testing noise: Flaring would produce some air-borne noise above the sea level where flaring is implemented for up to two days of flowing and flaring.
- Equipment in water: Noise is produced from equipment such as the drill string. The noise produced will be low relative to the drilling noise and the dynamic positioning system.

[1] For the purposes of the acoustic modelling for the sonar survey, the Kongsberg EM 712 MBES system with similar specifications to those proposed by AOSAC is used. The EM 712 MBES is a high-resolution seabed mapping system with a frequency range of 40 – 100 kHz. The source levels for the Kongsberg EM 712 MBES system show a Pk SPL of 240 dB, an RMS SPL of 237 dB, and a SEL of 210 dB.

- Helicopter noise: Helicopters will also form a source of noise, which can affect marine fauna both in terms of underwater noise beneath the helicopter and airborne noise. Helicopters will take off and operate at a minimum height of 2500 ft above sea level.

The extent of project-related noise above the background noise level may vary considerably depending on the specific vessels used and the number of support vessels operating. It will also depend on the variation in the background noise level with weather and with the proximity of other vessel traffic (not associated with the project).

An Underwater Noise Modelling Study has been undertaken to determine the underwater noise transmission loss with distance from well site and compare results with threshold values for marine fauna to determine zones of impact. These modelling results will be used in the assessment of impacts on marine fauna.

3.3.7.1.13 LIGHT EMISSIONS

Operational lighting will be required on the drilling unit and support vessels for safe operations and navigation purposes during the hours of darkness. Where feasible, operational lights will be shielded in such a way as to minimise their spill out to sea.

3.3.7.1.14 HEAT EMISSIONS

Flaring during well testing generates heat emissions from the combustion of hydrocarbons at the burner head.

3.3.8 UNPLANNED EVENTS – WELL BLOWOUT

The greatest environmental threat from offshore drilling operations is the risk of a major release of crude oil occurring either from a blow-out or loss of well control. A blow-out is the uncontrolled release of crude oil and/or natural gas from a well after pressure control systems have failed.

Oil released in the marine environment would have an immediate detrimental effect on water quality, with the toxic effects potentially resulting in mortality (e.g. suffocation and poisoning) of marine fauna or affecting faunal health (e.g. respiratory damage). If the spill reaches the coast, it can result in the smothering of sensitive coastal habitats (modelling indicates that in the event of an accidental release that the oil plume would dissipate a significant distance from the shore and would not reach the shore).

In the order of 47 wells have been drilled on the West Coast offshore environment to date and no well blow-outs have been recorded. Global data maintained by Lloyds Register indicates that frequency of a blow-out from normal exploration wells is in the order of 1.43 x 10-4 (0.000143) per well drilled. While the probability of a major spill happening is thus extremely small, the impact nonetheless needs to be considered as it could have devastating effects on the marine environment. Following the Deep Water Horizon (DWH) incident, however, Muehlenbacks et al. (2013) undertook an empirical analysis of performance indicators on offshore platforms in the Gulf of Mexico and identified that water depth played a statistically significant role in determining the probability of an incident.

In order to address the management of the risks associated with the highly unlikely scenario of a well blowout, the following project control measures will be required for implementation during the exploration activities in order to prevent or respond to an unplanned well blowout event:

- Compliance with COLREGS (the Convention dealing with safety at sea, particularly to reduce the risk of collisions at sea) and SOLAS (the Convention ensuring that vessels comply with minimum safety standards).
- A 500 m safety zones will be enforced around the drilling unit within which fishing and other vessels would be excluded.
- Regulation 37 of MARPOL Annex I will be applied, which requires that all ships of 400 gross tonnage and above carry an approved Shipboard Oil Pollution Emergency Plan (SOPEP). The purpose of a SOPEP is to assist personnel in dealing with unexpected discharge of oil, to set in motion the necessary actions to stop or minimise the discharge, and to mitigate its effects on the marine environment.

- As standard practice, an Emergency Response Plan (ERP) and an Oil Spill Contingency Plan (OSCP) will be prepared and available at all times during the drilling operation.
- Project vessels will be equipped with appropriate spill containment and clean-up equipment, e.g. booms, dispersants and absorbent materials. All relevant vessel crews will be trained in spill clean-up equipment use and routine spill clean-up exercises.
- The primary safeguard against a blow-out is the column of drilling fluid in the well, which exerts hydrostatic pressure on the wellbore. Under normal drilling conditions, this pressure should balance or exceed the natural rock formation pressure to help prevent an influx of gas or other formation fluids. As the formation pressures increase, the density of the drilling fluid is increased to help maintain a safe margin and prevent "blow-outs". However, if the density of the fluid becomes too heavy, the formation can break down. If drilling fluid is lost in the resultant fractures, a reduction of hydrostatic pressure occurs. Maintaining the appropriate fluid density for the wellbore pressure regime is therefore critical to safety and wellbore stability. Abnormal formation pressures are detected by primary well control equipment (pit level indicators, return mud-flow indicators and return mud gas detectors) on the drill unit. The drilling fluid is also tested frequently during drilling operations and its composition can be adjusted to account for changing downhole conditions. The likelihood of a blow-out is further minimised by installation of a blow-out preventer (BOP) on the wellhead at the start of the risered drilling stage. The BOP is a secondary control system, which contain a stack of independently-operated cut-off mechanisms, to ensure redundancy in case of failure. The BOP is designed to close in the well to prevent the uncontrolled flow of hydrocarbons from the reservoir. A blow-out occurs in the highly unlikely event of these pressure control systems failing.
- If the BOP does not successfully shut off the flow from the well, the drilling rig would disconnect and move away from the well site while crews mobilise a capping system. The capping system would be lowered into place from its support barge and connected to the top of the BOP to stop the flow of oil or gas.
- Information provided by the Applicant for the Oil Spill Modelling Study has considered both condensate and crude oil as potential fluid types. In addition, the scenarios modelled the possibility of high blow rates representing what is considered well beyond expectations and representative of a 'worst-case' scenario. Two release points were also modelled (i.e. a 'worst-case' of the potential five well locations identified); one in the northern and one in the central areas of interest (AOI).
- Oil Spill Response Limited (OSRL), the global oil spill response co-operative funded by more than 160 oil and energy companies, has a base in Saldanha Bay and another base in Aberdeen, which houses well capping equipment designed to shut-in an uncontrolled subsea well. The Saldanha based capping stack is available to oil and gas companies across the industry and provides for swift subsea incident response around the world. The equipment is maintained ready for immediate mobilisation and onward transportation by sea and/or air in the event of an incident. The operator must be a member of OSRL, at the point of commencing the project. This would significantly reduce the spill period. All of the wells must be designed to allow for capping.
- Other project controls include the preparation and implementation of plans that would include aspects related to Shipboard Oil Pollution Emergencies, Oil Spill Contingency and Well Control Contingency.

The project / well specific Oil Spill Contingency Plan (OSCP) will be prepared and approved internally by the Operator and submitted to the South African authorities (SAMSA, PASA and DFFE) for review and approval. The OSCP specifies how best to control an unlikely spill, how to prevent certain sensitive habitats / environments from exposure to oil, and what can be done to minimise the damage done by the spill (containment and recovery) and is based on the specific project conditions for that well.

The OSCP is the operational document prepared and aligned with local and national regulations, including the South Africa's National Oil Spill Contingency Plan, applicable international conventions and internal rules. The OSCP is guided by a detailed oil spill drift model and has the primary objective to set in motion the necessary actions to minimise the effects of an oil spill. It also:

- Provides an emergency notification system, including a standardised format for oil spill notification;
- Describes the escalation monitoring process from Tier 1 to Tier 2 and Tier 3 incidents;
- Outlines the system for command and control of the oil spill response operations and organisation;
- Provides checklists of actions for key personnel during an oil spill; and
- Provides strategy and tactics to respond to the different types and levels of oil spills (Tier 1 to 3), including resources to be involved.

The OSCP will be communicated to staff and periodically tested in order to ensure an effective and co-ordinated response to situations. The OSCP will be available at all times during the drilling operation.

4 POLICY AND LEGISLATIVE CONTEXT

This section provides an overview of the governing legislation identified which relates to the proposed project. Additional legislation and other guidelines and policies are discussed in Table 9 below.

4.1 CONSTITUTION OF THE REPUBLIC OF SOUTH AFRICA

The constitution of any country is the supreme law of that country. The Bill of Rights in chapter 2 section 24 of the Constitution of South Africa Act (Act No. 108 of 1996) makes provisions for environmental issues and declares that: *"Everyone has the right -*

a) to an environment that is not harmful to their health or well-being; and

b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that:

- ***i.*** *prevent pollution and ecological degradation;*
- ***ii.*** *promote conservation; and*
- *iii. secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development"*

The Scoping and EIA process as well as associated impact mitigation actions are conducted to fulfil the requirement of the Bill of Rights.

4.2 THE MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT

The aim of the MPRDA is to *"make provision for equitable access to and sustainable development of the nation's mineral and petroleum resources"*. The MPRDA outlines the procedural requirements that need to be met to acquire mining rights in South Africa. In this regard, the Applicant has compiled and submitted an Exploration Right Renewal application to PASA, a subsidiary of the DMRE, which was approved as the First Renewal Period for an additional two year term from 27 October 2022 to 26 October 2024. An application for EA, in term of Section 16 of the NEMA EIA Regulations, 2014 was submitted to PASA on for the proposed exploratory drilling activities.

As per Section 79 of the MPRDA, the Applicant is required to conduct an EIA and submit an EMPR for approval as well as to notify in writing and consult with interested and affected parties (I&APs) within 180 days of acceptance. The MPRDA also requires adherence with related legislation, chief amongst them is NEMA.

Several amendments have been made to the MPRDA. These include, but are not limited to, the amendment of Section 102, concerning amendment of rights, permits, programmes and plans, to requiring the written permission of the Minister for any amendment or alteration; and the section 5A(c) requirement that landowners or land occupiers receive twenty-one (21) days' written notice prior to any activities taking place on their properties. One of the most recent amendments requires all mining related activities to follow the full NEMA process as per the EIA Regulations, 2014, which came into effect on 4 December 2014.

On 3 June 2015, GNR 466 was published. The notice details amendments made to petroleum exploration and production relating, in particular, to the EIA process required, well design and construction, management and operations, water, waste, pollution incidents and air quality.

4.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT

The main aim of the National Environmental Management Act, 1998 (Act 107 of 1998 – NEMA) is to provide for co-operative governance by establishing decision-making principles on matters affecting the environment. In terms of the NEMA EIA Regulations, the applicant is required to appoint an EAP to undertake the EIA process, as well as conduct the public participation process towards an application for EA. In South Africa, EIA's became a legal requirement in 1997 with the promulgation of regulations under the Environment Conservation Act (ECA). Subsequently, NEMA was passed in 1998. Section 24(2) of NEMA empowers the Minister and any MEC, with the concurrence of the Minister, to identify activities which must be considered, investigated, assessed and reported on to the competent authority responsible for granting the relevant EA. On 21 April 2006, the Minister of Environmental Affairs and Tourism (now Department of Forestry, Fisheries and Environment – DFFE) promulgated regulations in terms of Chapter 5 of the NEMA. These regulations, in terms of the NEMA, were amended in June 2010 and again in December 2014 as well as April 2017. The NEMA EIA Regulations, 2014, as amended, are applicable to this project. Exploration activities officially became governable under the NEMA EIA Regulations in December 2014 with the competent authority identified as the DMRE.

The objective of the EIA Regulations is to establish the procedures that must be followed in the consideration, investigation, assessment and reporting of the listed activities that are triggered by the proposed project. The purpose of these procedures is to provide the competent authority with adequate information to make informed decisions which ensure that activities which may impact negatively on the environment to an unacceptable degree are not authorised, and that activities which are authorised are undertaken in such a manner that the environmental impacts are managed to acceptable levels.

In accordance with the provisions of Sections 24(5) and Section 44 of the NEMA the Minister has published Regulations (GN R. 982) pertaining to the required process for conducting EIA's in order to apply for, and be considered for, the issuing of an EA. These EIA Regulations provide a detailed description of the EIA process to be followed when applying for EA for any listed activity.

A Scoping and EIA process is reserved for activities which have the potential to result in significant impacts which are complex to assess. Scoping and EIA studies accordingly provide a mechanism for the comprehensive assessment of activities that are likely to have more significant environmental impacts. Figure 28 below provides a graphic representation of all the components of a full EIA process. The Table 6 below identifies the listed activities the proposed project triggers and consequently requires authorisation prior to commencement.

Table 6: NEMA listed activities to be authorised

Activity	Activity Description	Applicability
Listing Notice 2 Activity 18	Any activity including the operation of that activity which requires an exploration right in terms of section 79 of the Mineral and Petroleum Resources Development Act, **as well as any other applicable activity as contained in this Listing Notice, in Listing Notice 1 of 2014 or in Listing Notice 3 of 2014, required to exercise the exploration right**[2], excluding (a) any desktop study; (b) any arial survey; (c) any onshore seismic survey which is included in activity 21C in Listing Notice 1 of 2014, in which case that activity applies; (d) a hydraulic fracturing activity which is included in activity 20A, in which case activity 20A of this Notice applies; and (e) the processing of a petroleum resource, including the beneficiation or refining of gas, oil or petroleum products, in which case activity 5 of this Notice applies.	The undertaking of exploration activities within the Block 3B/4B offshore area, requires an Exploration Right in terms of the MPRDA.

[2] It is understood that bolded section was included in the Listed Activity 18 in order to ensure that it would not be required to apply for the "*other applicable activity as contained in this Listing Notice, in Listing Notice 1 of 2014 or in Listing Notice 3 of 2014, required to exercise the exploration right*". This understanding has been clarified with the Department of Forestry, Fisheries and the Environment (DFFE). As such, it is not required to apply for additional listed activities.

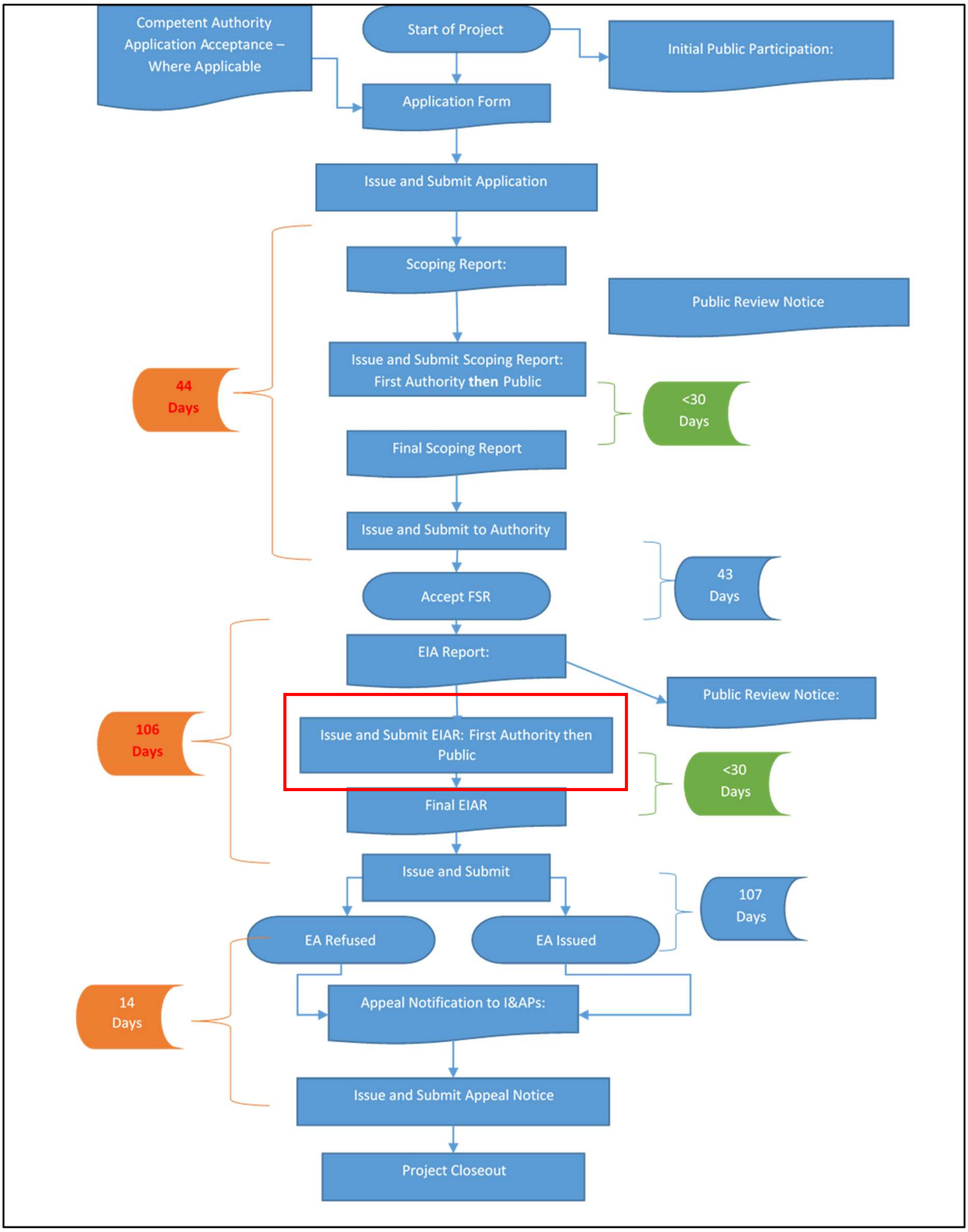


Figure 28: EIA process diagram.

NEMA sets out the general objectives of Integrated Environmental Management (IEM) in South Africa, including to (section 23(2)), of which the following two are of relevance for this report:

- Identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage, the risks and consequences and alternatives and options for mitigation of activities. This is to be done with a view to minimising negative impacts, maximising benefits and promoting compliance with the principles of environmental management set out in section 2 (of NEMA).

- Ensure that the effects of activities on the environment receive adequate consideration before actions are taken in connection with them.

4.3.1 DFFE SCREENING TOOL REPORT

A Screening Tool Report was generated from the DFFE Screening tool as per the requirements of Regulation 16 (1)(b)(v) of the EIA Regulations 2014, as amended, and was included in the Application for EA. The screening Tool provided a list of specialist studies for inclusion in the Scoping and EIA process.

In this regard, as Site Sensitivity Verification Report (SSVR) has been compiled in order to consider the recommendations of the DFFE Screening Tool Report and to provide a rationale for the selection of specialist studies included in line with the recommendations of the Plan of Study for EIA included in the Scoping Report. Please refer to Appendix 7 for the SSVR.

4.4 THE NATIONAL HERITAGE RESOURCES ACT

The National Heritage Resources Act (Act 25 of 1999 – NHRA) stipulates that cultural heritage resources may not be disturbed without authorisation from the relevant heritage authority. Section 34(1) of the NHRA states that, "*no person may alter or demolish any structure or part of a structure which is older than 60 years without a permit issued by the relevant provincial heritage resources authority…*" The NHRA is utilised as the basis for the identification, evaluation and management of heritage resources and in the case of Cultural Resource Management (CRM) those resources specifically impacted on by development as stipulated in Section 38 of NHRA, and those developments administered through the NEMA, MPRDA and the Development Facilitation Act (DFA) legislation. In the latter cases the feedback from the relevant heritage resources authority is required by the State and Provincial Departments managing these Acts before any authorisations are granted for a development. The last few years have seen a significant change towards the inclusion of heritage assessments as a major component of Environmental Impact Processes required by the NEMA and MPRDA. This change requires an evaluation of the Section of these Acts relevant to heritage (Fourie, 2008).

The NHRA provides for the protection of South Africa's natural heritage, including wrecks or associated debris or artefacts that may be found or disturbed on the seabed. Section 2.1.4 states that the South African Heritage Resources Agency (SAHRA) is the statutory organisation responsible for the protection of South Africa's cultural heritage. SAHRA thus has jurisdiction over any shipwrecks that may occur within the territorial waters and the maritime cultural zone fall. According to Section 35 of the NHRA, any person who discovers archaeological objects or material (including wrecks) in the course of a development must immediately report the find to SAHRA. No person may, without a permit issued by SAHRA, destroy, damage, excavate, alter, deface or otherwise disturb any archaeological site.

Furthermore, Section 38 deals with matters of Heritage Resource Management. Section 38(8) states that *"(8) The provisions of this section do not apply to a development as described in subsection (1) if an evaluation of the impact of such development on heritage resources is required in terms of the Environment Conservation Act, 1989 (Act No. 73 of 1989), or the integrated environmental management guidelines issued by the Department of Environment Affairs and Tourism, or the Minerals Act, 1991 (Act No. 50 of 1991), or any other legislation: Provided that the consenting authority must ensure that the evaluation fulfils the requirements of the relevant heritage resources authority in terms of subsection (3), and any comments and recommendations of the relevant heritage resources authority with regard to such development have been taken into account prior to the granting of the consent."*

In terms of the above, in terms of this section, the South African Heritage Resources Agency (SAHRA) have been notified regarding the proposed development and would act as a key commenting authority.

4.5 NATIONAL ENVIRONMENTAL MANAGEMENT: PROTECTED AREAS ACT

The National Environmental Management Protected Areas Act (Act No. 57 of 2003 – NEMPAA) is intended to *"provide for the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes"* and creating a *"national system of protected areas in South Africa as part of a strategy to manage and conserve its biodiversity".*

The NEMPAA defines various kinds of protected areas, namely: *"special nature reserves, national parks, nature reserves (including wilderness areas) and protected environments; world heritage sites; marine protected areas; specially protected forest areas, forest nature reserves and forest wilderness areas declared in terms of the National Forests Act, 1998 (Act 84 of 1998); and mountain catchment areas declared in terms of the Mountain Catchment Areas Act, 1970 (Act 63 of 1970)".*

Although Block 3B/4B is in close proximity to the Child's Bank and Benguela Muds MPAs, no marine protected areas (MPA) are located within Block 3B/4B. For oil and gas exploration activities, although vessels are permitted to sail through these areas, no invasive exploration activities are permitted in any proclaimed MPA. As such, under the proposed exploration right, no invasive exploration activities such as the proposed exploration drilling will take place in any proclaimed MPAs.

4.6 NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT

The National Environmental Management: Air Quality Act (Act No. 39 of 2004 as amended – NEMAQA) is the main legislative tool for the management of air pollution and related activities. The Object of the Act is:

- To protect the environment by providing reasonable measures for –
  - the protection and enhancement of the quality of air in the Republic;
  - the prevention of air pollution and ecological degradation; and
  - securing ecologically sustainable development while promoting justifiable economic and social development; and
- Generally, to give effect to Section 24(b) of the constitution in order to enhance the quality of ambient air for the sake of securing an environment that is not harmful to the health and well-being of people.

The NEMAQA mandates the Minister of Environment to publish a list of activities which result in atmospheric emissions and consequently cause significant detrimental effects on the environment, human health and social welfare. All scheduled processes as previously stipulated under the Air Pollution Prevention Act (APPA) are included as listed activities with additional activities being added to the list. The updated Listed Activities and Minimum National Emission Standards were published on 22 November 2013 (Government Gazette No. 37054).

According to the NEMAQA, air quality management control and enforcement is in the hands of local government with District and Metropolitan Municipalities as the licensing authorities. Provincial government is primarily responsible for ambient monitoring and ensuring municipalities fulfil their legal obligations, with national government primarily as policy maker and co-ordinator. Each sphere of government must appoint an Air Quality Officer responsible for co-ordinating matters pertaining to air quality management. Given that air quality management under the old Act was the sole responsibility of national government, local authorities have in the past only been responsible for smoke and vehicle tailpipe emission control.

The National Pollution Prevention Plans Regulations were published in March 2014 (Government Gazette 37421) and tie in with the National Greenhouse Gas (GHG) Emission Reporting Regulations which took effect on 3 April 2017. In summary, the Regulations aim to prescribe the requirements that pollution prevention plans of greenhouse gases declared as priority air pollutants, need to comply with in terms of the NEMAQA. The Regulations specify who needs to comply, and by when, as well as prescribing the content requirements. Tetra4 has an obligation to report on the GHG emissions under these Regulations. There is also a requirement to account for the amount of pollutants discharged into the atmosphere (total emissions for one or more specific GHG pollutants) by 31 March each year. GHG Monitoring and Reporting have been detailed in Section 4.9.11 below.

An Air Quality and Climate Change Impact Assessment was undertaken during the EIA phase to assess the impact of the proposed project on air quality.

4.6.1 NATIONAL AMBIENT AIR QUALITY STANDARDS FOR CRITERIA POLLUTANTS

National Ambient Air Quality Standards (NAAQS) were determined based on international best practice for particulate matter less than 10 and 2.5 µm in aerodynamic diameter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), carbon monoxide (CO), lead (Pb) and benzene. The NAAQS were published in the Government Gazette (no. 32816) on 24 December 2009 for PM_{10} and other pollutants (South Africa, 2009). The $PM_{2.5}$ NAAQS were published in 2012 (South Africa, 2012). The relevant NAAQS are listed in Table 7:

Table 7: South African NAAQS for relevant criteria pollutants

Pollutant	Averaging Period	Limit Value (µg/m³)	Frequency of Exceedance	Compliance Date
NO_2	1 hour	200	88	Currently enforceable
	1 year	40	0	Currently enforceable
CO	1 hour	30 000	88	Currently enforceable
	8 hour	10 000	11	Currently enforceable
SO_2	1 hour	350	88	Currently enforceable
	24 hour	125	4	Currently enforceable
	1 year	50	0	Currently enforceable
$PM_{2.5}$	24 hour	40	4	Currently enforceable
	1 year	20	0	Currently enforceable
PM_{10}	24 hour	75	4	Currently enforceable
	1 year	40	0	Currently enforceable

4.6.2 INHALATION HEALTH CRITERIA FOR NON-CRITERIA POLLUTANTS

There is at present no national assessment criterion for total volatile organic compounds (TVOC). Most reported TVOC-concentrations in non-industrial environments are below 100 µg/m^3 and few exceed 250 µg/m^3. At these concentration levels only sensory effects are likely to occur, but other health effects cannot be excluded after long-term exposure. The sensory effects include sensory irritation, dryness, weak inflammatory irritation in eyes, nose, air ways and skin. At TVOC concentrations above 250 µg/m^3, the likelihood of other types of health effects becomes of greater concern (ECA, 1992). For the purpose of this assessment, use is made of the "comfort" limit proposed for use by Mølhave of 200 µg/m^3. Inhalation criteria for VOCs are summarised in Table 8:

Table 8: Chronic inhalation screening criteria for VOCs

Pollutant	Averaging Period	Screening Criteria (µg/m³)	Source of Data
VOC	Chronic	200	ECA

4.6.3 ATMOSPHERIC EMISSION LICENCE AND OTHER AUTHORISATIONS

The National Environmental Management: Air Quality Act, 2004 (No. 39 of 2004) (NEMAQA) regulates all aspects of air quality, including prevention of pollution, providing for national norms and standards. The Minister, in terms of Section 21 of the NEMAQA, published a list of activities which result in atmospheric emissions, and which are believed to have significant detrimental effects on the environment, human health and social welfare. Minimum Emission Standards (MES) for these listed activities were originally published on 31 March 2010

(Government Gazette No. 33064) with revisions of the schedule on the 22 November 2013 (Government Gazette No. 37054, (South Africa, 2013)) and 31 October 2018 (Government Gazette No. 42013, (South Africa, 2018)). The proposed exploration operations are not included in the listed activities requiring an Atmospheric Emissions Licence (AEL).

4.7 NATIONAL ENVIRONMENTAL MANAGEMENT: INTEGRATED COASTAL MANAGEMENT ACT

The National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008 - ICMA), serves to:

- establish a system of integrated coastal and estuarine management in the Republic, including norms, standards and policies, in order to promote the conservation of the coastal environment, and maintain the natural attributes of coastal landscapes and seascapes, and to ensure that development and the use of natural resources within the coastal zone is socially and economically justifiable and ecologically sustainable;
- define rights and duties in relation to coastal areas;
- determine the responsibilities of organs of state in relation to coastal areas;
- prohibit incineration at sea;
- control dumping at sea, pollution in the coastal zone, inappropriate development of the coastal environment and other adverse effects on the coastal environment;
- give effect to South Africa's international obligations in relation to coastal matters; and
- provide for matters connected therewith.

Section 2 of the ICMA states the Objects of the Act and include:

- to determine the coastal zone of the Republic;
- to provide, within the framework of the National Environmental Management Act, for the coordinated and integrated management of the coastal zone by all spheres of government in accordance with the principles of co-operative governance;
- to preserve, protect, extend and enhance the status of coastal public property as being held in trust by the State on behalf of all South Africans, including future generations;
- to secure equitable access to the opportunities and benefits of coastal public property;
- to provide for the establishment, use and management of the coastal protection zone; and
- to give effect to the Republic's obligations in terms of international law-regarding coastal management and the marine environment.

Section 3 of the ICMA places a duty on the State to fulfill the rights contained in Section 24 of the Constitution in that the State through its functionaries and institutions implementing the ICMA, must act as the trustee of the coastal zone; and must, in implementing this Act, take reasonable measures to achieve the progressive realization of those rights in the interests of every person.

Section 58 of the ICMA refers to the duty of care provided for in Section 28 of the NEMA, and confirms that such duty applies to any impact caused by any person and which has an adverse effect on the Coastal Environment.

Section 63 of the ICMA places an obligation on the Competent Authority to take into account all relevant factors when deciding on an Environmental Authorisation required for coastal activities, including:

- the representations made by the applicant and by interested and affected parties;
- the extent to which the applicant has in the past complied with similar authorisations;

- whether coastal public property, the coastal protection zone or coastal access land will be affected, and if so, the extent to which the proposed development or activity is consistent with the purpose for establishing and protecting those areas;
- the estuarine management plans, coastal management programmes, coastal management lines and coastal management objectives applicable in the area;
- the socio-economic impact if the activity is authorised or not;
- the likely impact of coastal environmental processes on the proposed activity;
- whether the development or activity is situated within:
  - coastal public property and is inconsistent with the objective of conserving and enhancing coastal public property for the benefit of current and future generations;
  - is situated within the coastal protection zone and is inconsistent with the purpose for which a coastal protection zone is established as set out in section 17;
  - is situated within coastal access land and is inconsistent with the purpose for which coastal access land is designated as set out in section 18;
  - is likely to cause irreversible or long-lasting adverse effects to any aspect of the coastal environment that cannot satisfactorily be mitigated;
  - is likely to be significantly damaged or prejudiced by dynamic coastal processes;
  - would substantially prejudice the achievement of any coastal management objective; or
  - would be contrary to the interests of the whole community;
- whether the very nature of the proposed activity or development requires it to be located within coastal public property, the coastal protection zone or coastal access land;
- whether the proposed activity or development will provide important services to the public when using coastal public property, the coastal protection zone, coastal access land or a coastal protected area; and
- the objects of this Act, where applicable

Whilst the proposed activity does not specifically require authorisation under the ICMA, the Competent Authority must consider, where relevant the factors listed above when deciding on the EA. It is expected that the Competent Authority will consider the relevant factors listed above and where relevant the findings of this EIA (including but not limited to proximity to identified marine sensitive environments, impacts on marine environment, socio-economic impacts, potential pollution, the results of the public participation process, and the need and desirability of the proposed activity) when making a decision on this application.

4.8 ADDITIONAL SOUTH AFRICAN LEGISLATION

Additional legislation may be applicable to the exploration activities proposed for this project. These are presented in Table 9 below.

Table 9: Applicable legislation and guidelines overview

Legislation / Guidelines	Description
Potentially Applicable Legislation	
Dumping at Sea Control Act (Act No. 73 of 1980)	This Act controls the dumping of substances at sea. The Act lists substances that are prohibited to be dumped at sea (Schedule 1) and substances that are restricted when dumping at sea (Schedule 2). The Director-General may on application grant a special permit authorising the dumping of substances listed in Schedule 1 or 2.

Legislation / Guidelines	Description
Environment Conservation Act (Act No. 73 of 1989)	The Environment Conservation Act (Act No. 73 of 1989 – ECA) was, prior to the promulgation of the NEMA, the backbone of environmental legislation in South Africa. To date the majority of the ECA has been repealed by various other Acts, however Section 25 of the Act and the Noise Regulations (GN R. 154 of 1992) promulgated under this section are still in effect. These Regulations serve to control noise and general prohibitions relating to noise impact and nuisance.
Hazardous Substances Act (Act No. 85 of 1983)	This Act provides for the control of substances which may cause injury or ill-health to or death of human. No person may, without a licence: (1) sell any Group I Hazardous Substance; (2) use, operate or apply any Group III Hazardous Substance (listed electronic products); and (3) install or keep any Group Ill Hazardous Substance.
Marine Living Resources Act (Act No. 18 of 1998)	This Act provides for the conservation of marine ecosystems, the long-term sustainable utilisation of marine living resources and the orderly access to exploitation, utilisation and protection of certain marine living resources.
Marine Traffic Act (Act No. 2 of 1981)	This Act regulates marine traffic in South Africa's territorial waters. It regulates the entry and dropping of anchor within 500 m safety zone of installations, as well as seafloor infrastructure or any appliance used for the exploration or exploitation of the seabed.
Marine Pollution (Control and Civil Liability) Act (Act No. 6 of 1981)	The purpose of this Act is to provide protection of the marine environment from pollution by oil and other harmful substances, by giving power to South African Maritime Safety Authority (SAMSA) to take steps to prevent harmful substances being discharged from vessels. The applicant would have to disclose to SAMSA before the commencement of proposed activities the amounts and types of chemicals that would be used and disposed of during operations. No disposal of waste at sea is proposed.
Marine Pollution (Prevention of Pollution from Ships) Act (Act No. 2 of 1986)	This Act regulates pollution from ships, tankers and offshore installations, and for that purpose gives effect to MARPOL 73/78. In terms of the Act, it is an offence to discharge any oil from a ship, tanker or offshore installation within 12 miles (19 km) off the South African coast. The discharge of oily water or oil and any other substance which contains more than a hundred parts per million of oil is prohibited between 19 – 80 km offshore. No dumping at sea is proposed as part of this application.
Marine Pollution (Intervention) Act (Act No. 65 of 1987)	This Act gives effect to the international convention relating to the Intervention of the High Seas in cases of oil pollution casualties, and to the Protocol relating to Intervention of the High Seas in cases of Marine Pollution by substances other than Oil in South African Waters.
Maritime Safety Authority Act (Act No. 5 of 1998)	This Act provides for the establishment and functions of SAMSA. The objectives of the Act are to, inter alia: (1) ensure safety of life and property at sea; (2) prevent and combat pollution of the marine environment by ship; and (3) promote South Africa's maritime interests.
Maritime Safety Authority Levies Act (Act No. 6 of 1998)	This Act provides for the imposition of levies by SAMSA. SAMSA is permitted to raise and collect a levy on all vessels calling at South African ports and operating in South African waters.
Maritime Zones Act (Act No. 15 of 1994)	The Act defines the maritime zones, including territorial waters, contiguous zone, exclusive economic zone and continental shelf. Section 9(1) states that any law in force in South Africa shall also apply on and in respect of an installation.
National Environmental Management: Biodiversity Act (Act No. 10 of 2004)	This Act regulates the carrying out of restricted activities that may harm listed threatened or protected species or activities that encourage the spread of alien or invasive species subject to a permit.

Legislation / Guidelines	Description
Maritime Safety Authority Levies Act (Act No. 6 of 1998)	This Act provides for the imposition of levies by SAMSA. SAMSA is permitted to raise and collect a levy on all vessels calling at South African ports and operating in South African waters.
National Ports Act (Act No. 12 of 2005)	This Act regulates and controls navigation within port limits and the approaches to ports, cargo handling, and the pollution and the protection of the environment within the port limits. The Act specifies a requirement for an agreement with or a licence from the National Ports Authority to operate a port facility or service.
Sea-Shore Act (Act No. 21 of 1935)	This Act declares the State President the owner of the seashore and the sea within the territorial waters of South Africa and provides for the grant of rights in respect of the seashore and the sea and for the alienation of portions of the seashore and the sea.
Promotion of Administrative Justice Act (Act No. 3 of 2000)	The Bill of Rights in the Constitution of the Republic of South Africa 1996 states that everyone has the right to administrative action that is legally recognised, reasonable, and procedurally just. The Promotion of Administrative Justice Act (Act No. 3 of 2000) gives effect to this right. The PAJA applies to all decisions of all State organisations exercising public power or performing a public function in terms of any legislation that negatively affects the rights of any person. The Act prescribes what procedures an organ of State must follow when it takes decisions. If an organ of State implements a decision that impacts on an individual or community without giving them an opportunity to comment, the final decision will be illegal and may be set aside. The Promotion of Administrative Justice Act 3 of 2000 also forces State organisations to explain and give reasons for the manner in which they have arrived at their decisions and, if social issues were involved, and how these issues were considered in the decision-making process. The Promotion of Administrative Justice Act 3 of 2000 therefore protects the rights of communities and individuals to participate in decision-making processes, especially if these processes affect their daily lives.
Traditional and Khoi-San Leadership Act (Act No. 3 of 2019)	The Traditional and Khoi-San Leadership Act (Act No. 3 of 2019) aims: • to provide for the recognition of traditional and Khoi-San communities, leadership positions and for the withdrawal of such recognition; • to provide for the functions and roles of traditional and Khoi-San leaders; • to provide for the recognition, establishment, functions, roles and administration of kingship or queenship councils, principal traditional councils, traditional councils, Khoi-San councils and traditional sub-councils, as well as the support to such councils; • to provide for the establishment, composition and functioning of the National House of Traditional and Khoi-San Leaders; • to provide for the establishment of provincial houses of traditional and Khoi-San leaders; • to provide for the establishment and composition of local houses of traditional and Khoi-San leaders; • to provide for the establishment and operation of the Commission on Khoi-San Matters; • to provide for a code of conduct for members of the National House, provincial houses, local houses and all traditional and Khoi-San councils; • to provide for regulatory powers of the Minister and Premiers; • to provide for transitional arrangements; • to amend certain Acts; • to provide for the repeal of legislation; and

Legislation / Guidelines	Description
	• to provide for matters connected therewith.
Protection, Promotion, Development and Management of Indigenous Knowledge Act (Act No. 6 of 2019)	The Protection, Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019 intends: • to provide for the protection, promotion, development and management of indigenous knowledge; • to provide for the establishment and functions of the National Indigenous Knowledge Systems Office; • to provide for the management of rights of indigenous knowledge communities; • to provide for the establishment and functions of the Advisory Panel on indigenous knowledge; • to provide for access and conditions of access to knowledge of indigenous communities; • to provide for the recognition of prior learning; • to provide for the facilitation and coordination of indigenous knowledge-based innovation; and • to provide for matters incidental thereto.
Applicable Guidelines	
Integrated Environmental Management Information Guidelines Series	The various guidelines will be considered throughout this environmental Scoping and EIA process. This series of guidelines was published by the Department of Environmental Affairs (DEA – now DFFE) and refers to various environmental aspects. Applicable guidelines in the series for the project include: Guideline 5: Companion to NEMA EIA Regulations (October 2012); Guideline 7: Public participation (October 2012); and Guideline 9: Need and desirability (October 2014). Additional guidelines published in terms of the NEMA EIA Regulations, 2014 (as amended), in particular: Guideline 3: General Guide to Environmental Impact Assessment Regulations, 2006; Guideline 4: Public Participation in support of the EIA Regulations, 2006; and Guideline 5: Assessment of alternatives and impacts in support of the EIA Regulations, 2006.

4.9 NATIONAL POLICY AND PLANNING CONTEXT

Various other national policy and planning may be of specific relevance to the needs and desirability of the project with respect to overarching energy and climate change policy and planning in South Africa. These are described below:

4.9.1 INTEGRATED RESOURCE PLAN 2019

The Minister of Mineral Resources and Energy (Minister) published the current Integrated Resource Plan (IRP 2019) as GN 1360 of 18 October 2019 in Government Gazette No. 4278. The Determination provides for various energy sources to be procured from Independent Power Producers (IPPs) through one or more IPP Procurement Programmes as contemplated in the Electricity Regulations on New Generation Capacity, 2011. The plan aimed to balance a number of objectives namely, to ensure security of supply, to minimize cost of electricity, to minimize negative environmental impact (emissions) and to minimize water usage. The IRP 2019 makes provision for gas from year 2024.

4.9.2 NATIONAL DEVELOPMENT PLAN 2030

The National Development Plan (NDP) aims to eliminate poverty and reduce inequality by 2030. According to the plan, South Africa can realise these goals by drawing on the energies of its people, growing an inclusive economy, building capabilities, enhancing the capacity of the state, and promoting leadership and partnerships throughout society. One of the key priorities is "faster and more inclusive economic growth". To transform the economy and create sustainable expansion for job creation, an average economic growth exceeding 5% per annum is required. The NDP makes numerous mentions of the need to act responsibly to mitigate the effects of climate change. Diversification of the energy mix away from fossil fuels will be key as energy generation makes up 48 percent of South Africa's GHG emissions. The NDP indicates that "the country will explore the use of natural gas as a less carbon intensive transitional fuel".

4.9.3 WHITE PAPER ON THE ENERGY POLICY OF THE REPUBLIC OF SOUTH AFRICA (1998)

The White Paper on the Energy Policy (1998) is the overarching policy document which guides future policy and planning in the energy sector. The policy objectives include the stimulation of economic development, management of energy related environmental and health impacts and diversification of the country's energy supply to ensure energy security. The paper states that the government will, inter alia, "promote the development of South Africa's oil and gas resources…" and "ensure private sector investment and expertise in the exploitation and development of the country's oil and gas resources". The successful exploitation of these natural resources would contribute to the growth of the economy and relieve pressure on the balance of payments.

4.9.4 NATIONAL GAS INFRASTRUCTURE PLAN (2005)

The gas infrastructure plan is intended to be a strategy for the development of the natural gas industry in South Africa. Government wishes to promote the gas industry based on its energy policy objectives as set out in the White Paper on Energy (1998). These include:

- Increasing access to affordable energy services;
- Improving energy governance;
- Stimulating economic activity;
- Managing energy-related environmental impacts;
- Securing security of supply through diversity of supply;
- Competition within and between energy carriers; and
- Promoting New Partnership for African Development (NEPAD) cross-border type projects.

4.9.5 PARIS AGREEMENT – UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016. The Paris Agreement aims to limit the global temperature increase to below 2 °C. Each individual country is responsible for determining their contribution (referred to as the "nationally determined contribution") in reaching this goal. As a signatory to the Agreement, South Africa will be required to adopt the agreement within its own legal systems, through ratification, acceptance, approval or accession. "As a signatory to the Paris Agreement, South Africa is required to investigate alternatives to existing industries which have high carbon-emissions. A shift away from coal-based energy production within the energy sector and increased reliance on alternative energy sources is therefore anticipated."

4.9.6 NATIONAL CLIMATE CHANGE RESPONSE WHITE PAPER

The majority of South Africa's energy emissions arise from electricity generation. The Paper sets out South Africa's overall response strategy though strategic priorities, leading to a series of adaption, mitigation, response measures and priority flagship programmes. Policy decisions on new infrastructure investments must consider climate change impacts to avoid the lock-in of emissions intensive technologies into the future. In the medium-term, the Paper indicates that a mitigation option with the biggest potential includes a shift to lower-carbon electricity generation options.

The impacts of climate change as a result of, as well as potentially affecting the project is addressed by the environmental management tools of IEM and EIA, as prescribed by the NEMA. Given that the purpose of EIA is to give effect to the general objectives of IEM (section 24(1), NEMA), including sustainable development, there is a logical and necessary interrelationship between climate change and EIA.

4.9.7 SOUTH AFRICAN NATIONAL CLIMATE CHANGE RESPONSE POLICY

The National Climate Change Response White Paper of 2011, stated that in responding to climate change, South Africa has two objectives:

- to contribute to the global effort in stabilising GHG emissions at a level that avoids dangerous anthropogenic interference with the climate system and
- to manage the inevitable climate change impacts.

The White Paper proposed mitigation actions, especially a departure from coal-intensive electricity generation, be implemented in the short- and medium-term to match the GHG trajectory range. Peak GHG emissions were expected between 2020 and 2025 before a decade long plateau period and subsequent reductions in GHG emissions. The White Paper also highlighted the co-benefits of reducing GHG emissions by improving air quality, as well as minimising respiratory diseases by reducing ambient particulate matter, O_3 and sulphur dioxide (SO_2) concentrations to levels in compliance with the NAAQS by 2020. In order to achieve these objectives, the DFFE established a national GHG emissions inventory, which report through the South African Air Quality Information System (SAAQIS).

The Western Cape Government (WCG) similarly proposed the Western Cape Climate Change Response Strategy during 2022 in recognition to the urgency to reduce GHG emissions and adapt to global climate change. In contributing to global and national efforts to mitigate climate change and build resilience, the approach of the proposed strategic takes a two-pronged approach to addressing climate change:

- Mitigation: Contribute to national and global efforts to significantly reduce GHG emissions and build a sustainable low carbon economy, which simultaneously addresses the need for economic growth, job creation and improving socio-economic conditions. Most of the Western Cape's emissions arise from energy generation (electricity and liquid fuels) and use (industry and transport), and mitigation actions therefore need to focus on these areas. The main opportunities for mitigation therefore include energy efficiency, demand-side management and moving to a less emissions-intensive energy mix, which is dominated by electricity, coal, petrol, and diesel (in that order).
- Adaptation: Reduce climate vulnerability and develop the adaptive capacity of the Western Cape's economy, its people, its ecosystems and its critical infrastructure in a manner that simultaneously addresses the province's socio- economic and environmental goals.

4.9.8 NATIONALLY DETERMINED CONTRIBUTION

In 1992, countries joined an international treaty, the United Nations Framework Convention on Climate Change (UNFCCC), as a framework for international cooperation to combat climate change by limiting average global temperature increases and the resulting climate change, and coping with impacts that were, by then, inevitable. By 1995, countries launched negotiations to strengthen the global response to climate change, and, two years later, adopted the Kyoto Protocol. The Kyoto Protocol legally binds developed country parties to emission reduction targets. The Protocol's first commitment period started in 2008 and ended in 2012. As agreed in Doha in 2012, the second commitment period began on 1 January 2013 and would have ended in 2020 (UNFCCC, 2017), but due to lack of ratification has not come into force. The Paris Agreement (2016) builds upon the Convention and – for the first time – brought all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charted a new course in the global climate effort. The central aim of the Paris Agreement is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2.0°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives. All signed parties to the Paris Agreement are required to put forward proposed climate change minimisation efforts through "nationally determined contributions" (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts. There will also be a global stocktake every five years to assess the collective progress towards achieving the purpose of the Agreement and to inform further individual actions by Parties.

As of February 2020, 189 Parties of the 197 Parties to the UNFCCC Convention, including South Africa, had ratified the Paris agreement. As a non-Annex I country, South Africa is not bound to commit to a cap or reduce GHG emissions; however, a pledge was made in 2009 (Copenhagen 2009) to reduce emissions by 34% below business-as-usual (BAU) emissions by 2020 and 42% below BAU by 2025. The original NDC was submitted to the UNFCCC and became the first NDC on 1 November 2016 (RSA 2016). This was undertaken to comply with decision 1/CP.19 and 1/CP.20 of the Conference of the Parties to the UNFCCC. This document describes South Africa's NDC on adaptation, mitigation and finance and investment necessities to undertake the resolutions with updated revisions to the adaptation goals and mitigation targets.

All parties to the UNFCCC were updating their NDC's in the run-up to the 26th international climate change conference that was held in Glasgow, Scotland, in November 2021. The updated draft NDC1, was approved by Cabinet on 24 March 2021 and released for public comment. The committed 2030 target range (398 - 440 Mt CO_2-e) is an ambitious improvement on the current NDC target, i.e., the upper range of this proposed 2030 target range represents a 28% reduction in GHG emissions from the 2015 NDC targets. These original goals were ambitious and South Africa subsequently shifted from BAU-based targets for 2020 and 2025 in terms of the Cancun Agreement under the UNFCCC, to absolute GHG emissions targets under the Paris Agreement.

As part of the updated adaption portion of the NDC the following goals have been assembled:

- **Goal 1**: Enhance climate change adaptation governance and legal framework.
- **Goal 2**: Develop an understanding of the impacts on South Africa of 1.5 and 2°C global warming and the underlying global emission pathways through geo-spatial mapping of the physical climate hazards, and adaptation needs in the context of strengthening the key sectors of the economy. This will provide the scientific basis for strengthening the national and provincial governments' readiness to respond to climate risk.
- **Goal 3**: Implement National Climate Change Adaptation Strategy adaptation interventions for the period 2021 to 2030, where priority sectors have been identified as biodiversity and ecosystems, water, health, energy, settlements (coastal, urban, rural), disaster risk reduction, transport infrastructure, mining, fisheries, forestry and agriculture.
- **Goal 4**: Mobilise funding for adaptation implementation through multilateral funding mechanisms.
- **Goal 5**: Quantify and acknowledge national adaptation and resilience efforts.

As part of the mitigation portion of the NDC, the following have been, or can be, implemented at national level:

- At the time of writing, a total of 129 (9 910.37 MW) renewable energy Independent Power Producer projects as part of a Renewable Energy Independent Power Producer Procurement Programme

(REIPPPP) have been awarded. Of these projects, a total capacity of 6 200 MW renewable energy has been installed (or 5% of South Africa's energy supply)

- Creation of a “Green Climate Fund” to back green economy initiatives. This fund will be increased in the future to sustain and improve successful initiatives.
- Decarbonising electricity by 2050.
- Implementing Carbon Capture and Sequestration (or Carbon Capture and Storage) (CCS).
- Supporting the use of electric and hybrid electric vehicles.
- Reduction of emissions achieved through the use of energy efficient lighting; variable speed drives and efficient motors; energy efficient appliances; solar water heaters; electric and hybrid electric vehicles; solar photovoltaic (PV); wind power; CCS; and advanced bioenergy.
- Updating targets based on revised 100-year global warming potential (GWP) factors (published in the Annex to decision 18/CMA.1 of the IPCC 5th Assessment Report (AR5) and based on exclusion of land sector emissions arising from natural disturbance.

The updated NDC mitigation targets, consistent with South Africa’s fair share, are presented in Table 10.

Table 10: South Africa’s NDC mitigation targets

Year	Target	Corresponding Period
2025	South Africa’s annual GHG emissions will be in a range between 398 - 510 Mt CO2-e.	2021-2025
2030	South Africa’s annual GHG emissions will be in a range between 398 - 440 Mt CO2-e.	2026-2030

The GWP is the potential of an emitted gas to cause global warming relative to CO_2. This converts the emissions of all GHGs to the equivalent amount of CO_2 or CO_2-e. Although the GWP for the various pollutants are provided as ranges by the IPCC, to standardise, the South African National GHG reporting guidelines state that the following GWP values be used for reporting:

- CH_4 emissions should have a multiplier of 23; and
- N_2O emissions should have a multiplier of 296 (SA Technical Guidelines for Monitoring, Reporting and Verification of GHG Emissions (MG-2022.1 August 2022 Annexure H (DFFE, 2022)).

A substance's GWP is based on the energy absorbed over a period and therefore depends on the number of years over which the potential is calculated. The GWP value therefore depends on how the gas concentration decays over time in the atmosphere. GWPs based on a shorter timeframe will be larger for gases with lifetimes shorter than that of CO_2, and smaller for gases with lifetimes longer than CO_2. For example, for CH_4, which has a short lifetime, the AR5 100-year GWP of 28 is much less than the 20-year GWP of 84. N_2O, on the other hand, has a long lifetime, and the AR5 100-year GWP of 265 is nearly the same as the 20-year GWP of 264. The 100-year GWP is the most used and is also adopted in the National GHG reporting guidelines. The establishment of the GWP is an ongoing process, as is evident with the different values adopted in AR5 and sixth assessment (AR6) reports, respectively. This study follows the approach stipulated in National GHG reporting guidelines, i.e., a CH_4 GWP of 23 and a N_2O GWP of 296.

4.9.9 NATIONAL GHG EMISSIONS INVENTORY

South Africa is perceived as a global climate change contributor and is undertaking steps to mitigate and adapt to the changing climate. DFFE is tasked as the lead climate change institution and is required to coordinate and manage climate related information such as development of mitigation, monitoring, adaptation and evaluation strategies. This includes the establishment and updating of the National GHG Inventory. The National Greenhouse Gas Improvement Programme (GHGIP) has been initiated; it includes sector specific targets to improve methodology and emission factors used for the different sectors as well as the availability of data. The 2020 National GHG Inventory (DFFE, 2022), which includes inventories from 2000 to 2020, was prepared using the 2006 IPCC Guidelines (IPCC, 2006) and IPCC Good Practice Guidance (GPG) (IPCC 2000; IPCC 2003; IPCC 2014). The national GHG inventory covers four sectors, namely:

- Energy, including:
    - Exploration and exploitation of primary energy sources;
    - Conversion of primary energy sources into more useable energy forms in refineries and power plants;
    - Transmission and distribution of fuels; and
    - Final use of fuels in stationary and mobile applications.
- Industrial Process and Product Use (IPPU);
- Agriculture, Forestry and Other Land Use (AFOLU); and
- Waste.

The latest report covers sources of GHG emissions, and removals by sinks, resulting from human or anthropogenic activities for the major GHGs: CO_2, CH_4, N_2O, PFCs, and HFCs. Indirect greenhouse gases – carbon monoxide (CO) and oxides of nitrogen (NO_X) – are also included for biomass burning. SF6 emissions have not yet been included due to a lack of data.

The annual variation in the South African national GHG inventory from 2000 to 2020 is provided in Figure 29. According to the 2020 National GHG Inventory (DFFE, 2022) the total GHG emissions for 2020 were estimated at 468 811.7 kilo tonne (kt) CO_2-e (excluding Forestry and Other Land Use (FOLU)5) and 442 125.1 kt CO_2-e (including FOLU)).

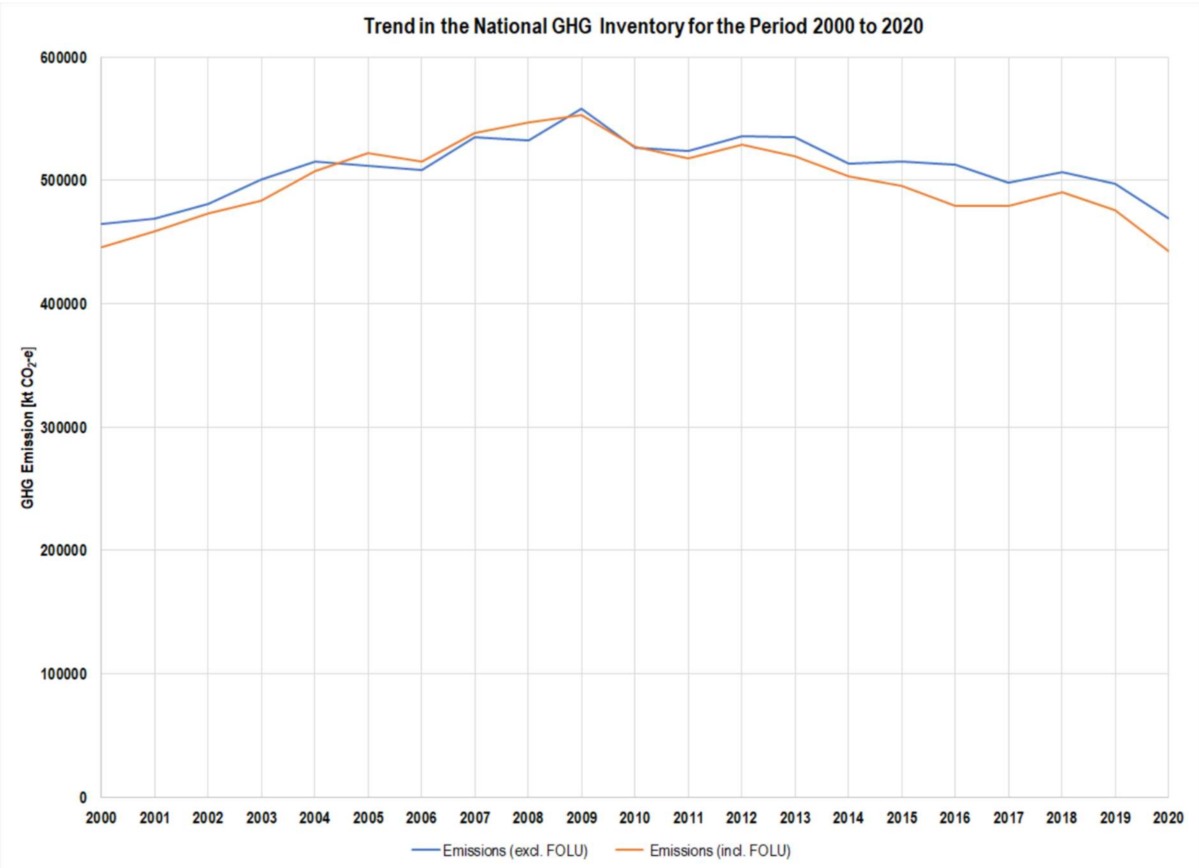


Figure 29: Annual trend in the South African national GHG emission inventory from 2000 to 2020 (note: FOLU is estimated to be a net carbon sink) (Source: DFFE 2022)

The 2020 results revealed an increase in emissions in the energy (2.2%) and waste (26.3%) sectors relative to the year 2000. The decrease in the net AFOLU sector is due to an increasing land sink, in other words, more GHG was estimated to be absorbed by vegetation than previously calculated and is reflected as a slight increase of 0.8% from the 2000 total GHG emissions (excluding FOLU) of 464 980.2 kt CO_2-e and a reduction of 0.8% with the inclusion of FOLU, i.e., 445 884.9 kt CO_2-e for 2000.

The Energy sector is the largest contributor to South Africa's emissions (excl. FOLU), contributing 80% in 2020. According to the 2020 Report the Energy sector emissions increased between 2000 and 2009, then declined to 2014 after which total emissions were stable until 2019. Emissions declined by 6.8% between 2019 and 2020. This decline was due to Commercial/institutional emissions declining by 19.7%, along with a 13.7% reduction in Road transport and a 54.3% reduction in Civil aviation emissions. These reductions can be attributed to the reduced travel and trading during the COVID-19 lockdown restrictions.

4.9.10 GHG EMISSION INVENTORY FOR THE ENERGY SECTOR

The DFFE published its Draft Methodological Guideline document on 19 February 2021 (Government Gazette No. 44190) with the updated and Final Methodological Guidelines for Quantification of GHG Emissions in October 2022 (DFFE, 2022) which describes the reporting methodology as specified in the NEMAQA (Act No. 39 of 2004): National Greenhouse Gas Emission Reporting Regulations (NGERs) (South Africa, 2017). The current Project would be categorised in the "Energy" category for both the global GHG inventory and for the national GHG inventory.

According to the World Resources Institute Climate Watch, global GHG emissions from the Energy sector were 35 475.65 Mt CO_2-e in 2020. This contributes to 75% of total anthropogenic GHG emissions (including FOLU) of 47 513.15 Mt CO_2-e and 77% of total anthropogenic GHG emissions (excluding FOLU) of 46 120.92 Mt CO_2-e. According to the 2022 National GHG Inventory (DFFE, 2022), the South African Energy sector contributed 379.505 Mt CO_2-e to global Total GHG emissions in 2020, i.e., 0.82% and 0.8% to the global total excluding and including FOLU, respectively; and 1.1% to the global Energy sector emissions.

CH_4 emissions, albeit of less concern in the current assessment since it is only emitted as part of fuel combustion, have a significant GWP, and it is prudent to include a short discussion on the contribution of fossil fuel to the global CH_4 budget. Estimates of CH_4 emissions are subject to a high degree of uncertainty, but the most recent comprehensive data in the Global Methane Budget (Global Methane Budget 2000-2017 (2020)) suggest that annual global methane emissions are around 592 Mt CO_2-e (572 – 614 Mt CO2-e). This includes emissions from natural sources (around 40% of emissions) and those originating from human activity (the remaining 61%). The largest source groups of anthropogenic CH_4 emissions are agriculture and waste, responsible for 38% of the total, followed closely by the energy sector (23%), which includes emissions from coal, oil, natural gas and bioenergy. Natural sources include wetlands (largest natural global CH_4 source), geological, termites and the oceans. Oil and gas operations are likely the largest source of CH_4 emissions from the energy sector due to fugitive emissions from vents, leaks and unit operations, and not from routine emissions.

4.9.11 GHG MONITORING AND REPORTING

The NEMAQA also provides for the monitoring and reporting of GHG emissions. The National Greenhouse Gas Emission Reporting Regulations (South Africa, 2017) were published in terms of Section 53 (aA), (o) and (p) of NEM: AQA on 3 April 2017 and amended on 11 September 2020 (South Africa, 2020). The purpose of these Regulations is to implement a single national reporting system for the transparent reporting of GHG emissions.

Exploration is included under IPCC Code 1.B.2 applicable for oil and natural gas operations as provided in Annexure 1 of the amended Regulations. This source category activity specifically addresses fugitive emissions associated with well drilling, testing and servicing. As the threshold for this IPCC source category in the table is reflected as none, it means that the data provider has to report activity data and greenhouse gas emissions, irrespective of the size of greenhouse gas emissions and the scale of the operation of the activity.

Other activities may be associated with Code 1.A.3 Transport, with a set threshold of 100 000 litres per year fuel usage applicable to Civil Aviation (1.A.3.a) and Water-borne Navigation (1.A.3.d). Therefore, if the fuel usage is above this threshold, then the Regulations require that CO2 and CH4 levels (calculated based on Tier 2 or 3 methodologies) be reported annually via the South African Greenhouse Gas Emissions Reporting System (SAGERS). The system forms part of the national atmospheric emission inventory component of South African Atmospheric Emission Licensing and Inventory Portal (SAAELIP).

The South African mandatory reporting guidelines focus on the reporting of Scope 1 emissions only. For information, the three broad scopes for estimating GHG are:

- Scope 1: All direct GHG emissions.
- Scope 2: Indirect GHG emissions from consumption of purchased electricity, heat or steam.
- Scope 3: Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities not covered in Scope 2, outsourced activities, waste disposal, as well as the emissions of the users of the products produced by a company, and indirect GHG emissions from other source.

The DFFE is working together with local sectors to develop country specific emissions factors in certain areas; however, in the interim the IPCC default emission figures may be used to populate the SAAELIP GHG emission factor database. These country specific emission factors will replace some of the default IPCC emission factors. Technical guidelines for GHG emission estimation have been issued.

Also, the Carbon Tax Act (South Africa, 2019) includes details on the imposition of a tax on the carbon dioxide equivalent (CO_2-e) of GHG emissions. According to this Act, a carbon taxpayer is a person who undertakes a taxable activity listed in Schedule 2 of the Carbon Tax Act in respect of which:

- it has an aggregated installed capacity equal to or above the tax threshold; or
- a tax threshold indicated as ‘none’ applies.

In Schedule 2 of the Act, the proposed project is classified under 1.A.3 Transportation and the tax threshold column for Civil Aviation (1.A.3.a) and Water-borne Navigation (1.A.3.d) provides a threshold of 100 000 litres per year fuel usage for both activities, respectively, as well as no threshold for the oil and gas operations (1.B.2), which therefore implies a carbon tax return submission.

Certain production processes indicated in Annexure A of the Declaration of Greenhouse Gases as Priority Pollutants (South Africa, 2017) with GHG in excess of 0.1 Mega tonne (Mt), measured as CO_2-e, are required to submit a Pollution Prevention Plan to the Minister for approval. The Pollution Prevention Plan regulations under Sections 29(3), 53 (o) and (p) read with section 57(1) (a) of the NEMAQA, prescribe the requirements for the development and submission of Pollution Prevention Plans. The exploration is not anticipated to have emissions in excess of 0.1 Mt, thus, it may be concluded that the current project does not require a Pollution Prevention Plan.

4.9.12 MARINE SPATIAL PLANNING FRAMEWORK (2017)

The Marine Spatial Planning Framework provides a regulatory framework within which relevant and directed spatial planning can occur for the marine resources available to South Africa and through which the potential of the economy can be unlocked and management in a sustainable way.

The framework provides high-level direction for undertaking Marine Spatial Planning in the context of the South African legislation and policies as well as existing planning regimes. It describes the process for the preparation of Marine Area Plans, their implementation, evaluation and revision in order to ensure sustainable development of South Africa’s ocean space through consistent and adaptive Marine Spatial Planning.

The framework seeks to establish a basis within which benefits for South Africa can be unlocked:

- Facilitate the unlocking of the ocean economy and sustainable ocean economic development;
- Enhance the achievement of societal benefits and strengthen the level of society’s interaction with the ocean;
- Promote a healthy marine environment and the sustainable use of marine resources; and

- Contribute to good ocean governance.

Furthermore, the goals of the Framework aim to:

- Unlock the ocean economy by stimulating the sustainable economic growth of South Africa's marine sectors to increase the ocean's contribution to the national Gross Domestic Product, create jobs, and, ultimately, eradicate poverty;
- Engaging with the ocean in order to increase our awareness of the value, opportunities and societal benefits of South Africa's ocean space;
- Ensuring healthy marine ecosystems by protecting, conserving and restoring South Africa's rich marine biodiversity by managing its living and non-living resources in a harmonious manner; and
- Contributing to good ocean governance and includes collaboration between organs of state relating to ocean management, achieved through the establishment of formal and informal relations.

The framework recognises that mineral and petroleum resources exploration and exploitation is an existing interest and spatial consideration within the context of the South African ocean economy. In terms of the hydrocarbon exploration and exploitation sectors the Marine Spatial Planning Framework's Draft Offshore Oil and Gas Sector Plan identifies that the industry should have an enabling environment, prioritise domestic oil and gas exploration and be able to attract foreign direct investment. The Plan also identifies the following sector development objectives:

- Create an enabling environment for the exploration and development of oil and gas resources within South Africa's offshore Exclusive Economic Zone (EEZ);
- Prioritise the exploration and development of domestic oil and gas reserves to support the broader economic growth objectives of South Africa;
- Prioritise early phase exploration with the intention of locating leads and prospectivity in the greater part of the EEZ;
- Attract foreign investment interest by international petroleum companies to further develop South Africa's underexplored hydrocarbon reserves, in addition to contributing positively towards job creation and skills development in South Africa, including attracting global service companies to set-up regional hub in South Africa;
- Create an industry which delivers effective risk management across all its operations, and which is especially vigilant in testing operational impacts on current and future environments;
- Maximize the recovery of potential hydrocarbon reserves sustainably and efficiently through a focus on industry-led innovation, enhancing the skills base and ensuring supply chain growth for the benefit of ordinary South Africans;
- Contribute to satisfying the future energy demands for the country while balancing this with the protection of the marine environment and those communities who rely on it;
- Exploration and production of oil and gas resources is developed in an orderly and sustainable manner, consistent with section 24 of the Constitution of the Republic of South Africa and environmental legislative framework, to ensure that while benefits are realised, environmental and socio-economic concerns are addressed; and
- The security of tenure for oil and gas rights holders as provided for in terms of section 2(g) of the Mineral and Petroleum Resources Development Act (Act No. 28 of 2002) must be safeguarded.

The Plan furthermore identifies several guidelines and spatial regulations within which oil and gas exploration and exploitation can occur.

4.9.13 JUST ENERGY TRANSITION INVESTMENT PLAN

The following description has been extracted from the Presidential Climate Commission website (Presidential Climate Commission, n.d.). South Africa's Just Energy Transition Investment Plan (JET IP) for the five-year period 2023-2027 sets out the scale of need and the investments required to achieve the decarbonisation commitments in our Nationally Determined Contribution (NDC), which outlines the rate at which South Africa plans to reduce greenhouse gas emissions and represents South Africa's fair contribution to the goals of the Paris Agreement.

The Investment Plan supports South Africa's goal of achieving a low carbon economy and a climate resilient society through the following interventions:

- Creating quality jobs in new sectors like electric vehicles, green hydrogen, renewable energy, and manufacturing.
- Increasing our energy security and ending load shedding through a massive rollout of new, sustainable energy sources.
- Addressing the risks of climate change and positioning South Africa to be an important global player in the green economy of the future.
- Boosting economic growth through more than R1 trillion of new investment in the South African economy.

The JETP shows the commitment of the partners to enable a just transition in South Africa that recognises the direct and indirect impact that the energy transition has on livelihoods, workers and communities. It is about addressing the global risks of climate change, while creating jobs and driving more rapid and inclusive economic growth. It is about translating commitments into reality, enabling stronger and deeper collaboration, and facing up to the greatest challenge of our times.

The JET IP gives effect to the historic Just Energy Transition Partnership (JETP) which was forged at the COP26 Climate Summit in 2021 between South Africa and France, Germany, United Kingdom, United States, and the European Union. The JETP followed engagements between the parties on the unique economic and social challenges of transitioning South Africa's fossil fuel dependent economy in a just manner.

The Political Declaration provides that the international partners will mobilise an initial US$8.5 billion between 2023 and 2027, subject to agreement on an investment framework. This catalytic financing is intended to leverage a much greater level of resources from both private and public sources.

The JETP Political Declaration says the government's aim to "establish an ambitious long-term partnership to support South Africa's pathway to low emissions and climate resilient development, to accelerate the just transition and the decarbonisation of the electricity system, and to develop new economic opportunities such as green hydrogen and electric vehicles amongst other interventions to support South Africa's shift towards a low carbon future."

The JETP identifies three priority areas to support the economy of the future: the electricity sector, New Energy Vehicles (NEV) and Green Hydrogen.

4.10 PROVINCIAL POLICY AND PLANNING CONTEXT

The Provincial Growth and Development Strategies of the Northern Cape and Western Cape Provinces which need to be considered for the project are outlined below.

4.10.1 NORTHERN CAPE STRATEGIC PLAN 2020-2035

The four drivers of the Northern Cape Provincial Growth and Development Plan:

4.10.1.1 **ECONOMIC TRANSFORMATION, GROWTH AND DEVELOPMENT**

To ensure economic growth and development that will lead to job creation and radical economic transformation for the people of the Northern Cape Province, ten economic drivers or development paths have been identified:

- Agriculture and agro processing;
- Mining and mineral beneficiation;
- Tourism market development;
- Rural development and land reform;
- Development of energy sector;
- Manufacturing and trade;
- Competitive infrastructure development;
- Employment and skills development;
- Innovation and knowledge economy;
- Marine economy; and
- Social transformation and human welfare.

To sustainably address the social injustices and inequalities in the province, social transformation must be accelerated and deepened towards human development and welfare. The following six drivers have been identified:

- Quality basic education;
- Quality health care;
- Social cohesion and community participation;
- Social protection and safety;
- Sustainable human developments;
- Employment and skills development; and
- Environmental sustainability and resilience.

The Northern Cape Province has an abundance of natural resources and environmental assets. While these present a wide range of economic opportunities, a concerted effort must be made to ensure that these are protected and enhance to support the developmental objectives of the province. As the province is an arid region, it must be ensured that enough is done to mitigate the real threat of climate change.

4.10.1.2 **EFFECTIVE, EFFICIENT, AND ACCOUNTABLE GOVERNANCE**

A capable and accountable government based on strong inter-governmental cooperation and participatory governance with civil society will be better positioned and capable to perform seamless services based on the needs of those on whose behalf they govern. Three drivers have been identified to facilitate effective, efficient, and accountable governance:

- Developmental and democratic state;
- Effective local government; and
- International relations.

4.10.1.3 **WESTERN CAPE PROVINCIAL STRATEGIC PLAN 2019-2024**

Vision has five strategic priorities with the following problem areas and focus areas:

- Safe and cohesive communities – a place where residents and visitors feel safe;
- Growth and jobs – an enabling environment for the private sector and markets to drive growth and create jobs;

- Empowering people -residents have opportunities to shape their lives and the lives of others, to ensure a meaningful and dignified live;
- Mobility and spatial transformation – residents live in well-connected, vibrant, and sustainable communities and move around efficiently on safe, affordable, low-carbon public transport
- Innovation and culture – government services are delivered to the people in an accessible, innovative, and citizen-centric way.

4.11 MUNICIPAL POLICY AND PLANNING CONTEXT

For the purpose of this project, Integrated Development Plan (IDP) documents of the below listed municipalities need to be considered.

4.11.1 NAMAKWA DISTRICT MUNICIPALITY

In its IDP the Namakwa District Municipality states that its strategic objectives are:

- Monitoring and support local municipalities to deliver basic services which include water, sanitation, housing, electricity and waste management;
- Support vulnerable groups in the district;
- Improve administrative and financial viability and capability;
- Promote and facilitate Local Economic Development (include tourism);
- Enhance good governance (include IGR) (IGR - intergovernmental relations);
- Promote and facilitate spatial transformation and sustainable urban development;
- To render municipal health services;
- To coordinate the disaster management and fire management services in the district; and
- Caring for the environment.

4.11.2 RICHTERSVELD LOCAL MUNICIPALITY

- The Richtersveld Local Municipality indicated in its IDP that its strategic goals/objectives are:
- For every household to have access to clean water, electricity, and sanitation;
- To treat all their residents with pride and dignity;
- To be an effective and efficient local government;
- To be an effective instrument of change within its community;
- To be a local government that is accountable with community driven development; and
- To be the gateway for local economic development and tourism in the north-western coast of the Northern Cape.

4.11.3 NAMA KHOI LOCAL MUNICIPALITY

The key performance areas of the Nama-Khoi Local Municipality are:

- Basic services delivery;
- Municipal financial viability and management;
- Local economic development;
- Municipal transformation and institutional development; and
- Good governance and community participation.

4.11.4 KAMIESBERG LOCAL MUNICIPALITY

The Kamiesberg Local Municipality identified its key performance areas in its IDP as:

- Service delivery – to provide and maintain superior decentralised customer services (water, sanitation, roads, storm water, waste management and electricity);
- Local economic development;
- Financial viability;
- Municipal transformation; and
- Good governance.

4.11.5 WEST COAST DISTRICT MUNICIPALITY

The West Coast District Municipality stated in its IDP that its objectives are to:

- Care for the social well-being, safety and health of all our communities;
- Promote regional economic growth and tourism.;
- Coordinate and promote the development of bulk and essential services and transport infrastructure;
- Foster sound relationships with all stakeholders, especially local municipalities; and
- Maintain financial viability and good governance.

4.11.6 MATZIKAMA LOCAL MUNICIPALITY

The Matzikama Local Municipality identified the following strategic objectives in its IDP:

- Provide municipal basic services to meet demands of growing population and development challenges;
- Maintain sufficient revenue resources to enable the municipality to meet its constitutional obligations;
- Coordinate, facilitate and stimulate sustainable economic development through strategy, policy and programme development;
- Reduce poverty levels as measured by SAMPI;
- Maintain sufficient organisation resources, enhance the involvement of the public in the development and decision making processes and provide ethical and professional services to support the needs of the communities;
- Provide opportunities to officials and councillors for the development of professional and leadership skills and enhance employment equity in the organisation; and
- Develop and sustain our spatial, natural and built environment.

4.11.7 CEDERBERG LOCAL MUNICIPALITY

The Cederberg Local Municipality identified the following strategic goals:

- Strengthen financial sustainability and further enhancing good governance;
- Sustainable service delivery;
- Facilitate an enabling environment for economic growth to alleviate poverty;
- Promote safe, healthy, educated and integrated communities; and
- A sustainable, inclusive and integrated living environment.

4.11.8 BERGRIVIER LOCAL MUNICIPALITY

The Bergrivier Local Municipality identified the following strategic objectives:

- Improve and sustain basic service delivery and infrastructure development;
- Financial viability and economically sustainability;
- Good governance, community development and public participation;
- Facilitate, expand and nurture sustainable economic growth and eradicate poverty;
- Enable a resilient, sustainable, quality and inclusive living environment and human settlements i.e. housing development and informal settlement upgrade;
- To facilitate social cohesion, safe and healthy communities; and
- Development and transformation of the institution to provide a people-centred human resources and administrative services to citizens, staff and council.

4.11.9 SALDANHA BAY LOCAL MUNICIPALITY

The Saldanha Bay Local Municipality identified the following strategic actions to create additional growth:

- Retaining large existing exporting businesses;
- Promote Aquaculture-, Fishing-, and Food processing sectors;
- Tourism growth;
- Attract new industrial investors by creating a more enabling environment;
- Maximise the competitive advantages for ports;
- Support local SME to access more opportunities; and
- Availability of credible vocational skills development and tertiary education.

4.11.10 SWARTLAND LOCAL MUNICIPALITY

The strategic goals of the Swartland Local Municipality are:

- Improved quality of life for citizens;
- Inclusive economic growth;
- Quality and sustainable living environment;
- Caring, competent and responsive institutions, organisations, and business; and
- Sufficient, affordable and well-run services.

4.11.11 CITY OF CAPE TOWN METROPOLITAN MUNICIPALITY

The City of Cape Town has sixteen objectives linked to its priorities and foundations:

- Economic growth
    - Increased jobs and investment in the Cape Town economy.
- Basic services
    - Improved access to quality and reliable basic services.
    - End load-shedding in Cape Town over time.
    - Well-managed and modernised infrastructure to support economic growth.

- Safety
    - Effective law enforcement to make communities safer.
    - Strengthen partnerships for safer communities.
- Housing
    - Increased supply of affordable, well-located homes.
    - Safer, better-quality homes in informal settlements and backyards over time.
    - Public space, environment and amenities.
    - Healthy and sustainable environment.
    - Clean and healthy waterways and beaches.
    - Quality and safe parks and recreational facilities supported by community partnerships.
- Transport
    - A sustainable transport system that is integrated, efficient and provides safe and affordable options for all.
    - Safe and quality roads for pedestrians, cyclists and vehicles.
- A resilient city
- A more spatial integrate and inclusive city.
- A capable and collaborative city government.

4.12 INTERNATIONAL LEGISLATION

Various other international legislation may be of specific relevance to the proposed project and is outlined in the sections below.

4.12.1 UNITED NATIONS CONVENTION ON THE LAW OF THE SEA

The United Nations Convention on the Law of the Sea 1982 sets out the roles and responsibilities of the signatory nations in the use of the oceans. The convention establishes guidelines for governments, businesses, and other organisations for the management of marine natural resources. The fundamental principle established in the Convention is that States should cooperate to ensure conservation and promote the objective of the optimum utilization of fisheries resources both within and beyond the exclusive economic zone.

The Agreement attempts to achieve this objective by providing a framework for cooperation in the conservation and management of those resources. It promotes the effective management and conservation of international marine resources by establishing, among other things, detailed minimum international standards for the conservation and management of straddling fish stocks and highly migratory fish stocks; ensuring that measures taken for the conservation and management of those stocks in areas under national jurisdiction and in the adjacent international waters are compatible and coherent; ensuring that there are effective mechanisms for compliance and enforcement of those measures in international waters; and recognizing the special requirements of developing states in relation to conservation and management as well as the development and participation in fisheries of straddling and highly migratory fish stocks.

4.12.2 CONVENTION FOR THE SAFEGUARDING OF THE INTANGIBLE CULTURAL HERITAGE

Through its efforts to safeguard Intangible heritage, United Nations Educational, Scientific and Cultural Organization (UNESCO) and its member states developed the Convention for the Safeguarding of the Intangible Cultural Heritage (ICHC). The following section is extracted from a UNESCO webpage that explains the importance of Intangible Heritage:

"While fragile, intangible cultural heritage is an important factor in maintaining cultural diversity in the face of growing globalization. An understanding of the intangible cultural heritage of different communities helps with intercultural dialogue and encourages mutual respect for other ways of life.

4.12.3 INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA

Under the convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972), an exploration vessel that is engaged in surveying is defined as a "vessel restricted in its ability to manoeuvre" and power-driven and sailing vessels are therefore required to give way to it. Vessels engaged in fishing shall, in so far as possible, keep out of the way of the exploration operation. Furthermore, under the Marine Traffic Act, 1981 (No. 2 of 1981), an exploration vessel falls under the definition of an "offshore installation" and as such it is protected by a 500 m horizontal safety zone. It is an offence for an unauthorised vessel to enter the safety zone. In addition to a statutory 500 m safety zone, contractors generally request a safe operational limit (that is greater than the 500 m safety zone) that they would like other vessels to stay beyond. Support vehicles are usually commissioned as 'chase' boats to ensure that other vessels adhere to the safe operational limits.

4.12.4 INTERNATIONAL MARINE CONVENTIONS

The following international marine conventions may be applicable to the proposed exploration activities:

- 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);
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (the London Convention) and the 1996 Protocol (the Protocol);
- International Convention relating to Intervention on the High Seas in case of Oil Pollution Casualties (1969) and Protocol on the Intervention on the High Seas in Cases of Marine Pollution by substances other than oil (1973);
- Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (1989);
- Convention for the Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region ("Abidjan Convention") (1981).
- Convention on Biological Diversity (1992); and
- Benguela Current Convention (2013).

5 NEED AND DESIRABILITY OF THE PROPOSED ACTIVITY

South Africa's crude oil demand has increased steadily to over 600 000 barrels / day. Most of the crude oil consumed in South Africa is imported, as local oil and gas production is low, contributing towards a current account deficit. Producing more oil and gas within South Africa is expected to contribute towards a lower current account deficit, more stable prices, create new jobs and industries in the upstream and downstream oil and gas industry supply chain and sectors, and counter volatility related to instabilities in major oil producing regions. The services sector in the oil and gas industry is not mature in the upstream side and this could provide opportunities to invest in the sector.

The proposed project aims to identify oil and gas resources and does not include any production activities. The identification and assessment of impacts is therefore limited to the activities associated with the exploration for oil and gas as outlined in Section 3 above.

According to the Integrated Resource Plan 2019 (IRP 2019), which is the country's electricity planning strategy, there is a need for gas in South Africa's energy mix in the future. This need is driven in part by the expectation that natural gas may act as a transition fuel, whilst other greener technologies mature. According to the National DFFE, targets have been determined to achieve South Africa's national GHG Emissions commitments. These targets consider the likely GHG emissions outcome of the implementation of current South African policies including the IRP. The proposed exploration activities may be used to determine whether a viable gas or oil resource is present. The outcomes of this could provide insight into potential alternative supply options to inform the future energy planning and policy for South Africa. Considering this, and other new information on supply options, as well as the rapid technological advancements in the energy sector (and specifically in the low carbon alternatives), it is crucial that the energy planning for South Africa is continually reassessed and revised to ensure that the most suitable and sustainable strategy is defined. The 2021 NDC's are aligned with the IRP 2019. The GHG emissions and associated climate change impacts associated with the exploration activities have been assessed as part of the Scoping and EIA Process (refer to Section 9 of this report).

Considering that the life-cycle of the project would be limited to the exploration activities only (i.e. identification of resources only – and does not necessarily imply actual further production of oil and gas resources), there are limited GHG emissions directly related to the proposed activity and a very low climate change vulnerability risks, mainly since the project will be of limited duration.

The needs and desirability analysis component of the "Guideline on need and desirability in terms of the EIA Regulations (Notice 819 of 2014)" includes, but is not limited to, describing the linkages and dependencies between human well-being, livelihoods and ecosystem services applicable to the area in question, and how the proposed development's ecological impacts will result in socio-economic impacts (e.g. on livelihoods, loss of heritage site, opportunity costs, etc.). Table 11 below presents the needs and desirability analysis undertaken for the project.

Table 11: Needs and desirability analysis for the proposed exploration activity.

Ref No.	Question	Answer
1	Securing ecological sustainable development and use of natural resources	
1.1	How were the ecological integrity considerations taken into account in terms of: Threatened Ecosystems, Sensitive and vulnerable ecosystems, Critical Biodiversity Areas, Ecological Support Systems, Conservation Targets, Ecological drivers of the ecosystem, Environmental Management Framework, Spatial Development Framework (SDF) and global and international responsibilities.	A number of specialist studies will inform the EIA Phase of this application and include: • Marine Ecological Impact Assessment; • Fisheries Impact Assessment; • Acoustic Modelling; • Cultural Heritage Assessment; • Tangible Heritage Assessment; • Palaeontological Assessment; • Social Impact Assessment; • Air Quality and Climate Change; • Oil Spill and Drill Cuttings Modelling; and • Economic Impact Assessment. Section 8.5.2 provides a description of the Threatened Ecosystems, Sensitive and vulnerable ecosystems, Critical Biodiversity Areas, Ecological Support Systems, Conservation Targets, Ecological drivers of the ecosystem in relation to the proposed activity. Section 4 provides a description of the relevant local and international spatial planning tools and international responsibilities. The designated competent authority will need to consider all local and international obligations in their relevant decision making.
1.2	How will this project disturb or enhance ecosystems and / or result in the loss or protection of biological diversity? What measures were explored to avoid these negative impacts, and where these negative impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	Refer to baseline marine ecological statement in Section 8, and the impact assessment in Section 9 of this report. The hierarchy of mitigation was applied in the assessment of potential impacts and the consequent identification of management and mitigation options.

Ref No.	Question	Answer
1.3	How will this development pollute and / or degrade the biophysical environment? What measures were explored to either avoid these impacts, and where impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	With reference to Section 9.3 management and mitigation measures were recommended to enhance any identified positive impacts.
1.4	What waste will be generated by this development? What measures were explored to avoid waste, and where waste could not be avoided altogether, what measures were explored to minimise, reuse and / or recycle the waste? What measures have been explored to safely treat and/or dispose of unavoidable waste?	Waste will be generated during the operational phase. The types of waste generated include sewage waste, biodegradable galley wastes, and non-biodegradable solid waste. Waste has been identified as an impact and assessed in Section 9.3. However, it is anticipated that the following measures can be utilised to reduce the impact of the waste on the receiving environment: • Visual inspection that waste does not leave the vessel. • Waste must be securely stored. • All hazardous waste such as oil must be stored separately and disposed of at a registered facility. • Proof of disposal must be kept by the Applicant. The impacts associated with the discharge of the drilling muds have been modelled, described and assessed in detail in Section 9.3 of this report.
1.5	How will this project disturb or enhance landscapes and / or sites that constitute the nation's cultural heritage? What measures were explored to firstly avoid these impacts, and where impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	Please refer to Section 8.8, Section 9.3 and the Cultural Heritage Assessment, Tangible Heritage Assessment and Palaeontological Assessment (Appendix 4), which describe and assess the impacts of the proposed project on the heritage features of the receiving environment. Mitigation measures are provided.
1.6	How will this project use and / or impact on non-renewable natural resources? What measures were explored to ensure responsible and equitable use of the resources? How have the consequences of the depletion of the non-renewable natural resources been considered? What measures were explored to firstly avoid these impacts, and where impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	Refer to the impact assessment in Section 9 of this report. As a result of the fact that this project entails the exploration for oil and gas, it is anticipated that this project will not lead to a significant impact or depletion of non-renewable resources.

Ref No.	Question	Answer
1.7	How will this project use and / or impact on renewable natural resources and the ecosystem of which they are part? Will the use of the resources and / or impacts on the ecosystem jeopardise the integrity of the resource and / or system taking into account carrying capacity restrictions, limits of acceptable change, and thresholds? What measures were explored to firstly avoid the use of resources, or if avoidance is not possible, to minimise the use of resources? What measures were taken to ensure responsible and equitable use of the resources? What measures were explored to enhance positive impacts?	Refer to the impact assessment in Section 9 of this report. Impacts are identified, assessed, and where relevant management and mitigation recommended. The proposed activity does not involve the significant direct use of natural resources such as water, biomass, etc.
1.7.1	Does the proposed project exacerbate the increased dependency on increased use of resources to maintain economic growth or does it reduce resource dependency (i.e. de-materialised growth)?	The proposed project aims to identify non-renewable oil and gas resources to be used in the energy production and/ or processing or manufacturing of materials.
1.7.2	Does the proposed use of natural resources constitute the best use thereof? Is the use justifiable when considering intra- and intergenerational equity, and are there more important priorities for which the resources should be used?	The proposed project aims to identify oil and gas resources and will not, at this stage, involve the significant use of the natural resources identified as part of the proposed exploration project.
1.7.3	Do the proposed location, type and scale of development promote a reduced dependency on resources?	The proposed project aims to identify oil and gas resources and will not, at this stage, involve the use of the natural resources identified as part of the proposed exploration project.
1.8	How were a risk-averse and cautious approach applied in terms of ecological impacts:	
1.8.1	What are the limits of current knowledge (note: the gaps, uncertainties and assumptions must be clearly stated)?	The limitations and/or gaps in knowledge are presented in Section 12.
1.8.2	What is the level of risk associated with the limits of current knowledge?	The level of risk is considered low at this stage. Please refer to the impact assessment in Section 9.
1.8.3	Based on the limits of knowledge and the level of risk, how and to what extent was a risk-averse and cautious approach applied to the development?	This project entails the exploration for oil and gas (including drilling). Since the exploration activities will include drilling, a risk averse and cautious approach has been implemented through the proposed specialist mitigation measures to limit the impact on the surrounding environment. The highest predicted impact to the surrounding environment would be a blow-out event which is considered unlikely.
1.9	How will the ecological impacts resulting from this development impact on people's environmental right in terms following?	

Ref No.	Question	Answer
1.9.1	Negative impacts: e.g. access to resources, opportunity costs, loss of amenity (e.g. open space), air and water quality impacts, nuisance (noise, odour, etc.), health impacts, visual impacts, etc. What measures were taken to firstly avoid negative impacts, but if avoidance is not possible, to minimise, manage and remedy negative impacts?	This project entails the exploration for oil and gas (including drilling). Since the exploration activities will include drilling, a risk averse and cautious approach has been implemented through the proposed specialist mitigation measures to limit the impact on the surrounding environment. The highest predicted impact to the surrounding environment would be a blow-out event which is considered unlikely. The impact of the exploration activities have been assessed during the EIA Phase. Refer to the impact assessment in Section 9 of this report.
1.9.2	Positive impacts: e.g. improved access to resources, improved amenity, improved air or water quality, etc. What measures were taken to enhance positive impacts?	
1.10	Describe the linkages and dependencies between human wellbeing, livelihoods and ecosystem services applicable to the area in question and how the development's ecological impacts will result in socio-economic impacts (e.g. on livelihoods, loss of heritage site, opportunity costs, etc.)?	A low impact on third party wellbeing, livelihoods and ecosystem services is foreseen at this stage of this application. Refer to the impact assessment in Section 9 of this report.
1.11	Based on all of the above, how will this development positively or negatively impact on ecological integrity objectives / targets / considerations of the area?	The highest predicted impact to the surrounding environment would be a blow-out event which is considered unlikely. Refer to the impact assessment in Section 9 in this report.
1.12	Considering the need to secure ecological integrity and a healthy biophysical environment, describe how the alternatives identified (in terms of all the different elements of the development and all the different impacts being proposed), resulted in the selection of the "best practicable environmental option" in terms of ecological considerations?	Refer to Section 6, details of the alternatives considered.
1.13	Describe the positive and negative cumulative ecological / biophysical impacts bearing in mind the size, scale, scope and nature of the project in relation to its location and existing and other planned developments in the area?	Refer to Section 9.4 of this report.
2	Promoting justifiable economic and social development	
2.1	What is the socio-economic context of the area, based on, amongst other considerations, the following:	
2.1.1	The IDP (and its sector plans' vision, objectives, strategies, indicators and targets) and any other strategic plans, frameworks or policies applicable to the area,	The offshore area of activity, as well as the Exclusive Economic Zone (EEZ) as a whole, do not fall within the borders of any municipality or province of South Africa. Thus, the related planning documentation, especially at the District and Local Municipality level, typically do not directly address offshore areas and activities in a significant level of detail. The Application Area is located adjacent to the district municipalities indicated in Table 4 above.

Ref No.	Question	Answer
		Refer to Section 8.6 of this report for a breakdown of the demographics and social environment in these areas. The Namakwa IDP (2022 – 2027) aligns with the Nine Point Plan Identified by the National Government and identifies the Growing the Oceans Economy and Tourism – Small Harbour Development & Coastal and Marine Tourism. The IDP does not specifically mention offshore activities or exploration. The impact of the actual exploration activities on the local economy was assessed during the EIA Phase. Spatial Development Goal 4 of the West Coast District Municipality IDP (2022 – 2027) states that the district should promote sustainable utilisation of the District's natural resource base to extract economic development opportunities. The impact of the actual exploration activities on the local economy have been assessed during the EIA Phase. Refer to the impact assessment in Section 9 of this report.
2.1.2	Spatial priorities and desired spatial patterns (e.g. need for integrated of segregated communities, need to upgrade informal settlements, need for densification, etc.),	Exploration activities typically require highly skilled employment. However, where feasible, it is anticipated that the use of local labour could be utilised.
2.1.3	Spatial characteristics (e.g. existing land uses, planned land uses, cultural landscapes, etc.), and	Refer to the baseline environment in Section 8 of this report.
2.1.4	Municipal Economic Development Strategy ("LED Strategy").	Considering the limited scope and extent of the proposed exploration activities, it is not anticipated to significantly promote or facilitate spatial transformation and sustainable urban development.
2.2	Considering the socio-economic context, what will the socio-economic impacts be of the development (and its separate elements/aspects), and specifically also on the socio-economic objectives of the area?	Refer to the impact assessment in Section 9 of this report.
2.2.1	Will the development complement the local socio-economic initiatives (such as local economic development (LED) initiatives), or skills development programs?	Considering the limited scope and extent of the proposed exploration activities, it is not anticipated to significantly promote or facilitate spatial transformation and sustainable urban development.
2.3	How will this development address the specific physical, psychological, developmental, cultural and social needs and interests of the relevant communities?	Refer to the public participation process and feedback contained Appendix 2.

Ref No.	Question	Answer
2.4	Will the development result in equitable (intra- and inter-generational) impact distribution, in the short- and long-term? Will the impact be socially and economically sustainable in the short- and long-term?	Refer to the impact assessment in Section 9 of this report.
2.5	In terms of location, describe how the placement of the proposed development will:	
2.5.1	Result in the creation of residential and employment opportunities in close proximity to or integrated with each other.	Exploration activities typically require highly skilled employment. However, where feasible, it is anticipated that the use of local labour could be utilised. The impact of the actual exploration activities on employment opportunities have been assessed during the EIA Phase. Refer to the impact assessment in Section 9 of this report.
2.5.2	Reduce the need for transport of people and goods.	The exploration activities are not anticipated to have an impact on the transportation of goods and people.
2.5.3	Result in access to public transport or enable non-motorised and pedestrian transport (e.g. will the development result in densification and the achievement of thresholds in terms of public transport),	The exploration activities are not anticipated to have an impact on the public transport.
2.5.4	Compliment other uses in the area,	Block 3B/4B offshore area has been subjected to a number of previous exploration activities and some wells have been drilled in the past. The proposed exploratory drilling complements previous activities undertaken in the block aimed at discovering potential oil and gas resources. These activities include a number of seismic surveys which have previously been undertaken.
2.5.5	Be in line with the planning for the area.	Refer to item 2.1.1 of this table (above).
2.5.6	For urban related development, make use of underutilised land available with the urban edge.	Not applicable. The proposed project is not located in an urban area.
2.5.7	Optimise the use of existing resources and infrastructure,	Refer to Section 3 of this report.
2.5.8	Opportunity costs in terms of bulk infrastructure expansions in non-priority areas (e.g. not aligned with the bulk infrastructure planning for the settlement that reflects the spatial reconstruction priorities of the settlement),	
2.5.9	Discourage "urban sprawl" and contribute to compaction / densification.	Not applicable. The proposed project is not located in an urban area.

Ref No.	Question	Answer
2.5.10	Contribute to the correction of the historically distorted spatial patterns of settlements and to the optimum use of existing infrastructure in excess of current needs,	Refer to items 2.5.7 – 2.5.9 of this table (above).
2.5.11	Encourage environmentally sustainable land development practices and processes	This project entails the exploration for oil and gas (including drilling). Since the exploration activities will include drilling, a risk averse and cautious approach has been implemented through the proposed specialist mitigation measures to limit the impact on the surrounding environment. The highest predicted impact to the surrounding environment would be a blow-out event which is considered unlikely. The impact of the exploration activities have been assessed during the EIA Phase. Refer to the impact assessment in Section 9 of this report.
2.5.12	Take into account special locational factors that might favour the specific location (e.g. the location of a strategic mineral resource, access to the port, access to rail, etc.),	The proposed project aims to identify potentially strategic oil and gas resources.
2.5.13	The investment in the settlement or area in question will generate the highest socio-economic returns (i.e. an area with high economic potential).	The proposed project aims to identify oil and gas resources. Given the location offshore, it is not anticipated that the exploration activities will contribute to the significantly to settlements or areas in terms of socio-economic returns.
2.5.14	Impact on the sense of history, sense of place and heritage of the area and the socio-cultural and cultural-historic characteristics and sensitivities of the area, and	Refer to the impact assessment in Section 9 of this report.
2.5.15	In terms of the nature, scale and location of the development promote or act as a catalyst to create a more integrated settlement?	Given the location offshore, it is not anticipated that the exploration activities will contribute to the significantly to settlements or areas in terms of socio-economic returns.
2.6	How was a risk-averse and cautious approach applied in terms of socio-economic impacts:	
2.6.1	What are the limits of current knowledge (note: the gaps, uncertainties and assumptions must be clearly stated)?	Refer to Section 12 of this report.
2.6.2	What is the level of risk (note: related to inequality, social fabric, livelihoods, vulnerable communities, critical resources, economic vulnerability and sustainability) associated with the limits of current knowledge?	The level of risk is low as the project is not expected to have far reaching negative impacts on socio-economic conditions.

Ref No.	Question	Answer
2.6.3	Based on the limits of knowledge and the level of risk, how and to what extent was a risk-averse and cautious approach applied to the development?	The level of risk is low as the project is not expected to have far reaching negative impacts on socio-economic conditions. Since the exploration activities will include drilling, a risk averse and cautious approach has been implemented through the proposed specialist mitigation measures to limit the impact on the surrounding environment. The highest predicted impact to the surrounding environment would be a blow-out event which is considered unlikely. The impact of the exploration activities has been assessed during the EIA Phase. Refer to the impact assessment in Section 9 of this report.
2.7	How will the socio-economic impacts resulting from this development impact on people's environmental right in terms following:	
2.7.1	Negative impacts: e.g. health (e.g. HIV-Aids), safety, social ills, etc. What measures were taken to firstly avoid negative impacts, but if avoidance is not possible, to minimise, manage and remedy negative impacts?	Refer to the impact assessment in Section 9 of this report.
2.7.2	Positive impacts. What measures were taken to enhance positive impacts?	Refer to the impact assessment in Section 9of this report.
2.8	Considering the linkages and dependencies between human wellbeing, livelihoods and ecosystem services, describe the linkages and dependencies applicable to the area in question and how the development's socioeconomic impacts will result in ecological impacts (e.g. over utilisation of natural resources, etc.)?	Refer to the impact assessment in Section 9 of this report.
2.9	What measures were taken to pursue the selection of the "best practicable environmental option" in terms of socio-economic considerations?	Refer to the impact assessment in Section 9 of this report.
2.10	What measures were taken to pursue environmental justice so that adverse environmental impacts shall not be distributed in such a manner as to unfairly discriminate against any person, particularly vulnerable and disadvantaged persons (who are the beneficiaries and is the development located appropriately)? Considering the need for social equity and justice, do the alternatives identified, allow the "best practicable environmental option" to be selected, or is there a need for other alternatives to be considered?	Refer to the impact assessment in Section 9 of this report. Exploration activities typically require highly skilled employment. However, where feasible, it is anticipated that the use of local labour/ services could be utilised, but it is anticipated that this will be limited.
2.11	What measures were taken to pursue equitable access to environmental resources, benefits and services to meet basic human needs and ensure human	By conducting a Scoping and EIA Process, the applicant ensures that equitable access has been considered. Refer to the impact assessment in Section 9 of this report.

Ref No.	Question	Answer
	wellbeing, and what special measures were taken to ensure access thereto by categories of persons disadvantaged by unfair discrimination?	
2.12	What measures were taken to ensure that the responsibility for the environmental health and safety consequences of the development has been addressed throughout the development's life cycle?	Refer to the impact assessment in Section 9 of this report. The EIA and EMPr specify timeframes within which mitigation measures must be implemented.
2.13	What measures were taken to:	
2.13.1	Ensure the participation of all interested and affected parties.	Refer to Section 7 of this report, describing the public participation process undertaken for the proposed project.
2.13.2	Provide all people with an opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation,	Refer to Section 7 of this report, describing the public participation process undertaken for the proposed project. The advertisement and site notice have been made available in English, Afrikaans and IsiXhosa to assist in understanding of the project. Further public consultation was held during the Scoping and EIA phases of the project.
2.13.3	Ensure participation by vulnerable and disadvantaged persons,	
2.13.4	Promote community wellbeing and empowerment through environmental education, the raising of environmental awareness, the sharing of knowledge and experience and other appropriate means,	
2.13.5	Ensure openness and transparency, and access to information in terms of the process,	
2.13.6	Ensure that the interests, needs and values of all interested and affected parties were taken into account, and that adequate recognition were given to all forms of knowledge, including traditional and ordinary knowledge,	
2.13.7	Ensure that the vital role of women and youth in environmental management and development were recognised and their full participation therein will be promoted?	
2.14	Considering the interests, needs and values of all the interested and affected parties, describe how the development will allow for opportunities for all the segments of the community (e.g. a mixture of low-, middle-, and high-income	Refer to Section 7 of this report, describing the public participation process undertaken for the proposed project. Further public consultation were held during the EIA phase of the project.

Ref No.	Question	Answer
	housing opportunities) that is consistent with the priority needs of the local area (or that is proportional to the needs of an area)?	
2.15	What measures have been taken to ensure that current and / or future workers will be informed of work that potentially might be harmful to human health or the environment or of dangers associated with the work, and what measures have been taken to ensure that the right of workers to refuse such work will be respected and protected?	Potential future workers will have to be educated on a regular basis as to the environmental and safety risks that may occur within their work environment. Furthermore, adequate measures will have to be taken to ensure that the appropriate personal protective equipment is issued to workers based on the conditions that they work in and the requirements of their job.
2.16	Describe how the development will impact on job creation in terms of, amongst other aspects:	
2.16.1	The number of temporary versus permanent jobs that will be created.	Exploration activities typically require highly skilled employment. However, where feasible, it is anticipated that the use of local labour/ services could be utilised, but it is anticipated that this will be limited. However, should local labour be required during the exploration activities, then travel will be from suitable ports.
2.16.2	Whether the labour available in the area will be able to take up the job opportunities (i.e. do the required skills match the skills available in the area).	
2.16.3	The distance from where labourers will have to travel.	
2.16.4	The location of jobs opportunities versus the location of impacts.	
2.16.5	The opportunity costs in terms of job creation.	
2.17	What measures were taken to ensure:	
2.17.1	That there were intergovernmental coordination and harmonisation of policies, legislation and actions relating to the environment.	The Scoping and EIA Process requires governmental departments to communicate regarding any application. In addition, all relevant departments are notified at various phases of the project by the EAP.
2.17.2	That actual or potential conflicts of interest between organs of state were resolved through conflict resolution procedures.	
2.18	What measures were taken to ensure that the environment will be held in public trust for the people, that the beneficial use of environmental resources will serve the public interest, and that the environment will be protected as the people's common heritage?	Refer to Section 7 of this report, describing the public participation process implemented for the application, as well Section 9, the impact on any national estate.

Ref No.	Question	Answer
2.19	Are the mitigation measures proposed realistic and what long-term environmental legacy and managed burden will be left?	Refer to the impact assessment in Section 9 of this report.
2.20	What measures were taken to ensure that the costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage or adverse health effects will be paid for by those responsible for harming the environment?	The proposed exploration activities are not anticipated to produce significant pollution, environmental damage or adverse health effects in the long term, with the exception of a well-blow out event, which has been assessed in greater detail Section 9 of this report.
2.21	Considering the need to secure ecological integrity and a healthy bio-physical environment, describe how the alternatives identified (in terms of all the different elements of the development and all the different impacts being proposed), resulted in the selection of the best practicable environmental option in terms of socio-economic considerations?	Refer to Section 6 and Section 11.2 for a description of the process followed to reach the proposed preferred site.
2.22	Describe the positive and negative cumulative socio-economic impacts bearing in mind the size, scale, scope and nature of the project in relation to its location and other planned developments in the area?	Refer to the impact assessment in Section 9 of this report.

6 PROJECT ALTERNATIVES

This section provides a description of the alternatives considered as part of this Scoping and EIA process. It should be noted that the exploration for oil and gas within the Block 3B/4B offshore area will be undertaken by the drilling of exploration wells focused mostly on north and central sections of the licence block (i.e. the Areas of Interest – AOI – depicted in Figure 15).

6.1 LOCATION ALTERNATIVES

The Applicant is proposing to drill 1 exploration well, with the option to drill up to four additional wells. It should be noted that the exploration for oil and gas within the Block 3B/4B offshore area will be undertaken by the drilling of exploration wells focused mostly on north and central of the exploration area. The sites which have been identified as AOI are located north where four (4) exploration wells are proposed and at the central area where one (1) well is proposed within the 3B/4B exploration area. It is understood that prospects and leads outlines were depicted for the areas where drilling of exploration wells is proposed. Further to this, more mature prospects were depicted in the northern section of the block where the 3D volume was reprocessed which now need to be further explored. As such no further location alternatives will be assessed in the study. Specific spatial sensitives within the AOI and the available alternatives are discussed further in Section 6.2.

6.2 LAYOUT ALTERNATIVES

Though Block 3B/4B is in close proximity to the Child's Bank and Benguela Muds MPAs, the proposed AOIs which, should they be authorised, can only occur within Block 3B/4B do not overlap with any proclaimed MPAs as the AOI already avoids these areas. Block 3B/4B overlaps to some extent with the Child's Bank Ecologically and Biologically Significant Area (EBSA). However, the AOIs avoid all EBSAs. For oil and gas exploration activities, although vessels are permitted to sail through these areas, no invasive exploration activities are permitted in any proclaimed MPA. Under the currently issued exploration permit, no invasive exploration activities such as the proposed exploration drilling will take place in any proclaimed MPAs.

The AOIs do, however, overlap with some Critical Biodiversity Areas (CBA), and as such, the option of avoiding these CBAs within the AOI was assessed as a layout alternative during the EIA Phase (Figure 30). No other environmental sensitivities which require further avoidance were identified in the proposed AOI, and as such no further layout alternatives were considered feasible for further consideration. Please refer to Section 11.2 for further details on the preferred layout alternative recommended based on the impact assessment.

6.3 TECHNOLOGY ALTERNATIVES

Various types of drilling technology can be used to drill an exploration well (e.g. barges, jack-up rigs, semi-submersible drilling units (rigs) and drill-ships) depending on, inter alia, the water depth and marine operating conditions experienced at the well site. Based on the anticipated sea conditions and the depths, the Applicants are proposing to utilise a semi-submersible drilling unit or a drillship, both with dynamic positioning system suitable for the deep-water harsh marine environment. The final rig selection will be made depending upon availability and final design specifications.

- A semi-submersible drilling unit is essentially a drilling rig located on a floating structure of pontoons. When at the well location, the pontoons are partially flooded (or ballasted), with seawater, to submerge the pontoons to a pre-determined depth below the sea level where wave motion is minimised. This gives stability to the drilling vessel thereby facilitating drilling operations.
- A drillship is a fit for purpose-built drilling vessel designed to operate in deep water conditions. The drilling "derrick" is normally located towards the centre of the ship with support operations from both sides of the ship using fixed cranes. The advantages of a drillship over the majority of semi-submersible units are that a drillship has much greater storage capacity and is independently mobile, not requiring any towing and reduced requirement of support vessels.

The activities proposed in this application require specialised technology and skills. The final technology selection will be made based on equipment availability and final design criteria/selection.

6.4 SCHEDULING ALTERNATIVES

Based on the findings of the Drill Cutting and Oil Spill Modelling, Acoustics, Marine Ecology and Fisheries recommendations, alternatives scheduling alternatives were considered as part of the environmental impact assessment in order to avoid/ minimise the impacts associated with exploration activities. These include considerations on:

- Avoid/ minimise impacts/ likelihood of well-blowout or other pollution events;
- Avoid sensitive areas and periods for some marine fauna: e.g. movement of migratory animals and feeding grounds; and
- Avoid periods of peak fishing activity.

6.5 NO GO ALTERNATIVE

The no go alternative would imply that no exploration activities are undertaken. As a result, the opportunity to identify potential oil and gas resources within the Block 3B/4B and proposed AOI would not exist. This will negate the potential negative and positive impacts associated with the proposed exploration activities.

A no-go alternative assessment was undertaken during the EIA Phase (Section 9.5).

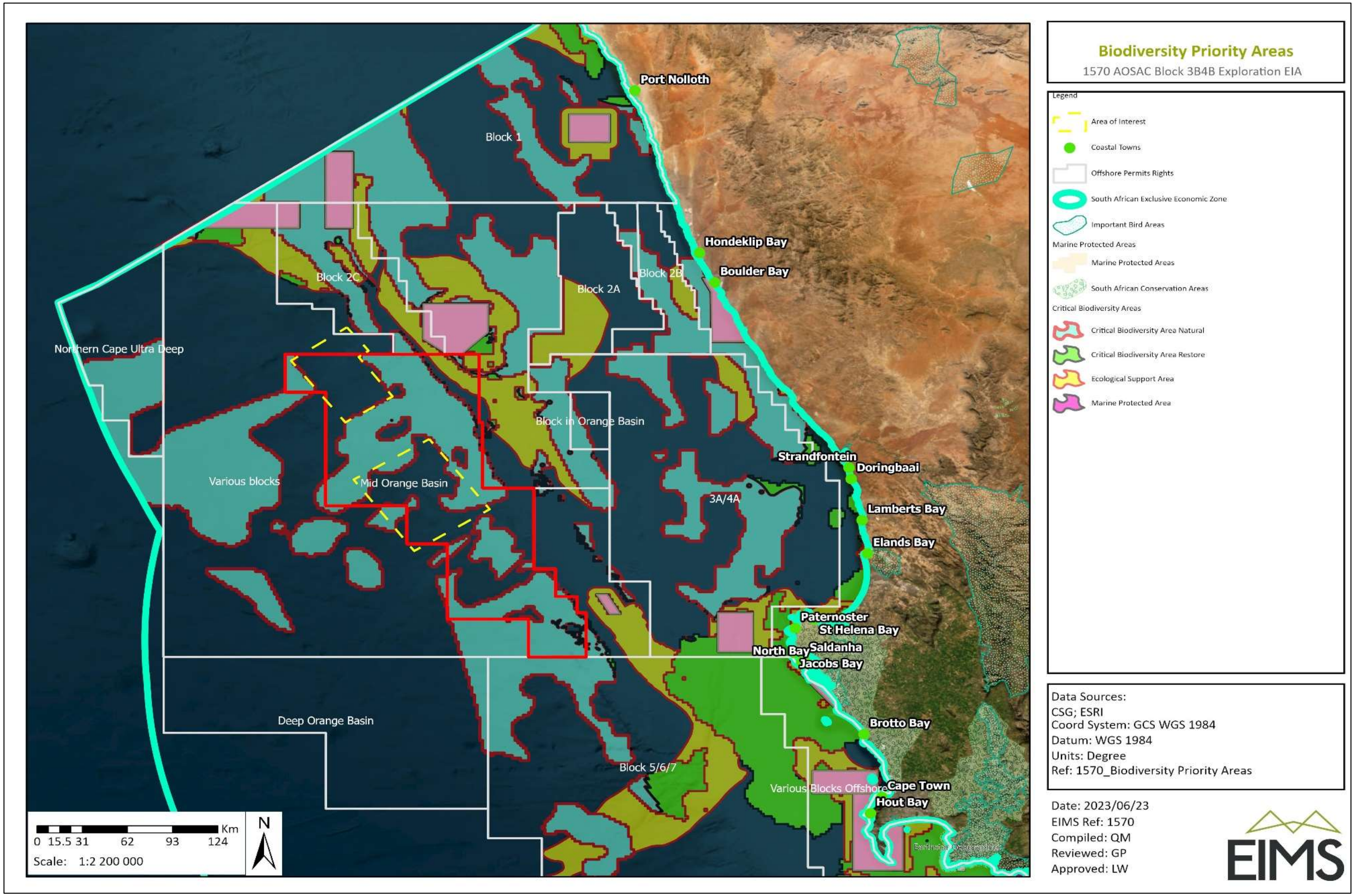


Figure 30: Biodiversity Priority and Marine Protected Areas in relation to the application area.

7 STAKEHOLDER ENGAGEMENT

The Public Participation Process (PPP) is a requirement of several pieces of South African legislation and aims to ensure that all relevant Interested and Affected Parties (I&APs) are consulted, involved and their comments are considered, and a record included in the reports submitted to the Authorities. The process ensures that all stakeholders are provided this opportunity as part of a transparent process which allows for a robust and comprehensive environmental study. The PPP for the proposed project needs to be managed sensitively and according to best practises to ensure and promote:

- Compliance with international best practice options;
- Compliance with national legislation;
- Establishment and management of relationships with key stakeholder groups; and
- Involvement and participation in the environmental study and authorisation/approval process.

As such, the purpose of the PPP and stakeholder engagement process is to:

- Introduce the proposed project;
- Explain the authorisations required;
- Explain the environmental studies already completed and yet to be undertaken (where applicable);
- Solicit and record any issues, concerns, suggestions, and objections to the project;
- Provide opportunity for input and gathering of local knowledge;
- Establish and formalise lines of communication between the I&APs and the project team;
- Identify all significant issues for the project; and
- Identify possible mitigation measures or environmental management plans to minimise and/or prevent negative environmental impacts and maximize and/or promote positive environmental impacts associated with the project.

7.1 GENERAL APPROACH TO PUBLIC PARTICIPATION

The PPP for the proposed project has been undertaken in accordance with the requirements of the NEMA EIA Regulations (2014), and in line with the principles of IEM. IEM implies an open and transparent participatory process, whereby stakeholders and other I&APs are afforded an opportunity to comment on the project and have their views considered and included as part of project planning. The details of the approach and processes undertaken for public participation are outlined in the Public Participation Report (PPR), refer to Appendix 2. Table 12 provides a summary of the opportunities provided to I&APs for participation in the public participation process to date.

Table 12: Opportunities Provided for Public Participation

Action	Description	Publication/Place	Date
Initial Call to Register	Notification of landowners, occupiers, and other key I&Aps.	Affected landowners and key I&Aps were notified via email, fax, and/or post.	12 June 2023
	Placement of site notices.	One hundred and fifty (150) A1 Correx site notices (in English, Afrikaans and isiXhosa) placed at 150 locations along the West Coast.	12-17 June 2023

Action	Description	Publication/Place	Date
	Newspaper advertisement	Notices were placed in five (5) newspapers.	14-16 June 2023
	Radio Adverts	Four (4) radio adverts were aired.	12-16 June 2023
DSR Availability	Placement of DSR for Public Review	DSR placed at various libraries and locations along the west coast.	19 July – 21 August 2023
	Public Meetings and Focus Group Discussions	Several public meetings and focus group discussions held in key communities along the west coast.	31 July – 10 August 2023
DEIAR Availability	Placement of DEIAR for Public Review	DEIAR placed at various libraries and locations along the west coast.	8 January 2024
	Public Open Days	Several public open days held in key communities along the west coast.	22 January – 1 February 2024

7.2 RECORD OF ISSUES RAISED

The comments presented below are those that have been received and addressed from 15 June 2023 to date and will be updated during and following the public participation period. A high-level summary of the comments raised to date are presented below.

- I&AP registrations and de-registrations;
- Request for clarity regarding terminology such as the reprocessing of data;
- Request for clarity on the nature of the project;
- Request to be informed about updates of the project;
- Request for files related to the location and situation of the project site;
- Provision of information related to SAHRIS application procedure for the project;
- Acknowledgement of receipt of notifications from local municipality;
- Request for clarity on the geographical extent of initial notification;
- Enquiry on the status of the application;
- Current employment opportunities enquiry;
- Questions around the risks of a blow-out;
- Comment on opinion on Afrikaans translations of documentation;
- Mitigation measures currently in place to deal with spillage risks;

- Questions about the duration of the drilling activity;
- Comments on relating to Scoping Report;
    - Drilling operations (including fluids and cuttings discharge) damage the seafloor;
    - Pollution from drilling operations affecting health of marine life;
    - Potential disturbance to ecosystems;
    - Impacts on spawning of fish species as well as other marine species;
    - Potential of significant adverse residual environmental effect on marine biota populations;
    - Potential impacts on species should a species be displaced;
- Concerns around Increase in underwater noise levels;
- Concern around marine fauna behavioural changes;
- Concern around impact on fishing sector;
- Concern around cultural heritage;
- Number of concerns related to the construction and operation phases of the project:
    - Increased levels of *E. coli* in the water due to the presence of drilling rig and crew;
    - Fish aggregation and increased predator - prey interactions;
    - Light emissions in marine environment;
    - Potential effects of project contributing to the disorientation and mortality of seabirds;
    - Attraction of plankton through project activities and increased risk to fish, turtles and cetaceans;
- Comments related to Climate Change and Just Energy transition:
    - Reasons requested for the need for oil and gas exploration despite the Just transition and move away from carbon emissions;
    - Commitment of applicant to Just transition questioned;
    - Potential bearing of the project on Climate Change;
    - Future commitment and reassurance of applicant to the Just energy transition;
    - Questions around the potential impacts of oil and gas production should a discovery be made;
- Question on contributions of applicant to skills development;
- Future employment opportunities related to activities of the project;
- Enquiry on future contributions to be made by applicant;
- Effects of project activities of fisheries and fishermen;
- Effect of project activities on economic wellbeing of coastal communities;
- The accuracy of the data and findings of scoping report questioned;
- The reliability and relevance of any older data used as part of the scoping report;
- The impact of the project on snoek (*Thyrsites atun*) and snoek fishing as a seasonal and sensitive activity;
- Comment on the potential of the project to affect beaches and tourism;
- Effect of activities on livelihood of communities;

- New or novel approaches to the EIA process this project engages with;
- Questions on the extent of public participation to be employed throughout the process;
- Question on the extent of community engagement during the public participation process;
- Enquiry on previous information used to select potential drilling spots;
- Block 3B/4B's in relation to protected biodiversity areas;
- Potential of not proceeding with the project to avoid risks involved altogether; and
- Comment from SAHRIS relating to further heritage studies of the affected area.

All comments and/or queries received to date are included in the PPR in Appendix 2.

8 ENVIRONMENTAL ATTRIBUTES AND BASELINE ENVIRONMENT

This section of the EIA Report provides a description of the environmental attributes that may be affected by the proposed project. Aspects of the biophysical, social and economic environment that could be directly or indirectly affected by, or could affect, the proposed development have been described. This information has been sourced from existing information available for the area, specialist baseline assessments, as well as previous reports undertaken for Block 3B/4B. The DFFE screening tool was also used to inform this section and a copy of the screening report is included in Appendix 4.

A broad description of the entire west coast offshore environment has been included due to the possibility of a well blowout having potential impacts on these environments, however unlikely.

8.1 GEOPHYSICAL CHARACTERISTICS

This section provides a description of the geophysical characteristics of the application area. The information has been sourced from the Marine Ecological Baseline undertaken by Pisces Environmental Services (Pty) Ltd (Appendix 4).

8.1.1 BATHYMETRY

The continental shelf along the West Coast is generally wide and deep, although large variations in both depth and width occur. The shelf maintains a general NNW trend, widening north of Cape Columbine and reaching its widest off the Orange River (180 km). The nature of the shelf break varies off the South African West Coast. Between Cape Columbine and the Orange River, there is usually a double shelf break, with the distinct inner and outer slopes, separated by a gently sloping ledge. The immediate inshore area consists mainly of a narrow (about 8 km wide) rugged rocky zone and slopes steeply seawards to a depth of around 80 m. The middle (-50 to 150 m) and outer shelf (-150 to -350 m) normally lacks relief and slopes gently seawards reaching the shelf edge at a depth of between -350 to -500 m (Sink *et al*. 2019). The three shelf zones characterising the West Coast are recognised following both abiotic (de Wet 2013) and biotic (Karenyi *et al*. 2016) patterns.

Banks on the continental shelf include the Orange Bank (Shelf or Cone), a shallow (160 - 190 m) zone that reaches maximal widths (180 km) offshore of the Orange River, and Child's Bank, situated ~150 km offshore at about 31°S, and adjacent to the northeastern corner of the licence block. Child's Bank is a major feature on the West Coast margin and is the only known submarine bank within South Africa's Exclusive Economic Zone (EEZ), rising from a depth of 350 - 400 m water to less than -200 m at its shallowest point. It is a rounded, flat topped, sandy plateau, which lies at the edge of the continental shelf. The bank has a gentle northern, eastern and southern margin but a steep, slump-generated outer face (Birch & Rogers 1973; Dingle *et al*. 1983; de Wet 2013). At its southwestern edge, the continental slope drops down steeply from -350 to -1 500 m over a distance of less than 60 km (de Wet 2013) creating precipitous cliffs at least 150 m high (Birch & Rogers 1973). The bank consists of resistant, horizontal beds of Pliocene sediments, similar to that of the Orange Banks, and represents another perched erosional outlier formed by Post-Pliocene erosion (Dingle 1973; Siesser *et al*. 1974). The top of this feature has been estimated to cover some 1 450 km^2 (Sink *et al*. 2012).

Tripp Seamount, a geological feature ~130 km to the north-northwest of the licence block, rises from the seabed at ~1 000 m to a depth of 150 m. It is a roughly circular feature with a flat apex that drops steeply on all sides.

A further two unnamed seamounts are situated ~110 km and ~140 km to the west of the western boundary of the licence block rising from depths of 3 000 m and 3 500 m. Refer to Figure 94 for a map for the general bathymetry of the licence block.

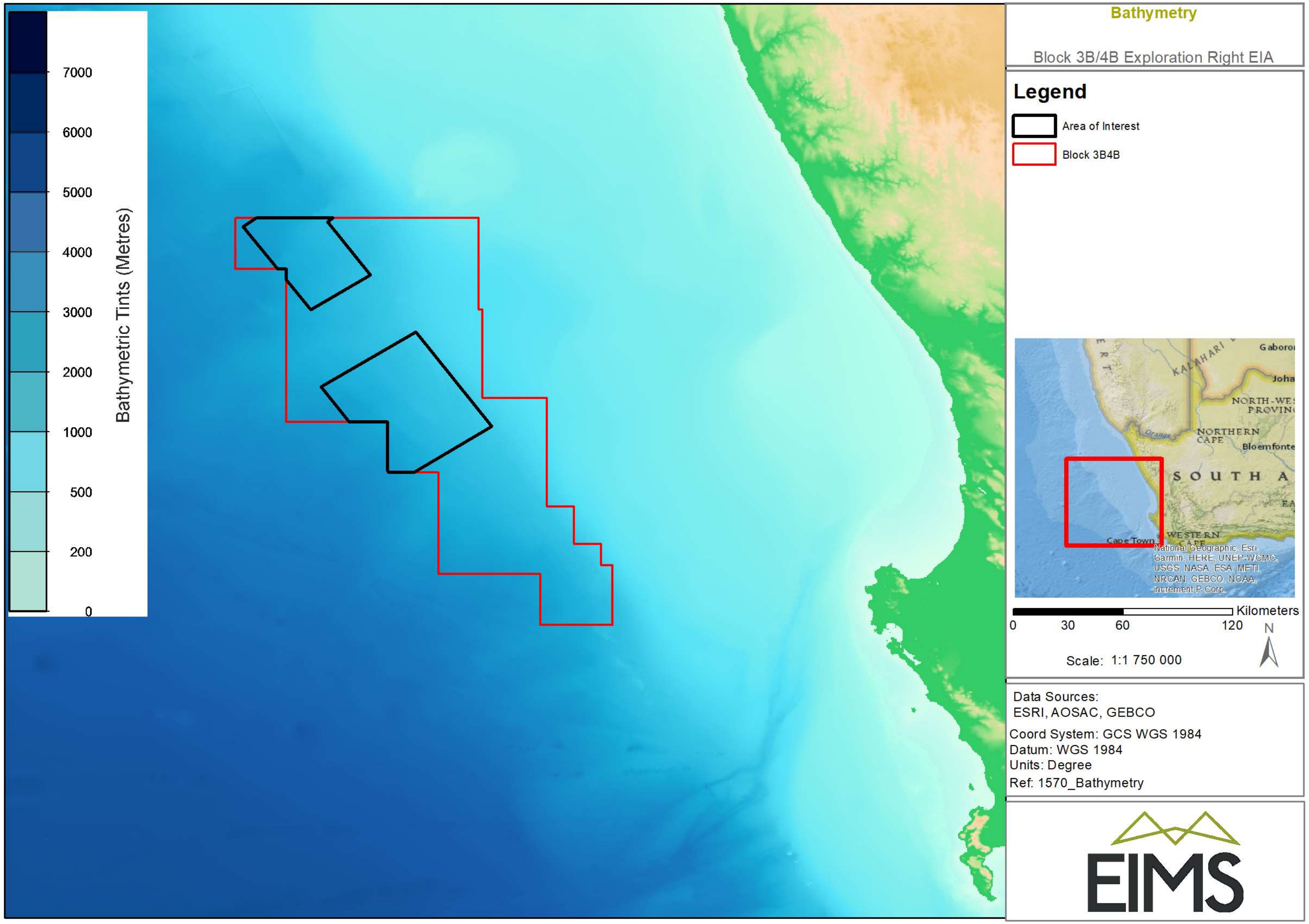


Figure 31: Bathymetry of Block 3B/4B

8.1.2 COASTAL AND INNER-SHELF GEOLOGY AND SEABED GEOMORPHOLOGY

Figure 32 and Figure 33 below illustrates the distribution of seabed surface sediment types off the South African north-western coast. The inner shelf is underlain by Precambrian bedrock (Pre-Mesozoic basement), whilst the middle and outer shelf areas are composed of Cretaceous and Tertiary sediments (Dingle 1973; Dingle *et al*. 1987; Birch *et al*. 1976; Rogers 1977; Rogers & Bremner 1991). 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 approximately 500 km long mud belt (up to 40 km wide, and of 15 m average thickness) is situated over the innershelf shelf between the Orange River and St Helena Bay (Birch *et al*. 1976). Further offshore and within the licence block, sediment is dominated by muds and sandy muds, with the eastern portion of the licence block having muddy sands and sands being present in the northeastern corner of the block. The continental slope, seaward of the shelf break, has a smooth seafloor, underlain by calcareous ooze.

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.

The benthic habitat types of the West Coast were classified and mapped in detail through the 2011 National Biodiversity Assessment (NBA) (Sink *et al*. 2012a). These were refined in the 2018 NBA (Sink *et al*. 2019) to provide substratum types (Figure 32).

In the licence block the water depth ranges from ~300 m to 2 600 m. The Southeast Atlantic Unclassified Slopes substratum dominates across the area. The shelf inshore of the licence block boasts a diversity of substrata (Sink *et al*. 2019).

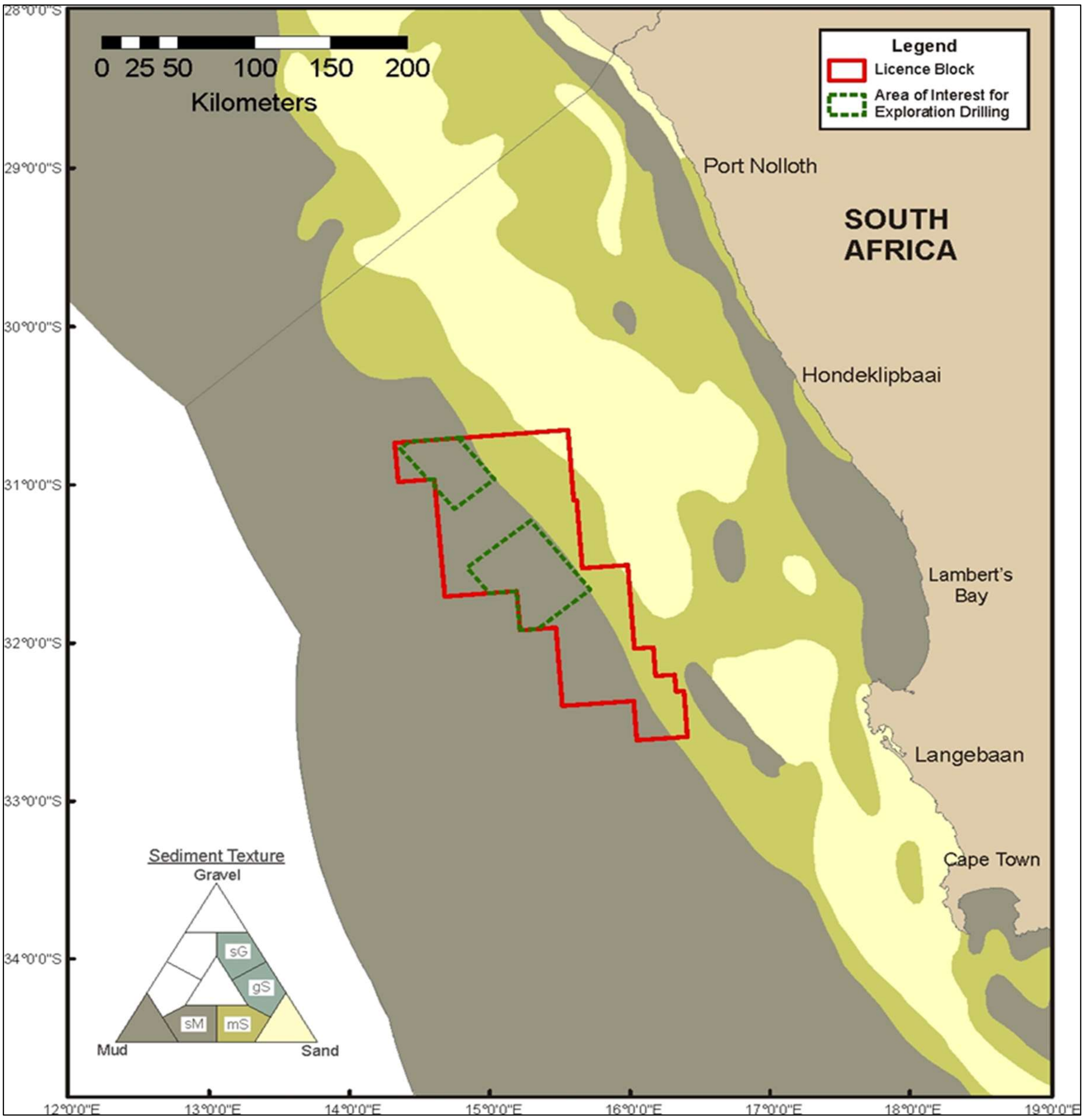


Figure 32: Block 3B/4B (red polygon) in relation to sediment distribution on the continental shelf of the South African West Coast (Adapted from Rogers 1977). Based on information in Holness *et al*. (2014) and Sink *et al*. (2019), the mud/sandy mud sediments have been extended to the edge of the EEZ beyond that shown in Rogers (1977).

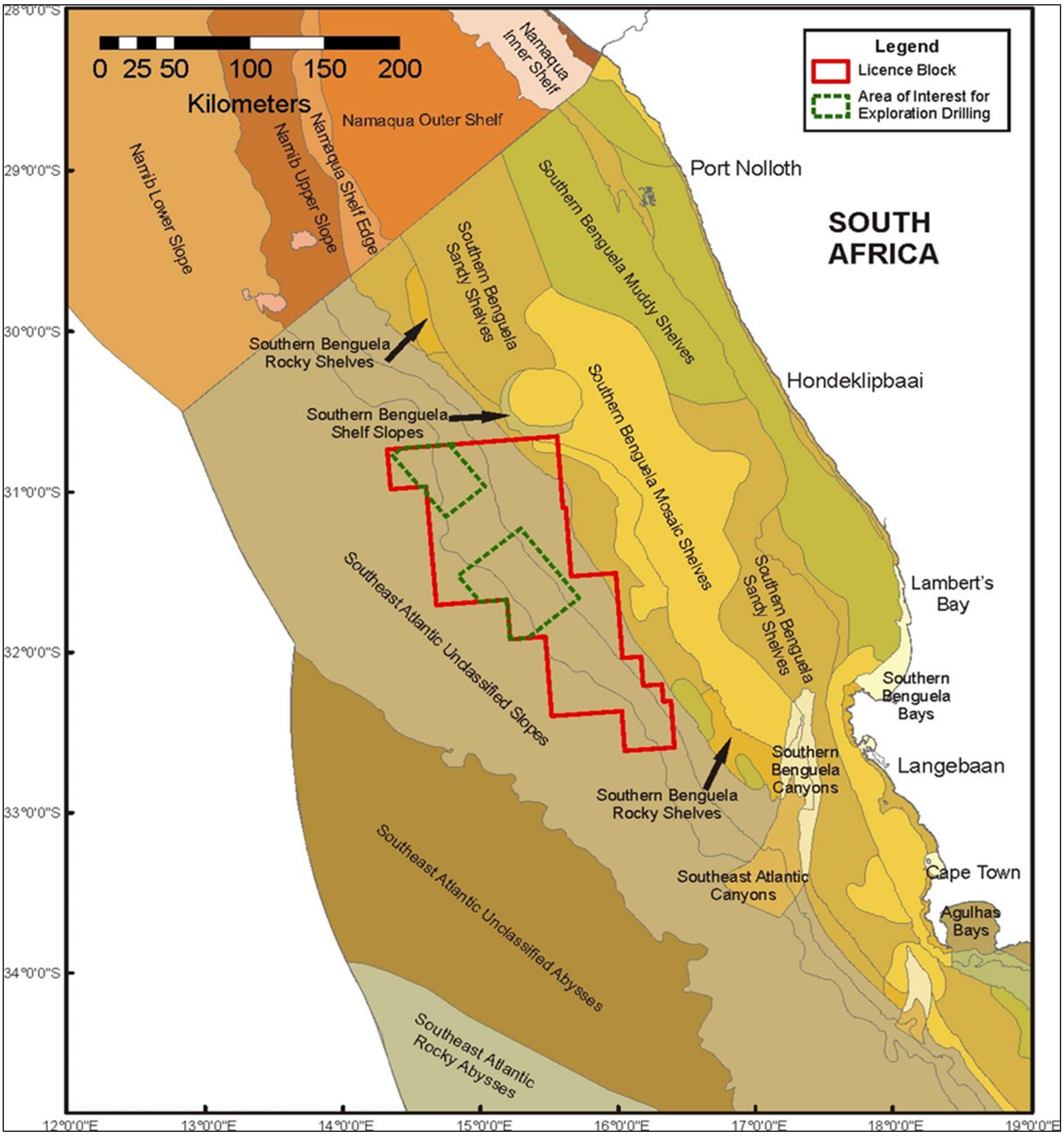


Figure 33: Block 3B/4B (red polygon) in relation to the distribution of seabed substratum types along the West Coast (adapted from Sink *et al*. 2019). The adjacent Namibian substratum types (adapted from Holness *et al*. 2019) are also shown.

8.1.3 SEDIMENTARY PHOSPHATES

Phosphorite, or phosphate-rich rock, is defined as sedimentary rock typically containing between 5%-20% phosphate. In the marine environment, it occurs either as a nodular hard ground capping of a few metres thick (Figure 34, left) or as series of unconsolidated sediments (Morant 2013). Several types of sedimentary phosphates occur offshore and onshore in South Africa, the largest of which is the diagenetic replacement resource on the Agulhas Bank. These replacement phosphate resources occur as near-continuous ‘pavements’ or cappings of limestones at depths between 200 m and 500 m on the continental shelf between Cape Agulhas and Cape Recife, covering an approximate area of 21 500 km^2. Further sporadic phosphate mantles over the continental shelf are known to occur from Lamberts Bay, north to the mouth of the Orange River (Figure 34, right). Block 3B/4B lies offshore of the phosphorite hard grounds.

The “open shelf” phosphorite deposits were formed during several episodes over the last 1.7 – 65 million years. They originated from the precipitation of phosphate in the form of calcium phosphate in an environment of intense upwelling and high biological activity along the continental margin of South Africa. The upwelling resulted in a change in temperature and pressure of the phosphate-laden oceanic waters, thus lowering the solubility of the phosphate salts they contained, and consequently precipitating the phosphates (in the form of apatite) over the continental shelf to form phosphatic packstones and colitic pellets at the sediment-water interface. The precipitation is facilitated by the decay of siliceous phytoplankton. The precipitated phosphates subsequently combined with calcium, derived from the disaggregation of calcareous foraminiferal and coccolithophorid debris on the outer continental shelf, to form phosphatised lime-rich muds. These muds subsequently lithified or consolidated through their replacement by secondary calcium phosphate (francolite), to form a near continuous hard capping of phosphate rock over the seafloor sediments (Birch 1990; Morant 2013).

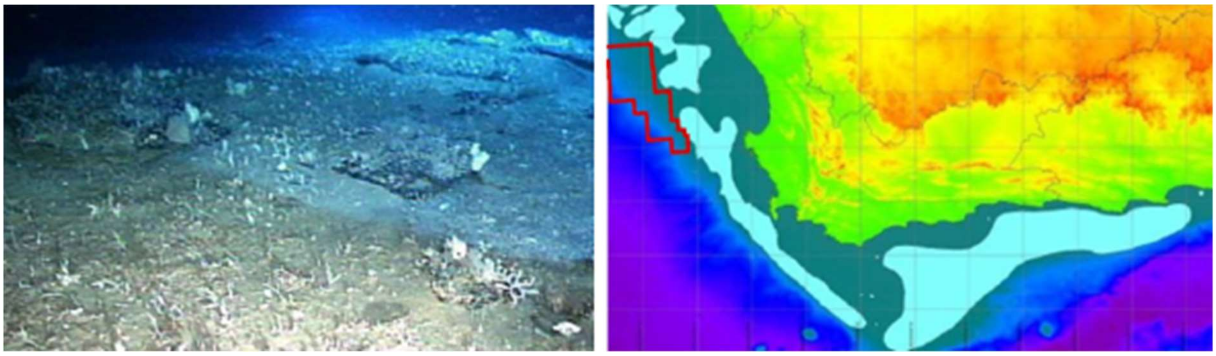


Figure 34: Phosphorite hard ground (left) and its distribution (cyan) on the South African continental shelf (right) in relation to Block 3B/4B (red polygon) (adapted from Morant 2013).

During repeated sea level changes, the phosphate-rich rocks were extensively re-worked, eroding the hard capping pavements thereby liberating the heavy phosphate-bearing minerals (mainly glauconite and apatite) and concentrating them in the overlying unconsolidated sediments. Migrating zones of deposition and erosion occurred during repeated transgressive/regressive cycles. Renewed carbonate deposition and a further period of phosphatization occurred when the deposition zones migrated back across the shelf in response to a rising sea level, thereby incorporating boulders and cobbles of phosphatized limestone and glauconite left behind after the previous regressive cycle into the second-generation phosphatic deposits, forming conglomeratic rock types. Two main periods of phosphatization have been identified, namely the Middle Miocene (ca 15 million years ago), and possibly the Upper Eocene (ca 37 million years ago) (Birch 1990; Morant 2013).

The phosphate-bearing lithologies comprise three non-conglomeratic and two conglomeratic rock types. The non-conglomeratic types are phosphatized foraminiferal lime packstones (a type of limestone), which are either poor in glauconite and quartz, rich in goethite, or highly glauconitic. The first conglomeratic type is also rich in glauconite but contains pebble inclusions of phosphatized foraminiferal limestone. The second conglomeratic type is distinguished by its low glauconite content and high macrofossil and goethite abundance. The depth of mineralization within the conglomeratic ores is typically restricted to the upper few metres of sediment. The phosphate-rich rocks on the Agulhas Bank are estimated to have an average P2O5 content of 16.2%. With an area of 35 000 million m^2, an average thickness of 0.5 m, the Agulhas Bank offshore phosphate deposits are estimated to contain in the order of 5 000 million tons of P2O5 (Birch 1990). Block 3B/4B and the AOI for drilling lies offshore of the known phosphate-bearing hard grounds, and drilling operations and associated drill cuttings discharges should not affect these areas.

8.2 BIOPHYSICAL CHARACTERISTICS

This section provides a description of the biophysical characteristics of the application area. The information has been sourced from the Marine Ecological Baseline undertaken by Pisces Environmental Services (Pty) Ltd (Appendix 4).

8.2.1 WIND PATTERNS

Winds are one of the main physical drivers of the nearshore Benguela region, both on an oceanic scale, generating the heavy and consistent south-westerly swells that impact this coast, and locally, contributing to the northward-flowing longshore currents, and being the prime mover of sediments in the terrestrial environment. Consequently, physical processes are characterised by the average seasonal wind patterns, and substantial episodic changes in these wind patterns have strong effects on the entire Benguela region.

The prevailing winds in the Benguela region are controlled by the South Atlantic subtropical anticyclone, the eastward moving mid-latitude cyclones south of southern Africa, and the seasonal atmospheric pressure field over the subcontinent. The South Atlantic anticyclone is a perennial feature that forms part of a discontinuous belt of high-pressure systems which encircle the subtropical southern hemisphere. This undergoes seasonal variations, being strongest in the austral summer, when it also attains its southernmost extension, lying south west and south of the subcontinent. In winter, the south Atlantic anticyclone weakens and migrates north-westwards.

These seasonal changes result in substantial differences between the typical summer and winter wind patterns in the region, as the southern hemisphere anti-cyclonic high-pressures system, and the associated series of cold fronts, moves northwards in winter, and southwards in summer. The strongest winds occur in summer (October to March), during which winds blow 98% of the time, with a total of 226 gales (winds exceeding 18 m/s or 35 knots (kts)) being recorded over the period. Virtually all winds in summer come from the south to south-southeast (Figure 35 below). These southerlies occur over 40% of the time, averaging 20 – 30 kts and reaching speeds in excess of 60 kts, bringing cool, moist air into the coastal region and driving the massive offshore movements of surface water, and the resultant strong upwelling of nutrient-rich bottom waters, which characterise this region in summer. The winds also play an important role in the loss of sediment from beaches. These strong equator-wards winds are interrupted by the passing of coastal lows with which are associated periods of calm or north or northwest wind conditions. These northerlies occur throughout the year but are more frequent in winter.

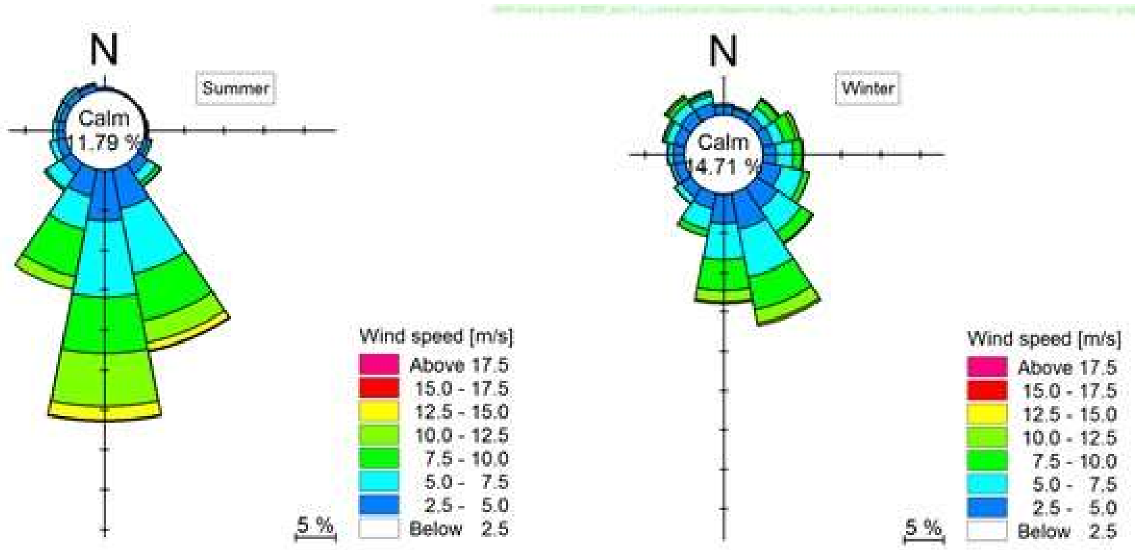


Figure 35: Wind Speed vs. Wind Direction for NCEP hind cast data at location 16.5°E, 29°S (From PRDW, 2013).

Winter remains dominated by southerly to south-easterly winds, but the closer proximity of the winter cold-front systems results in a significant south-westerly to north-westerly component (Figure 35 above). This ‘reversal’ from the summer condition results in cessation of upwelling, movement of warmer mid-Atlantic water shore-wards and breakdown of the strong thermoclines which typically develop in summer. There are also more calms in winter, occurring about 3% of the time, and wind speeds generally do not reach the maximum speeds of summer. However, the westerly winds blow in synchrony with the prevailing south-westerly swell direction, resulting in heavier swell conditions in winter.

During autumn and winter, catabatic, or easterly ‘berg’ winds can also occur. These powerful offshore winds can exceed 50 km/h, producing sandstorms that considerably reduce visibility at sea and on land. Although they occur intermittently for about a week at a time, they have a strong effect on the coastal temperatures, which often exceed 30°C during 'berg' wind periods. The winds also play a significant role in sediment input into the coastal marine environment with transport of the sediments up to 150 km offshore (Figure 36 below).

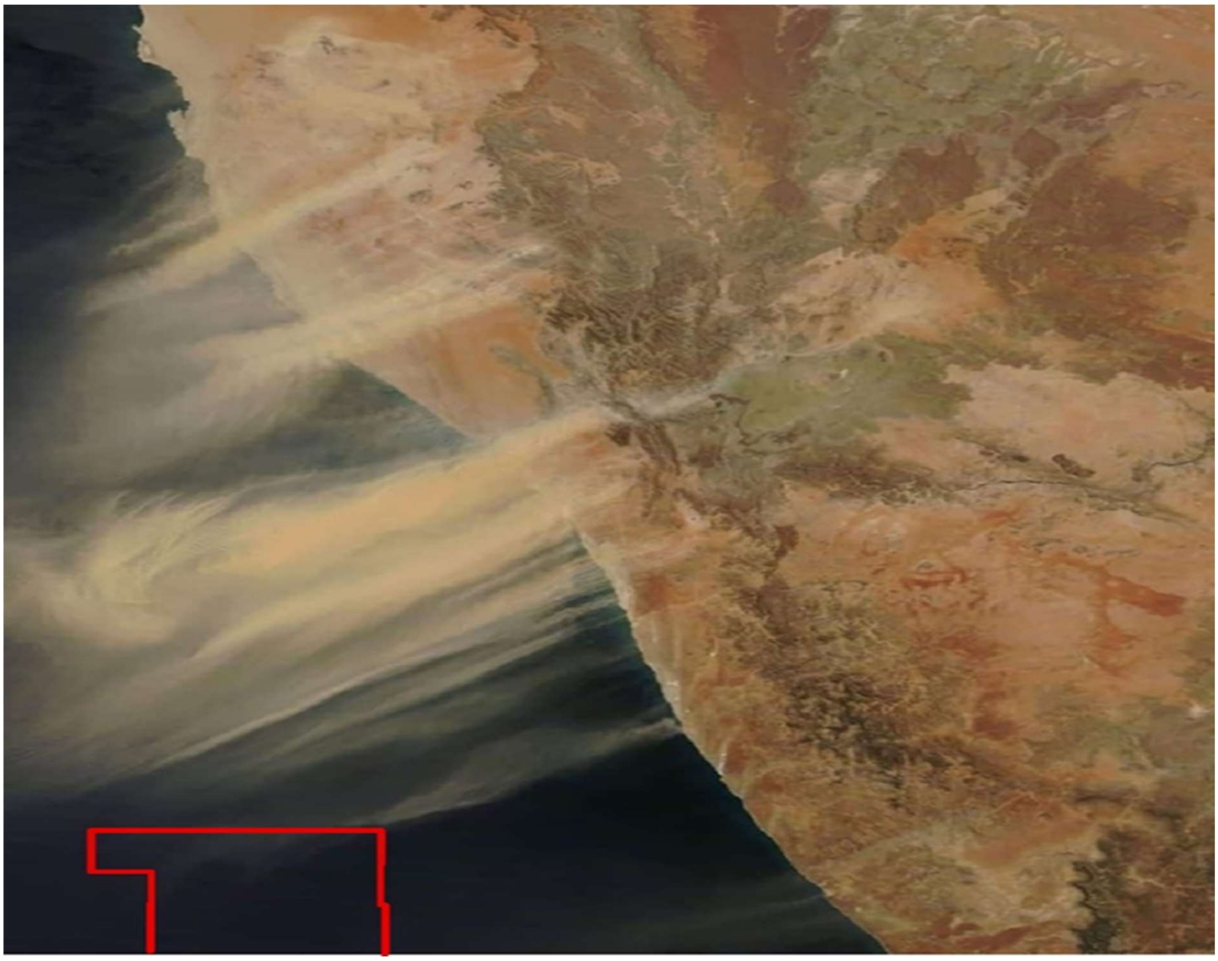


Figure 36: Block 3B/4B (red polygon) in relation to aerosol plumes of sand and dust due to a 'berg' wind event on the southern African west coast in October 2019 (Image Source: LandWaterSA).

8.2.2 LARGE-SCALE CIRCULATION AND COASTAL CURRENTS

The southern African West Coast is strongly influenced by the Benguela Current. Current velocities in continental shelf areas generally range between 10–30 cm/s (Boyd & Oberholster 1994), although localised flows in excess of 50 cm/s occur associated with eddies (PRDW 2013). On its western side, flow is more transient and characterised by large eddies shed from the retroflection of the Agulhas Current. This results in considerable variation in current speed and direction over the domain (PRDW 2013). In the south the Benguela current has a width of 200 km, widening rapidly northwards to 750 km. The surface flows are predominantly wind-forced, barotropic and fluctuate between poleward and equatorward flow (Shillington *et al*. 1990; Nelson & Hutchings 1983) (Figure 37). Fluctuation periods of these flows are 3-10 days, although the long-term mean current residual is in an approximate northwest (alongshore) direction. Current speeds decrease with depth, while directions rotate from predominantly north-westerly at the surface to south-easterly near the seabed. Near bottom shelf flow is mainly poleward with low velocities of typically <5 cm/s (Nelson 1989; PRDW 2013). The poleward flow becomes more consistent in the southern Benguela.

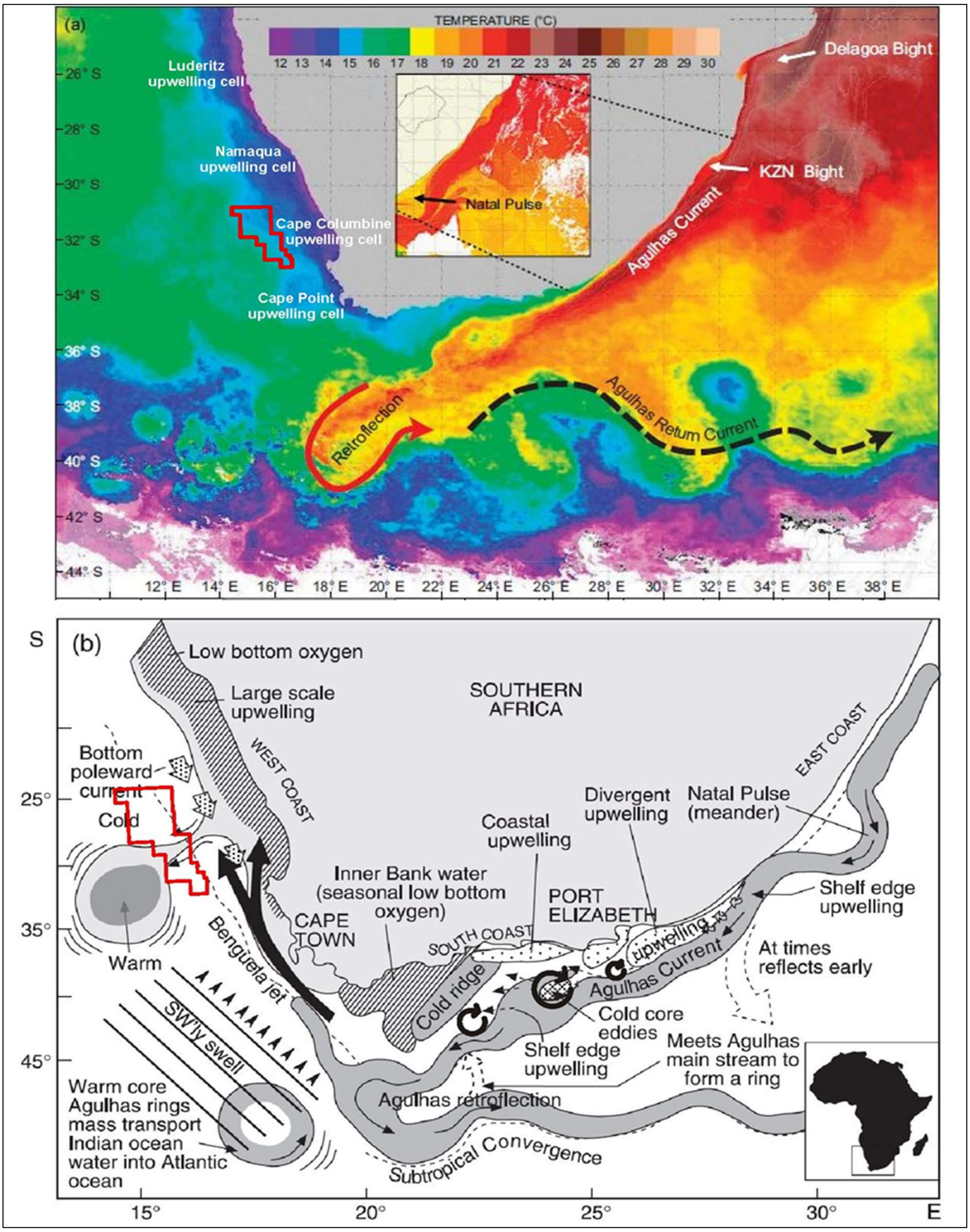


Figure 37: (a) Satellite sea-surface temperature image showing the predominance of the warm Agulhas Current along the South African south coast and the colder upwelled water on the west coast (adapted from Roberts *et al*. 2010), and (b) physical processes and features associated with the Southwest Coast in relation to Block 3B/4B (red polygon) (adapted from Roberts 2005).

Where the Agulhas Current passes the southern tip of the Agulhas Bank (Agulhas Retroflection area), it may shed a filament of warm surface water that moves north-westward along the shelf edge towards Cape Point, and Agulhas Rings, which similarly move north-westwards into the South Atlantic Ocean (Figure 37). These rings may extend to the seafloor and west of Cape Town may split, disperse or join with other rings. During the process of ring formation, intrusions of cold subantarctic water moves into the South Atlantic. The contrast in warm (nutrient-poor) and cold (nutrient-rich) water is thought to be reflected in the presence of cetaceans and large migratory pelagic fish species (Best 2007). The licence area lies offshore of 15°E on the outer edge of these features.

8.2.3 WAVES AND TIDES

Most of the west coast of southern Africa is classified as exposed, experiencing strong wave action, rating between 13-17 on the 20 point exposure scale (McLachlan 1980). Much of the coastline is therefore impacted by heavy south-westerly swells generated in the roaring forties, as well as significant sea waves generated locally by the prevailing moderate to strong southerly winds characteristic of the region (Figure 38 below). The peak wave energy periods fall in the range 9.7 – 15.5 seconds.

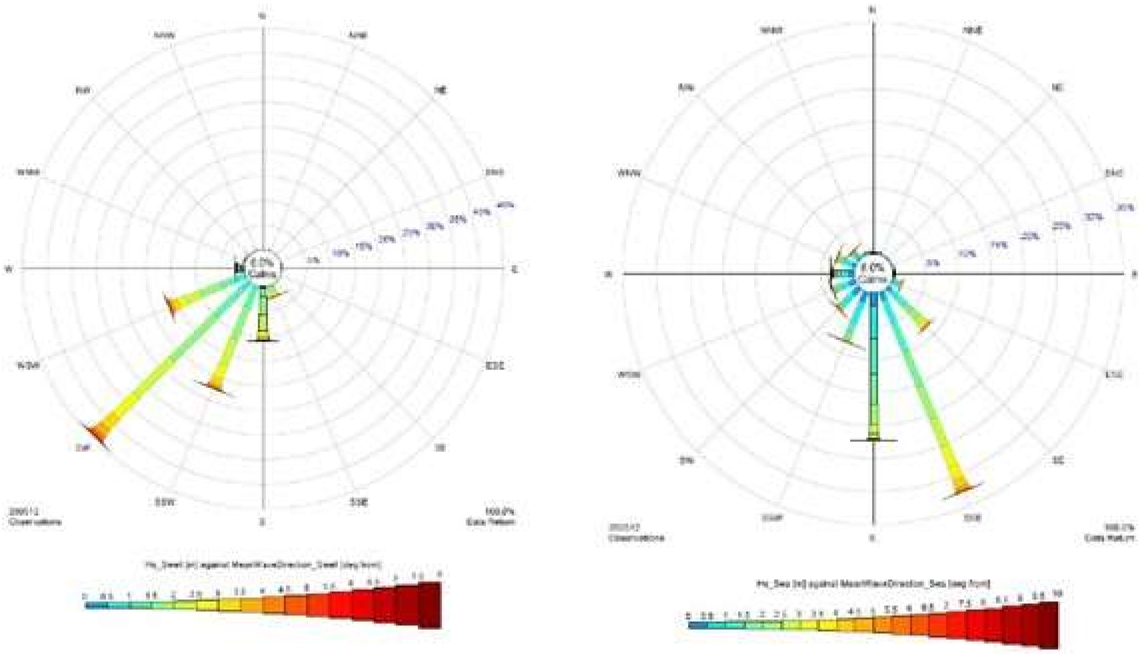


Figure 38: Annual roseplots of significant wave height partitions of swell (left) and wind-sea (right) for GROW1012 hind cast data at location 15°E, 31°S (Pisces, 2023).

The wave regime along the southern African west coast shows only moderate seasonal variation in direction, with virtually all swells throughout the year coming from the S and SSW direction. Winter swells are strongly dominated by those from the S and SSW, which occur almost 80% of the time, and typically exceed 2 m in height, averaging about 3 m, and often attaining over 5 m. With wind speeds capable of reaching 100 km/h during heavy winter south-westerly storms, winter swell heights can exceed 10 m.

In comparison, summer swells tend to be smaller on average, typically around 2 m, not reaching the maximum swell heights of winter. There is also a slightly more pronounced southerly swell component in summer. These southerly swells tend to be wind-induced, with shorter wave periods (~8 seconds), and are generally steeper than swell waves. These wind-induced southerly waves are relatively local and, although less powerful, tend to work together with the strong southerly winds of summer to cause the northward-flowing nearshore surface currents, and result in substantial nearshore sediment mobilisation, and northwards transport, by the combined action of currents, wind and waves. In common with the rest of the southern African coast, tides are semi-diurnal, with a total range of some 1.5 m at spring tide, but only 0.6 m during neap tide periods.

8.2.4 WATER

South Atlantic Central Water (SACW) comprises the bulk of the seawater in the study area, either in its pure form in the deeper regions, or mixed with previously upwelled water of the same origin on the continental shelf. Salinities range between 34.5‰ and 35.5‰.

Seawater temperatures on the continental shelf of the southern Benguela typically vary between 6°C and 16°C. Well-developed thermal fronts exist, demarcating the seaward boundary of the upwelled water. Upwelling filaments are characteristic of these offshore thermal fronts, occurring as surface streamers of cold water, typically 50 km wide and extending beyond the normal offshore extent of the upwelling cell. Such fronts typically have a lifespan of a few days to a few weeks, with the filamentous mixing area extending up to 625 km offshore.

The continental shelf waters of the Benguela system are characterised by low oxygen concentrations, especially on the bottom. SACW itself has depressed oxygen concentrations (~80% saturation value), but lower oxygen concentrations (<40% saturation) frequently occur. Nutrient concentrations of upwelled water of the Benguela system attain 20 µM nitrate-nitrogen, 1.5 µM phosphate and 15-20 µM silicate, indicating nutrient enrichment. This is mediated by nutrient regeneration from biogenic material in the sediments. Modification of these peak concentrations depends upon phytoplankton uptake, which varies according to phytoplankton biomass and production rate. The range of nutrient concentrations can thus be large but, in general, concentrations are high.

8.2.5 UPWELLING AND PLANKTON PRODUCTION

The cold, upwelled water is rich in inorganic nutrients, the major contributors being various forms of nitrates, phosphates and silicates (Chapman & Shannon 1985). During upwelling the comparatively nutrient-poor surface waters are displaced by enriched deep water, supporting substantial seasonal primary phytoplankton production. This, in turn, serves as the basis for a rich food chain up through zooplankton, pelagic baitfish (anchovy, pilchard, round-herring and others), to predatory fish (hake and snoek), mammals (primarily seals and dolphins) and seabirds (jackass penguins, cormorants, pelicans, terns and others). High phytoplankton productivity in the upper layers again depletes the nutrients in these surface waters. This results in a wind-related cycle of plankton production, mortality, sinking of plankton detritus and eventual nutrient re-enrichment occurring below the thermocline as the phytoplankton decays. Block 3B/4B is located well offshore (>100 km) of these upwelling events and waters are expected to be comparatively warm and nutrient poor (Figure 37).

8.2.6 ORGANIC INPUTS

The Benguela upwelling region is an area of particularly high natural productivity, with extremely high seasonal production of phytoplankton and zooplankton. These plankton blooms in turn serve as the basis for a rich food chain up through pelagic baitfish (anchovy, pilchard, round-herring and others), to predatory fish (snoek), mammals (primarily seals and dolphins) and seabirds (jackass penguins, cormorants, pelicans, terns and others). All of these species are subject to natural mortality, and a proportion of the annual production of all these trophic levels, particularly the plankton communities, die naturally and sink to the seabed.

Balanced multispecies ecosystem models have estimated that during the 1990s the Benguela region supported biomasses of 76.9 tons/km^2 of phytoplankton and 31.5 tons/km^2 of zooplankton alone (Shannon *et al*. 2003). Thirty six percent of the phytoplankton and 5% of the zooplankton are estimated to be lost to the seabed annually. This natural annual input of millions of tons of organic material onto the seabed off the southern African West Coast has a substantial effect on the ecosystems of the Benguela region. It provides most of the food requirements of the particulate and filter-feeding benthic communities that inhabit the sandy-muds of this area, and results in the high organic content of the muds in the region. As most of the organic detritus is not directly consumed, it enters the seabed decomposition cycle, resulting in subsequent depletion of oxygen in deeper waters. Block 3B/4B lies offshore of the zone of influence of upwelling-induced low-oxygen concentrations through remineralisation of linked phytoplankton productivity.

An associated phenomenon ubiquitous to the Benguela system is red tides (dinoflagellate and/or ciliate blooms) (see Shannon & Pillar 1985; Pitcher 1998; Pitcher & Calder 2000). Also referred to as Harmful Algal Blooms (HABs), these red tides can reach very large proportions, extending over several square kilometres of ocean (Figure 39, left). Toxic dinoflagellate species can cause extensive mortalities of fish and shellfish through direct poisoning, while degradation of organic-rich material derived from both toxic and non-toxic blooms results in oxygen depletion of subsurface water (Figure 39, right). HABs, being associated primarily with upwelling cells, are unlikely to occur within Block 3B/4B, but may occur inshore of the block.

Figure 39: Red tides can reach very large proportions (Left, Photo: www.e-education.psu.edu) and can lead to mass stranding, or 'walk-out' of rock lobsters, such as occurred at Elands Bay in March 2022 (Right, Photo: Henk Kruger/African News Agency).

8.2.7 LOW OXYGEN EVENTS

The continental shelf waters of the Benguela system are characterised by low oxygen concentrations with <40% saturation occurring frequently. The low oxygen concentrations are attributed to nutrient remineralisation in the bottom waters of the system. The absolute rate of this is dependent upon the net organic material build-up in the sediments, with the carbon rich mud deposits playing an important role. As the mud on the shelf is distributed in discrete patches (refer to Figure 32 above), there are corresponding preferential areas for the formation of oxygen-poor water. The two main areas of low-oxygen water formation in the southern Benguela region are in the Orange River Bight and St Helena Bay. The spatial distribution of oxygen-poor water in each of the areas is subject to short- and medium-term variability in the volume of hypoxic water that develops. De Decker (1970) showed that the occurrence of low oxygen water off Lambert's Bay is seasonal, with highest development in summer/autumn. Bailey & Chapman (1991), on the other hand, demonstrated that in the St Helena Bay area daily variability exists as a result of downward flux of oxygen through thermoclines and short-term variations in upwelling intensity. Subsequent upwelling processes can move this low-oxygen water up onto the inner shelf, and into nearshore waters, often with devastating effects on marine communities.

Periodic low oxygen events in the nearshore region can have catastrophic effects on the marine communities leading to large-scale stranding of rock lobsters, and mass mortalities of marine biota and fish. The development of anoxic conditions as a result of the decomposition of huge amounts of organic matter generated by phytoplankton blooms is the main cause for these mortalities and walkouts. The blooms develop over a period of unusually calm wind conditions when sea surface temperatures where high. Algal blooms usually occur during summer-autumn (February to April) but can also develop in winter during the 'berg' wind periods, when similar warm windless conditions occur for extended periods.

8.2.8 TURBIDITY

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulate matter. Total Suspended Particulate Matter (TSPM) can be divided into Particulate Organic Matter (POM) and Particulate Inorganic Matter (PIM), the ratios between them varying considerably. The POM usually consists of detritus, bacteria, phytoplankton and zooplankton, and serves as a source of food for filter-feeders. Seasonal microphyte production associated with upwelling events will play an important role in determining the concentrations of POM in coastal waters. PIM, on the other hand, is primarily of geological origin consisting of fine sands, silts and clays. Off Namaqualand, the PIM loading in nearshore waters is strongly related to natural inputs from the Orange River or from 'berg' wind events (refer to Figure 36 above). Although highly variable, annual discharge rates of sediments by the Orange River is estimated to vary from 8 - 26 million tons/year. 'Berg' wind events can potentially contribute the same order of magnitude of sediment input as the annual estimated input of sediment by the Orange River. For example, a 'berg' wind event in May 1979 described by Shannon and Anderson (1982) was estimated to have transported in the order of 50 million tons of sand out to sea, affecting an area of 20 000 km^2.

Concentrations of suspended particulate matter in shallow coastal waters can vary both spatially and temporally, typically ranging from a few mg/ℓ to several tens of mg/ℓ. Field measurements of TSPM and PIM concentrations in the Benguela current system have indicated that outside of major flood events, background concentrations of coastal and continental shelf suspended sediments are generally <12 mg/ℓ, showing significant long-shore variation. Considerably higher concentrations of PIM have, however, been reported from southern African West Coast waters under stronger wave conditions associated with high tides and storms, or under flood conditions. In the vicinity of the Orange River mouth, where river outflow strongly influences the turbidity of coastal waters, measured concentrations ranged from 14.3 mg/ℓ at Alexander Bay just south of the mouth to peak values of 7 400 mg/ℓ immediately upstream of the river mouth during the 1988 Orange River flood.

The major source of turbidity in the swell-influenced nearshore areas off the West Coast is the redistribution of fine inner shelf sediments by long-period Southern Ocean swells. The current velocities typical of the Benguela (10-30 cm/s) are capable of resuspending and transporting considerable quantities of sediment equatorward. Under relatively calm wind conditions, however, much of the suspended fraction (silt and clay) that remains in suspension for longer periods becomes entrained in the slow poleward undercurrent.

Superimposed on the suspended fine fraction, is the northward littoral drift of coarser bedload sediments, parallel to the coastline. This northward, nearshore transport is generated by the predominantly south-westerly swell and wind-induced waves. Longshore sediment transport varies considerably in the shore-perpendicular dimension, being substantially higher in the surf-zone than at depth, due to high turbulence and convective flows associated with breaking waves, which suspend and mobilise sediment.

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

Offshore of the continental shelf, the oceanic waters are typically clear as they are beyond the influence of aeolian and riverine inputs. The waters in the offshore portions of Block 3B/4B are thus expected to be comparatively clear.

8.3 BIOLOGICAL ENVIRONMENT

This section provides a description of the biological characteristics of the application area. The information has been sourced from the Marine Ecological Baseline undertaken by Pisces Environmental Services (Pty) Ltd (Appendix 4).

Biogeographically, the study area falls into the cold temperate Namaqua Bioregion, which extends from Sylvia Hill, north of Lüderitz in Namibia to Cape Columbine. Within this bioregion, Block 3B/4B falls primarily into the Southwest Atlantic Deep Ocean Ecoregion (Figure 40). The coastal, wind-induced upwelling characterising the Western Cape coastline, is the principle physical process which shapes the marine ecology of the southern Benguela region. The Benguela system is characterised by the presence of cold surface water, high biological productivity, and highly variable physical, chemical and biological conditions.

Communities within marine habitats are largely ubiquitous throughout the southern African West Coast region, being particular only to substrate type or depth zone. These biological communities consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales). The offshore marine ecosystems comprise a limited range of habitats, namely unconsolidated seabed sediments, deepwater reefs and the water column. The biological communities 'typical' of these habitats are described briefly below, focussing both on dominant, commercially important and conspicuous species, as well as potentially threatened or sensitive species, which may be affected by the proposed exploration activities.

8.3.1 DEMERSAL COMMUNITIES

8.3.1.1 BENTHIC INVERTEBRATE MACROFAUNA

The seabed communities in the Deep Water Orange Basin area lie within the Namaqua sub-photic and continental slope biozones, which extend from a 30 m depth to the shelf edge, and beyond to the lower deep-sea slope, respectively. The benthic habitats of South Africa were mapped as part of the 2018 National Biodiversity Assessment (Sink *et al*. 2019) to develop assessments of the ecosystem threat status and ecosystem protection level. The benthic ecosystem types were subsequently mapped (Figure 41) and assigned an ecosystem threat status based on their level of protection (Figure 42). The Licence Area is characterised by a limited variety of ecosystem types, with the majority of Block 3B/4B characterised by Southeast Atlantic Lower-, Mid- and Upper Slope habitats, with some representation in the northeastern corner by Southern Benguela Sandy Shelf Edge and Shelf Edge Mosaic Abyss habitats.

The AOI for drilling coincides with three ecosystem types, namely:

- Southeast Atlantic Lower Slope - Unknown seabed type on the lower slope of Southeast Atlantic with a depth range of -1 800 m to -3 500 m.
- Southeast Atlantic Mid Slope - Unknown seabed type on the mid slope in the Southeast Atlantic ecoregion spanning depths of -1 000 m to -1 800 m.
- Southeast Atlantic Upper Slope - Unknown seabed type and associated water column on the upper slope (-500 m to -1 000 m) in the Southeast Atlantic ecoregion.

The benthic biota of unconsolidated marine sediments constitute invertebrates that live on (epifauna) or burrow within (infauna) the sediments and are generally divided into macrofauna (animals >1 mm) and meiofauna (<1 mm). Numerous studies have been conducted on southern African West Coast continental shelf benthos, mostly focused on mining, pollution or demersal trawling impacts. These studies, however, concentrated on the continental shelf and nearshore regions, and consequently the benthic fauna of the outer shelf and continental slope (beyond ~450 m depth) are very poorly known. This is primarily due to limited opportunities for sampling as well as the lack of access to Remote Operated Vehicles (ROVs) for visual sampling of hard substrata.

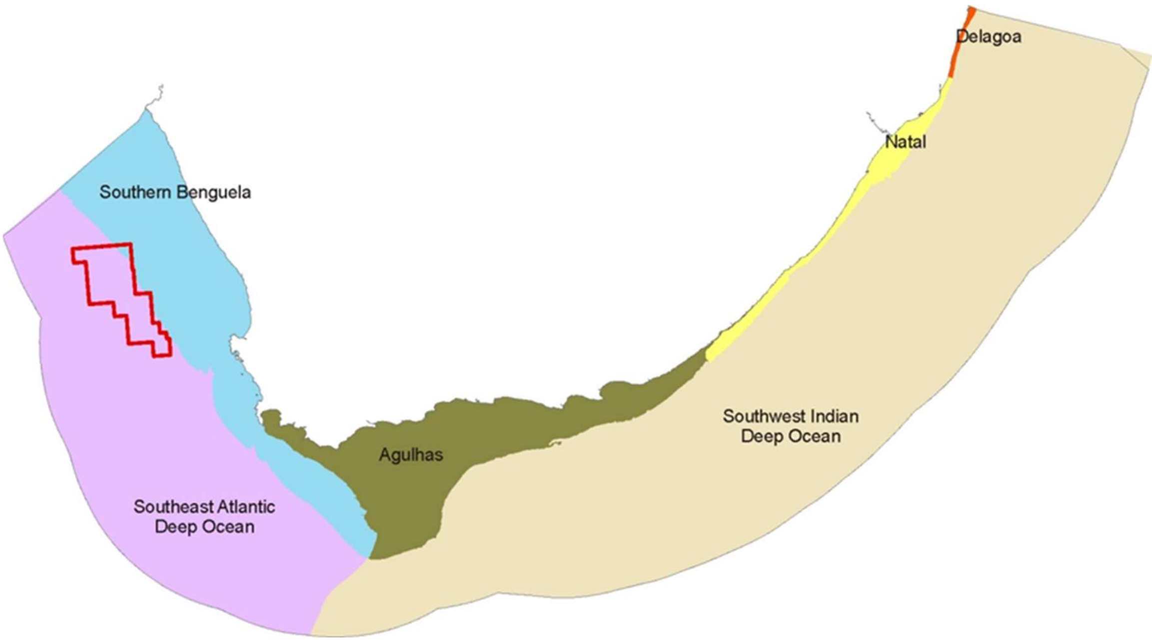


Figure 40: Block 3B/4B (red polygon) in relation to the inshore and offshore ecoregions of the South African coast (adapted from Sink *et al*. 2019).

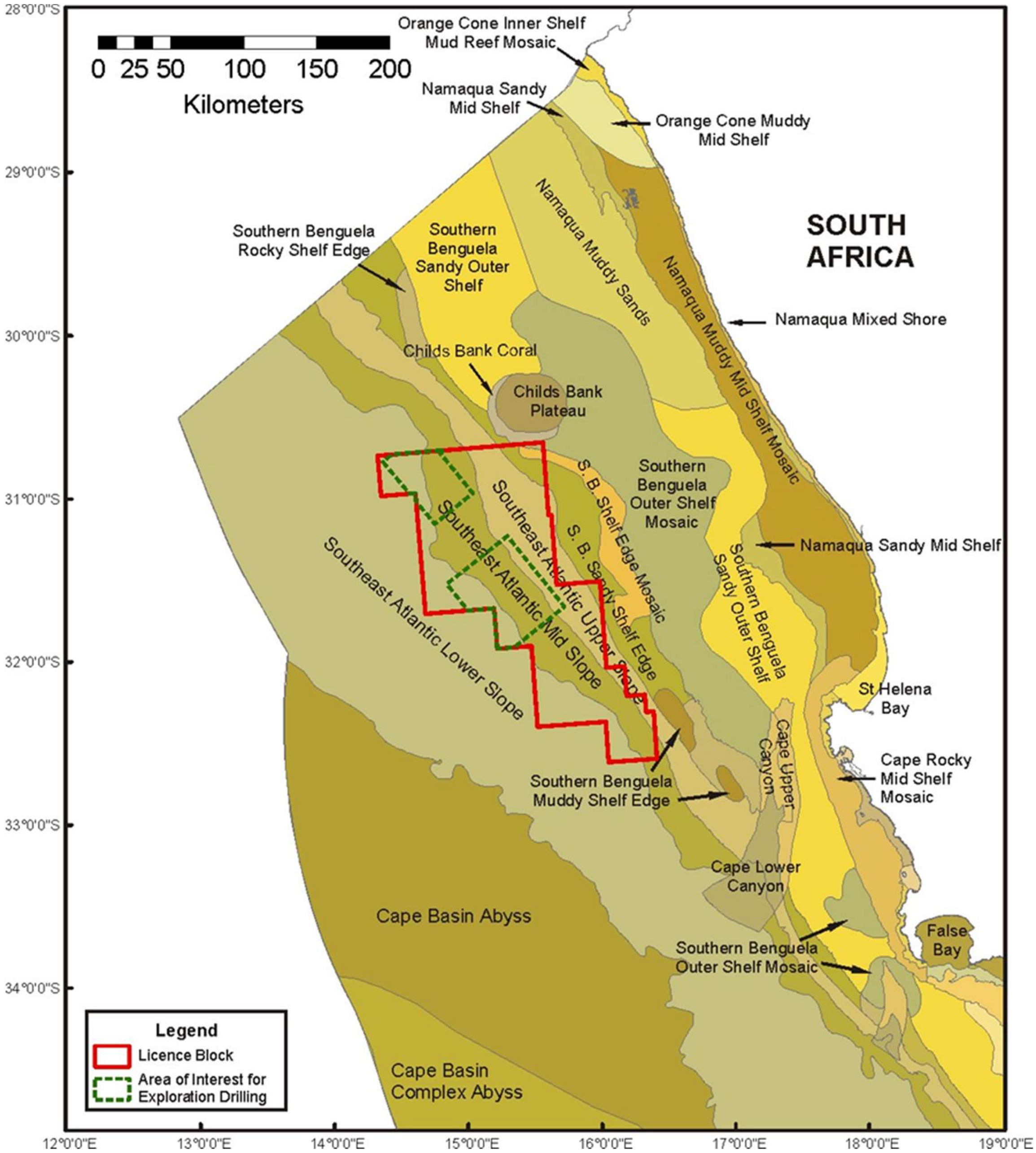


Figure 41: Block 3B/4B (red polygon) in relation to the distribution of ecosystem types along the West Coast (adapted from Sink *et al*. 2019).

To date very few areas on the continental slope off the West Coast have been biologically surveyed. Although sediment distribution studies suggest that the outer shelf is characterised by unconsolidated sediments (Figure 32 above), surveys conducted between 180 m and 480 m depth offshore of the Northern Cape coast revealed high proportions of hard ground rather than unconsolidated sediment, although this requires further verification (unpublished data).

There have also to date been no studies examining connectivity between slope, plateau or abyssal ecosystems in South Africa and there is thus limited knowledge on the benthic biodiversity of all three of these broad ecosystem groups in South African waters. There is no quantitative data describing bathyal ecosystems in South Africa and hence limited understanding of ecosystem functioning and sensitivity. Due to the lack of information on benthic macrofaunal communities beyond the shelf break, no description can be provided specifically for the Licence Area. The description below for areas on the continental shelf, offshore of the Northern Cape coast is drawn from recent surveys.

Three macro-infauna communities have been identified on the inner- (0-30 m depth) and mid-shelf (30-150 m depth. Polychaetes, crustaceans and molluscs make up the largest proportion of individuals, biomass and species on the west coast. The inner-shelf community, which is affected by wave action, is characterised by various mobile gastropod and polychaete predators and sedentary polychaetes and isopods. The mid-shelf community inhabits the mudbelt and is characterised by mud prawns. A second mid-shelf community occurring in sandy sediments is characterised by various deposit-feeding polychaetes. The distribution of species within these communities are inherently patchy reflecting the high natural spatial and temporal variability associated with macro-infauna of unconsolidated sediments with evidence of mass mortalities and substantial recruitments recorded on the South African West Coast.

Despite the current lack of knowledge of the community structure and endemicity of South African macro-infauna off the edge of the continental shelf, the marine component of the 2018 National Biodiversity Assessment, rated the South Atlantic bathyal and abyssal unconsolidated habitat types that characterise depths beyond 500 m, as being of 'Least Concern' (Figure 42), with only those communities occurring along the shelf edge (-500 m) in the eastern portions of Block 3B/4B being considered 'Vulnerable'. This primarily reflects the great extent of these habitats in the South African EEZ.

Studies show that off Namaqualand, species richness increases from the inner-shelf across the mid-shelf and is influenced by sediment type. The highest total abundance and species diversity was measured in sandy sediments of the mid-shelf. Biomass is highest in the inshore (±50 g/m^2 wet weight) and decreases across the mid-shelf averaging around 30 g/m^2 wet weight. This is contrary to other studies which found that biomass was greatest in the mudbelt at 80 m depth off Lamberts Bay, where the sediment characteristics and the impact of environmental stressors (such as low oxygen events) are likely to differ from those off the northern Namaqualand coast.

Benthic communities are structured by the complex interplay of a large array of environmental factors. Water depth and sediment grain size are considered the two major factors that determine benthic community structure and distribution on the South African west coast and elsewhere in the world. However, studies have shown that shear bed stress - a measure of the impact of current velocity on sediment – oxygen, organic carbon and seafloor temperature may also strongly influence the structure of benthic communities. There are clearly other natural processes operating in continental shelf areas of the West Coast that can over-ride the suitability of sediments in determining benthic community structure, and it is likely that periodic intrusion of low oxygen water masses is a major cause of this variability. In areas of frequent oxygen deficiency, benthic communities will be characterised either by species able to survive chronic low oxygen conditions, or colonising and fast-growing species able to rapidly recruit into areas that have suffered oxygen depletion. The combination of local, episodic hydrodynamic conditions and patchy settlement of larvae will tend to generate the observed small-scale variability in benthic community structure. On the continental shelf slope and deeper areas, near-bottom conditions are oligoxic (Berg *et al.* 2015), with benthic communities characterised by greater stablility and longer-lived species.

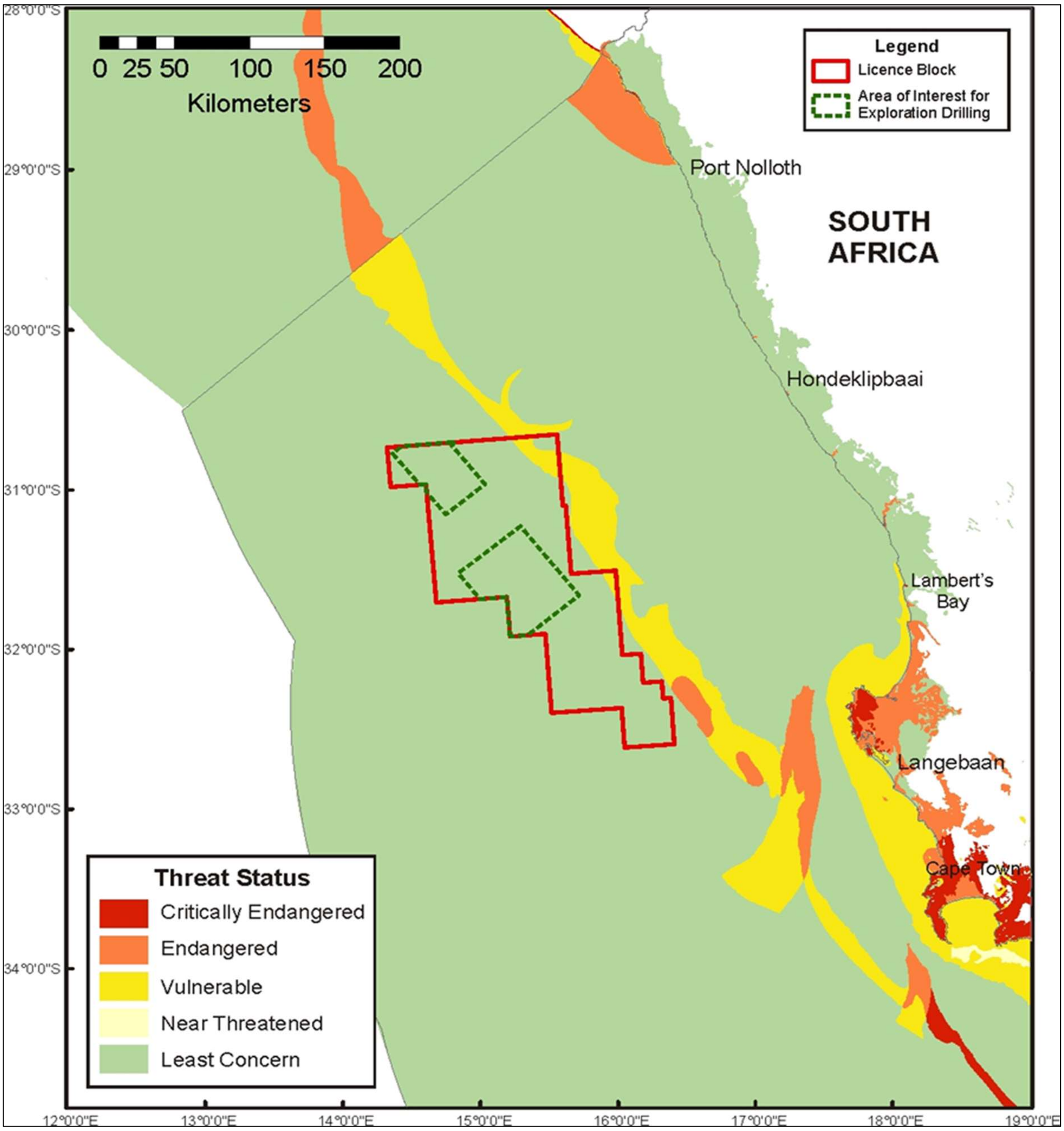


Figure 42: Block 3B/4B (red polygon) in relation to the ecosystem threat status for coastal and offshore benthic and pelagic habitat types on the South African West Coast (adapted from Sink *et al*. 2019). The adjacent Namibian threat status is also shown (adapted from Holness *et al*. 2019).

The invertebrate macrofauna are important in the marine benthic environment as they influence major ecological processes (e.g. remineralisation and flux of organic matter deposited on the sea floor, pollutant metabolism, sediment stability) and serve as important food source for commercially valuable fish species and other higher order consumers. As a result of their comparatively limited mobility and permanence over seasons, these animals provide an indication of historical environmental conditions and provide useful indices with which to measure environmental impacts.

Also associated with soft-bottom substrates are demersal communities that comprise epifauna and bottom-dwelling vertebrate species, many of which are dependent on the invertebrate benthic macrofauna as a food source. The continental shelf on the West Coast between depths of 100 m and 250 m, contained a single epifaunal community characterised by the hermit crabs *Sympagurus dimorphus* and *Parapaguris pilosimanus*, the prawn *Funchalia woodwardi* and the sea urchin *Brisaster capensis*. Numerous species of urchins and burrowing anemones beyond 300 m depth off the West Coast. Unconsolidated sediments beyond 2 000 m depth host a variety of sea pens, sea whips, holothurians, brittle stars and cushion stars, sea urchins, burrowing anemones, crustaceans (shrimps, crabs), larvaceans and cepahlopods (TEEPSA, unpublished data). Information on the benthic fauna of the lower continental slope and abyss (beyond 1 800 m depth) is largely lacking due to limited opportunities for sampling. However, deep water benthic sampling was undertaken as part of the Environmental Baseline Survey for Total E&P Namibia's Block 2913B to the north of Block 3B/4B. This provided valuable information on the benthic infaunal communities of the lower continental slope. As conditions in such deep water habitats tend to be more uniform (low temperatures and oligoxic conditions characterising the SACW that comprises the bulk of the water in the area), similar communities may be expected in the Deep Water Orange Basin.

The macrofauna in Block 2913B were generally impoverished but fairly consistent, which is typical for deep water sediments. The 105 species recorded, were dominated by polychaetes, which accounted for 64.1% of the total individuals. Molluscs were represented by 11 species (19.6% of total individuals), whilst 20 species of crustaceans were recorded (contributing to only 9.8% of total individuals). Echinoderms were represented by only 3 species (5.8% of total individuals), whilst all other groups (Actiniaria, Nemertea, Nematoda, Ascidiacea and Priapulida) accounted for the remaining 5.9% of individuals. The deposit-feeding polychaete *Spiophanes sp.* was the most abundant species recorded. This small bristleworm can either be a passive suspension feeder or a surface deposit feeder, living off sediment particles, planktonic organisms and meiobenthic organisms. The bivalve mollusc *Microgloma mirmidina* was the second most common species, with the polychaete tentatively identified as a Leiocapitellide being the third most abundant. With the exception of the carnivorous polychaete *Glycera capitata*, most species were suspension or deposit feeders typical of soft unconsolidated sediments.

Examples of the macroinvertebrate infauna of the Namibian Block 2913B area located ~135 km to the west-northwest of Block 3B/4B are illustrated in Figure 43. A wide diversity of macroinvertebrates has been recorded inshore of the 1 000 m depth contour.

The 2018 National Biodiversity Assessment for the marine environment (Sink *et al*. 2019) points out that very few national IUCN Red List assessments have been conducted for marine invertebrate species to date owing to inadequate taxonomic knowledge, limited distribution data, a lack of systematic surveys and limited capacity to advance species red listing for these groups.

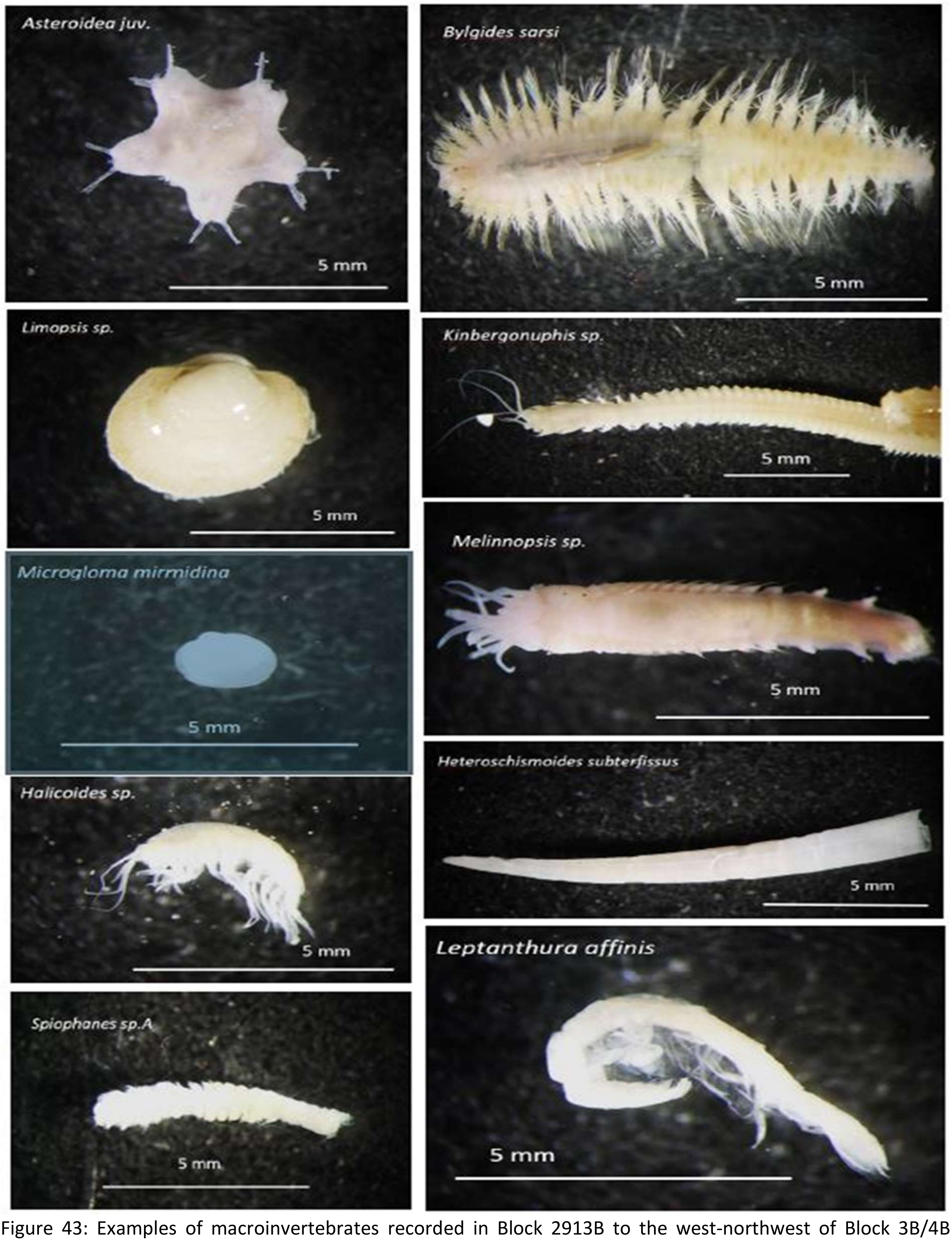


Figure 43: Examples of macroinvertebrates recorded in Block 2913B to the west-northwest of Block 3B/4B (Source Benthic Solutions Ltd 2019).

The invertebrate macrofauna are important in the marine benthic environment as they influence major ecological processes (e.g. remineralisation and flux of organic matter deposited on the sea floor, pollutant metabolism, sediment stability) and serve as important food source for commercially valuable fish species and other higher order consumers. As a result of their comparatively limited mobility and permanence over seasons, these animals provide an indication of historical environmental conditions and provide useful indices with which to measure environmental impacts.

Also associated with soft-bottom substrates are demersal communities that comprise epifauna and bottom-dwelling vertebrate species, many of which are dependent on the invertebrate benthic macrofauna as a food source. The continental shelf on the West Coast between depths of 100 m and 250 m, contained a single epifaunal community characterised by the hermit crabs *Sympagurus dimorphus* and *Parapaguris pilosimanus*, the prawn *Funchalia woodwardi* and the sea urchin *Brisaster capensis*. Numerous species of urchins and burrowing anemones beyond 300 m depth off the West Coast were also reported.

The 2018 National Biodiversity Assessment for the marine environment points out that very few national IUCN Red List assessments have been conducted for marine invertebrate species to date owing to inadequate taxonomic knowledge, limited distribution data, a lack of systematic surveys and limited capacity to advance species red listing for these groups.

8.3.1.2 **DEEP-WATER CORAL COMMUNITIES**

There has been increasing interest in deep-water corals in recent years because of their likely sensitivity to disturbance and their long generation times. These benthic filter-feeders generally occur at depths below 150 m with some species being recorded from as deep as 3 000 m. Some species form reefs while others are smaller and remain solitary. Corals add structural complexity to otherwise uniform seabed habitats thereby creating areas of high biological diversity. Deep water corals establish themselves below the thermocline where there is a continuous and regular supply of concentrated particulate organic matter, caused by the flow of a relatively strong current over special topographical formations which cause eddies to form. Nutrient seepage from the substratum might also promote a location for settlement. In the productive Benguela region, substantial areas on and off the edge of the shelf should thus potentially be capable of supporting rich, cold water, benthic, filter-feeding communities, and various species of scleractine and stylastrine corals have been reported from depths beyond -200 m in the Orange Basin.

Such communities would also be expected with topographic features such as seamounts located adjacent to the northern boundary of Block 3B/4B. Nonetheless, our understanding of the invertebrate fauna of the sub-photic zone is relatively poor and the conservation status of the majority of invertebrates in this bioregion is not known.

8.3.1.3 **DEMERSAL FISH SPECIES**

Demersal fish are those species that live and feed on or near the seabed. As many as 110 species of bony and cartilaginous fish have been identified in the demersal communities on the continental shelf of the West Coast (Roel 1987). Changes in fish communities occur both latitudinally (Shine 2006, 2008; Yemane *et al*. 2015) and with increasing depth (Roel 1987; Smale *et al*. 1993; Macpherson & Gordoa 1992; Bianchi *et al*. 2001; Atkinson 2009; Yemane *et al*. 2015), with the most substantial change in species composition occurring in the shelf break region between 300 m and 400 m depth (Roel 1987; Atkinson 2009). The shelf community (<380 m) is dominated by the Cape hake M. capensis, and includes jacopever *Helicolenus dactylopterus*, Izak catshark *Holohalaelurus regain*, soupfin shark *Galeorhinus galeus* and whitespotted houndshark *Mustelus palumbes*. The more diverse deeper water community is dominated by the deepwater hake *Merluccius paradoxus*, monkfish *Lophius vomerinus*, kingklip *Genypterus capensis*, bronze whiptail *Lucigadus ori* and hairy conger *Bassanago albescens* and various squalid shark species. There is some degree of species overlap between the depth zones.

Roel (1987) showed seasonal variations in the distribution ranges shelf communities, with species such as the pelagic goby *Sufflogobius bibarbatus*, and West Coast sole *Austroglossus microlepis* occurring in shallow water north of Cape Point during summer only. The deep-sea community was found to be homogenous both spatially and temporally. In a more recent study, however, Atkinson (2009) identified two long-term community shifts in demersal fish communities; the first (early to mid-1990s) being associated with an overall increase in density of many species, whilst many species decreased in density during the second shift (mid-2000s). These community shifts correspond temporally with regime shifts detected in environmental forcing variables (Sea Surface Temperatures and upwelling anomalies) (Howard *et al*. 2007) and with the eastward shifts observed in small pelagic fish species and rock lobster populations (Coetzee *et al*. 2008, Cockcroft *et al*. 2008).

The diversity and distribution of demersal cartilaginous fishes on the West Coast is discussed by Compagno *et al*. (1991). The species that may occur in the general project area and on the continental shelf inshore thereof, and their approximate depth range, are listed in Table 6. Details on demersal cartilaginous species beyond the shelf break and in the Deep Water Orange Basin area are lacking, however. The shelf-associated[3] distribution of some of these species was provided in Harris *et al*. (2022) (Figure 44 and Figure 45).

There is limited information about bathyal fish communities in South Africa. South Africa defines its bathyal zone as extending from 500 m to 3 500 m, recognising an upper slope (500-1 000 m), mid slope (1 000-1 800 m) and lower slope (1 800-3 500 m). Typical upper slope fishes (200-2 000 m) include rattails (Macrouridae), tripod and grideyefish (Ipnopidae), greeneyes (*Chlorophthalmus species*), oreos, notacanthids, halosaurs, chimaeras, skates, bythitids such as Cataetyx spp. and morids (deepsea cods) (Smith & Heemstra 2003). Rattails, bythitids, liparidids (snail fishes) and notacanthids (Polyacanthonotus species and halosaurs) are characteristic of the lower bathyal (see also Iwamoto & Anderson 1994; Jones 2014).

Table 13: Demersal cartilaginous species found on the continental shelf along the West Coast, with approximate depth range at which the species occurs (Pisces, 2023).

Common Name	Scientific name	Depth Range (m)	IUCN Conservation Status
Frilled shark	*Chlamydoselachus anguineus*	200-1 000	LC
Six gill cowshark	*Hexanchus griseus*	150-600	NT
Gulper shark	*Centrophorus granulosus*	480	EN
Leafscale gulper shark	*Centrophorus squamosus*	370-800	EN
Bramble shark	*Echinorhinus brucus*	55-285	EN
Black dogfish	*Centroscyllium fabricii*	>700	LC
Portuguese shark	*Centroscymnus coelolepis*	>700	NT
Longnose velvet dogfish	*Centroscymnus crepidater*	400-700	NT
Birdbeak dogfish	*Deania calcea*	400-800	NT
Arrowhead dogfish	*Deania profundorum*	200-500	NT
Longsnout dogfish	*Deania quadrispinosa*	200-650	VU
Sculpted lanternshark	*Etmopterus brachyurus*	450-900	DD
Brown lanternshark	*Etmopterus compagnoi*	450-925	LC
Giant lanternshark	*Etmopterus granulosus*	>700	LC
Smooth lanternshark	*Etmopterus pusillus*	400-500	LC
Spotted spiny dogfish	*Squalus acanthias*	100-400	VU
Shortnose spiny dogfish	*Squalus megalops*	75-460	LC
Shortspine spiny dogfish	*Squalus mitsukurii*	150-600	EN
Sixgill sawshark	*Pliotrema warreni*	60-500	LC

[3] The distributions provided by Harris *et al*. (2022) are based on data from demersal fisheries. The apparent absence of fish offshore is thus due to a lack of survey data rather than an indication that no species occur there.

Common Name	Scientific name	Depth Range (m)	IUCN Conservation Status
Goblin shark	*Mitsukurina owstoni*	270-960	LC
Smalleye catshark	*Apristurus microps*	700-1 000	LC
Saldanha catshark	*Apristurus saldanha*	450-765	LC
“grey/black wonder” catsharks	*Apristurus* spp.	670-1 005	LC
Tigar catshark	*Halaelurus natalensis*	50-100	VU
Izak catshark	*Holohalaelurus regani*	100-500	LC
Yellowspotted catshark	*Scyliorhinus capensis*	150-500	NT
Soupfin shark/Vaalhaai	*Galeorhinus galeus*	<10-300	CR (EN)
Houndshark	*Mustelus mustelus*	<100	EN (DD)
Whitespotted houndshark	*Mustelus palumbes*	>350	LC
Little guitarfish	*Rhinobatos annulatus*	>100	VU (LC)
Atlantic electric ray	*Torpedo nobiliana*	120-450	LC
African softnose skate	*Bathyraja smithii*	400-1 020	LC
Smoothnose legskate	*Cruriraja durbanensis*	>1 000	DD
Roughnose legskate	*Cruriraja parcomaculata*	150-620	LC
African dwarf skate	*Neoraja stehmanni*	290-1 025	LC
Thorny skate	*Raja radiata*	50-600	VU
Bigmouth skate	*Raja robertsi*	>1 000	LC
Slime skate	*Dipturus pullopunctatus*	15-460	LC
Rough-belly skate	*Raja springeri*	85-500	LC
Yellowspot skate	*Raja wallacei*	70-500	VU
Roughskin skate	*Dipturus trachydermus*	1 000-1 350	EN
Biscuit skate	*Raja clavata*	25-500	NT
Munchkin skate	*Rajella caudaspinosa*	300-520	LC
Bigthorn skate	*Raja confundens*	100-800	LC
Ghost skate	*Rajella dissimilis*	420-1 005	LC
Leopard skate	*Rajella leopardus*	300-1 000	LC
Smoothback skate	*Rajella ravidula*	500-1 000	LC

Common Name	Scientific name	Depth Range (m)	IUCN Conservation Status
Spearnose skate	*Rostroraja alba*	75-260	EN
St Joseph	*Callorhinchus capensis*	30-380	LC (LC)
Cape chimaera	*Chimaera notafricana*	680-1 000	LC
Brown chimaera	*Chimaera carophila*	420-850	LC
Spearnose chimaera	*Rhinochimaera atlantica*	650-960	LC

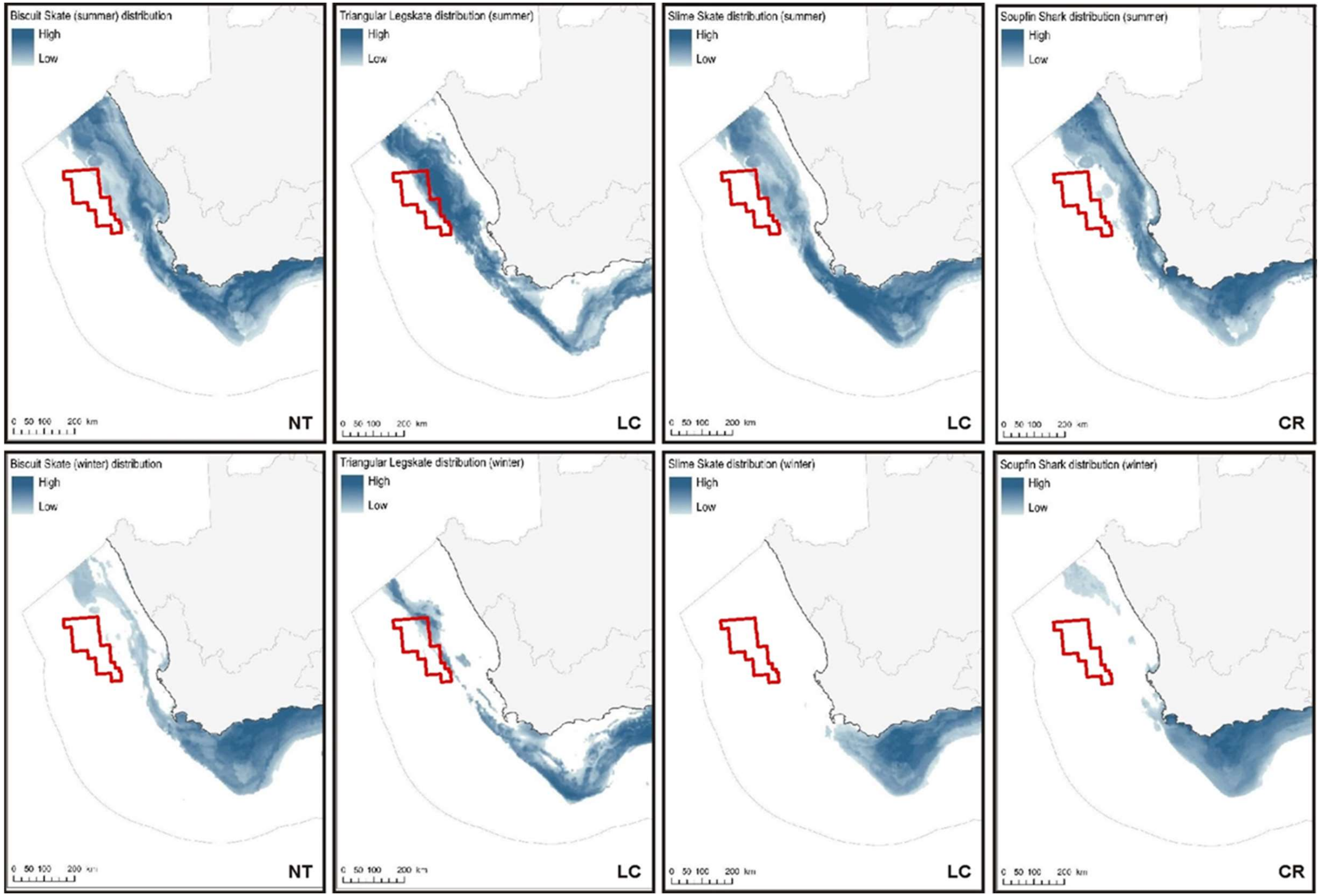


Figure 44: The summer (top) and winter (bottom) distribution of biscuit skate, triangular legskate,slime skate and soupfin shark in relation to Block 3B/4B (red polygon) (adapted from Harris *et al*. 2022). The IUCN conservation status is provided.

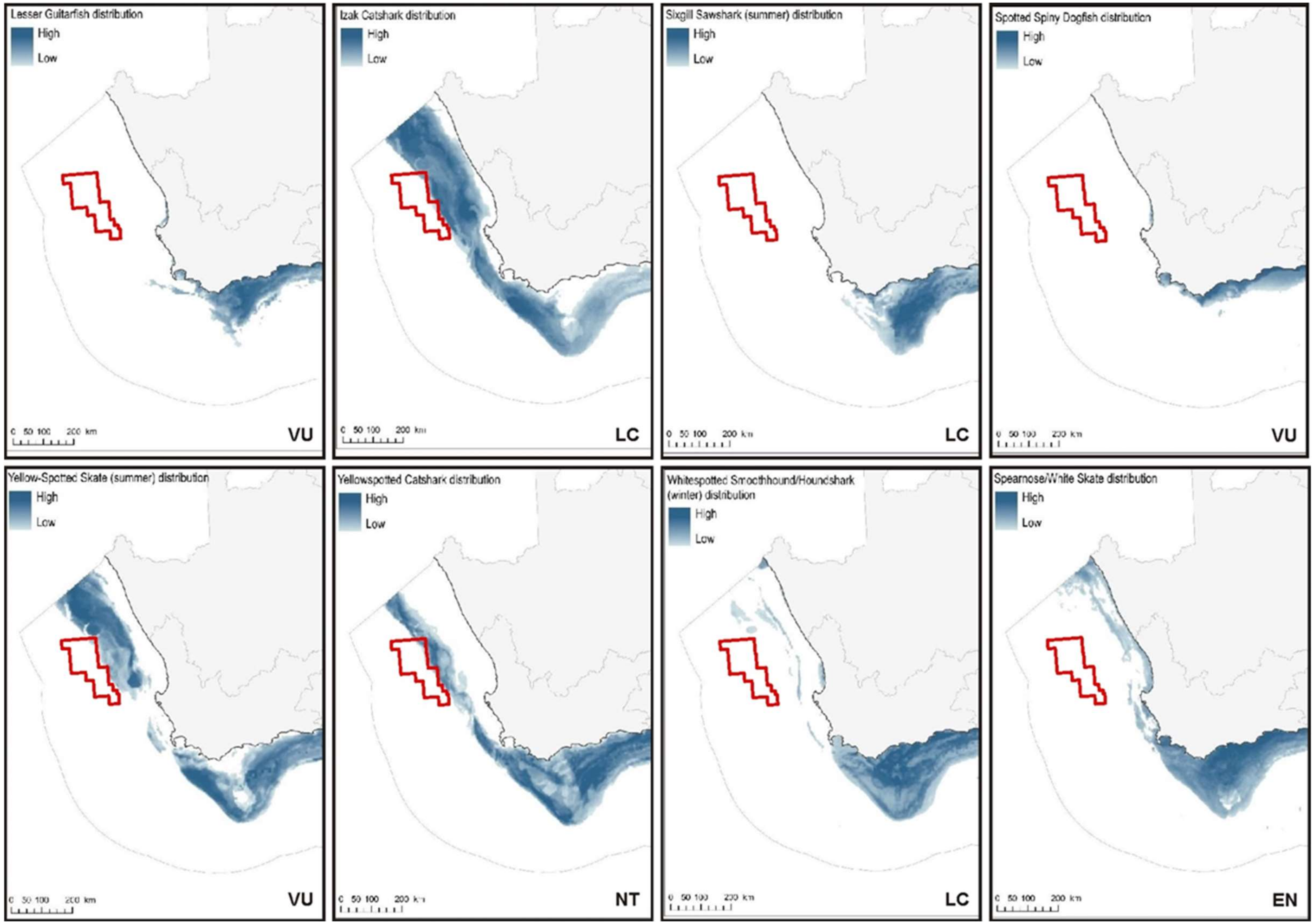


Figure 45: The distribution of various cartilaginous species mentioned in Table 6 in relation to Block 3B/4B (red polygon) (adapted from Harris *et al*. 2022). The IUCN conservation status is provided.

8.3.1.4 SEAMOUNT AND SUBMARINE CANYON COMMUNITIES

Features such as banks, knolls and seamounts (referred to collectively here as "seamounts"), which protrude into the water column, are subject to, and interact with, the water currents surrounding them. The effects of such seabed features on the surrounding water masses can include the up-welling of relatively cool, nutrient-rich water into nutrient-poor surface water thereby resulting in higher productivity (Clark *et al.* 1999), which can in turn strongly influences the distribution of organisms on and around seamounts. Evidence of enrichment of bottom-associated communities and high abundances of demersal fishes has been regularly reported over such seabed features.

The enhanced fluxes of detritus and plankton that develop in response to the complex current regimes lead to the development of detritivore-based food-webs, which in turn lead to the presence of seamount scavengers and predators. Seamounts provide an important habitat for commercial deepwater fish stocks such as orange roughy, oreos, alfonsino and Patagonian toothfish, which aggregate around these features for either spawning or feeding (Koslow 1996).

Such complex benthic ecosystems in turn enhance foraging opportunities for many other predators, serving as mid-ocean focal points for a variety of pelagic species with large ranges (turtles, tunas and billfish, pelagic sharks, cetaceans and pelagic seabirds) that may migrate large distances in search of food or may only congregate on seamounts at certain times (Hui 1985; Haney *et al.* 1995). Seamounts thus serve as feeding grounds, spawning and nursery grounds and possibly navigational markers for a large number of species (SPRFMA 2007; Derville *et al.* 2020).

Enhanced currents, steep slopes and volcanic rocky substrata, in combination with locally generated detritus, favour the development of suspension feeders in the benthic communities characterising seamounts (Rogers 1994). Deep- and cold-water corals (including stony corals, black corals and soft corals) are a prominent component of the suspension-feeding fauna of many seamounts, accompanied by barnacles, bryozoans, polychaetes, molluscs, sponges, sea squirts, basket stars, brittle stars and crinoids (reviewed in Rogers 2004). There is also associated mobile benthic fauna that includes echinoderms (sea urchins and sea cucumbers) and crustaceans (crabs and lobsters) (reviewed by Rogers 1994; Kenyon *et al.* 2003). Some of the smaller cnidarians species remain solitary while others form reefs thereby adding structural complexity to otherwise uniform seabed habitats.

Consequently, the fauna of seamounts is usually highly unique and may have a limited distribution restricted to a single geographic region, a seamount chain or even a single seamount location (Rogers *et al.* 2008). As a result of conservative life histories (*i.e*. very slow growing, slow to mature, high longevity, low fecundity and unpredictable recruitment) and sensitivity to changes in environmental conditions, such biological communities have been identified as Vulnerable Marine Ecosystems (VMEs). They are recognised as being particularly sensitive to anthropogenic disturbance (primarily deep-water trawl fisheries and mining), and once damaged are very slow to recover, or may never recover (FAO 2008).

Geological features of note within the broader project area are Child's Bank and Tripp Seamount, with an unnamed seamount located in ~3 500 m at ~32°20'S; 13°30'E, as well as the Cape Canyon and Cape Point Valley. Child's Bank, which is situated at about 31°S, was described by Dingle *et al.* (1987) to be a carbonate mound (bioherm). The top of this feature is a sandy plateau with dense aggregations of brittle stars, while the steeper slopes have dense invertebrate assemblages including unidentified cold-water corals/rugged limestone feature, bounded at outer edges by precipitous cliffs at least 150 m high (Birch & Rogers 1973). Composed of sediments and the calcareous deposits from an accumulation of carbonate skeletons of sessile organisms (e.g. cold-water coral, foraminifera or marl), such features typically have topographic relief, forming isolated seabed knolls in otherwise low profile homogenous seabed habitats (Kopaska-Merkel & Haywick 2001; Kenyon *et al.* 2003, Wheeler *et al.* 2005, Colman *et al.* 2005). Tripp Seamount situated at about 29°40'S, lies ~110 km north of the northern boundary of the survey area. It rises from the seabed at ~1 000 m to a depth of 150 m and roughly circular with a flat apex that drops steeply on all sides. There is reference to decapods crustaceans from Tripp Seamount (Kensley 1980, 1981) and exploratory deepwater trawl fishing (Hampton 2003), but otherwise knowledge of benthic communities characterising this seamount is lacking.

The Cape Rise comprises a group of NE-SW trending seamounts – the Southeast Atlantic Seamounts - which include Argentina and Protea Seamounts and the recently discovered Mount Marek. These rise up from over -2 500 m depth in the Cape Basin abyss to 700 m deep. Other than a geoscience survey conducted in 1986 using a deep water camera to sample the lower bathyal and abyssal zones, including the seamount flanks, of the Cape Basin (Rogers 1986) no biodiversity surveys are known to have been conducted at Protea and Argentina seamounts. Southern Africa's seamounts and their associated benthic communities have not been sampled by either geologists or biologists (Sink & Samaai 2009) and little is known about the benthic and neritic communities associated with them.

A recent study reporting on the megabenthos and benthopelagic fish on the Southeast Atlantic Seamounts (Bergstad *et al.* 2019) over 250 km to the southeast of the licence area, provides descriptions of the Erica and Schmitt-Ott Seamounts that lie approximately 450 – 500 km southwest of the Argentina Seamount and rise from the surrounding abyss to depths of 770 m and 920 m, respectively. Corals were the most frequent and widespread sessile invertebrate recorded on video transects, dominated by gorgonians whose abundance increased towards the seamount summits. Scleractinian and hydrocorals were also observed as was a diversity of sponges, echinoderms and crustaceans. Fish associated with the seamount included oreo dories, grenadiers and lantern shark. Similar communities might therefore be expected from the seamounts to the west of the licence area.

During 2016-2018 the Department of Environmental Affairs: Oceans and Coast Branch (DEA: O&C) undertook research cruises to explore some of the undocumented areas of seabed off the West Coast, among them the Cape Canyon. Using tow-cameras, benthic grabs and dredges, the biota of the canyon head to -500 m depth were sampled (Figure 46). A diversity of echinoderms, molluscs, and crustaceans were reported to dominate the canyon head, while scavengers such as ophuiroidea and decapoda were prevalent within habitats ranging from sandy areas, to patches of inshore and offshore mud belts. At depths of <100 m inshore of the canyon head, boulder beds hosted gorgonian and stylasterine corals.

The concept of a 'Vulnerable Marine Ecosystem' (VME) centres upon the presence of distinct, diverse benthic assemblages that are limited and fragmented in their spatial extent and dominated (in terms of biomass and/or spatial cover) by rare, endangered or endemic component species that are physically fragile and vulnerable to damage (or structural/biological alteration) by human activities (Parker *et al.* 2009; Auster *et al.* 2011; Hansen *et al.* 2013).

VMEs are known to be associated with higher biodiversity levels and indicator species that add structural complexity, resulting in greater species abundance, richness, biomass and diversity compared to surrounding uniform seabed habitats (Buhl-Mortensen *et al.* 2010; Hogg *et al.* 2010; Barrio Froján *et al.* 2012; Beazley *et al.* 2013, 2015). Compared to the surrounding deep-sea environment, VMEs typically form biological hotspots with a distinct, abundant and diverse fauna, many species of which remain unidentified. Levels of endemism on VMEs are also relatively high compared to the deep sea. The coral frameworks offer refugia for a great variety of invertebrates and fish (including commercially important species) within, or in association with, the living and dead coral framework thereby creating spatially fragmented areas of high biological diversity. The skeletal remains of Scleractinia coral rubble and Hexactinellid poriferans can also represent another important deep-sea habitat, acting to stabilise seafloor sediments allowing for colonisation by distinct infaunal taxa that show elevated abundance and biomass in such localised habitats (Bett & Rice 1992; Raes & Vanreusel 2005; Beazley *et al.* 2013; Ashford *et al.* 2019).

VMEs are also thought to contribute toward the long-term viability of a stock through providing an important source of habitat for commercial species (Pham *et al.* 2015; Ashford *et al.* 2019). They can provide a wide range of ecosystem services ranging from provision of aggregation- and spawning sites to providing shelter from predation and adverse hydrological conditions (Husebø & Nøttestad *et al.* 2002; Krieger & Wing, 2002; Tissot *et al.*, 2006; Baillon *et al.* 2012; Pham *et al.* 2015). Indicator taxa for VMEs are also known to provide increased access to food sources, both directly to associated benthic fauna, and indirectly to other pelagic species such as fish and other predators due to the high abundance and biomass of associated fauna (Krieger & Wing, 2002; Husebø & Nøttestad *et al.* 2002; Buhl-Mortensen *et al*, 2010; Hogg *et al.*, 2010; Auster *et al.* 2011).

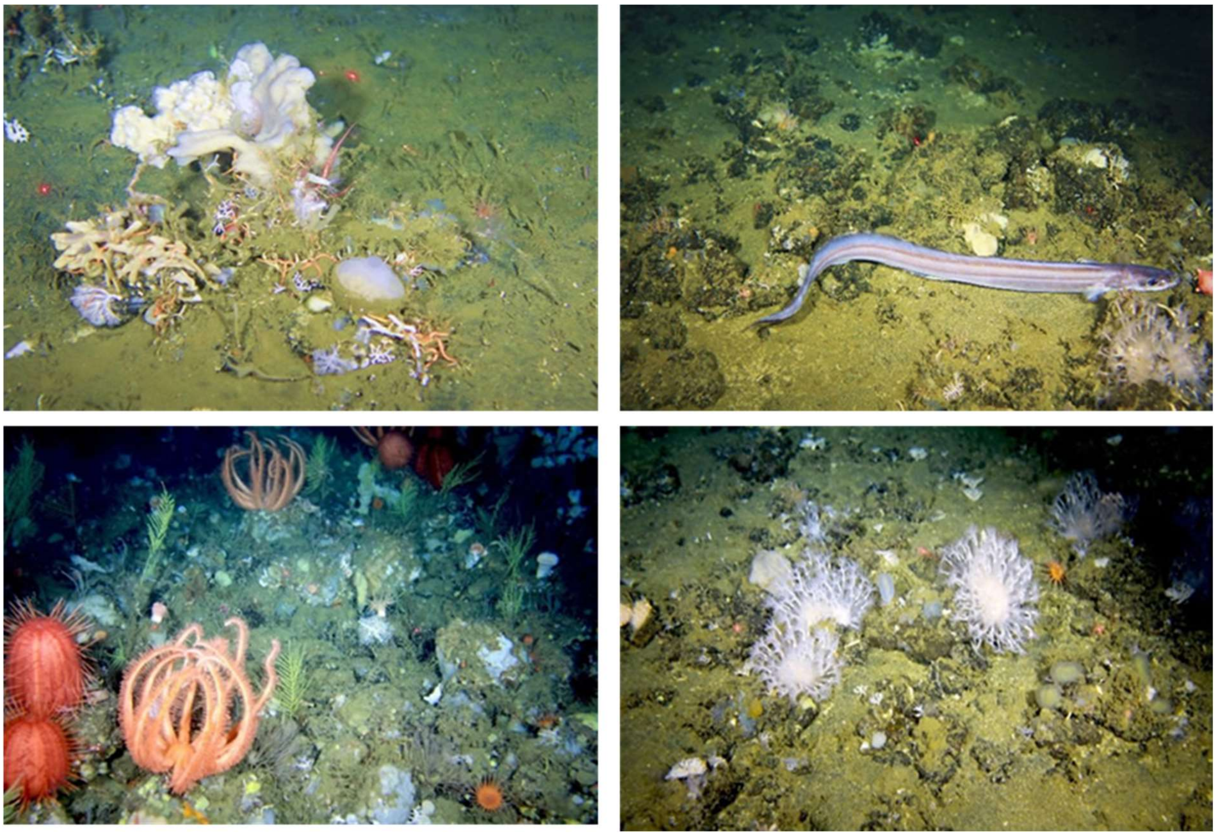


Figure 46: Deep water benthic macrofauna from various depths in the Cape Canyon (Source: www.environment.gov.za/dearesearchteamreturnfromdeepseaexpedition).

VME frameworks are typically elevated from the seabed, increasing turbulence and raising supply of suspended particles to suspension feeders (Krieger & Wing 2002; Buhl-Mortensen & Mortensen 2005; Buhl-Mortensen *et al.* 2010). Poriferans and cold-water corals have further been shown to provide a strong link between pelagic and benthic food webs (Pile & Young 2006; Cathalot *et al.* 2015). VMEs are increasingly being recognised as providers of important ecosystem services due to associated increased biodiversity and levels of ecosystem functioning (Ashford *et al.* 2019).

It is not always the case that seamount habitats are VMEs, as some seamounts may not host communities of fragile animals or be associated with high levels of endemism. Evidence from video footage taken on hard-substrate habitats in 100 - 120 m depth off southern Namibia and to the south-east of Child's Bank (De Beers Marine, unpublished data) (Figure 47), and in 190-527 m depth on Child's Bank (Sink *et al.* 2019) suggest that vulnerable communities including gorgonians, octocorals and reef-building sponges and hard-corals do occur on the continental shelf, some of which are thought to be Vulnerable Marine Ecosystem (VME) indicator species (Table 14). The distribution of 22 potential VME indicator taxa for the South African EEZ was recently mapped, with those from the West Coast listed in Table 14 (Atkinson & Sink 2018; Sink *et al.* 2019).

Figure 47: Gorgonians and bryozoans communities recorded on deep-water reefs (100-120 m) off the southern African West Coast (Photos: De Beers Marine).

Table 14: Potential VME species from the continental shelf and shelf edge on the West Coast (Atkinson & Sink 2018)

Phylum	Name	Common Name
Porifera	*Suberites dandelenae*	Amorphous solid sponge
	Rossella cf. antarctica	Glass sponge
Cnidaria	*Melithaea* spp.	Colourful sea fan
	Thouarella spp.	Bottlebrush sea fan
Family: Isididae		Bamboo coral
	Anthoptilum grandiflorum	Large sea pen*
	Lophelia pertusa	Reef-building cold water coral
	Stylaster spp.	Fine-branching hydrocoral
Bryozoa	*Adeonella* spp.	Sabre bryozoan
	Phidoloporidae spp.	Honeycomb false lace coral
Hemichordata	*Cephalodiscus gilchristi*	Agar animal

As sampling beyond 1 000 m depth has not taken place (Atkinson & Sink 2018) it is not known whether similar communities may be expected in Block 3B/4B. The distribution of known and potential Vulnerable Marine Ecosystem habitat based on potential VME features, DFFE and SAEON trawl survey data, and many visual surveys indicating the presence of indicator taxa were mapped by Harris *et al*. 2022 (Figure 48). Some sites need more research to determine their status. The location of Block 3B/4B is offshore of these known and potential VMEs emphasising the gaps in our knowledge specific to the vulnerability of marine communities of abyssal habitats.

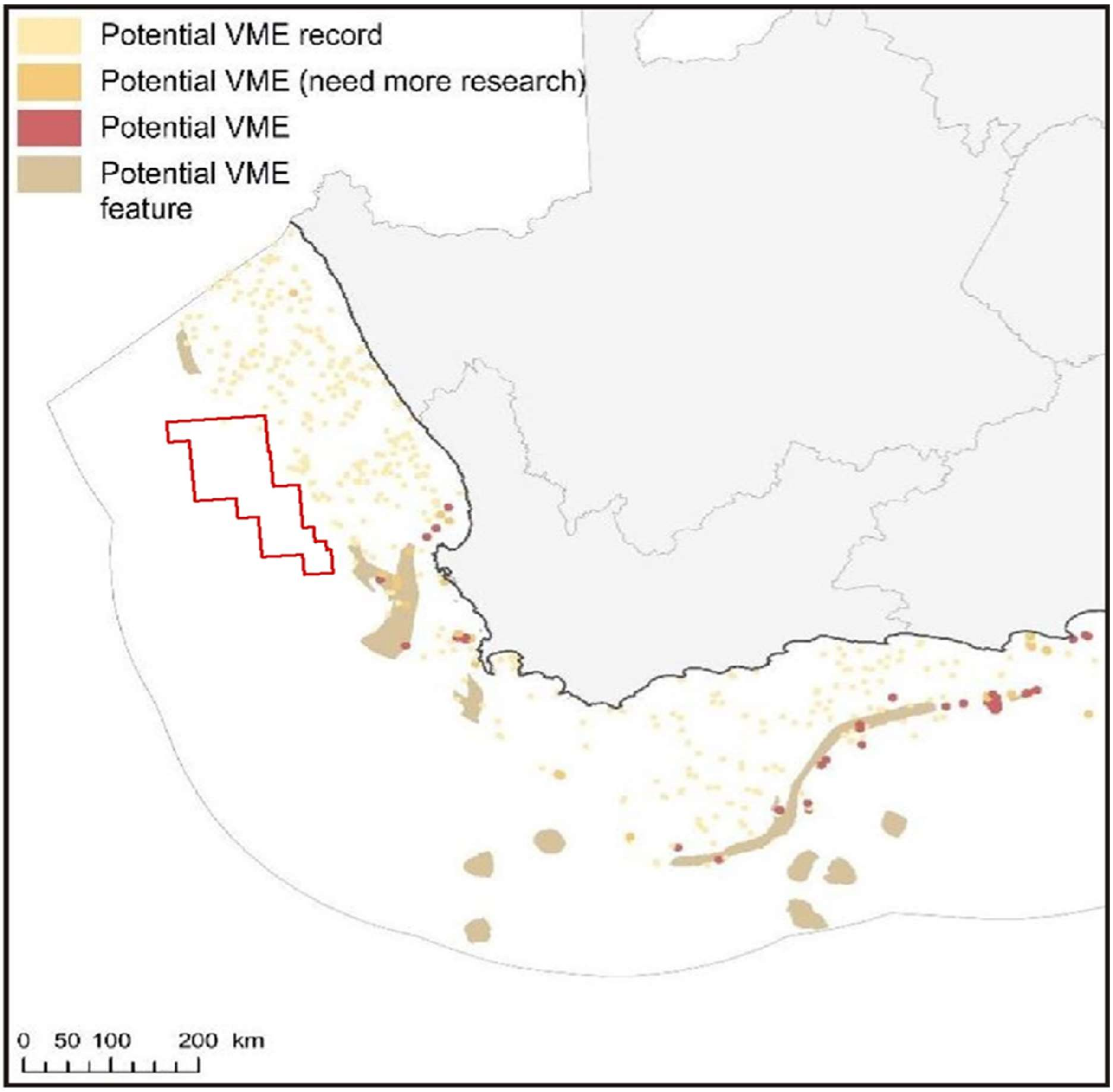


Figure 48: Block 3B/4B (red polygon) in relation to the distribution of known and potential Vulnerable Marine Ecosystem habitat (adapted from Harris *et al*. 2022).

Sediment samples collected at the base of Norwegian cold-water coral reefs revealed high interstitial concentrations of light hydrocarbons (methane, propane, ethane and higher hydrocarbons C4+) (Hovland & Thomsen 1997), which are typically considered indicative of localised light hydrocarbon micro-seepage through the seabed. Bacteria and other micro-organisms thrive on such hydrocarbon pore-water seepages, thereby providing suspension-feeders, including corals and gorgonians, with a substantial nutrient source. Some scientists believe there is a strong correlation between the occurrence of deep-water coral reefs and the relatively high values of light hydrocarbons (methane, ethane, propane and n-butane) in near-surface sediments (Hovland *et al.* 1998, Duncan & Roberts 2001, Hall-Spencer *et al.* 2002, Roberts & Gage 2003). A recent study by January (2018) identified that hydrocarbon seeps and gas escape structures have been identified in the Orange Basin area. Large fluid seep/pockmark fields of varying morphologies were also reported by Palan (2017) to the south of Block 3B/4B.

8.3.2 PELAGIC COMMUNITIES

In contrast to demersal and benthic biota that are associated with the seabed, pelagic species live and feed in the open water column. The pelagic communities are typically divided into plankton and fish, and their main predators, marine mammals (seals, dolphins and whales), seabirds and turtles. These are discussed separately below.

8.3.2.1 PLANKTON

Plankton is particularly abundant in the shelf waters off the West Coast, being associated with the upwelling characteristic of the area. Plankton range from single-celled bacteria to jellyfish of 2 m diameter, and include bacterio-plankton, phytoplankton, zooplankton, and ichthyoplankton (Figure 49).

Phytoplankton are the principle primary producers with mean productivity ranging from 2.5 - 3.5 g C/m^2/day for the midshelf region and decreasing to 1 g C/m^2/day inshore of 130 m (Shannon & Field 1985; Mitchell-Innes & Walker 1991; Walker & Peterson 1991). The phytoplankton is dominated by large-celled organisms, which are adapted to the turbulent sea conditions. The most common diatom genera are *Chaetoceros*, *Nitschia*, *Thalassiosira*, *Skeletonema*, *Rhizosolenia*, *Coscinodiscus* and *Asterionella* (Shannon & Pillar 1985). Diatom blooms occur after upwelling events, whereas dinoflagellates (e.g. *Prorocentrum*, *Ceratium* and *Peridinium*) are more common in blooms that occur during quiescent periods, since they can grow rapidly at low nutrient concentrations. In the surf zone, diatoms and dinoflagellates are nearly equally important members of the phytoplankton, and some silicoflagellates are also present.

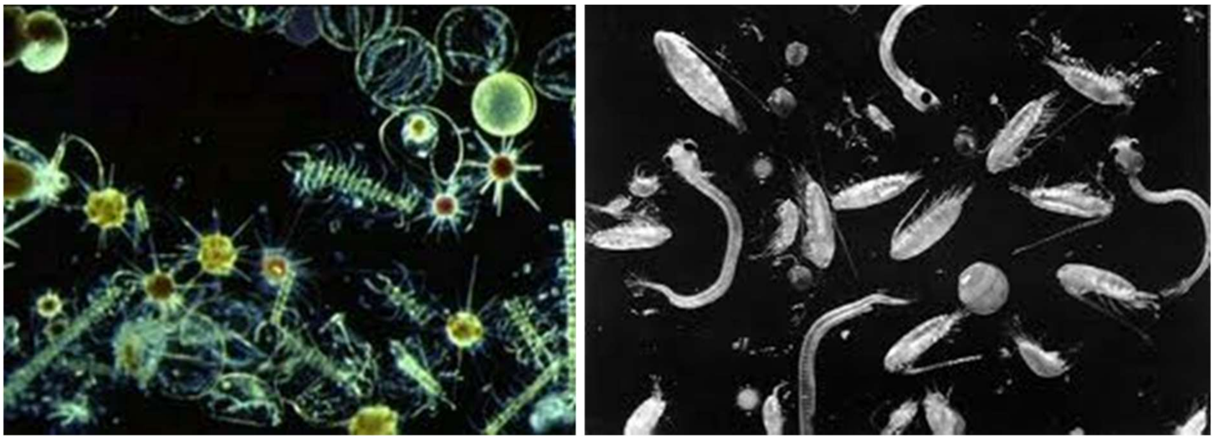


Figure 49: Phytoplankton (left, photo: hymagazine.com) and zooplankton (right, photo: mysciencebox.org) is associated with upwelling cells.

Red tides are ubiquitous features of the Benguela system (see Shannon & Pillar, 1986). The most common species associated with red tides (dinoflagellate and/or ciliate blooms) are *Noctiluca scintillans*, *Gonyaulax tamarensis*, *G. polygramma* and the ciliate *Mesodinium rubrum*. *Gonyaulax* and *Mesodinium* have been linked with toxic red tides. Most of these red-tide events occur quite close inshore although Hutchings *et al.* (1983) have recorded red-tides 30 km offshore. They are unlikely to occur in the offshore regions of Block 3B/4B.

The mesozooplankton (≥200 µm) is dominated by copepods, which are overall the most dominant and diverse group in southern African zooplankton. Important species are *Centropages brachiatus*, *Calanoides carinatus*, *Metridia lucens*, *Nannocalanus minor*, *Clausocalanus arcuicornis*, *Paracalanus parvus*, *P. crassirostris* and *Ctenocalanus vanus*. All of the above species typically occur in the phytoplankton rich upper mixed layer of the water column, with the exception of *M. lucens* which undertakes considerable vertical migration.

The macrozooplankton (≥1 600 µm) are dominated by euphausiids of which 18 species occur in the area. The dominant species occurring in the nearshore are *Euphausia lucens* and *Nyctiphanes capensis*, although neither species appears to survive well in waters seaward of oceanic fronts over the continental shelf (Pillar *et al.* 1991).

Standing stock estimates of mesozooplankton for the southern Benguela area range from 0.2 - 2.0 g C/m^2, with maximum values recorded during upwelling periods. Macrozooplankton biomass ranges from 0.1-1.0 g C/m^2, with production increasing north of Cape Columbine (Pillar 1986). Although it shows no appreciable onshore-offshore gradients, standing stock is highest over the shelf, with accumulation of some mobile zooplanktors (euphausiids) known to occur at oceanographic fronts. Beyond the continental slope biomass decreases markedly. Localised peaks in biomass may, however, occur in the vicinity of Child's Bank and Tripp seamount in response to topographically steered upwelling around such seabed features.

Zooplankton biomass varies with phytoplankton abundance and, accordingly, seasonal minima will exist during non-upwelling periods when primary production is lower (Brown 1984; Brown & Henry 1985), and during winter when predation by recruiting anchovy is high. More intense variation will occur in relation to the upwelling cycle; newly upwelled water supporting low zooplankton biomass due to paucity of food, whilst high biomasses develop in aged, upwelled water subsequent to significant development of phytoplankton. Irregular pulsing of the upwelling system, combined with seasonal recruitment of pelagic fish species into West Coast shelf waters during winter, thus results in a highly variable and dynamic balance between plankton replenishment and food availability for pelagic fish species.

Although ichthyoplankton (fish eggs and larvae) comprise a minor component of the overall plankton, it remains significant due to the commercial importance of the overall fishery in the region. Various pelagic and demersal fish species are known to spawn in the inshore regions of the southern Benguela, (including pilchard, round herring, chub mackerel lanternfish and hakes (Crawford *et al.* 1987; Hutchings 1994; Hutchings *et al.* 2002) (see Figure 50, Figure 51 and Figure 52, and Figure 53), and their eggs and larvae form an important contribution to the ichthyoplankton in the region. Spawning of key species is presented below.

- Hake, snoek and round herring move to the western Agulhas Bank and southern west coast to spawn in late winter and early spring (key period), when offshore Ekman losses are at a minimum and their eggs and larvae drift northwards and inshore to the west coast nursery grounds. Figure 52 and Figure 53 highlight the temporal variation in hake eggs and larvae with there being a greater concentration of eggs and larvae between September - October compared to March - April. However, hake are reported to spawn throughout the year (Strømme *et al*. 2015). Snoek spawn along the shelf break (150-400 m) of the western Agulhas Bank and the West Coast between June and October (Griffiths 2002).
- Horse mackerel spawn over the east/central Agulhas Bank during winter months.
- Sardines spawn on the whole Agulhas Bank during November, but generally have two spawning peaks, in early spring and autumn, on either side of the peak anchovy spawning period (Figure 54, left). There is also sardine spawning on the east coast and even off KwaZulu-Natal, where sardine eggs are found during July–November.
- Anchovies spawn on the whole Agulhas Bank (Figure 54, right), with spawning peaking during mid-summer (November–December) and some shifts to the west coast in years when Agulhas Bank water intrudes strongly north of Cape Point.

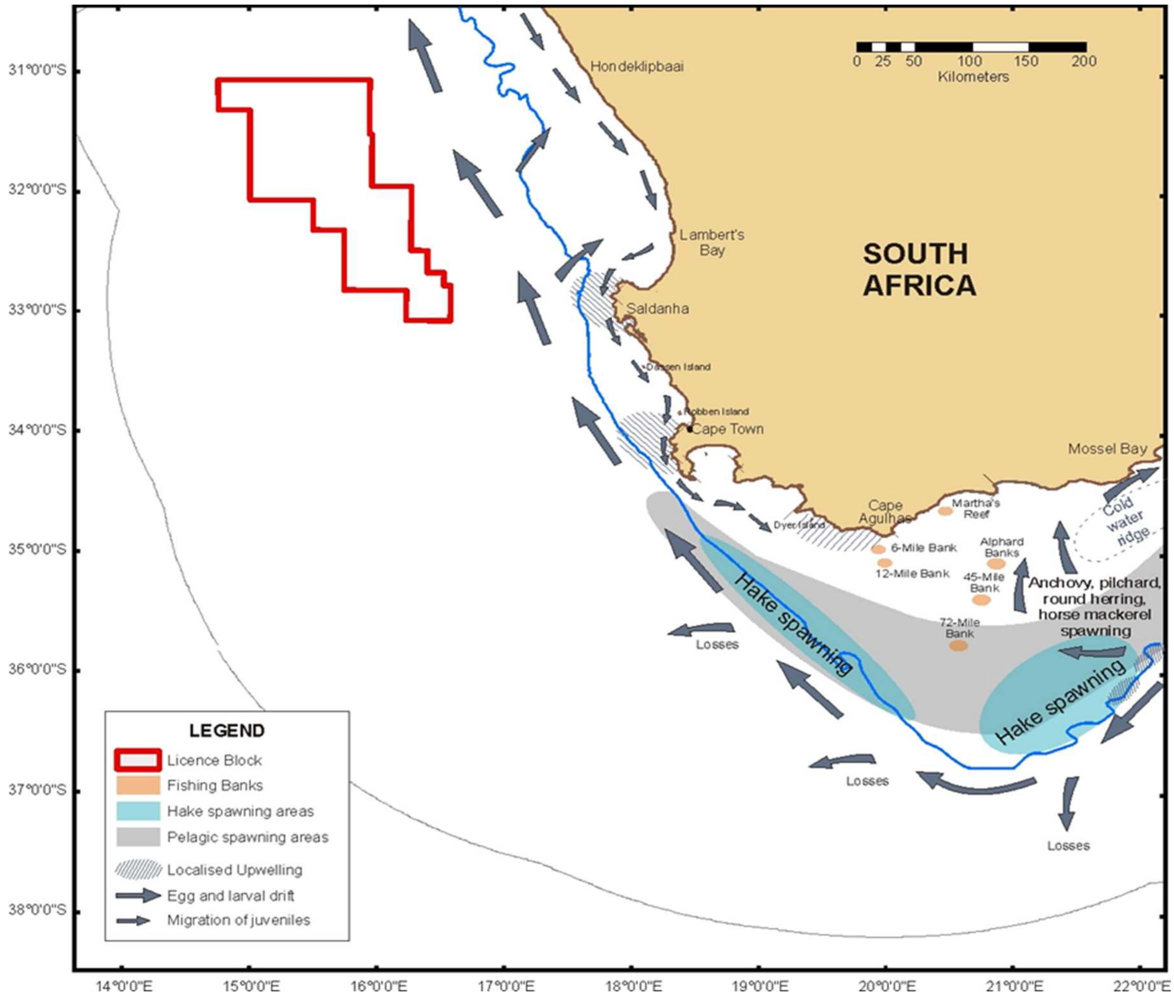


Figure 50: Block 3B/4B (red polygon) in relation to major spawning, recruitment and nursery areas in the southern Benguela region (adapted from Crawford *et al*. 1987; Hutchings 1994; Hutchings *et al*. 2002).

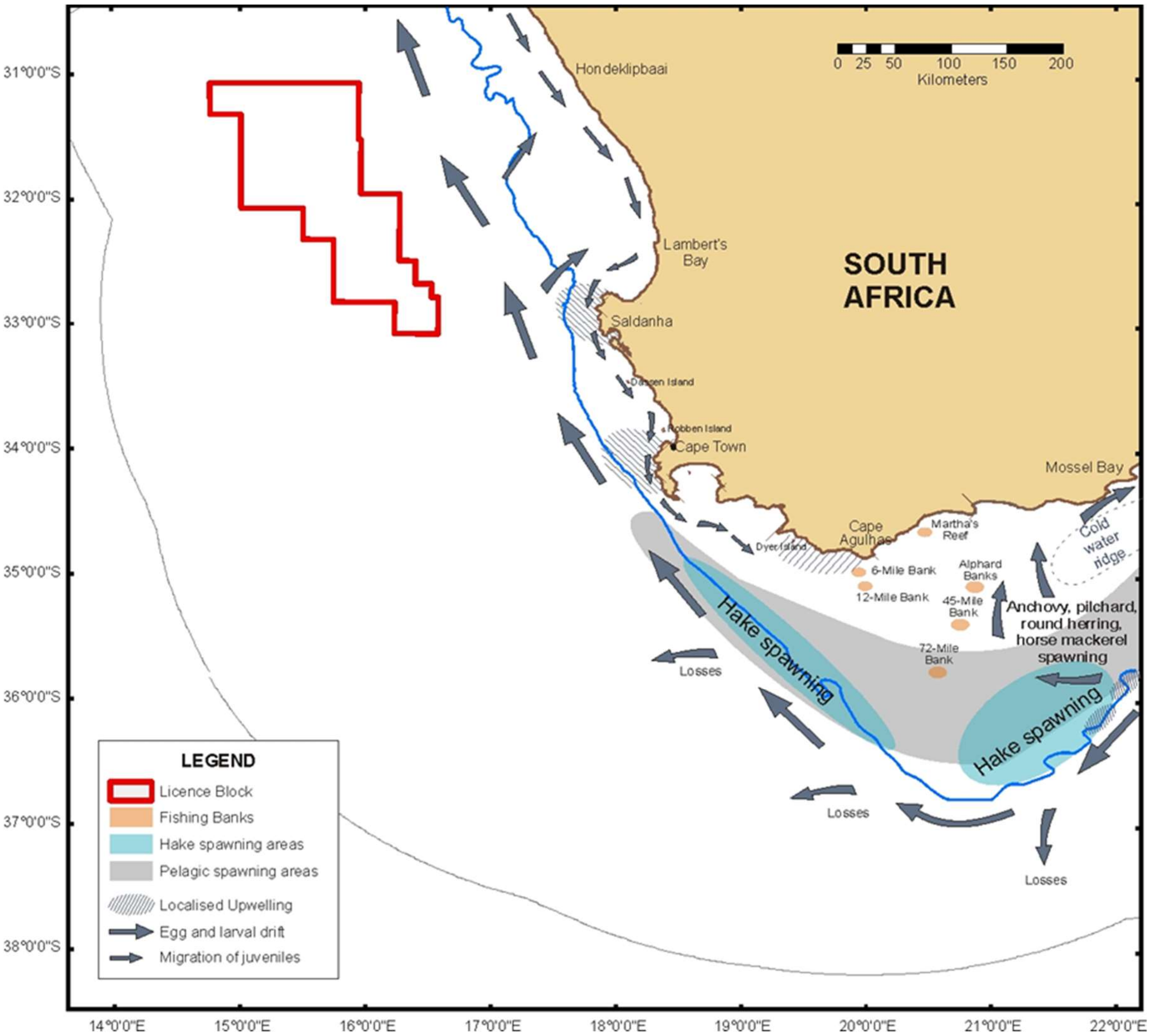


Figure 51: Block 3B/4B (red polygon) in relation to major spawning, recruitment and nursery areas in the southern Benguela region (adapted from Crawford *et al.* 1987; Hutchings 1994; Hutchings *et al.* 2002).

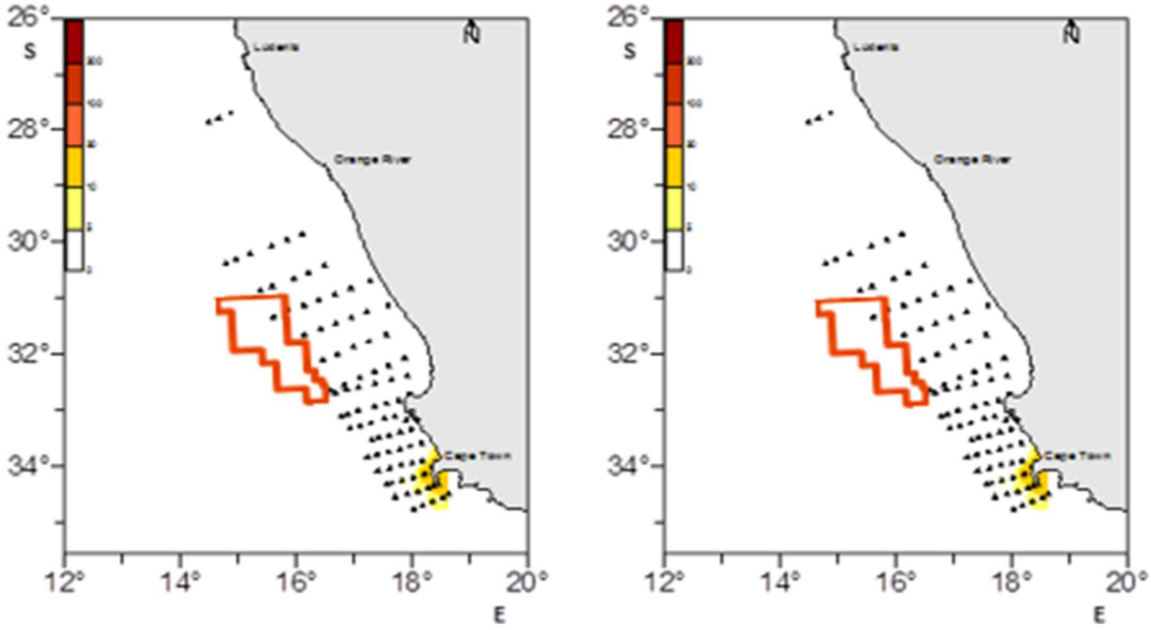


Figure 52: Distribution of hake eggs (left) and larvae (right) off the West Coast of South Africa between September and October 2005 (adapted from Stenevik *et al*. 2008) in relation to Block 3B/4B (red polygon).

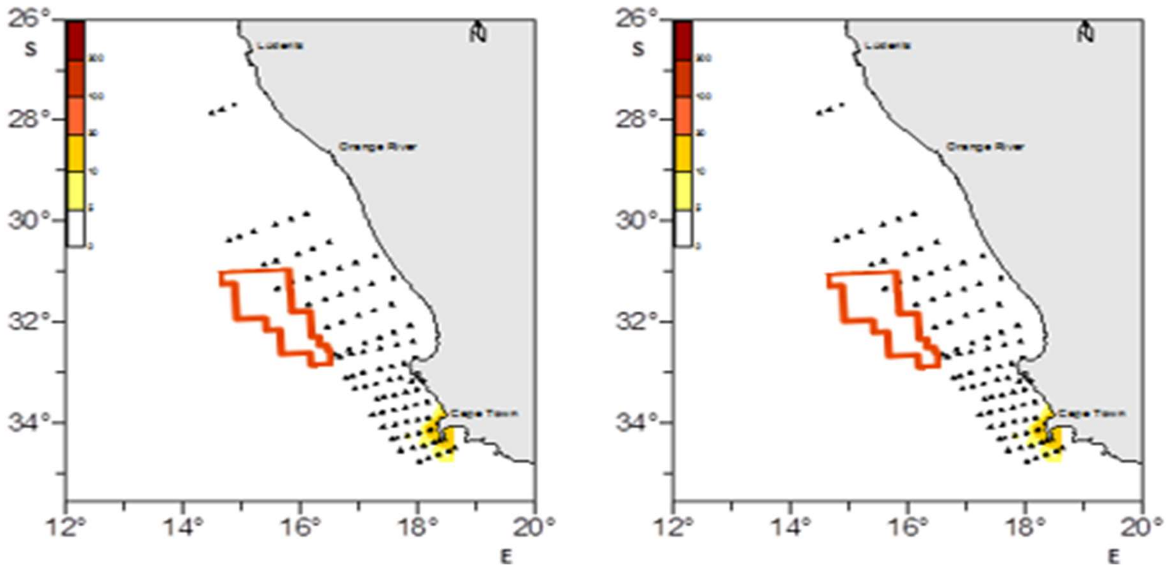
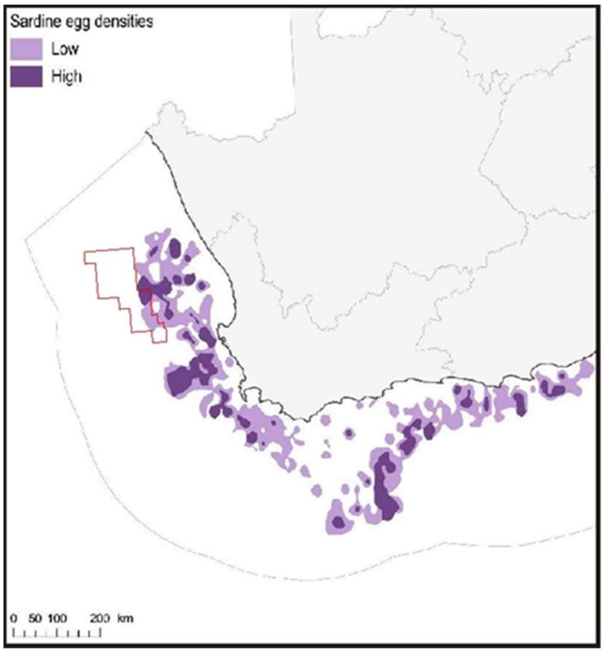


Figure 53: Distribution of hake eggs (left) and larvae (right) off the West Coast of South Africa between March and April 2007 (adapted from Stenevik *et al*. 2008) in relation to Block 3B/4B (red polygon).

The eggs and larvae are carried around Cape Point and up the coast in northward flowing surface waters. At the start of winter every year, the juveniles recruit in large numbers into coastal waters across broad stretches of the shelf between the Orange River and Cape Columbine to utilise the shallow shelf region as nursery grounds before gradually moving southwards in the inshore southerly flowing surface current, towards the major spawning grounds east of Cape Point. Following spawning, the eggs and larvae of snoek are transported to inshore (<150 m) nursery grounds north of Cape Columbine and east of Danger Point, where the juveniles remain until maturity. There is only limited overlap of the inshore portions of Block 3B/4B with the northward egg and larval drift of commercially important species, and the return migration of recruits (Figure 51). In the offshore oceanic waters of Block 3B/4B, ichthyoplankton abundance is, therefore, expected to be low.



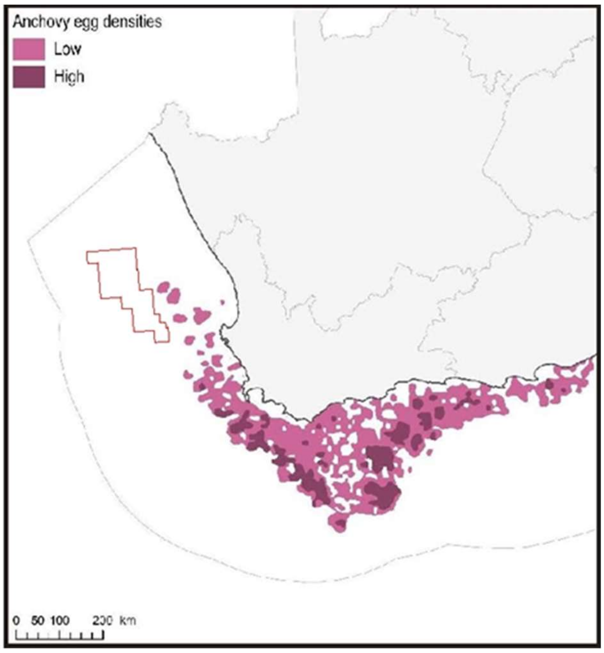


Figure 54: Distribution of sardine (left) and anchovy (right) spawning areas, as measured by egg densities, in relation to Block 3B/4B (red polygon) (adapted from Harris *et al.* 2022).

8.3.2.2 CEPHALOPODS

Fourteen species of cephalopds have been recorded in the southern Benguela, the majority of which are sepiods/cuttlefish (Lipinski 1992; Augustyn *et al.* 1995). Most of the cephalopod resource is distributed on the mid-shelf with *Sepia australis* being most abundant at depths between 60-190 m, whereas *S. hieronis* densities were higher at depths between 110-250 m. *Rossia enigmatica* occurs more commonly on the edge of the shelf to depths of 500 m. Biomass of these species was generally higher in the summer than in winter.

Cuttlefish are largely epi-benthic and occur on mud and fine sediments in association with their major prey item; mantis shrimps (Augustyn *et al.* 1995). They form an important food item for demersal fish.

The colossal squid *Mesonychoteuthis hamiltoni* and the giant squid *Architeuthis* sp. may also be encountered in the project area. Both are deep dwelling species, with the colossal squid's distribution confined to the entire circum-antarctic Southern Ocean (Figure 55, top) while the giant squid is usually found near continental and island slopes all around the world's oceans (Figure 55, bottom). Both species could thus potentially occur in the pelagic habitats of the project area, although the likelihood of encounter is extremely low.

Growing to in excess of 10 m in length, they are the principal prey of the sperm whale, and are also taken by beaked whaled, pilot whales, elephant seals and sleeper sharks. Nothing is known of their vertical distribution, but data from trawled specimens and sperm whale diving behaviour suggest they may span a depth range of 300 – 1 000 m. They lack gas-filled swim bladders and maintain neutral buoyancy through an ammonium chloride solution occurring throughout their bodies.

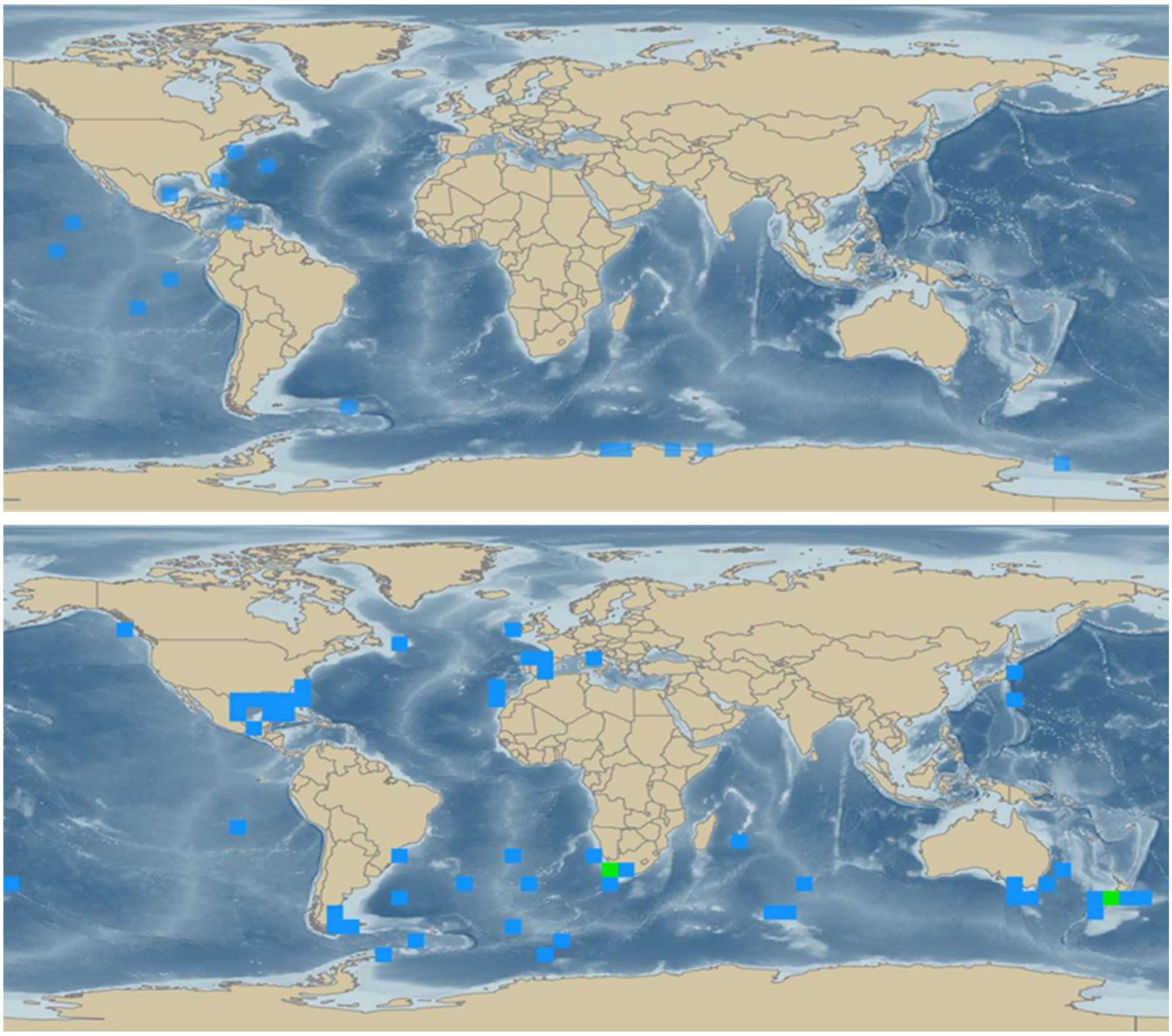


Figure 55: Distribution of the colossal squid (top) and the giant squid (bottom). Blue squares <5 records, green squares 5-10 records (Source: http://iobis.org).

8.3.2.3 PELAGIC FISH

Small pelagic species include the sardine/pilchard (*Sadinops ocellatus*) (Figure 56, left), anchovy (*Engraulis capensis*), chub mackerel (*Scomber japonicus*), horse mackerel (*Trachurus capensis*) (Figure 56). At the start of winter every year, juveniles of most small pelagic shoaling species recruit into coastal waters in large numbers between the Orange River and Cape Columbine. They recruit in the pelagic stage, across broad stretches of the shelf, to utilise the shallow shelf region as nursery grounds before gradually moving southwards in the inshore southerly flowing surface current, towards the major spawning grounds east of Cape Point. Recruitment success relies on the interaction of oceanographic events and is thus subject to spatial and temporal variability. Consequently, the abundance of adults and juveniles of these small, short-lived (1-3 years) pelagic fish is highly variable both within and between species.


Figure 56: Cape fur seal preying on a shoal of pilchards (left). School of horse mackerel (right) (photos: www.underwatervideo.co.za; www.delivery.superstock.com).

Two species that migrate along the West Coast following the shoals of anchovy and pilchards are snoek *Thyrsites atun* and chub mackerel *Scomber japonicas*. Both these species have been rated as 'Least concern' on the national assessment (Sink *et al.* 2019). While the appearance of chub mackerel along the West and South-West coasts is highly seasonal, adult snoek are found throughout their distribution range and longshore movement are random and without a seasonal basis (Griffiths 2002). Initially postulated to be a single stock that undergoes a seasonal longshore migration from southern Angola through Namibia to the South African West Coast (Crawford & De Villiers 1985; Crawford *et al.* 1987), Benguela snoek are now recognised as two separate sub-populations separated by the Lüderitz upwelling cell (Griffiths 2003). On the West Coast, snoek move offshore to spawn and there is some southward dispersion as the spawning season progresses, with females on the West Coast moving inshore to feed between spawning events as spawning progresses. In contrast, those found further south along the western Agulhas Bank remain on the spawning grounds throughout the spawning season (Griffiths 2002) (Figure 57). They are voracious predators occurring throughout the water column, feeding on both demersal and pelagic invertebrates and fish. Chub mackerel similarly migrate along the southern African West Coast reaching South-Western Cape waters between April and August. They move inshore in June and July to spawn before starting the return northwards offshore migration later in the year. Their abundance and seasonal migrations are thought to be related to the availability of their shoaling prey species (Payne & Crawford 1989). The distribution of snoek and chub mackerel therefore lies well inshore of Block 3B/4B.

The fish most likely to be encountered on the shelf, beyond the shelf break and in the offshore waters of Block 3B/4B are the large migratory pelagic species, including various tunas, billfish and sharks, many of which are considered threatened by the International Union for the Conservation of Nature (IUCN), primarily due to overfishing (Table 15). Tuna and swordfish are targeted by high seas fishing fleets and illegal overfishing has severely damaged the stocks of many of these species. Similarly, pelagic sharks, are either caught as bycatch in the pelagic tuna longline fisheries, or are specifically targeted for their fins, where the fins are removed and the remainder of the body discarded.

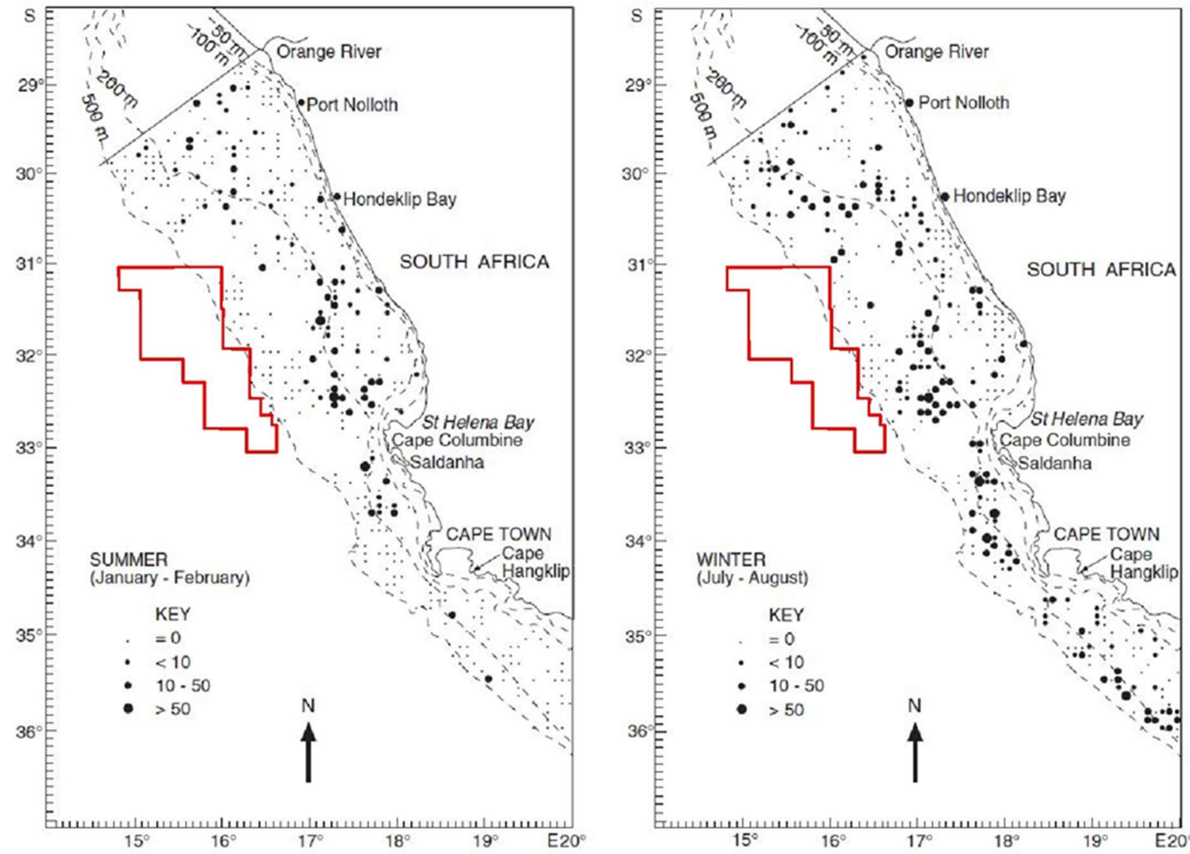


Figure 57: Mean number of snoek per demersal trawl per grid block (5 × 5 Nm) by season for (A) the west coast (July 1985–Jan 1991) and (B) the south coast in relation to Block 3B/4B (red polygon) (Pisces, 2023).

These large pelagic species migrate throughout the southern oceans, between surface and deep waters (>300 m) and have a highly seasonal abundance in the Benguela. Species occurring off western southern Africa include the albacore/longfin tuna *Thunnus alalunga* (Figure 58, right), yellowfin *T. albacares*, bigeye *T. obesus*, and skipjack *Katsuwonus pelamis* tunas, as well as the Atlantic blue marlin *Makaira nigricans* (Figure 58, left), the white marlin *Tetrapturus albidus* and the broadbill swordfish *Xiphias gladius* (Payne & Crawford 1989). The distribution of these species is dependent on food availability in the mixed boundary layer between the Benguela and warm central Atlantic waters. Concentrations of large pelagic species are also known to occur associated with underwater feature such as canyons and seamounts as well as meteorologically induced oceanic fronts (Shannon *et al*. 1989; Penney *et al*. 1992). Seasonal association with Child's Bank and Tripp Seamount occurs between October and June, with commercial catches often peaking in March and April (www.fao.org/fi/fcp/en/NAM/body.htm; see CapMarine 2023 – Fisheries Specialist Study).

Table 15: Some of the more important large migratory pelagic fish likely to occur in the offshore regions of the West Coast (TOPS list under NEMBA, Act 10 of 2004; Sink *et al*. 2019; www.iucnredlist.org;). The National and Global IUCN Conservation Status are also provided. Species reported from Deep Water Orange Basin Area by MMOs are highlighted (CapFish 2013a).

Common Name	Species	National Assessment	IUCN Conservation Status
Tunas			
Southern Bluefin Tuna	*Thunnus maccoyii*	Not Assessed	Endangered
Bigeye Tuna	*Thunnus obesus*	Vulnerable	Vulnerable

Common Name	Species	National Assessment	IUCN Conservation Status
Longfin Tuna/Albacore	*Thunnus alalunga*	Near Threatened	Least concern
Yellowfin Tuna	*Thunnus albacares*	Near Threatened	Least concern
Frigate Tuna	*Auxis thazard*	Not Assessed	Least concern
Eastern Little Tuna	*Euthynnus affinis*	Least concern	Least concern
Skipjack Tuna	*Katsuwonus pelamis*	Least concern	Least concern
Atlantic Bonito	*Sarda sarda*	Not Assessed	Least concern
Billfish			
Black Marlin	*Istiompax indica*	Data deficient	Data deficient
Blue Marlin	*Makaira nigricans*	Vulnerable	Vulnerable
Striped Marlin	*Kajikia audax*	Near Threatened	Least concern
Sailfish	*Istiophorus platypterus*	Least concern	Vulnerable
Swordfish	*Xiphias gladius*	Data deficient	Near Threatened
Pelagic Sharks			
Oceanic Whitetip Shark	*Carcharhinus longimanus*	Not Assessed	Critically Endangered
Dusky Shark	*Carcharhinus obscurus*	Data deficient	Endangered
Bronze Whaler Shark	*Carcharhinus brachyurus*	Data deficient	Vulnerable
Great White Shark	*Carcharodon carcharias*	Least concern	Vulnerable
Shortfin Mako	*Isurus oxyrinchus*	Vulnerable	Endangered
Longfin Mako	*Isurus paucus*	Not Assessed	Endangered
Whale Shark	*Rhincodon typus*	Not Assessed	Endangered
Blue Shark	*Prionace glauca*	Least concern	Near Threatened

A number of species of pelagic sharks are also known to occur on the West Coast, including blue *Prionace glauca*, short-fin mako *Isurus oxyrinchus* and oceanic whitetip sharks *Carcharhinus longimanus*. Occurring throughout the world in warm temperate waters, these species are usually found further offshore on the West Coast. Great whites *Carcharodon carcharias* and whale sharks *Rhincodon typus* may also be encountered in coastal and offshore areas, although the latter occurs more frequently along the South and East coasts. The recapture of a juvenile blue shark off Uruguay, which had been tagged off the Cape of Good Hope, supports the hypothesis of a single blue shark stock in the South Atlantic (Hazin 2000; Montealegre-Quijano & Vooren 2010) and Indian Oceans (da Silva *et al*. 2010). Using the Benguela drift in a north-westerly direction, it is likely that juveniles from the parturition off the south-western Cape would migrate through Block 3B/4B *en route* to South America (da Silva *et al.* 2010).

Figure 58: Large migratory pelagic fish such as blue marlin (left) and longfin tuna (right) occur in offshore waters (photos: www.samathatours.com; www.osfimages.com).

The shortfin mako inhabits offshore temperate and tropical seas worldwide. It can be found from the surface to depths of 500 m, and as one of the few endothermic sharks is seldom found in waters <16 °C (Compagno 2001; Loefer *et al.* 2005). As the fastest species of shark, shortfin makos have been recorded to reach speeds of 40 km/h with burst of up to 74 km/h and can jump to a height of 9 m (http://www.elasmo-research.org/education/shark_profiles/ i_oxyrinchus.htm). Most makos caught by longliners off South Africa are immature, with reports of juveniles and sub-adults sharks occurring near the edge of the Agulhas Bank and off the South Coast between June and November (Groeneveld *et al.* 2014), whereas larger and reproductively mature sharks were more common in the inshore environment along the East Coast (Foulis 2013).

Until recently, the Southern Bluefin Tuna was globally assessed as ‘Critically Endangered’ by the IUCN, and in South Africa the stock is considered collapsed (Sink *et al.* 2019). Although globally the stock remains at a low state, it is not considered overfished as there have been improvements since previous stock assessments. Consequently, the list of species changing IUCN Red List Status for 2020-2021 now list Southern Bluefin Tuna as globally ‘Endangered’.

Whale sharks are regarded as a broad ranging species typically occurring in offshore epipelagic areas with sea surface temperatures of 18–32°C (Eckert & Stewart 2001). Adult whale sharks reach an average size of 9.7 m and 9 tonnes, making them the largest non-cetacean animal in the world. They are slow-moving filter-feeders and therefore particularly vulnerable to ship strikes (Rowat 2007). Although primarily solitary animals, seasonal feeding aggregations occur at several coastal sites all over the world, those closest to the project area being off Sodwana Bay in KwaZulu Natal (KZN) (Cliff *et al.* 2007). Satellite tagging has revealed that individuals may travel distances of tens of 1 000s of kms (Eckert & Stewart 2001; Rowat & Gore 2007; Brunnschweiler *et al.* 2009). On the West Coast their summer and winter distributions are centred around the Orange River mouth and between Cape Columbine and Cape Point (Harris *et al*. 2022). The likelihood of an encounter in the offshore waters of Block 3B/4B is relatively low.

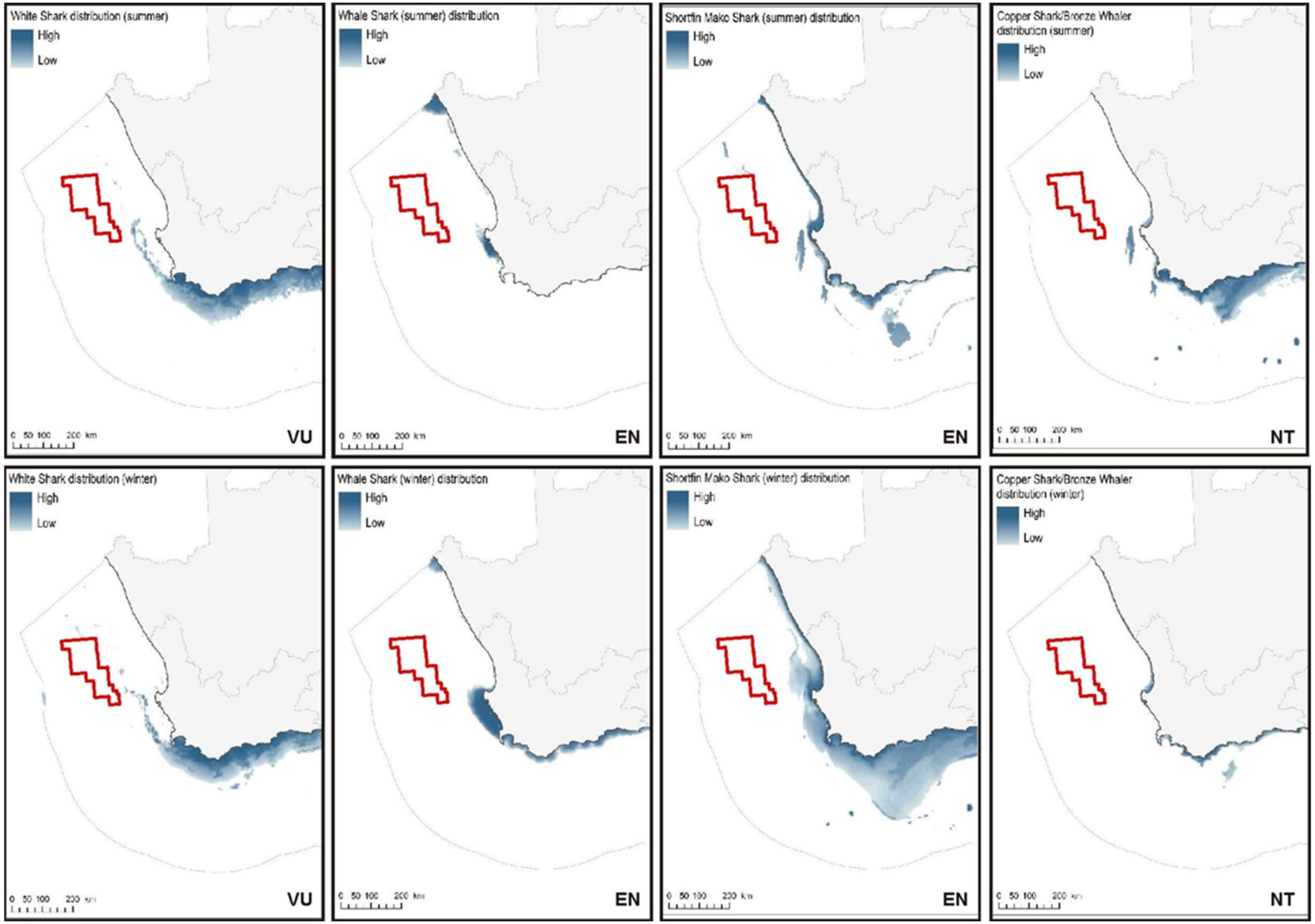


Figure 59: The summer (top) and winter (bottom) distribution of white shark, whale shark, shortfin mako and bronze whaler shark in relation to Block 3B/4B (red polygon) (adapted from Harris *et al.* 2022).

The whale shark and shortfin mako are listed in Appendix II (species in which trade must be controlled in order to avoid utilization incompatible with their survival) of CITES (Convention on International Trade in Endangered Species) and Appendix I and/or II of the Bonn Convention for the Conservation of Migratory Species (CMS). The whale shark is also listed as 'vulnerable' in the List of Marine Threatened or Protected Species (TOPS) as part of the National Environmental Management: Biodiversity Act (Act 10 of 2004) (NEMBA). The shelf-associated[4] distributions of some of the pelagic sharks (Great white, Bronze whaler, shortfin mako and whale shark) were provided in Harris *et al.* (2022) (Figure 59).

8.3.2.4 **TURTLES**

Three species of turtle occur along the West Coast, namely the Leatherback (*Dermochelys coriacea*) (Figure 60, left), and occasionally the Loggerhead (*Caretta caretta*) (Figure 60, right) and the Green (*Chelonia mydas*) turtle. Green turtles are non-breeding residents often found feeding on inshore reefs on the South and East Coasts and are expected to occur only as occasional visitors along the West Coast. The most recent conservation status, which assessed the species on a sub-regional scale, is provided in Table 16.

Figure 60: Leatherback (left) and loggerhead turtles (right) occur along the West Coast of Southern Africa (Photos: Ketos Ecology 2009; www.aquaworld-crete.com).

Table 16: Global and Regional Conservation Status[5] of the turtles occurring off the West Coast showing variation depending on the listing used.

IUCN Red List: Species (date)	Leatherback	Loggerhead	Green
Population (RMU)	V (2013)	V (2017)	E (2004)
Sub-Regional/National	CR (2013)	NT (2017)	*
NEMBA TOPS (2017)	CR	E	E
Sink & Lawrence (2008)	CR	E	E
Hughes & Nel (2014)	E	V	NT

After completion of the nesting season (October to January) both Leatherbacks and Loggerheads undertake long-distance migrations to foraging areas. Loggerhead turtles are coastal specialists keeping inshore, hunting around reefs, bays and rocky estuaries along the African South and East Coast, where they feed on a variety of benthic

[4] The distributions provided by Harris et al. (2022) are based on data from pelagic fisheries. In reality these species all have wide-ranging distributions in offshore temperate and/or tropical seas.

[5] NT – Near Threatened; V – Vulnerable; E – Endangered; CR – Critically Endangered; DD – Data Deficient; UR – Under Review; * - not yet assessed.

fauna including crabs, shrimp, sponges, and fish. In the open sea their diet includes jellyfish, flying fish, and squid (www.oceansafrica.com/turtles.htm). Satellite tagging of loggerheads suggests that they seldom occur west of Cape Agulhas (Harris *et al.* 2018; Robinson *et al.* 2018). A green turtle and loggerhead turtle recently released on the Cape Peninsula by the Two Oceans Aquarium has, however stayed in the West Coast waters, spending time in St Helena Bay and travelling up the Namaqualand coast before heading northwards into Namibian waters, suggesting that occurrence in West Coast waters does arise (https://www.aquarium.co.za/foundation/news/tracking-our-turtles-the-first-update-of-2024). A sighting of a Loggerhead turtle in the Deep Water Orange Basin Area has, however, been reported by an MMO (CapFish 2013a). The Leatherback is the turtle most likely to be encountered in the offshore waters of west South Africa. The Benguela ecosystem, especially the northern Benguela where jelly fish numbers are high, is increasingly being recognized as a potentially important feeding area for leatherback turtles from several globally significant nesting populations in the south Atlantic (Gabon, Brazil) and south east Indian Ocean (South Africa) (Lambardi *et al.* 2008, Elwen & Leeney 2011; SASTN 2011[6]). Leatherback turtles from the east South Africa population have been satellite tracked swimming around the west coast of South Africa and remaining in the warmer waters west of the Benguela ecosystem (Lambardi *et al.* 2008; Robinson *et al.* 2018) (Figure 61).

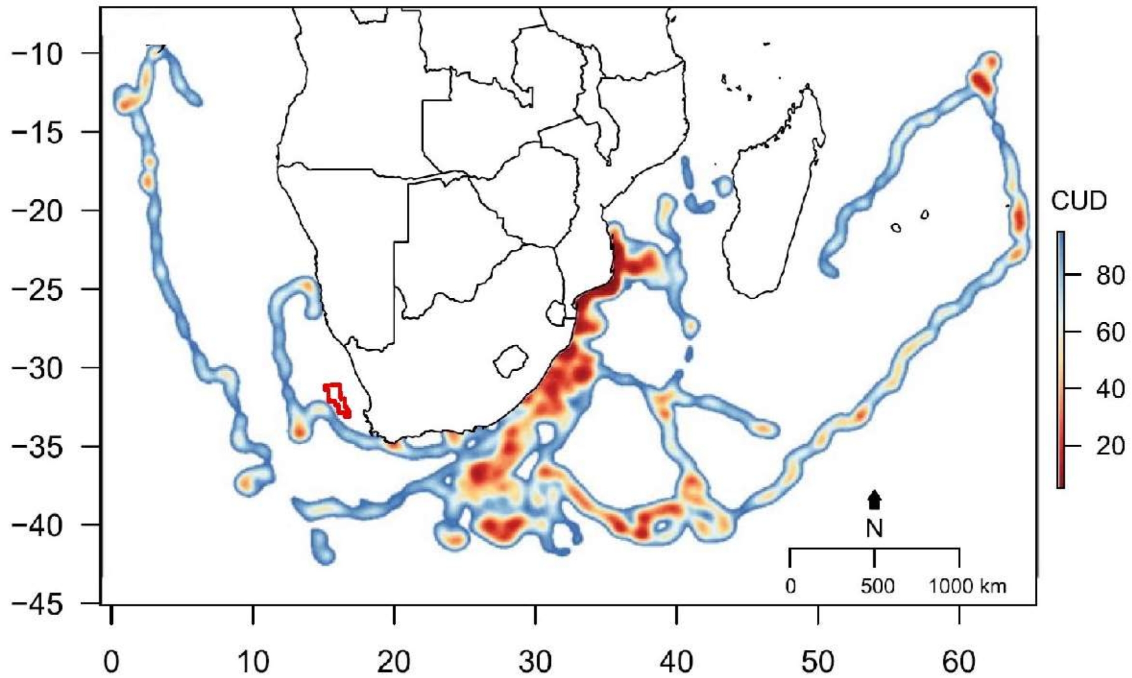


Figure 61: Block 3B/4B (red polygon) in relation to the migration corridors of leatherback turtles in the south-western Indian Ocean. Relative use (CUD, cumulative utilization distribution) of corridors is shown through intensity of shading: light, low use; dark, high use (adapted from Harris *et al.* 2018).

Leatherback turtles inhabit deeper waters and are considered a pelagic species, travelling the ocean currents in search of their prey (primarily jellyfish). While hunting they may dive to over 600 m and remain submerged for up to 54 minutes (Hays *et al.* 2004). Their abundance in the study area is unknown but expected to be low. Leatherbacks feed on jellyfish and are known to have mistaken plastic marine debris for their natural food. Ingesting this can obstruct the gut, lead to absorption of toxins and reduce the absorption of nutrients from their real food. Leatherback Turtles are listed as ‘Critically endangered’ worldwide by the IUCN and are in the highest categories in terms of need for conservation in CITES (Convention on International Trade in Endangered Species), and CMS (Convention on Migratory Species). The 2017 South African list of Threatened and Endangered Species (TOPS) similarly lists the species as ‘Critically endangered’, whereas on the National Assessment (Hughes & Nel 2014) leatherbacks were listed as ‘Endangered’, whereas Loggerhead and green turtles are listed globally as ‘Vulnerable’ and ‘Endangered’, respectively, whereas on TOPS both species are listed as ‘Endangered’. As a

[6] *SASTN Meeting - Second meeting of the South Atlantic Sea Turtle Network, Swakopmund, Namibia, 24-30 July 2011.*

signatory of CMS, South Africa has endorsed and signed a CMS International Memorandum of Understanding specific to the conservation of marine turtles. South Africa is thus committed to conserve these species at an international level.

8.3.2.5 SEABIRDS

Large numbers of pelagic seabirds exploit the pelagic fish stocks of the Benguela system. Of the 49 species of seabirds that occur in the Benguela region, 15 are defined as resident, 10 are visitors from the northern hemisphere and 25 are migrants from the southern Ocean. The species classified as being common in the southern Benguela, and likely to occur in Block 3B/4B, are listed in Table 17. The area between Cape Point and the Orange River supports 38% and 33% of the overall population of pelagic seabirds in winter and summer, respectively. Most of the pelagic species in the region reach highest densities offshore of the shelf break (200 – 500 m depth) and are therefore likely to occur in the proposed AOI, with highest population levels during their non-breeding season (winter). Pintado petrels and Prion spp. show the most marked variation here. Support vessels and possible helicopter flights may, however, encounter more coastal seabirds when *en route* between the drilling unit and the port or airport. On the South Coast, 60 seabird species are known, or thought likely to occur. These can be categorised into three categories: 'breeding resident species', 'non-breeding migrant species' and 'rare vagrants' (Shaughnessy 1977; Harrison 1978; Liversidge & Le Gras 1981; Ryan & Rose 1989).

Fifteen species of seabirds breed in southern Africa, including Cape Gannet (Figure 62, left), African Penguin (Figure 62, right), African Black Oystercatcher, four species of Cormorant, White Pelican, three Gull and four Tern species (Table 18). The breeding areas are distributed around the coast with islands being especially important. The closest breeding islands to Block 3B/4B are Bird Island in Lambert's Bay, the Saldanha Bay islands, Dassen Island, Robben Island and Seal Island approximately 180 km, 130 km, 145 km, 190 km and 225 km to the east and southeast of the southern section of Block 3B/4B, respectively. The number of successfully breeding birds at the particular breeding sites varies with food abundance. Most of the breeding seabird species forage at sea with most birds being found relatively close inshore (10-30 km). Cape Gannets, which breed at only three locations in South Africa (Bird Island Lamberts Bay, Malgas Island and Bird Island Algoa Bay) are known to forage within 200 km offshore (Dundee 2006; Ludynia 2007; Grémillet *et al.* 2008; Crawford *et al.* 2011), and African Penguins have also been recorded as far as 60 km offshore. Block 3B/4B lies on the western extent of Cape Gannet foraging and distribution areas and well offshore of African Penguin foraging and distribution areas but overlaps with the foraging ranges of various pelagic bird species, particularly Wandering Albatross and Atlantic, Yellow-nosed Albatross (Figure 63). Cape Cormorant and Bank Cormorant core usage areas lie well inshore of Block 3B/4B (BirdLife South Africa 2021; Harris *et al.* 2022).

Interactions with commercial fishing operations, either through incidental bycatch or competition for food resources, is the greatest threat to southern African seabirds, impacting 56% of seabirds of special concern. Crawford *et al.* (2014) reported that four of the seabirds assessed as Endangered compete with South Africa's fisheries for food: African Penguins, Cape Gannets and Cape Cormorants for sardines and anchovies, and Bank Cormorants for rock lobsters (Crawford *et al.* 2015). Populations of seabirds off the West Coast have recently shown significant decreases, with the population numbers of African Penguins currently only 2.5% of what the population was 80 years ago; declining from 1 million breeding pairs in the 1920s, 25 000 pairs in 2009 and 15 000 in 2018 (Sink *et al.* 2019). For Cape Gannets, the global population decreased from about 250 000 pairs in the 1950s and 1960s to approximately 130 000 in 2018, primarily as a result of a >90% decrease in Namibia's population in response to the collapse of Namibia's sardine resource. In South Africa, numbers of Cape Gannets have increased since 1956 and South Africa now holds >90% of the global population. However, numbers have recently decreased in the Western Cape but increased in Algoa Bay mirroring the southward and eastward shift sardine and anchovy. Algoa Bay currently holds approximately 75% of the South African Gannet population.

Figure 62: Cape Gannets *Morus capensis* (left) (Photo: NACOMA) and African Penguins *Spheniscus demersus* (right) (Photo: Klaus Jost) breed primarily on the offshore Islands.

Cape cormorants and Bank cormorants showed a substantial decline from the late 1970s/early 1980s to the late 2000s/early 2010s, with numbers of Cape cormorants dropping from 106 500 to 65 800 breeding pairs, and Bank cormorants from 1 500 to only 800 breeding pairs over that period (Crawford *et al.* 2015).

Demersal and pelagic longlining are key contributors to the mortality of albatrosses (Browed albatross 7%, Indian and Atlantic, Yellow-Nosed Albatross 3%), petrels (white-chinned petrel 66%), shearwaters and Cape Gannets (2%) through accidental capture (bycatch and/or entanglement in fishing gear), with an estimated annual mortality of 450 individuals of 14 species for the period 2006 to 2013 (Rollinson *et al.* 2017). Other threats include predation by mice on petrel and albatross chicks on sub-Antarctic islands, predation of chicks of Cape, Crowned and Bank Cormorants by Great White Pelicans, and predation of eggs and chicks of African Penguins, Bank, Cape and Crowned Cormorants by Kelp gulls. Disease (avian flu), climate change (heat stress and environmental variability) and oil spills are also considered major contributors to seabird declines (Sink *et al.* 2019).

Table 17: Pelagic seabirds common in the southern Benguela region (Crawford *et al*. 1991; BirdLife 2021). IUCN Red List and Regional Assessment status are provided (Sink *et al*. 2019). Species reported from the adjacent Deep Water Orange Basin Area by MMOs are highlighted (CapFish 2013a, 2013b).

Common Name	Species name	Global IUCN	Regional Assessment
Shy Albatross	*Thalassarche cauta*	Near Threatened	Near Threatened
Black-browed Albatross	*Thalassarche melanophrys*	Least concern	Endangered
Atlantic, Yellow-nosed Albatross	*Thalassarche chlororhynchos*	Endangered	Endangered
Indian, Yellow-nosed Albatross	*Thalassarche carteri*	Endangered	Endangered
Wandering Albatross	*Diomedea exulans*	Vulnerable	Vulnerable
Southern Royal Albatross	*Diomedea epomophora*	Vulnerable	Vulnerable
Northern Royal Albatross	*Diomedea sanfordi*	Endangered	Endangered
Sooty Albatross	*Phoebetria fusca*	Endangered	Endangered
Light-mantled Albatross	*Phoebetria palpebrata*	Near Threatened	Near Threatened
Tristan Albatross	*Diomedea dabbenena*	Critically Endangered	Critically Endangered
Grey-headed Albatross	*Thalassarche chrysostoma*	Endangered	Endangered

Common Name	Species name	Global IUCN	Regional Assessment
Giant Petrel sp.	*Macronectes halli/giganteus*	Least concern	Near Threatened
Southern Fulmar	*Fulmarus glacialoides*	Least concern	Least concern
Pintado Petrel	*Daption capense*	Least concern	Least concern
Blue Petrel	*Halobaena caerulea*	Least concern	Near Threatened
Salvin's Prion	*Pachyptila salvini*	Least concern	Near Threatened
Arctic Prion	*Pachyptila desolata*	Least concern	Least concern
Slender-billed Prion	*Pachyptila belcheri*	Least concern	Least concern
Broad-billed Prion	*Pachyptila vittata*	Least concern	Least concern
Kerguelen Petrel	*Aphrodroma brevirostris*	Least concern	Near Threatened
Greatwinged Petrel	*Pterodroma macroptera*	Least concern	Near Threatened
Soft-plumaged Petrel	*Pterodroma mollis*	Least concern	Near Threatened
White-chinned Petrel	*Procellaria aequinoctialis*	Vulnerable	Vulnerable
Spectacled Petrel	*Procellaria conspicillata*	Vulnerable	Vulnerable
Cory's Shearwater	*Calonectris diomedea*	Least concern	Least concern
Sooty Shearwater	*Puffinus griseus*	Near Threatened	Near Threatened
Flesh-footed Shearwater	*Ardenna carneipes*	Near Threatened	Least concern
Great Shearwater	*Puffinus gravis*	Least concern	Least concern
Manx Shearwater	*Puffinus puffinus*	Least concern	Least concern
Little Shearwater	*Puffinus assimilis*	Least concern	Least concern
European Storm Petrel	*Hydrobates pelagicus*	Least concern	Least concern
Leach's Storm Petrel	*Oceanodroma leucorhoa*	Vulnerable	Critically Endangered
Wilson's Storm Petrel	*Oceanites oceanicus*	Least concern	Least concern
Black-bellied Storm Petrel	*Fregetta tropica*	Least concern	Near Threatened
White-bellied Storm Petrel	*Fregetta grallaria*	Least concern	Least concern
Pomarine Jaeger	*Stercorarius pomarinus*	Least concern	Least concern
Subantarctic Skua	*Catharacta antarctica*	Least concern	Endangered
Parasitic Jaeger	*Stercorarius parasiticus*	Least concern	Least concern
Long-tailed Jaeger	*Stercorarius longicaudus*	Least concern	Least concern
Sabine's Gull	*Larus sabini*	Least concern	Least concern

Common Name	Species name	Global IUCN	Regional Assessment
Lesser Crested Tern	*Thalasseus bengalensis*	Least concern	Least concern
Sandwich Tern	*Thalasseus sandvicensis*	Least concern	Least concern
Little Tern	*Sternula albifrons*	Least concern	Least concern
Common Tern	*Sterna hirundo*	Least concern	Least concern
Arctic Tern	*Sterna paradisaea*	Least concern	Least concern
Antarctic Tern	*Sterna vittata*	Least concern	Endangered

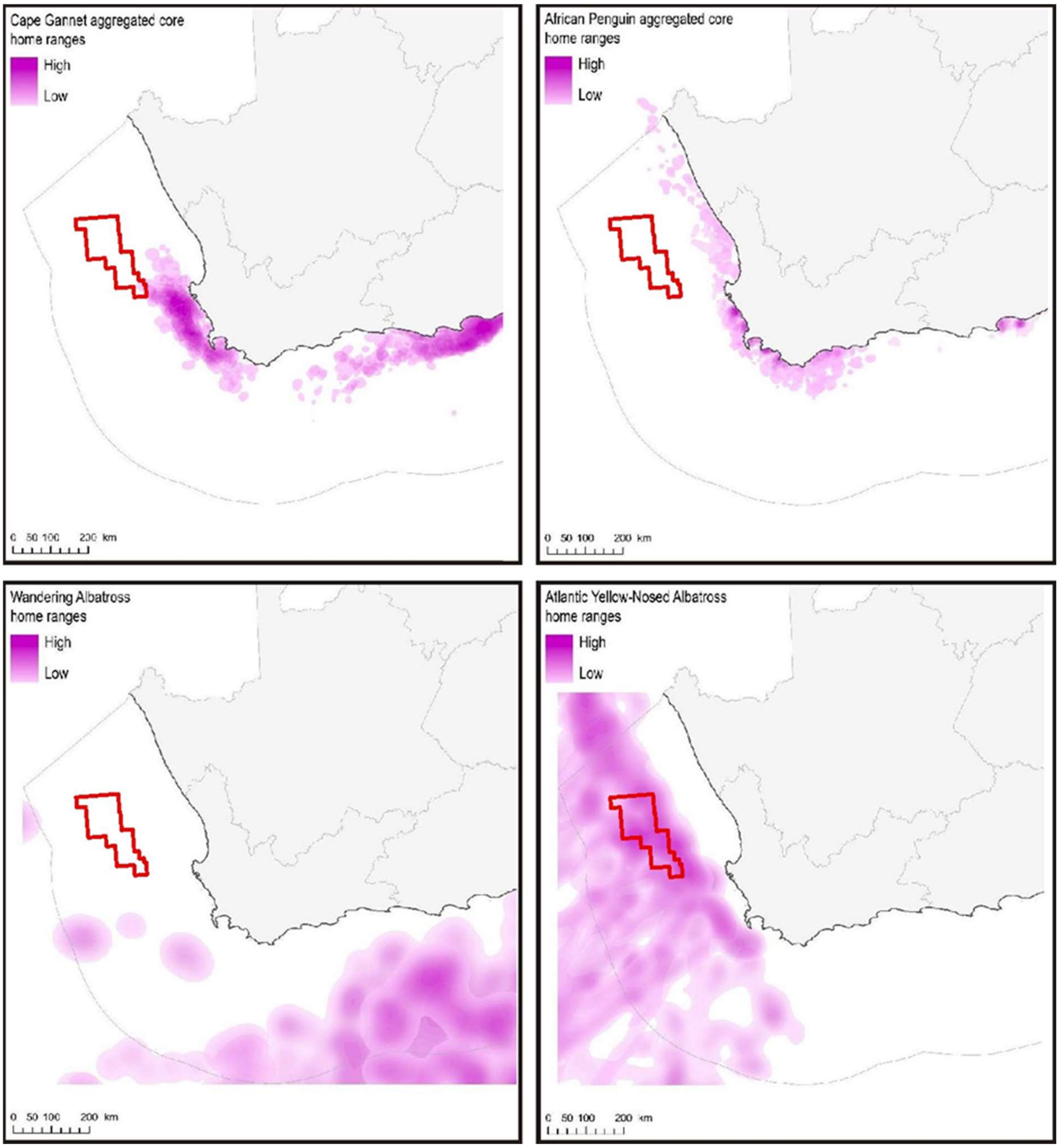


Figure 63: Block 3B/4B (red polygon) in relation to aggregate core home ranges of Cape Gannet (top left), African Penguin (top right) for different colonies and life-history stages, and foraging areas of Wandering Albatross

(bottom left) and Atlantic, Yellow-nosed Albatross (bottom right). For foraging areas, darker shades are areas of higher use and where foraging areas from different colonies overlap (adapted from Harris *et al*. 2022).

Table 18: Breeding resident seabirds present along the South-West Coast (adapted from CCA & CMS 2001). IUCN Red List and National Assessment status are provided (Sink *et al*. 2019). Species reported from the adjacent Deep Water Orange Basin Area by MMOs are highlighted (CapFish 2013a, 2013b). * denotes endemicity.

Common Name	Species Name	Global IUCN	National Assessment
African Penguin*	*Spheniscus demersus*	Endangered	Endangered
African Black Oystercatcher*	*Haematopus moquini*	Least Concern	Least Concern
White-breasted Cormorant	*Phalacrocorax carbo*	Least Concern	Least Concern
Cape Cormorant*	*Phalacrocorax capensis*	Endangered	Endangered
Bank Cormorant*	*Phalacrocorax neglectus*	Endangered	Endangered
Crowned Cormorant*	*Phalacrocorax coronatus*	Least Concern	Near Threatened
White Pelican	*Pelecanus onocrotalus*	Least Concern	Vulnerable
Cape Gannet*	*Morus capensis*	Endangered	Endangered
Kelp Gull	*Larus dominicanus*	Least Concern	Least Concern
Greyheaded Gull	*Larus cirrocephalus*	Least Concern	Least Concern
Hartlaub's Gull*	*Larus hartlaubii*	Least Concern	Least Concern
Caspian Tern	*Hydroprogne caspia*	Least Concern	Vulnerable
Swift Tern	*Sterna bergii*	Least Concern	Least Concern
Roseate Tern	*Sterna dougallii*	Least Concern	Endangered
Damara Tern*	*Sterna balaenarum*	Vulnerable	Vulnerable

8.3.2.6 MARINE MAMMALS

The marine mammal fauna occurring off the southern African coast includes several species of whales and dolphins and one resident seal species. Thirty five species or sub-species/populations of whales and dolphins are known (based on historic sightings or strandings records) or likely (based on habitat projections of known species parameters) to occur in the waters of the South-West Coast. Of the species listed, the blue whale is considered 'Critically Endangered', fin and sei whales are 'Endangered' and one is considered vulnerable (IUCN Red Data list Categories). Altogether 17 species are listed as 'data deficient' underlining how little is known about cetaceans, their distributions and population trends. The offshore areas have been particularly poorly studied with most available information from deeper waters (>200 m) arising from historic whaling records prior to 1970. In the past ten years, passive acoustic monitoring and satellite telemetry have begun to shed light on current patterns of seasonality and movement for some large whale species Best 2007; Elwen *et al.* 2011; Rosenbaum *et al.* 2014; Shabangu *et al.* 2019; Thomisch *et al.* 2019) but information on smaller cetaceans in deeper waters remains poor. Records from marine mammal observers on exploration vessels have provided valuable data into cetacean presence although these are predominantly during summer months (Purdon *et al.* 2020). Information on general distribution and seasonality is improving but data population sizes and trends for most cetacean species occurring on the west coast of southern Africa is lacking.

Block 3B/4B extends from Hondeklipbaai to Cape Columbine from roughly the 300 m isobath to ~2 600 m water depth. Oceanographically this area lies largely within the cool waters of the Benguela Ecosystem and receives some input from the warm Agulhas Current as well as the warm waters of the South Atlantic. In terms of cetacean distribution patterns, the area thus covers a broad range of habitats and species associated with each of those water masses may occur within the target area. Records from stranded specimens show that the area between St Helena Bay (~32° S) and Cape Agulhas (~34° S, 20° E) is an area of transition between Atlantic and Indian Ocean species, and includes records from Benguela associated species such as dusky dolphins, Heaviside's dolphins and long finned pilot whales, and those of the warmer east coast such as striped and Risso's dolphins (Findlay *et al.* 1992). Species such as rough toothed dolphins, Pan-tropical spotted dolphins and short finned pilot whales are known from the southern Atlantic. Owing to the uncertainty of species occurrence offshore, species that may occur there have been included here for the sake of completeness.

The distribution of cetaceans can largely be split into those associated with the continental shelf and those that occur in deep, oceanic water. Importantly, species from both environments may be found on the continental slope (200 – 2 000 m) making this the most species rich area for cetaceans and also high in density (De Rock *et al.* 2019; SLR data). Cetacean density on the continental shelf is usually higher than in pelagic waters as species associated with the pelagic environment tend to be wide ranging across 1 000s of km. The most common species within the project area (in terms of likely encounter rate not total population sizes) are likely to be the long-finned pilot whale, common dolphin, sperm whale and humpback whale.

Cetaceans are comprised of two taxonomic groups, the mysticetes (filter feeders with baleen) and the odontocetes (predatory whales and dolphins with teeth). The term 'whale' is used to describe species in both groups and is taxonomically meaningless (e.g., the killer whale and pilot whale are members of the Odontoceti, family Delphinidae and are thus dolphins). Due to differences in sociality, communication abilities, ranging behavior and acoustic behavior, these two groups are considered separately.

Table 19 lists the cetaceans likely to be found within the project area, based on all available data sources but mainly: Findlay *et al.* (1992), Best (2007), Weir (2011), De Rock *et al.* (2019), Purdon *et al.* (2020a, 2020b, 2020c). The majority of data available on the seasonality and distribution of large whales in the project area is the result of commercial whaling activities mostly dating from the 1960s. Changes in the timing and distribution of migration may have occurred since these data were collected due to extirpation of populations or behaviours (e.g., migration routes may be learnt behaviours). The large whale species for which there are current data available are the humpback and southern right whale, although almost all data is limited to that collected on the continental shelf close to shore. A review of the distribution and seasonality of the key cetacean species likely to be found within the project area is provided below.

8.3.2.7 **MYSTICETE (BALEEN) WHALES**

The majority of mysticetes whales fall into the family Balaenopeteridae. Those occurring in the area include the blue, fin, sei, Antarctic minke, dwarf minke, humpback and Bryde's whales. The southern right whale (Family Balaenidae) and pygmy right whale (Family Neobalaenidae) are from taxonomically separate groups. The majority of mysticete species occur in pelagic waters with only occasional visits to shelf waters. All of these species show some degree of migration either to or through the latitudes encompassed by the broader project area when en route between higher latitude (Antarctic or Subantarctic) feeding grounds and lower latitude breeding grounds.

Table 19: Cetaceans occurrence off the West Coast of South Africa, their seasonality, likely encounter frequency with proposed exploration activities and South African (Child *et al*. 2016) and Global IUCN Red List conservation status.

Common Name	Species	Hearing Frequency	Shelf (<200 m)	Offshore (>200 m)	Seasonality	RSA Regional Assessment	IUCN Global Assessment
Delphinids							
Dusky dolphin	*Lagenorhynchus obscurus*	HF	Yes (0- 800 m)	No	Year round	Least Concern	Least Concern
Heaviside's dolphin	*Cephalorhynchus heavisidii*	VHF	Yes (0-200 m)	No	Year round	Least Concern	Near Threatened
Common bottlenose dolphin	*Tursiops truncatus*	HF	Yes	Yes	Year round	Least Concern	Least Concern
Common dolphin	*Delphinus delphis*	HF	Yes	Yes	Year round	Least Concern	Least Concern
Southern right whale dolphin	*Lissodelphis peronii*	HF	Yes	Yes	Year round	Least Concern	Least Concern
Striped dolphin	*Stenella coeruleoalba*	HF	No	Yes	Year round	Least Concern	Least Concern
Pantropical spotted dolphin	*Stenella attenuata*	HF	Edge	Yes	Year round	Least Concern	Least Concern
Long-finned pilot whale	*Globicephala melas*	HF	Edge	Yes	Year round	Least Concern	Least Concern
Short-finned pilot whale	*Globicephala macrorhynchus*	HF	Edge	Yes	Year round	Least Concern	Least Concern
Rough-toothed dolphin	*Steno bredanensis*	HF	No	Yes	Year round	Not Assessed	Least Concern
Killer whale	*Orcinus orca*	HF	Occasional	Yes	Year round	Least Concern	Data deficient
False killer whale	*Pseudorca crassidens*	HF	Occasional	Yes	Year round	Least Concern	Near Threatened
Pygmy killer whale	*Feresa attenuata*	HF	No	Yes	Year round	Least Concern	Least Concern
Risso's dolphin	*Grampus griseus*	HF	Yes (edge)	Yes	Year round	Data Deficient	Least Concern

Common Name	Species	Hearing Frequency	Shelf (<200 m)	Offshore (>200 m)	Seasonality	RSA Regional Assessment	IUCN Global Assessment
			Sperm whales				
Pygmy sperm whale	*Kogia breviceps*	VHF	Edge	Yes	Year round	Data Deficient	Least Concern
Dwarf sperm whale	*Kogia sima*	VHF	Edge	Yes	Year round	Data Deficient	Least Concern
Sperm whale	*Physeter macrocephalus*	HF	Edge	Yes	Year round	Vulnerable	Vulnerable

Common Name	Species	Hearing Frequency	Shelf (<200 m)	Offshore (>200 m)	Seasonality	RSA Regional Assessment	IUCN Global Assessment
			Beaked whales				
Cuvier's	*Ziphius cavirostris*	HF	No	Yes	Year round	Data Deficient	Least Concern
Arnoux's	*Beradius arnouxii*	HF	No	Yes	Year round	Data Deficient	Least Concern
Southern bottlenose	*Hyperoodon planifrons*	HF	No	Yes	Year round	Least Concern	Least Concern
Layard's	*Mesoplodon layardii*	HF	No	Yes	Year round	Data Deficient	Least Concern
True's	*Mesoplodon mirus*	HF	No	Yes	Year round	Data Deficient	Least Concern
Gray's	*Mesoplodon grayi*	HF	No	Yes	Year round	Data Deficient	Least Concern
Blainville's	*Mesoplodon densirostris*	HF	No	Yes	Year round	Data Deficient	Least Concern
			Baleen whales				
Antarctic Minke	*Balaenoptera bonaerensis*	LF	Yes	Yes	>Winter	Least Concern	Near Threatened
Dwarf minke	*B. acutorostrata*	LF	Yes	Yes	Year round	Least Concern	Least Concern
Fin whale	*B. physalus*	LF	Yes	Yes	MJJ & ON	Endangered	Vulnerable
Blue whale (Antarctic)	*B. musculus intermedia*	LF	No	Yes	Winter peak	Critically Endangered	Critically Endangered
Sei whale	*B. borealis*	LF	Yes	Yes	MJ & ASO	Endangered	Endangered
Bryde's (inshore)	*B brydei (subspp)*	LF	Yes	Edge	Year round	Vulnerable	Least Concern
Bryde's (offshore)	*B. brydei*	LF	Edge	Yes	Summer (JFM)	Data Deficient	Least Concern
Pygmy right	*Caperea marginata*	LF	Yes	?	Year round	Least Concern	Least Concern

Common Name	Species	Hearing Frequency	Shelf (<200 m)	Offshore (>200 m)	Seasonality	RSA Regional Assessment	IUCN Global Assessment
Humpback sp.	*Megaptera novaeangliae*	LF	Yes	Yes	Year round, SONDJF	Least Concern	Least Concern
Humpback B2 population	*Megaptera novaeangliae*	LF	Yes	Yes	Spring/Summer peak ONDJF	Vulnerable	Not Assessed
Southern Right	*Eubalaena australis*	LF	Yes	No	Year round, ONDJFMA	Least Concern	Least Concern

Marine animals do not hear equally well at all frequencies within their functional hearing range. Based on the hearing range and sensitivities, Southall *et al* (2019) have categorised noise sensitive marine mammal species into six underwater hearing groups: low-frequency (LF), high-frequency (HF) and very high-frequency (VHF) cetaceans, Sirenians (SI), Phocid carnivores in water (PCW) and other marine carnivores in water (OCW).

Table 20: Seasonality of baleen whales in the broader project area based on data from multiple sources, predominantly commercial catches (Best 2007 and other sources) and data from stranding events (NDP unpublished data). Values of high (H), Medium (M) and Low (L) are relative within each row (species) and not comparable between species. For abundance / likely encounter rate within the broader project area.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bryde's Inshore	L	L	M	M	M	M	M	L	L	M	M	L
Sei	M	L	L	L	H	H	M	H	H	H	M	M
Fin	M	M	M	M	H	H	H	L	L	H	H	M
Blue	L	L	L	L	M	M	M	L	L	L	L	L
Minke	M	M	M	H	H	H	M	H	H	H	M	M
Humpback	H	M	L	L	L	M	M	M	H	H	H	H
Southern Right	H	M	L	L	L	M	M	M	H	H	H	H

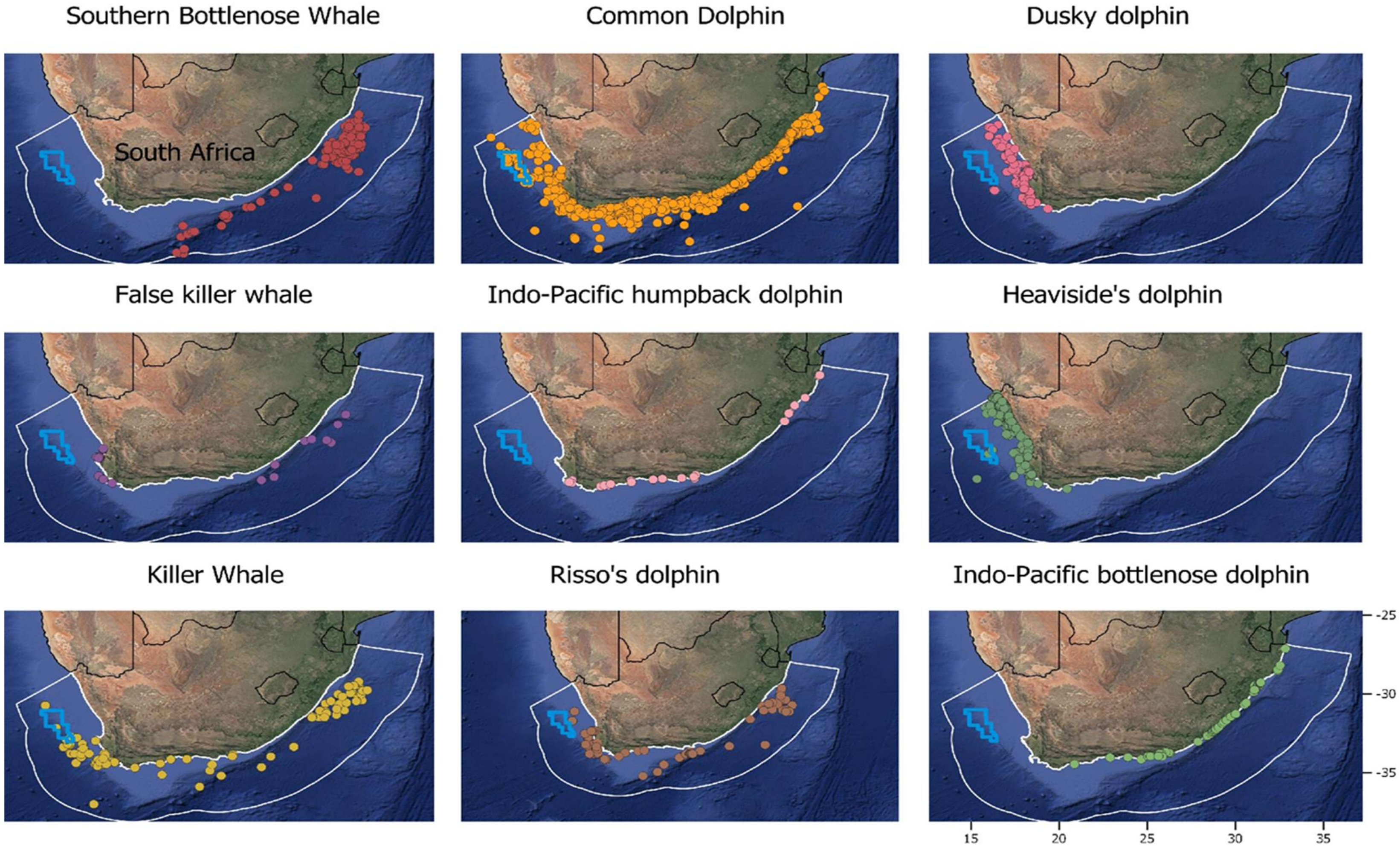


Figure 64: Block 3B/4B (cyan polygon) in relation to projections of predicted distributions for nine odontocete species off the coast of South Africa (adapted from: Purdon *et al.* 2020a).

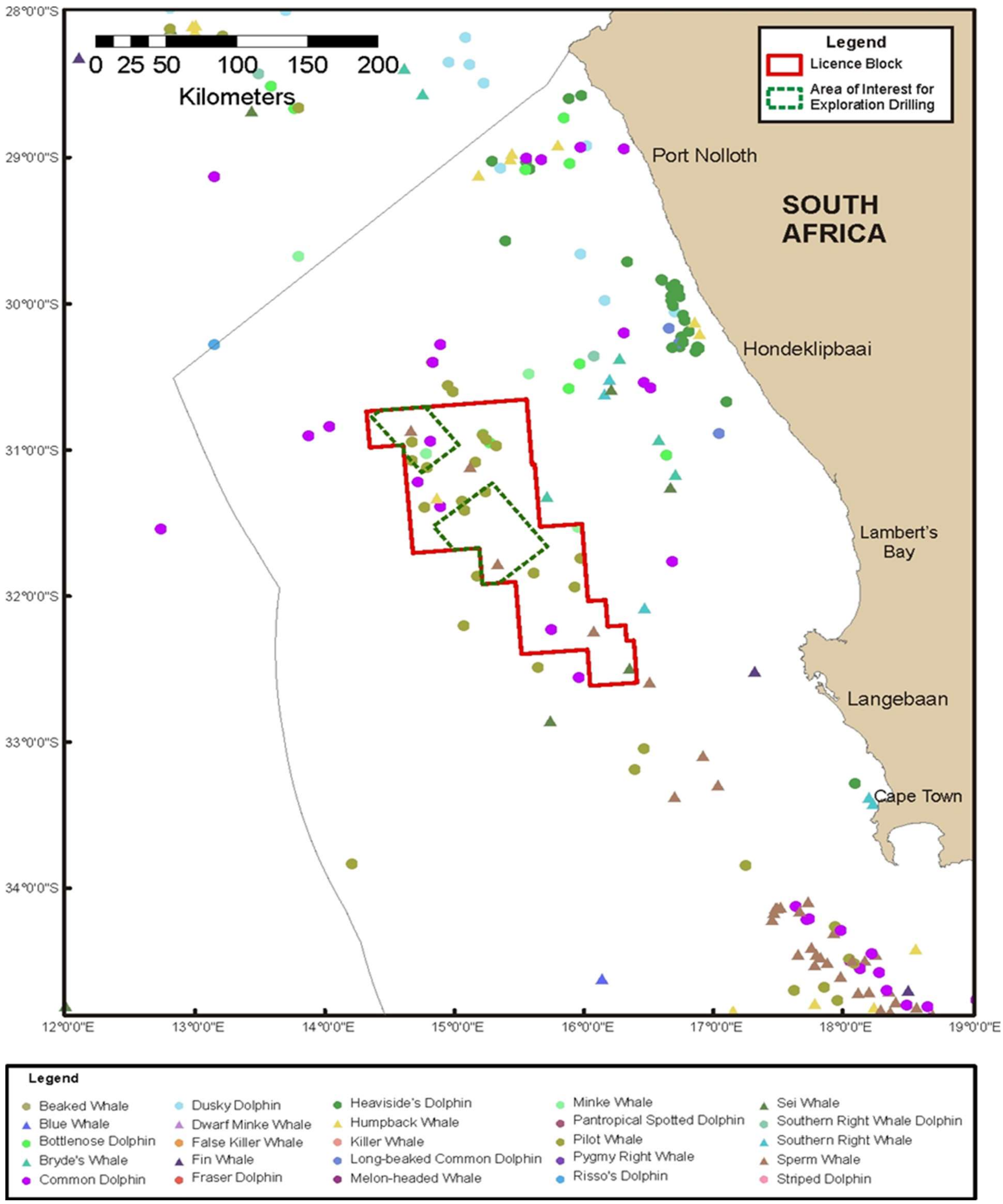


Figure 65: Block 3B/4B (red polygon) in relation to the distribution and movement of cetaceans along the West and South Coasts collated between 2001 and 2020 (SLR MMO database). Note: Figure depicts MMO sightings from seismic surveys undertaken between 2001 and 2020

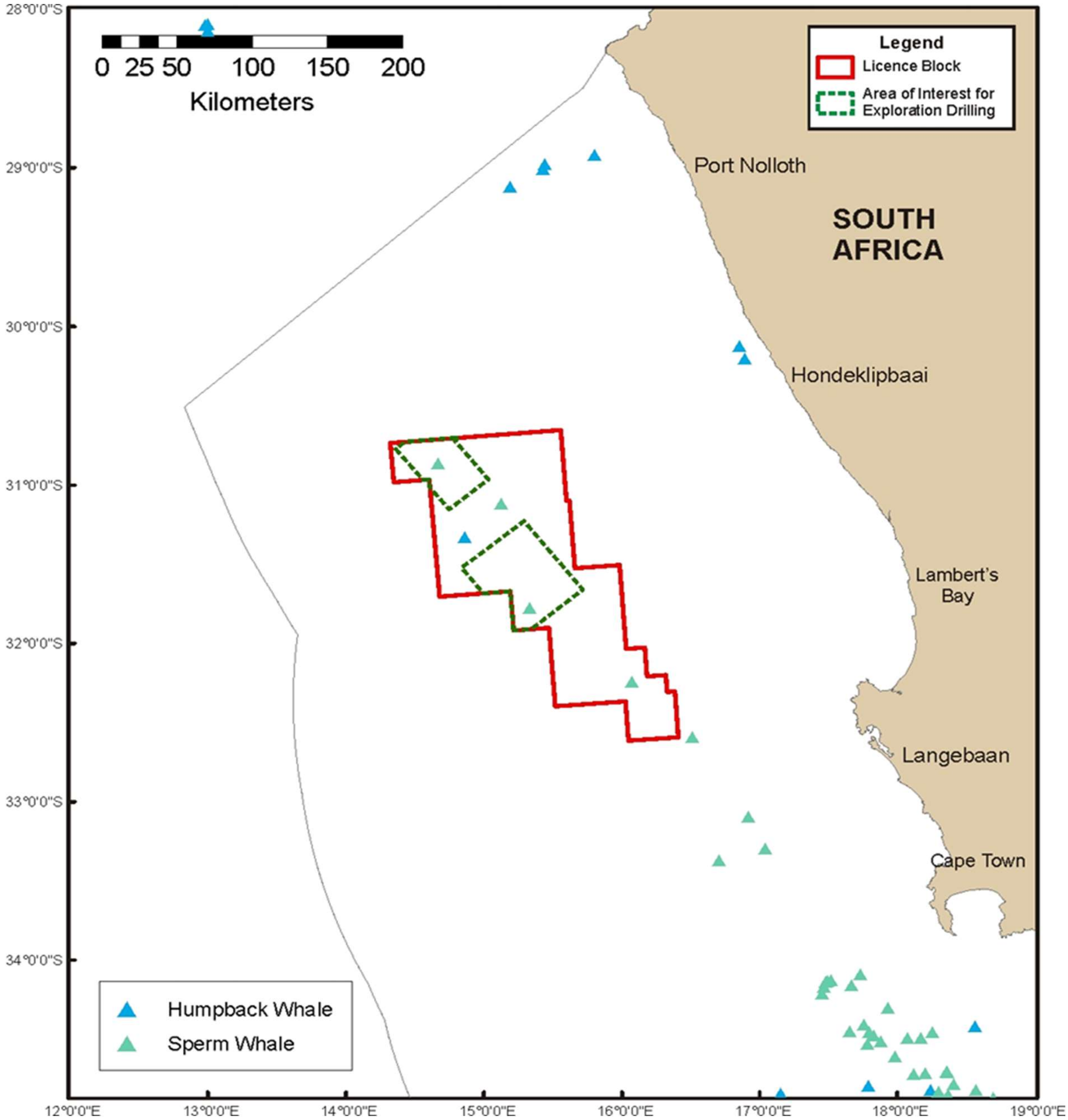


Figure 66: Block 3B/4B (red polygon) in relation to the distribution and movement of Humpback whales and Sperm whales along the southern African coast collated between 2001 and 2020 (SLR MMO database).

Depending on the ultimate location of these feeding and breeding grounds, seasonality may be either unimodal, usually in winter months (June-August, e.g. minke and blue whales), or bimodal (e.g. May to July and October to November), reflecting a northward and southward migration through the area. Northward and southward migrations may take place at different distances from the coast due to whales following geographic or oceanographic features, thereby influencing the seasonality of occurrence at different locations. Because of the complexities of the migration patterns, each species is discussed separately below.

Bryde's whales: Two genetically and morphologically distinct populations of Bryde's whales (Figure 68, left) live off the coast of southern Africa (Best 2001; Penry 2010). The "offshore population" lives beyond the shelf (>200 m depth) off west Africa and migrates between wintering grounds off equatorial west Africa (Gabon) and summering grounds off western South Africa. Its seasonality on the West Coast is thus opposite to the majority of the balaenopterids with abundance likely to be highest in the area in January - March. The "inshore population" of Bryde's whale lives mainly on the continental shelf and Agulhas Bank and is unique amongst baleen whales in the region by being non-migratory. The inshore population has recently been recognised as its own (yet to be named) sub species (*Balaenoptera brydei edeni*, Penry *et al.* 2018) with a total population for this subspecies of likely fewer than 600 individuals. The published range of the population is the continental shelf and Agulhas Bank of South Africa ranging from Durban in the east to at least St Helena Bay off the west coast with possible movements further north up the West Coast and into Namibia during the winter months (Best 2007). The offshore stock was subjected to heavy whaling in the mid-20th century (Best 2001) and there are no current data on population size or stock recovery therefrom and is currently listed as 'Data deficient' (offshore population) and Vulnerable (inshore population) on the South African Red List. The inshore stock is regarded as extremely vulnerable and listed as such on the South African red list as it regularly suffers losses from entanglement in trap fisheries and has been subject to significant changes in its prey base due to losses and shifts in the sardine and small pelagic stocks around South Africa. Encounters in the offshore waters of the licence block are unlikely.

Sei whales: Almost all information is based on whaling records 1958-1963, most from shore-based catchers operating within a few hundred km of Saldanha Bay. At this time the species was not well differentiated from Bryde's whales and records and catches of the two species intertwined. There is no current information on population recovery, abundance or much information on distribution patterns outside of the whaling catches and the species remains listed as 'Endangered' on the South African Red List. Sei whales feed at high latitudes (40-50˚S) during summer months and migrate north through South African waters to unknown breeding grounds further north (Best 2007). Their migration pattern thus shows a bimodal peak with numbers west of Saldanha Bay being highest in May and June, and again in August, September and October. All whales were caught in waters deeper than 200 m with most occurring deeper than 1 000 m (Best & Lockyer 2002). A recent survey to Vema Seamount ~1 000 km west of Cape Town during October to November 2019, encountered a broadly spread feeding aggregation of over 30 sei and fin whales at around 200 m water depth (Elwen *et al.* in prep). This poorly surveyed area (roughly 32˚S, 15˚E) is just to the Northwest of the historic whaling grounds suggesting this region remains an important feeding area for the species. As sei whales have been reported by MMOs to the east of and within Block 3B/4B, encounters are possible.

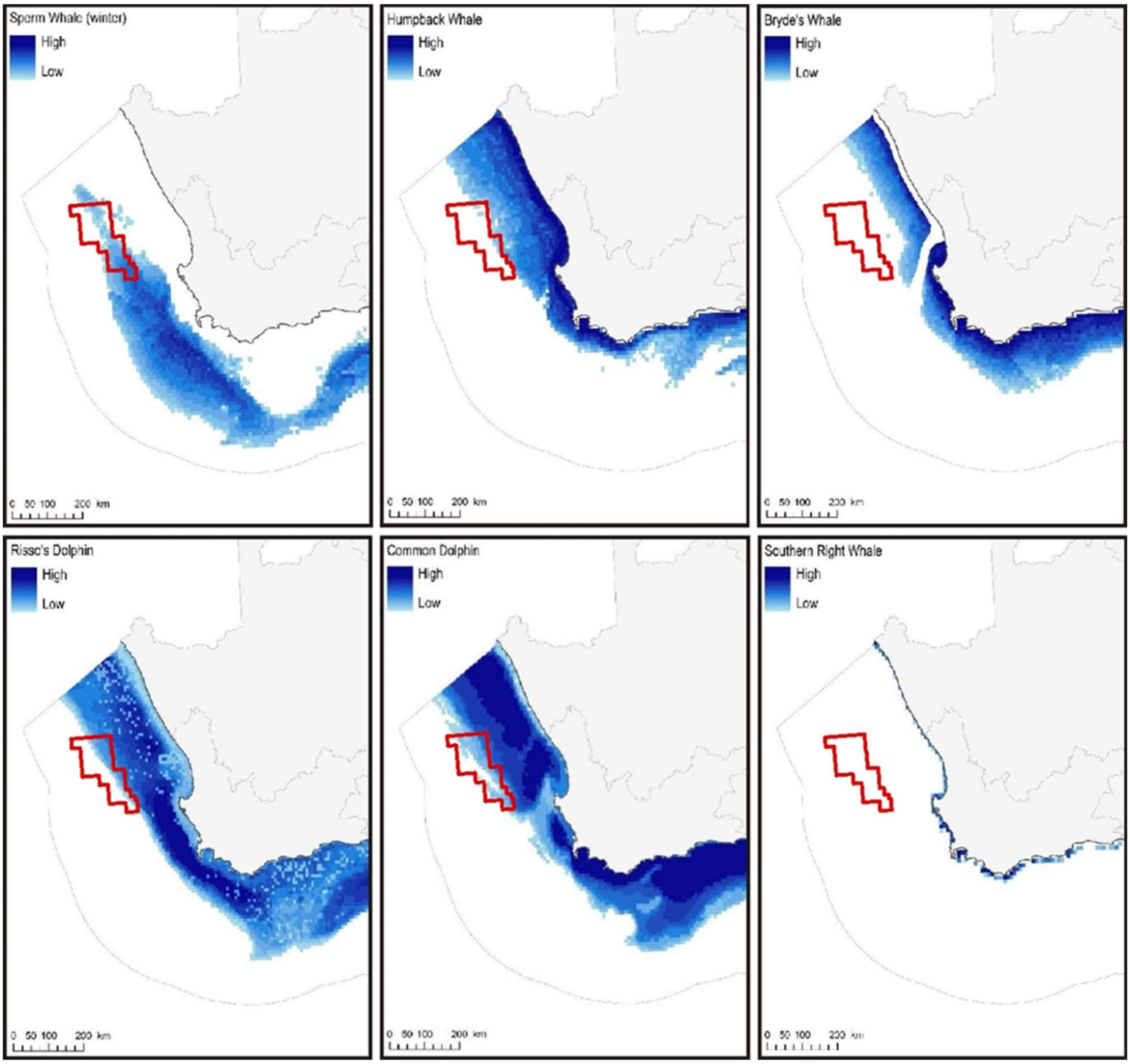


Figure 67: Block 3B/4B (red polygon) in relation to the predicted distribution of sperm whales (winter distribution)(top left), humpback whale (top middle), Bryde's whale (top right), Risso's dolphin (bottom left), common dolphin (bottom middle) and southern right whale (bottom right) with darker shades of blue indicating highest likelihood of occurrence (adapted from Harris *et al*. 2022).

Figure 68: The Bryde's whale *Balaenoptera brydei* (left) and the Minke whale *Balaenoptera bonaerensis* (right) (Photos: www.dailymail.co.uk; www.marinebio.org).

Fin whales: Fin whales were historically caught off the West Coast of South Africa, with a bimodal peak in the catch data suggesting animals were migrating further north during May-June to breed, before returning during August-October en route to Antarctic feeding grounds. However, the location of the breeding ground (if any) and how far north it is remains a mystery (Best 2007). Some juvenile animals may feed year round in deeper waters off the shelf (Best 2007). The occasional single whale has been reported during humpback whale research in November in the southern Benguela, and a feeding aggregation of ~30 animals was observed in November 2019 ~200 km west of St Helena Bay in ~2 000 m of water. Current sightings records support the bimodal peak in presence observed from whaling data (but with some chance of year-round sightings) with animals apparently feeding in the nutrient rich Benguela during their southward migration as is observed extensively for humpback and right whales (see below) there is clearly a chance of encounters year round. There are no recent data on abundance or distribution of fin whales off western South Africa. The sighting of a fin whale was reported by MMOs during a 3D seismic survey in the Deep Water Orange Basin Area (CapFish 2013a). Encounters in the licence area are thus possible.

Blue whales: Although Antarctic blue whales were historically caught in high numbers off the South African West Coast, with a single peak in catch rates during July in Namibia and Angola suggesting that these latitudes are close to the northern migration limit for the species in the eastern South Atlantic (Best 2007). Although there were only two confirmed sightings of the species in the area between 1973 and 2006 (Branch *et al*. 2007), evidence of blue whale presence off Namibia is increasing. Recent acoustic detections of blue whales in the Antarctic peak between December and January (Tomisch *et al*. 2016) and off the South African West Coast (Shanbangu *et al*. 2019; Seakamela *et al*. 2022) and in northern Namibia between May and July (Thomisch 2017) support observed timing from whaling records. Several recent (2014-2015) sightings of blue whales during seismic surveys off the southern part of Namibia (water depth >1 000 m) confirm their existence in the area and occurrence in Autumn months (April to June). Blue whales have previously been sighted by MMOs in the Deep Water Orange Basin Area (CapFish 2013a) although the chance of encounters is considered low. As the species is 'Critically Endangered' all precautions must be taken to avoid impact.

Minke whales: Two forms of minke whale (Figure 68, right) occur in the southern Hemisphere, the Antarctic minke whale (*Balaenoptera bonaerensis*) and the dwarf minke whale (*B. acutorostrata* subsp.); both species occur in the Benguela (Best 2007). Antarctic minke whales range from the pack ice of Antarctica to tropical waters and are usually seen more than ~50 km offshore. Although adults migrate from the Southern Ocean (summer) to tropical/temperate waters (winter) to breed, some animals, especially juveniles, are known to stay in tropical/temperate waters year-round. Recent data available from passive acoustic monitoring over a two-year period off the Walvis Ridge (Namibia) shows acoustic presence in June - August and November - December (Thomisch *et al*. 2016), supporting a bimodal distribution in the area. The dwarf minke whale has a more temperate distribution than the Antarctic minke and they do not range further south than 60-65°S. Dwarf minkes have a similar migration pattern to Antarctic minkes with at least some animals migrating to the Southern Ocean during summer. Dwarf minke whales occur closer to shore than Antarctic minkes and have been seen <2 km from shore on several occasions around South Africa. Both species are generally solitary and densities are likely to be low in Block 3B/4B, although sightings have been reported in the general project area (SLR data). Thus, encounters within Block 3B/4B may occur.

The pygmy right whale is the smallest of the baleen whales reaching only 6 m total length as an adult (Best 2007). The species is typically associated with cool temperate waters between 30°S and 55°S with records from southern and central Namibia being the northern most for the species (Leeney *et al*. 2013). Its distribution off the West Coast of South Africa is thus likely to be limited to the cooler shelf waters of the main Benguela upwelling areas and encounters within Block 3B/4B may thus occur.

The most abundant baleen whales in the Benguela are southern right whales and humpback whales (Figure 69). Both species have long been known to feed in the Benguela Ecosystem and numbers since 2000 have grown substantially. The feeding peak in the Benguela is spring and early summer (October – February) and follows the 'traditional' South African breeding season (June – November) and its associated migration (Johnson *et al.* 2022). Some individual right whales are known to move directly from the south coast breeding area into the west coast feeding area where they remained for several months (Barendse *et al.* 2011; Mate *et al.* 2011). Increasing numbers of summer records of both species, from the southern half of Namibia suggest that animals may also be feeding in the Lüderitz upwelling cell (NDP unpublished data).

Figure 69: The Humpback whale *Megaptera novaeangliae* (left) and the Southern Right whale *Eubalaena australis* (right) are the most abundant large cetaceans occurring along the southern African West Coast (Photos: www.divephotoguide.com; www.aad.gov.au).

Humpback whales: The majority of humpback whales passing through the Benguela are migrating to breeding grounds off tropical West Africa, between Angola and the Gulf of Guinea (Rosenbaum *et al.* 2009; Barendse *et al.* 2010). Until recently it was believed that that these breeding grounds were functionally separate from those off east (Mozambique-Kenya-Madagascar), with only rare movements between them (Pomilla & Rosenbaum 2005) and movements to other continental breeding grounds being even more rare. Recent satellite tagging of animals between Plettenberg Bay and Port Alfred during the northward migration, showed them to turn around and end up feeding in the Southern Benguela (Seakamela *et al*. 2015) before heading offshore and southwards using the same route as whales tracked off Gabon and the West Coast of South Africa. Unexpected results such as this highlight the complexities of understanding whale movements and distribution patterns and the fact that descriptions of broad season peaks in no way captures the wide array of behaviours exhibited by these animals. Furthermore, four separate matches have been made between individuals off South Africa and Brazil by citizen scientist photo-identification (www.happywhale.com; Ramos *et al*. 2023). This included whales from the Cape Town and Algoa Bay-Transkei areas. Analysis of humpback whale breeding song on Sub-Antarctic feeding grounds also suggests exchange of singing male whales from western and eastern South Atlantic populations (Darling & Sousa-Lima 2005; Schall *et al.* 2021; but see also Darling *et al.* 2019; Tyarks *et al*. 2021).

In southern African coastal waters, the northward migration stream is larger than the southward peak (Best & Allison 2010; Elwen *et al.* 2014), suggesting that animals migrating north strike the coast at varying places north of St Helena Bay, resulting in increasing whale density on shelf waters and into deeper pelagic waters as one moves northwards. On the southward migration, many humpbacks follow the Walvis Ridge offshore then head directly to high latitude feeding grounds, while others follow a more coastal route (including the majority of mother-calf pairs) possibly lingering in the feeding grounds off west South Africa in summer (Elwen *et al.* 2014; Rosenbaum *et al.* 2014). Although migrating through the Benguela, there is no existing evidence of a clear 'corridor' and humpback whales appear to be spread out widely across the shelf and into deeper pelagic waters, especially during the southward migration (Barendse *et al.* 2010; Best & Allison 2010; Elwen *et al.* 2014). The only available abundance estimate put the number of animals in the West African breeding population (Gabon) to be in excess of 9 000 individuals in 2005 (IWC 2012) and it is likely to have increased substantially since this time at about 5% per annum (IWC 2012; see also Wilkinson 2021). The number of humpback whales feeding in the southern Benguela has increased substantially since estimates made in the early 2000s (Barendse *et al.* 2011). Since ~2011, 'supergroups' of up to 200 individual whales have been observed feeding within 10 km from shore (Findlay *et al.* 2017) with many hundred more passing through and whales are now seen in all months of the year around Cape Town. It has been suggested that the formation of these super-groups may be in response to anomalous oceanographic conditions in the Southern Benguela, which result in favourable food availability, thereby leading to these unique humpback whale feeding aggregations (Dey *et al.* 2021; see also Avila *et al.* 2019; Meynecke *et al.* 2020; Cade *et al.* 2021). Humpback whales are thus likely to be the most frequently encountered baleen whale in the project area (Figure 69), ranging from the coast out beyond the shelf, with year round presence but numbers peaking during the northward migration in June – February and a smaller peak with the southern breeding migration around September – October but with regular encounters until February associated with subsequent feeding in the Benguela ecosystem. Humpback whale sightings have been reported by MMOs during a 2012 3D seismic survey in the adjacent Deep Water Orange Basin Area (CapFish 2013a) and encounters within Block 3B/4B are thus likely.

In the first half of 2017 (when numbers are expected to be at their lowest) more than 10 humpback whales were reported stranded along the Namibian and South African west coasts. A similar event was recorded in late 2021-early 2022 when numerous strandings of young humpbacks were reported along the Western Cape Coast and in Namibia (Simon Elwen, Sea Search, pers. comm.). The cause of these deaths is not known, but a similar event off Brazil in 2010 (Siciliano *et al.* 2013) was linked to possible infectious disease or malnutrition. Unusual mortality events of humpback whales between 2016 and 2022 have similarly been reported along the US Atlantic Coast from Maine to Florida (https://www.fisheries.noaa.gov/national/marine-life-distress/2016-2022-humpback-whale-unusual-mortality-event-along-atlantic-coast). The West African population may be undergoing similar stresses in response to changes in their ecosystem (see for example Kershaw *et al.* 2021). It is not yet understood what may be driving these ecosystem changes and what the long-term effects to populations could potentially be.

Figure 70: Block 3B/4B (red polygon) in relation to 'blue corridors' or 'whale superhighways' showing tracks of Humpback whales (orange) and Southern Right whales (green) between southern Africa and the Southern Ocean feeding grounds (adapted from Johnson *et al*. 2022).

Southern right whales: The southern African population of southern right whales historically extended from southern Mozambique (Maputo Bay) to southern Angola (Baie dos Tigres) and is considered to be a single population within this range (Roux *et al.* 2011). The most recent abundance estimate for this population is available for 2017 which estimated the population at ~6 100 individuals including all age and sex classes, and still growing at ~6.5% per annum (Brandaõ *et al.* 2017). When the population numbers crashed in 1920, the range contracted down to just the south coast of South Africa, but as the population recovers, it is repopulating its historic grounds including Angola (Whitt *et al*. 2023), Namibia (Roux *et al.* 2001, 2015; de Rock *et al.* 2019) and Mozambique (Banks *et al.* 2011).

Some southern right whales move from the South Coast breeding ground directly to the West Coast feeding ground (Mate *et al.* 2011). When departing from feeding ground all satellite tagged animals in that study took a direct south-westward track, which would take them across the southern portion of Block 3B/4B. Mark-recapture data from 2003-2007 estimated roughly one third of the South African right whale population at that time were using St Helena Bay for feeding (Peters *et al.* 2005). While annual surveys have revealed a steady population increase since the protection of the species from commercial whaling, the South African right whale population has undergone substantial changes in breeding cycles and feeding areas (Van Den Berg *et al.* 2020), and numbers of animal using our coast since those studies were done – notably a significant decrease in the numbers of cow-calf-pairs following the all-time record in 2018, a marked decline of unaccompanied adults since 2010 and variable presence of mother-calf pairs since 2015 (Roux *et al.* 2015; Vermeulen *et al.* 2020). The change in demographics are indications of a population undergoing nutritional stress and has been attributed to likely spatial and/or temporal displacement of prey due to climate variability (Vermeulen *et al.* 2020; see also Derville *et al.* 2019; Kershaw *et al.* 2021; van Weelden *et al.* 2021). Recent sightings (2018-2021) confirm that there is still a clear peak in numbers on the West Coast (Table Bay to St Helena Bay) between February and April. Given this high proportion of the population known to feed in the southern Benguela, and current numbers reported, it is highly likely that several hundreds of right whales can be expected to pass through the southern portion of Block 3B/4B when migrating southwards from the feeding areas between April and June (Figure 70).

8.3.2.8 ODONTOCETES (TOOTHED) WHALES AND DOLPHINS

The Odontoceti are a varied group of animals including the dolphins, porpoises, beaked whales and sperm whales. Species occurring within the broader project area display a diversity of features, for example their ranging patterns vary from extremely coastal and highly site specific to oceanic and wide ranging. Those in the region can range in size from 1.6-m long (Heaviside's dolphin) to 17 m (bull sperm whale).

Sperm whales: Most information about sperm whales in the southern African sub-region results from data collected during commercial whaling activities prior to 1985 when over 10 000 whales were taken, (Best 1974; Best 2007) although passive acoustic monitoring (Shabangu & Andrew 2020) and sightings from MMOs are beginning to provide insights into current behaviour. Sperm whales are the largest of the toothed whales and have a complex, structured social system with adult males behaving differently to younger males and female groups. They live in deep ocean waters, usually greater than 1 000 m depth, although they occasionally come onto the shelf in water 500 - 200 m deep (Best 2007) (Figure 71, left). They are considered to be relatively abundant globally (Whitehead 2002), although no estimates are available for South African waters. Seasonality of historical catches off west South Africa suggests that medium and large sized males are more abundant in winter months while female groups are more abundant in autumn (March - April), although animals occur year round (Best 2007). Analysis of recent passive acoustic monitoring data from the edge of the South African continental shelf (800 – 1 000 m water depth, roughly 80 km WSW of Cape Point) confirms year-round presence. Sperm whales have also been regularly identified by Marine Mammal Observers (MMOs) working in this area (Figure 66). Sperm whales feed at great depths during dives in excess of 30 minutes making them difficult to detect visually, however, the regular echolocation clicks made by the species when diving make them relatively easy to detect acoustically using Passive Acoustic Monitoring (PAM). Sperm whales were the most commonly reported species sighted by MMOs and detected with PAM during 2D and 3D seismic surveys undertaken in the adjacent Deep Water Orange Basin Area (CapFish 2013a, 2013b).

There are almost no data available on the abundance, distribution or seasonality of the smaller odontocetes (including the beaked whales and dolphins) known to occur in oceanic waters (>200 m) off the shelf of the southern African West Coast. Beaked whales are all considered to be true deep-water species usually being seen in waters in excess of 1 000 – 2 000 m deep (see various species accounts in Best 2007). Presence in the project area may fluctuate seasonally, but insufficient data exist to define this clearly. Beaked whales seem to be particularly susceptible to man-made sounds and several strandings and deaths at sea, often *en masse,* have been recorded in association with naval mid-frequency sonar (Cox *et al.* 2006; MacLeod & D'Amico 2006) and a seismic survey for hydrocarbons also running a multi-beam echo-sounder and sub bottom profiler (Cox *et al.* 2006). Although the exact reason that beaked whales seem particularly vulnerable to man-made noise is not yet fully understood, the existing evidence clearly shows that animals change their dive behaviour in response to acoustic disturbance (Tyack *et al.* 2011), and all possible precautions should be taken to avoid causing any harm. Sightings of beaked whales in the project area are expected to be very low.

Figure 71: Sperm whales *Physeter macrocephalus* (left) and killer whales *Orcinus orca* (right) are toothed whales likely to be encountered in offshore waters (Photos: www.onpoint.wbur.org; www.wikipedia.org).

Pygmy and Dwarf Sperm Whales: The genus *Kogia* currently contains two recognised species, the pygmy (*K. breviceps*) and dwarf (*K. sima*) sperm whales, both of which occur worldwide in pelagic and shelf edge waters, with few sighting records of live animals in their natural habitat (McAlpine 2018). Their abundance and population trends in South African waters are unknown (Seakamela *et al*. 2021). Due to their small body size, cryptic behaviour, low densities and small school sizes, these whales are difficult to observe at sea, and morphological similarities make field identification to species level problematic, although their narrow-band high frequency echolocation clicks make them detectable and identifiable (at least to the genus) using passive acoustic monitoring equipment. The majority of what is known about the distribution and ecology of Kogiid whales in the southern African subregion is derived mainly from stranding records (e.g. Ross 1979; Findlay *et al.* 1992; Plön 2004; Elwen *et al.* 2013 but see also Moura *et al*. 2016). *Kogia* species most frequently occur in pelagic and shelf edge waters and are thus likely to occur in Block 3B/4B at low levels. Dwarf sperm whales are associated with warmer tropical and warm-temperate waters, being recorded from both the Benguela and Agulhas ecosystem (Best 2007) in waters deeper than ~1 000 m.

During 2020 the incidence of kogiid strandings between Strandfontein on the West Coast and Groot Brak River on the South Coast (n=17), was considerably higher than the annual average during the previous 10 years (n=7). The dwarf sperm whale (*K. sima*) accounted for 60% of these strandings, of which most were recorded during autumn and winter. These seasonal stranding patterns are consistent with previously published accounts for the South African coast. In 2020, 40% of the total strandings were recorded in winter and 15% during summer. The occurrence of strandings throughout the year may, however, indicate the presence of a resident population with a seasonal distributiuon off the South Coast in autumn and winter (Seakamela *et al*. 2020, 2021). The cause of the strandings is unknown.

Killer whales: Killer whales in South African waters were referred to a single morphotype, Type A, although recently a second 'flat-toothed' morphotype that seems to specialize in an elasmobranch diet has been identified but only 5 records are known all from strandings (Best *et al.* 2014). Killer whales have a circum-global distribution being found in all oceans from the equator to the ice edge (Best 2007). Killer whales occur year-round in low densities off South Africa (Best *et al.* 2010, Elwen *et al.* in prep), Namibia (Elwen & Leeney 2011) and in the Eastern Tropical Atlantic (Weir *et al.* 2010). Historically sightings were correlated with that of baleen whales, especially sei whales on their southward migration. In more recent years – their presence in coastal waters (e.g. False Bay) has been strongly linked to the presence and hunting of common dolphins (Best *et al.* 2010; Sea Search unpublished data) and great white sharks (Towner *et al.* 2022). Further from shore, there have been regular reports of killer whales associated with long-line fishing vessels on the southern and eastern Agulhas Bank, and the Cape Canyon to the south-west of Cape Point. Killer whales are found in all depths from the coast to deep open ocean environments and may thus be encountered in the project area at low levels.

False killer whale: Although the false killer whale is globally recognized as one species, clear differences in morphological and genetic characteristics between different study sites show that there is substantial difference between populations and a revision of the species taxonomy may be needed (Best 2007). False killer whales are more likely to be confused with the smaller melon-headed or pygmy killer whales with which they share all-black colouring and a similar head-shape, than with killer whales. The species has a tropical to temperate distribution and most sightings off southern Africa have occurred in water deeper than 1 000 m, but with a few recorded close to shore (Findlay *et al.* 1992). They usually occur in groups ranging in size from 1 - 100 animals (Best 2007). The strong bonds and matrilineal social structure of this species makes it vulnerable to mass stranding (8 instances of 4 or more animals stranding together have occurred in the Western Cape, all between St Helena Bay and Cape Agulhas). There is no information on population numbers or conservation status and no evidence of seasonality in the region (Best 2007). Encounters within the project area may occur.

Pilot Whales: Long finned pilot whales display a preference for temperate waters and are usually associated with the continental shelf or deep water adjacent to it but moving inshore to follow prey (primarily squid) (Mate *et al.* 2005; Findlay *et al.* 1992; Weir 2011; Seakamela *et al*. 2022). They are regularly seen associated with the shelf edge by MMOs, fisheries observers and researchers. The distinction between long-finned and short finned pilot whales is difficult to make at sea. As the latter are regarded as more tropical species confined to the southwest Indian Ocean (Best 2007), it is likely that the majority of pilot whales encountered in the project area will be long-finned. There are many confirmed sighting of pilot whales along the shelf edge of South Africa and Namibia including within the project area since 2010 (de Rock *et al.* 2019; Sea Search unpublished data, SLR data, CapFish 2013a, 2013b). Observed group sizes range from 8-100 individuals (Seakamela *et al*. 2022). Pilot whales were commonly sighted by MMOs and detected by PAM during 2D and 3D seismic surveys in the adjacent Deep Water Orange Basin Area (CapFish 2013a, 2013b). A recent tagging study showed long-finned pilot whale movements within latitudes of 33-36°S, along the shelf-edge from offshore of Cape Columbine to the Agulhas Bank, with concentrations in canyon areas, especially around the Cape Point Valley, and to a lesser degree around the Cape Canyon. It is postulated that the pilot whales target prey species in these productive areas (Seakamela *et al*. 2022).

Common dolphin: Two forms of common dolphins occur around southern Africa, a long-beaked and short-beaked form (Findlay *et al.* 1992; Best 2007), although they are currently considered part of a single global species (Cunha *et al.* 2015). The long-beaked common dolphin lives on the continental shelf of South Africa rarely being observed north of St Helena Bay on the west coast or in waters more 500 m deep (Best 2007), although more recent MMO sightings suggest presence to 1 000 m or more (SLR data, Sea Search data). Group sizes of common dolphins can be large, averaging 267 (± *SD* 287) for the South Africa region (Findlay *et al.* 1992). Far less is known about the short-beaked form which is challenging to differentiate at sea from the long-beaked form. Group sizes are also typically large. It is likely that common dolphins encountered in the Northern Cape or deeper than 2 000 m are of the short-beaked form. Sightings of common dolphins were reported by MMOs during the 2012/13 3D seismic survey in the adjacent Deep Water Orange Basin Area (CapFish 2013a). Encounters in Block 3B/4B are thus likely to occur.

Dusky dolphin: In water <500 m deep, dusky dolphins (Figure 72, left) are likely to be the most frequently encountered small cetacean as they are very "boat friendly" and often approach vessels to bowride. The species is resident year-round throughout the Benguela ecosystem in waters from the coast to at least 500 m deep (Findlay *et al*. 1992). A recent abundance estimate from southern Namibia calculated roughly ~3 500 dolphins in the ~400 km long Namibian Islands Marine Protected area (Martin *et al*. 2020), at a density of 0.16 dolphins/km^2 and similar density is expected to occur off the South African coast where they are regularly encountered in nearshore waters between Cape Town and Lamberts Bay (Elwen *et al*. 2010; NDP unpublished data) with group sizes of up to 800 having been reported (Findlay *et al*. 1992). Encounters in the offshore waters of Block 3B/4B are unlikely.

Figure 72: The dusky dolphin *Lagenorhynchus obscurus* (left) and endemic Heaviside's Dolphin *Cephalorhynchus heavisidii* (left) (Photos: Simon Elwen, Sea Search Research and Conservation).

Heaviside's dolphins: Heaviside's dolphins (Figure 72, right) are relatively abundant in the Benguela ecosystem region with 10 000 animals estimated to live in the 400 km of coast between Cape Town and Lamberts Bay (Elwen *et al*. 2009) and ~1 600 in the ~400 km long Namibian Islands Marine Protected Area (Martin *et al*. 2020). This species occupies waters from the coast to at least 200 m depth, (Elwen *et al*. 2006; Best 2007; Martin *et al*. 2020), and may show a diurnal onshore-offshore movement pattern (Elwen *et al*. 2010a, 2010b), as they feed offshore at night. Heaviside's dolphins are resident year round but will mostly occur inshore of Block 3B/4B.

Bottlenose dolphin: Two species of bottlenose dolphins occur around southern Africa. The smaller Indo-Pacific bottlenose dolphin (aduncus form) occurs exclusively to the east of Cape Point in water usually less than 50 m deep and generally within 1 km of the shore (Ross 1984; Ross *et al*. 1987). The larger common bottlenose dolphin (truncatus form) is widely distributed in tropical and temperate waters throughout the world, but frequently occur in small (10s to low 100s) isolated coastal populations. An offshore 'form' of common bottlenose dolphins occurs around the coast of southern Africa including Namibia and Angola (Best 2007) with sightings restricted to the continental shelf edge and deeper. Offshore bottlenose dolphins frequently form mixed species groups, often with pilot whales or Risso's dolphins. Encounters in the offshore waters of Block 3B/4B are likely to be low.

Risso's Dolphin: A medium sized dolphin with a distinctively high level of scarring and a proportionally large dorsal fin and blunt head. Risso's dolphins are distributed worldwide in tropical and temperate seas and show a general preference for shelf edge waters <1 500 m deep (Best 2007; Purdon *et al*. 2020a, 2020b). Many sightings in southern Africa have occurred around the Cape Peninsula and along the shelf edge of the Agulhas bank. Presence within Block 3B/4B is possible (see also Figure 72).

Other Delphinids: Several other species of dolphins that might occur in deeper waters at low levels include the pygmy killer whale, southern right whale dolphin, rough toothed dolphin, pantropical spotted dolphin and striped dolphin (Findlay *et al*. 1992; Best 2007). Nothing is known about the population size or density of these species in the project area but encounters are likely to be rare.

Beaked whales: These whales were never targeted commercially and their pelagic distribution makes them the most poorly studied group of cetaceans. They are all considered to be true deep water species usually being seen in waters in excess of 1 000 – 2 000 m deep (see various species accounts in Best 2007). With recorded dives of well over an hour and in excess of 2 km deep, beaked whales are amongst the most extreme divers of any air breathing animals (Tyack *et al*. 2011). All the beaked whales that may be encountered in the project area are pelagic species that tend to occur in small groups usually less than five, although larger aggregations of some species are known (MacLeod & D'Amico 2006; Best 2007). The long, deep dives of beaked whales make them difficult to detect visually, but PAM will increase the probability of detection as animals are frequently echo-locating when on foraging dives. Beaked whales seem to be particularly susceptible to man-made sounds and several strandings and deaths at sea, often en masse, have been recorded in association with mid-frequency naval sonar (Cox *et al*. 2006; MacLeod & D'Amico 2006) and a seismic survey for hydrocarbons also running a low frequency multi-beam echo-sounder and sub bottom profiler (Southall *et al*. 2008; Cox *et al*. 2006; DeRuiter *et al*. 2013). Although the exact reason that beaked whales seem particularly vulnerable to man-made noise is not yet fully understood, existing evidence suggests that animals change their dive behaviour in response to acoustic disturbance (Tyack *et al*. 2011), showing a fear-response and surfacing too quickly with insufficient time to release nitrogen resulting in a form on decompression sickness. Necropsy of stranded animals has revealed gas embolisms and haemorrhage in the brain, ears and acoustic fat - injuries consistent with decompression sickness (acoustically mediated bubble formation) (Fernandez *et al*. 2005). Beyond decompression sickness, the fear/flee response may be the first stage in a multi-stage process ultimately resulting in stranding (Southall *et al*. 2008; Jepson *et al*. 2013). This type of stranding event has been linked to both naval sonar and low frequency multi-beam echosounders used for commercial-scale side scan sonar (Southall *et al*. 2008). Thus, although hard to detect and avoid, beaked whales are amongst the most sensitive marine mammals to noise exposure and all cautions must be taken to reduce impact. Sightings of beaked whales in the project area are expected to be very low.

All whales and dolphins are given protection under the South African Law. The Marine Living Resources Act, 1998 (No. 18 of 1998) states that no whales or dolphins may be harassed, killed or fished. No vessel or aircraft may, without a permit or exemption, approach closer than 300 m to any whale and a vessel should move to a minimum distance of 300 m from any whales if a whale surfaces closer than 300 m from a vessel or aircraft.

8.3.2.9 **SEALS (PINNIPEDS)**

The Cape fur seal (*Arctocephalus pusillus pusillus*) is the only species of seal resident along the west coast of Africa, occurring at numerous breeding and non-breeding sites on the mainland and on nearshore islands and reefs (Figure 73). The South African population, which includes the West Coast colonies, was estimated at ca. 725 000 individuals in 2020. This is about 40% of the total southern African population, which has previously been estimated at up to 2 million (Seakamela *et al*. 2022). Vagrant records from four other species of seal more usually associated with the subantarctic environment have also been recorded: southern elephant seal (*Mirounga leoninas*), subantarctic fur seal (*Arctocephalus tropicalis*), crabeater (*Lobodon carcinophagus*) and leopard seals (*Hydrurga leptonyx*) (David 1989).

Figure 73: Colony of Cape fur seals *Arctocephalus pusillus pusillus* (Photo: Dirk Heinrich).

There are a number of Cape fur seal breeding colonies within the broader study area: at Bucchu Twins near Alexander Bay, at Cliff Point (~17 km north of Port Nolloth), at Kleinzee (incorporating Robeiland), Strandfontein Point (south of Hondeklipbaai), Paternoster Rocks and Jacobs Reef at Cape Columbine, Vondeling Island, Robbesteen near Koeberg and Seal Island in False Bay. The colony at Kleinzee has the highest seal population and produces the highest seal pup numbers on the South African Coast (Wickens 1994). The closest breeding colonies to Block 3B/4B are at Bucchu Twins, Cliff Point, Kleinzee, Strandfontein Point and Cape Columbine located between 150 km and 250 km inshore of the Block.

Non-breeding colonies and haul-out sites occur at Doringbaai south of Cliff Point, Rooiklippies, Swartduin and Noup between Kleinzee and Hondeklipbaai, at Spoeg River and Langklip south of Hondeklip Bay, on Bird Island at Lambert's Bay, at Paternoster Point at Cape Columbine and Duikerklip in Hout Bay. These colonies all fall well inshore and to the east of Block 3B/4B, although overlap with foraging trips may occur in the inshore portions of the licence area.

Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nautical miles offshore (Shaughnessy 1979), with bulls ranging further out to sea than females (Figure 74). Their diet varies with season and availability and includes pelagic species such as horse mackerel, pilchard, and hake, as well as squid and cuttlefish. Although Cape fur seals are primarily epipelagic foragers, some degree of geographic and temporal variation in resource and habitat use have been demonstrated (Botha *et al*. 2023). Benthic feeding to depths of up to 454 m has been recorded in females from the Kleinzee colony on the West Coast, with individual modal dive durations of 0.2 – 5.6 minutes (Kirkman *et al*. 2015; Kirkman *et al*. 2019). Botha *et al*. (2020) reported diel foraging patterns in females from the Kleinzee and False Bay colonies, with dive depth and benthic foraging increasing during daylight hours likely reflecting the vertical movements of prey species.

The timing of the annual breeding cycle is very regular, occurring between November and January, after which the breeding colonies break up and disperse. Breeding success is highly dependent on the local abundance of food, territorial bulls and lactating females being most vulnerable to local fluctuations as they feed in the vicinity of the colonies prior to and after the pupping season (Oosthuizen 1991).

Historically the Cape fur seal was heavily exploited for its luxurious pelt. Sealing restrictions were first introduced to southern Africa in 1893, and harvesting was controlled until 1990 when it was finally prohibited. The protection of the species has resulted in the recovery of the populations, and numbers continue to increase. Consequently, their conservation status is not regarded as threatened. The Cape Fur Seal population in South Africa is regularly monitored by the Department of Forestry, Fisheries and Environment (DFFE) (e.g. Kirkman *et al*. 2013). The overall population is considered healthy and stable in size, although there has been a westward and northward shift in the distribution of the breeding population (Kirkman *et al*. 2013).

An unprecedented mortality event was recorded in South Africa between September and December 2021 at colonies around the West Coast Peninsula and north to Lambert's Bay and Elands Bay. Primarily pups and juveniles were affected. Post-mortem investigations revealed that seals died in a poor condition with reduced blubber reserves, and protein energy malnutrition was detected for aborted foetuses, for juveniles and subadults. Although no unusual environmental conditions were identified that may have triggered the die-off, or caused it indirectly (e.g. HABs), 2021 was a year of below average recruitment of anchovy and sardine, the main food source for seals. While a lack of food, as a result of possibly climate change and/or overfishing, has been predicted to be the cause of this mass mortality, the underlying causes of the mortality event remain uncertain (Seakamela *et al*. 2022).

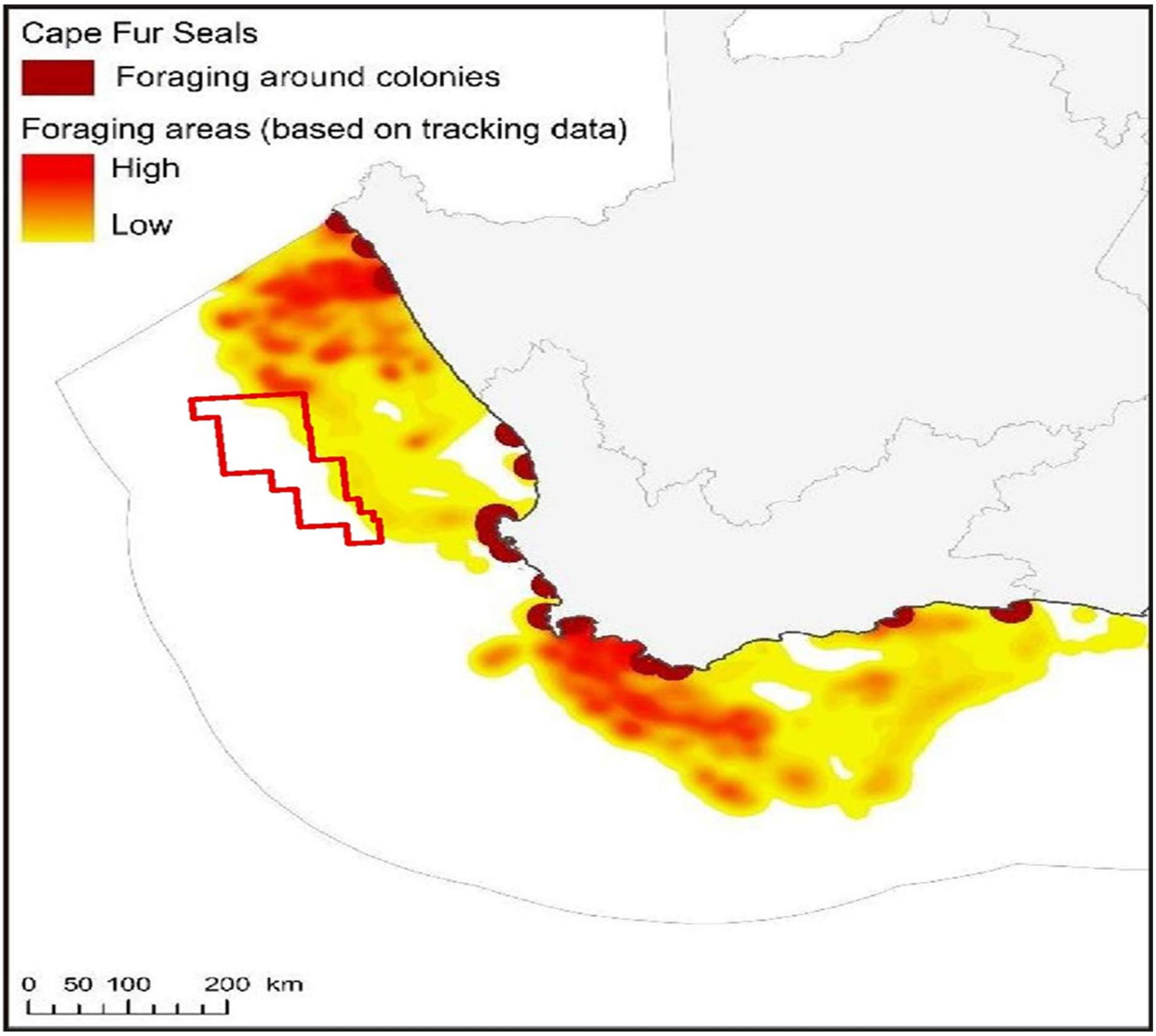


Figure 74: Block 3B/4B (red polygon) in relation to seal foraging areas on the West and South Coasts. Brown areas are generalised foraging areas around colonies, and areas in shades of red are foraging areas based on tracking data. Darker shades of red indicate areas of higher use (Adapted from Harris *et al*. 2022).

8.3.2.10 **COASTAL COMMUNITIES**

The coastline of the broader project area is characterised by a mixture of intertidal sandy beaches and rocky shores, but also estuaries, rocky subtidal habitats and kelp beds. These were categorised into ecosystem types by Sink *et al*. (2019) and assigned a threat status depending on their geographic extent and extent of ecosystem degradation. Numerous methods of classifying beach zonation have been proposed, based either on physical or biological criteria. The general scheme proposed by Branch & Griffiths (1988) is used, *supplemented* by data from various publications on West Coast sandy beach biota (e.g. Bally 1987; Brown *et al*. *1989*; Soares *et al*. 1996*,* 1997; Nel 2001; Nel *et al*. 2003; *Soares* 2003; Branch *et al*. 2010; Harris *2012)*. The macrofaunal communities of sandy beaches are generally ubiquitous throughout the southern African West Coast region, being particular only to substratum type, wave exposure and/or depth zone. Due to the exposed nature of the coastline in the study area, most beaches are of the intermediate to reflective type. The upper beach dry zone (supralittoral) is situated above the high water spring (HWS) tide level and receives water input only from large waves at spring high tides or through sea spray. This zone is characterised by a mixture of air breathing terrestrial and semi-terrestrial fauna, often associated with and feeding on kelp deposited near or on the driftline. Terrestrial species include a diverse array of beetles and arachnids and some oligochaetes, while semi-terrestrial fauna include the oniscid isopod Tylos granulatus, and amphipods *of the* genus Talorchestia. The mid-beach retention zone and low-beach saturation zone (intertidal zone or mid-littoral zone) has a vertical range of about

2 m. This mid-shore region is characterised by the cirolanid isopods Pontogeloides latipes, Eurydice (longicornis=*)* kensleyi, *and Excirolana natalensis,* the polychaetes *Scolelepis squamata*, Orbinia angrapequensis, Nepthys hombergii *and Lumbrineris* tetraura*, and* amphipods *of the* families Haustoridae and Phoxocephalidae. In some areas, juvenile and adult sand mussels Donax serra may also be present in considerable numbers.

The surf zone (inner turbulent and transition zones) extends from the Low Water Spring mark to about -2 m depth. The mysid *Gastrosaccus psammodytes* (Mysidacea, Crustacea), the ribbon worm *Cerebratulus fuscus* (Nemertea), the cumacean Cumopsis robusta (Cumacea) and a variety of polychaetes including *Scolelepis squamata* and *Lumbrineris tetraura*, are typical of this zone, although they generally extend partially into the midlittoral above. In areas where a suitable swash climate exists, the gastropod Bullia digitalis (Gastropoda, Mollusca) may also be present in considerable numbers, surfing up and down the beach in search of carrion.

Table 21 summarises the threat status of these ecosystem types in the broader project area. A general description of intertidal and shallow subtidal habitats on the West Coast is provided below. Although well inshore of Block 3B/4B and unlikely to be directly impacted by proposed exploration drilling operations, these habitats fall into the area of indirect influence possibly affected in the event of an oil spill.

8.3.2.11 **INTERTIDAL SANDY BEACHES**

Sandy beaches are one of the most dynamic coastal environments. A description of these environments has been included due to the possibility of a well blowout having potential impacts on these environments. With the exception of a few beaches in large bay systems (such as St Helena Bay, Saldanha Bay, Table Bay), the beaches along the South African West Coast are typically highly exposed. Exposed sandy shores consist of coupled surf-zone, beach and dune systems, which together form the active littoral sand transport zone (Short & Hesp 1985). The composition of their faunal communities is largely dependent on the interaction of wave energy, beach slope and sand particle size, which is termed beach morphodynamics. Three morphodynamic beach types are described: dissipative, reflective and intermediate beaches (McLachlan *et al*. 1993). Generally, dissipative beaches are relatively wide and flat with fine sands and low wave energy. Waves start to break far from the shore in a series of spilling breakers that 'dissipate' their energy along a broad surf zone. This generates slow swashes with long periods, resulting in less turbulent conditions on the gently sloping beach face. These beaches usually harbour the richest intertidal faunal communities. Reflective beaches in contrast, have high wave energy, and are coarse grained (>500 µm sand) with narrow and steep intertidal beach faces. The relative absence of a surf-zone causes the waves to break directly on the shore causing a high turnover of sand. The result is depauperate faunal communities. Intermediate beach conditions exist between these extremes and have a very variable species composition (McLachlan *et al*. 1993; Jaramillo *et al*. 1995, Soares 2003). This variability is mainly attributable to the amount and quality of food available. Beaches with a high input of e.g. kelp wrack have a rich and diverse drift-line fauna, which is sparse or absent on beaches lacking a drift-line (Branch & Griffiths 1988). As a result of the combination of typical beach characteristics, and the special adaptations of beach fauna to these, beaches act as filters and energy recyclers in the nearshore environment (Brown & McLachlan 2002).

Numerous methods of classifying beach zonation have been proposed, based either on physical or biological criteria. The general scheme proposed by Branch & Griffiths (1988) is used, supplemented by data from various publications on West Coast sandy beach biota (e.g. Bally 1987; Brown *et al*. 1989; Soares *et al*. 1996, 1997; Nel 2001; Nel *et al*. 2003; Soares 2003; Branch *et al*. 2010; Harris 2012). The macrofaunal communities of sandy beaches are generally ubiquitous throughout the southern African West Coast region, being particular only to substratum type, wave exposure and/or depth zone. Due to the exposed nature of the coastline in the study area, most beaches are of the intermediate to reflective type. The upper beach dry zone (supralittoral) is situated above the high water spring (HWS) tide level and receives water input only from large waves at spring high tides or through sea spray. This zone is characterised by a mixture of air breathing terrestrial and semi-terrestrial fauna, often associated with and feeding on kelp deposited near or on the driftline. Terrestrial species include a diverse array of beetles and arachnids and some oligochaetes, while semi-terrestrial fauna include the oniscid isopod *Tylos granulatus*, and amphipods of the genus Talorchestia. The mid-beach retention zone and low-beach saturation zone (intertidal zone or mid-littoral zone) has a vertical range of about 2 m. This mid-shore region is characterised by the cirolanid isopods Pontogeloides latipes, Eurydice (longicornis=) kensleyi, and *Excirolana natalensis*, the polychaetes *Scolelepis squamata*, *Orbinia angrapequensis, Nepthys hombergii* and *Lumbrineris* *tetraura*, and amphipods of the families Haustoridae and Phoxocephalidae. In some areas, juvenile and adult sand mussels Donax serra may also be present in considerable numbers.

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Table 21: Threat status of the intertidal and shallow subtidal ecosystem types in the broader project area (Sink *et al*. 2019).

Ecosystem Type	2019 Threat Status
Agulhas Boulder Shore	Near threatened
Agulhas Dissipative Intermediate Sandy Shore	Least Concern
Agulhas Dissipative Sandy Shore	Near threatened
Agulhas Exposed Rocky Shore	Vulnerable
Agulhas Exposed Stromatolite Rocky Shore	Vulnerable
Agulhas Intermediate Sandy Shore	Least Concern
Agulhas Island	Vulnerable
Agulhas Kelp Forest	Vulnerable
Agulhas Mixed Shore	Near threatened
Agulhas Reflective Sandy Shore	Vulnerable
Agulhas Sheltered Rocky Shore	Endangered
Agulhas Stromatolite Mixed Shore	Vulnerable
Agulhas Very Exposed Rocky Shore	Vulnerable
Agulhas Very Exposed Stromatolite Rocky Shore	Near threatened
Cape Bay	Endangered
Cape Boulder Shore	Vulnerable
Cape Exposed Rocky Shore	Vulnerable
Cape Island	Endangered
Cape Kelp Forest	Vulnerable
Cape Mixed Shore	Vulnerable
Cape Sheltered Rocky Shore	Endangered
Cape Very Exposed Rocky Shore	Near threatened

Ecosystem Type	2019 Threat Status
Eastern Agulhas Bay	Vulnerable
False and Walker Bay	Vulnerable
Namaqua Exposed Rocky Shore	Vulnerable
Namaqua Kelp Forest	Vulnerable
Namaqua Mixed Shore	Vulnerable
Namaqua Sheltered Rocky Shore	Vulnerable
Namaqua Very Exposed Rocky Shore	Vulnerable
Southern Benguela Dissipative Intermediate Sandy Shore	Least Concern
Southern Benguela Dissipative Sandy Shore	Least Concern
Southern Benguela Intermediate Sandy Shore	Near threatened
Southern Benguela Reflective Sandy Shore	Endangered
St Helena Bay	Vulnerable
Western Agulhas Bay	Endangered

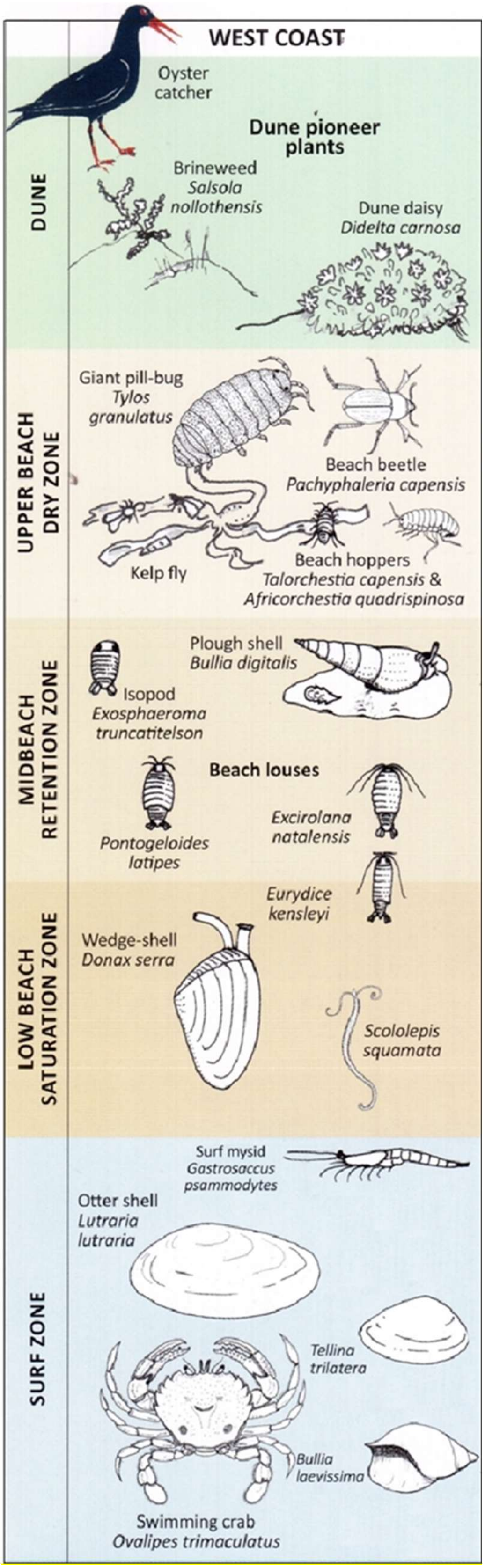


Figure 75: Schematic representation of the West Coast intertidal beach zonation (adapted from Branch & Branch 2018).

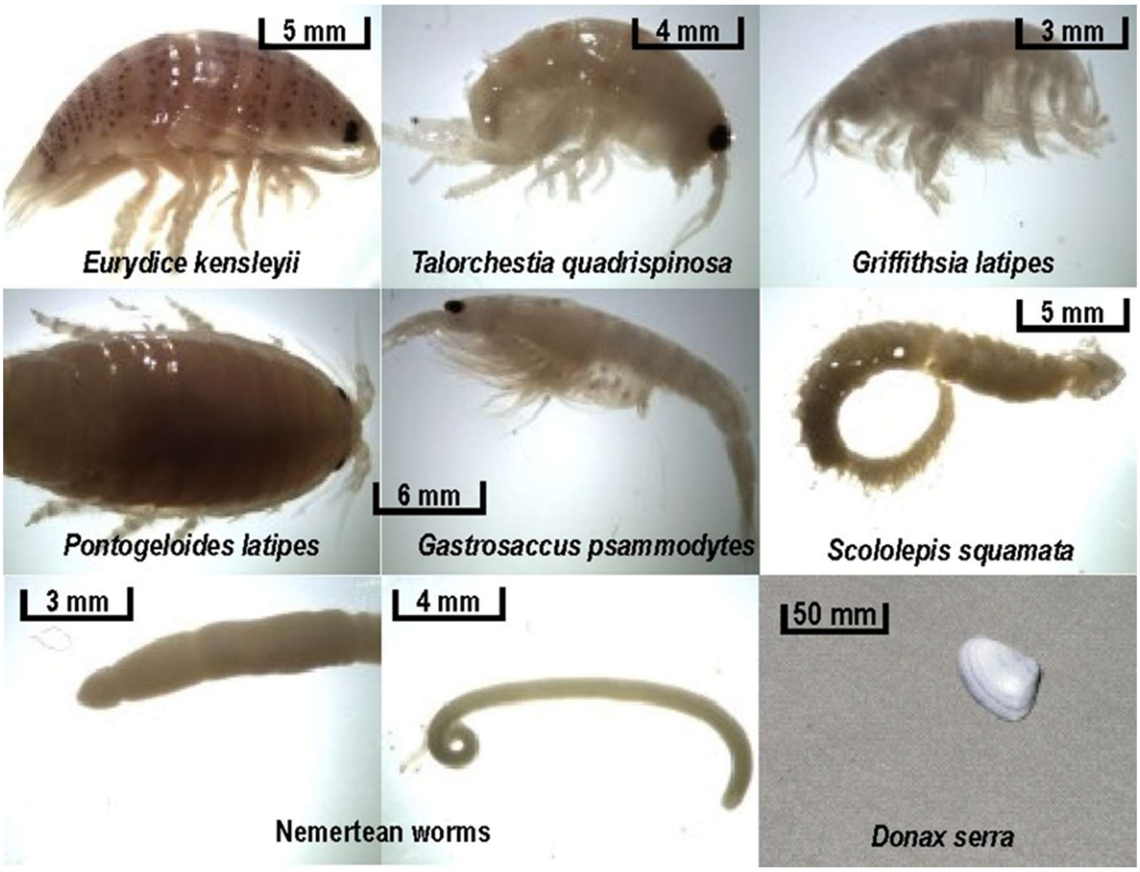


Figure 76: Common beach macrofaunal species occurring on exposed West Coast beaches.

The transition zone spans approximately 2 - 5 m depth beyond the inner turbulent zone. Extreme turbulence is experienced in this zone, and as a consequence this zone typically harbours the lowest diversity on sandy beaches. Typical fauna include amphipods such as *Cunicus profundus* and burrowing polychaetes such as *Cirriformia tentaculata* and *Lumbrineris tetraura.*

The outer turbulent zone extends beyond the surf zone and below 5 m depth, where turbulence is significantly decreased and species diversity is again much higher. In addition to the polychaetes found in the transition zone, other polychaetes in this zone include *Pectinaria capensis*, and *Sabellides ludertizii*. The sea pen V*irgularia schultzi* (Pennatulacea, Cnidaria) is also common as is a host of amphipod species and the three spot swimming crab *Ovalipes punctatus* (Brachyura, Crustacea).

8.3.2.12 **INTERTIDAL ROCKY SHORES**

The following general description of the intertidal and subtidal habitats for the West Coast is based on Field *et al.* (1980), Branch & Griffiths (1988), Field & Griffiths (1991) and Branch & Branch (2018). A description of these environments has been included due to the possibility of a well blowout having potential impacts on these environments.

Several studies on the west coast of southern Africa have documented the important effects of wave action on the intertidal rocky-shore community. Specifically, wave action enhances filter-feeders by increasing the concentration and turnover of particulate food, leading to an elevation of overall biomass despite low species diversity (McQuaid & Branch 1985, Bustamante & Branch 1995, 1996a, Bustamante *et al.* 1997). Conversely, sheltered shores are diverse with relatively low biomass, and only in relatively sheltered embayments does drift kelp accumulate and provide a vital support for very high densities of kelp trapping limpets, such as *Cymbula granatina* that occur exclusively there (Bustamante *et al.* 1995). In the subtidal, these differences diminish as wave exposure is moderated with depth.

West Coast rocky intertidal shores can be divided into five zones on the basis of their characteristic biological communities: The Littorina, Upper Balanoid, Lower Balanoid, Cochlear/Argenvillei and the Infratidal Zones.

These biological zones correspond roughly to zones based on tidal heights (Figure 77 and Figure 78). Tolerance to the physical stresses associated with life on the intertidal, as well as biological interactions such as herbivory, competition and predation interact to produce these five zones.

The uppermost part of the shore is the supralittoral fringe, which is the part of the shore that is most exposed to air, perhaps having more in common with the terrestrial environment. The supralittoral is characterised by low species diversity, with the tiny periwinkle *Afrolittorina knysnaensis*, and the red alga *Porphyra capensis* constituting the most common macroscopic life.

The upper mid-littoral is characterised by the limpet *Scutellastra granularis*, which is present on all shores. The gastropods *Oxystele variegata*, *Nucella dubia*, and *Helcion pectunculus* are variably present, as are low densities of the barnacles *Tetraclita serrata*, *Octomeris angulosa* and *Chthalamus dentatus*. Flora is best represented by the green algae *Ulva* spp.

Toward the lower Mid-littoral or Lower Balanoid zone, biological communities are determined by exposure to wave action. On sheltered and moderately exposed shores, a diversity of algae abounds with a variable representation of green algae – *Ulva* spp, *Codium* spp.; brown algae – *Splachnidium rugosum*; and red algae – *Aeodes orbitosa*, *Mazzaella (=Iridaea) capensis*, *Gigartina polycarpa* (=*radula*), *Sarcothalia* (=*Gigartina*) *stiriata*, and with increasing wave exposure *Plocamium rigidum* and *P. cornutum*, and *Champia lumbricalis*. The gastropods *Cymbula granatina* and *Burnupena* spp. are also common, as is the reef building polychaete *Gunnarea capensis*, and the small cushion starfish *Patiriella exigua*. On more exposed shores, almost all of the primary space can be occupied by the dominant alien invasive mussel *Mytilus galloprovincialis*. First recorded in 1979 (although it is likely to have arrived in the late 1960's), it is now the most abundant and widespread invasive marine species spreading along the entire West Coast and parts of the South Coast (Robinson *et al.* 2005). *M. galloprovincialis* has partially displaced the local mussels *Choromytilus meridionalis* and *Aulacomya ater* (Hockey & Van Erkom Schurink 1992) and competes with several indigenous limpet species (Griffiths *et al.* 1992; Steffani & Branch 2003a, b). Recently, another alien invasive has been recorded, the acorn barnacle *Balanus glandula*, which is native to the west coast of North America where it is the most common intertidal barnacle. The presence of *B. glandula* in South Africa was only noticed a few years ago as it had always been confused with the native barnacle *Cthamalus dentatus* (Simon-Blecher *et al.* 2008). There is, however, evidence that it has been in South Africa since at least 1992 (Laird & Griffith 2008). At the time of its discovery, the barnacle was recorded from 400 km of coastline from Elands Bay to Misty Cliffs near Cape Point (Laird & Griffith 2008). Thus, it is likely that it occurs inshore of Block 3B/4B. When present, the barnacle is typically abundant at the mid zones of semi-exposed shores.

Along the sublittoral fringe, the large kelp-trapping limpet *Scutellastra argenvillei* dominates forming dense, almost monospecific stands achieving densities of up to 200/m^2 (Bustamante *et al.* 1995). Similarly, *C. granatina* is the dominant grazer on more sheltered shores, also reaching extremely high densities (Bustamante *et al.* 1995). On more exposed shores *M. galloprovincialis* dominates. There is evidence that the arrival of the alien *M. palloprovincialis* has led to strong competitive interaction with *S. argenvillei* (Steffani & Branch 2003a, 2003b, 2005). The abundance of the mussel changes with wave exposure, and at wave-exposed locations, the mussel can cover almost the entire primary substratum, whereas in semi-exposed situations it is never abundant. As the cover of *M. galloprovincialis* increases, the abundance and size of *S. argenvillei* on rock declines and it becomes confined to patches within a matrix of mussel bed. As a result exposed sites, once dominated by dense populations of the limpet, are now largely covered by the alien mussel. Semi-exposed shores do, however, offer a refuge preventing global extinction of the limpet. In addition to the mussel and limpets, there is variable representation of the flora and fauna described for the lower mid-littoral above, as well as the anemone *Aulactinia reynaudi*, numerous whelk species and the sea urchin *Parechinus angulosus*. Some of these species extend into the subtidal below.

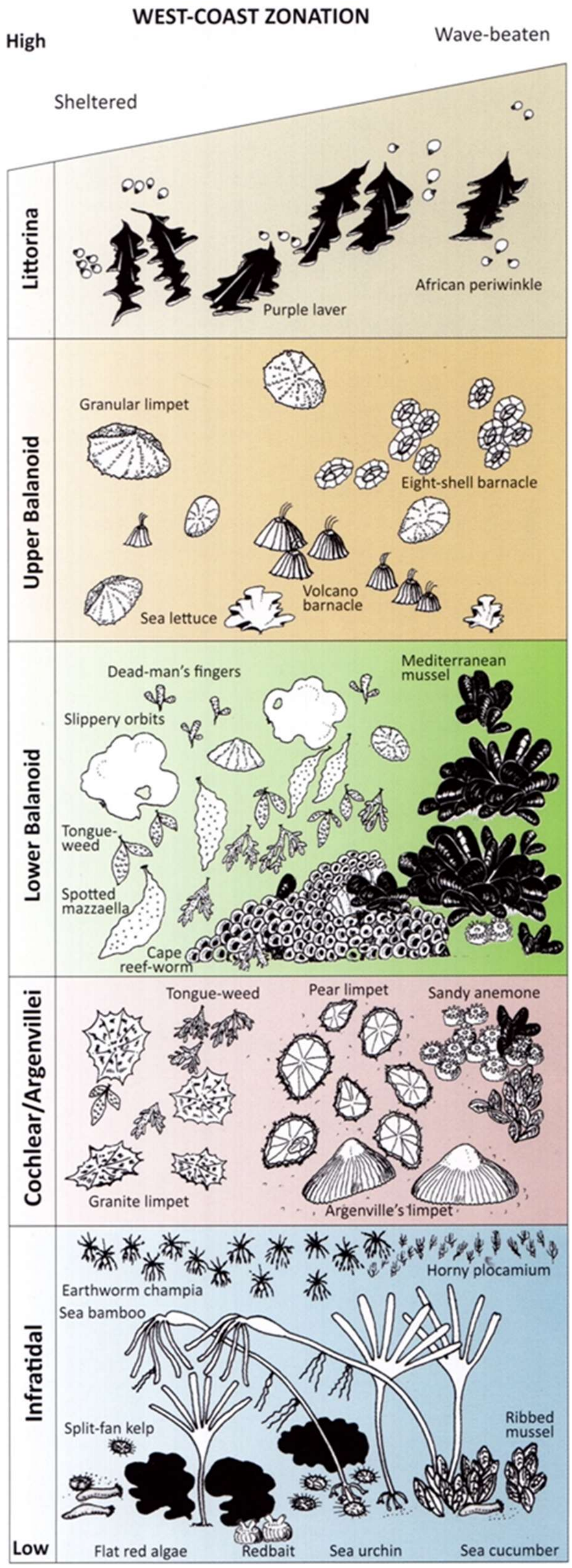


Figure 77: Schematic representation of the West Coast intertidal rocky shore zonation (adapted from Branch & Branch 2018).

Figure 78: Typical rocky intertidal zonation on the southern African west coast.

The invasion of west coast rocky shores by another mytilid, the small *Semimytilus algosus*, has been noted (de Greef *et al.* 2013). It is hypothesized that this species has established itself fairly recently, probably only in the last ten years. Its current range extends from the Groen River mouth in the north to Bloubergstrand in the south. Where present, it occupies the lower intertidal zone, where they completely dominate primary rock space, while *M. galloprovincialis* dominates higher up the shore. Many shores on the West Coast have thus now been effectively partitioned by the three introduced species, with *B. glandula* colonizing the upper intertidal, *M. galloprovincialis* dominating the mid-shore, and now *S. algosus* smothering the low shore (de Greef *et al.* 2013).

8.3.2.13 **ROCKY SUBTIDAL HABITAT AND KELP BEDS**

Biological communities of the rocky sublittoral on the southwest coast can be broadly grouped into an inshore zone from the sublittoral fringe to a depth of about 10 m dominated by flora, and an offshore zone below 10 m depth dominated by fauna. This shift in communities is not knife-edge, and rather represents a continuum of species distributions, merely with changing abundances.

From the sublittoral fringe to a depth of between 5 and 10 m, the benthos is largely dominated by algae, in particular two species of kelp. The canopy forming kelp *Ecklonia maxima* extends seawards to a depth of about 10 m. The smaller *Laminaria pallida* forms a sub-canopy to a height of about 2 m underneath *Ecklonia* but continues its seaward extent to about 30 m depth, although further north up the west coast increasing turbidity limits growth to shallower waters (10-20 m) (Velimirov *et al.* 1977; Jarman & Carter 1981; Branch 2008). *Ecklonia maxima* is the dominant species in the south forming extensive beds from west of Cape Agulhas to north of Cape Columbine but decreasing in abundance northwards. *Laminaria* becomes the dominant kelp north of Cape Columbine and thus in the project area, extending from Danger Point east of Cape Agulhas to Rocky Point in northern Namibia (Stegenga *et al.* 1997; Rand 2006).

Kelp beds absorb and dissipate much of the typically high wave energy reaching the shore, thereby providing important partially-sheltered habitats for a high diversity of marine flora and fauna, resulting in diverse and typical kelp-forest communities being established (Figure 79).

Figure 79: The canopy-forming kelp *Ecklonia maxima* provides an important habitat for a diversity of marine biota (Photo: Geoff Spiby).

Growing beneath the kelp canopy, and epiphytically on the kelps themselves, are a diversity of understorey algae, which provide both food and shelter for predators, grazers and filter-feeders associated with the kelp bed ecosystem. Representative under-storey algae include *Botryocarpa prolifera*, *Neuroglossum binderianum*, *Botryoglossum platycarpum*, *Hymenena venosa* and *Rhodymenia* (=*Epymenia*) *obtusa*, various coralline algae, as well as subtidal extensions of some algae occurring primarily in the intertidal zones (Bolton 1986). Epiphytic species include *Polysiphonia virgata*, *Gelidium vittatum (=Suhria vittata)* and *Carpoblepharis flaccida*. In particular, encrusting coralline algae are important in the under-storey flora as they are known as settlement attractors for a diversity of invertebrate species. The presence of coralline crusts is thought to be a key factor in supporting a rich shallow-water community by providing substrate, refuge, and food to a wide variety of infaunal and epifaunal invertebrates (Chenelot *et al.* 2008).

The sublittoral invertebrate fauna is dominated by suspension and filter-feeders, such as the mussels *Aulacomya ater* and *Choromytilus meriodonalis*, and the Cape reef worm *Gunnarea capensis*, and a variety of sponges and sea cucumbers. Grazers are less common, with most herbivory being restricted to grazing of juvenile algae or debris-feeding on detached macrophytes. The dominant herbivore is the sea urchin *Parechinus angulosus*, with lesser grazing pressure from limpets, the isopod *Paridotea reticulata* and the amphipod *Ampithoe humeralis*. The abalone *Haliotis midae*, an important commercial species present in kelp beds south of Cape Columbine is naturally absent north of there. Key predators in the sub-littoral include the commercially important West Coast rock lobster *Jasus lalandii* and the octopus *Octopus vulgaris*. The rock lobster acts as a keystone species as it influences community structure *via* predation on a wide range of benthic organisms (Mayfield *et al.* 2000). Relatively abundant rock lobsters can lead to a reduction in density, or even elimination, of black mussel *Choromytilus meriodonalis*, the preferred prey of the species, and alter the size structure of populations of ribbed mussels *Aulacomya ater*, reducing the proportion of selected size-classes (Griffiths & Seiderer 1980). Their role as predator can thus reshape benthic communities, resulting in large reductions in taxa such as black mussels, urchins, whelks and barnacles, and in the dominance of algae (Barkai & Branch 1988; Mayfield 1998).

Of lesser importance as predators, although numerically significant, are various starfish, feather and brittle stars, and gastropods, including the whelks *Nucella* spp. and *Burnupena* spp. Fish species commonly found in kelp beds off the West Coast include hottentot *Pachymetopon blochii*, two tone finger fin *Chirodactylus brachydactylus*, red fingers *Cheilodactylus fasciatus*, galjoen *Dichistius capensis*, rock suckers *Chorisochismus dentex* and the catshark *Haploblepharus pictus* (Branch *et al.* 2010).

There is substantial spatial and temporal variability in the density and biomass of kelp beds, as storms can remove large numbers of plants and recruitment appears to be stochastic and unpredictable (Levitt *et al.* 2002; Rothman *et al.* 2006). Some kelp beds are dense, whilst others are less so due to differences in seabed topography, and the presence or absence of sand and grazers.

8.3.2.14 **ESTUARIES**

Estuaries along the West Coasts generally fall within the Cool Temperate bioregion. There are three perennial river mouths that are always open to the sea and have estuarine systems in their lower reaches: the Orange, Olifants and Berg Rivers. The Berg River Estuary has the largest and most diverse associated saline and freshwater wetlands compared to all other permanently open estuaries in South Africa. Langebaan is an estuarine lagoon comprising shallow intertidal sand banks and deeper channels that experience tidally driven input of nutrient rich, upwelled water from the sea and groundwater input in the upper reaches. Together, this creates an ecologically productive system that supports long-standing fisheries. Other estuaries include the Verlorenvlei and Klein estuarine lakes. The numerous smaller estuaries along the West Coast are intermittently, or seasonally, open (Holgat, Buffels, Swartlintjies, Bitter, Spoeg, Groen, Brak, Sout and Jakkals Rivers).

Predominantly open estuaries, estuarine lagoons and estuarine bays are particularly important for recruitment for some inshore linefish species and are the most vulnerable to marine pollution events as they receive tidal inflows almost constantly.

Estuarine habitats are highly variable environments with salinity, temperature pH and other variables change with the tides, seasons and climatic conditions. Changes in the extent of water coverage and flow may alternately expose estuarine organisms to desiccation and scouring floods. This high variability has led to a high degree of specialisation within estuaries.

The smaller estuaries are generally wave-dominated, with little freshwater inflow to maintain inlet stability and over 75% of South African estuaries close periodically due to wave-driven sandbar formation. If these periods persist for lengthy time periods, warm, hypersaline conditions can form (van Niekerk *et al.* 2019), which are unfavourable to most estuarine fauna. Toxic algal blooms are also common under these conditions and increase the likelihood of fish and invertebrate mortality.

There are 64 estuarine systems along the West Coast between the Orange River and Cape Agulhas (SANBI 2018). Approximately 75% of the Cool Temperate bioregion estuarine ecosystem (West Coast) types are 'Critically Endangered' or 'Endangered', while 13% are considered 'Vulnerable'.

Approximately 176 estuarine associated plant species are known within South Africa, with 56 species associated with salt marsh habitat. Salt marsh dominates the vegetation in the cool temperate estuaries along the West coast. The Langebaan and Olifants estuaries support large salt marsh habitat, with the combined area of inter- and supratidal habitat of 1 350 ha and 1 010 ha, respectively. There is a high degree of endemism with only 66 estuarine plant species occurring in five or more estuaries nationally (van Niekerk *et al.* 2019).

The vulnerable freshwater mullet *Pseudomyxus capensis* is one of the few marine fish species that spawns at sea but makes extensive use of the estuarine environment as a nursery area. Endemic to South Africa it occurs predominantly from Kosi Bay to Table Bay but has recently been recorded in a few estuaries on the West Coast as far north as the Orange River indicating that it may be expanding its range in response to climate change. The razor clam *Solen capensis* is endemic to estuaries in the cool temperate bioregions in South Africa, occurring from the Olifants Estuary on the West Coast to St Lucia on the East Coast.

Even the common species in the West and Southwest Coast estuaries have ranges restricted to southern Africa; sand and mud prawns *Callichirus krausii* and *Upogebia africana* are limited to southern Africa, while the freshwater sand-shrimp (*Paleamon capensis*) is endemic to South Africa (van Niekerk *et al.* 2019). Turpie *et al.* (2012) and Hockey *et al.* (2005) also list 35 bird species that are likely to be dependent on estuaries, many of which occur throughout the West and Southwest Coast.

Estuaries are highly productive systems and offer rich feeding grounds, warmer temperatures and sheltered habitat for many organisms. The high productivity is exploited by many line-fish and harvested invertebrate species either as a nursery or later in life either directly through habitat availability or indirectly through the contribution to overall coastal productivity (van Niekerk *et al.* 2019). Turpie *et al.* (2017) estimated the contribution of the estuarine nursery function as R960 million in 2018 terms (equivalent to over R1 billion in 2020) to the South African economy, with the highest value attributed to the estuaries of the south Western and Eastern Cape.

Location of estuaries on the West and South-West Coast and their conservation status are summarised in this section and Table 22.

Table 22: Threat status of the estuaries in the broader project area from the Namibian Border to Cape Agulhas (Van Niekerk *et al*. 2019). Only true estuaries, not micro-systems are listed.

Estuary	2018 Threat Status	Estuary	2018 Threat Status
Orange	Endangered	Krom	Endangered
Buffels	Endangered	Silwermyn	Critically Endangered
Swartlintjies	Endangered	Zand	Critically Endangered
Spoeg	Endangered	Zeekoei	Endangered
Groen	Endangered	Eerste	Critically Endangered
Sout (noord)	Endangered	Lourens	Endangered
Olifants	Endangered	Sir Lowry's Pass	Endangered
Jakkals	Critically Endangered	Steenbras	Least Concern
Wadrift	Endangered	Rooiels	Endangered
Verlorenvlei	Endangered	Buffels (Oos)	Endangered
Groot Berg	Endangered	Palmiet	Critically Endangered
Langebaan	Vulnerable	Bot/Kleinmond	Endangered
Diep/Rietvlei	Critically Endangered	Onrus	Endangered
Sout (Wes)	Critically Endangered	Klein	Endangered
Disa	Critically Endangered	Uilkraals	Endangered
Wildevoëlvlei	Critically Endangered	Ratel	Endangered
Schuster	Endangered	Heuningnes	Endangered

8.3.2.15 COASTAL SENSITIVITY

The last coastal sensitivity map for the South African coastline was compiled by Jackson & Lipschitz (1984). An updated National Coastal Assessment is currently being established by the CSIR and DEFF based on the biological components of the 2018 National Biodiversity Assessment (Harris *et al.* 2019). It includes the detection of coastal erosion hotspots and was completed in June 2020 (DEFF & CSIR 2020). A further report on the analysis of hotspots is in draft form and will be released in early 2021 (DEFF & CSIR 2021). This will take the form of a website with customisable GIS layers including natural resources, ecosystem infrastructure and services, human infrastructure, threats etc. Harris *et al.* (2019) compiled a GIS habitat map for the entire South African coastline, which identified that 60% of coastal ecosystem types are threatened, thereby having proportionally three times more threatened ecosystem types than the rest of the country. Coastal sensitivity would need to be taken into consideration in the event of an oil spill.

8.3.3 ECOLOGICAL NETWORK CONCEPTUAL MODEL

Figure 80 provides a simplified conceptual model for the nearshore and offshore receiving environment on the West Coast illustrating key variables, processes, linkages, relationships, dependencies and feed-back-loops.

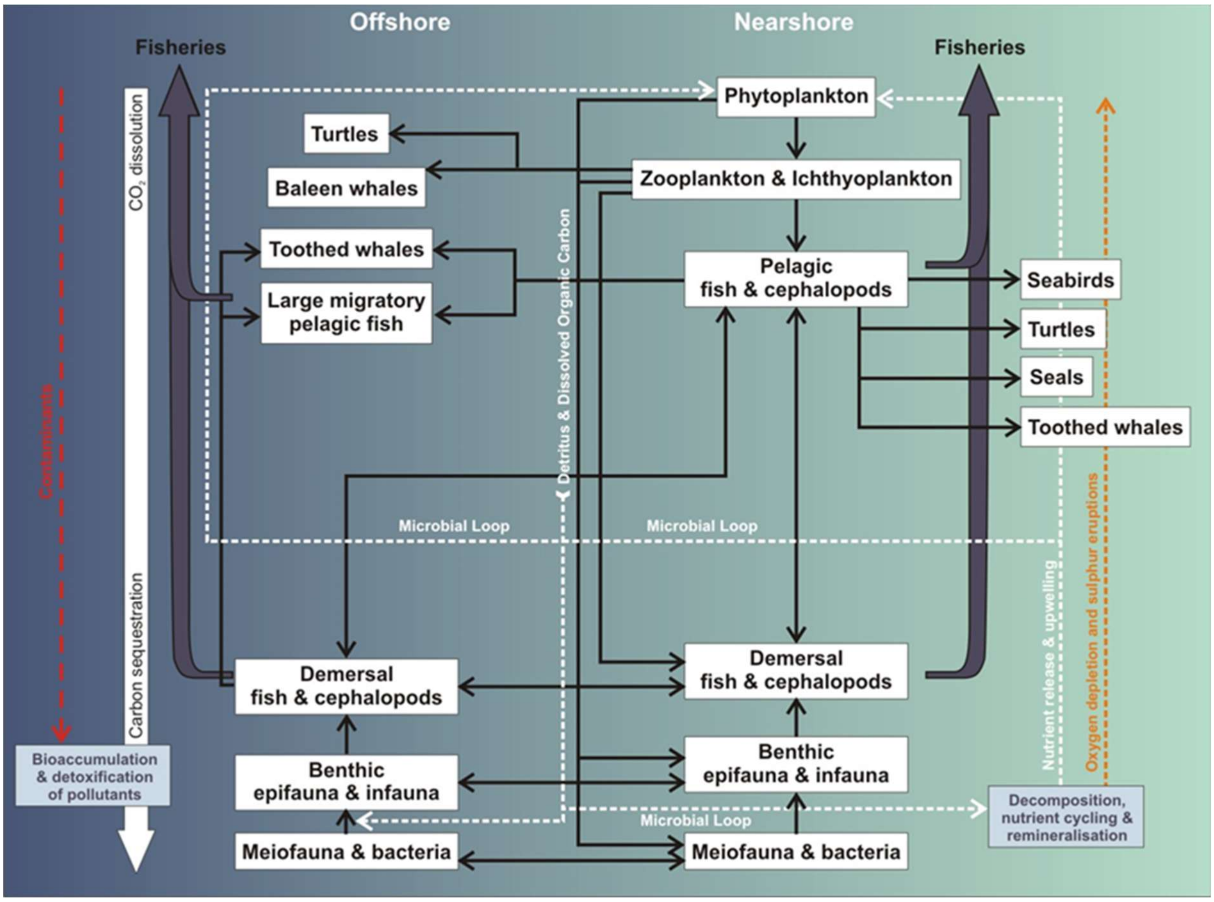


Figure 80: Simplified network diagram indicating the interaction between the key ecosystem components off the South-west and West Coasts

The upwelling of nutrients in the southern Benguela is the main driver that supports substantial seasonal phytoplankton production, which in turn serves as the basis for a rich food chain up through zooplankton, pelagic fish, cephalopods, and marine mammals, as well as demersal species and benthic fauna. High phytoplankton productivity in the upper layers again depletes the nutrients in these surface waters, resulting in a wind-related cycle of plankton production, mortality, sinking of detritus and eventual nutrient enrichment and remineralisation through the microbial loops active in the water column and on the seabed. The natural annual input of millions of tonnes of organic material onto the seabed provides most of the food requirements of the particulate and filter-feeding benthic communities, resulting in the high organic content of the muds in the region. Organic detritus not directly consumed enters the seabed decomposition cycle, potentially resulting in the depletion of oxygen in deeper waters and the formation of hydrogen sulphide by anaerobic bacteria.

In the offshore oceanic environment in the vicinity of a seamount or a submarine canyon, similar processes of decomposition and remineralisation, upwelling of nutrients and enhanced localised primary and secondary production would apply, thereby serving as focal points for higher order consumers. The cold-water corals typically associated with seamounts and canyons also add structural complexity to otherwise uniform seabed habitats thereby creating areas of high biological diversity and the development of detritivore-based food-webs, which in turn lead to the presence of seamount scavengers and predators. Seamounts also provide an important habitat for commercial deepwater fish stocks.

Ecosystem functions of the offshore deepwater environment include the support of highly productive fisheries, the dissolution of CO_2 from the atmosphere and subsequent sequestering of carbon in seabed sediments, as well as waste absorption and detoxification. The structure and function of these nearshore and offshore marine ecosystems is influenced both by natural environmental variation (e.g. El Niño Southern Oscillation (ENSO)) and multiple human uses, such as hydrocarbon developments and the harvest of marine living resources.

A brief discussion of potential population-level and ecosystem-wide effects of disturbance and the application of the integrated ecosystem assessment framework for evaluating the cumulative impacts of multiple pressures on multiple ecosystem components is provided below. This focuses mainly on the ecosystem-wide effects of anthropogenic noise, as similar research approaches to determining the effects of exploration-well drilling and hydrocarbon production at population and ecosystem level are as yet lacking.

With growing evidence of the ecosystem-wide effects of anthropogenic noise in the ocean (Nieukirk *et al*. 2012; Kavanagh *et al*. 2019; Kyhn *et al*. 2019) and the potential consequences of sub-lethal anthropogenic sounds affecting marine animals at multiple levels (e.g. behaviour, physiology, and in extreme cases survival), there is increasing recognition for the need to consider the effects of anthropogenic noise at population and ecosystem level. The sub-lethal effects of sound exposure may seem subtle, but small changes in behaviour can lead to significant changes in feeding behaviour, reductions in growth and reproduction of individuals (Pirotta *et al*. 2018) and can have effects that go beyond a single species, which may cause changes in food web interactions (Francis *et al*. 2009; Hubert *et al*. 2018; Slabbekoorn & Halfwerk 2009).

For example, the intensified upwelling events associated with the Cape Canyon, provide highly productive surface waters, which power feeding grounds for cetaceans and seabirds (www.environment.gov.za/dearesearchteamreturnfromdeepseaexpedition). Roman & McCarthy (2010) demonstrated the importance of marine mammal faecal matter in replenishing nutrients in the euphotic zone, thereby locally enhancing primary productivity in areas where whales and/or seals gather to feed (Kanwisher & Ridgeway 1983; Nicol *et al*. 2010). Surface excretion may also extend seasonal plankton productivity after a thermocline has formed, and where diving and surfacing of deep-feeding marine mammals (e.g. pilot whales, seals) transcends stratification, the vertical movement of these air-breathing predators may act as a pump bringing nutrients below the thermocline to the surface thereby potentially increasing the carrying capacity for other marine consumers, including commercial fish species (Roman & McCarthy 2010). Behavioural avoidance of marine mammals from such seasonal feeding areas in response to increasing anthropogenic disturbance may thus alter the nutrient fluxes in these zones, with possible ecosystem repercussions.

Likewise, long-lived, slow-reproducing species play important stabilising roles in the marine ecosystem, especially through predation, as they play a vital role in balancing and structuring food webs, thereby maintaining their functioning and productivity. Should such predators be impacted by hydrocarbon exploration at population level, and this have repercussions across multiple parts of a food web, top-down trophic cascades in the marine ecosystem could result (Ripple *et al*. 2016).

At the other end of the scale, significant impacts on plankton by anthropogenic sources can have significant bottom-up ripple effects on ocean ecosystem structure and health as phytoplankton and their zooplankton grazers underpin marine productivity. Healthy populations of fish, top predators and marine mammals are not possible without viable planktonic productivity. Furthermore, as a significant component of zooplankton communities comprises the egg and larval stages of many commercial fisheries species, large-scale disturbances (both natural and anthropogenic) on plankton communities can therefore have knock-on effects on ecosystem services across multiple levels of the food web.

Due to the difficulties in observing population-level and/or ecosystem impacts, numerical models are needed to provide information on the extent to which sound or other anthropogenic disturbances may affect the structure and functioning of populations and ecosystems. Attempts to model noise-induced changes in population parameters were first undertaken for marine mammals using the Population Consequences Of Acoustic Disturbance (PCAD) or Population Consequences of Disturbance (PCoD) approach (NRC 2005). The PCAD/PCoD framework assesses how observed behavioural responses on the health of an individual translates into changes in critical life-history traits (e.g. growth, reproduction, and survival) to estimate population-level effects. Since then, various frameworks have been developed to enhance our understanding of the consequences of behavioural responses of individuals at a population level. This is typically done through development of bio-energetics models that quantify the reduction in bio-energy intake as a function of disturbance and assess this reduction against the bio-energetic need for critical life-history traits (Costa *et al*. 2016; Keen *et al*. 2021). The consequences of changes in life-history traits on the development of a population are then assessed through population modelling. These frameworks are usually complex and under continual development but have been successfully used to assess the population consequences and ecosystem effects of disturbance in real-life conditions both for marine mammals (Villegas-Amtmann 2015, 2017; Costa *et al*. 2016; Ellison *et al*. 2016; McHuron *et al*. 2018; Pirotta *et al*. 2018; Dunlop *et al*. 2021), fish (Slabbekoorn & Halfwerk 2009; Hawkins *et al*. 2014; Slabbekoorn *et al*. 2019) and invertebrates (Hubert *et al*. 2018). The PCAD/PCoD models use and synthesise data from behavioural monitoring programmes, ecological studies on animal movement, bio-energetics, prey availability and mitigation effectiveness to assess the population-level effects of multiple disturbances over time (Bröker 2019).

There is a wealth of studies on the effects of drilling discharges on benthic communities (reviewed by Bakke *et al*. 2013; Beyer *et al*. 2020). Population and ecosystem effects from drilling discharges is relatively easy to study as they primarily affect the sediment ecosystem for which analysis of community responses to natural and anthropogenic disturbance has a long tradition in marine environmental monitoring (e.g. Gray *et al*. 1988, 1990). The sessile nature of benthic communities more readily facilitates repeated studies of the same sites to assess temporal changes and recovery over time. All evidence suggests that the effects of drilling discharges remain confined to within 1 - 2 km from an outlet both in the waters and on the seabed, that the risk of widespread impact from the operational discharges is low and that recovery of benthic communities at drill sites occurs within 4-10 years (Bakke *et al*. 2011). While some studies suggest that meiofauna respond to cuttings discharges in a similar way to macrofauna (Montagna & Harper 1996; Netto *et al*. 2010), there is, however, very little knowledge on the sensitivity of microfauna, epifauna, hyperfauna and coral and sponge communities to drilling discharges, and there is virtually no information of potential long term effects on benthic population and community functions such as production, reproduction, and trophic interaction (Bakke *et al*. 2013). It is also notoriously difficult to study the effects of drilling discharges on populations of higher order consumers (e.g. of commercial fish stocks) and the structure and function of marine ecosystems.

Although risk assessments on the effects of drilling discharges suggest that population-wide effects are unlikely, the possibility of subtle, cumulative effects from the operational discharges at population or ecosystem level cannot be ignored.

Ecosystem-based management is a holistic living resource management approach that concurrently addresses multiple human uses and the effect such stressors may have on the ability of marine ecosystems to provide ecosystem services and processes (e.g. recreational opportunities, consumption of seafood, coastal developments) (Holsman *et al*. 2017; Spooner *et al*. 2021). Within complex marine ecosystems, the integrated ecosystem assessment framework, which incorporates ecosystem risk assessments, provides a method for evaluating the cumulative impacts of multiple pressures on multiple ecosystem components (Levin *et al*. 2009, 2014; Holsman *et al*. 2017; Spooner *et al*. 2021). It, therefore, has the potential to address cumulative impacts and balance multiple, often conflicting, objectives across ocean management sectors and explicitly evaluate trade-offs. It has been repeatedly explored in fisheries management (Large *et al*. 2015) and more recently in marine spatial planning (Hammar *et al*. 2020; Carlucci *et al*. 2021; Jonsson *et al*. 2021; Harris *et al*. 2022).

However, due primarily to the multi-dimensional nature of both ecosystem pressures and ecosystem responses, quantifying ecosystem-based reference points or thresholds has proven difficult (Large *et al*. 2015). Ecosystem thresholds occur when a small change in a pressure causes either a large response or an abrupt change in the direction of ecosystem state or function. Complex numerical modelling that concurrently identifies thresholds for a suite of ecological indicator responses to multiple pressures is required to evaluate ecosystem reference points to support ecosystem-based management (Large *et al*. 2015).

The required data inputs into such models are currently limited in southern Africa. Slabbekoorn et al. (2019) point out that in such cases expert elicitation would be a useful method to synthesise existing knowledge, potentially extending the reach of explicitly quantitative methods to data-poor situations.

8.4 FISHERIES

This section provides a description of the fisheries activities of the application area. The information has been sourced from the Fisheries Assessment undertaken by CapMarine (Appendix 4).

8.4.1 OVERVIEW OF FISHERIES SECTORS

South Africa is home to a diverse and complex marine environment, with two distinct ecosystems along its extensive 3 623 km coastline. The western coastal shelf boasts highly productive commercial fisheries, similar to other upwelling ecosystems around the world, while the east coast is known for its high species diversity and endemics but has a less productive fishing industry. Licence Block 3B/4B is situated within the southern Benguela Large Marine Ecosystem, which is considered one of the largest and most productive of the world's coastal upwelling systems.

Fisheries in South Africa are regulated and monitored by the DFFE, which is responsible for ensuring the sustainable use of marine resources. The DFFE plays a critical role in managing and conserving the country's marine environment, including the allocation of fishing rights, setting sustainable total allowable catch (TAC) and total allowable effort (TAE), and developing flexible Operational Management Procedures (OMPs) that can accommodate changes in fish populations.

All fishing activities, as well as the processing, sale, and trade of marine resources in South Africa, are subject to regulation under the Marine Living Resources Act of 1998. This act provides the legal framework for the conservation and management of marine resources and ensures their sustainable use, while also protecting the marine ecosystem from the negative impacts of human activities such as oil and gas exploration. The DFFE is responsible for monitoring and controlling these activities to prevent damage to the marine environment and ensure the sustainability of South Africa's fishing industry.

The fisheries sector is worth around R8 billion a year and the commercial sector directly employs approximately 28 000 people with many thousands more people depending on fisheries resources to meet basic needs in the small-scale and recreational sectors.

Approximately 22 different fisheries sectors are monitored and managed by DFFE. Table 24 lists these along with ports and regions of operation, catch landings and the number of active vessels and rights holders (2017). The proportional volume of catch and economic value of each of these sectors for 2017 is indicated in Figure 81. Fisheries are generally divided into commercial and non-commercial fishing. The largest and most valuable commercial sectors include the deep-sea trawl fishery, targeting the Cape hakes (*Merluccius paradoxus* and *M. capensis*) and the pelagic-directed purse-seine fishery targeting pilchard (*Sardinops sagax*), anchovy (*Engraulis encrasicolus*) and red-eye round herring (*Etrumeus whitheadii*).

Highly migratory tuna and tuna-like species are caught on the high seas and seasonally within the South African waters by the pelagic long-line and pole fisheries. Targeted species include albacore (*Thunnus alalunga*), bigeye tuna (*T. obesus*), yellowfin tuna (*T. albacares*) and swordfish *(Xiphias gladius*). These species play a crucial role in the marine food chain, serving as a food source for larger predatory fish and marine mammals.

The traditional line fishery targets a large assemblage of species close to shore including snoek (*Thyrsites atun*), Cape bream (*Pachymetopon blochii*), geelbek (*Atractoscion aequidens*), Silver kob (*Argyrosomus inodorus*), yellowtail (*Seriola lalandi*) and other reef fish. This type of fishing has a long history in South Africa, with many communities relying on this fishery as a source of livelihood and food. The traditional line fishery operates mostly inshore and utilises hook and line but excludes the use of longlines.

Crustacean fisheries comprise a trap and hoop net fishery targeting West Coast rock lobster (*Jasus lalandii*), a line trap fishery targeting the South Coast rock lobster (*Palinurus gilchristi*) and a trawl fishery based solely along the East Coast targeting penaeid prawns, langoustines (*Metanephrops andamanicus* and *Nephropsis stewarti*), deep-water rock lobster (*Palinurus delagoae*) and red crab (*Chaceon macphersoni*).

Other fisheries include a mid-water trawl fishery targeting horse mackerel (*Trachurus trachurus capensis*) predominantly on the Agulhas Bank (South Coast) and a hand-jig fishery targeting chokka squid (*Loligo vulgaris reynaudii*) exclusively on the South Coast.

Seaweed is also regarded as a fishery, with harvesting of kelp (*Ecklonia maxima*) and (*Laminaria pallida*) in the Western and Northern Cape and hand-picking of Gelidium sp. in the Eastern Cape. The seaweed industry employs over 313 people who are permanent and approximately 1450 people who are employed seasonally. Most of the employed people are women from previously disadvantaged backgrounds. E. maxima is primarily used by the abalone aquaculture industry as abalone feed.

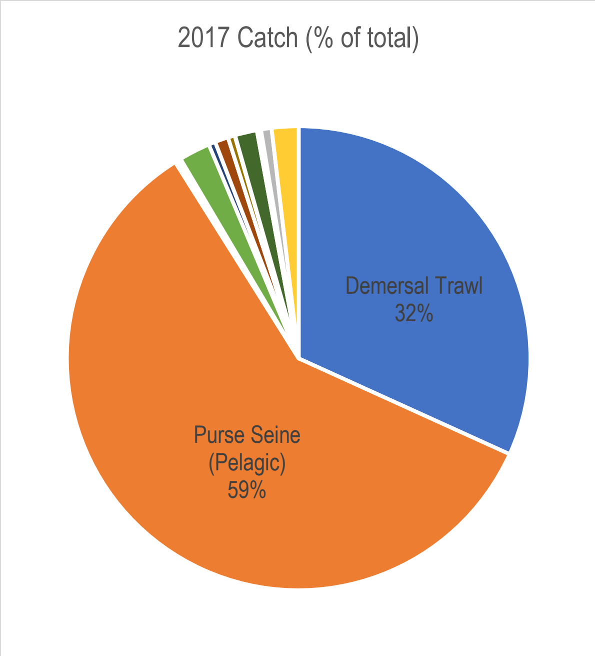
Marine aquaculture in South Africa involves the farming of species such as abalone, mussels, and oysters in ocean-based pens or cages. This industry has shown steady growth in recent years as demand for sustainably farmed seafood products has increased. The aquaculture sector creates jobs and contributes to the economy in coastal communities, while also helping to relieve pressure on wild fish stocks. The South African government has actively supported the development of the aquaculture industry through the implementation of regulations and initiatives aimed at promoting sustainable and responsible practices.

Most commercial fish landings must take place at designated fishing harbours. For the larger industrial vessels targeting hake, only the major ports of Saldanha Bay, Cape Town, Mossel Bay and Gqeberha are used. On the West Coast, St. Helena Bay and Saldanha Bay are the main landing sites for the small pelagic fleets. These ports also have significant infrastructure for the processing of anchovy into fishmeal as well as the canning of sardine. Smaller fishing harbours on the West / South-West Coast include Port Nolloth, Hondeklipbaai, Dooringbaai, Laaiplek, Hout Bay and Gansbaai harbours. On the East Coast, Durban and Richards Bay are deployment ports for crustacean trawl and large pelagic longline sectors.

The recreational fishing sector in South Africa includes a diverse range of activities, from shore and boat-based angling to spearfishing and collecting of marine species. This sector targets a wide range of line fish species, some of which are also targeted by commercial operators. Divers participate in the collection of rock lobsters and other subtidal invertebrates. Bait collection is another popular activity, where mussels, limpets, and red bait are gathered for use as bait. Net fisheries are limited to cast netting within the recreational sector. These activities provide an important source of recreation for South Africans and help to support the local economy by providing a source of livelihood for many people involved in the sector.

The commercial and recreational fisheries are reported to catch over 250 marine species, although fewer than 5% of these are actively targeted by commercial fisheries, which comprise 90% of the landed catch. To reduce user conflicts between commercial and recreational fishing, and to protect stocks during breeding periods, certain areas have been declared closed areas.

The Small-Scale Fisheries sector in South Africa is relatively new and permits the harvesting of a variety of species for commercial and consumptive use. This sector is established through the allocation of rights to co-operative groups and management co-operatives that represent over 230 small-scale fishing communities along the South African coastline. These co-operatives are comprised of more than 10 000 individual fishers who work together to harvest a variety of species for commercial purposes. The small-scale fisheries sector provides important livelihoods and food security for these communities, and the allocation of rights through co-operative management helps to ensure that the sector is sustainable and equitable.



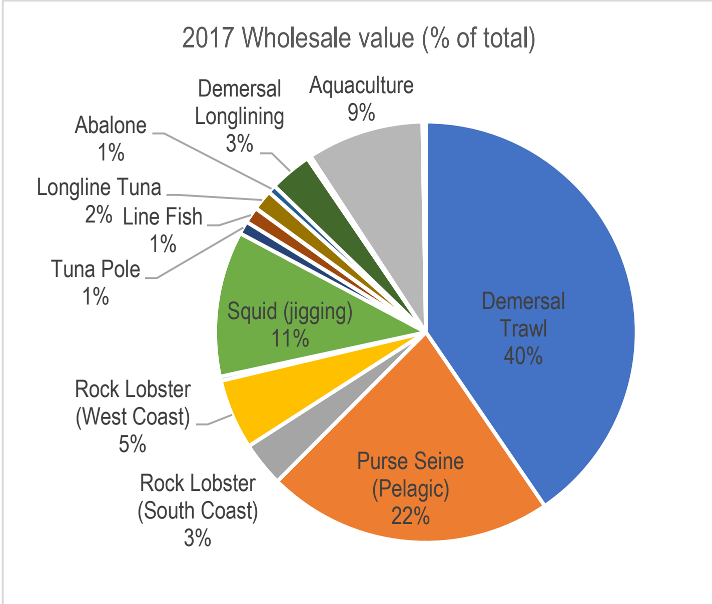


Figure 81: Pie chart showing percentage of landings by weight (left) and wholesale value (right) of each commercial fishery sector as a contribution to the total landings and value for all commercial fisheries sectors combined (2017). Source: DEFF, 2019.

Table 23: South African offshore commercial fishing sectors: wholesale value of production in 2017 (adapted from DEFF, 2019).

Sector	No. of Rights Holders (Vessels)	Catch (tons)	Landed Catch /sales (tons)	Wholesale Value of Production in 2017 (R'000)	% of Total Value
Small pelagic purse-seine	111 (101)	313 476	313 476	2 164 224	22.0
Demersal trawl (offshore)	50 (45)	163 743	98 200	3 891 978	39.5
Demersal trawl (inshore)	18 (31)	4 452	2 736	90 104	0.9
Midwater trawl	34 (6)	19 555			
Demersal longline	146 (64)	8 113	8 113	319 228	3.2
Large pelagic longline	30 (31)	2 541	2 541	154 199	1.6
Tuna pole-line	170 (128)	2 399	2 399	97 583	1.0
Traditional linefish	422 (450)	4 931	4 931	122 096	1.2
Longline shark demersal		72	72	1 566	0.0
South coast rock lobster	13 (12)	699	451	337 912	3.4
West coast rock lobster	240 (105)	1 238	1 238	531 659	5.4

Sector	No. of Rights Holders (Vessels)	Catch (tons)	Landed Catch /sales (tons)	Wholesale Value of Production in 2017 (R'000)	% of Total Value
Crustacean trawl	6 (5)	310	310	32 012	0.3
Squid jig	92 (138)	11 578	11 578	1 099 910	11.2
Miscellaneous nets	190 (N/a)	1 502	1 502	25 589	0.3
Oysters	146 pickers	42	42	3 300	0.0
Seaweeds	14 (N/a)	9 877	6 874	27 095	0.3
Abalone	N/a (N/a)	86	86	61 920	0.6
Aquaculture		3 907	3 907	881 042	9.0
Total		528 966	458456	9 841 417	100

Table 24: South African offshore fishing sectors, areas of operation and target species (DEFF, 2019).

Sector	Areas of Operation	Main Ports in Priority	Target Species
Small pelagic purse-seine	West, South Coast	St Helena Bay, Saldanha, Hout Bay, Gansbaai, Mossel Bay	Anchovy (*Engraulis encrasicolus*), sardine (*Sardinops sagax*), Redeye round herring (*Etrumeus whiteheadi*)
Demersal trawl (offshore)	West, South Coast	Cape Town, Saldanha, Mossel Bay, Gqeberha	Deepwater hake (Merluccius paradoxus), shallow-water hake (Merluccius capensis)
Demersal trawl (inshore)	South Coast	Cape Town, Saldanha, Mossel Bay	East coast sole (*Austroglossus pectoralis*), shallow-water hake (*Merluccius capensis*), juvenile horse mackerel (*Trachurus capensis*)
Midwater trawl	West, South Coast	Cape Town, Gqeberha	Adult horse mackerel (*Trachurus capensis*)
Demersal longline	West, South Coast	Cape Town, Saldanha, Mossel Bay, Gqeberha, Gansbaai	Shallow-water hake (*Merluccius capensis*)
Large pelagic longline	West, South, East Coast	Cape Town, Durban, Richards Bay, Gqeberha	Yellowfin tuna (*T. albacares*), big eye tuna (*T. obesus*), Swordfish (*Xiphius gladius*), southern bluefin tuna (*T. maccoyii*)
Tuna pole-line	West, South Coast	Cape Town, Saldanha	Albacore tuna (*T. alalunga*), yellowfin tuna

Sector	Areas of Operation	Main Ports in Priority	Target Species
Linefish	West, South, East Coast	All ports, harbours and beaches around the coast	Snoek (*Thyrsites atun*), Cape bream (*Pachymetopon blochii*), geelbek (*Atractoscion aequidens*), Silver kob (*Argyrosomus inodorus*), yellowtail (*Seriola lalandi*), Sparidae, Serranidae, Carangidae, Scombridae, Sciaenidae
South coast rock lobster	South Coast	Cape Town, Gqeberha	*Palinurus gilchristi*
West coast rock lobster	West Coast	Hout Bay, Kalk Bay, St Helena	Jasus lalandii
Crustacean trawl	East Coast	Durban, Richards Bay	Tiger prawn (*Panaeus monodon*), white prawn (*Fenneropenaeus indicus*), brown prawn (*Metapenaeus monoceros*), pink prawn (*Haliporoides triarthrus*)
Squid jig	South Coast	Gqeberha, St Francis	Squid/chokka (Loligo vulgaris reynaudii)
Gillnet	West Coast	False Bay to Port Nolloth	Mullet / harders (*Liza richardsonii*)
Beach seine	West, South, East Coast	Coastal	Mullet / harders (*Liza richardsonii*)
Oysters	South, East Coast	Coastal	Cape rock oyster (*Striostrea margaritaceae*)
Seaweeds	West, South, East	Coastal	Beach-cast seaweeds (kelp, *Gelidium spp*. and *Gracilaria spp.*)
Abalone	West Coast	Coastal	*Haliotis midae*
Small-scale fishery	West, South, East	Coastal	Various

8.4.2 SPAWNING AND RECRUITMENT OF FISH STOCKS

Spawning is the process by which fish lay and fertilize eggs, which then develop into new individuals. This process is critical for maintaining and replenishing fish populations. In South Africa, the timing and location of spawning for many fish species is influenced by environmental factors such as water temperature, light levels, and ocean currents.

Recruitment, on the other hand, is the process by which juvenile fish grow and mature, and eventually join the adult population. This is an important stage in the life cycle of a fish, as the survival and growth of young fish can have a major impact on the overall health of the population.

The southern African coastline is characterized by strong ocean currents. On the eastern seaboard, the warm western boundary Agulhas Current flows close to the coast before moving away from the coast on the Agulhas Bank and eventually returning to the Indian Ocean. On the western seaboard, powerful jet currents form in the southern Benguela region due to the strong thermal differences caused by upwelling and the influence of the

Agulhas Current and its eddies. Generally, the surface waters in the Benguela Current flow northward and are subject to strong losses off the coast near Luderitz, where upwelling is particularly active.

There are several mechanisms that contribute to the dispersal and loss of productive shelf waters, such as eddies, filaments, retroflections, and offshore Ekman drift, which pose challenges for the successful retention of planktonic eggs and larvae from broadcast spawners. To overcome these challenges, most fish species in southern Africa have evolved selective reproductive patterns that ensure sufficient progeny are retained or reach the nursery grounds along the coastline. Three important and one minor reproductive habitats occur between Mozambique and Angola and are utilized by a wide range of pelagic, demersal, and inshore-dwelling fish species, comprising spawning areas, transport mechanisms, and nursery grounds. The three key nursery grounds for commercially important species can be identified in South African waters as a) the Natal Bight b) the Agulhas Bank and c) the inshore Western Cape coasts. The central Namibian shelf region is also identified as important, but to a lesser extent of a - c. Each is linked to a spawning area, a transport and/or recirculation mechanism, a potential for deleterious offshore or alongshore transport and an enriched productive area of coastal or shelf-edge upwelling (Hutchings *et al*., 2002). According to Hutchings (1992, 1994), despite the wide shelf and high primary productivity in southern Africa, fish yields are not particularly high. This suggest that the oceanographic climate is potentially restrictive to spawning success.

There are a number of factors that can negatively affect the success of recruitment in South Africa's marine fisheries, including overfishing, habitat destruction, pollution, and changes in ocean temperature and chemistry. In order to sustain healthy fish populations, it is important for management agencies to monitor and understand the factors that influence spawning and recruitment, and to implement measures to protect and conserve these processes. Most research on spawning and recruitment of commercially important species was completed in the 1990s to early 2000s, with no follow up to see if these patterns may have changed as a result of the negatively factors mentioned above.

8.4.2.1 **THE WEST COAST SPAWNING GROUND**

Hake, sardines, anchovy and horse mackerel are broadcast spawners, producing large numbers of eggs that are widely dispersed in ocean currents (Hutchings *et al*., 2002). These principal commercial fish species undergo a critical migration pattern in the Agulhas and Benguela ecosystems (refer to Figure 82).

Many species of pelagic fish that are commonly found in the major upwelling systems in the region use the central or western Agulhas Bank as a spawning area. This area is known for its surface waters that flow towards the northwest and coastal upwelling that occurs during late summer. The convergent water mass formed by this process turns into a coastal jet current that moves along the west coast, including the highly active upwelling centers at Cape Town and Cape Columbine. This jet current plays a crucial role in transporting eggs and larvae to the west coast nursery grounds, where the young fish can grow and mature. At Cape Columbine, the jet current appears to diverge, with different components flowing offshore, alongshore, and inshore.

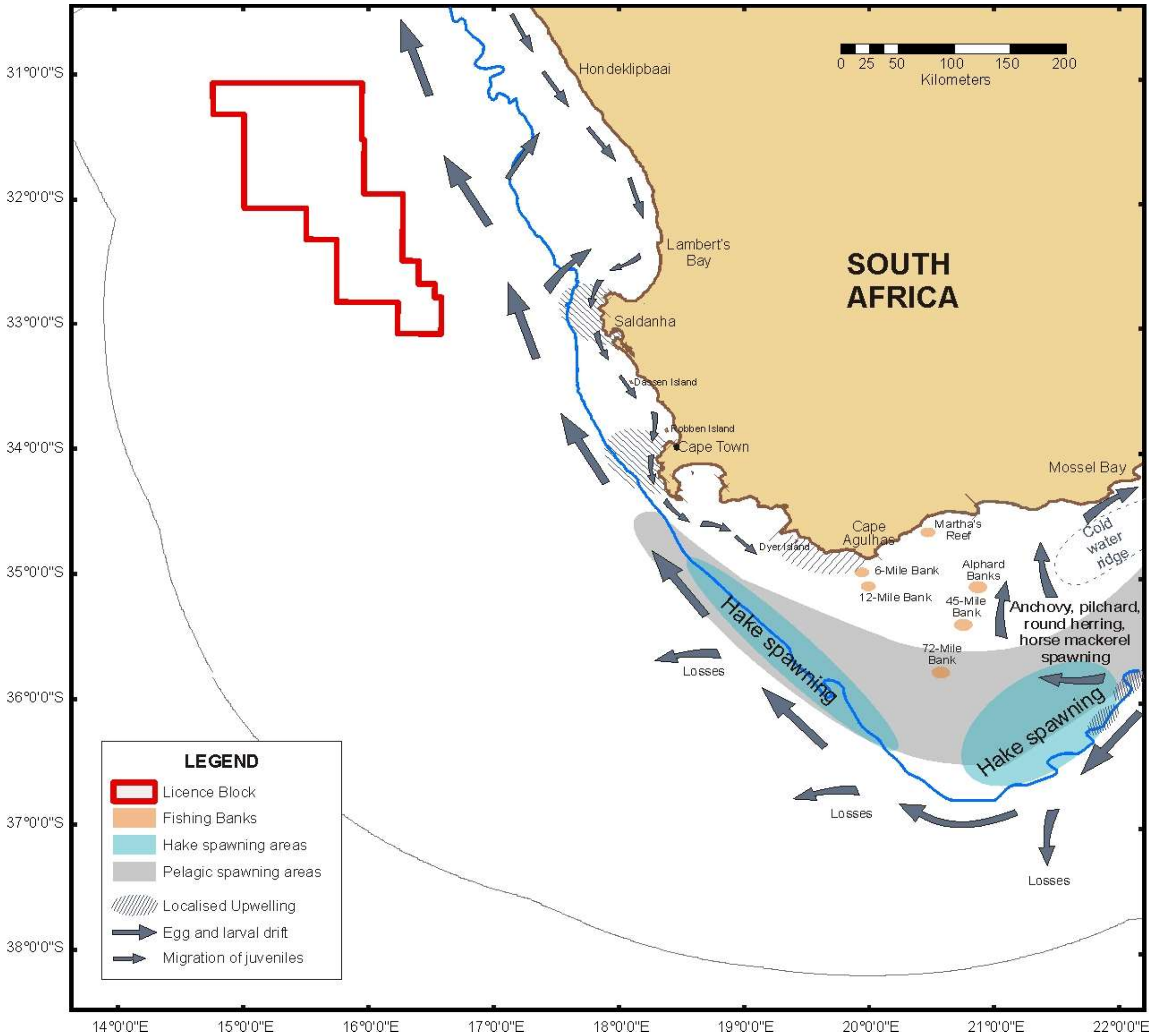


Figure 82: Block 3B/4B (red polygon) in relation to major spawning areas in the southern Benguela region (Source: Pulfrich, 2023 adapted from Crawford et al. 1987; Hutchings 1994; Hutchings et al. 2002).

8.4.2.2 **HORSE MACKEREL**

Horse mackerel spawns in the east/central Agulhas Bank during the winter months and the young juveniles can be found close inshore along the southern Cape coastline (20–26°E) However, during the summer months, there is a significant overlap with the inshore west coast nursery habitat (Barange *et al*. 1998). As the horse mackerel mature, they become more demersal and move offshore before migrating back to the Agulhas Bank as adults.

8.4.2.3 **ANCHOVIES**

Anchovies spawn on the entire Agulhas Bank from October to March with the highest spawning activity occurring during mid-summer (November–December; van der Lingen and Huggett, 2003; Figure 83). In some years, when the Agulhas Bank water strongly intrudes north of Cape Point, there is a shift in the anchovy spawning to the west coast (van der Lingen *et al*. 2001). The bulk of the anchovy recruits can be found along the west coast, with less than 5% found on the inshore south coast (Hampton 1992; Figure 84). Older anchovies tend to shift further east to the central and eastern parts of the Agulhas Bank and often spawn between the cool ridge and the Agulhas Current (Roel *et al*. 1994). Since 1994, there has been a noticeable eastward shift in the anchovy spawning distribution to the east-central Agulhas Bank. While anchovies are known to spawn on the east coast shelf, the narrow shelf limits the population size of the spawners (Armstrong *et al*. 1991; Beckley and Hewitson 1994).

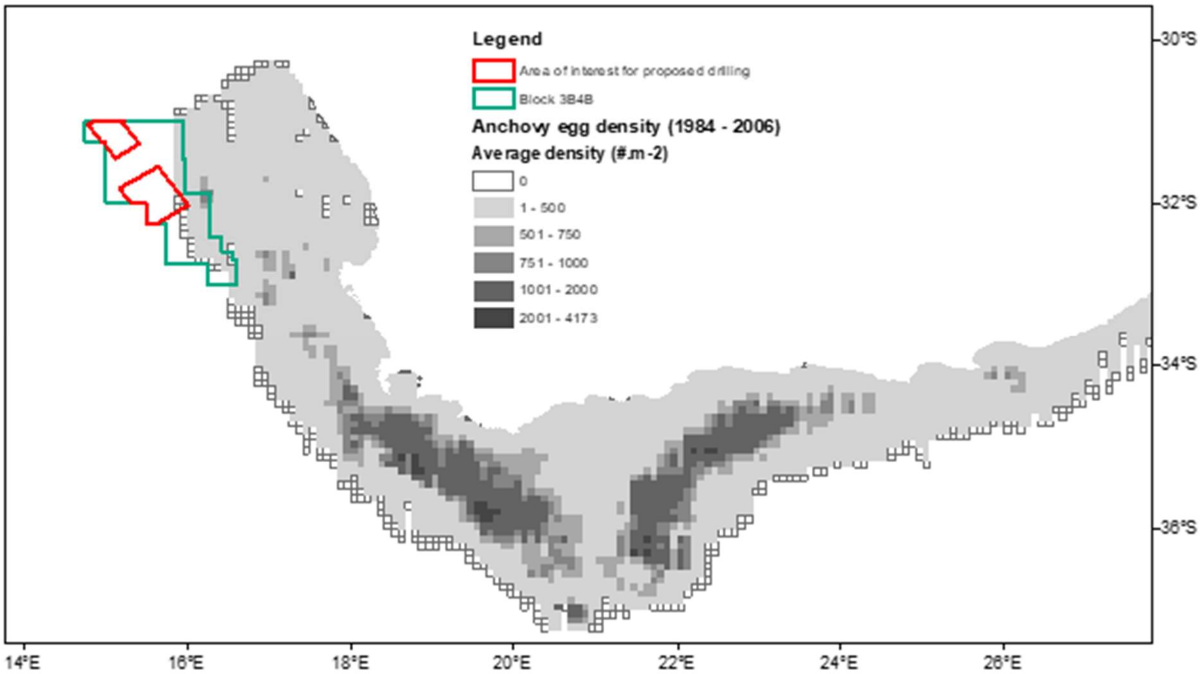


Figure 83: Block 3B/4B (Green polygon) and the AOI for drilling (Red polygon) in relation to the distribution of anchovy spawning areas, as measured by egg densities (DFFE).

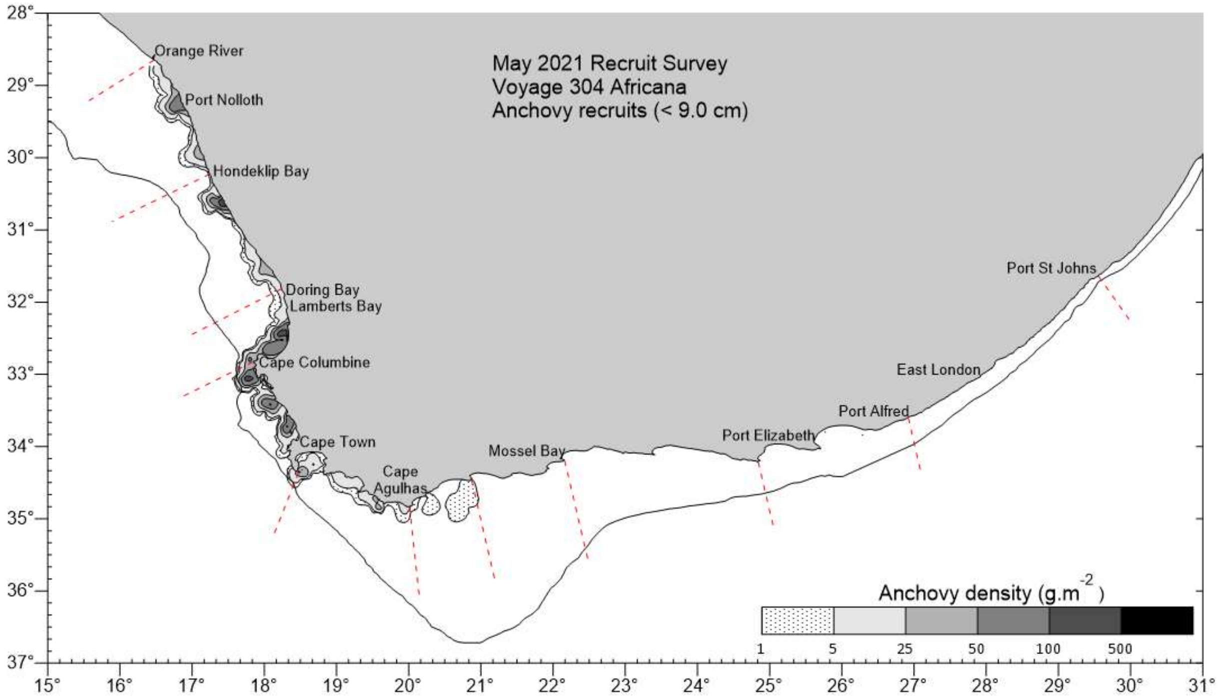


Figure 84: Distribution and relative abundance of anchovy recruits (< 9 cm) (Source: DFFE Small Pelagic Scientific Working Group FISHERIES/2021/JUL/SWG-PEL/51draft

8.4.2.4 **SARDINES**

There are two stocks of sardine off South Africa; the Cool Temperate Sardine (CTS) off the west coast and Warm Temperate Sardine (WTS) off the south coast, with some mixing (in both directions) between the two (Teske *et al*. 2021, Figure 85). In the West Coast Spawning Ground the stock of interest is the CTS.

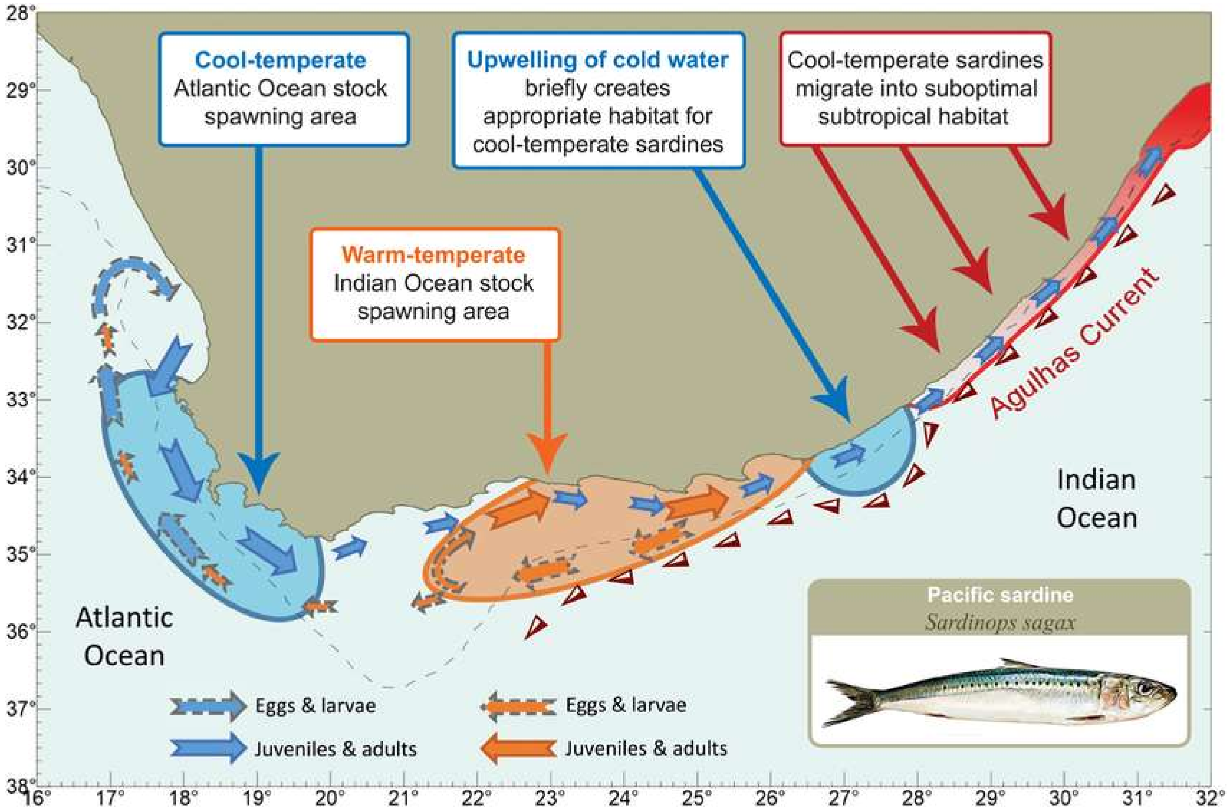


Figure 85: Stock structure of Pacific sardine, S. sagax, in South African waters. The spawning area in the Atlantic Ocean (blue) is numerically dominated by cool-temperate sardine, and the spawning area in the Indian Ocean (orange) is dominated by warm-temperate sardines (Source: Teske *et al*. 2021)

Sardines spawn in a similar area to anchovies during November and generally have two spawning peaks in early spring and autumn, which occur on either side of the peak anchovy spawning period. There has been a recent shift westwards in the sardine spawning distribution in November, with the majority of spawning now occurring on the west coast between latitudes 31°S and 35°S, and to a lesser extent, off the central and eastern Agulhas Bank, concurrent with anchovy (Beckley and van der Lingen 1999; Figure 86). Sardine spawning also occurs on the east coast and even off KwaZulu-Natal, where sardine eggs can be found from July to November. Importantly, the eggs of both anchovies and sardines are frequently found far offshore on the Agulhas Bank, sometimes extending over the shelf break, and they spawn in a narrow zone between the cool upwelling ridge and the rapidly flowing Agulhas Current.

On the western seaboard, the sardine eggs that are deposited in the peripheral shelf areas are susceptible to being moved away from the coast by powerful equatorial winds that cause Ekman drift. Additionally, the eggs and larvae can be caught up in filaments or Agulhas Rings and transported further out to sea. Sardines have a lengthy spawning season that spans from late winter to spring and from autumn, when the southern winds are not at their strongest. The majority of the new recruits on the west coast likely originate from eggs laid either before or after the summer southern wind peak (Figure 87). Juveniles shoal and then begin a southward migration. It is at this stage that both anchovy and sardine are targeted by the small pelagic purse seine fishery.

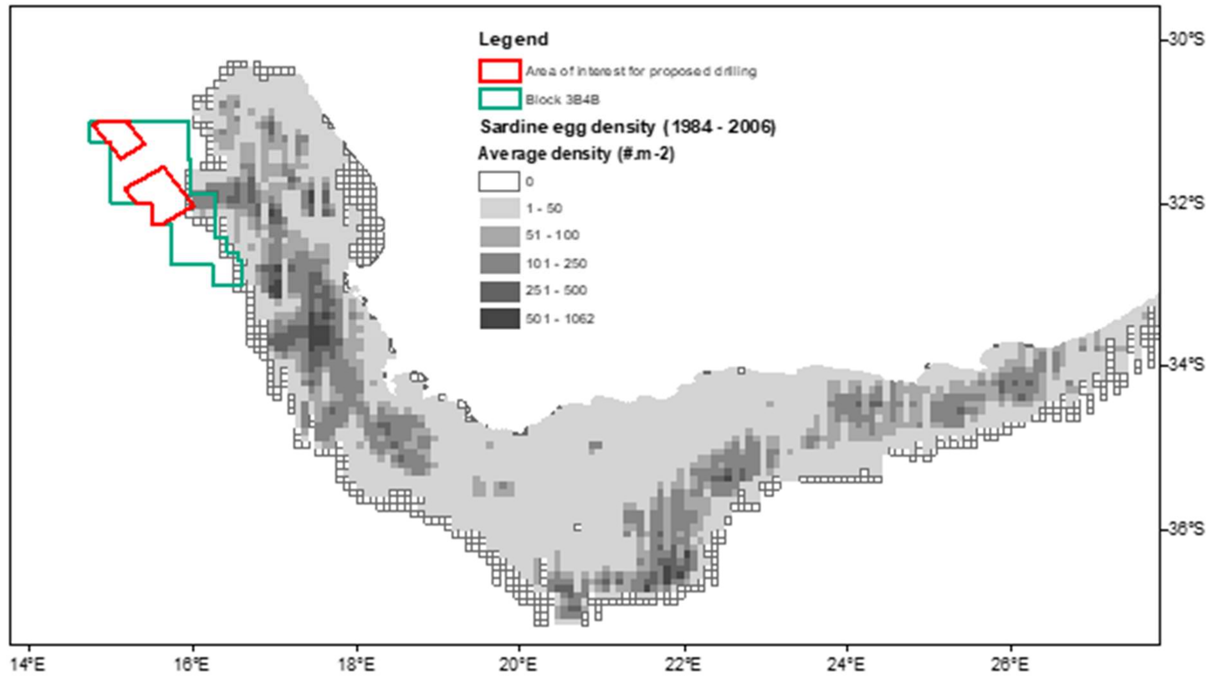


Figure 86: Block 3B/4B (Green polygon) and the AOI for drilling (Red polygon) in relation to the distribution of sardine spawning areas, as measured by egg densities (collected during spawner biomass surveys by DFFE over the period 1984 to 2006).

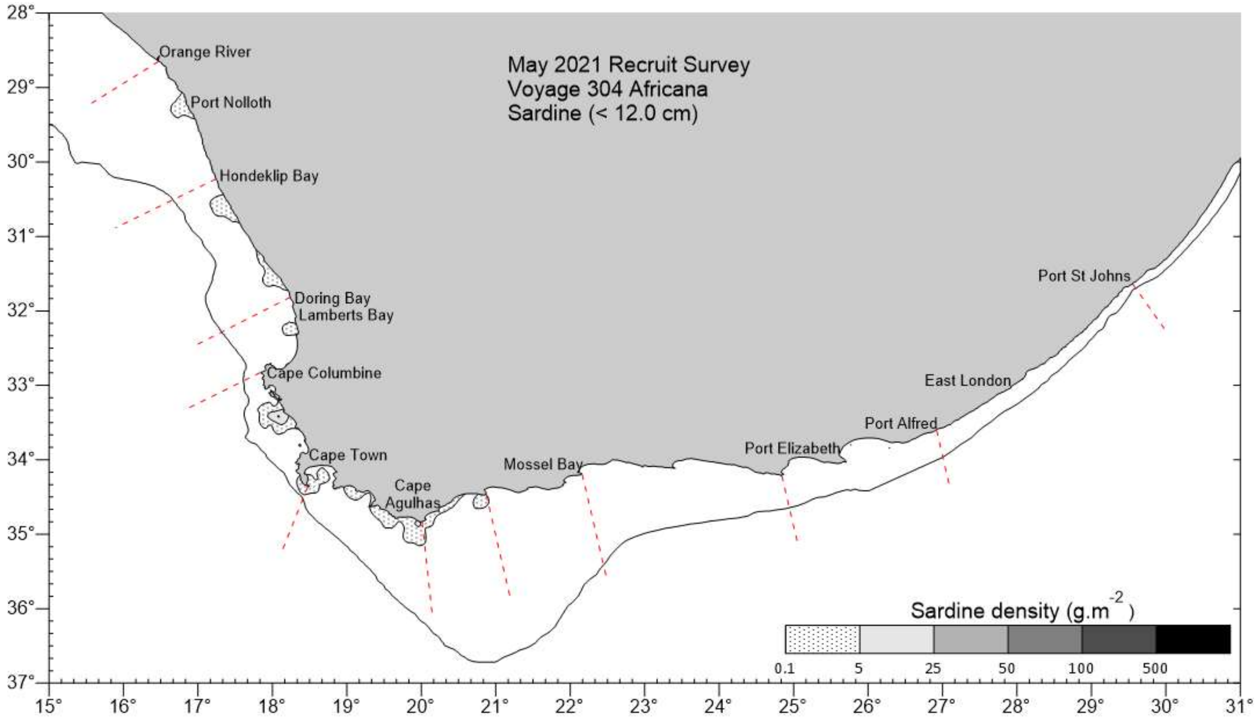


Figure 87: Distribution and relative abundance of sardine recruits (< 12 cm) (Source: DFFE Small Pelagic Scientific Working Group FISHERIES/2021/JUL/SWG-PEL/51draft

8.4.2.5 **HAKE SPECIES**

The two hake species, shallow-water hake (*M. capensis*) and deep-water hake (*M. paradoxus*), have different spawning patterns in terms of depth and timing. Hake spawn throughout the year, with peaks in October/November and March/April, and are serial spawners (Johann Augustyn, SADSTIA and Dave Japp, CapMarine pers com.). Although the Namibian spawning ground will be discussed separately it is important to note that deep-water hake (*M. paradoxus*) do not spawn in Namibian waters, but shallow-water hake (*M. capensis*) does. Adult hakes generally migrate offshore during June to August and it is here that they are targeted by commercial fisheries. However, it's important to note that the timing and extent of adult hake movements can vary depending on factors such as water temperature, food availability, and environmental conditions.

Shallow-water hake spawn mainly over the shelf, at depths less than 200 m, while deep-water hake spawn in deeper waters beyond the shelf. Although both species spawn throughout their distributional range, high spawning concentrations occur mid-shelf off Cape Columbine and on the western Agulhas Bank, with peak spawning areas observed at 31.0°-32.5°S and 34.5°-36.0°S (Jansen *et al*., 2015; Figure 88).

The depth at which the hake species spawn differs as well, with *M. paradoxus* spawning at bottom depths between 200 m and 650 m, and *M. capensis* spawning at an average depth of 180 m. The distribution of their eggs also varies, with *M. paradoxus* eggs distributed over greater bottom depths (340 m – 1500 m) than *M. capensis* eggs (120 m to 300 m) (Stenevik *et al*., 2008; Figure 89).

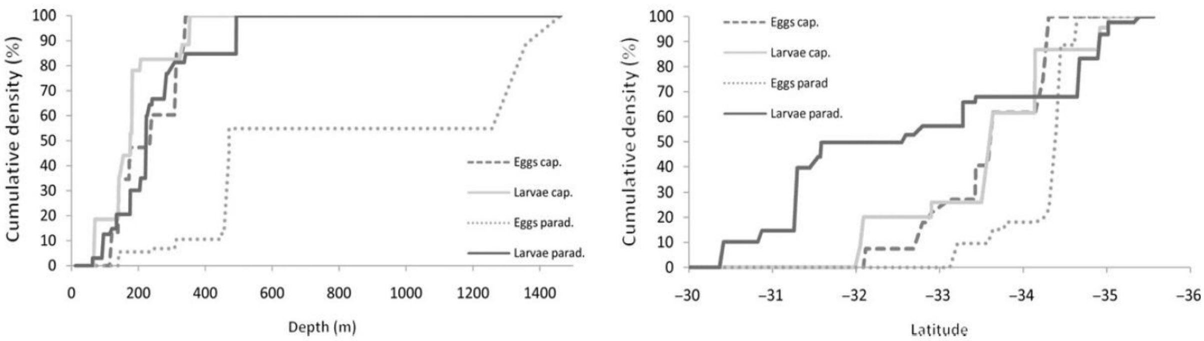


Figure 88: Cumulative density plots of Cape hake eggs and larvae sorted by (left panel) increasing seafloor depth and (right panel) increasing latitude (degrees south) (Source: Stenevik *et al*., 2008).

Water currents play a crucial role in the transport of hake spawning products. The offshore drift route along the outer shelf carries the eggs and larvae of both species away from the coast and into the deep ocean, while inshore drift transports larvae along the west coast to the Orange Banks, with *M. paradoxus* mainly concentrated around the 100 m depth contour (Stromme *et al*., 2015). Eggs spawned inshore are likely to be transported in the slower inshore branch of the current from the western Agulhas Bank to inshore areas farther north (Grote *et al*., 2012 in Jansen *et al*., 2015). The vertical distribution of hake eggs and larvae is between the surface and 200 m depth, with the highest concentrations in the 50 – 100 m depth range (Stenevik *et al*., 2008).

Compared to pelagic species, the eggs and larvae of hake are found deeper in the water column, making them less vulnerable to Ekman transport (Sundby *et al*., 2001; Hutchings *et al*., 2002 in Stenevik *et al*., 2008).

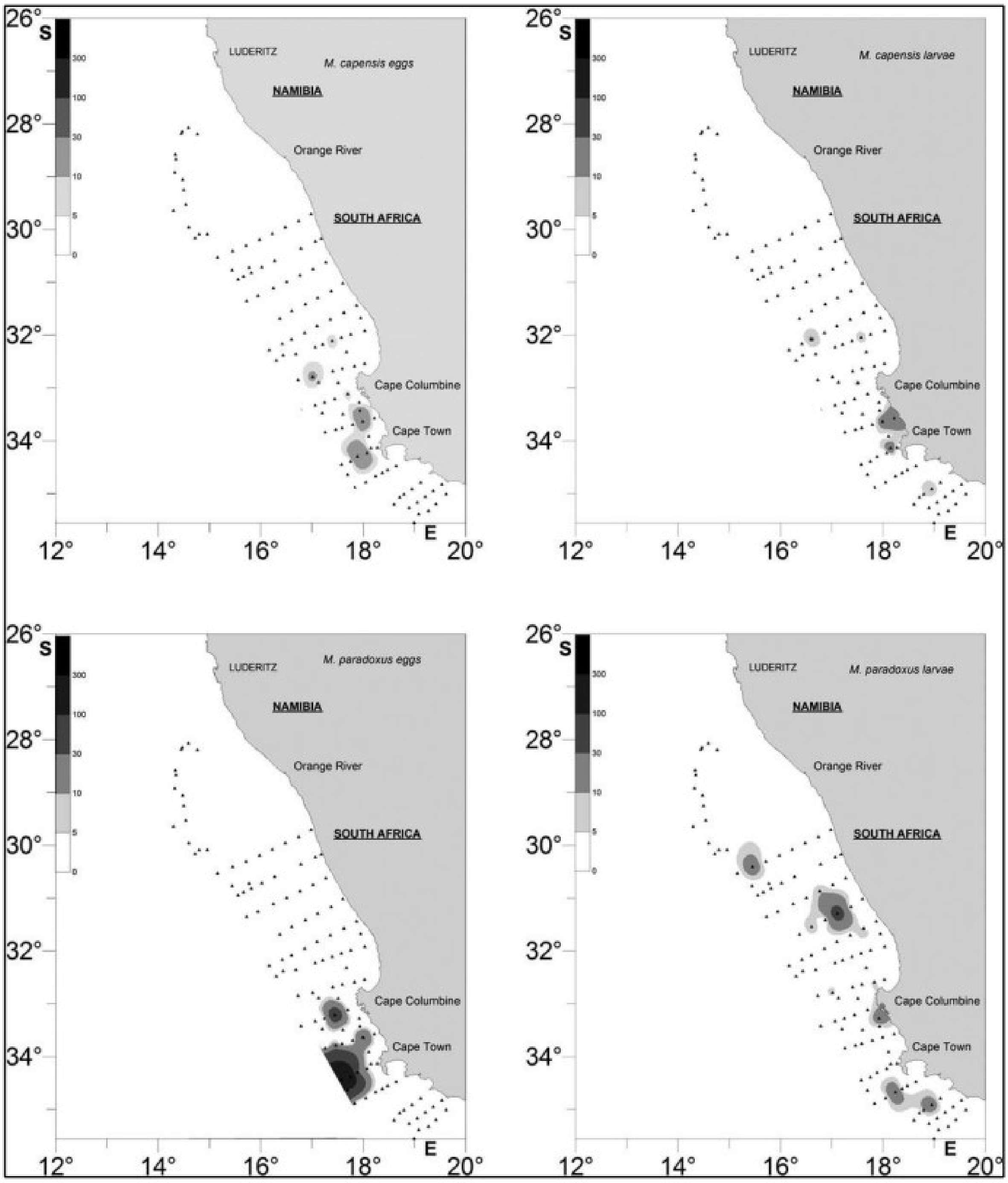


Figure 89: Station map showing the distribution of eggs (left) and larvae (right) of Cape hakes (M. capensis upper and M. paradoxus lower) during a research survey conducted between September and October 2005. Numbers per 10 m2 (Stenevik *et al*., 2008).

8.4.2.6 SNOEK

Snoek (*Thyrsites atun*) is a valuable commercial species and is targeted during their inshore migration period by the linefishery and small-scale fishers. It is also landed by the demersal trawl fishery as a by-catch species. Snoek is also a significant predator of small pelagic fish in the Benguela ecosystem. The South African population reaches 50% sexual maturity at a fork length of around 73 cm (3 years). Spawning takes place offshore during winter-spring (June to October) along the shelf break (150-400 m) of the western Agulhas Bank and the South African west coast. Eggs and larvae are transported by prevailing currents to a primary nursery ground located north of Cape Columbine and a secondary nursery area situated to the east of Danger Point, both shallower than

150 m (Figure 90). Juveniles grow between 33 and 44 cm in their first year (3.25 cm/month) and remain on the nursery grounds until maturity. Their onshore-offshore distribution between 5 and 150 m isobaths is determined primarily by prey availability and includes a seasonal inshore migration in autumn in response to clupeoid recruitment.

Adults can be found throughout the distribution range of the species, and while they move offshore to spawn, there is a southward dispersion as the spawning season progresses. Their longshore movement is apparently random and without a seasonal basis. The relative condition of both sexes declines significantly during spawning, with females experiencing higher mesenteric fat loss despite consuming prey at a greater rate. Sex ratios and indices of prey consumption suggest that females on the west coast move inshore to feed between spawning events, while those found farther south along the western Agulhas Bank remain on the spawning ground throughout the season. This difference in behaviours is attributed to the higher offshore abundance of clupeid prey on the western Agulhas Bank, as determined from diet and prey consumption rates (Griffiths, 2002; refer to Figure 90 for the spawning grounds and nursery areas for snoek).

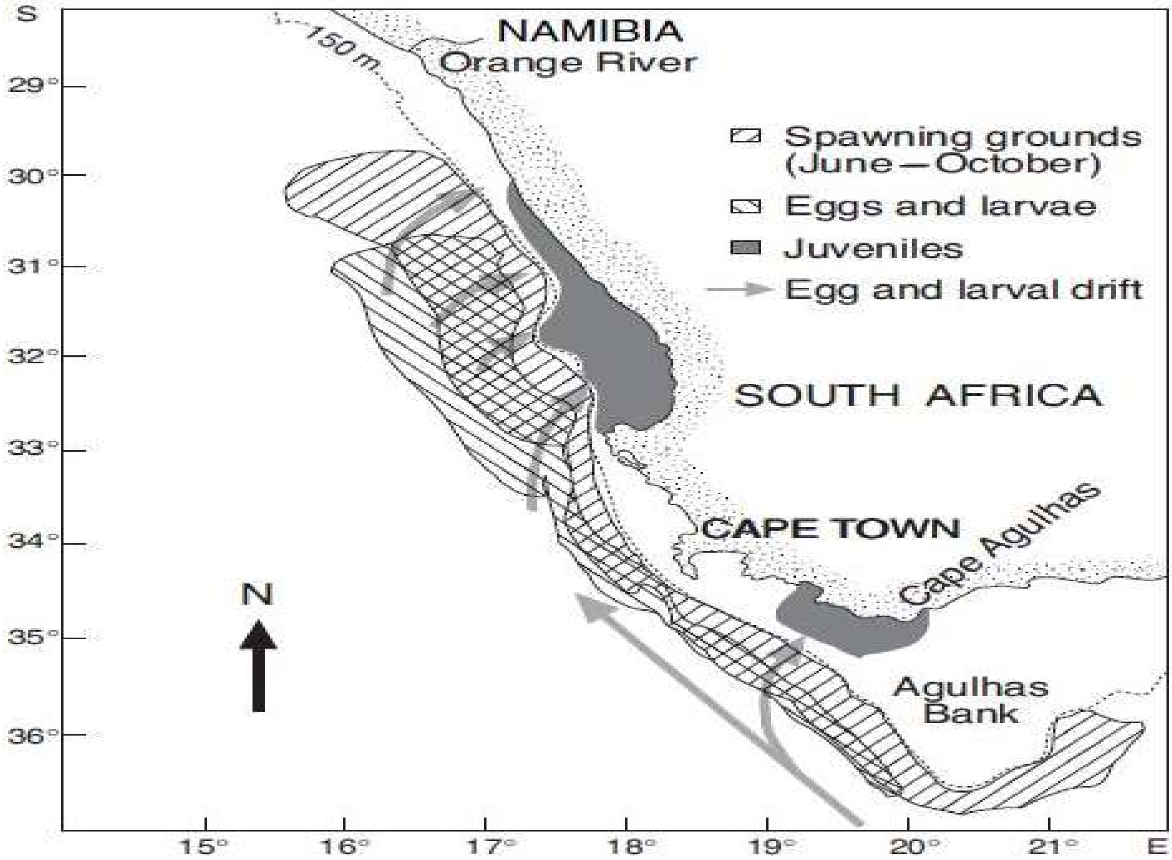


Figure 90: Conceptual model depicting the life history of snoek (left; Source: Griffiths, 2002) in the southern Benguela ecosystem, including spawning grounds, distribution and transport of eggs and larvae, and the nursery areas.

8.4.2.7 **SQUID**

Although the West Coast spawning ground is of little importance to Squid (Loligo spp.) spawning, paralarvae have been found West of Cape Agulhas so for the purpose of the current application it will feature here. Squid spawn in the nearshore zone on the eastern Agulhas Bank, principally in shallow waters (<50 m) between Knysna and Gqeberha (Figure 91). Their distribution and abundance are erratic and linked to temperature, turbidity, and currents (Augustyn *et al*. 1994; Schön *et al*. 2002). This niche area on the eastern Agulhas Bank optimises their spawning and early life stage as nowhere else on the shelf are both bottom temperature and bottom dissolved oxygen simultaneously at optimal levels for egg development (Roberts 2005; Oosthuizen & Roberts

2009). The greatest concentration of their food (copepods) tends to be found further west in the cold-water ridge on the central Agulhas Bank (Roberts & van den Berg 2002). Squid are not broadcast spawners but instead they lay benthic egg sacs. The paralarvae that hatch from the sacs are distributed close inshore and juveniles are dispersed over the entire shelf region of the Agulhas Bank. Larvae and juveniles are carried offshore and westwards (via the Benguela jet) to feed and mature, before returning to the spawning grounds to complete their lifecycle (Olyott *et al*. 2007).

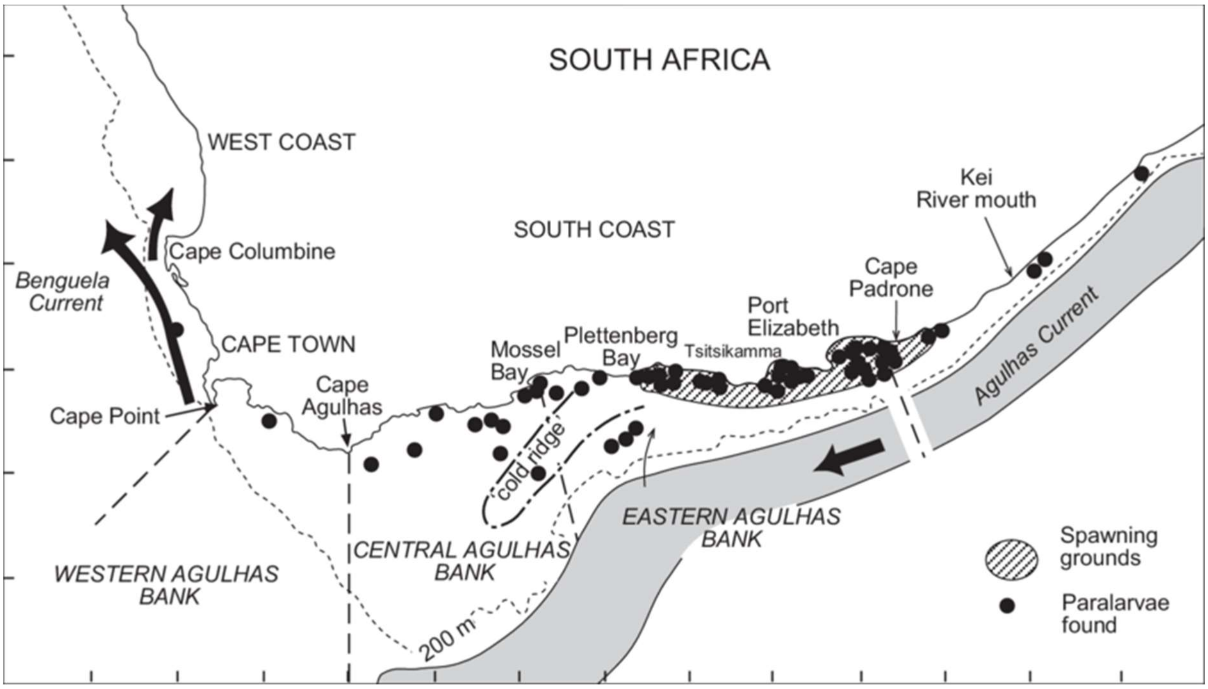


Figure 91: Main spawning grounds of Squid (Loligo spp.) on the eastern Agulhas Bank, east of the 'cold ridge'. Positions where paralarvae have been found are indicated (data from Augustyn *et al*. 1994).

8.4.2.8 **CENTRAL NAMIBIAN SPAWNING AND NURSERY GROUND**

The spawning of several types of fish, including hake, sardines, and horse mackerel, occurs in the waters off the coast of Namibia, from the Lüderitz upwelling center in the north down to the Angola-Benguela Front in the south (Sundby *et al*. 2001; Figure 92). The circulation patterns in this area are complex, with eddying and southward and onshore transport occurring beneath the surface drift to the northwest (Sundby *et al*. 2001). Sardine spawning peaks offshore in September and October, and larvae occur slightly further out to sea, with recruits appearing closer to shore (Sundby *et al*. 2001). Spawning also occurs in mid-summer in the Angola-Benguela Front region (Crawford *et al*. 1987), and warm water from the Angolan Current pushes southwards into central Namibian waters during late summer, which may transport pelagic spawning products into nursery grounds off central Namibia (Shannon 1985).

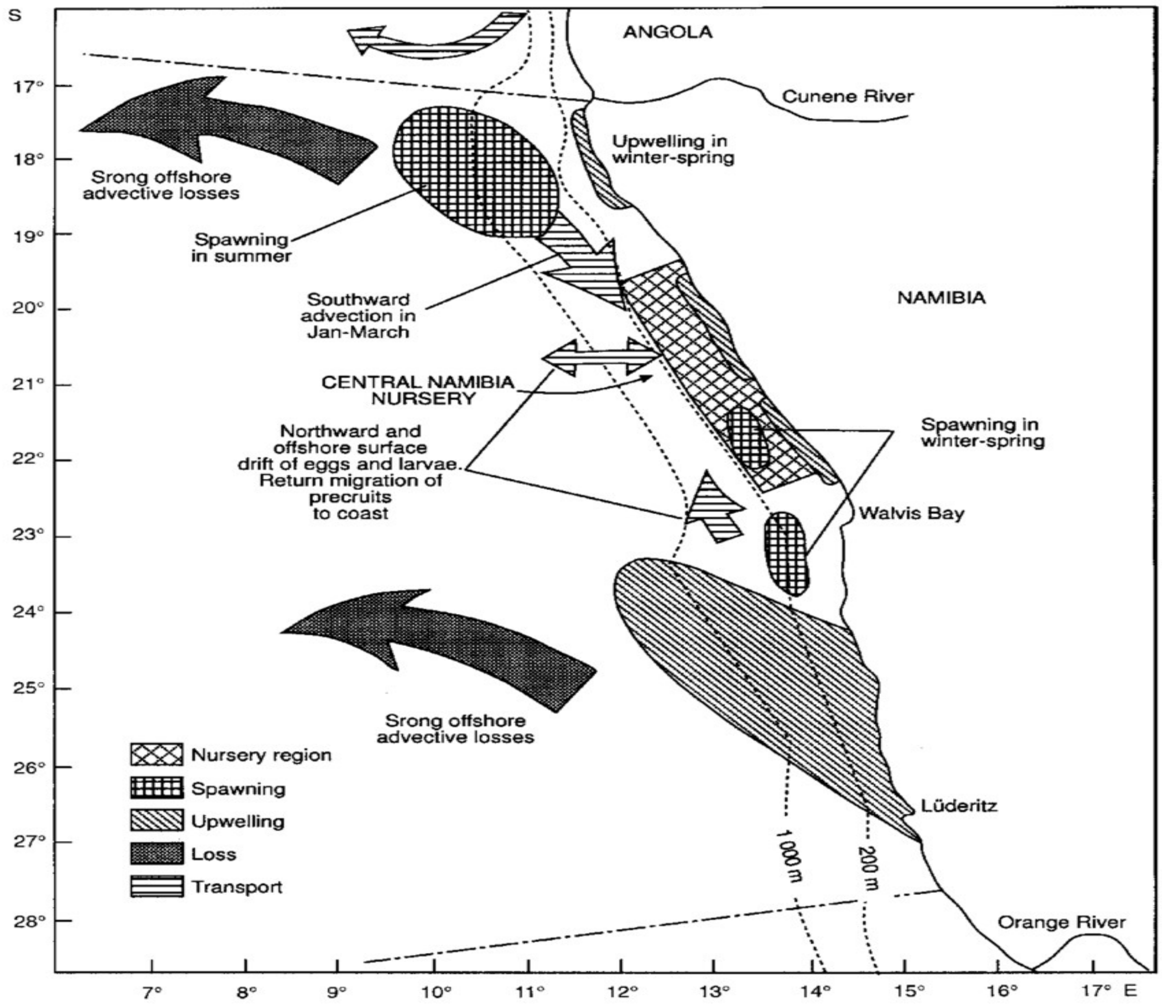


Figure 92: Central Namibian spawning/nursery ground, between the Lüderitz upwelling cell and the Angola-Benguela Front (Hutchings *et al*. 2002).

8.4.2.9 **OTHER IMPORTANT LINEFISH**

The inshore area of the Agulhas Bank, especially between the cool water ridge and the shore, serves as an important nursery area for numerous linefish species (e.g. elf Pomatomus saltatrix, leervis *Lichia amia*, geelbek *Atractoscion aequidens*, carpenter *Argyrozona argyrozona*) (Wallace *et al*. 1984; Smale *et al*. 1994). A significant proportion of these eggs and larvae originate from spawning grounds along the east coast, as adults undertake spawning migrations along the South Coast into KwaZulu-Natal waters (van der Elst 1976, 1981; Griffiths 1987; Garratt 1988; Beckley & van Ballegooyen 1992). The eggs and larvae are subsequently dispersed southwards by the Agulhas Current, with juveniles occurring on the inshore Agulhas Bank, using the area between the cold-water ridge and the shore as nursery grounds (van der Elst 1976, 1981; Garratt 1988). In the case of the carpenter, a high proportion of the reproductive output comes from the central Agulhas Bank and the Tsitsikamma Marine Protected Area (MPA), and two separate nursery grounds exist, one near Gqeberha and a second off the deep reefs off Cape Agulhas, with older fish spreading eastwards and westwards (van der Lingen *et al*. 2006).

For breeding season and locality of prominent commercial, recreational and artisanal linefish species associated with the Western Cape please refer to Table 25 below. Table 26 shows known spawning periods of key commercial species off the West Coast of South Africa.

Table 25: Summary breeding season and locality for important linefish species in Western Cape. Information adapted from Marine Linefish Species Profiles (Mann *et al*. 2013).

Common Name	Scientific Name	Concerned Fishery	Breeding/spawning Season	Breeding/spawning Locality
Blue Hottentot	Pachymetopon blochii	Artisanal line fishery, Recreational shore anglers and ski-boat fishers, bycatch of the gill-net fishery.	Throughout the year, with peaks in winter and summer (Pulfrich and Griffiths1988)	Throughout its distribution range (Pulfrich and Griffiths 1988)
Carpenter	Argyrozona argyrozona	Commercial line fishery, bycatch in demersal trawl (Attwood et al. 2011)	Summer and autumn (Brouwer and Griffiths 2005)	Throughout its distribution range (Brouwer and Griffiths 2005)
Dusky Kob	Argyrosomus japonicus	Mostly recreational shore, estuarine and ski boat anglers but also a component of commercial and artisanal line fishery.	October to January in the Eastern and Western Cape (Griffiths 1996)	Inshore reefs, pinnacles and wrecks (mainly at night) in KZN, Transkei and EC (Griffiths 1996, Connell 2012)
Geelbek	Atractoscion aequidens	Boat-based commercial and recreational line fishery. To a lesser extent, artisanal line fishery. Bycatch of the inshore demersal trawl.	Aug-Nov with a peak in Sep-Oct (Garratt 1988, Griffiths and Hecht 1995b, Connell 2012)	KZN offshore reefs 40-60m (Griffiths and Hecht 1995b, Connell 2012)
Red Roman	Chrysoblephus laticeps	Commercial and recreational line fishery.	Oct-Jan (Buxton 1990) observed Nov-Feb in the Goukamma area, WC (Götz 2005)	Eastern and Western Cape
Silver Kob	Argyrosomus inodorus	Recreational and commercial line fishery in SA and Namibia, bycatch of inshore trawl, taken by artisanal beach seine fishery.	Throughout the year, mainly from Aug-Dec with a peak between Sep-Nov (Griffiths 1997)	Inshore throughout distribution (Griffiths 1997)
White stumpnose	Rhabdosargus globiceps	Commercial and Recreational line fishery, occasional bycatch to artisanal net fisheries.	Summer, Sep-Mar (Griffiths et al. 2002).	Throughout the distribution range (Griffiths et al. 2002)
Yellowtail	Seriola lalandi	Large component of commercial line fishery, recreational fishery and artisanal beach seine fishers off Simonstown.	November to February.	Southern KZN to Cape Point.

Table 26: Summary table of known spawning periods for key commercial species off the West Coast of South Africa.

Commercial Species	Breeding/Spawning Season	Breeding/spawning Locality	Recruits	DWOB OVERLAP
Horse Mackerel	June to August	Central / Eastern Agulhas bank	Inshore southern Cape	No
Anchovies	October to March, peaks November to December	Agulhas Bank and West Coast nursery grounds	Inshore West Coast	No
Sardine	August to February	West Coast and Agulhas nursery grounds, into KZN.	Migrate South East back to Agulhas bank	No
Hake spp	Throughout the year, peaks in March/April and October/November	Throughout SA distribution, concentrated mid-shelf Cape Columbine and W Agulhas bank	Inshore, migrate to depth as adults	No
Snoek	June to October	West Coast and Agulhas bank	Cape Columbine and Danger Point nursery	No
Squid	Throughout with peaks in November, and December.	Nearshore Eastern Agulhas Bank	Offshore and Westward	No

8.4.3 RESEARCH SURVEYS

Swept-area trawl surveys of demersal fish resources are carried out twice a year by DFFE in order to assess stock abundance. Results from these surveys are used to set the annual TACs for demersal fisheries. First started in 1985, the West Coast survey extends from Cape Agulhas (20°E) to the Namibian maritime boarder and takes place over the duration of approximately one month during January/February. The survey of the Southeast coast (20°E – 27°E longitude) takes place in April/May. Following a stratified, random design, bottom trawls are conducted to assess the biomass, abundance and distribution of hake, horse mackerel, squid and other demersal trawl species on the shelf and upper slope of the South African coast. Trawl positions are randomly selected to cover specific depth strata that range from the coast to the 1 000 m isobath. Figure 93 shows the spatial distribution of research trawls in relation to the licence block and the proposed AOI for drilling. Over the period 2013 to 2021, 46 research trawls were carried out within the licence block (average 5 trawls per survey), at a seafloor depth range of 345 m to 950 m. Surveys in the licence block take place over the period January to March. Over the period 2013 to 2021 no demersal research trawls were undertaken within the AOI for well drilling.

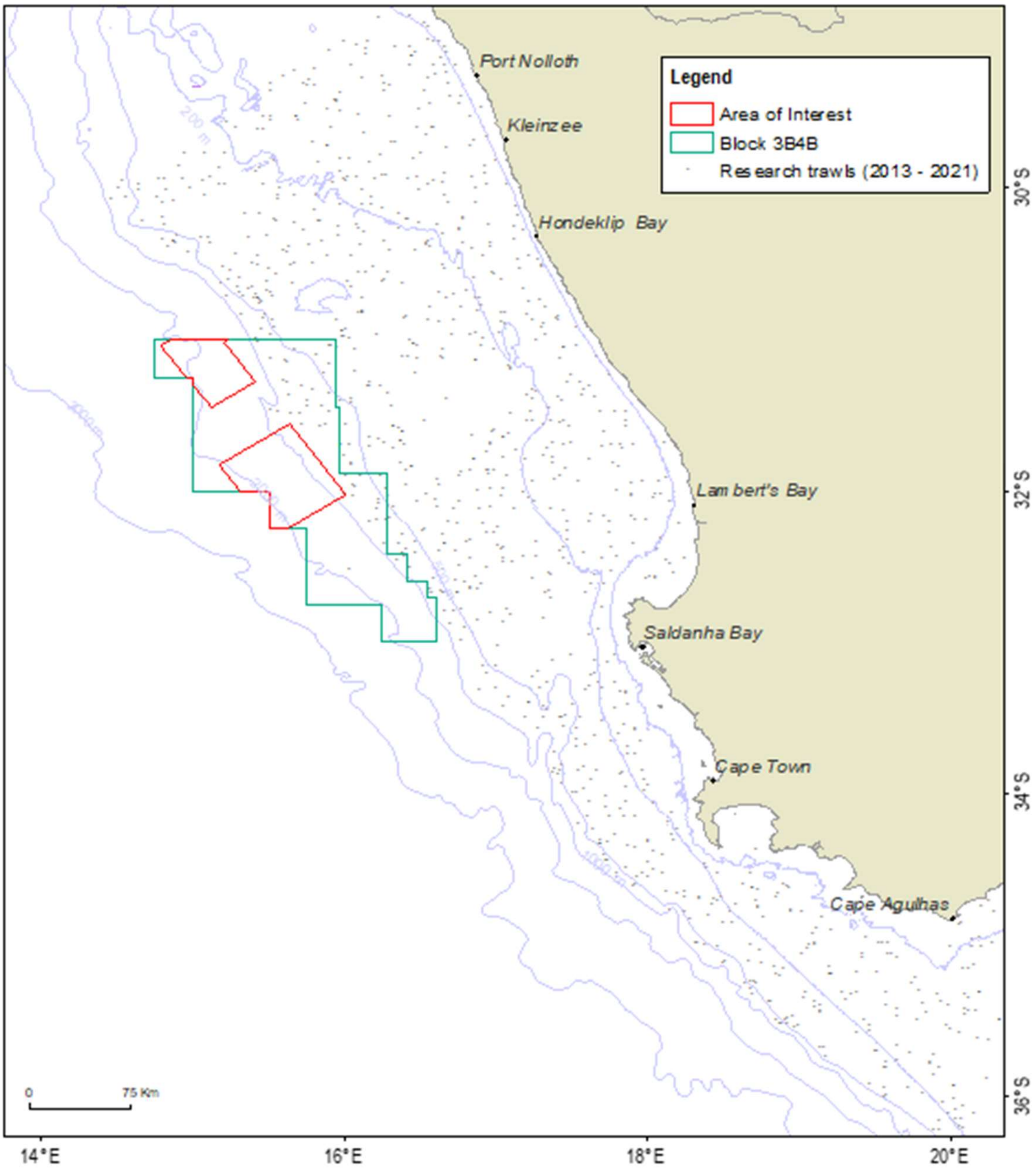


Figure 93: Spatial distribution of trawling effort expended by DFFE over the period 2013 to 2021 in assessing the biomass of demersal fish species.

The biomass of small pelagic species is assessed bi-annually by an acoustic survey. The first of these surveys is timed to commence in mid-May and runs until mid-June while the second starts in mid-October and runs until mid-December. The timing of the demersal and acoustic surveys is not flexible, due to restrictions with availability of the research vessel as well as scientific requirements. The surveys are designed to cover an extensive area from the Orange River on the West Coast to Port Alfred on the East Coast and the DFFE survey vessel progresses systematically from the Northern border Southwards, around Cape Agulhas and on towards the east. During these surveys the survey vessels travel pre-determined transects (perpendicular to bathymetric contours) running offshore from the coastline to approximately the 200 m isobath. There are a few occasions that the transects off Cape Point will just extend to about 1 000 m, with the shelf being so narrow there and the offshore fish distribution being dictated by strong frontal features, there would be occasions where the survey would go even further offshore than the 1 000 m. Figure 94 shows the research survey transects undertaken by DFFE in November 2020 and May 2021 in respect to the licence block and AOI for proposed drilling. No transects coincided with the licence block or AOI for well drilling.

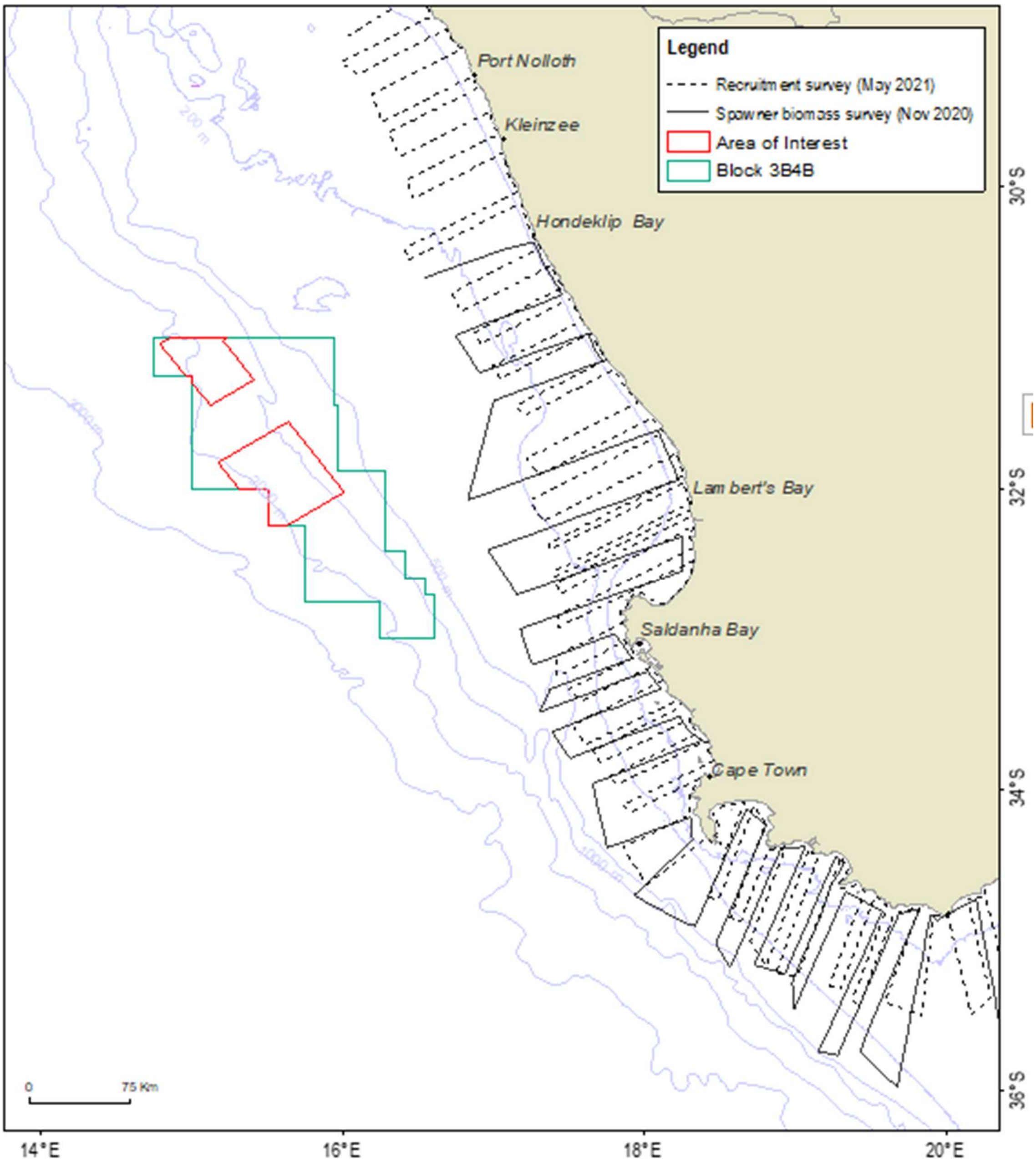


Figure 94: Spatial distribution of survey transects undertaken by DFFE during November 2020 and May 2021 during the research surveys of recruitment and spawner biomass of small pelagic species, respectively.

8.4.4 COMMERCIAL FISHERIES SECTORS

8.4.4.1 DEMERSAL TRAWL

The primary fisheries in terms of highest economic value are the demersal (bottom) trawl and longline fisheries targeting the Cape hakes (*Merluccius paradoxus* and *M. capensis*). Secondary species include a large assemblage of demersal fish of which monkfish (*Lophius vomerinus*), kingklip (*Genypterus capensis*) and snoek (*Thyrsites atun*) are the most commercially important (Figure 95). The demersal trawl fishery comprises an offshore (deep-sea) and inshore fleet, which differ primarily in terms of vessel capacity and the areas in which they operate.

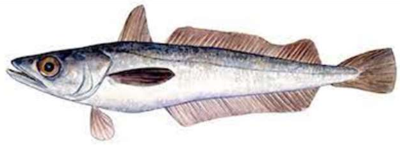
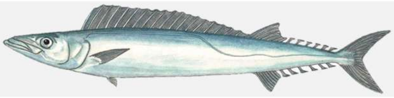
Fish species	*Reference Image*	*Targeted or Bycatch*
Deepwater Hake Merluccius paradoxus		Targeted
Shallow water Hake Merluccius capensis		Targeted
Monkfish Lophius vomerinus		Bycatch
Kingklip Genypterus capensis		Bycatch
Snoek Thyrsites atun		Bycatch

Figure 95: Commercially important target and bycatch species in the South African Demersal Trawl Fishery. Reference images courtesy of South African Institute for Aquatic Biodiversity (SAIAB).

Vessels operating in the fishery usually trawl throughout the traditional “inshore” area i.e., in waters shallower than the 110 m isobaths, but are not restricted from operating in deeper water. By contrast, vessels operating in the deep-sea trawl fishery may not operate in water depths of less than 110 m or within 20 nautical miles of the coast, whichever is the greater distance from the coast.

The wholesale value of catch landed by the inshore and offshore demersal trawl sectors, combined, during 2017 was R3.982 billion, or 40.5% of the total value of all fisheries combined. In 2020 the offshore trawl industry was values at R4.3 billion. The latest value estimates (Table 27) show a steady increase to R6 billion and R550 million for the offshore and inshore trawl fishery, respectively. The 2022 TAC for Cape hakes was set at 8 131 and 110 448 tonnes for the inshore and offshore trawl fisheries, respectively. Of the national TAC for Cape Hakes a further 10% is allocated to the hake demersal longline sector.

Table 27: Estimates for the inshore and offshore demersal hake trawl fisheries. This includes financially value of the fishery (as of 2021) and TAC as of 2022.

Values	Inshore	Offshore
Number of rights holders	32	28
Value of catch (2021, quayside)	R550 million	R6 billion
Tac 2022	8 131 tonnes	110 448 tonnes
Employment creation	4 500	7 300
Rights valid until	31 December 2031	31 December 2037

The annual TAC limits and landings of hake (both species) by the trawl and longline sectors is listed in Table 28. A time-series of total hake catch as well as hake catch by sector is shown in Figure 96.

Table 28: Annual total allowable catch (TAC) limits and catches (tons) of the two species of hake by the hake-directed fisheries on the West (WC) and South (SC) coasts (Adapted from DEFF, 2020).

		M. paradoxus					*M. capensis*						TOTAL both species
Year	TAC	Deep-sea		Longline		TOTAL	Deep-sea		Inshore	Longline		TOTAL	
		WC	SC	WC	SC		WC	SC	SC	WC	SC		
2010	119831	69709	15457	2394	1527	89087	10186	4055	5472	3086	3024	26098	115185
2011	131780	76576	17904	2522	140	97142	15673	4086	6013	3521	3047	35525	129667
2012	144671	81411	16542	4358	306	102616	12928	4584	3223	2570	1737	25050	127666
2013	156075	74341	28859	6056	60	109316	8761	4475	2920	2606	1308	20071	129387
2014	155280	73252	41156	6879	8	121295	9671	6286	2965	2123	315	21361	142656
2015	147500	77521	31745	4001	18	113286	12727	4085	3077	2325	53	22217	135503
2016	147500	93173	18968	2806	1	114948	14744	2810	3973	4360	2	25889	140837
2017	140125	72326	30961	5288	25	108600	15273	4466	2812	2807	126	25488	134088
2018	133119	64252	29218	5217	90	98777	12689	12863	3983	2615	481	32668	131370
2019	146431	70608	22201	5328	34	98171	14193	9454	4149	3623	299	31718	129898
2020	146400	97093	10061	5847	47	113048	18115	3500	4536	2348	321	28820	141872
2021	139109	102865	15597	5892	18	124372	15585	2937	4517	2932	194	26165	150537
2022	132154												

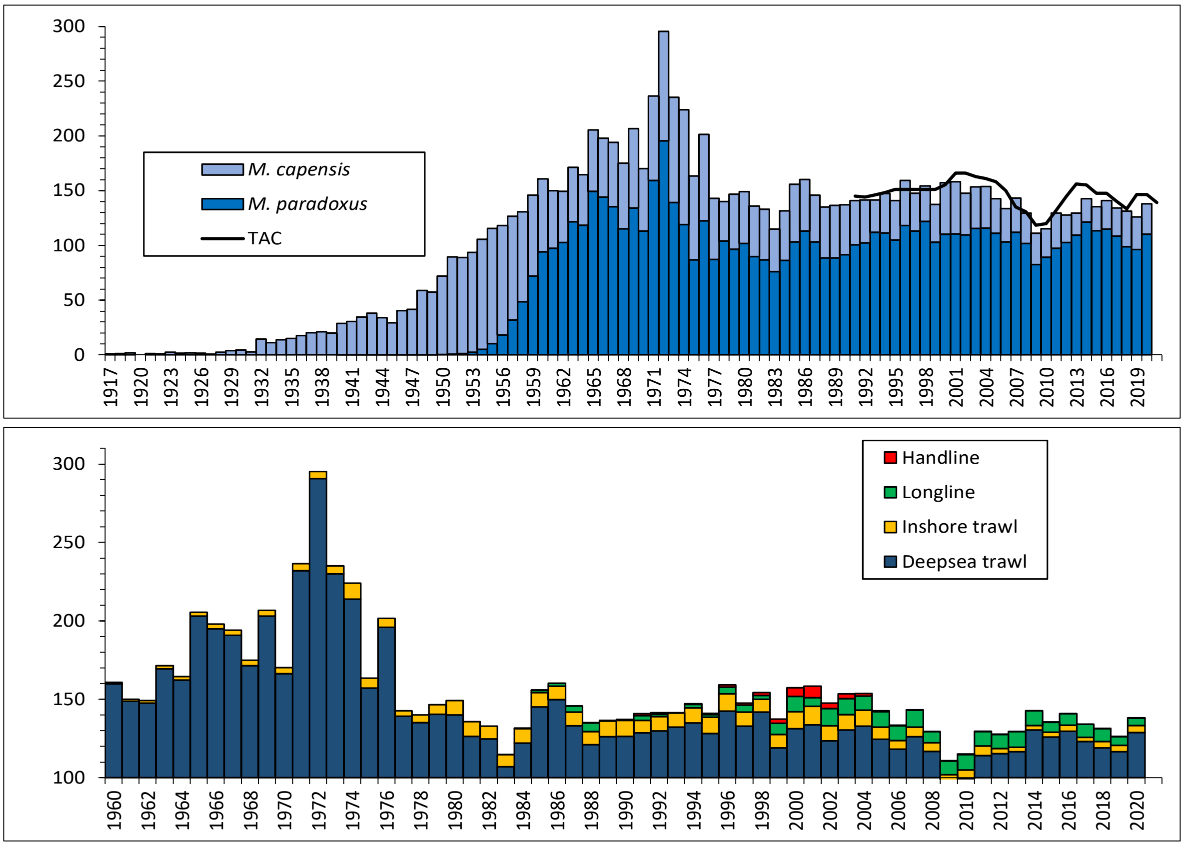


Figure 96: (Top panel) Total catches ('000 tonnes) of Cape hakes split by species over the period 1917–2020 and the TAC set each year since the 1991. (Bottom panel) Catches of Cape hakes per fishing sector for the period 1960–2020. Prior to 1960, all catches are attributed to the deep-sea trawl sector. Note that the vertical axis commences at 100 000 tonnes to better clarify the contributions by each sector (Source DFFE, 2022).

8.4.4.2 **OFFSHORE DEMERSAL TRAWL FISHERY**

The offshore demersal trawl fleet consists of 53 trawlers. Twenty-six fresh fish trawlers preserve hake on ice and return it to shore for processing, while 27 freezer vessels produce frozen headed and gutted (H&G) hake or sea-frozen fillets. Wetfish vessels range between 24 m and 56 m in length while freezer vessels are usually larger, ranging up to 90 m in length. Figure 97 shows a photograph of a wetfish trawler operating in South Africa's offshore demersal trawl fishery. Inshore vessels range in length from 15 m to 40 m. Trips average three to five days in length and all catch is stored on ice. These vessels operate from most major harbours on both the West and South Coasts. On the West and South-West Coasts, these grounds extend in a continuous band along the shelf edge between the 200 m and 1 000 m bathymetric contours although most effort is in the 300 m to 600 m depth range.

Between 2014 and 2019, a five-year benthic trawl experiment was conducted by the South African Deep Sea Trawling Industry Association (SADSTIA), in collaboration with the DFFE, the University of Cape Town, the South African Environmental Observation Network and the South African National Biodiversity Institute. The aim of the study was to assess the environmental impact of demersal trawling in South African waters. The offshore demersal trawl sector catches between 118 000 and 166 000 tonnes, with 90% of the catch being *M. paradoxus* and 10% *M. capensis*. The trawler owners and operators produce fresh and frozen products, which are sold in retail and food-service markets locally and internationally, with the main export markets being in Europe, Australia and the United States (Durholtz *et al*., 2015).

The main bycatch species are kingklip and monk. Monkfish-directed trawlers tend to fish shallower waters than hake-directed vessels on mostly muddy substrates. Trawling on rough ground near the Cape Canyon (off Saldanha Bay) started in the late 1990s and has been fished regularly since then. With improvements in technology and experience, rough ground in areas such as "the Blades" off Cape Point (an area of irregular hard ground near the Cape Valley) became more frequently trawled with less damage or loss of gear. At present, the Cape Valley, the southern canyon off Cape Point, has a high trawling effort in the South African context, and this area has been quite intensively fished for the last 25 years (Sink *et al*., 2012).

Trawl nets are generally towed parallel to the depth contours (thereby maintaining a relatively constant depth) in a north-westerly or south-easterly direction. Trawlers also target fish aggregations around bathymetric features, in particular seamounts and canyons, where there is an increase in seafloor slope and in these cases the direction of trawls follow the depth contours. As mentioned, the offshore sector is prohibited from operating in waters shallower than 110 m or within five nautical miles of the coastline. There are other measures in place to ease socio-economic concerns and environmental sustainability (Figure 98).

Figure 97: Photograph of MFV Harvest Mzansi, a wetfish vessel operating in the South African offshore demersal trawl sector source: www.sadstia.co.za).

Since South Africa declared its exclusive economic zone (EEZ) under the United Nations Law of the Sea in November 1977, the offshore demersal trawl fishery for hake has been closely managed and regulated. South Africa has implemented a range of regulatory and conservation measures to rehabilitate hake stocks that were previously overfished by international fishing fleets, working closely with the trawling industry (Durholtz et al., 2015). Today, the primary management measure for regulating hake fisheries is the setting of an annual total allowable catch (TAC). However, a comprehensive suite of additional measures has been developed over time to address socio-economic and ecosystem concerns, including spatial and temporal closures, gear restrictions, and bycatch limits (SADSTIA, 2021).

1. Restrictions on **vessel power and size** implemented in 2003 for inshore trawl fishery.
2. **Capacity management** measures introduced in 2008 to offshore demersal trawl fishery.
3. **Capacity-limitation** models developed to avoid fleet overcapacity.
4. Minimum **mesh size** regulations introduced in 1974 to minimize juvenile fish catch.
5. **Paired trawling** prohibited in 1977 to limit seabed impact of fishing.
6. **Limits** on bobbins and foot ropes size/weight introduced in 2003 to reduce seabed impact of fishing.
7. **Marine protected areas** introduced, some impacting deep-sea trawling, e.g., for protecting kingklip spawning grounds.
8. **Ring-fencing**, a voluntary measure adopted in 2008, to prevent further impact on benthic habitat.
9. **Mitigation** of seabird mortalities includes vessel-specific waste management measures, mandatory deployment of bird-scaring devices, and regulations on trawl warps.
10. **Bycatch** limitation measures introduced, including precautionary upper catch limits, "move-on" rules, and bycatch species proportion restrictions per landing.

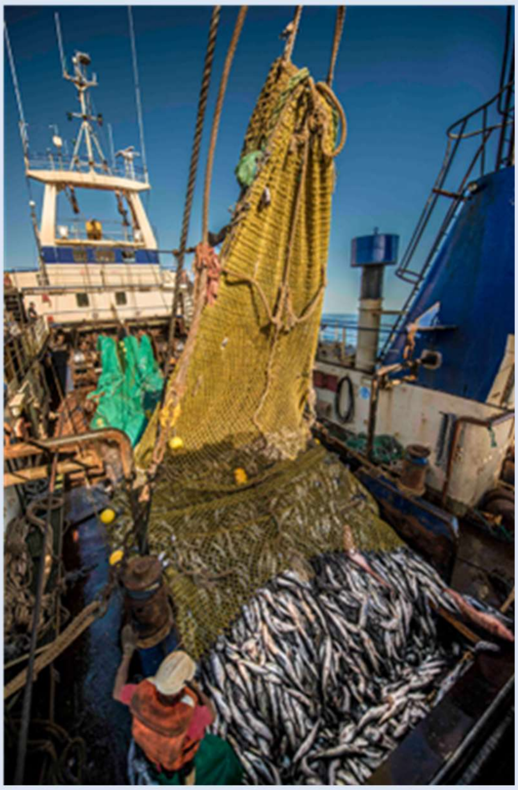


Figure 98: Additional management protocols for offshore demersal trawlers in South Africa (SADSTIA 2017).

8.4.4.3 INSHORE DEMERSAL TRAWL FISHERY

The inshore fishery consists of 31 vessels, which operate on the South Coast mainly from the harbours of Mossel Bay and Gqeberha. Inshore grounds are located on the Agulhas Bank and extend towards the Great Kei River in the east. Vessels primarily target shallow water hake (*M. capensis*). The Agulhas sole (*Austroglossus pectoralis*) is the second most important catch close inshore between Struisbaai and Mossel Bay, between the 50 m and 80 m isobaths. Catches display a much higher species mix than those of the deep-sea trawl fishery. The vessels are smaller and less powerful than those used in the deep-sea trawl fishery; they range in length from 14 to 36 m and engine size is restricted to 1 000 hp. Modern stern trawlers, as well as much older side trawlers, form part of the fishing fleet. The inshore fishery also targets Hakes further offshore, where they can encounter both Hake species, in traditional grounds between 100 m and 200 m depth in fishing grounds known as the Blues located on the Agulhas Bank.

The activity of both the inshore and offshore fishery is restricted by permit condition to operating within the confines of a historical “footprint” – an area of approximately 57 300 km^2 and 17 000 km^2 for the offshore and inshore fleets, respectively.

8.4.4.4 OTTER TRAWLING

Otter trawling is the main trawling method used in the South African hake fishery. This method of trawling makes use of trawl doors (also known as otter boards) that are dragged along the seafloor ahead of the net, maintaining the horizontal net opening. Bottom contact is made by the footrope and by long cables and bridles between the doors and the footrope. Behind the trawl doors are bridles connecting the doors to the wings of the net (to the ends of the footrope and headrope). A headline, bearing floats and the weighted footrope (that may include rope, steel wire, chains, rubber discs, spacers, bobbins or weights) maintain the vertical net opening. The "belly", "wings" and the "cod-end" (the part of the net that retains the catch) may contact the seabed (Figure 99).

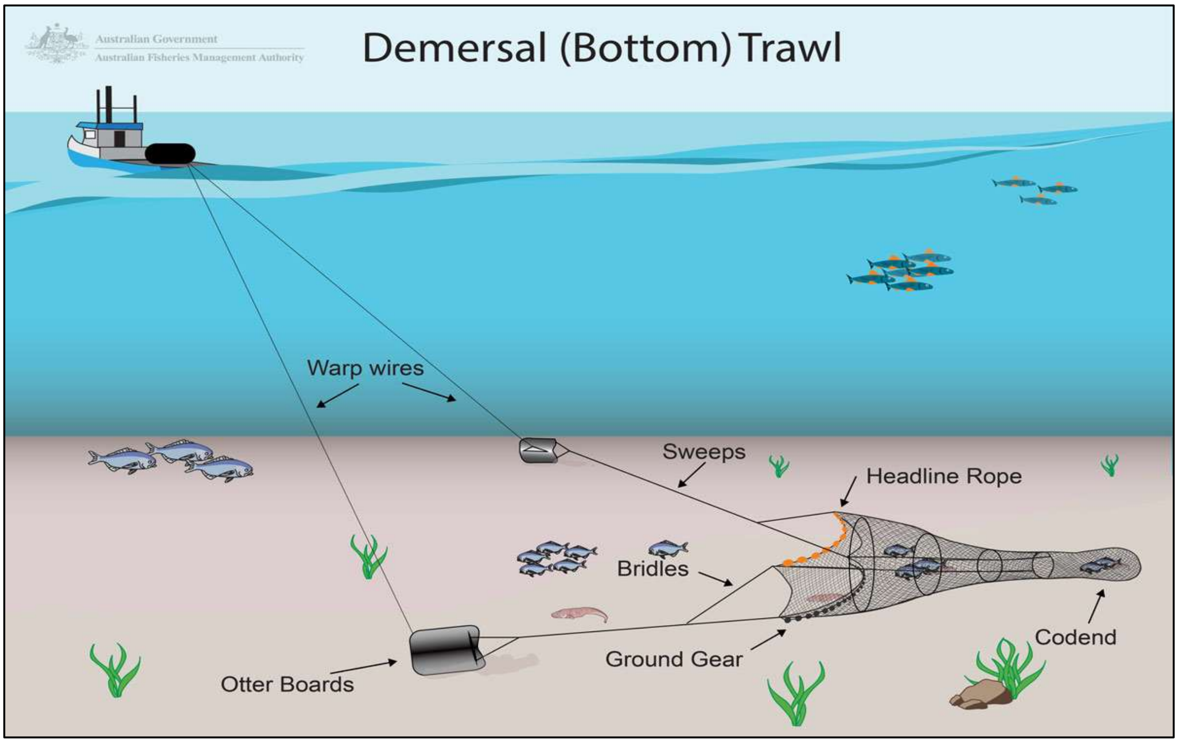


Figure 99: Gear configuration similar to that used by the offshore demersal trawlers targeting hake (Source: www.afma.gov.au/fisheries-management/methods-and-gear/trawling).

The configuration of trawling gear is similar for both offshore and inshore vessels however inshore vessels are smaller and less powerful than those operating within the offshore sector. Trawl depth records ranged from approximately 20 to 980 m, though very few trawls were recorded deeper than 800 m (Currie *et al*., 2021).

Licence Block 3B/4B does overlap the spatial extent of demersal trawling ground whereas the northern and central AOI are situated 25 km and 10 km, respectively, from the trawl footprint. A 500 m safety zone around the drilling unit would therefore not coincide with trawl ground nor present an exclusion to fishing operations or loss of access to fishing ground. Refer to Figure 100 which shows the location of demersal trawling grounds in relation to the AOI for well drilling.

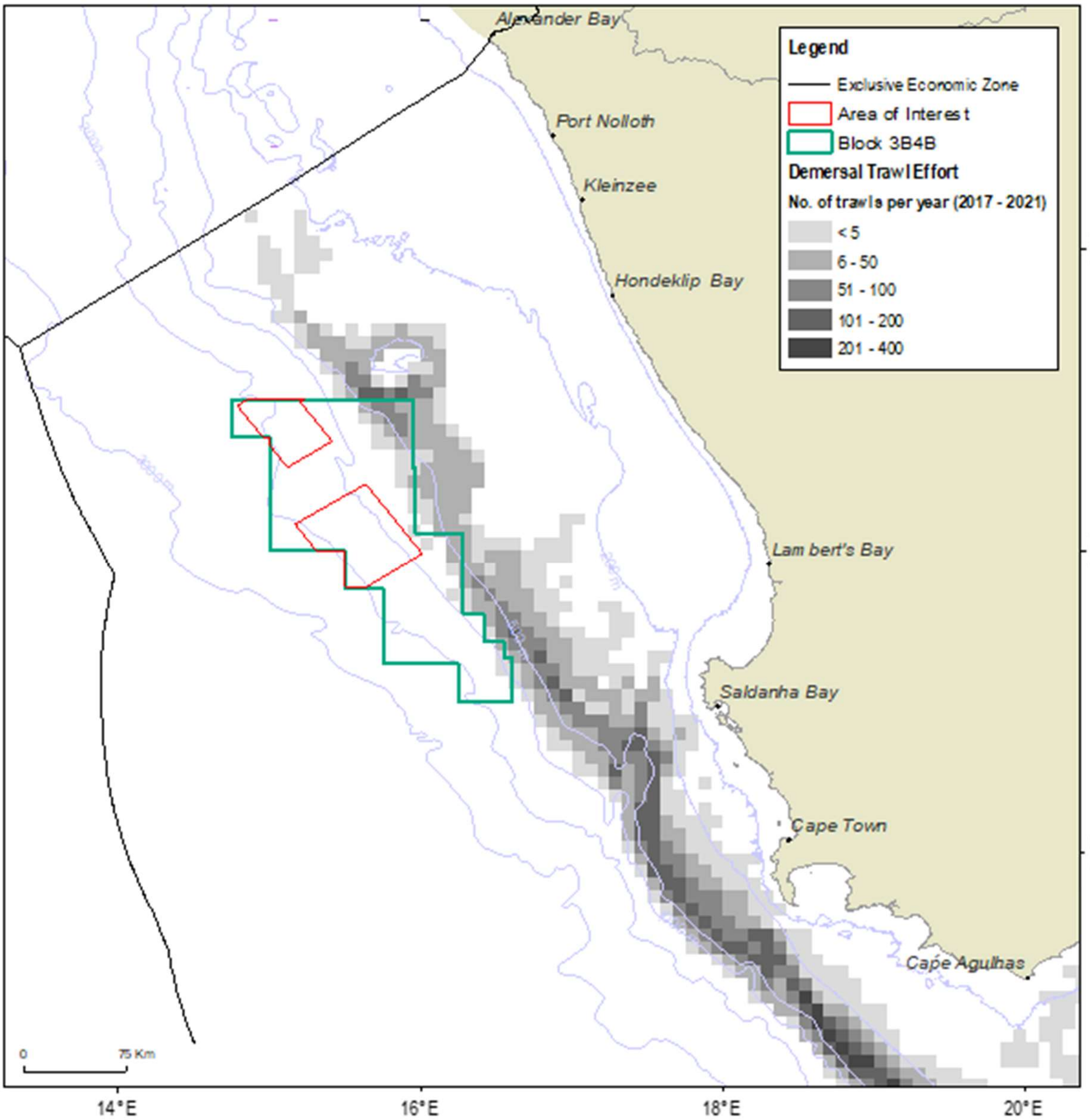


Figure 100: Overview of the spatial distribution of demersal trawl effort (2017 - 2021) in relation the licence block and AOI for proposed drilling.

8.4.4.5 MIDWATER TRAWL

The midwater trawl fishery targets adult Cape horse mackerel (*Trachurus capensis*) (Figure 101), which aggregate in highest concentration on the Agulhas Bank. Cape horse mackerel are semi-pelagic shoaling fish that occur on the continental shelf off southern Africa from southern Angola to the Wild Coast. Off South Africa, adult horse mackerel are currently more abundant off the South Coast than the West Coast. Horse mackerel yield a low-value product and are a source of cheap protein (DEFF, 2020).

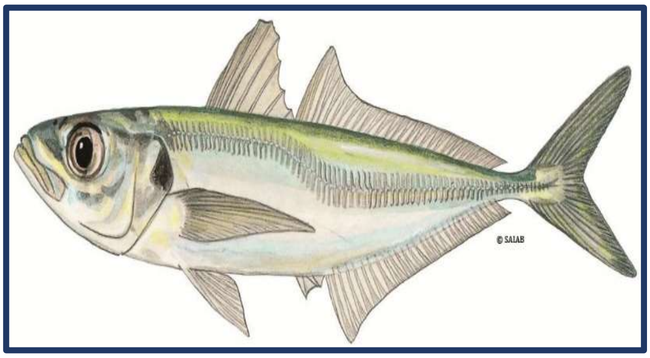


Figure 101: Cape horse mackerel (Trachurus capensis), primary target species of the Midwater Trawl Fishery in South Africa. Images courtesy of SAIAB (left) and Oceana (Right).

This sector comprises six vessels and 34 rights holders which landed a total catch of 19 555 in 2019. The fleet is split between dual rights holders who fish horse mackerel on hake-directed trawlers and others that combine their allocation on a single large midwater trawl vessel. Dual rights holders fishing only occurs if horse mackerel availability is high when fishing for hake at which point that may switch from bottom trawl to midwater trawl. The amounts of horse mackerel caught by these vessels is a relatively small component of the horse mackerel TAC. Those horse mackerel rights holders that do not have hake rights or who do not have a suitable vessel to catch horse mackerel allow their share of the horse mackerel to be caught on a single large midwater trawler. This facilitates the economic use of a single large vessel that can more efficiently catch their horse mackerel allowing the vessels to fish year round. The area fished by this vessel is restricted largely (but not exclusively) to water deeper than 110 m or more than 20 nm from the coast and in an area east of Cape Point. The dual vessels may fish in a broader area, mostly on or near the hake fishing grounds.

Midwater trawl is defined in the Marine Living Resources Act (No. 18 of 1998) (MLRA) as any net which can be dragged by a fishing vessel along any depth between the sea bed and the surface of the sea without continuously touching the bottom. In practice, midwater trawl gear does occasionally come into contact with the seafloor. Midwater trawling gear configuration is similar to that of demersal trawlers, except that the net is manoeuvred vertically through the water column (refer to Figure 102) for a schematic diagram of gear configuration). The towed gear may extend up to 1 km astern of the vessel and comprises trawl warps, net and cod end. Trawl warps are between 32 mm and 38 mm in diameter. The trawl doors (3.5 t each) maintain the net opening which ranges from 120 to 130 m in width and from 40 m to 80 m in height. Weights in front of, and along the ground-rope provide for vertical opening of the trawl. The cable transmitting acoustic signal from the net sounder might also provide a lifting force that maximizes the vertical trawl opening. To reduce the resistance of the gear and achieve a large opening, the front part of the trawls are usually made from very large rhombic or hexagonal meshes. The use of nearly parallel ropes instead of meshes in the front part is also a common design. Once the gear is deployed, the net is towed for several hours at a speed of 4.8 to 6.8 knots predominantly parallel with the shelf break.

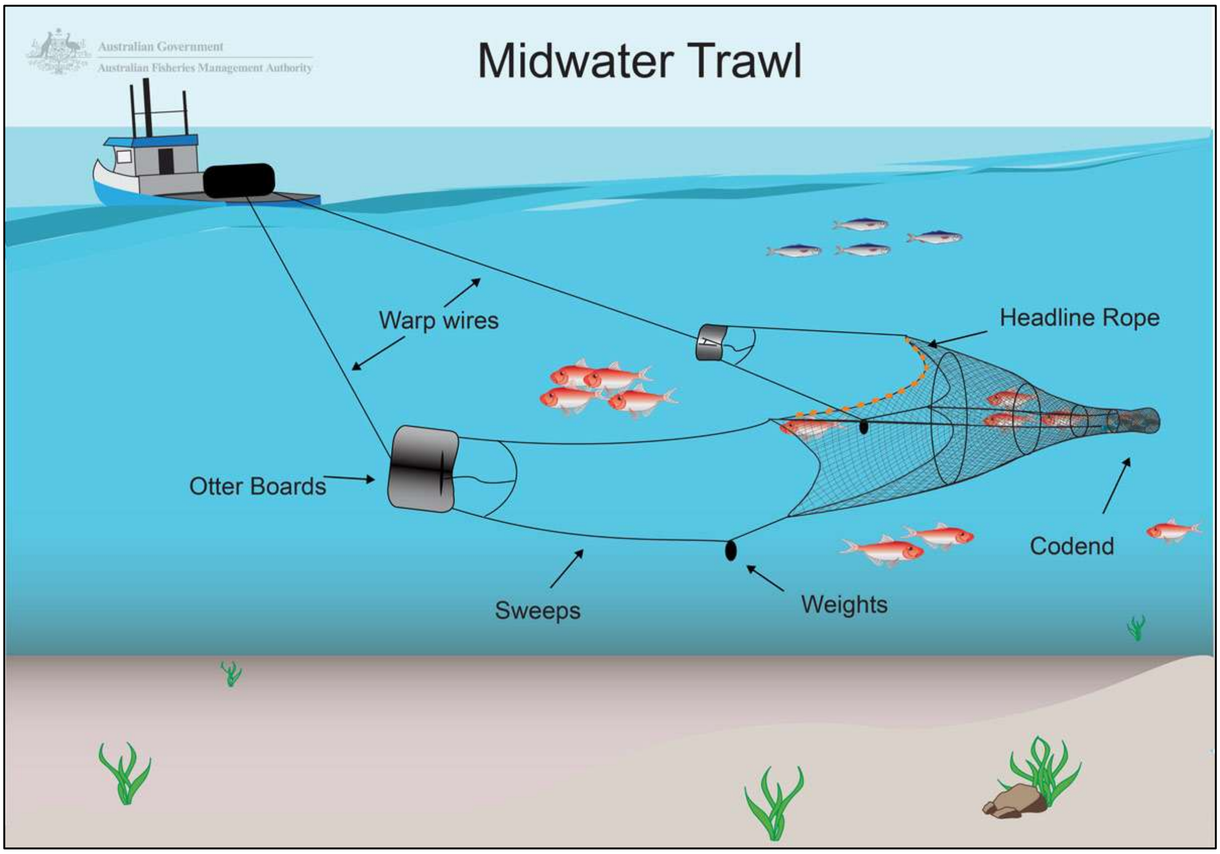


Figure 102: Schematic diagram showing the typical gear configuration of a midwater trawler. Source: www.afma.gov.au/fisheries-management/methods-and-gear/trawling.

The fishery operates predominantly on the edge of the Agulhas Bank, where shoals are found in commercial abundance. Fishing grounds off the South Coast are situated along the shelf break and three dominant areas can be defined. The first lies between 22 °E and 23 °E at a distance of approximately 70 nm offshore from Mossel Bay and the second extends from 24 °E to 27 °E at a distance of approximately 30 nm offshore. The third area lies to the south of the Agulhas Bank 21 °E and 22 °E. These grounds range in depth from 100 m to 400 m and isolated trawls are occasionally recorded up to 650 m. Since 2017, DFFE has permitted experimental fishing to take place westward of 20°E and horse mackerel is occasionally targeted around Child's Bank situated east of the licence block.

Figure 103 shows the spatial extent of grounds fished by mid-water trawlers in relation to the licence block and AOI for drilling. There is no overlap of fishing grounds with either the licence block or the AOI.

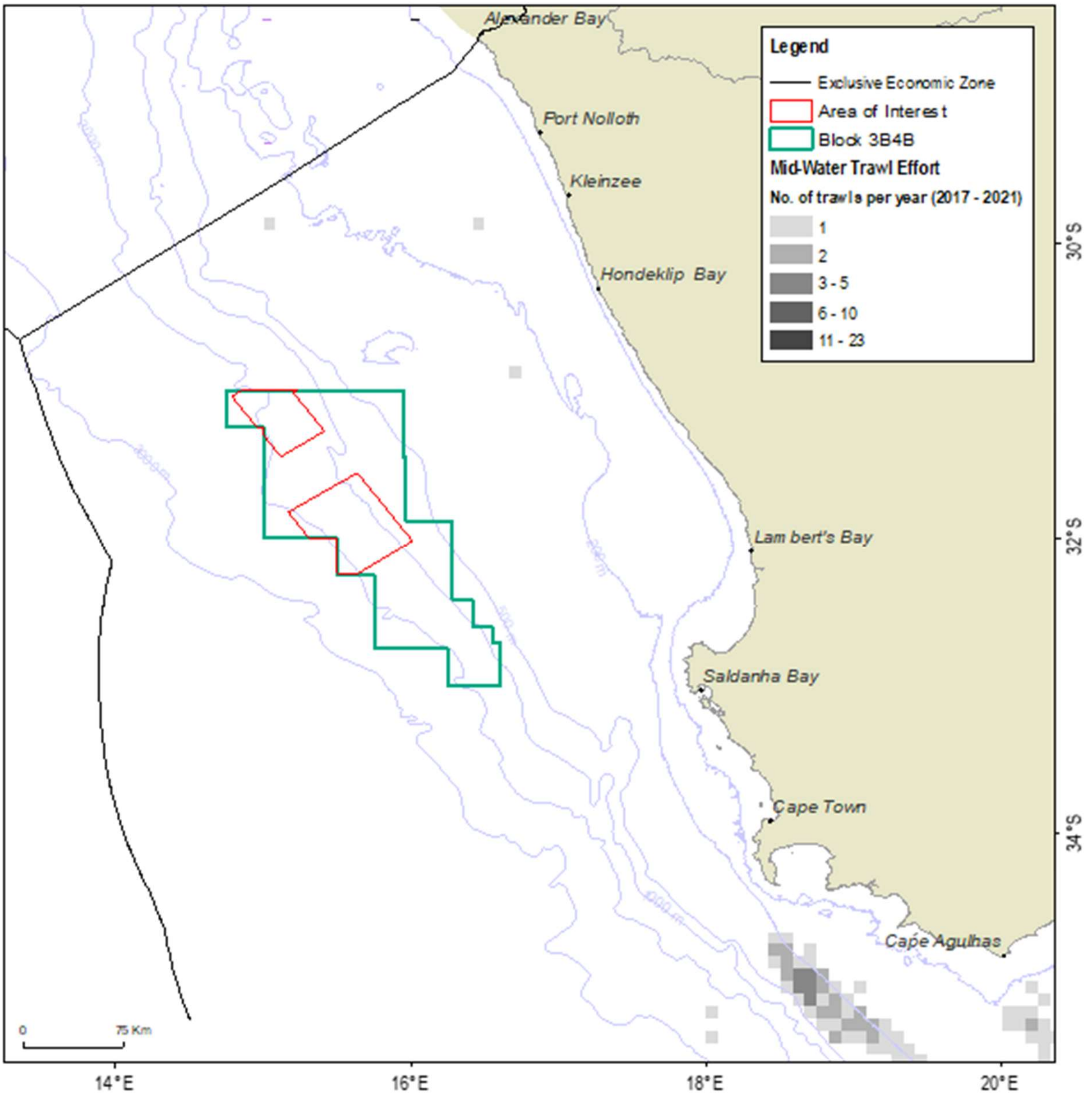


Figure 103: Overview of the spatial distribution of fishing effort expended by the midwater trawl sector (2017-2019) targeting horse mackerel in relation to the AOI for proposed drilling (red polygon) and block 3B/4B (green polygon).

8.4.4.6 HAKE DEMERSAL LONGLINE

In 1983, a demersal longline fishery aimed at catching Kingklip *Genypterus capensis* was launched in the continental shelf waters of South Africa, but the fishery was closed in 1990 due to concerns over the sustainability of the Kingklip resource (Japp, 1993). In 1994, a new experimental longline fishery was started, targeting Cape hakes *Merluccius capensis* and *M. paradoxus* (Japp, 1993; Japp & Wissema, 1999). In 2017, 8 113 tons of catch was landed with a wholesale value of R319.2 million, or 3.2% of the total value of all fisheries combined. Landings of 8 230 tons were reported in 2018.

A demersal longline vessel may deploy either a double or single line which is weighted along its length to keep it close to the seafloor. Steel anchors, of 40 kg to 60 kg, are placed at the ends of each line to anchor it and are marked with an array of floats. If a double line system is used, top and bottom lines are connected by means of dropper lines. Since the top-line (polyethylene, 10 – 16 mm diameter) is more buoyant than the bottom line, it is raised off the seafloor and minimizes the risk of snagging or fouling. The purpose of the top-line is to aid in gear retrieval if the bottom line breaks at any point along the length of the line. Lines are typically between 10 km and 20 km in length, carrying between 6 900 and 15 600 hooks each. Baited hooks are attached to the bottom line at regular intervals (1 to 1.5 m) by means of a snood. Gear is usually set at night at a speed of between five and nine knots. Once deployed the line is left to soak for up to eight hours before it is retrieved. A line hauler is used to retrieve gear (at a speed of approximately one knot) and can take six to ten hours to complete.

Currently 64 hake-directed vessels are active (this can vary between 32 and 71 vessels Japp & Wissema 1999) within the fishery, most of which operate from the harbours of Cape Town, Hout Bay, Mossel Bay and Gqeberha. Secondary points of deployment include St Helena Bay, Saldanha Bay, Hermanus, Gansbaai, Plettenberg Bay and Cape St Francis. Vessels based in Cape Town and Hout Bay operate almost exclusively on the West Coast (west of 20° E). Fishing grounds are similar to those targeted by the hake-directed demersal trawl fleet. The hake longline footprint extends down the west coast from approximately 150 km offshore of Port Nolloth (15°E, 29°S). It lies inshore to the south of St Helena Bay moving offshore once again as it skirts the Agulhas Bank to the south of the country (21°E, 37°S). Along the South Coast the footprint moves inshore again towards Mossel Bay. The eastern extent of the footprint lies at approximately (26°E, 34.5°S). Lines are set parallel to bathymetric contours, along the shelf edge up to the 1 000 m depth contour in places. The more patchy nature of effort in the north western extents of the footprint and the eastern edge of the Agulhas Bank may be attributed to proximity to fishing harbours.

Figure 104 shows the spatial distribution of hake demersal longline fishing areas in relation to the licence block and proposed drilling area. The AOI for proposed drilling area is situated offshore of the main fishing grounds which, in this area extend up to the 380 m bathymetric contour; the closest point of fishing effort to the boundary of the AOI is 15 km. There is no overlap of fishing grounds with the AOI.

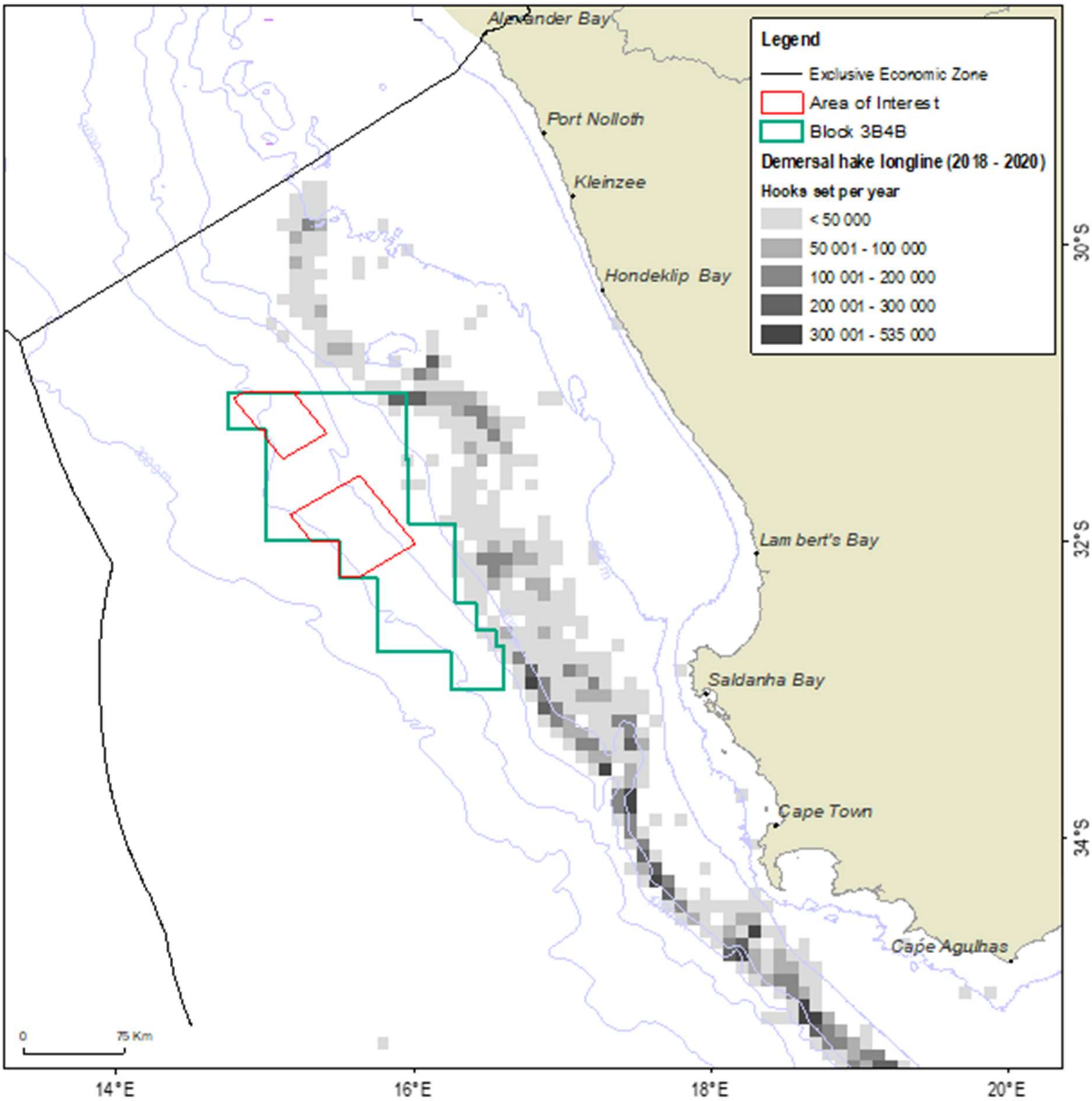


Figure 104: An overview of the spatial distribution of fishing effort expended by the hake demersal longline sector in relation to the licence block 3B/4B (green polygon) and AOI for proposed drilling (red polygon).

8.4.4.7 SHARK DEMERSAL LONGLINE

After the tuna longline fishery declined in the mid-1960s, South African longline fishers shifted their focus to more profitable stocks. In 1991, permits were granted for the demersal shark longline fishery, which initially arose from exploiting regulatory loopholes to catch hake with longline gear, an activity that had been discontinued in 1990. Fishers targeted hake and kingklip under the guise of shark permits, but when bycatch limits for these species were lowered in the shark fishery, fishing effort decreased significantly. The number of permits issued was reduced from over 30 to just 6 by 2006, due to poor performance in the fishery. In the past decade, only 4 vessels have been active at any given time, despite 6 rights being allocated during the previous allocation process, with 2 of those vessels remaining inactive. As the majority of Right Holders own additional Rights in other fisheries, the number of active vessels fluctuates over the year but rarely exceeds four vessels operating at the same time. Annual landings have fluctuated widely due to variation in demand and price. Rights are due to be re-allocated during the fishing Rights allocation process in 2021/2022.

The demersal shark longline fishery is permitted to operate in coastal waters from the Orange River on the West Coast to the Kei River on the East Coast but fishing rarely takes place north of Table Bay. Vessels are typically

<30 m in length and use nylon monofilament Lindgren Pitman spool systems to set weighted longlines baited with up to 2 000 hooks (average = 917 hooks). The fishery operates in waters generally shallower than 100 m and uses bottom-set gear to target predominantly soupfin sharks and smoothhound sharks (Figure 105). Following an initial period of adjustment to catching and marketing demersal sharks, catches of soupfin and smoothhound sharks started increasing in 2006, and reporting became more reliable.

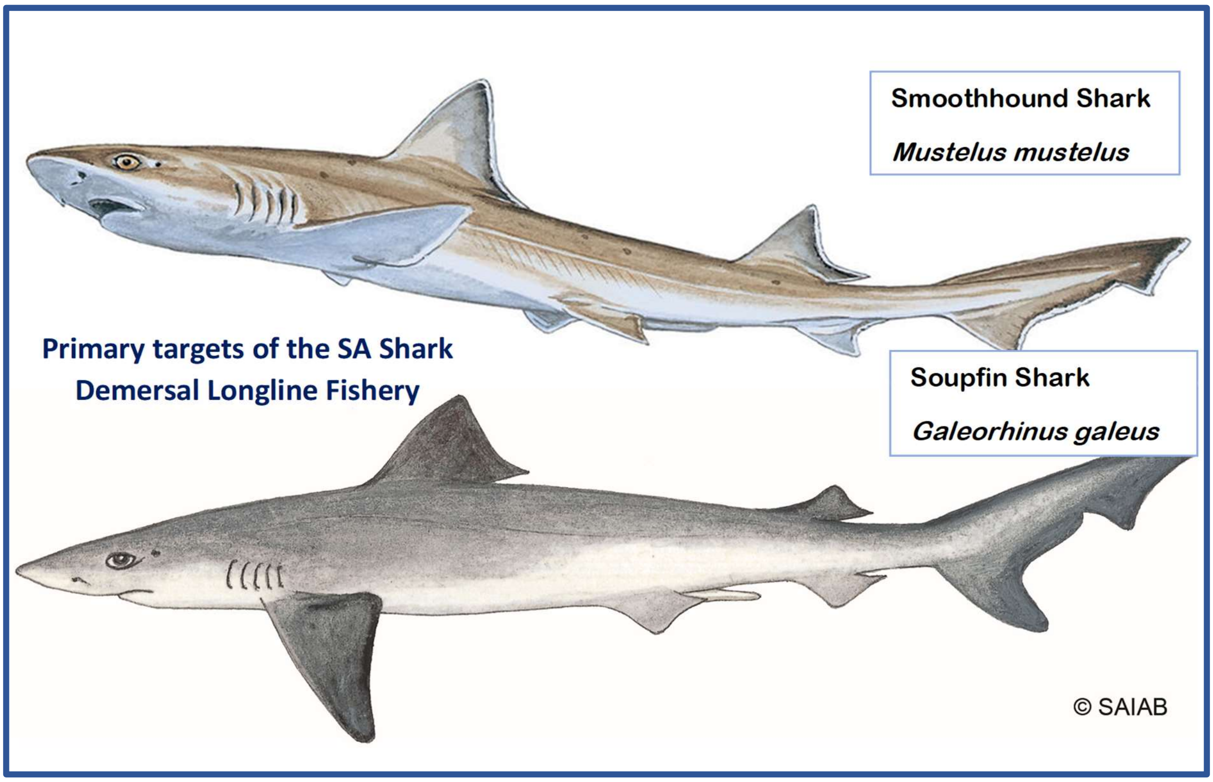


Figure 105: Primary target species of the Shark Demersal Longline fishery in South Africa, the Smoothhound and Soupfin shark. Images courtesy of Shark Research Institute and SAIAB.

The commercial-scale exploitation of sharks began in the 1930s around traditional fishing villages in the Western Cape. This fishery used handlines and targeted inshore demersal sharks for their livers to be used in the production of Vitamin A oil. By the 1940s, catches of soupfin sharks had declined (Davies 1964) as targeting shifted. Refer to Figure 106 for the concerning stock status of Soupfin sharks based on stock status estimates. To date, this Western Cape soupfin fishery has not recovered to historical catch levels. To compensate for declining catch rates of high-value line fish species, a rapid increase was seen in shark catches between 1990 and 1993. After 2000, species-specific reporting came into effect and sharks continued to constitute a large proportion of the livelihood of these fishers around South Africa, with the establishment of a number of dedicated shark processing facilities.

Shark catches by the line fishery since the 1990s have typically fluctuated in response to the availability of higher priced line fish species and market influences. With the traditional linefishery being the largest participant in shark catches. It was only in the mid-2000s when participation in shark landing was seen in other fisheries (See Soupfin estimated landings example in Figure 106). Species targeted include soupfin sharks, smoothhound sharks, dusky sharks Carcharhinus obscurus, bronze whaler sharks C. brachyurus, and various skate species.

Table 29 lists 2018 landings of the main demersal shark and skate species caught by line and Figure 107 shows the spatial distribution of catch between 2017 and 2019. Fishing effort is coastal and directed inshore of the 100 m depth contour. The proposed drilling area is situated approximately 350 km from the closest expected fishing activity and there is no overlap of fishing grounds with the AOI for proposed drilling.

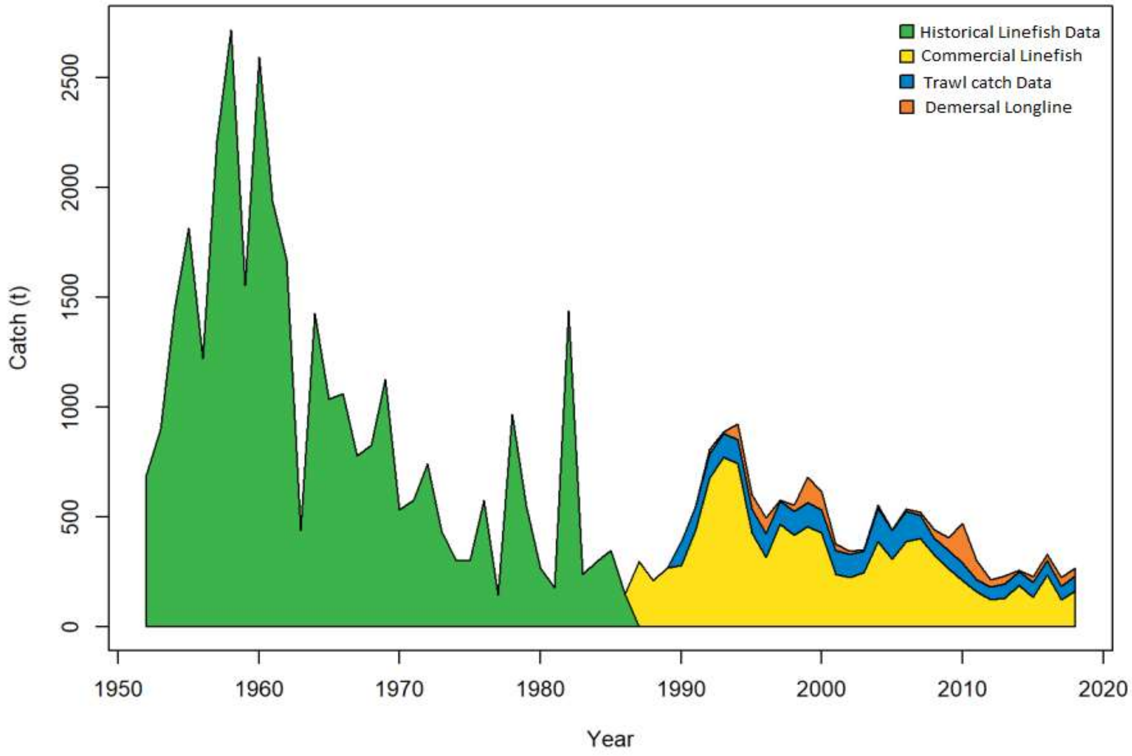


Figure 106: Time-series of estimated catch in metric tons (t) for soupfin sharks *Galeorhinus galeus* (1952-2018) showing the linefish historical data (green), commercial linefish data (yellow), trawl catch data (blue) and demersal shark longline catch data (orange; A century of shark fishing in SA, DFFE).

Table 29: Total catches per FAO area of demersal shark (2018).

Species	Catch by FAO Area (kg)			Total
	1.6	2.1	2.2	
Soupfin shark	7	2017	365	2388
Smoothhound shark	6	4244	5340	9591
Bronze shark	6	384	0	390
St. Joseph shark	0	112	33	144
Skate	0	145	444	589
Total	19	6902	6183	13103

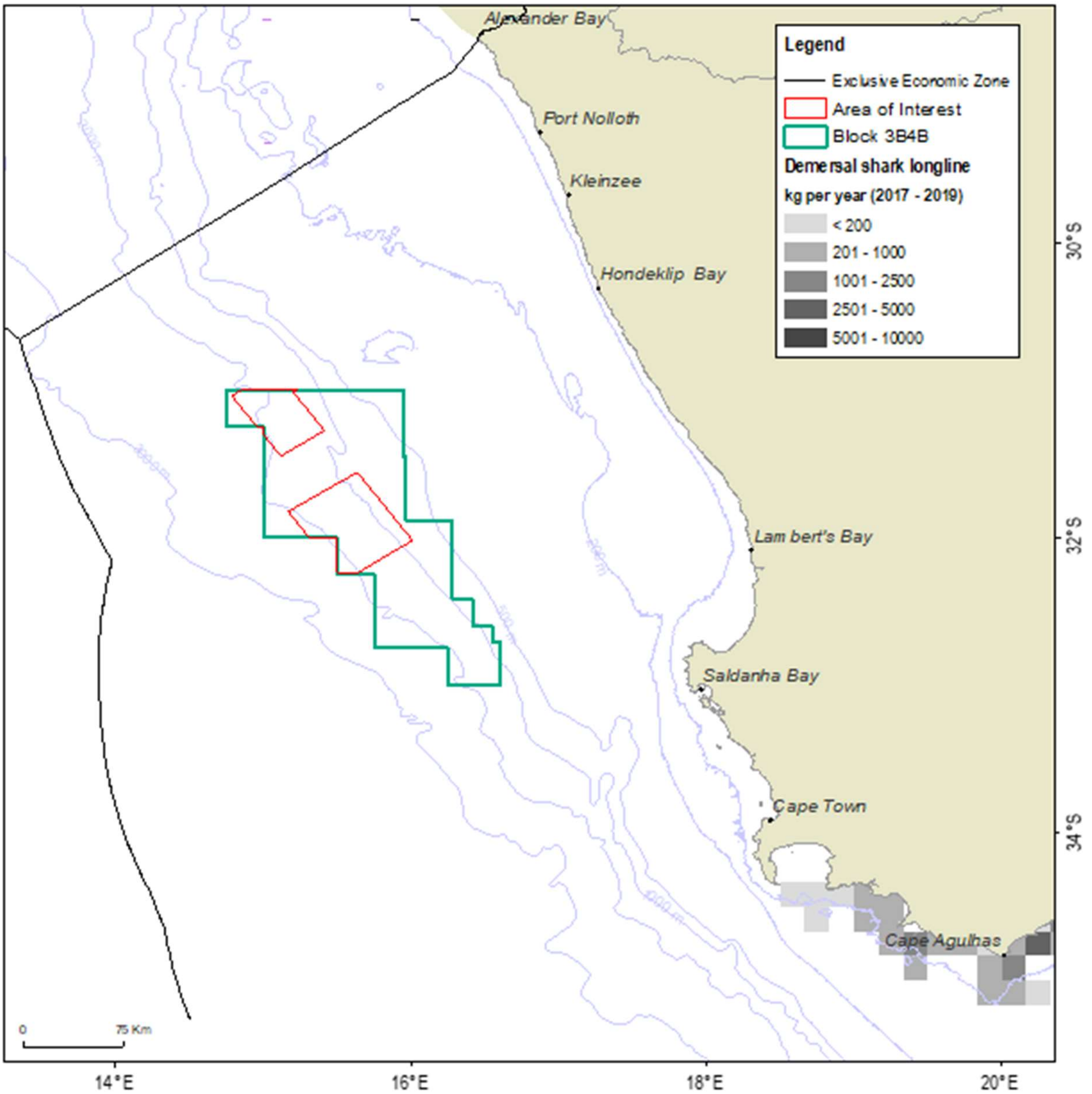


Figure 107: Spatial distribution of catch taken by the demersal shark longline fishery (2017 – 2019) in relation to the licence block 3B/4B (green polygon) and the AOI for proposed drilling (red polygon).

8.4.4.8 **SMALL PELAGIC PURSE-SEINE**

The South African small pelagic fishery developed in the 1940s primarily targeting adult sardine (*Sardinops sagax*) along the West Coast. However, the sardine catch collapsed in the early 1960s, possibly due to overfishing. The industry then switched to smaller meshed nets and targeted anchovy (*Engraulis encrasicolus*) instead, which dominated catches from about 1964 to the mid-1990s. Recovery of the sardine stock was achieved under a stock rebuilding management strategy and catches of both species have been at similar levels (around 250 000 tons) as biomass increased from the mid-1990s. The fishery also targets round herring (*Etrumeus whiteheadi*) to a lesser degree, which, along with anchovy, is processed into fishmeal and fish oil (93% of processed mass in the small pelagic fishery is fish oil and fish meal, South African Pelagic Fishing Industry Association – SAPFIA). Bycatch species are mainly juvenile sardine, horse mackerel, and chub mackerel. The industry precautionary upper catch limits (PUCLs) are currently set at 60 000 t for round herring (Red Eye) and 25 000 t for Lantern and Lightfish (combined). The TACs and PUCLs have been repeatedly reduced to allow for stock stabilisation. Anchovy and Sardine directed fishing have been further decreased by 10% for 2023 (See Figure 108 for 2023 TAC and PUCLs).

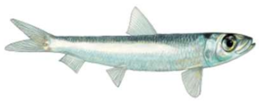
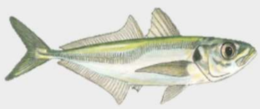
2023 TAC Small Pelagic Fishery			
	Directed Anchovy	Has been decreased by 10%	222 750t
	Juvenile Sardine	Has been decreased by 10%, associated with anchovy directed catches	4 500t
	Directed Sardine	Has been decreased by 10%, not to exceed 70% West of Cape Agulhas and 30% East of Cape Agulhas	18 000t
2023 Pools and Precautionary Upper Limits			
	Anchovy, Sardine-only permit holders	Not to be actively targeted	100t
	Red Eye	Associated with Sardine and Anchovy permit holders	60 000t
	Adult Sardine	Associated with directed Red Eye and Anchovy fishing, not to be targeted	2 000t
	Juvenile Sardine	Associated with directed Red Eye and Sardine fishing, not to be targeted	500t
	Horse Mackerel	Not to be targeted	6 200t
 	Lantern and Lightfish (combined)	Associated with Sardine and Anchovy permit holders	25 000t

Figure 108: Small pelagic anchovy and sardine TACs, PUCL's, and Pools for the 2023 season (DFFE notice, 20 Dec 2022)

The pelagic-directed purse-seine fishery is the largest South African fishery by volume and the second most important in terms of economic value. The wholesale value of catch landed by the sector during 2018 was R3.2 billion, or more than 22% of the total value of all fisheries combined. However, the total combined catch of anchovy, sardine, and round herring landed by the pelagic fishery has decreased by 38% from 395 000 t in 2016 to just 243 000 t in 2021. This is below both long-term (338 000 t) and short-term (294 000 t) averages (Figure 109).

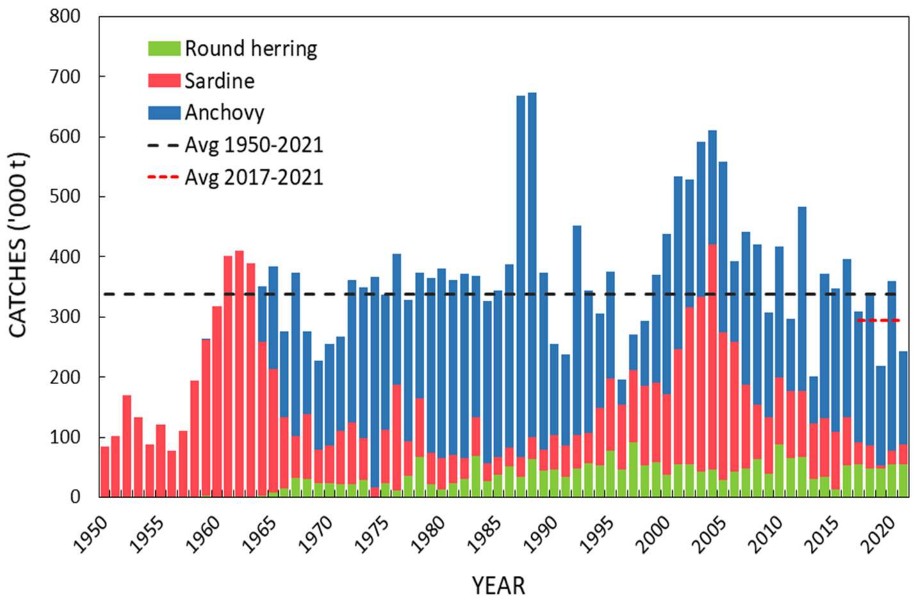


Figure 109: The annual combined catch of anchovy, sardine and round herring. Also shown is the average combined catch since the start of the fishery (1950-2021; black dashed line) and for the past five years (red solid line). Source DFFE, 2022.

The abundance and distribution of small pelagic species fluctuates considerably in accordance with the upwelling ecosystem in which they exist. Fish are targeted in inshore waters, primarily along the west and south Coasts of the Western Cape and the Eastern Cape coast, up to a maximum offshore distance of about 100 km.

The fleet consists of approximately 100 vessels ranging in length from 11 m to 48 m (Figure 110). Once a shoal of the targeted species is located, the vessel encircles it with a large net extending to a depth of 60 m to 90 m. Netting walls surround the aggregated fish, preventing them from diving downwards. These are surface nets framed by lines: a float line on top and lead line at the bottom. Once the shoal has been encircled, the net is pursed, hauled in, and the fish pumped onboard into the hold of the vessel. It is important to note that after the net is deployed, the vessel has no ability to manoeuvre until the net has been fully recovered on board, which may take up to 1.5 hours. Vessels usually operate overnight and return to offload their catch the following day.

The majority of the fleet operates from St Helena Bay, Laaiplek, Saldanha Bay, and Hout Bay, with fewer vessels operating on the South Coast from the harbours of Gansbaai, Mossel Bay, and Gqeberha. The ports of deployment correspond to the location of canning factories and fish reduction plants along the coast. Approximately 80% of the sardine catch in South Africa is processed by six canneries located in St Helena Bay (4), Gans Bay (1) and Mossel Bay (1), with the remaining catch packed by a decreasing number of pack-and-freeze processors, down from around 26 in 2004 to 12 in 2013. In addition to canning sardines, five of the canneries located west of Cape Agulhas produce fishmeal and fish oil from reduction processing of anchovy, round herring, small quantities of mesopelagic species (e.g. lanternfish and light fish) and sardine offal. However, the canning of round herring has been discontinued due to limited seasonal availability and issues with fish quality.

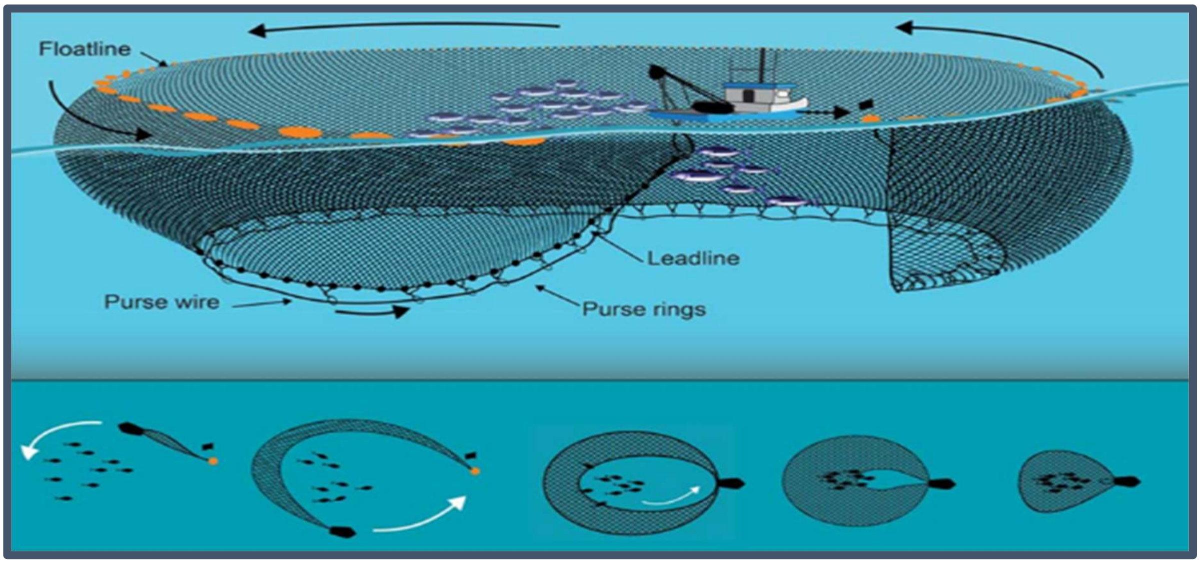


Figure 110: (Above) Photograph of a purse-seine vessel registered to fish for small pelagic species (credit C. Heinecken, CapMarine). (Below) Typical configuration and deployment of a small pelagic purse seine for targeting anchovy, sardine and round herring as used in South African waters. Source: http://www.afma.gov.au/portfolio-item/purse-seine.

Between 2005 and 2008, in response to the decline in sardine biomass west of Cape Agulhas, the directed sardine catch was mostly made east of Cape Point, with over 50% of the catch taken east of Cape Agulhas. This shift had socio-economic impacts for the industry due to the mismatch between processing capacity (which was mostly located in St Helena Bay) and the area of sardine availability. As a result, sardines were caught using smaller vessels in the Mossel Bay area and transported at additional cost to the west coast processors. This shift also led to the development of canning capacity in Mossel Bay and resulted in some restructuring of vessel use and operational procedures (FAO, 2016). As of the 2023 TAC and PUCL updates, it is specified that a maximum of 70% of directed sardine catches must be made West of Cape Agulhas with no more than 30% maximum East of Cape Agulhas.

The geographical distribution and intensity of the fishery are largely dependent on the seasonal fluctuation and distribution of the targeted species. The sardine-directed fleet concentrates its effort in a broad area extending from Lambert's Bay, southwards past Saldanha and Cape Town towards Cape Point, and then eastwards along the coast to Mossel Bay and Gqeberha. The anchovy-directed fishery takes place predominantly on the South-West Coast from Lambert's Bay to Kleinbaai (19.5°E) and is most active in the period from March to September. Round herring is targeted when available, specifically in the early part of the year (January to March) and is distributed from Lambert's Bay to south of Cape Point. This fishery may extend further offshore than the sardine and anchovy-directed fisheries.

The catch and effort statistics for this sector are recorded by skippers on a grid block basis at a resolution of 10 by 10 nm. The fishery operates throughout the year with a short seasonal break from mid-December to mid-January. Seasonality of catches is shown in Figure 111 with an increase in fishing effort and landings evident during the winter months.

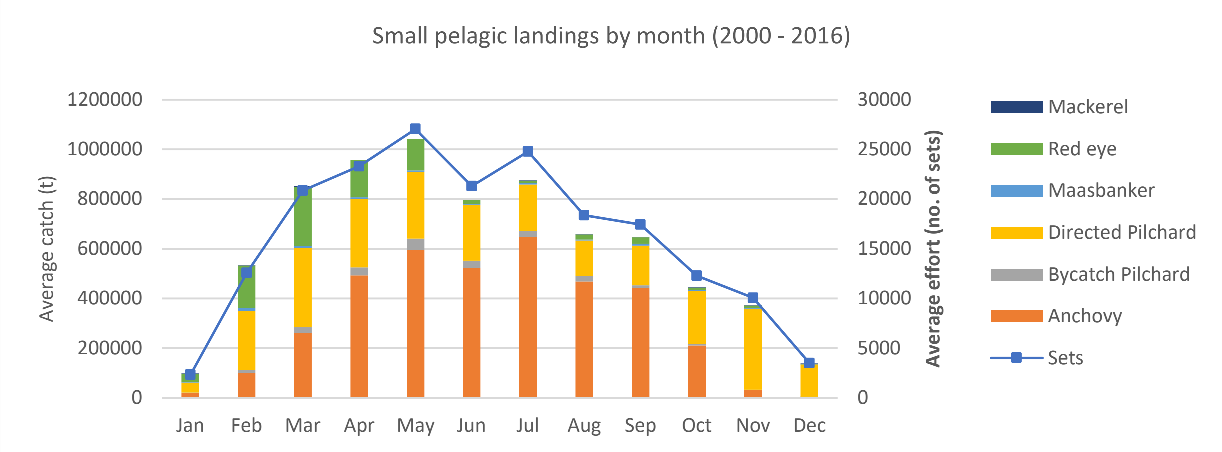


Figure 111: Graph showing monthly catch (tons) and effort (number of sets) reported for the small pelagic purse-seine fleet over the period 2000 to 2016 (cumulative). Source: DFFE.

Figure 112 shows the spatial extent of fishing grounds in relation to the license block and AOI for proposed drilling. There is no direct overlap and the AOI which is situated at least 100 km from fishing grounds.

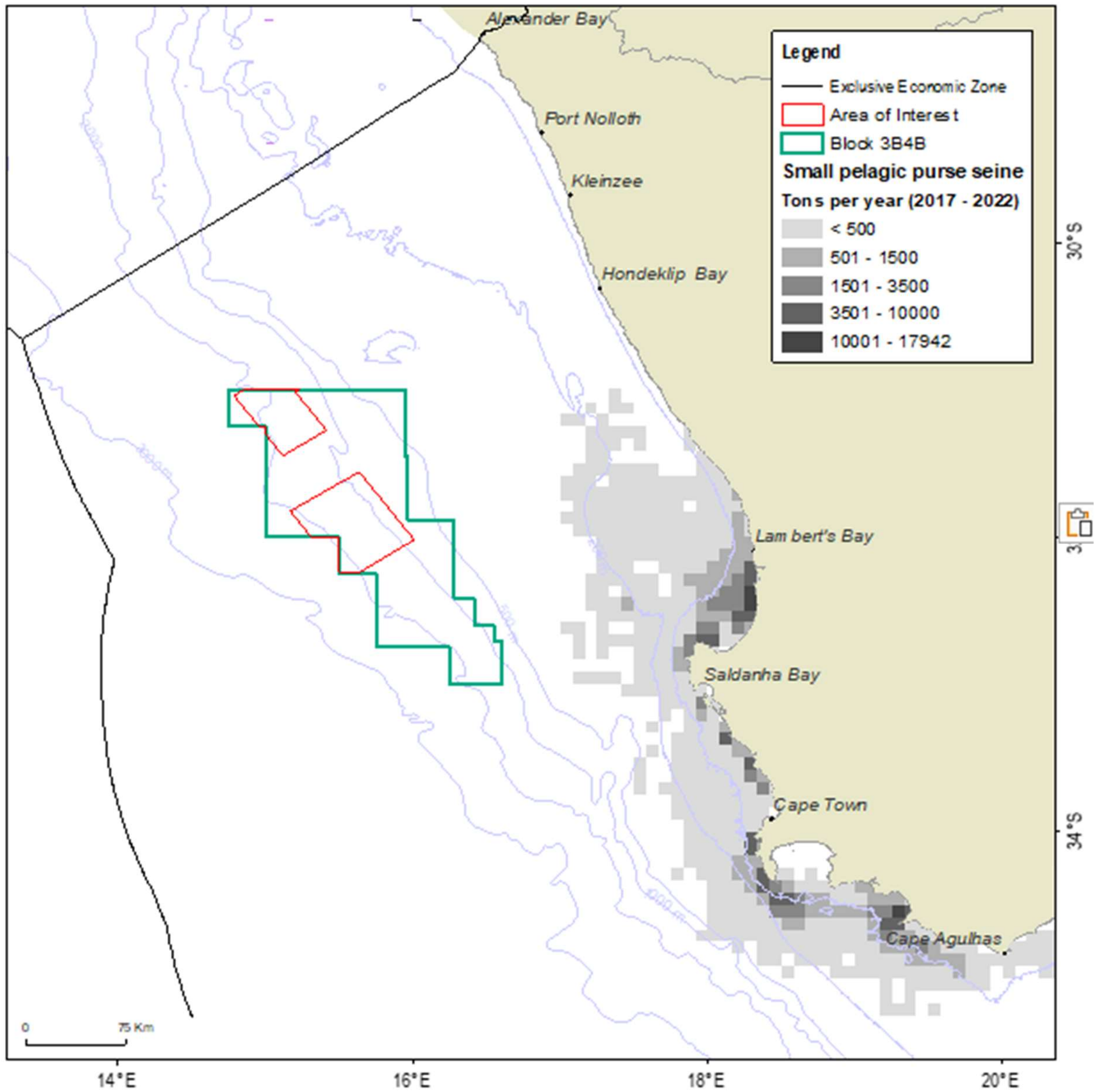


Figure 112: An overview of the spatial distribution of effort expended by the purse-seine sector targeting small pelagic species in in relation to the licence block 3B/4B (Green polygon) and the proposed AOI for drilling (Red Polygon).

8.4.4.9 LARGE PELAGIC LONGLINE

Highly migratory tuna and tuna-like species are caught on the high seas and seasonally within the South African Exclusive Economic Zone (EEZ) by the pelagic longline and pole fisheries. Targeted species include albacore (*Thunnus alalunga*), bigeye tuna (*T. obesus*), yellowfin tuna (*T. albacares*), swordfish (*Xiphias gladius*) and shark species (Figure 113). The wholesale value of catch landed by the sector during 2017 was R154.2 million, or 1.6% of the total value of all fisheries combined, with landings of 2 541 tons (2017) and 2 815 tons (2018). Catch by species and number of active vessels for each year from 2005 to 2018 are given in Table 30.

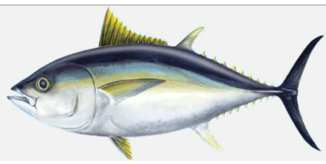
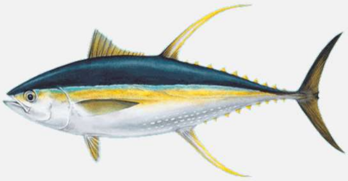
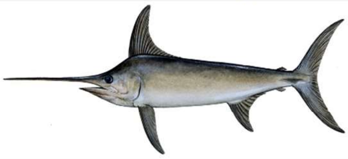
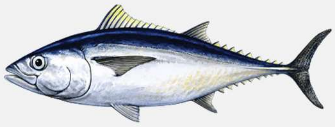
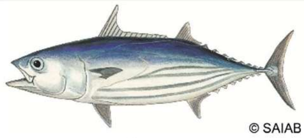
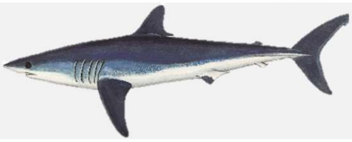
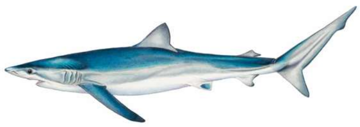
SPECIES NAME	REFERENCE IMAGE	LARGE PELAGIC LONGLINE (LPL) / TUNA POLE (TP)
BIGEYE TUNA (THUNNUS *OBESUS*)		LPL & TP
ALBACORE (*THUNNUS ALALUNGA*)		LPL & TP
YELLOWFIN TUNA (*THUNNUS ALBACARES*)		LPL & TP
SWORDFISH (*XIPHIAS GLADIUS*)		LPL
SOUTHERN BLUEFIN (*THUNNUS MACCOYII*)		LPL
SKIPJACK TUNA (*KATSUWONUS PELAMIS*)		TP
SHORTFIN MAKO (*ISURUS OXYRINCHUS*)		LPL
BLUE SHARK (*PRIONACE GLAUCA*)		LPL

Figure 113: Primary species targets for the Large Pelagic Longline Fishery (LPL) and Tuna Pole Fishery in South Africa. Images courtesy of WWF-SASSI and SAIAB.

Table 30: Total catch (t) and number of active domestic and foreign-flagged vessels targeting large pelagic species for the period 2005-2018 (Source: DEFF, 2019).

Year	Bigeye tuna	Yellowfin tuna	Albacore	Southern bluefin tuna	Swordfish	Shortfin mako shark	Blue shark	Number of active vessels	
								Domestic	Foreign-flagged
2005	1077	1603	189	27	408	700	225	13	12
2006	138	337	123	10	323	457	121	19	0
2007	677	1086	220	48	445	594	259	22	12
2008	640	630	340	43	398	471	283	15	13
2009	765	1096	309	30	378	511	286	19	9
2010	940	1262	165	34	528	591	312	19	9
2011	907	1182	339	49	584	645	542	16	15
2012	822	607	245	79	445	314	333	16	11
2013	882	1091	291	51	471	482	349	15	9
2014	544	486	114	31	223	610	573	16	4
2015	399	564	151	11	341	778	531	Fleets merged under SA	
2016	315	439	85	18	275	883	528	flag with only a few	
2017	497	400	172	47	246	726	523	foreign boats : up to 30	
2018	478	478	238	208	313	613	592	boats operating	

Total catch and effort figures reported by the fishery for the years 2000 to 2018 are shown in Figure 114. Catches landed by the South African fleet operating in the ICCAT region (i.e. off the West Coast) from 1998 – 2020 are shown in Figure 115.

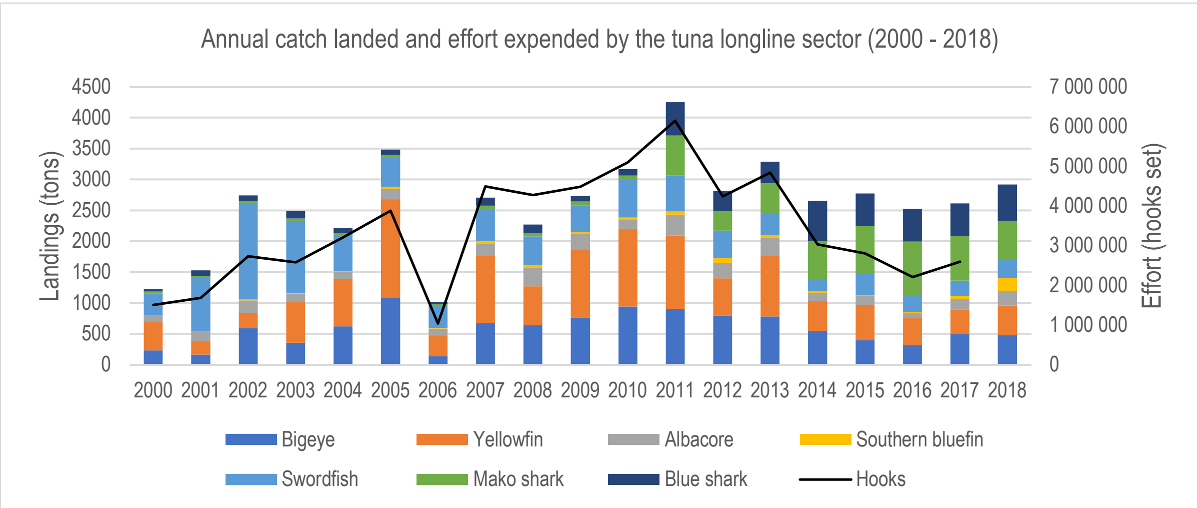


Figure 114: Inter-annual variation of catch landed and effort expended by the large pelagic longline sector in South African waters as reported to the two regional management organisations, ICCAT and IOTC (2000 – 2018; Source: DEFF, 2019).

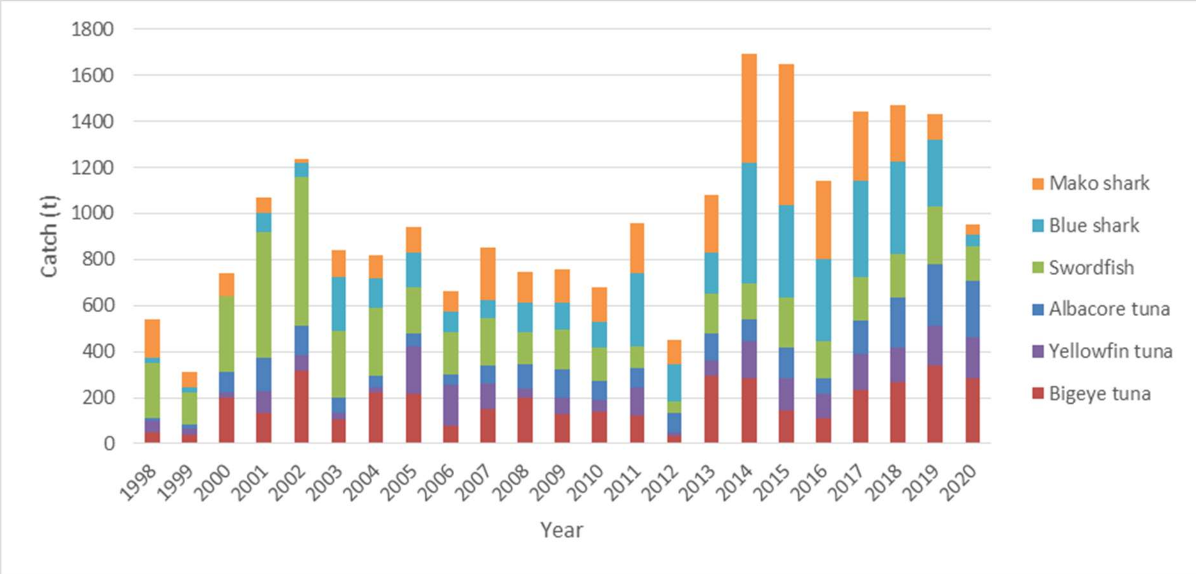


Figure 115: Inter-annual variation of catch landed by the large pelagic longline sector operating in the ICCAT region of South African waters (i.e. West of 20°E from 1998 – 2020).

Tuna and billfish are migratory stocks and are managed as a "shared resource" among various countries under the jurisdiction of the International Commission for the Conservation of Atlantic Tunas (ICCAT) and the Indian Ocean Tuna Commission (IOTC). South Africa has a long history of commercial longlining for tuna, which began in the 1960s and initially focused on southern bluefin tuna and albacore. The fishery declined after the mid-1960s due to a poor market for low-quality bluefin and albacore. Interest in longline fishing for tuna and swordfish in South African waters was revived in 1995, and 30 experimental longline permits were issued in 1997. The primary objective of the fishery was to develop a large pelagic catch performance for South Africa so that it could receive equitable quotas from RFMOs (Regional Fisheries Management Organisations) such as ICCAT and IOTC.

During the experimental phase of the fishery, catches peaked at over 2,500 t, but swordfish comprised the bulk of the catch in each year. Targeting of swordfish led to sharp declines in swordfish abundance in South Africa's EEZ. In 2005, long-term rights were made available, with 17 rights issued to the swordfish-directed fishery and 26 to the tuna-directed fishery. The primary objectives of this allocation were to develop a tuna catch performance for South Africa and to South Africanize the fishery. Catches improved to over 3,500 t in 2005 with the assistance of foreign-flagged charters. However, none of the Asian-flagged vessels reflagged South African, and no further provision was made for the use of foreign-flagged charters in 2006. Consequently, catches declined to less than 500 t.

In 2007, foreign-flagged vessels were once again allowed to fish in South Africa to improve its catch performance, transfer skills to South African crew, and eventually reflag South African. To date, an average of 10-15 foreign-flagged vessels takes out permits to fish in South Africa each year. In March 2011, the Department consolidated the tuna/swordfish longline fishery and the pelagic shark fishery, absorbing the 6 pelagic shark vessels into the tuna/swordfish longline fishery. The decision to terminate the targeting of pelagic sharks was due to several reasons, including concerns over substantial pelagic shark bycatch in the tuna/swordfish fisheries, the slow-growing, late-maturing, and low fecundity nature of sharks, and the threats to the survival of blue and mako shark populations.

In 2017, 60 fishing rights were allocated for a period of 15 years, with the total number of active longline vessels within South African waters being 22. Of these, 18 fished exclusively in the Atlantic (West of 20°E) and were domestic vessels, while three Japanese vessels fished exclusively in the Indian Ocean (East of 20°E) in joint ventures with South African companies.

Gear consists of monofilament mainlines of between 25 km and 100 km in length which are suspended from surface buoys and marked at each end. As gear floats close to the water surface it would present a potential obstruction to surface navigation. The main fishing line is suspended about 20 m below the water surface via dropper lines connecting it to surface buoys at regular intervals. Up to 3 500 baited hooks are attached to the mainline via 20 m long trace lines, targeting fish at a depth of 40 m below the surface. Various types of buoys are used in combinations to keep the mainline near the surface and locate it should the line be cut or break for any reason. Each end of the line is marked by a Dahn Buoy and radar reflector, which marks the line position for later retrieval. Typical configuration of set gear is shown in Figure 116 and photographs of monofilament fishing line and marker buoys are included in Figure 117 below. Rights Holders in the large pelagic longline fishery are required to complete daily logs of catches, specifying catch locations, number of hooks, time of setting and hauling, bait used, number and estimated weight of retained species, and data on bycatch.

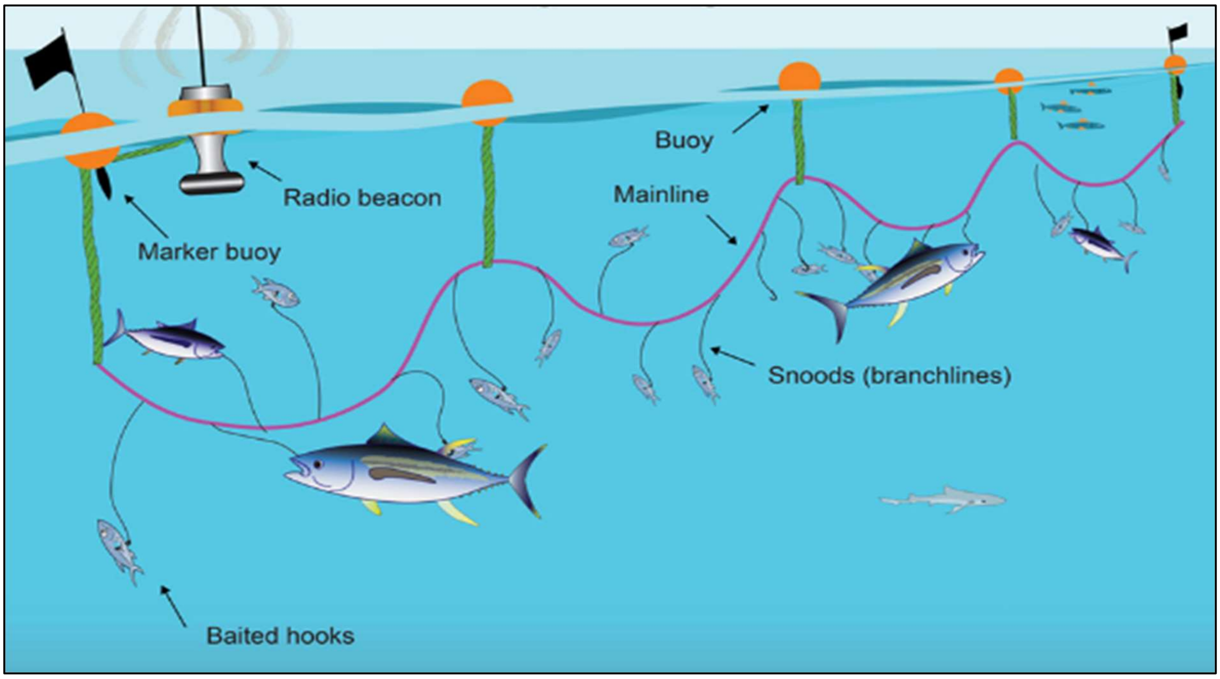


Figure 116: Typical large pelagic longline gear (Source: http://www.afma.gov.au/portfolio-item/longlining).

Figure 117: Photographs showing marker buoys (left), radio buoys (centre) and monofilament branch lines (right) (Source: CapMarine, 2015).

Lines are usually set at night and may be left drifting for a considerable length of time before retrieval, which is done by means of a powered hauler at a speed of approximately one knot. During hauling, vessel manoeuvrability is severely restricted. In the event of an emergency, the line may be dropped and hauled in at a later stage.

The fishery operates year-round with a relative increase in effort during winter and spring shown by foreign-flagged longliners (Figure 118). Catch per unit effort (CPUE) variations are driven both by the spatial and temporal distribution of the target species and by fishing gear specifications. Variability in environmental factors such as oceanic thermal structure and dissolved oxygen can lead to behavioural changes in the target species, which may in turn influence CPUE (Punsly and Nakano, 1992).

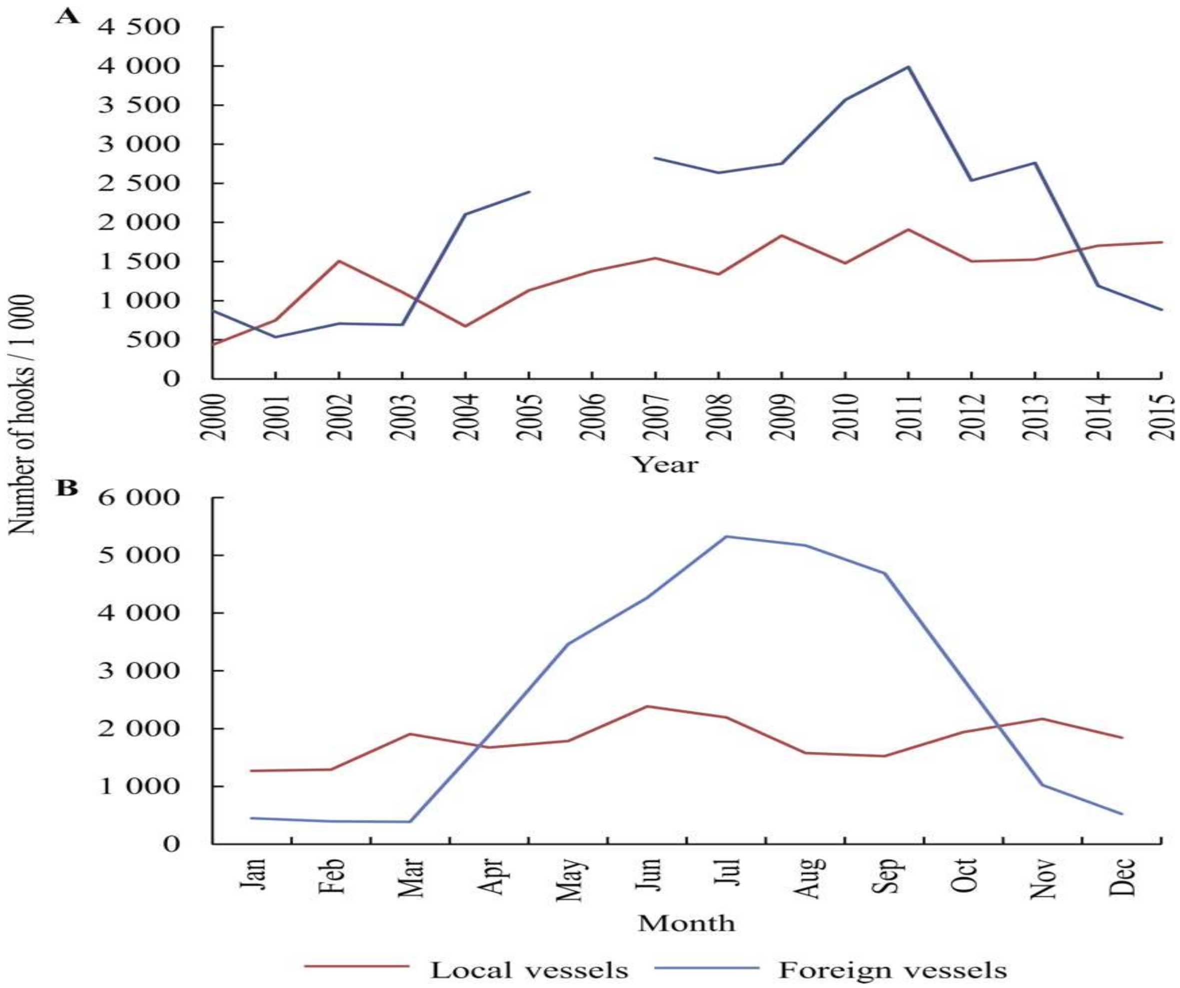


Figure 118: Numbers of hooks set per (A) year (2000–2015) and (B) per calendar month, as reported by local and foreign pelagic longliners (Jordaan *et al*., 2018).

Fishing areas are subdivided into the SE Atlantic (reporting to ICCAT) and the SW Indian Ocean (reporting to IOTC) along 20°E, and the West, Southwest, South and East sampling areas are shown in Figure 119. Bubble size is proportional to the numbers of hooks set per line.

The numbers of hooks set by foreign vessels peak between May and October each year, whereas local vessels fish throughout the year, with marginally fewer hooks set in January and February than other months (Figure 118). Foreign vessels venture further southwards than local vessels, which tend to remain within the EEZ (Figure 119; Jordaan *et al*., 2018).

Local vessels fish in all four areas, but in the East their range is limited to the northern half of the area, near a landing site at Richards Bay. Foreign vessels fish mainly in the SW Indian Ocean, with the bulk of all hooks set in the South (58%) and East (33%) areas, and the remaining 9% in the SE Atlantic. Foreign vessels set an average of 2 493 ± 597 (SD) hooks per line, compared to only 1 282 ± 250 hooks per line used by local vessels.

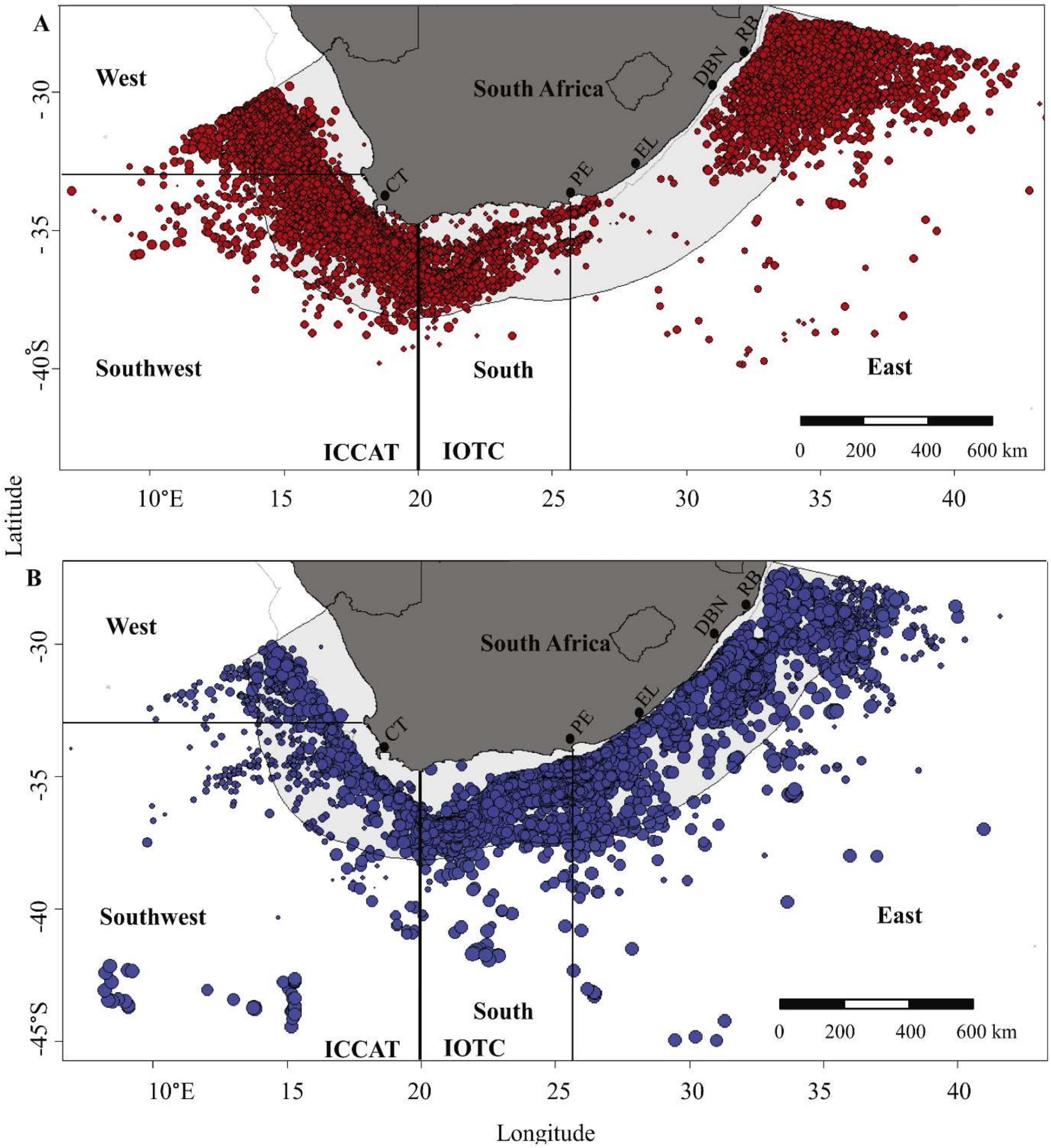


Figure 119: Geographical distribution of fishing effort by (A) local and (B) foreign pelagic longliners between 2000 and 2015, based on logbook data provided by vessel skippers (Jordaan *et al*., 2018).

The fishery operates extensively within the South African EEZ, primarily along the continental shelf break and further offshore. Figure 120 shows the spatial extent of pelagic longline fishing grounds in relation to the licence block and AOI for proposed drilling.

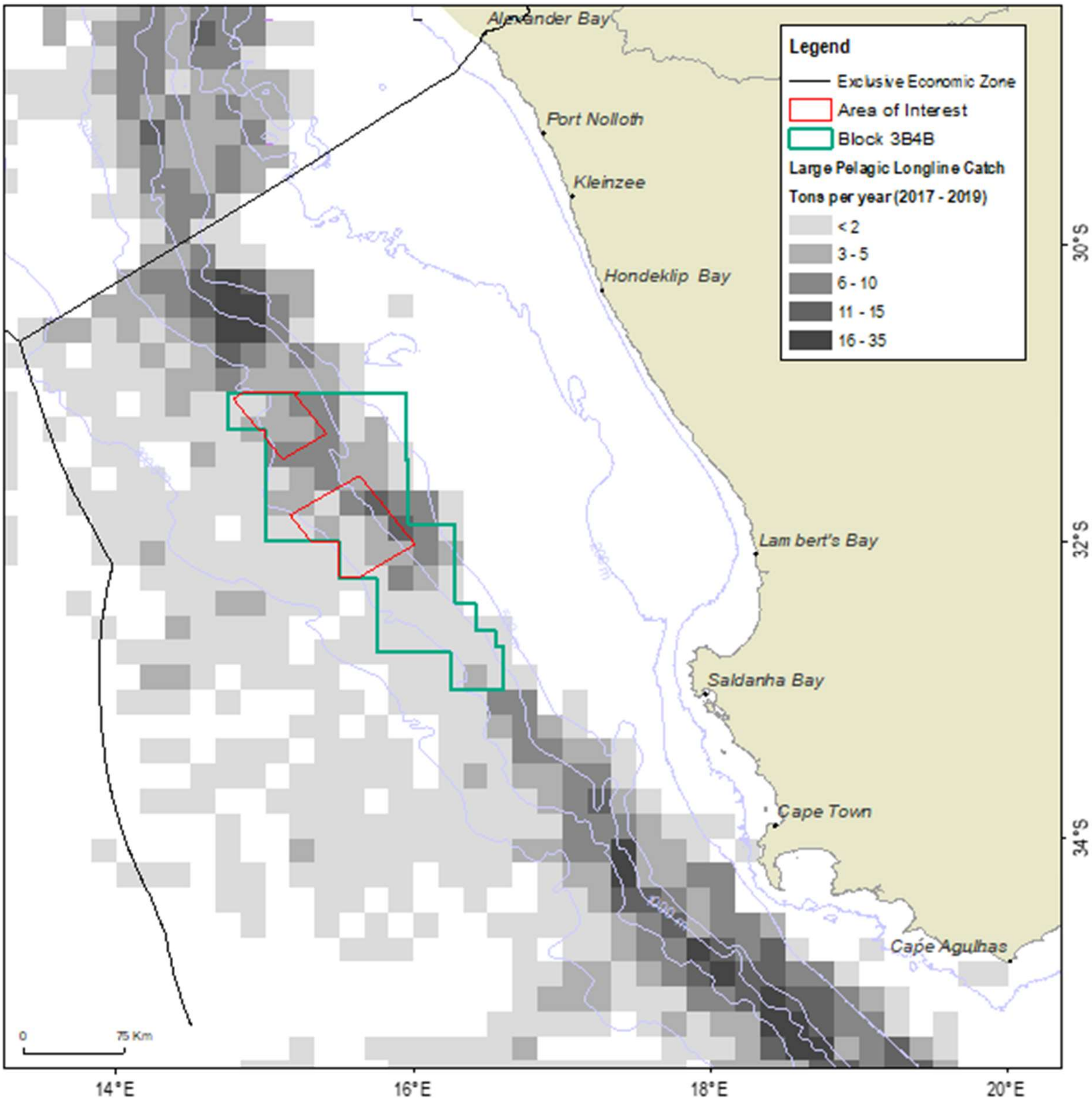


Figure 120: An overview of the spatial distribution of fishing effort expended by the longline sector targeting large pelagic fish species in relation to licence block 3B/4B (Green polygon) and AOI for proposed drilling (Red polygon).

Over the period 2017 to 2019 an average of 95 lines per year were set within the AOI yielding 127 tonnes of catch (4.5% of total national catch). Fishing activity takes place over the entire AOI for proposed exploration drilling but is concentrated towards the shelf break. Fishing effort within the AOI is highest during the period May, June and July. The 500 m safety zone around the drilling unit would result in an exclusion area of 0.79 km^2. Since surface longlines are buoyed and unattended, they drift in surface currents and cover a large area before they are retrieved. The potential area of exclusion to fishing operations would therefore not be limited to the 500 m safety zone around the drilling unit. Vessel operators would be obliged to take a precautionary approach in order to avoid gear entanglement with the (stationary) drilling unit by avoiding a much wider area. Based on an assumed average line length of 60 km, operators could be expected to avoid setting lines within a distance of 30 km of the drilling unit, in order to avoid potential gear entanglement.

8.4.4.10 **TUNA POLE-LINE**

The tuna pole fishery in South Africa has been operating since 1980, and traditionally targets high volume, low-value albacore (*Thunnus alalunga*) for canning along the west coast of the country. In recent years, some vessels have also begun targeting low volume, high-value yellowfin tuna (*T. albacares*) for sashimi markets. The fishery has faced challenges due to the seasonality of tuna in South African waters, with catches of albacore fluctuating around 3 000 tonnes per year, largely dependent on the availability of the species in near-shore waters between October and May.

To reduce conflict with the traditional linefish sector, access to additional species, including snoek (*Thyrsites atun*) and yellowtail (*Seriola lalandi*), has been granted to the tuna pole fishery. However, some operators have exacerbated the situation by targeting these species without also targeting tuna. As a result, the South African government has instituted bag limits for yellowtail of 10 per person per trip, and a minimum vessel size of 10 m, unless the vessel can demonstrate good performance on tuna. Access to snoek is still under deliberation.

The fishery is managed by a total allowable effort (TAE) of 200 vessels, with 200 rights made available in a long-term allocation process in 2005. The four major contracting parties actively fishing for albacore in the South Atlantic are Chinese-Taipei, South Africa, Brazil, and Namibia. The International Commission for the Conservation of Atlantic Tunas (ICCAT) is responsible for conducting stock assessments, devising control measures, and issuing country allocations. In 2011, the stock assessment for southern Atlantic longfin tuna (albacore) determined a total allowable catch (TAC) of 24 000 MT for the region, with South Africa and Namibia allocated a combined total of 104 000 tonnes. This allocation is currently being managed on an Olympic-type system.

Fishing for tuna occurs along the entire west coast of South Africa beyond the 200 m bathymetric contour, along the shelf break with favoured fishing grounds between 60 km and 120 km offshore of Saldanha Bay and north of Cape Columbine. Fishing activity for snoek is seasonal and takes place inshore of the 100 m depth contour along the coast between March and July, with a peak in activity during April and May.

Overall, the South African tuna pole fishery has faced challenges due to the seasonality of the target species and competition with the traditional linefish sector. The government has implemented bag limits and vessel size restrictions to reduce conflict, and the fishery is managed through an allocation system overseen by ICCAT. The reported wholesale value of the fishery in 2018 was R124 Million in 2018, or 1.2% of the total value of all fisheries combined. Landings of albacore in 2020 amounted to 3 941 tons. A historical time series of catch and effort reported by the South African sector operating within the Atlantic region is shown in Figure 121. The total effort of 4 131 catch days within the ICCAT convention area in 2019 represents an increase in effort of 9% compared to 2018.

The active fleet consists of approximately 92 pole-and-line vessels (also referred to as “baitboat”), which are based at the ports of Cape Town, Hout Bay and Saldanha Bay. Vessels normally operate within a 100 nm (185 km) radius of these locations with effort concentrated in the Cape Canyon area (South-West of Cape Point), and up the West Coast to the Namibian border with South Africa.

Vessels are typically small (an average length of 16 m but ranging up to 25 m). Catch is stored on ice, refrigerated sea water or frozen at sea and the storage method often determines the range of the vessel. Trip durations average between four and five days, depending on catch rates and the distance of the fishing grounds from port. Vessels drift whilst attracting and catching shoals of pelagic tunas. Sonars and echo sounders are used to locate schools of tuna. Once a school is located, water is sprayed outwards from high-pressure nozzles to simulate small baitfish aggregating near the water surface. Live bait is then used to entice the tuna to the surface (chumming). Tuna swimming near the surface are caught with hand-held fishing poles. The ends of the poles are fitted with a short length of fishing line leading to a hook. In order to land heavier fish, lines may be strung from the ends of the poles to overhead blocks to increase lifting power (Figure 122).

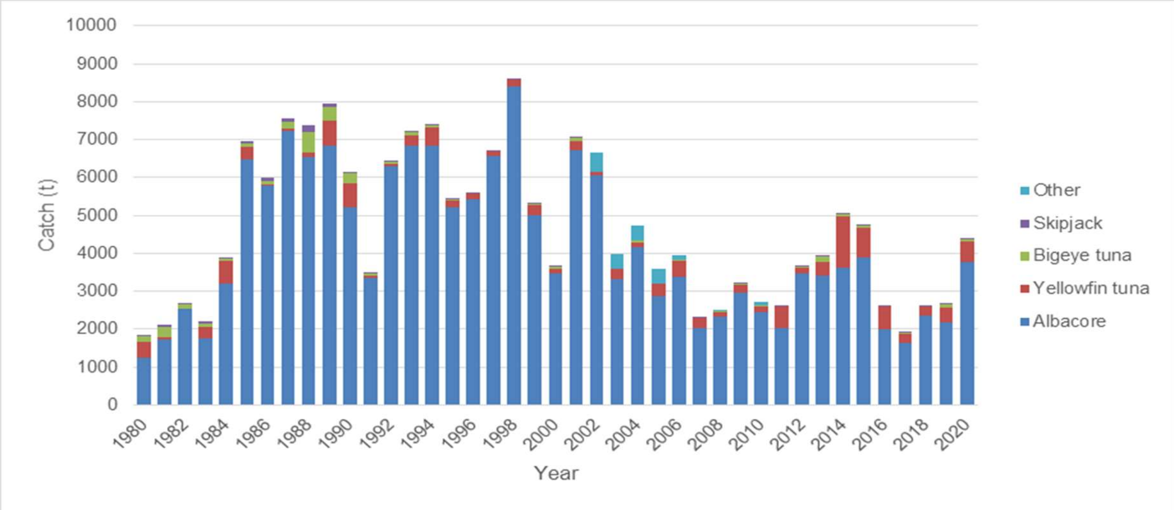


Figure 121: Catches (tons) of pelagic species by the South Africa pole-line ("Baitboat") fleet between 1980 and 2020 (ICCAT, 2022).

Figure 122: Schematic diagram of pole and line operation (Source: http://www.afma.gov.au/portfolio-item/minor-lines).

The nature of the fishery and communication between vessels often results in a large number of vessels operating in close proximity to each other at a time. The vessels fish predominantly during daylight hours and are highly manoeuvrable. However, at night in fair weather conditions the fleet of vessels may drift or deploy drogues to remain within an area and would be less responsive during these periods.

Figure 123 shows the location of fishing activity in relation to the licence block and AOI for proposed drilling. Fishing records received from DFFE for the reporting period 2017 to 2019 show fishing within the licence block but no activity within the AOI.

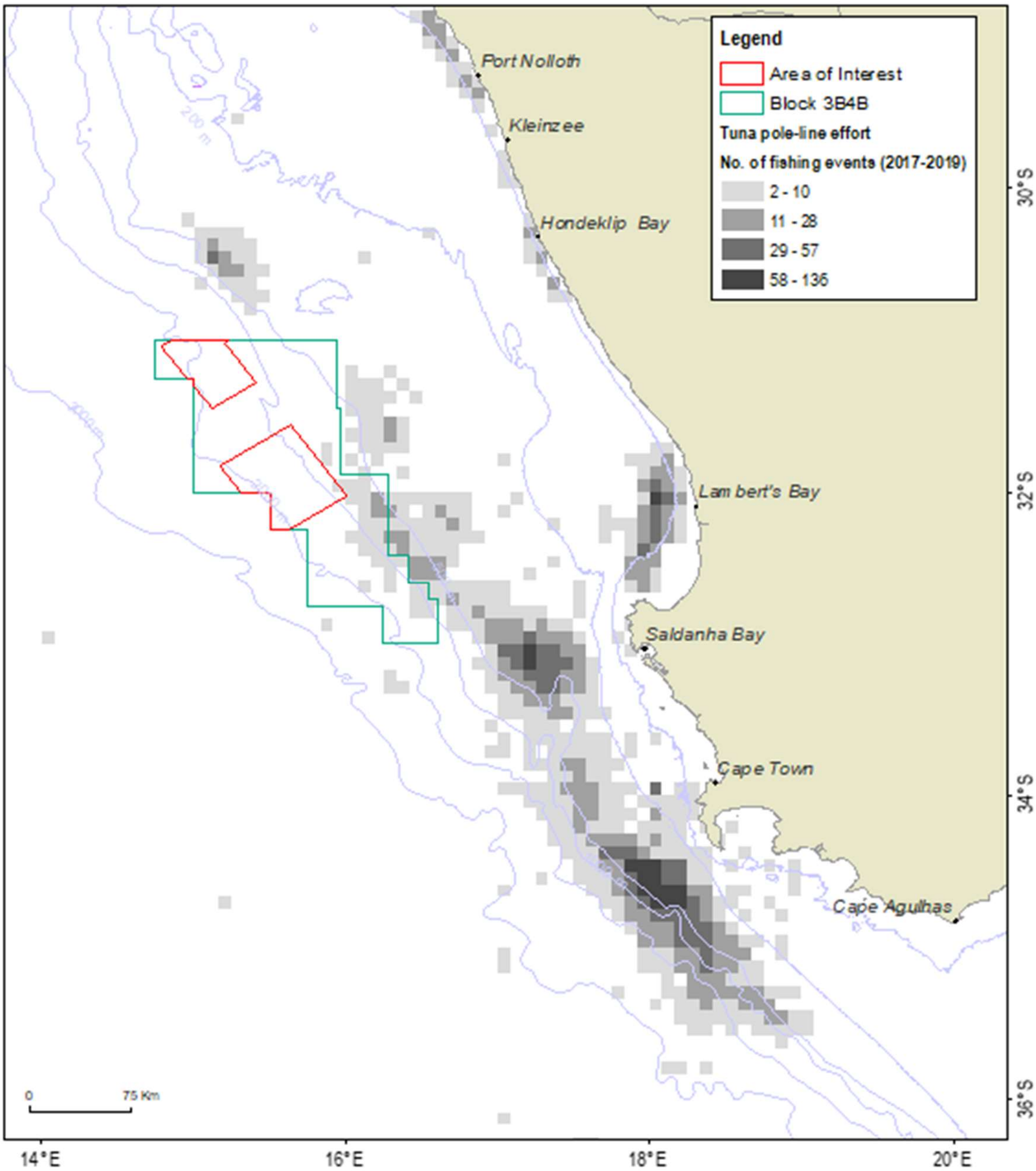


Figure 123: An overview of the spatial distribution of fishing effort expended by the pole- line sector targeting pelagic tuna (offshore areas) and snoek (inshore areas) in relation to the licence block 3B/4B (Green polygon) and AOI for proposed drilling (Red polygon).

8.4.4.11 COMMERCIAL OR TRADITIONAL LINE FISH

The commercial linefish sector is one of the oldest fisheries in South Africa and has its origins from the recreational sector. Essentially recreational linefishers commercialised resulting in a systematic decline in the "linefish" stocks. The Minister of Fisheries in the 1980's reformed the sector. This was done by creating a smaller commercial linefish sector, as well as introducing a moratorium on exploiting many species that were collapsed or near collapse. The commercial linefish sector now only allows a limited number of key species to be exploited using hook and line but excludes the use of longlines. Target species of the linefishery include temperate, reef-associated seabreams (e.g. carpenter, hottentot, santer and slinger), coastal migrants (e.g. geelbek and dusky kob) and nomads (e.g. snoek and yellowtail). More than 90% of the current linefish catch is derived from the aforementioned eight species. Almost all of the traditional line fish catch is consumed locally.

Of all South African marine fisheries, the linefishery is the most vulnerable to external impacts. Linefish resources are at risk of overcapacity as they area directly or indirectly exploited by other sectors, including the recreational, small-scale linefishery, inshore and offshore trawl fisheries, tuna pole-line fishery, the inshore *netfishery* and the demersal shark longline fishery (DEFF, 2020). The increased expectation of commercial access to linefish resources combined with the localised anticipation of community ownership by small-scale fishers may impact linefish stocks.

The traditional linefishery is the country's third most important fishery in terms of tonnage landed and economic value. It is a long-standing, nearshore fishery based on a large assemblage of different species using hook and line but excludes the use of longlines. Within the Western Cape the predominant catch species is snoek (*Thyrsites atun*) while other species such as Cape bream (hottentot) (*Pachymetopon blochii*), geelbek (*Atractoscion aequidens*), kob (*Argyrosomus japonicus*) and yellowtail (*Seriola lalandi*) are also important. Towards the East Coast the number of catch species increases and includes resident reef fish (Sparidae and Serranidae), pelagic migrants (Carangidae and Scombridae) and demersal migrants (Sciaenidae and Sparidae).

The traditional commercial line fishery is a relatively low-cost and labour-intensive industry, therefore important from an employment and human livelihood point of view. Although the commercial linefishery has the largest fleet, it contributes only 6% of the total estimated value of all South African marine fisheries (DFFE, 2020). In 2017, the wholesale value of catch was reported as R122.1 million.

The commercial line fishery is a nearshore boat-based activity which is currently managed through a total allowable effort (TAE) allocation, based on boat and crew numbers. The number of rights holders is currently 425. For the 2021/2022 fishing season, 325 vessels were apportioned to commercial fishing, whilst 122 vessels apportioned to small-scale fishing.

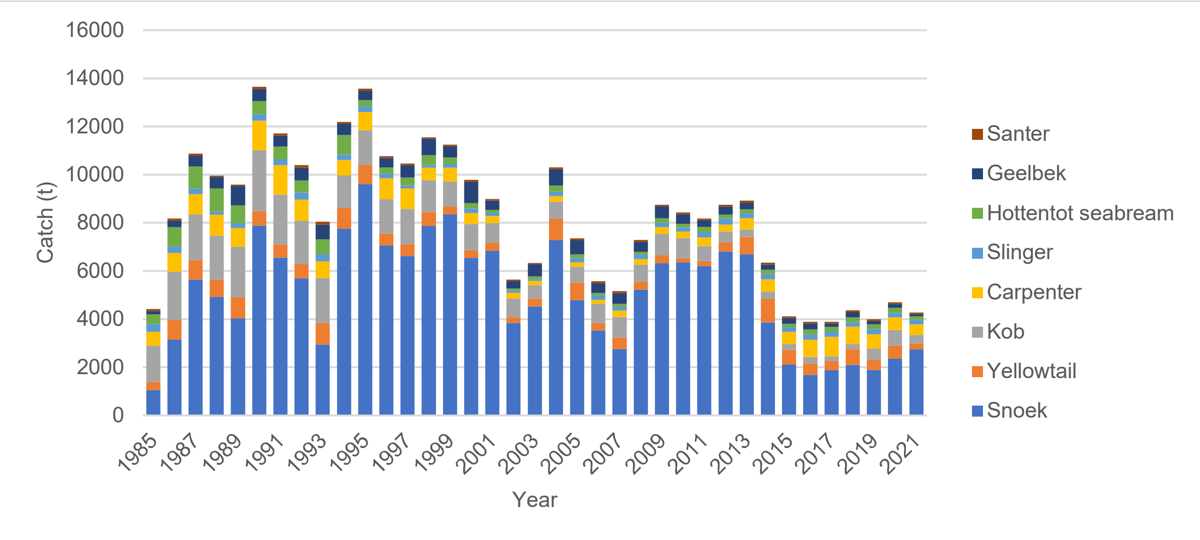


Figure 124: Annual catch (t) of the eight most important linefish species for the period 1985-2021 (DFFE, 2022).

A standard vessel is defined as a vessel that can carry a crew of 7. Vessels with a maximum length overall of 10 m and a maximum crewing capacity of 12, including the skipper. The maximum standard vessel allocation for the commercial linefishery within the three management Zones (2021/2022) is 340 vessels for Zone A (Port Nolloth to Cape Infanta), 64 vessels for Zone B (Cape Infanta to Port St Johns) and 51 vessels for Zone C (KwaZulu-Natal).

Annual catches prior to the reduction of the commercial effort were estimated at 16 000 tons for the traditional commercial line fishery. Almost all of the traditional line fish catch is consumed locally. The fishery is widespread along the country's shoreline from Port Nolloth on the West Coast to Cape Vidal on the East Coast. Effort is managed geographically with the spatial effort of the fishery divided into three zones. Zone A extends from Port Nolloth to Cape Infanta, Zone B extends from Cape Infanta to Port St Johns and Zone C covers the KwaZulu-Natal region.

Most of the catch (up to 95%) is landed by the Cape commercial fishery, which operates on the continental shelf from the Namibian border on the West Coast to the Kei River in the Eastern Cape. Fishing takes place throughout the year but there is some seasonality in catches.

Crew use hand line or rod-and-reel to target approximately 200 species of marine fish along the full 3 000 km coastline, of which 50 species may be regarded as economically important. To distinguish between line fishing and long lining, line fishers are restricted to a maximum of 10 hooks per line. Target species include resident reef-fish, coastal migrants and nomadic species. Many species allocated to the small-scale fisheries "baskets" are primary targets of the commercial and recreational linefish sectors, and these shared resources must be carefully monitored given the increased fishing pressure expected. A revision of the Linefish Management Protocol (LMP) is also underway to ensure the future sustainability of linefish stocks.

Snoek is an important linefish species as it makes up the largest annual catch in terms of biomass, contributing more than 80% to the total catch west of Cape Infanta. Snoek spawning occurs offshore during winter-spring, along the shelf break (150-400 m) of the western Agulhas Bank and the South African west coast. Prevailing currents transport eggs and larvae to a primary nursery ground north of Cape Columbine and to a secondary nursery area to the east of Danger Point; both shallower than 150 m. Juveniles remain on the nursery grounds until maturity, growing to between 33 and 44 cm in the first year (3.25 cm/month). Onshore-offshore distribution (between 5- and 150-m isobaths) of juveniles is determined largely by prey availability and includes a seasonal inshore migration in autumn in response to clupeoid recruitment. Adults are found throughout the distribution range of the species, and although they move offshore to spawn - there is some southward dispersion as the spawning season progresses - longshore movement is apparently random and without a seasonal basis (Griffiths, 2002). Snoek are caught within the inshore zone along most of the South African coastline with the majority of catches being made along the West and South-West Coast of South Africa. Although snoek can be caught year-round, during the snoek seasonal migration (between April and July) when they shoal nearshore, they are caught more frequently using handlines by the linefishery (Figure 125). Snoek are not distributed offshore of the 1000 m depth contour and therefore not targeted or caught by the commercial linefishery in the AOI for proposed drilling.

Figure 125: Fishermen landing snoek on board a vessel operating in the traditional linefishery (photo credit Jaco Barendse).

Spatial mapping of effort and catches in the line fishery is less accurate than in other sectors because of the reporting structure implemented by DFFE. Fishing locations are described by skippers in relation to numbered sections along the coast and estimated distance offshore. No bearings are given, and no GPS data are recorded. Furthermore, due to the large number of vessels, associated reporting complexities and also the unwillingness of local fisherman to share fishing locations, inaccuracies in the spatial representation are to be expected. This fishery's operational footprint may at times be limited by operating costs and is sensitive to local reports of fish availability. Vessels range in length between 4.5 m and 11 m and the offshore operational range is restricted by vessel category to 40 nautical miles (75 km). Fishing effort at this outer limit is sporadic. Operating ranges vary greatly but most of the activity is conducted within 15 km of a launch site.

Figure 126 shows the spatial extent of traditional linefish grounds in relation to the licence block and AOI for proposed drilling. Fishing effort is primarily coastal, with vessels operating in waters shallower than 100 m. Activity in deeper waters are reflected in the vicinity of Cape Canyon at a distance of 55 km offshore of Saldanha Bay, as well as and Hope Canyon due South of Cape Point. There is no overlap with the licence block or the AOI.

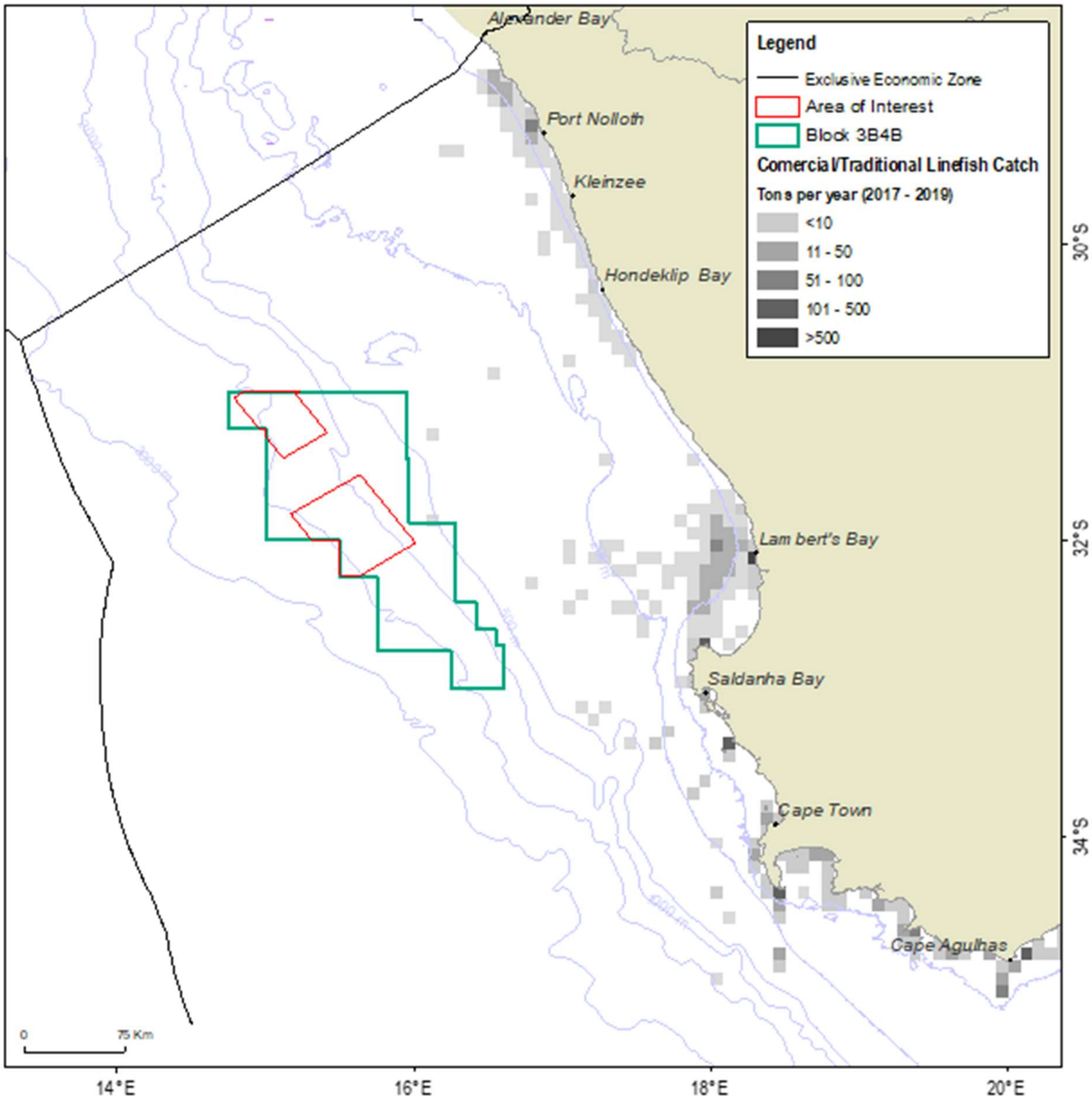


Figure 126: An overview of the spatial distribution of catch taken by the line fish sector in relation to licence block 3B/4B (Green polygon) and AOI for proposed drilling (Red polygon).

8.4.4.12 **WEST COAST ROCK LOBSTER**

The West Coast rock lobster (*Jasus lalandii*) is a valuable resource of the South African West Coast and consequently an important income source for West Coast fishermen. The resource occurs inside the 200 m depth contour along the West Coast from Namibia to East London on the East Coast of South Africa. Fishing grounds stretch from the Orange River mouth to east of Cape *Hangklip* in the South-Eastern Cape.

The fishery is comprised of four sub-sectors – commercial offshore, commercial nearshore, small-scale and recreational, all of which have to share from the same national TAC. The 2021/22 TAC was set at 600 tonnes. The TAC for the 2021/2022 fishing season was reduced by 28% from the previous fishing season (2020/2021). The updated stock assessment for the resource has indicated that it is further depleted than was thought to be the case two years ago, and poaching is one of the major contributors to the recently exacerbated depleted status of the resource. The resource has over recent decades been at about 2.5% of the pristine level, but that over the last few years this had dropped to about 1.5%.

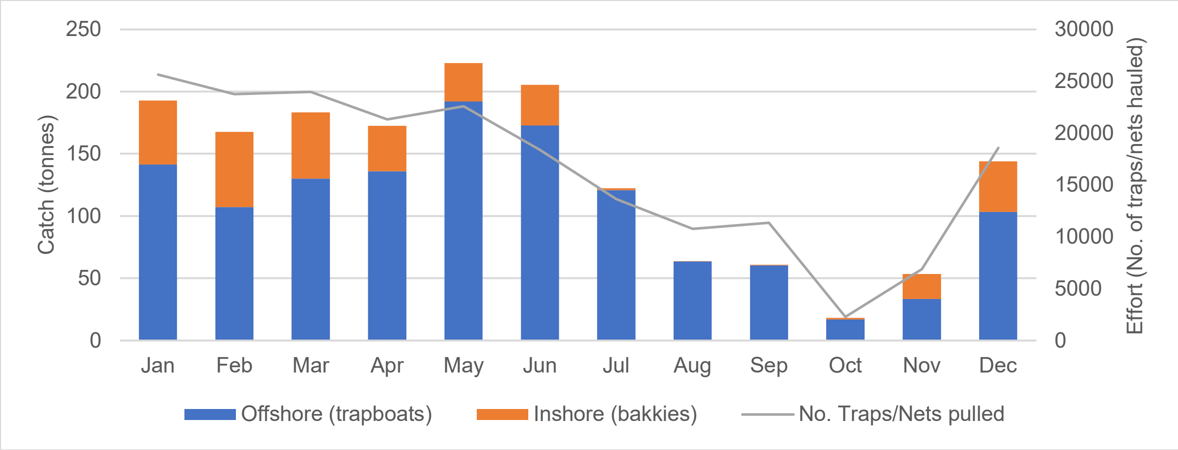


Figure 127: Graph showing the average monthly catch (tonnes) and effort (number of traps hauled) reported by the offshore (trap boat) and inshore (bakkie) rock lobster sectors over the period 2006 to 2020.

The resource is managed geographically, with TACs set annually for different management areas. The commercial and small-scale fishing sectors are authorised to undertake fishing for four months in each management zone therefore closed seasons are applicable to different management zones. The start and end dates for the 2021/22 fishing season per sector and zone are shown in Table 31.

Table 31: Start and end dates for the fishing season 2021/22 by management zone. Special Project Report on the review of the TAC for West Coast Rock Lobster for the 2021/22 fishing season by the Consultative Advisory Forum for Marine Living Resources

Area	**Catch period**	
	Commercial nearshore, interim relief, small-scale: nearshore	Commercial offshore, small-scale: offshore
Area 1 + 2	15 Oct, Nov, Dec, Jan, 15 Feb	
Area 3 + 4	15 Nov, Dec, Jan, Feb, 15 Mar	15 Nov, Dec, Jan, Feb, 15 Mar
Area 5 + 6	15 Nov, Dec, Jan, Feb, 15 Mar	
Area 7		Dec, Jan, Feb, Mar
Areas 8 and 11	15 Nov, Dec, Jan, Feb, 15 Mar	Jan, Mar, Apr, May
Area 8 (deep water)		Jun, Jul
Areas 12, 13 and 14	15 Nov, Dec, Jan, Feb, 15 Mar	

The commercial offshore sector operates at a depth range of approximately 30 m to 100 m, making use of traps consisting of rectangular metal frames covered by netting. These traps are set at dusk and retrieved during the early morning. Approximately 138 vessels participate in the offshore sector.

The commercial nearshore sector makes use of hoop nets to target lobster at discrete suitable reef areas along the shore at a water depth of up to 15 – 30 m. These are deployed from a fleet of small dinghies/bakkies which operate from the shore and coastal harbours. Approximately 653 boats participate in the sector.

The delineation of management zones is shown in Figure 128. The five super-areas are: areas 1–2, corresponding to zone A; areas 3–4, to zone B; areas 5–6, to zone C; area 7, being the northernmost area within zone D; and area 8+, comprising area 8 of zone D as well as zones E and F. Figure 129 shows rock lobster catch by area for the commercial offshore and nearshore sub-sectors over the period 2005 to 2016.

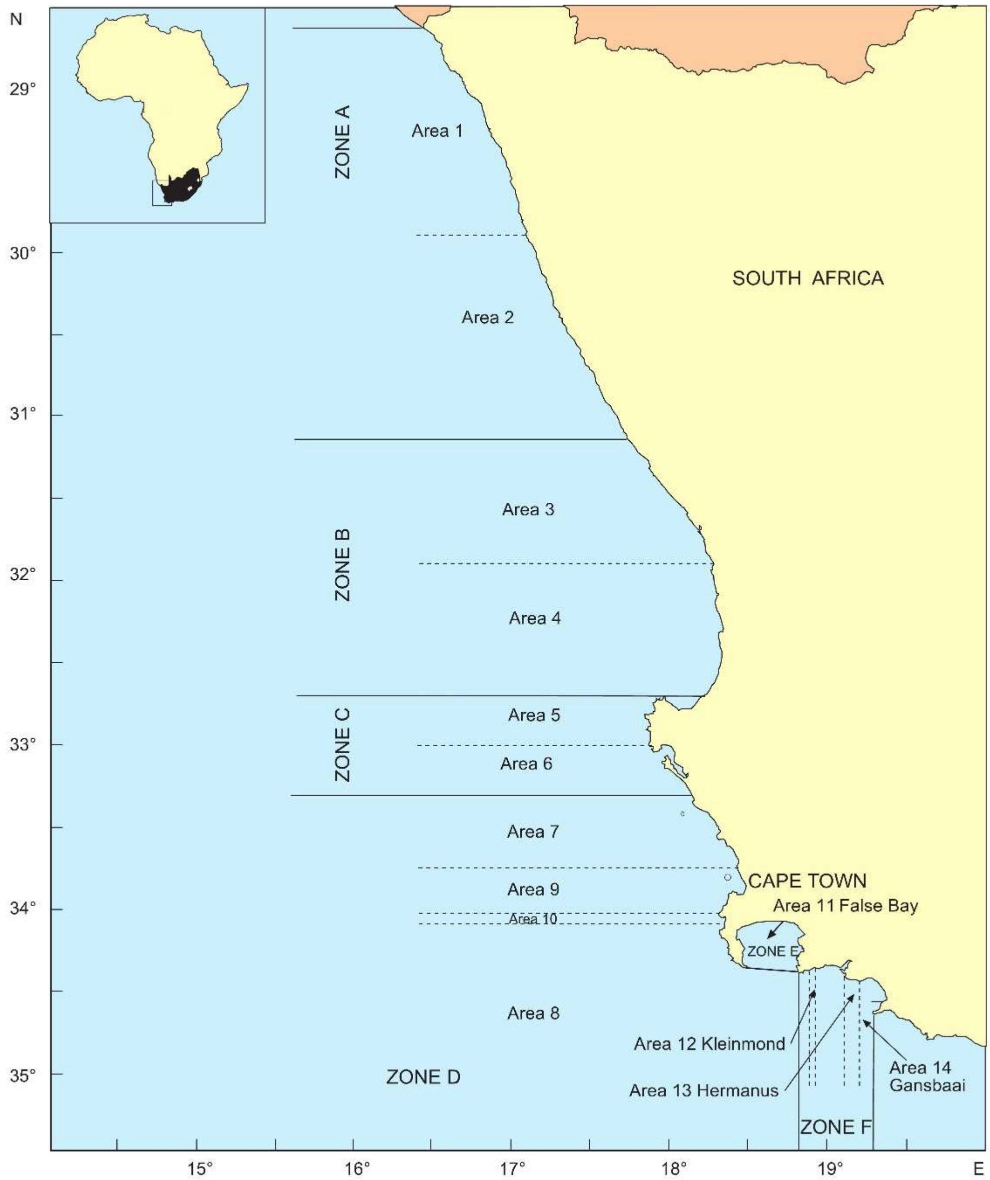


Figure 128: West Coast rock lobster fishing zones and areas. The five super-areas are: areas 1–2, corresponding to zone A; areas 3–4, to zone B; areas 5–6, to zone C; area 7, being the northernmost area within zone D; and area 8+, comprising area 8 of zone D as well as zones E and F.

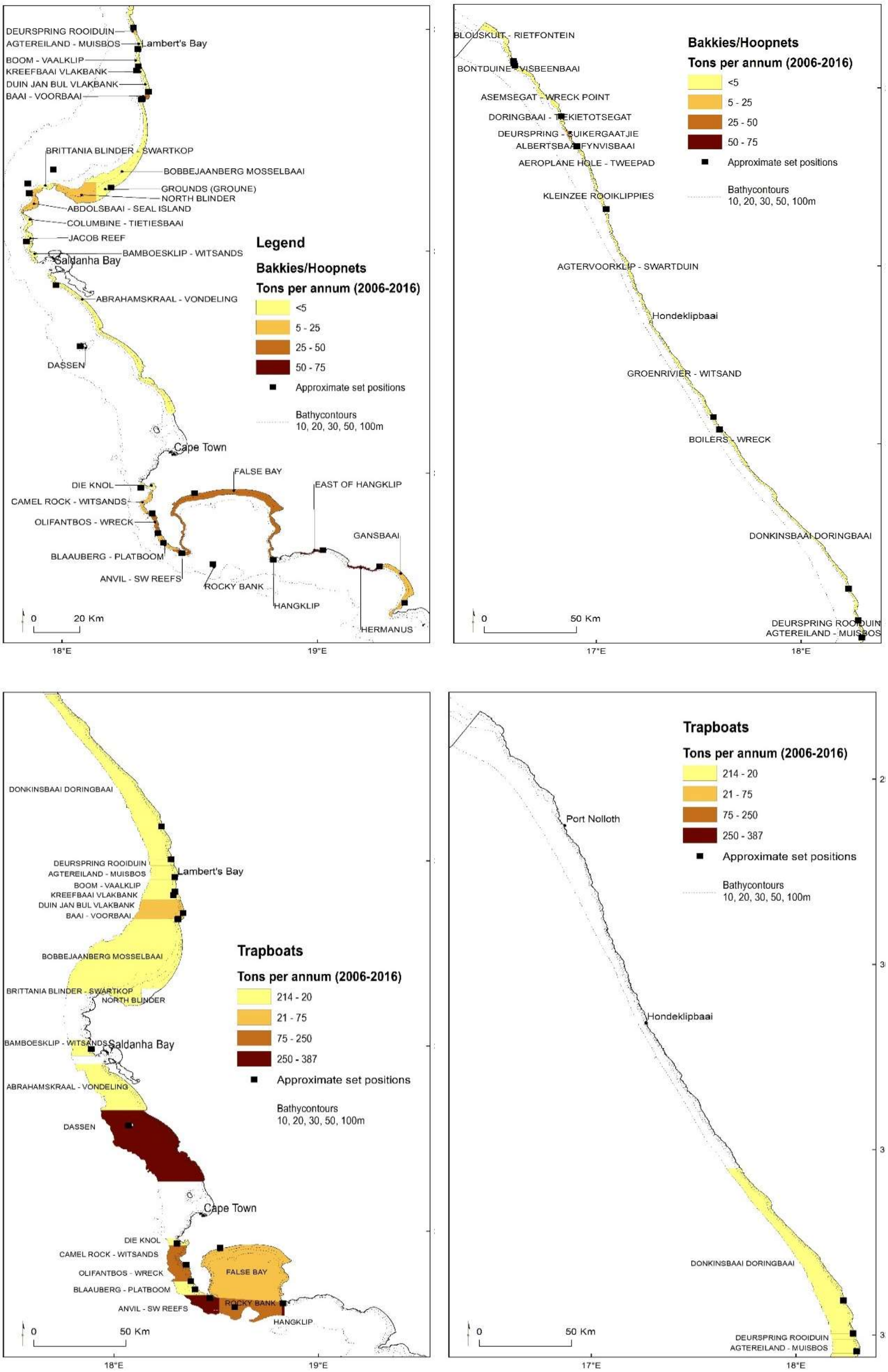


Figure 129: An overview of the spatial distribution of fishing effort expended by the west coast rock lobster nearshore (above) and offshore (below) sub-sectors within demarcated lobster management zones.

The licence area is situated offshore of rock lobster management zones B and A; and offshore of the depth range at which rock lobster is targeted. Over the period 2006 to 2020, there was no fishing activity reported by the (Figure 130).

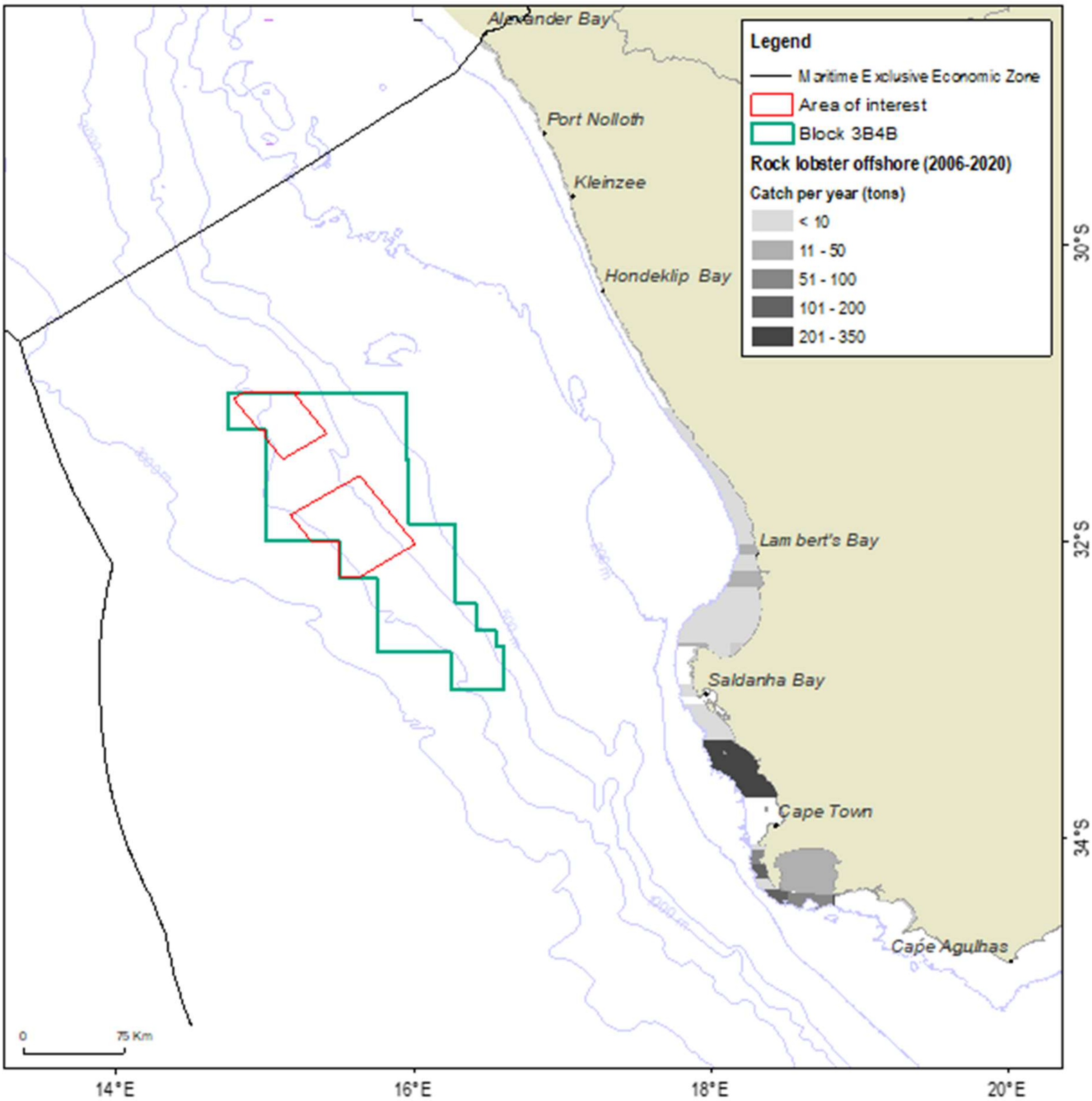


Figure 130: Spatial distribution of lobster catch by management sub-area over the period 2006 to 2020 (offshore/trap boat sub-sector) in relation to licence block 3B/4B (Green polygon) and AOI for proposed drilling (Red polygon). Depth contours range from 100 m to 1000 m.

8.4.4.13 **WHITE MUSSELS**

White mussels of the species *Donax serra* are found in the intertidal zone of sandy beaches ranging from northern Namibia to the Eastern Cape of South Africa. Their abundance is highest along the West Coast because of the higher plankton production in that area, compared with the rest of the South African coast, which is associated with upwelling of the Benguela Current.

The fishery for white mussels started in the late 1960s as part of the general commercial bait fishery and was suspended in 1988 when the bait Rights were revoked. Subsequent to stock assessments conducted in 1988/1989, harvesting of white mussels was retained as a commercial fishing sector and limited to seven areas along the West Coast, the closest of which (between Doring Bay and Lambert’s Bay) is located between 280 km and 380 km to the south-east of the Area if Interest for proposed drilling.

Surveys conducted in the 1990s showed that commercial catches amounted to less than 1% of the standing biomass in the relevant areas and the stock is therefore considered to be under-exploited.

Prior to 2007, each Right Holder was limited to a monthly maximum catch of 2 000 mussels. However, data from the fishery were unreliable, due to under-reporting and difficulties with catch monitoring, and hence catch limits were not considered to be an adequate regulatory tool to manage this fishery. As of October 2006, the monthly catch limit was lifted. Since 2007 the commercial sector has been managed by means of a total allowable effort (TAE) allocation of seven Right Holders (a Right Holder may have up to seven "pickers"), each harvesting within only one of the seven fishing areas along the West Coast. In 2013, the fishing Rights allocation process (FRAP 2013) for this fishery started and new Rights were granted in addition to those of some of the previous Right Holders. After an appeal process, 26 commercial Rights were confirmed in 2015, until December 2020. In August 2019, it was announced that the FRAP 2020 process would be extended to December 2021 and is currently ongoing. Each Right Holder was allocated a specific number of pickers. The Interim Relief sector was started in 2007 to authorize exemption to harvest certain species until the small-scale policy has been finalized. During the 2013/2014 season, 1 995 Interim Relief permits were issued for the Western and Northern Cape combined. This sector is subject to a limit of 50 mussels per person per day. The recreational sector is also limited by a daily bag limit of 50 mussels per person per day. For all sectors, a minimum legal size of 35 mm applies.

In the decades preceding the 1990s, commercial catches declined continuously. The lifting of the commercial upper catch limit in 2006 led to a steep increase in the number of white mussels collected by this sector over the last few years. In addition, the development of a bait market in Namibia in recent years has created a greater demand for the resource. Recently, CPUE has remained relatively stable overall at between 300 and 500 mussels per hour harvested.

It should be noted that not all the areas allocated are being harvested, and that the largest component of the overall catch of white mussels is that of the recreational sector, but these catches are not monitored. There are also information gaps regarding the level of exploitation by Interim Relief harvesters and the levels of illegal take. On account of irregularities, and despite the improvement post-2006, the catch-and-effort data are still considered to be unreliable.

8.4.4.14 **OYSTERS**

The Cape rock oyster (*Striostrea margaritacea*) occurs on rocky reefs from Cape Agulhas to Mozambique and is targeted by the fishery along with smaller amounts of Crassostrea gigas. The harvesting of oysters is managed by DEFF within four broad areas namely, Southern Cape, Gqeberha, KwaZulu-Natal (KZN) North and KZN South. The coastal locations of boundaries between management zones for the Southern Cape area are shown Figure 131.

Shore-based collectors pry oysters off rocks and sell the oysters locally. Harvesting takes place during spring low tides from the intertidal zone and shallow subtidal rocky reefs and areas of operation can be considered to extend from the shoreline to the 10 m depth contour. DEFF proposes that oysters will be reclassified as a small-scale fishing species and that, from 2021, will be managed under the small-scale fisheries sector (DEFF 2020).

Total catch in the Southern Cape region was at least 373 306 oysters in 2018. In 2019, there were 73 individuals listed with commercial rights to harvest oysters and these rights were due to expire on 31 December 2020. From 01 January 2021 the sector was re-classified under the small-scale fisheries sector. Most oyster pickers sell to middlemen who in turn sell to local restaurants. However, some of the catch is sold directly to the public on the beach. The fishery is managed using total applied effort (TAE) based on the catch returns received. Due to the uncertain status of the resource, and evidence of over-exploitation in the Southern Cape, this region has been prioritised for research efforts aimed at establishing indices of abundance, estimating density and population size structure, and determining a more accurate TAE. The number of pickers is limited based on the TAE and a daily bag limit of 190 oysters applies in KZN. A rotational harvesting system is implemented in KZN, whereby the north and south coast are each divided into four zones. Harvesting is limited to only one zone on the north coast and one zone on the south coast for a period of one year, affording each zone a fallow period of three years. The change over to a new zone occurs on the 1st of November of every year, which is the start of the peak oyster breeding season in KZN and thus, promotes the recovery of the exploited oyster beds (Schleyer 1988). Oysters are broadcast spawners and those along the KZN coast spawn throughout the year, with peaks during spring and summer.

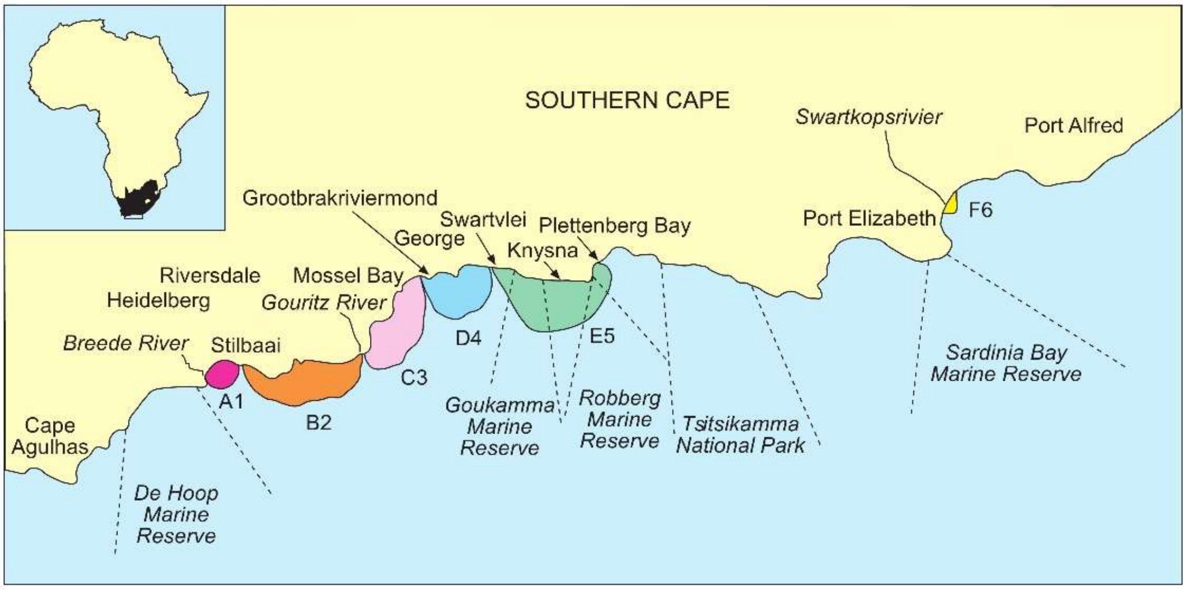


Figure 131: Oyster fishery in Gqeberha and the Southern Cape. Colour areas denote dedicated oyster collection zones (DEFF, 2020)

8.4.4.15 **ABALONE**

Abalone (*Haliotis midae*) are widely distributed around the South African coastline, from St Helena Bay on the West Coast to just north of Port St Johns on the East Coast. Once a lucrative commercial fishery, earning up to approximately R100 million annually at the turn of the century, rampant illegal harvesting and continued declines in the abundance of the resource resulted in the prohibition of recreational harvesting since 2003/4 and a total closure of the commercial fishery during the 2008/9 season. In 2010 the commercial fishery was reopened with an annual quota of 150 tons; however, this was reduced in 2013/14 to 96 tons and further reduced in 2019/2020 to 50.5 tons (refer to Figure 3.60). Estimated weight and number of illegally-harvested abalone for the years 2000–2020 is shown in Figure 3.61.

Currently the fishery is commercial, however, DFFE proposes that 50% of the TAC be apportioned to small-scale fisheries, from 2021 (DEFF Government Gazette No. 1129, 23 October 2020).

Landings of abalone (kg), effort (hours) and catch per unit effort (CPUE) are managed by harvesting area (zones A to G – refer to Figure 3.62). Wild abalone may only be harvested by quota holders and is harvested by divers during specified harvesting seasons. The collection range is assumed to be from the coastline to 20 m depth contour, thus well inshore of the licence block and AOI for proposed drilling.

In order to sustain and protect wild populations of abalone, they are bred in abalone farms along the South African coast. Land-based flow-through systems (also referred to as raceways) using pumped seawater are the most common abalone farming systems used in South Africa. However, ocean-based abalone farming is also done in four designated areas in the Northern Cape. This is called ‘ranching’. Today there are 18 abalone farms along the South African coast, from Saldanha in the West Coast and along the South Coast up to the East Coast.

Figure 132: Abalone fishing Zones A to G, including sub-zones, and distribution of abalone (insert). The experimental fisheries (2010/11-2013/14) on the western and eastern sides of False Bay and in the Eastern Cape are also shown. These areas within False Bay, included in the commercial fishery recommendations for 2017/18, are referred to as Sub-zone E3 and Sub-zone D3 (DEFF, 2020)

8.4.4.16 ABALONE RANCHING

The Abalone *Haliotus midae*, is endemic to South Africa and referred to locally as "perlemoen". The natural population extends along 1500 km of coastline east from St Helena Bay in the Western Cape to Port St Johns on the east coast (Branch *et al*. 2010; Troell *et al* 2006). *H. midae* inhabits intertidal and subtidal rocky reefs, with the highest densities found in kelp forests (Branch *et al*., 2010). Kelp forests are a key habitat for abalone, as they provide a source of food and ideal ecosystem for abalone's life cycle (Branch *et al*., 2010). Light is a limiting factor for kelp beds, which are therefore limited to depths of 10m on the Namaqualand coast (Anchor Environmental, 2012). Habitat preferences change as abalone develop. Larvae settle on encrusted coralline substrate and feed on benthic diatoms and bacteria (Shepherd and Turner, 1985). Juveniles of 3-10 mm are almost entirely dependent on sea urchins for their survival, beneath which they conceal themselves from predators such as the West Coast rock lobster (Sweijd, 2008; Tarr *et al*., 1996). Juveniles may remain under sea urchins until they reach 21-35 mm in size, after which they move to rocky crevices in the reef. Adult abalone remain concealed in crevices, emerging nocturnally to feed on kelp fronds and red algae (Branch *et al*., 2010). In the wild, abalone may take 30 years to reach full size of 200 mm, but farmed abalone attain 100 mm in only 5 years, which is the maximum harvest size (Sales & Britz, 2001).

South Africa is the largest producer of abalone outside of Asia (Troell *et al*., 2006). For example, in 2001, 12 abalone farms existed, generating US$12 million at volumes of 500-800 tonnes per annum (Sales & Britz, 2001). By 2006, this number had almost doubled, with 22 permits granted and 5 more being scheduled for development (Troell *et al*., 2006). Until recently, abalone cultivation has been primarily onshore, but abalone ranching provides more cost effective opportunities for production (Anchor Environmental, 2012). Abalone ranching is "where hatchery-produced seed are stocked into kelp beds outside the natural distribution" (Troell *et al*., 2006). Translocation of abalone occurs along roughly 50 km of the Namaqualand coast in the Northern Cape due to the seeding of areas using cultured spat specifically for seeding of abalone in designated ranching areas (Anchor Environmental, 2012). The potential to increase this seeded area to 175 km has been made possible through the issuing of “Abalone Ranching Rights” (Government Gazette, 20 August 2010 No. 729) in four concession zones for abalone ranching between Alexander Bay and Hondeklipbaai (Diamond Coast Abalone 2016).

Abalone ranching was pioneered by Port Nolloth Sea Farms who were experimentally seeding kelp beds in Port Nolloth by 2000. Abalone ranching expanded in the area in 2013 when DAFF issued rights for each of four Concession Area Zones. Abalone ranching includes the spawning, larval development, seeding and harvest. An onshore hatchery supports the ranching in the adjacent sea (Anchor Environmental, 2012). Two hatcheries exist in Port Nolloth producing up to 250 000 spat. To date, there has been no seeding in Zones 1 or 2. Seeding has taken place in Zones 3 and 4.

The AOI is situated 185 km offshore of the ranching zones (refer to Figure 133). The maximum depth of seeding is considered to be approximately 10 m within each of the zones.

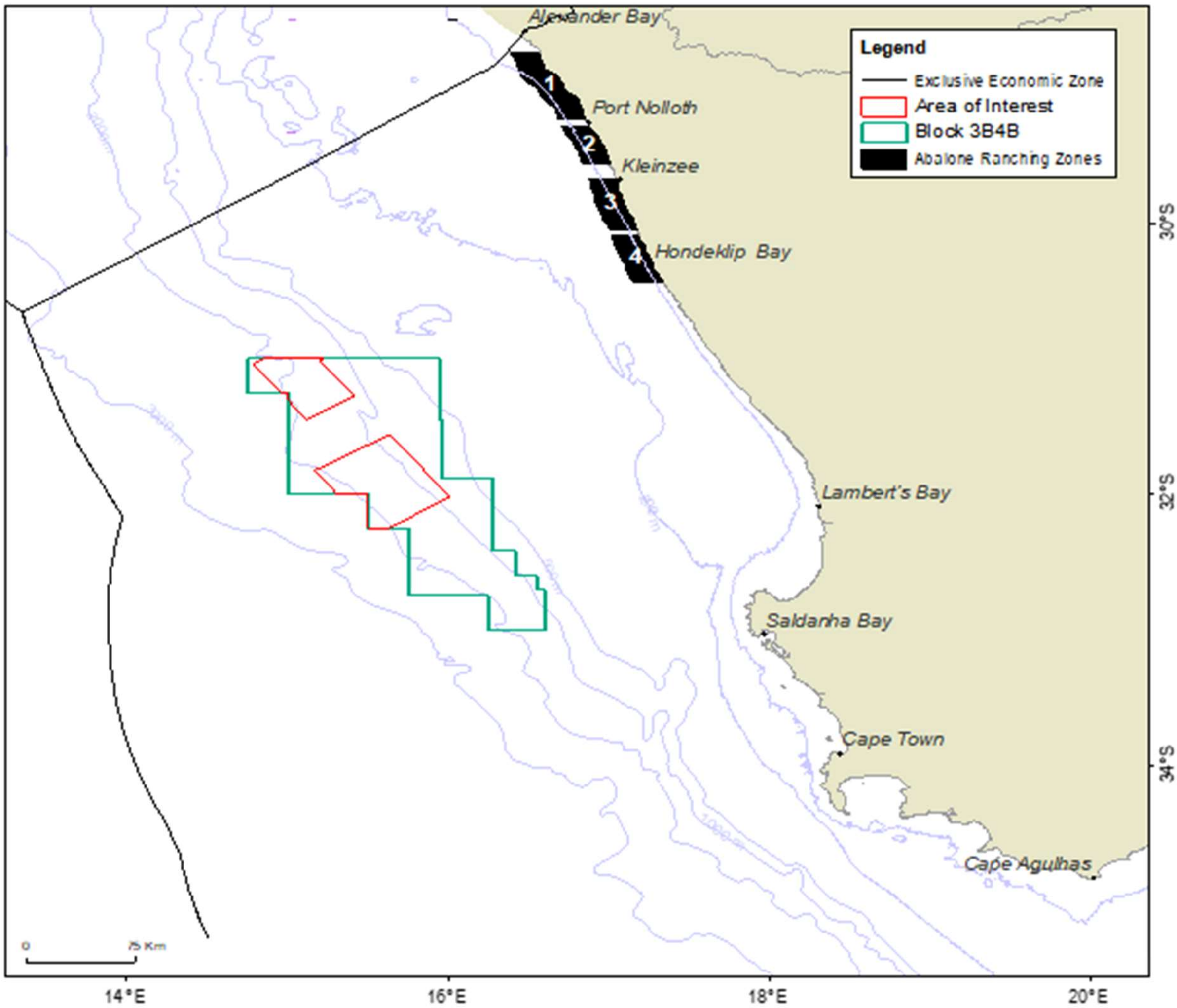


Figure 133: An overview of the spatial distribution of abalone ranching concession areas 1 – 4 in relation to licence block 3B/4B (Green polygon) and AOI for proposed drilling (Red polygon).

8.4.4.17 BEACH-SEINE AND GILLNET FISHERIES ("NETFISH" SECTOR)

There are a number of active beach-seine and gillnet operators throughout South Africa (collectively referred to as the “netfish” sector). Initial estimates indicate that there are at least 7 000 fishermen active in fisheries using beach-seine and gillnets, mostly (86%) along the West and South coasts. These fishermen utilize 1 373 registered and 458 illegal nets and report an average catch of about 1 600 tons annually, constituting 60% harders (also known as mullet, *Chelon richardsonii*), 10% St Joseph shark (*Callorhinchus capensis*) and 30% "bycatch" species such as galjoen (*Dichistius capensis*), yellowtail (*Seriola lalandii*) and white steenbras (*Lithognathus lithognathus*). Catch-per-unit-effort declines eastwards from 294 and 115 kg·net-day−1 for the beach-seine and gill-net fisheries respectively off the West Coast to 48 and 5 kg·net-day−1 off KwaZulu-Natal. Consequently, the fishery changes in nature from a largely commercial venture on the West Coast to an artisanal/subsistence fishery on the East Coast (Lamberth *et al*. 1997).

The fishery is managed on a Total Allowable Effort (TAE) basis with a fixed number of operators in each of 15 defined areas (see Figure 134 for the fishing areas). The number of Rights Holders operating on the West Coast from Port Nolloth to False Bay is listed as 28 for beach-seine and 162 for gillnet (DAFF, 2021). Permits are issued solely for the capture of harders, St Joseph and species that appear on the 'bait list'. The exception is False Bay, where Right Holders are allowed to target linefish species that they traditionally exploited.

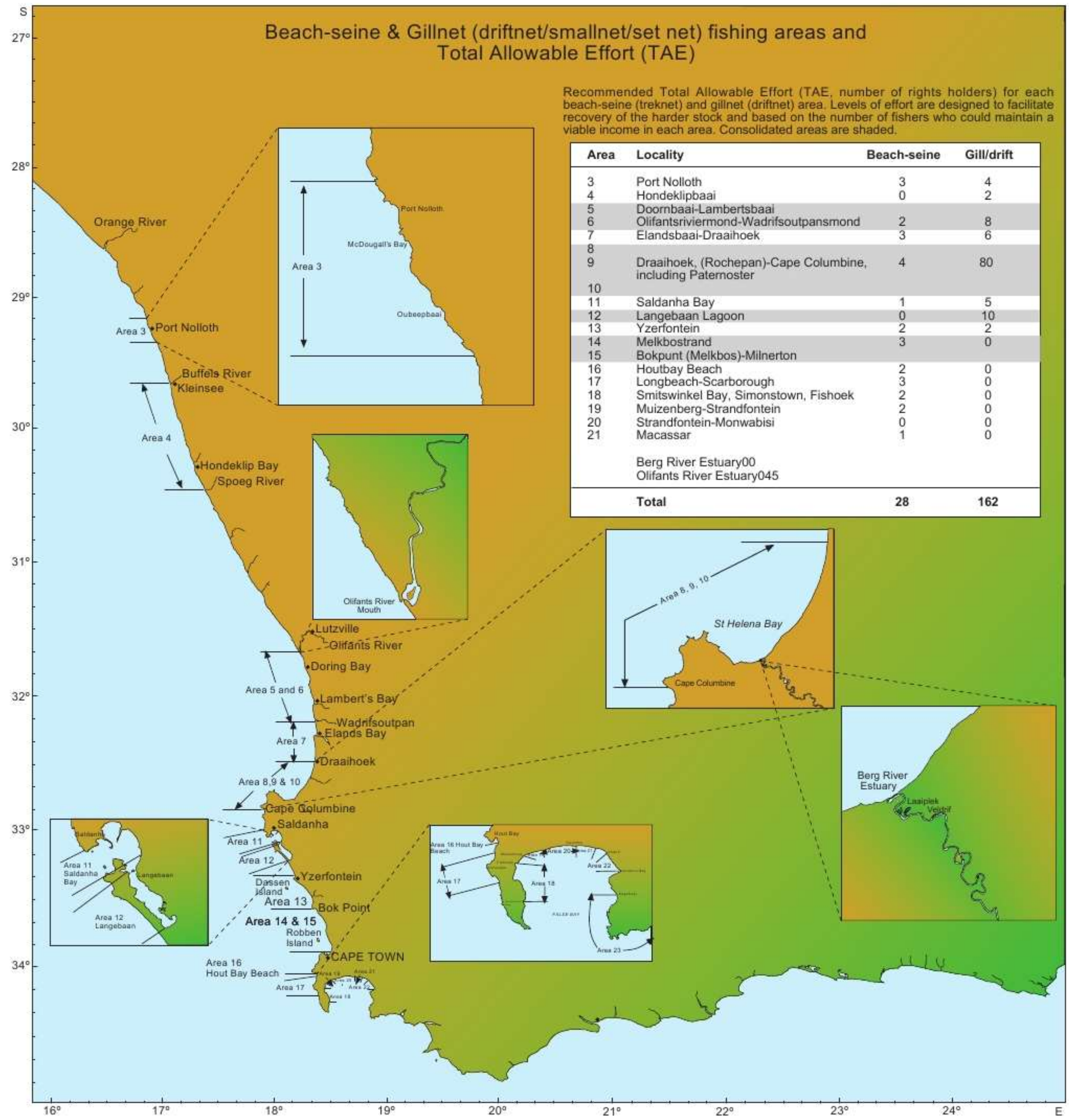


Figure 134: Beach-seine and gillnet fishing management areas and TAE (DAFF, 2014)

The beach-seine fishery operates primarily on the West Coast of South Africa between False Bay and Port Nolloth (Lamberth 2006) with a few permit holders in KwaZulu-Natal targeting mixed shoaling fish during the annual winter migration of sardine (Fréon *et al*. 2010). Beach-seining is an active form of fishing in which woven nylon nets are rowed out into the surf zone to encircle a shoal of fish. They are then hauled shorewards by a crew of 6–30 persons, depending on the size of the net and length of the haul. Nets range in length from 120 m to 275 m. Fishing effort is coastal and net depth may not exceed 10 m (DAFF 2014b).

The gillnet fishery operates from Yzerfontein to Port Nolloth on the West Coast. Surface-set gillnets (targeting mullet) are restricted in size to 75 m x 5 m and bottom-set gillnets (targeting St Joseph shark) are restricted to 75 m x 2.5 m (da Silva *et al*. 2015) and are set in waters shallower than 50 m. The spatial distribution of effort is represented as the annual number of nets per kilometre of coastline.

The range of gillnets (50 m) and that of beach-seine activity (20 m) will not overlap with the licence block or the AOI for proposed drilling. Figure 135 shows the expected range of gillnet fishing activity off the west coast of South Africa.

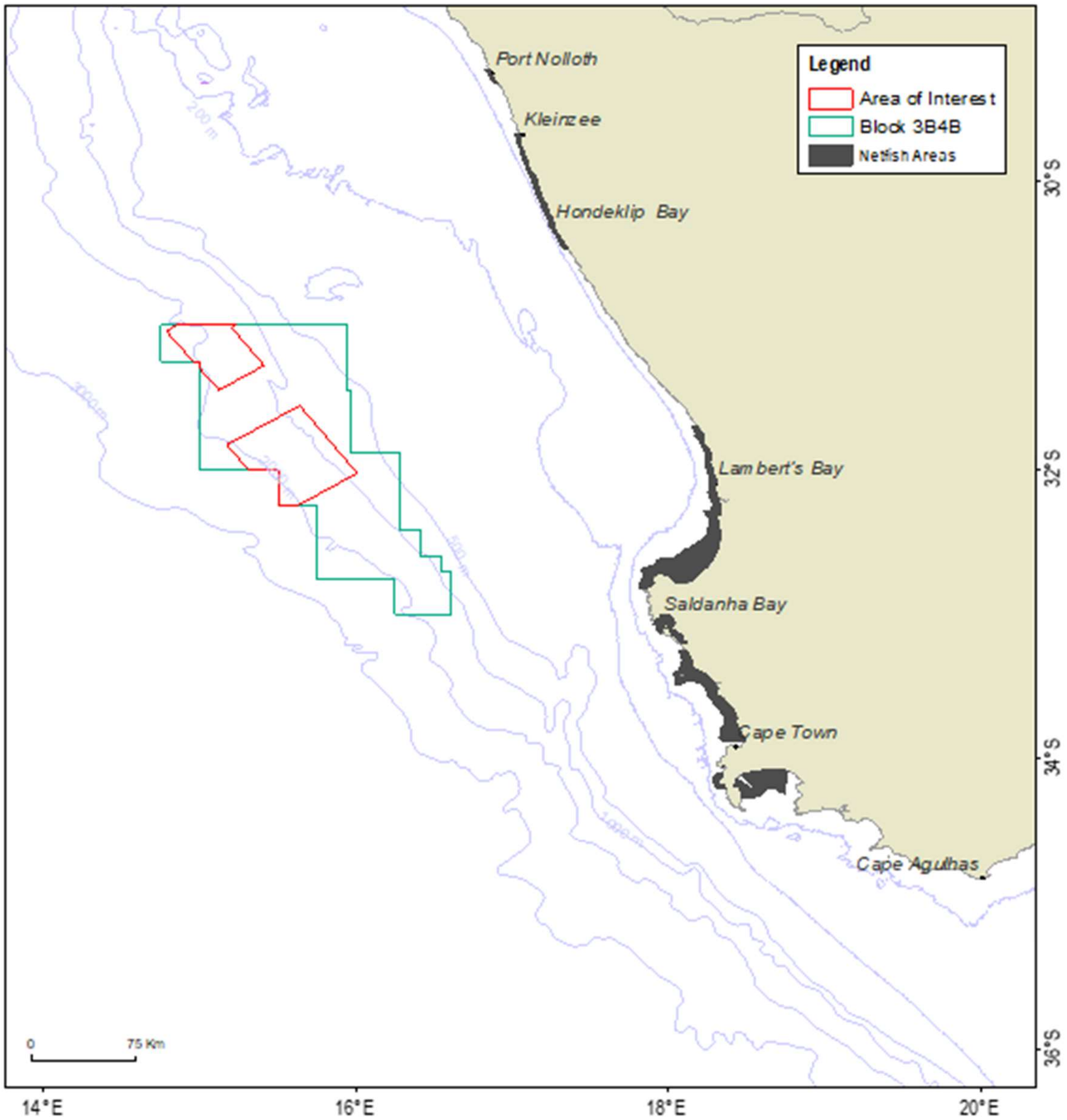


Figure 135: Netfish (gillnet and beach-seine) management areas (DAFF, 2016/17) in relation to licence block 3B/4B (Green polygon) and AOI for proposed drilling (Red polygon).

8.4.4.18 **SEAWEED**

The South African seaweed industry is based on the commercial collection of kelps (*Ecklonia maxima* and *Laminaria pallida*) and red seaweed (*Gelidium spp.*) as well as small quantities of several other species. In the Northern and Western Cape, the industry is currently based on the collection of beach-cast kelps and harvesting of fresh kelps. Beach-cast red seaweeds were collected in Saldanha Bay and St Helena Bay, but there has been no commercial activity there since 2007. Gelidium species are harvested in the Eastern Cape (DAFF, 2014a).

The seaweed sector employs approximately 1 700 people, 92% of whom are historically disadvantaged persons. Much of the harvest is sun-dried, milled and exported for the extraction of alginate. Fresh kelp is also harvested in large quantities in the Western Cape as feed for farmed abalone. This resource, with a market value of about R6 million is critically important to local abalone farmers. Fresh kelp is also harvested for high-value plant-growth stimulants that are marketed locally and internationally.

Harvesting rights are issued by management area. Whilst the Minister annually sets both a TAC and TAE for the sector, the principle management tool is effort control and the number of right holders in each seaweed harvesting area is restricted. Fourteen commercial seaweed harvesting rights are currently allocated and each concession area is limited to one right-holder for each functional group of seaweed (e.g. kelps, *Gelidium spp*. and Gracilarioids). In certain areas there are also limitations placed on the amounts that may be harvested. The South African coastline is divided between the Orange River and Port St Johns into 23 seaweed Rights areas (Figure 136).

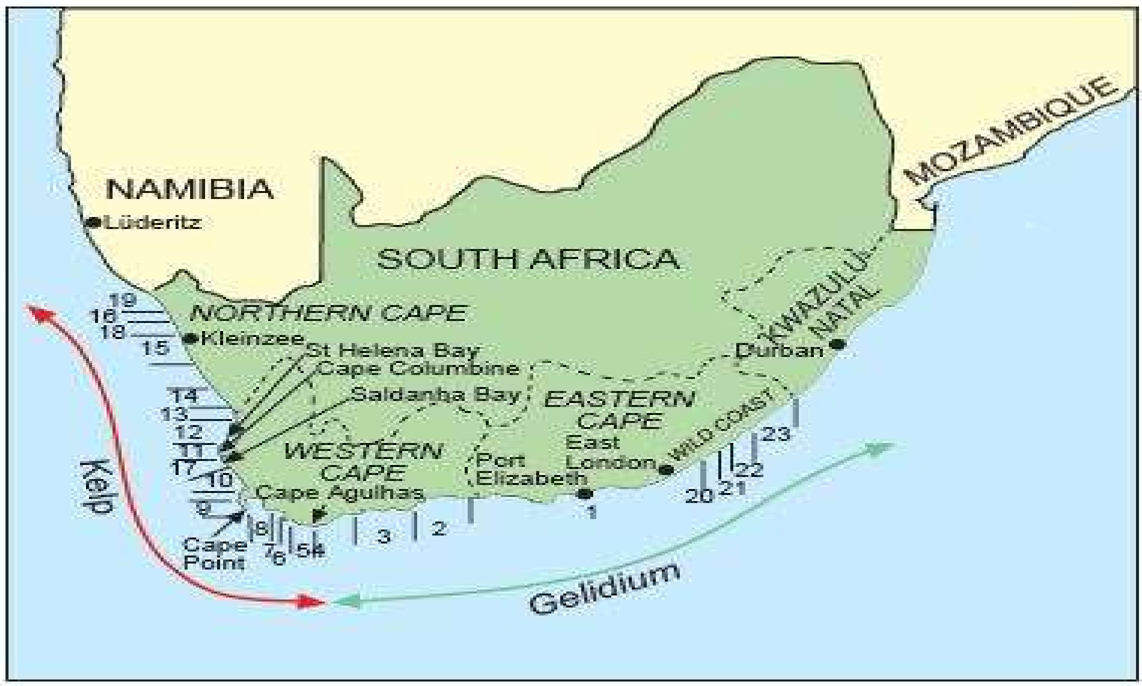


Figure 136:Map of seaweed rights areas in South Africa (DEFF, 2020).

Permit conditions stipulate that beach cast kelp may be collected by hand within these management areas and that kelp may be harvested using a diver deployed from a boat or the shore. Over the period 2000 to 2017, an average of 4560 tonnes per annum of dry harvested kelp (beach cast) and 367 tonnes per annum of wet harvested kelp were reported within collection areas 5 to 11. An additional 1397 tonnes per annum of kelp was harvested for KELPAK (fertilizer). Amounts harvested within these collection areas amounts to approximately 98.5% of the total kelp harvests, nationally.

The AOI for proposed drilling lies offshore of Kelp collection areas 5 – 11 (Figure 137). Permit conditions stipulate that within this area kelp may be harvested using a diver deployed from a boat or the shore but is not expected to coincide with the depth range at which divers could harvest kelp. No kelp plants with a stipe less than 50 cm long may be cut or harmed. Beach cast plants may be collected by hand. The harvesting areas therefore do not coincide with the licence area, which lies far beyond the safe depth range at which divers could harvest kelp.

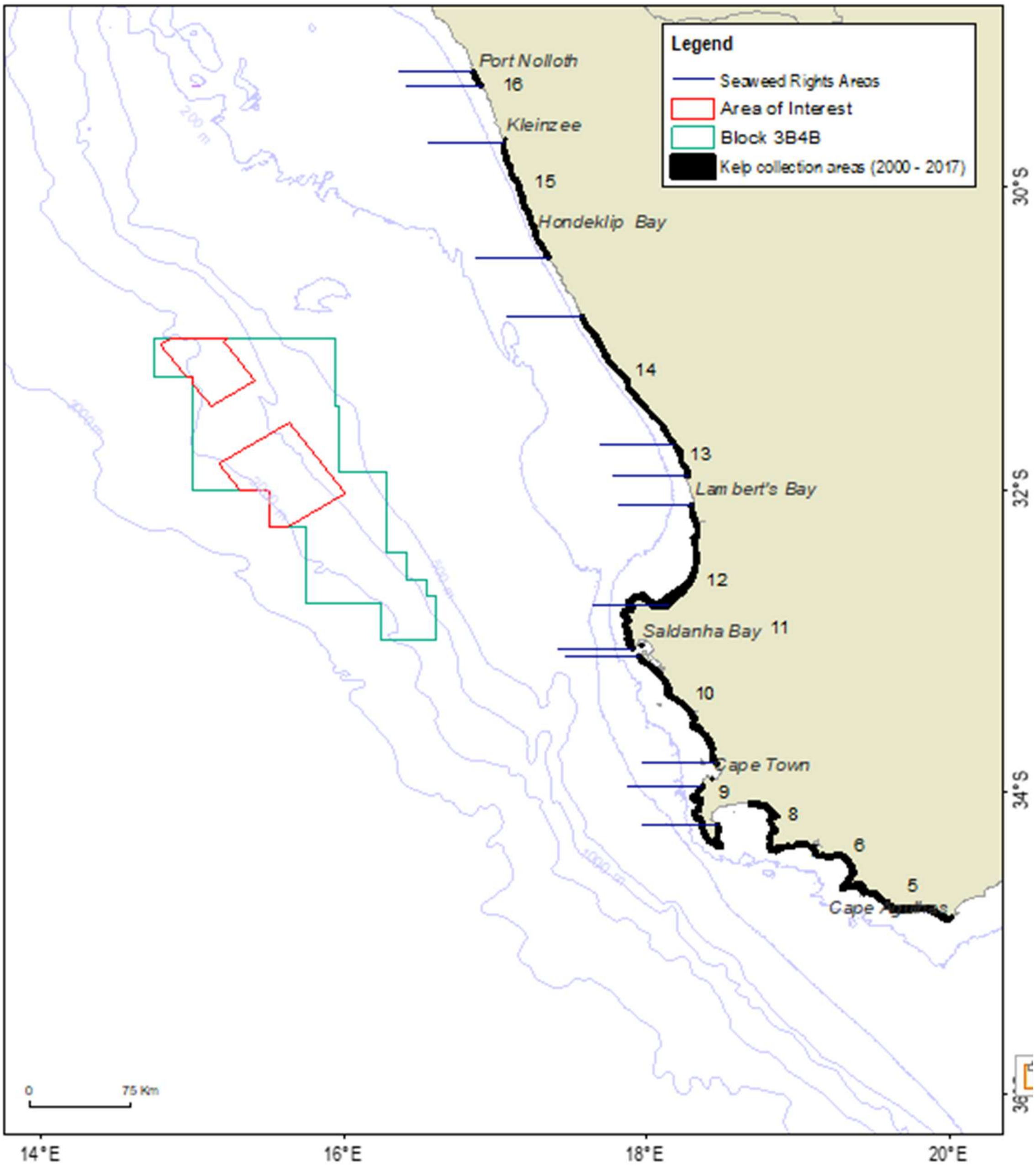


Figure 137: Location of seaweed rights areas (numbered) and kelp collection areas in relation to licence block 3B/4B (Green polygon) and AOI for proposed drilling (Red polygon).

8.4.4.19 MARICULTURE

In support of the Government's Operation Phakisa to implement the National Development Goals and boost economic growth, a Strategic Environmental Assessment (SEA) was undertaken in 2019 (CSIR, 2019) for the purpose of identifying and assessing Aquaculture Development Zones (ADZs) to streamline and accelerate authorisation of aquaculture projects. Eight ADZs were proposed around South Africa's coastline of which four are located in the Western Cape Province: Strandfontein-Lamberts Bay, Velddrif-Saldanha, Hermanus-Arniston, and George-Gouritz zones (Figure 138). The Orange-Hondeklip Bay and Strandfontein-Lamberts Bay are the closest ADZs to the licence block.

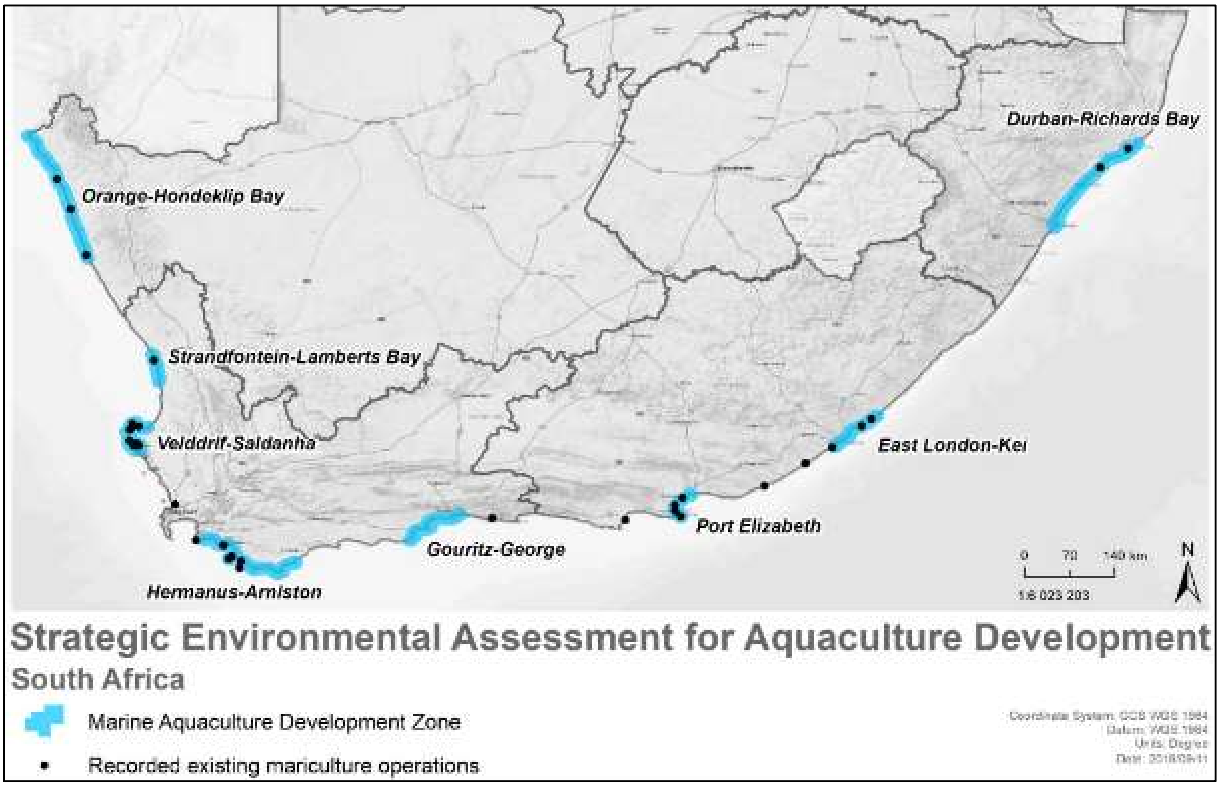


Figure 138: Proposed Marine Aquaculture Development Zones and existing mariculture operations.

Currently, 39 marine aquaculture farms operate in South Africa, most of them are experimental or of a small-scale commercial nature. The Western Cape is the highest provincial contributor with 71.7% of the national marine aquaculture production. There are 30 marine aquaculture farms operating in the Western Cape Province. Western Cape mariculture is composed of four sub-sectors namely abalone (13) finfish (2), oysters (4) and mussels (11), several farms produce multiple products (DFFE, 2019).–Northern Cape Province contributed 4.1% (175.6 tons) to the national marine aquaculture production. In 2018, there were five marine farms in the province comprising four abalone and one oyster facility. Refer to Figure 139 for mariculture methods.

In 2018, the Western Cape Province recorded a production of 3701.5 tons and was the main contributor of the total marine aquaculture production in South Africa. In the Western Cape the mussel sub-sector was the highest contributor recording a production of 2182.1 tons, followed by the abalone sub-sector recording a total production of 1208.2 tons, the oyster sub-sector recorded a total production of 282.7 tons and finfish sub-sector recorded the lowest production of 28.5 tons (DFFE, 2019). It is expected that the scale of production at individual farms will increase over time along with the number of farms and the variety of products within the ADZ's, particularly of finfish (DFFE, 2019).

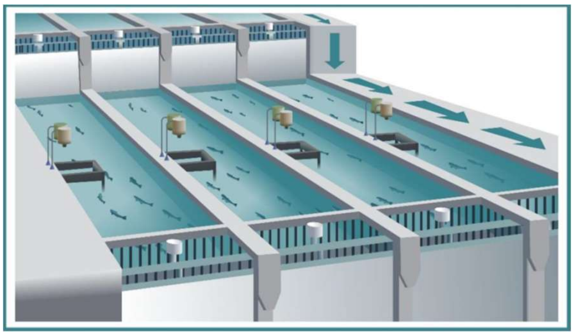
The mussel sub-sector is the highest biomass contributor to aquaculture in South Africa. The sub-sector is entirely represented by the Western Cape Province with eight longline culture operations and three raft culture operations. The species cultured in South Africa are the exotic Mediterranean mussel (*Mytilus galloprovincialis*) and the indigenous black mussel (*Choromytilus meridionalis*) (DFFE, 2019).

In the Western Cape Province thirteen abalone farms were operational with one farm operating as an abalone hatchery (some also produce seaweed as a by-product). Of the thirteen abalone farms, twelve farms are operating as flow-through operations and one farm is operating as a cage culture operation. The abalone species currently being cultivated in South Africa is the indigenous *Haliotis midae* (DFFE, 2019).

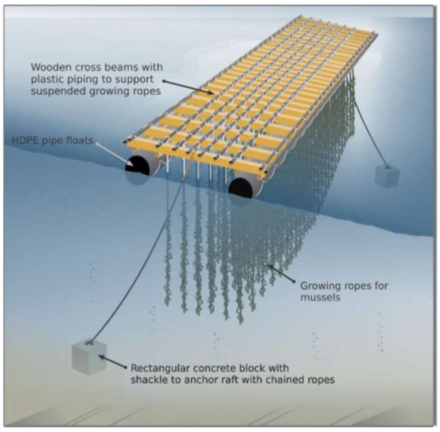
There were four Oyster farms recorded in the Western Cape, which are represented by three longline systems and one raft system. The species cultivated in South Africa is the exotic Pacific oyster (Crassostrea gigas) (DFFE, 2019).

Finfish farming of exotic salmonids in the Western Cape Province is represented by two farms; a cage culture system situated in Saldanha Bay and a semi Re-Circulating Aquaculture System (RAS) (DFFE, 2019). Finfish currently farmed include dusky kob and yellowtail and the exotic salmonids (Atlantic salmon, Coho salmon and king salmon).

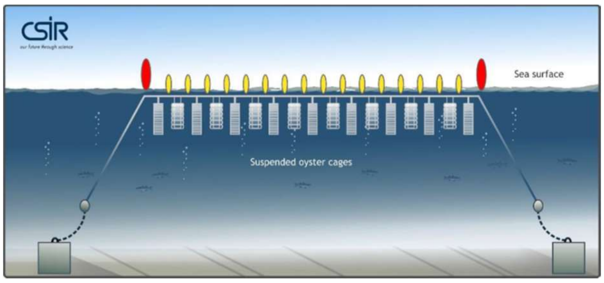
Cage culture involves the placing of cages in oceans to contain and protect the fish until they can be harvested. Finfish cage culture types include nearshore gravity net cages or pens, and open water floating, submersible and/or semi-submersible cages.



Flow-through systems are single-pass production systems where a continuous supply of water from the ocean, a storage reservoir or other water source is channelled via an inlet through tanks, ponds or channels before returning to the environment via an outlet. This system also allows for high density aquaculture production.



Raft culture is a form of suspended culture in which the “on-growing” structures (i.e. ropes) are suspended and submerged beneath a floating raft. Rafts are mostly used for marine shellfish culture, especially mussels.



Longline culture is a form of open-water suspended culture in which species are grown on ropes or in containers such as baskets, stacked trays or lantern nets, which are suspended from anchored and buoyed surface or sub-surface ropes. Longlines are commonly used for the culture of bivalve molluscs including mussels, oysters, clams and scallops, as well as marine macro algae.

Figure 139: Schematic diagrams of the types of aquaculture systems a) cage, b) flow-through, c) raft and d) longline.

8.4.5 SMALL-SCALE FISHERY SECTOR

Small Scale Fishers are defined as "…persons that fish to meet food and basic livelihood needs or are directly involved in harvesting/ processing or marketing of fish, traditionally operate on or near shore fishing grounds, predominantly employ traditional low technology or passive fishing gear, usually undertake single day fishing trips, and are engaged in the sale or barter or are involved in commercial activity" (Small-Scale Fisheries Policy, 2012).

Small scale fishers in South Africa can apply for a subsistence and small-scale fishing exemption if they reside in a coastal community and wish to utilize marine living resources. To qualify for the exemption, fishers must me*et all* verification criteria and apply through locally established local co-management committees. It is illegal to engage in subsistence and small-scale fishing without a permit, and currently, subsistence and small-scale fishers are managed by fishing exemptions until the finalization of the small-scale fisheries policy. The exemption is renewable annually, and before issuing exemptions, departmental staff explain exemption conditions and bag limits. Fishers should register and apply at their local co-management committee, indicate the sector or fishery they want to engage in, and sign the list to acknowledge receipt of their exemptions. The application process can take a month or longer, depending on the volume of applications. Failure to adhere to exemption conditions may result in legal proceedings, including the suspension, cancellation, or revocation of the exemption.

The concept of Small-Scale Fisheries (SSF) is a relatively new addition to the fisheries complexity in South Africa. The concept has its origin in a global initiative supported by the Food and Agricultural Organisation of the United Nations (FAO). In South Africa, there is a long history of coastal communities utilizing marine resources for various purposes. Many of these communities have been marginalized through apartheid practices and previous fisheries management systems. In 2007 government was compelled through an equality court order to redress the inequalities suffered by these traditional fishers. The development of a SSF sector aims in part to compensate previously disadvantaged fishing communities that have been displaced either politically, economically or by the development of large-scale commercial fisheries (Figure 140). This led to the development of the Small-Scale Fisheries Policy (SSFP), the aim of which is to redress and provide recognition of the rights of small-scale fishers (DAFF, 2015).

Figure 140: The University of Western Cape's PLAAS and Masifundise Development Trust organized a round table discussion on the status of small-scale fisheries in South Africa on 19 April 2018. More than 60 people, including civil society members, academics, community representatives, students, and legal practitioners, attended the event and presented their views. Image: Fishing Industry News SA

In 2013 the SSFP Implementation Plan (IP) was finalised. The IP estimated a five-year process and a total budget of R424 million. Accordingly, the Marine Living Resources Act (MLRA) had to be amended to accommodate the small-scale fishing sector. Since the Act was amended to accommodate the small-scale fishing sector, much progress has been made in rolling out the small-scale fishing sector.

Looking at the SSF sector in more detail, the majority of applicants are male, averaging 44 years in age and the majority are classified as previously disadvantaged ethnic groups. The majority of respondents in each province are mainly dependent on fishing for more than 50% of their income. Additionally, there is a large dependency on government grants (32-45%) and limited involvement in other forms of economic activity. Approximately 80% of respondents are living with an income that is under or close to the poverty line of R1 558 pm.

The SSFP was gazetted in May 2019 under the Marine Living Resources Act, 1998 (Act No. 18 of 1998). It is only now (2021/2022) in an advanced process of implementation. It is a challenging process that has been exacerbated by the conflict and overlap with another fisheries-related process of fishing rights allocations (known as Fishery Rights Allocation Process or "FRAP"). As of August 2022, neither process has been concluded and the issues at stake are highly politicised.

The SSF overlaps other historical fisheries in South Africa, leading to legal challenges where the SSF rights allocations are in conflict with other established commercial fishing sectors, most notably the commercial squid fishing sector. SSF is defined as a fishery although specific operations and dynamics are not yet fully defined as they are subject to an ongoing process by DFFE. The SSF regulations (DAFF, 2016) do however define the fishing area for SSF as ""near-shore", meaning "the region of sea (including seabed) within close proximity to the shoreline". The regulations further specify under Schedule 5 Small-scale fishing areas and zones "5. (1) In order to facilitate the establishment of areas where small-scale fishers may fish, the Department must set up a procedure to engage and consult with the small-scale fishing community in proposing demarcated areas that may be established as areas where small-scale fishers may fish and which under section 5 (2)b. "take into account the mobility of each species in the allocated basket of species with sessile species requiring smaller fishing areas while nomadic and migratory species requiring larger area".

Small-scale fishers fish to meet food and basic livelihood needs but may also directly be involved in fishing for commercial purposes. These fishers traditionally operate on nearshore fishing grounds to harvest marine living resources on a full-time, part-time or seasonal basis. Fishing trips are usually of short-duration and fishing/harvesting techniques are labour intensive.

Small-scale fishers are an integral part of the rural and coastal communities in which they reside and this is reflected in the socio-economic profile of such communities. In the Eastern Cape, KwaZulu-Natal and the Northern Cape, small scale fishers live predominantly in rural areas while those in the Western Cape live mainly in urban areas (Sunde & Pedersen C., 2007; Sunde, 2016.).

Many communities living along the coast have, over time, developed local systems of rules to guide their use of coastal lands, forests and waters. These local rules are part of their systems of customary law. Rights to access, use, and own different natural resources arise from local customary systems of law. These systems of law are not written down as in Western law, but are passed down from generation to generation through practice (https://www.masifundise.org/wp-content/uploads/2011/06/vissernet-eng-news-3-final.pdf). South Africa's Constitution recognises customary law together with common law and state law. Section 39 (3) makes provision for a community that has a system of customary rights arising from customary law to be recognised as long as these rights comply with the Bill or Rights. In line with this, the SSFP also recognises rights arising in terms of customary law. Customary fishers are normally associated with discrete groups (tribes or communities with unique identities and associations with the sea) who may be defined by traditions and beliefs (see also Pretorius, 2022). These traditions are increasingly being challenged as stocks and marine resources have been depleted. This would include, for example, intertidal harvesting of seaweed, mussels, oysters, cephalopods and virtually any species available to these communities. These fishers are generally localised and do not range far beyond the areas in which they live.

SSF resources are managed in terms of a community-based co-management approach that aims to ensure that harvesting and utilisation of the resource occurs in a sustainable manner in line with the ecosystems approach.

The SSF is to be implemented along the coast in series of community co-operatives. Only a co-operative is deemed to be a suitable legal entity for the allocation of small-scale fishing rights. These community co-operatives will be given 15-year small-scale fishing Rights. The criteria to be applied in determining whether a person is a small-scale fisher are that the person must (a) be a South African citizen who associates with or resides in the relevant small-scale fishing community; (b) be at least 18 years of age; (c) historically have been involved in traditional fishing operations, which include catching, processing or marketing of fish for a cumulative period of at least 10 years; and (d) derive the major part of his or her livelihood from traditional fishing operations and be able to show historical dependence on fish, either directly or in a household context, to meet food and basic livelihoods needs. These permits are still outstanding and for now SSF operate under "exemptions".

More than 270 communities have registered an Expressions of Interest (EOI) with the Department. DFFE has split Small Scale Fishing (SSF) by communities into district municipalities and local municipalities. These fishers are generally localised and do not range far beyond the areas in which they live:

- In the Northern Cape, there are 103 fishers registered in the Namakwa district, comprising the Richtersveld and Kamiesberg local municipalities. These fishers form part of 2 Co-Operatives.
- Western Cape districts include 1) West Coast (Berg River, Saldanha Bay, Cederberg, Matzikama and Swartland local municipalities; 2) Cape Metro; 3) Overberg (Overstrand and Cape Agulhas); and 4) Eden (Knysna, Bitou and Hessequa). In total there are 2 741 fishers registered in the province. The number of Co-Operatives are still under review.
- In the Eastern Cape, the communities are again split up, broadly as 1) Nelson Mandela Bay, 2) Sarah Baartman, 3) Buffalo City, 4) Amathole, 5) O.R. Tambo and 6) Alfred Nzo. There are 5 335 fishers registered in the province. These fishers form part of 72 Co-Operatives.
- KwaZulu-Natal has 2 184 registered small-scale fishers divided by district into 1) Ugu, 2) Ethekwini Metropolitan, 3) Ilembe, 4) King Shwetshayo/Uthungula, and 5) Umkhanyakude. These fishers form part of 35 Co-Operatives.

Approximately 10 000 small-scale fishers have been identified around the coast. The licence block is situated offshore of the Namakwa and West Coast municipal districts. Between Port Nolloth and Saldanha Bay, 19 communities have been registered for small-scale fishing rights, comprising a total of 842 fishers.

The Smallscale Fisheries Policy (SSFP) requires a multi-species approach to allocating rights, which entails the allocation of rights for a basket of species that may be harvested or caught within particular designated areas. Section 6 of the regulations covers access Management of the rights of access and includes amongst other parts. Co-operatives can only request access to species found in their local vicinity. DFFE recommends five basket areas: 1. Basket Area A – The Namibian border to Cape of Good Hope – 57 different resources 2. Basket Area B – Cape of Good Hope to Cape Infanta – 109 different resources 3. Basket Area C – Cape Infanta to Tsitsikamma – 107 different resources 4. Basket Area D – Tsitsikamma to the Pondoland MPA – 138 different resources 5. Basket Area E – Pondoland MPA to the Mozambican border – 127 different resources.

The mix of species to be utilised by small-scale fishers includes species that are exploited by existing commercial sectors viz; traditional linefish, west coast rock lobster, squid, hake handline, abalone, KZN beach seine, netfish (gillnet and beach-seine), seaweed and white mussel. An apportionment of TAE/TACs for these species will be transferred from existing commercial rights to SSF, whereas white mussels will become the exclusive domain of SSF. Species nominated for commercial use will be subject to TAE and/or TAC allocation. Species nominated for own use will be available to all members of a particular co-operative, but subject to output controls.

The small-scale fishery rights cover the nearshore area (defined in section 19 of the MLRA as being within close proximity of shoreline). Small-scale fishermen along the Northern Cape and Western Cape coastlines are typically involved in the traditional line, west coast rock lobster and abalone fisheries, whereas communities on the South Coast would be involved in traditional line, squid jig and oyster harvesting. The small-scale communities on the West Coast, with long family histories of subsistence fishing, prioritise the harvest of nearshore resources (using boats) over the intertidal and subtidal resources. An example of such boats is shown in Figure 141.

Figure 141: Fishing boats outside the Hondeklipbaai small-scale community co-operative (photo credit Carika van Zyl).

Snoek (*Thyrsites atun*), Cape bream / hottentot (*Pachymetopon blochii*) and yellowtail (*Seriola lalandi*) are important linefish species that are targeted by small-scale fishers operating nearshore along the West and South-West Coast of South Africa.

Snoek are targeted by small-scale fishers during the snoek seasonal migration between April and June, during which time they shoal nearshore and are therefore available to handline fishermen. Snoek availability coincides with peaks in the availability of other small pelagic species, notably anchovy and sardine. As shown by Crawford *et al*. (1987) snoek stay inshore on their southward migration (i.e. April through to June) and then move offshore into deeper waters to spawn in July and August (and are not available to linefishers during these times as the fish are beyond the depth range of surface linefishers).

Small-scale fishers also target west coast rock lobster (*Jasus lalandii*) using hoopnets set by small “bakkies” on suitable reefs at a water depth of less than 30 m. Fishing activity may range up to 100 m water depth by the larger vessels that participate in the offshore commercial rock lobster trap sector. The harvesting of wild abalone along the South-West Coast is expected to range to a maximum water depth of 20 m. Catches of chokka squid (*Loligo vulgaris reynaudii*) off the South Coast rarely exceed a water depth of 60 m. The collection of oysters (*Striostrea margaritacea*) along the South Coast is confined to intertidal and shallow sub-tidal areas.

The small-scale fisheries off the Northern, Western and Southern Cape coastlines are unlikely to range beyond 20 km from the coastline, thus inshore of the AOI for proposed drilling at its closest point, and inshore of the area of noise disturbance. The small-scale fishery rights cover the nearshore area (defined in section 19 of the MLRA as being within close proximity of shoreline). As, such, SSF are currently not permitted to target tuna as it is not listed in the basket of species for SSF exploitation, although they are allowed to catch up to 10 tuna per day. Based on the distance from key SSF harbours to the AOI and on vessel clarification (with Class C to E vessels not being allowed to travel beyond 28 km from the coast, tuna is caught closer to the coast by the SFF (and traditional line fish and recreational fishers) when warmer waters move closer inshore during the summer months.

This assessment is however cognisant of the ongoing issues related to the perceived areas fished and species targeted by SSF off the West Coast of South Africa e.g. that cultural practice of SSF may occur to 55 km offshore. While SSF regulations clearly specify that fishing is required to take place "nearshore" the actual differentiation between SSF and other fishing operations that might include SSF, such as the commercial "traditional linefish" and "pole and line" and the extent to which these commercial fisheries might include SSF, remains unclear. As such the offshore extent to which SSF may operate requires a precautionary approach in this assessment and consideration that the possibility exists (albeit a remote possibility that cannot be verified through the information made available on these fisheries), that SSF may have occurred historically and potentially in the future further offshore than suggested by the information made available for this assessment i.e. there is a remote possibility that some SSF may have targeted certain species (of which tuna and snoek are the main candidate species) further offshore than 20 km. The distance fished offshore by SSF and the associated risks determined in this assessment further necessarily considers practical aspects, notably that bottom fishing is impractical in waters deeper than 100 m and as such any bottom fishing, whether SSF or commercial, is highly unlikely beyond a precautionary depth being the 100 m depth contour. Further, in regard to migratory species, such as longfin tuna and snoek, economic and regulatory aspects relating to distances fished offshore is pertinent [i.e. such as the requirements of the South African Maritime Safety Authority (SAMSA)] in particular that most SSF are not likely to be "B" class certified (i.e. can operate vessels up to 40 nm offshore and are longer than 9 m) are likely limited to "C" class being mainly vessels of <9 m permitted to only operate < 15 nm offshore. It should also be noted that the AOI does not overlap with the traditional line fish (which also targets snoek and tuna) and small pelagic purse-seine (which targets sardine and anchovy) fishing grounds. Based on the above, there is no anticipated overlap with the SSF.

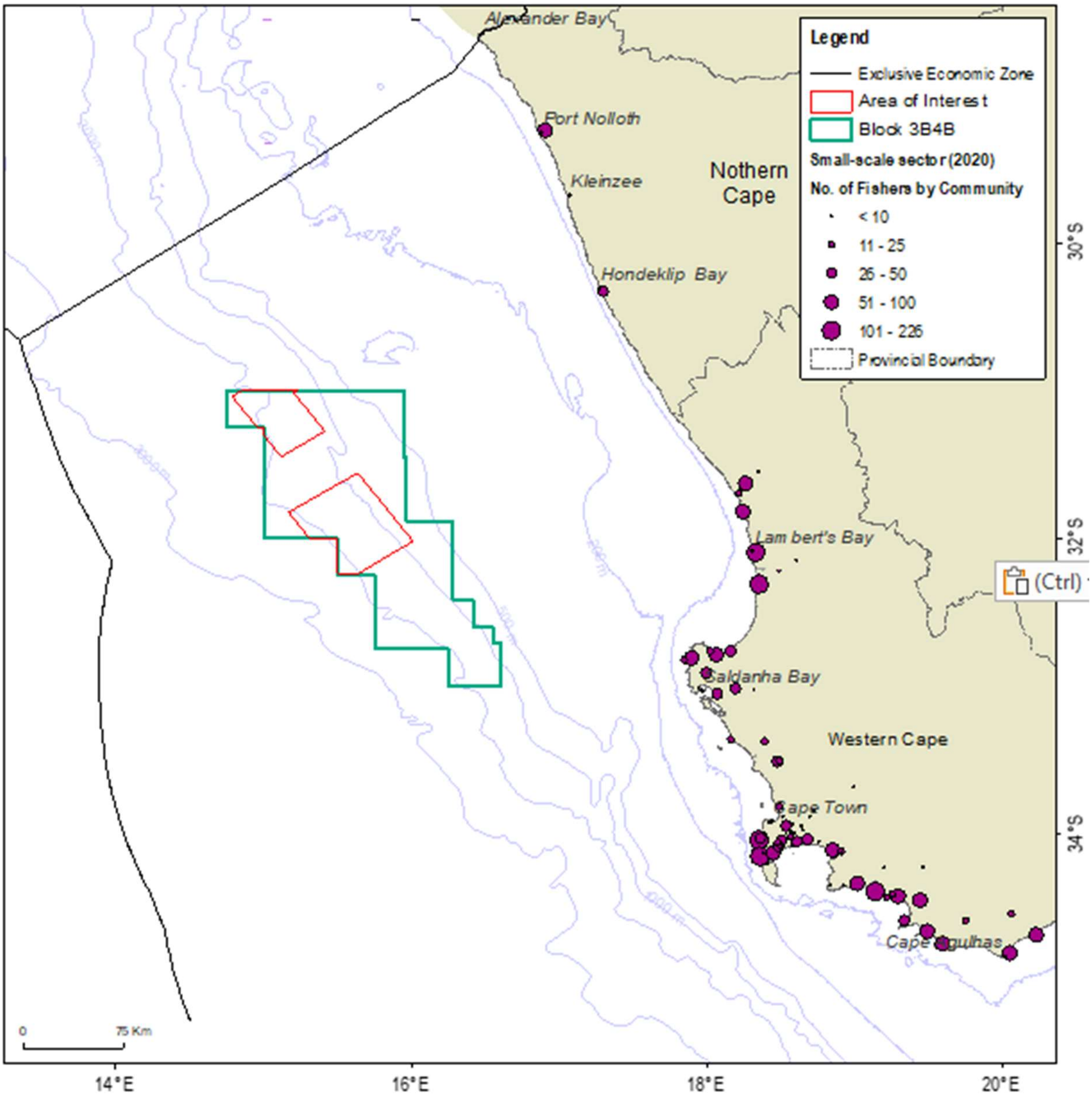


Figure 142: Block 3B/4B (Green polygon) and AOI for proposed drilling (Red polygon) in relation to the spatial distribution of small-scale fishing communities and number of participants per community along the west coast of South Africa.

8.4.6 RECREATIONAL FISHING

Recreational fishing is a non-commercial fishery in South Africa that is regulated by individual permits obtained by the public. It is estimated to have the largest number of participants of all fishery sectors in South Africa, with over 450,000 participants (DFFE, 2020). In 1996, it was estimated that there were 500,000 recreational fishers in the country (McGrath *et al*., 1997), but a more recent study by Leibold and van Zyl (2008) estimated that there were 900 000 participants in 2007.

Recreational fishing is a valuable industry in South Africa, with the tourism infrastructure, boats, vehicles, tackle, and bait making it an important economic contributor, estimated to be more than R9 billion per annum (DFFE, 2020). Recreational fishing includes subsets of numerous commercial fisheries, such as linefish, west and east coast lobster, spearfishing, squid, crabs, and many other species.

A recreational fishing permit entitles the holder to catch fish for their own use only and not for the purpose of selling or trading fish. The recreational fishery is managed by several output restrictions, such as size and bag limits, closed areas, and seasons. These restrictions are in place to ensure the sustainability of fish stocks and to minimize the impact on the marine ecosystem.

Less than 6% of anglers are affiliated to angling clubs and organizations (Mann *et al*., 2013), which suggests that the majority of recreational fishers operate independently. This could pose a challenge for monitoring and regulating the recreational fishery, as it may be difficult to ensure compliance with regulations and to collect accurate data on catches and effort.

Recreational fishing is extensive around the coast of South Africa and comprises shore based and boat-based fishing activities. Offshore recreational fishing is dependent on vessel size. Offshore small recreational or pleasure craft are limited by their certification – which varies from Category E (limited to a distance of 5 nautical mile from shore and 15 nautical miles from an approved launch site) to Category C (15 nautical miles offshore), Category B (limited to day or night passages, but within 40 nautical miles of the coastline) to Category A (allowing for extended or ocean passage). Most recreational craft are Category C certified, targeting nearshore marine species, and therefore would not technically be authorised to travel to the AOI for proposed exploration drilling.

Category A and B certified recreational vessels as well as fishing charter operation vessels targeting offshore pelagic species (tuna, dorado, marlin, etc.) with rod-and-reel are known to focus their effort on the North-eastern boundary between Cape Canyon offshore of Saldanha Bay and Hope Canyon due South of Cape Point. These anglers are unlikely to fish in the AOI for proposed drilling as they seldom fish offshore of the 1 000 m depth contour. These vessels fish seasonally in the above-mentioned areas with the majority of their effort taking place between October and May.

Overall, recreational fishing is an important and valuable industry in South Africa, with a large number of participants and significant economic impact. However, effective management and regulation are crucial to ensure the sustainability of fish stocks and the marine ecosystem, as well as to maintain the economic benefits of recreational fishing in the long term.

Landings and operational effort from this open-access recreational fishery are not reported nor recorded throughout the region.

8.4.7 ILLEGAL, UNREPORTED AND UNREGULATED FISHING

In 1977 South Africa first declared its Exclusive Economic Zone (EEZ) out for 200 nautical miles to seaward from the coastal baselines of both South Africa and its possessions in the Southern Ocean, the Marion and Prince Edward Islands. Following the coming into force of the 1982 United Nations Conference on the Law of the Sea (UNCLOS) on 16 November 1994, South Africa passed the Maritime Zones Act 15 of 1994 affirming its rights and obligations to Fisheries, Oil and Gas Exploration and Exploitation as well as Marine Scientific Research within its EEZ.

Illegal, unreported and unregulated (IUU) fishing may include activities conducted by national or foreign vessels in waters under the jurisdiction of a state – without that state's permission or in contravention of that state's laws and regulations. IUU fishing does not only entail the illegal catching of fish, but also relates to the storing, shipping and selling of fish caught illegally. IUU fishing is an international problem faced by many countries. South Africa is vulnerable to illegal fishing since it has a coastline of over 3 000 km and an exclusive economic zone of 1 068 659 km2. In light of the above South Africa is one of the few countries in the region with the resources to patrol its waters in the effort to stop IUU fishing. The South African Authority strictly regulates fishing activity within its own EEZ and the area is regularly patrolled by a fleet of Offshore Environmental Protection Vessels operated by DFFE. The South African Navy also patrol offshore regions, whilst the South African Police patrols areas within their jurisdiction (within 24 nm). Legislation also requires all foreign fishing vessels entering the EEZ to apply for an EEZ permit and that all fishing gear be stowed and that the vessel switch on their Automatic Identification System (AIS). This is monitored by the DFFE VMS operations room.

Whilst South Africa experiences difficulties with land-based coastal marine poaching activity, such as abalone and rock-lobster poaching, offshore areas are not considered viable for large scale illegal activity, especially in the AOI for drilling.

Considering that the Licence Block is situated offshore of the continental shelf in water depths exceeding 500m, the risk of Illegal, Unreported and Unregulated (IUU) fishing would, most likely, be conducted by offshore Large Scale Tuna Longline Vessels (LSTLVs). If these vessels illegally enter the EEZ, any fishing vessel that is not reporting on its AIS would be regarded with suspicion. Fishing industry operating in the area would report any illegal fishing activity if it were sighted.

8.4.8 NAMIBIAN COMMERCIAL FISHERIES

The Namibian fishing industry is a major contributor to the country's GDP, ranking among the top ten fishing countries globally. Fish resources in Namibian waters are historically abundant due to the high productivity of the Benguela upwelling ecosystem, with commercial fish stocks typically supporting intensive commercial fisheries. The main targeted species and gear types are demersal, small pelagic, large migratory pelagic fish, linefish, and crustacean resources. Mariculture is a developing industry mainly in Walvis Bay and Lüderitz Bay. The industry has only two major fishing ports, Walvis Bay and Lüderitz, and currently has 116 Namibian-registered commercial fishing vessels, mostly demersal trawlers that fish year-round with the exception of a one month closed season in October. The midwater trawlers that target horse mackerel and the large pelagic tuna longline vessels are also significant. Licensed foreign fishing vessels in Namibian waters are limited, and licensed fishers must reflag under Namibia. The license block and AOI for drilling fall within South Africa, but for the purpose of understanding the potential impacts under worst-case scenarios summary information will be provided for Namibia's commercial fisheries, with particular focus on Hake and Tuna-based fisheries.

8.4.8.1 **MANAGEMENT AND RESEARCH**

The management of fish stocks for commercial purposes is overseen by the Ministry of Fisheries and Marine Resources (MFMR), which receives guidance from the National Marine Information and Research Centre (NatMIRC) in Swakopmund under the Ministry. TACs are set every year by the Minister based on recommendations from an advisory council. The Confederation of Namibian Fishing Industries represents commercial fisheries at the industry level, while sector-specific associations, such as the Namibian Hake Association and the Pelagic Fishing Association of Namibia, represent different fish species. MFMR conducts regular research surveys to determine the biomass of demersal, midwater, and small pelagic species, covering the entire continental shelf from the Angolan to South African maritime borders. These surveys typically follow fixed transects, are spaced 20-25 nm apart, and are designed to statistically optimize the number of stations. Demersal trawl surveys, for example, take place between January and February over a one-month period, with most of the sampling trawls occurring during daylight hours. Occasionally, "transboundary" surveys may be conducted by the Benguela Current Commission.

8.4.8.2 **STOCK DISTRIBUTION AND SPAWNING**

Commercial species spawning and distribution in Namibian waters are crucial to the country's fishing industry. The sardine population, which historically spawned continuously from September to April, collapsed in the 1960s and has remained overexploited. The southern border of this species' range is demarcated by the Lüderitz upwelling front, and it currently remains closed due to a significant population reduction. Cape horse mackerel, whose concentrations are dense between Cape Cross and the Kunene River, spawns during both summer and winter, with peak activity between January and April. Albacore and bigeye tuna are the most important to fisheries, with the availability of these species increasing in different periods. Albacore tuna is most abundant in southern Namibia in the first trimester (January to March), while bigeye tuna is available during the second and third trimesters. Hake, the most commercially important fishery in Namibia, displays seasonal variation in spawning, with spawning peaks occurring between July and September along the shelf break off central Namibia. Monkfish is found along the entire extent of the Namibian coast, with the fishery concentrated between 17°15'S and 29°30'S on the deeper continental shelf and upper slope depths at 200 m to 500 m). The abundance of these species has a strong seasonal signal resulting in increased availability to the fisheries targeting them at different periods. It is important to note that weather conditions play an important role in operations within the tuna fisheries (pole-and-line and longline).

The migration patterns of key commercial fish species in Namibia are crucial to sustain the small pelagic and Hake fisheries. Hake spawns north of the Lüderitz upwelling centre, while sardines and horse mackerel spawn between Lüderitz and the Angola–Benguela Front. Complex eddying and southward transport occur beneath the surface drift. Larval settlement happens in inshore areas, and sardine spawning peaks offshore during September and October. Warm water from the Angolan Current pushes southwards in late summer, transporting pelagic spawning products to the nursery grounds off central Namibia.

8.4.8.3 **HAKE SPECIES**

Namibia's fishing industry is largely driven by the shallow-water hake (Merluccius capensis) and the deep-water hake (Merluccius paradoxus), which are managed as a single. At the peak of exploitation in the mid-1970s, catches of hake in Namibian waters reached almost 1 million tons, although some believe that this figure was underestimated. The fishery is currently managed through a total allowable catch (TAC) system, which varies from year to year but is around 150 000 tons.

The shallow-water hake is the predominant species, but the deep-water hake is also important. The fleet of 71 demersal trawlers licensed to operate within the fishery primarily targets hake, caught in deeper waters, while smaller trawlers fish inshore for monkfish, sole, and kingklip. Eighteen demersal longliners also target hake, as well as smaller quantities of kingklip and snoek. The directed hake trawl fishery is Namibia's most valuable fishery, with a current annual hake TAC of 154 000 tons.

The deep-sea fleet is divided into wetfish and freezer vessels, with a prescribed 70:30 ratio. Freezer vessels process fish offshore, while wetfish vessels land fish at factories ashore for processing. Wetfish vessels are smaller, with an average length of 45 m, and can only remain in an area for about a week before returning to port, whereas freezer vessels can work in an area for up to a month at a time. Most trawlers operate from the port of Walvis Bay, with fewer vessels operating from Lüderitz.

Spawning by M. capensis has been recorded along most of the Namibian coast, from about 27°S to 18°S, although areas of localized spawning appear to be focused off central Namibia (25°S to 20°S), and the exact location varies between years. Fishing effort is relatively constant throughout the year, except for a closure in October and relatively lower levels of effort in November and December.

The target species of the demersal longline fishery is the Cape hakes, with a small non-targeted commercial by-catch that includes kingklip. The catch is packed unfrozen, on ice, and landed as either prime quality or headed and gutted. A total hake TAC of 154,000 tons was set for 2021/2022, but less than 10 000 tons of this was caught by longline vessels.

8.4.8.4 **TUNA-BASED FISHERIES**

Namibia has two major tuna fisheries: the Large Pelagic Longline fishery and the Tuna-Pole fishery. The Large Pelagic Longline fishery utilizes surface long-lines to target migratory pelagic species, including yellowfin tuna, bigeye tuna, swordfish, and various pelagic shark species. The fishery has provisions for up to 26 fishing rights and 40 vessels. Yellowfin tuna is distributed between 10°S and 40°S in the south Atlantic and spawns in the central Atlantic off Brazil in the austral summer. Immature yellowfin tuna can be found throughout the year in the Benguela system. After reaching sexual maturity, they migrate in summer from feeding grounds off the West Coast of southern Africa to the spawning grounds in the central Atlantic. Bigeye tuna occurs in the Atlantic between 45°N and 45°S, and it is believed that they migrate to the Benguela system to feed. Swordfish spawn in warm tropical and subtropical waters and migrate to colder temperate waters during summer and autumn months. The tuna are targeted at thermocline fronts, predominantly along and offshore of the shelf break. The spatial distribution of fishing effort is widespread and may be expected predominantly along the shelf break (approximately along the 500 m isobath) and into deeper waters (2 000 m). Effort occurs year-round with a slight peak over the period March to May. Longline vessels targeting pelagic tuna species and swordfish operate extensively around the entire Namibian coast.

The Tuna-Pole fishery is predominantly based on the southern Atlantic albacore stock and a very small amount of skipjack tuna, yellowfin tuna, and bigeye tuna. Namibia's quota for tuna and swordfish is allocated by the International Commission for Conservation of Atlantic Tunas (ICCAT), of which Namibia is a member. Albacore tuna is a temperate species that prefers subtropical ocean waters of 16° – 20°C but appears to be differentially distributed depending on their life-history stage. Spawning occurs in equatorial regions where water temperatures exceed 24°C. The Tuna-Pole fishery catches albacore using long poles that have lines attached to them, with hooks and bait at the end. The poles are manually lowered into the water and raised to retrieve the catch.

One of the key features of the Namibian tuna pole fishery is the fact that it is certified as sustainable by the Marine Stewardship Council (MSC), an international non-profit organization that sets standards for sustainable fishing. The certification recognizes that the fishery is well-managed, operates in an environmentally responsible manner, and meets rigorous standards for sustainability.

8.4.9 SUMMARY TABLE OF SEASONALITY OF CATCHES

The seasonality of each of the main commercial fishing sectors that operate off the west coast (west of 20°E) of South Africa is indicated in Table 32 – also presented is the relative intensity of fishing effort on a month-by-month basis.

Table 32: Summary table showing seasonal variation in fishing effort expended by each of the main commercial fisheries sectors operating in West Coast South African waters.

Sector	Targeted Species	Fishing Intensity by Month within South African Exclusive Economic Zone (EEZ) H = high; M = Low to Moderate; N = None											
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Demersal Trawl	Deepwater hake and shallow-water hake	H	H	H	H	H	H	H	H	H	H	H	H
Midwater Trawl	Horse mackerel	H	H	H	H	H	H	H	H	H	H	H	H
Demersal Longline	Shallow-water hake	M	M	M	H	H	H	H	H	H	H	H	H
Small Pelagic Purse-Seine	Anchovy, sardine, Red-eye round herring	M	H	H	H	H	H	H	H	H	H	H	M
Pelagic Longline	Yellowfin tuna, big eye tuna, Swordfish, southern bluefin	M	M	M	H	H	H	H	H	H	H	H	H
Tuna Pole	Albacore	H	H	H	H	H	M	M	M	M	M	H	H
Traditional Linefish	Snoek, Cape bream, geelbek, kob, yellowtail, Sparidae, Serranidae, etc	H	M	M	M	M	M	M	M	M	M	M	H
West Coast Rock Lobster	*Jasus lalandii*	M	M	M	M	M	M	M	M	M	N	M	M

Sector	Targeted Species	Fishing Intensity by Month within South African Exclusive Economic Zone (EEZ) H = high; M = Low to Moderate; N = None											
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Research survey (trawl)	Demersal spp.	N	N	N	M	M	N	N	N	M	M	N	N
Research survey (acoustic)	Pelagic spp.	N	N	M	M	M	N	N	N	N	N	N	N

8.5 OTHER USES OF THE AREA

This section provides a description of the other characteristics of the application area. The information has been sourced from the Marine Ecological Baseline undertaken by Pisces Environmental Services (Pty) Ltd (Appendix 4).

8.5.1 BENEFICIAL USES

Block 3B/4B is located well offshore beyond the 300 m depth contour. Other users of the offshore areas include the commercial fishing industry (see Section 8.4), with marine diamond mining concessions being located inshore of the eastern portion of Block 3B/4B (Figure 143). Recreational activities along the coastline north of St Helena Bay are limited to the area around Lambert's Bay, Hondeklip Bay and Port Nolloth.

On the Namaqualand coast marine diamond mining activity is restricted to nearshore, diver-assisted operations from small, converted fishing vessels working in the a-concessions, which extend to 1 000 m offshore of the high water mark. No deep-water diamond mining is currently underway in the South African offshore concession areas, although prospecting activities are ongoing. In Namibian waters, deep-water diamond mining by De Beers Marine Namibia is currently operational in the Atlantic 1 Mining Licence Area, to the northeast of Block 3B/4B.

These mining operations are typically conducted to depths of 150 m from fully self-contained mining vessels with on board processing facilities, using either large-diameter drill or seabed crawler technology. The vessels operate as semi-mobile mining platforms, anchored by a dynamic positioning system, commonly on a three to four anchor spread. Computer-controlled positioning winches enable the vessels to locate themselves precisely over a mining block of up to 400 m x 400 m. These mining vessels thus have limited manoeuvrability and other vessels should remain at a safe distance.

Figure 143: Typical crawler-vessel (left) and drillship (right) operating in the Atlantic 1 Mining Licence Area (Photos: De Beers Marine).

Other industrial uses of the marine environment include the intake of feed-water for mariculture, or diamond-gravel treatment, submarine telecommunications cables, ammunition dumps and hydrocarbon wellheads (Figure 144). None of these activities should in any way be affected by exploration drilling activities offshore.

There are a number of existing and proposed subsea fibreoptics cables that make landfall between Cape Town and Saldanha Bay (Figure 144), most of which pass to the west of Block 3B/4B. Of the ammunition dump sites off the West Coast, none fall within Block 3B/4B.

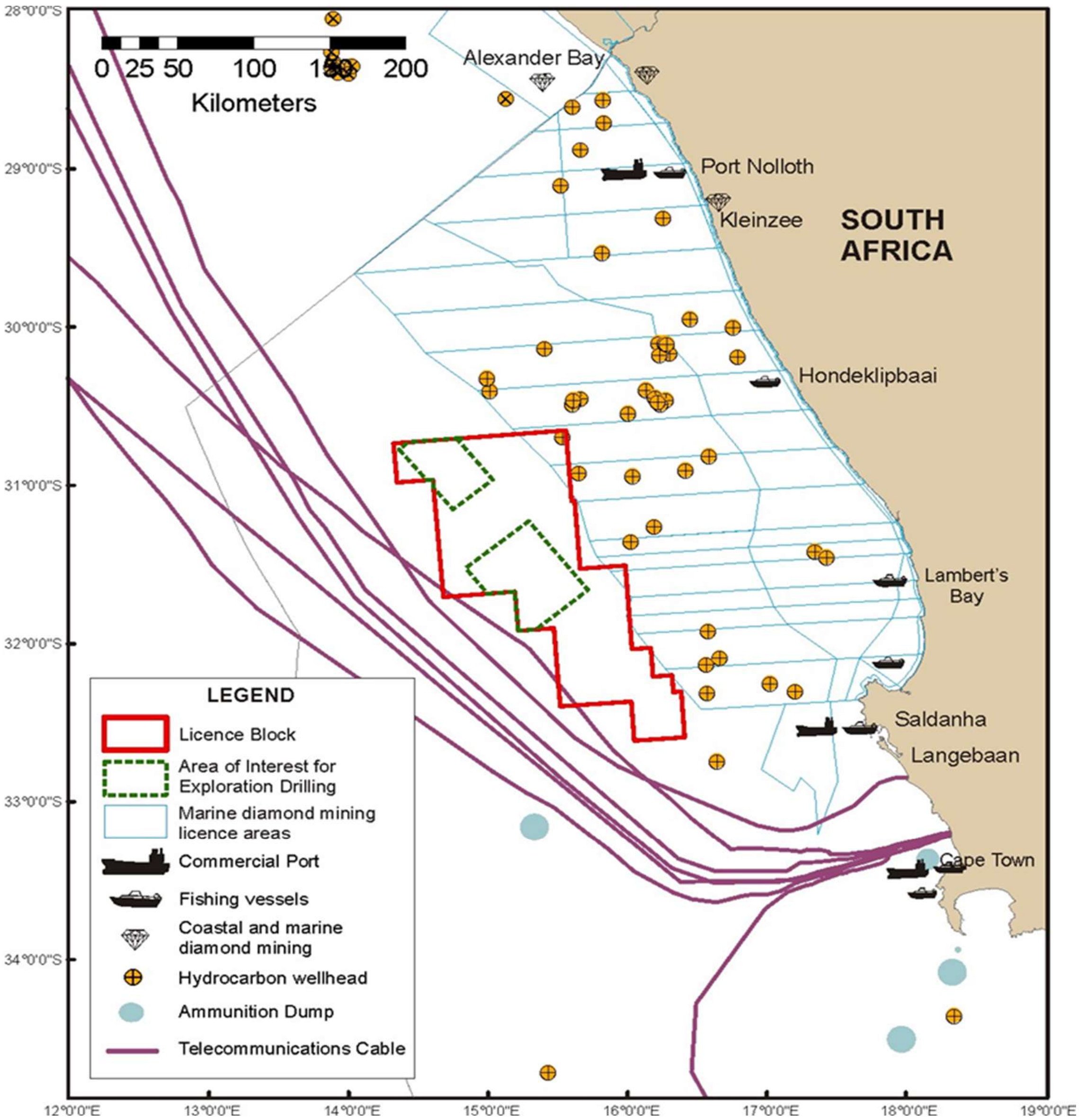


Figure 144: Block 3B/4B (red polygon) in relation to other marine infrastructure on the West Coast, illustrating the location of well heads, diamond mining concessions, submarine telecommunications cables and ammunition dumps.

8.5.2 SANCTUARIES, MARINE PROTECTED AREAS AND OTHER SENSITIVE AREAS

Numerous conservation areas and a coastal marine protected area (MPA) exist along the coastline of the Western Cape, although none overlap with Block 3B/4B (Figure 145).

8.5.2.1 **SANCTUARIES**

Sanctuaries are considered a type of management area within South Africa's multi-purpose expanded MPA network in which access and/or resource use is prohibited. Sanctuaries in the vicinity of the project area in which restrictions apply are the McDougall's Bay, Stompneusbaai, Saldanha Bay, Table Bay and Hout Bay rock lobster sanctuaries, which are closed to commercial exploitation of rock lobsters. These sanctuaries were originally proclaimed early in the 20th century under the Sea Fisheries Act of 1988 as a management tool for the protection of the West Coast rock lobster (Mayfield *et al.* 2005). They lie well inshore or to the south of Block 3B/4B.

8.5.2.2 MARINE PROTECTED AREAS

No-take MPAs offering protection of the Namaqua biozones (sub-photic, deep-photic, shallow-photic, intertidal and supratidal zones) are absent northwards from Cape Columbine (Emanuel *et al*. 1992; Lombard *et al*. 2004). This resulted in substantial portions of the coastal and shelf-edge marine biodiversity in the area being assigned a threat status of 'Critically Endangered', 'Endangered' or 'Vulnerable' in the 2011 National Biodiversity Assessment (NBA) (Lombard *et al*. 2004; Sink *et al*. 2012). Using biodiversity data mapped for the 2004 and 2011 NBAs a systematic biodiversity plan was developed for the West Coast (Majiedt *et al*. 2013) with the objective of identifying both coastal and offshore priority areas for MPA expansion. Potentially vulnerable marine ecosystems (VMEs) that were explicitly considered during the planning included the shelf break, seamounts, submarine canyons, hard grounds, submarine banks, deep reefs and cold water coral reefs. To this end, nine focus areas were identified for protection on the West Coast between Cape Agulhas and the South African – Namibian border. These focus areas were carried forward during Operation Phakisa, which identified potential offshore MPAs. A network of 20 MPAs was gazetted on 23 May 2019, thereby increasing the ocean protection within the South African Exclusive Economic Zone (EEZ) to 5%. There is no overlap with Block 3B/4B and any of these offshore MPAs, but the northern boundary of Block 3B/4B lies adjacent to the Child's Bank MPA and the Benguela Muds MPA lies ~12 km east of the southeastern boundary of Block 3B/4B. The AOI for drilling specifically avoids both this MPA and the associated EBSA (see later). These are described briefly below.

8.5.2.3 COASTAL MARINE PROTECTED AREAS

The **Namaqua National Park MPA** provides the first protection to habitats in the Namaqua bioregion, including several 'critically endangered' coastal ecosystem types. The area is a nursery area for Cape hakes, and the coastal areas support kelp forests and deep mussel beds, which serve as important habitats for the West Coast rock lobster. This 500 km^2 MPA was proclaimed in 2019, both to boost tourism to this remote area and to provide an important baseline from which to understand ecological changes (e.g. introduction of invasive alien marine species, climate change) and human impacts (harvesting, mining) along the West Coast. Protecting this stretch of coastline is part of South Africa's climate adaptation strategy.

The **Rocher Pan MPA**, which stretches 500 m offshore of the high water mark of the adjacent Rocher Pan Nature Reserve, was declared in 1966. The MPA primarily protects a stretch of beach important as a breeding area to numerous waders. It is located in St Helena Bay inshore of Block 3B/4B.

The **West Coast National Park**, which was established in 1985 incorporates the Langebaan Lagoon and Sixteen Mile Beach MPAs, as well the islands Schaapen (29 ha), Marcus (17 ha), Malgas (18 ha) and Jutten (43 ha). Langebaan Lagoon was designated as a Ramsar site in April 1988 under the Convention on Wetlands of International Importance especially as Waterfowl Habitat. The lagoon is divided into three different utilization zones namely: wilderness, limited recreational and multi-purpose recreational areas. The wilderness zone has restricted access and includes the southern end of the lagoon and the inshore islands, which are the key refuge sites of the waders and breeding seabird populations respectively. The limited recreation zone includes the middle reaches of the lagoon, where activities such as sailing and canoeing are permitted. The mouth region is a multi-purpose recreation zone for power boats, yachts, water-skiers and fishermen. However, no collecting or removal of abalone and rock lobster is allowed. The length of the combined shorelines of Langebaan Lagoon MPA and Sixteen Mile Beach is 66 km. The uniqueness of Langebaan lies in its being a warm oligotrophic lagoon, along the cold, nutrient-rich and wave exposed West Coast.

The **Table Mountain National Park (TMNP) MPA** was declared in 2004 and includes 996 km^2 of the sea area and 137 km of coastline around the Cape Peninsula from Moullie Point in the North to Muizenberg in the south. Although fishing is allowed in the majority of the MPA (subject to Department of Agriculture, Forestry and Fisheries (DAFF) permits, regulations and seasons), the MPA includes six 'no-take' zones where no fishing or extractive activities are allowed. These 'no-take' zones are important breeding and nursery areas for a wide variety of marine species thereby providing threatened species with a chance to recover form over-exploitation.

8.5.2.4 **OFFSHORE MARINE PROTECTED AREAS**

The **Orange Shelf Edge MPA** covers depths of between 250 m and 1 500 m and is unique as it has to date never been trawled. Proclaimed in 2019, this MPA provides a glimpse into what a healthy seabed should look like, what animals live there and how the complex relationships between them support important commercial fish species such as hake, thereby contributing fundamentally towards sustainable fisheries development. This MPA also protects the pelagic habitats that are home to predators such as blue sharks, as well as surface waters where thousands of seabirds such as Atlantic, yellow-nosed albatrosses feed.

The 1 335 km^2 **Child's Bank MPA**, located on the northern boundary of Block 3B/4B at its closest point, supports seabed habitats inhabited by a diversity of starfish, brittle stars and basket stars, many of which feed in the currents passing the bank's steep walls. Although trawling has damaged coral in the area, some pristine coral gardens remain on the steepest slopes. The Child's Bank area was first proposed for protection in 2004 but was only proclaimed in 2019, after reducing its size to avoid petroleum wellheads and mining areas. The MPA provides critical protection to these deep sea habitats (180 – 450 m) as they allow for the recovery of important nursery areas for young fish. Located on the northern edge of the licence block, this MPA is 38 km east of the northern AOI at its closest point.

The **Benguela Muds MPA**, is the smallest of the South African offshore MPAs. At only 72 km^2 the muddy habitats located in this area are created by sediment washed down the Orange River and out to sea. These mud habitats are of limited extent and were considered 'critically endangered' on South Africa's deep continental margin of the west coast (Sink *et al.* 2014). The MPA represents the least trawled stretch of muddy seabed on the west coast. It lies ~ 12 km east of the southeastern boundary of Block 3B/4B and ~90 km southeast of the southern AOI.

The **Namaqua Fossil Forest MPA,** which lies ~165 km northeast of Block 3B/4B, provides evidence of age-old temperate yellowwood forests from a hundred million years ago when the sea-level was more than 200 m below what it is today; trunks of fossilized yellowwood trees covered in delicate corals. These unique features stand out against surrounding mud, silt and gravel habitats. The fossilized trees are not known to be found anywhere else in our oceans and are valuable for research into past climates. In 2014 this area was recognised as globally important and declared as an Ecologically and Biologically Significant Area (EBSA). The 1 200 km^2 MPA protects the unique fossil forests and the surrounding seabed ecosystems and including a new species of sponge previously unknown to science.

The **Cape Canyon** is a deep and dramatic submarine canyon carved into the continental shelf and extending to a maximum depth of 3,600 m. The 580 km^2 MPA was proclaimed in 2019 and protects the upper part of the canyon where depths range from 180 to 500 m. Underwater footage has revealed a rich diversity of seafans, hermit crabs and mantis shrimps, with hake, monk and john dory resident on the soft canyon floor. Rocky areas in the west of the canyon support fragile rocky habitat, but the area also includes sandy and muddy habitats, which have been trawled in the past. Interaction of nutrient-rich bottom water with a complex seascape results in upwelling, which in turn provides productive surface waters in which seabirds, humpback whales and Cape fur seals feed. The MPA lies ~75 km east of the southeastern boundary of Block 3B/4B and, approximately 155 km southeast of the southern AOI.

The 612 km^2 **Robben Island MPA** was proclaimed in 2019 to protect the surrounding kelp forests – one of the few areas that still supports viable stocks of abalone. The island harbours the 3rd largest penguin colony, with the breeding population peaking in 2004 at 8 524, but declining since. The island also holds the largest numbers of breeding Bank Cormorant in the Western Cape (120 pairs in 2000) and significant populations of Crowned Cormorant, African Black Oystercatcher (35 breeding pairs in 2000), Hartlaub's Gull and Swift Tern.

8.5.2.5 **SENSITIVE AREAS**

Despite the current lack of knowledge of the community structure and endemicity of South African macro-infauna off the edge of the continental shelf, the marine component of the 2018 National Biodiversity Assessment (Sink *et al.* 2019), rated the South Atlantic bathyal and abyssal unconsolidated habitat types that characterise depths beyond 500 m, as being of 'Least concern' (see Figure 145), reflecting the great extent of these habitats in the South African Exclusive Economic Zone (EEZ). However, those ecosystem types occurring along the shelf edge (-500 m) and Cape Canyon are considered 'Vulnerable', with isolated portions being rates as 'Endangered' (Cape Upper Canyon and Southern Benguela Muddy Shelf Edge), and 'Critically Endangered' (Brown's Bank Rocky Shelf Edge). Block 3B/4B and the AOI for drilling is dominated by ecosystems rated as 'Least Concern' by the 2018 National Biodiversity Assessment.

Despite the development of the offshore MPA network, most of the ecosystem types in Block 3B/4B (i.e. Southeast Atlantic Upper, Mid and Lower Slopes, Cape Basin Abyss) are currently considered 'not protected' or 'poorly protected' and further effort is needed to improve protection of these threatened ecosystem types (Sink *et al.* 2019). Ideally, all highly threatened ('Critically Endangered' and 'Endangered') ecosystem types should be well protected. Currently, however, most of the Southeast Atlantic Upper- and Mid-Slope are poorly protected receiving only 0.2-10% protection, whereas the Southeast Atlantic Lower Slope receives no protection at all (Sink *et al.* 2019). Expanding the size of the Orange Shelf Edge MPA to form a single MPA along the South African Border could improve protection of these threatened habitats.

8.5.2.6 **ECOLOGICALLY OR BIOLOGICALLY SIGNIFICANT AREAS**

As part of a regional Marine Spatial Management and Governance Programme (MARISMA 2014-2020), the Benguela Current Commission (BCC) and its member states have identified a number of Ecologically or Biologically Significant Areas (EBSAs) both spanning the border between Namibia and South Africa and along the South African West, South and East Coasts, with the intention of implementing improved conservation and protection measures within these sites. South Africa currently has 12 EBSAs solely within its national jurisdiction with a further three having recently been proposed. It also shares eight trans-boundary EBSAs with Namibia (3), Mozambique (2) and the high seas (3). The principal objective of these EBSAs is identification of features of higher ecological value that may require enhanced conservation and management measures. They currently carry no legal status. The impact management and conservation zones within the EBSAs are under review and currently constitute a subset of the biodiversity priority areas (see next section); EBSA conservation zones equate to Critical Biodiversity Areas (CBAs), whereas impact management zones equate to Ecological Support Area (ESAs). The relevant sea-use guidelines accompanying the CBA areas would apply.

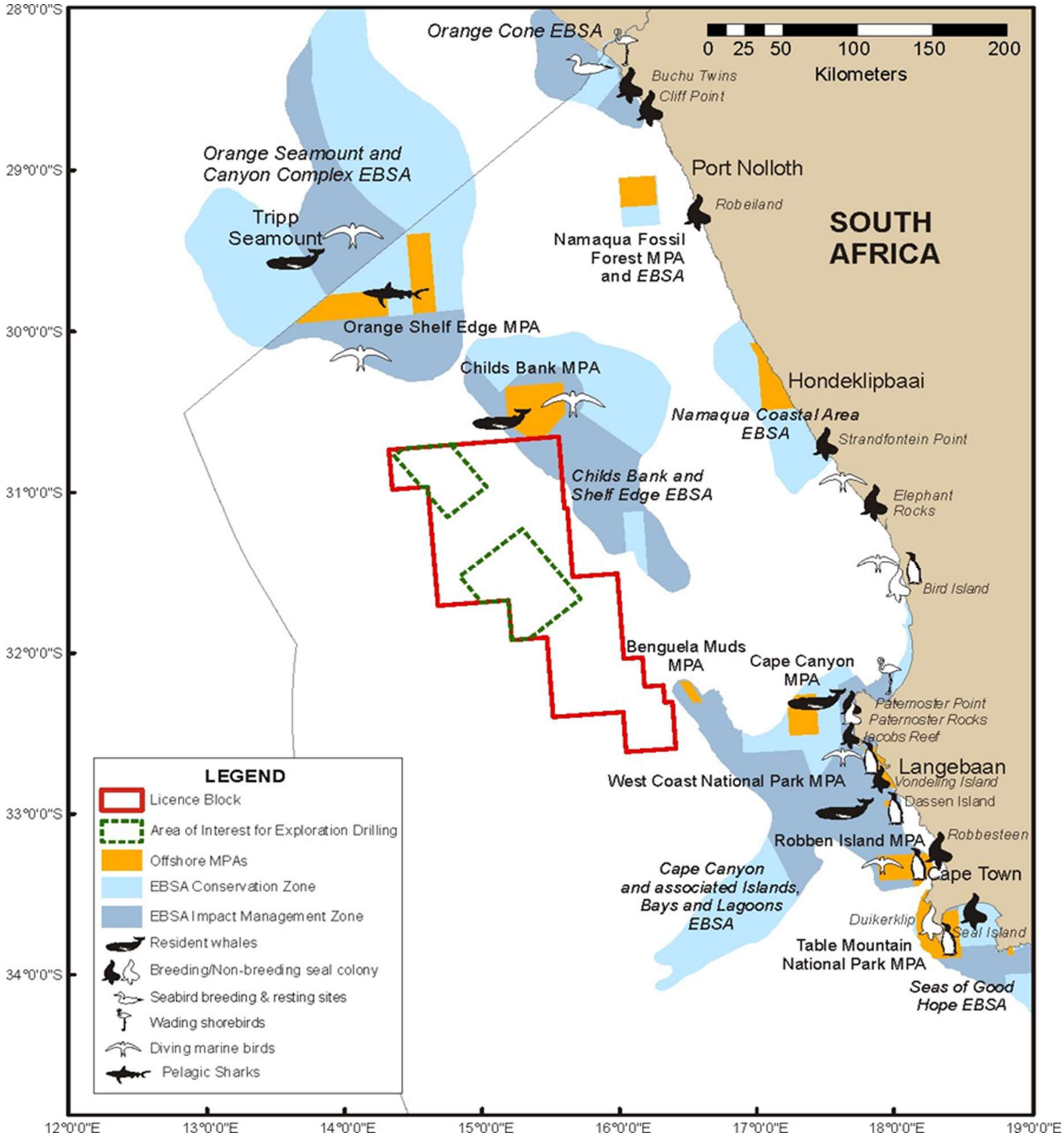


Figure 145: Block 3B/4B (red polygon) in relation to project – environment interaction points on the West Coast, illustrating the location of seabird and seal colonies and resident whale populations, Marine Protected Areas (MPAs) and Ecologically and Biologically Significant Areas (EBSAs) (Adapted from MARISMA Project 2020).

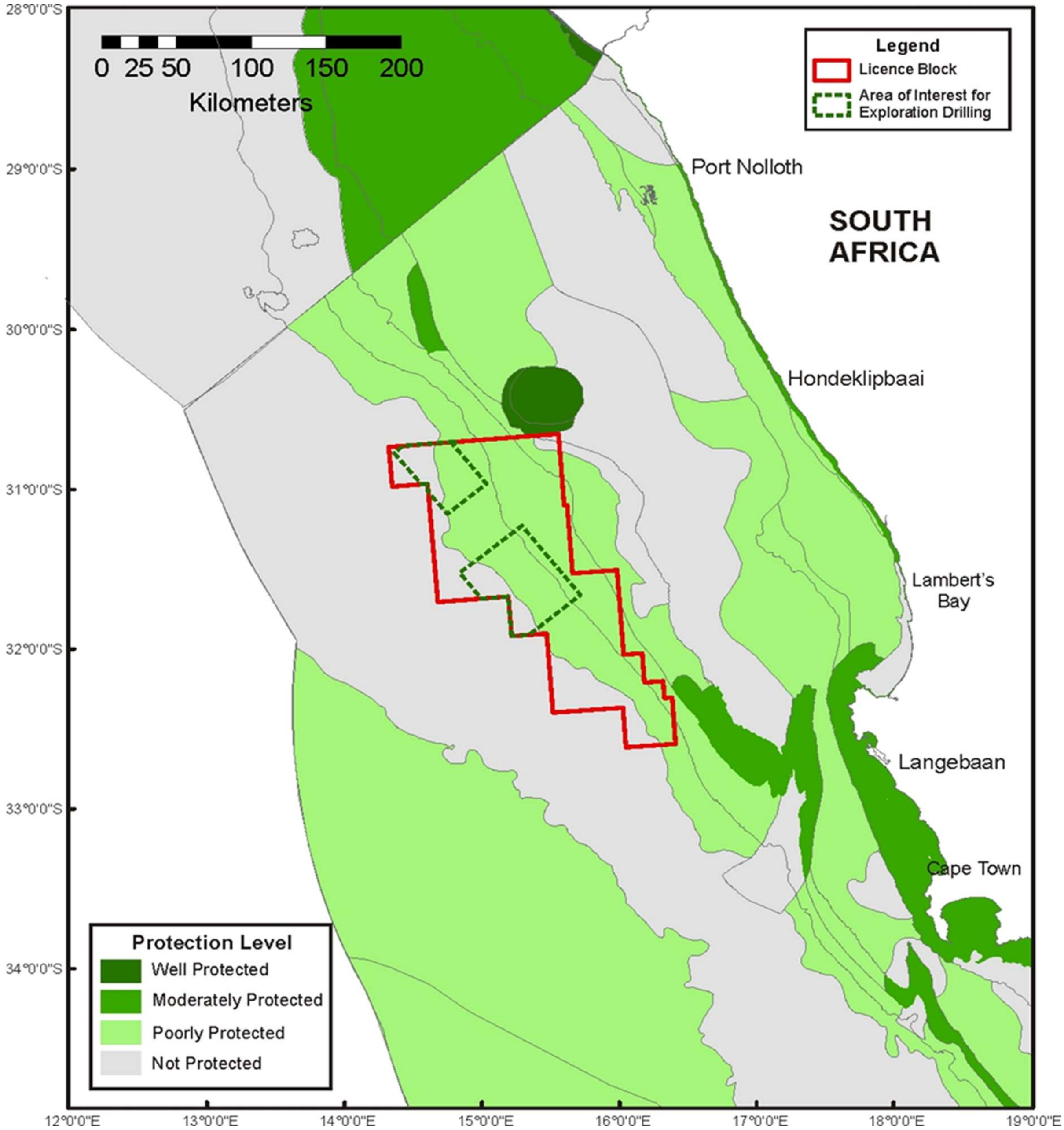


Figure 146: Block 3B/4B (red polygon) in relation to protection levels of 150 marine ecosystem types as assessed by Sink *et al.* (2019). The adjacent Namibian protection levels (adapted fom Holness *et al.* 2019) are also shown.

The following summaries of the EBSAs in the project area are adapted from http://cmr.mandela.ac.za/EBSA-Portal/Namibia/. Although Block 3B/4B overlaps to some extent with the Child's Bank EBSA, the AOI for exploration drilling avoids all EBSAs. The text and figures below are based on the EBSA status as of October 2020.

The **Childs Bank and Shelf Edge** EBSA is a unique submarine bank feature rising from -400 m to -180 m on the western continental margin on South Africa (approximately 75 km north-west of the AOI). This area includes five benthic habitat types, including the bank itself, the outer shelf and the shelf edge, supporting hard and unconsolidated habitat types. Childs Bank and associated habitats are known to support structurally complex cold-water corals, hydrocorals, gorgonians and glass sponges; species that are particularly fragile, sensitive and vulnerable to disturbance, and recover slowly. This EBSA overlaps to some extent with Block 3B/4B.

There are also a number of EBSAs in the indirect area of influence to the north, south and east of Block 3B/4B. These are described briefly below.

The **Orange Cone** transboundary EBSA is a transboundary EBSA, spanning the mouth of the Orange River (approximately 610 km north of the AOI). The estuary is biodiversity-rich but modified, and the coastal area includes many 'Critically Endangered', 'Endangered' and 'Vulnerable' habitat types (with the area being particularly important for the 'Critically Endangered' Namaqua Sandy Inshore, Namaqua Inshore Reef and Hard Grounds and Namaqua Intermediate and Reflective Sandy Beach habitat types). The marine environment experiences slow, but variable currents and weaker winds, making it potentially favourable for reproduction of pelagic species. An ecological dependence of river outflow for fish recruitment on the inshore Orange Cone is also likely. The Orange River Mouth is a transboundary Ramsar site and falls within the Tsau//Khaeb (Sperrgebiet) National Park. It is also under consideration as a protected area (RAMSAR site) by South Africa and is an Important Bird and Biodiversity Area. This EBSA lies ~220 km to the northeast of Block 3B/4B at its closest point.

The **Orange Seamount and Canyon Complex EBSA**, occurs at the western continental margin of southern Africa, spanning the border between South Africa and Namibia (approximately 100 km north-west of the AOI). On the Namibian side, it includes Tripp Seamount and a shelf-indenting canyon. The EBSA comprises shelf and shelf-edge habitat with hard and unconsolidated substrates, including at least eleven offshore benthic habitat types of which four habitat types are 'Threatened', one is 'Critically endangered' and one 'Endangered'. The Orange Shelf Edge EBSA is one of few places where these threatened habitat types are in relatively natural/pristine condition. The local habitat heterogeneity is also thought to contribute to the Orange Shelf Edge being a persistent hotspot of species richness for demersal fish species. Although focussed primarily on the conservation of benthic biodiversity and threatened benthic habitats, the EBSA also considers the pelagic habitat, which is characterized by medium productivity, cold to moderate Atlantic temperatures (SST mean = 18.3°C) and moderate chlorophyll levels related to the eastern limit of the Benguela upwelling on the outer shelf. This EBSA lies ~45 km to the north of Block 3B/4B at its closest point.

The **Namaqua Fossil Forest** EBSA is a small seabed outcrop composed of fossilized yellowwood trees at 136-140 m depth, approximately 30 km offshore on the west coast of South Africa approximately 150 km north-east of the AOI). A portion of the EBSA comprised the Namaqua Fossil Forest MPA. The fossilized tree trunks form outcrops of laterally extensive slabs of rock have been colonized by fragile, habitat-forming scleractinian corals and a newly described habitat-forming sponge species. The EBSA thus encompasses a unique feature with substantial structural complexity that is highly vulnerable to benthic impacts. This EBSA lies ~150 km to the northeast of Block 3B/4B at its closest point.

The **Namaqua Coastal Area** EBSA encompasses the Namaqua Coastal Area MPA and is characterized by high productivity and community biomass along its shores (approximately 200 km north-east of the AOI). The area is important for several threatened ecosystem types represented there, including two 'Endangered' and four 'Vulnerable' ecosystem types, and is important for conservation of estuarine areas and coastal fish species. This EBSA lies ~115 km to the east of Block 3B/4B at its closest point.

The **cape Canyon and Associated Islands** EBSA includes the Benguela Muds MPA and the Cape Canyon, which is thought to hosts fragile habitat-forming species. The area is considered important for pelagic fish, foraging marine mammals and several threatened seabird species and serves to protect nine 'Endangered' and 12 'Vulnerable' ecosystem types, and two that are 'Near Threatened'. There are several small coastal MPAs within the EBSA. Block 3B/4B lies approximately 4 km westward of this EBSA at its closest point.

The proposed **Seas of Good Hope EBSA** is located at the coastal tip of Africa, wrapping around Cape Point and Cape Agulhas. It extends from the coast to the inner shelf, and includes key islands (Seal Island, Dyer Island and Geyser Rocks), two major bays (False Bay and Walker Bay), and is of key importance for threatened species and habitats. The threatened habitats include coastal, inshore and inner shelf ecosystem types. The important life-history stages supported by the area are breeding and/or foraging grounds for a myriad of top predators, including sharks, whales, and seabirds, some of which are threatened species. This EBSA is also the place where the Benguela and Agulhas Currents meet. This EBSA lies over 200 km to the southeast of Block 3B/4B at its closest point.

The **Benguela Upwelling System** EBSA is a transboundary EBSA and is globally unique as the only cold-water upwelling system to be bounded in the north and south by warm-water current systems and is characterized by very high primary production (>1 000 mg $C.m^{-2}.day^{-1}$). It includes important spawning and nursery areas for fish as well as foraging areas for threatened vertebrates, such as sea- and shorebirds, turtles, sharks, and marine mammals. Another key characteristic feature is the diatomaceous mud-belt in the Northern Benguela, which supports regionally unique low-oxygen benthic communities that depend on sulphide oxidising bacteria.

8.5.2.7 BIODIVERSITY PRIORITY AREAS

The National Coastal and Marine Spatial Biodiversity Plan comprises a map of Critical Biodiversity Areas (CBAs), Ecological Support Area (ESAs) and accompanying sea-use guidelines. The CBA Map presents a spatial plan for the marine environment, designed to inform planning and decision-making in support of sustainable development. The sea-use guidelines enhance the use of the CBA Map in a range of planning and decision-making processes by indicating the compatibility of various activities with the different biodiversity priority areas so that the broad management objective of each can be maintained. The intention is that the CBA Map (CBAs and ESAs) and sea-use guidelines inform the Marine Spatial Planning (MSP) Conservation Zones and management regulations, respectively.

Block 3B/4B overlaps with areas mapped as Critical Biodiversity Area 1 (CBA 1) Natural, CBA 1 Restore, Critical Biodiversity Area 2 (CBA 2) Natural, CBA 2 Restore and Ecological Support Area (ESA). There is minimal overlap of the northern AOI for proposed exploration drilling with CBA 1 Natural (2.6 km^2) and CBA 2 Natural (35.9 km^2) areas but for the southern AOI, the overlap with CBA 1 Natural and CBA2 Natural, amounts to 520.1 km^2 and 251.2 km^2, respectively (Figure 147). CBA 1 indicates irreplaceable or near-irreplaceable sites that are required to meet biodiversity targets with limited, if any, option to meet targets elsewhere, whereas CBA 2 are "best design sites" and there are often alternative areas where feature targets can be met; however, these will be of higher cost to other sectors and / or will be larger areas.

Regardless of how CBAs are split, CBAs are generally areas of low use and with low levels of human impact on the marine environment but can also include some moderately to heavily used areas with higher levels of human impact. Given that some CBAs are not in natural or near-natural ecological condition, but still have very high biodiversity importance and are needed to meet biodiversity feature targets, CBA 1 and CBA 2 were split into two types based on their ecological condition. CBA Natural sites have natural / near-natural ecological condition, with the management objective of maintaining the sites in that natural / near natural state; and CBA Restore sites have moderately modified or poorer ecological condition, with the management objective to improve ecological condition and, in the long-term, restore these sites to a natural/near-natural state, or as close to that state as possible. ESAs include all portions of EBSAs that are not already within MPAs or CBAs, and a 5-km buffer area around all MPAs (where these areas are not already CBAs or ESAs), with the exception of the eastern edge of Robben Island MPA in Table Bay where a 1.5-km buffer area was applied (Harris *et al.* 2022).

Activities within these management zones are classified into those that are "compatible", those that are "not compatible", and those that have "restricted compatibility". Non-invasive (e.g. seismic surveys) and invasive (e.g. exploration wells) exploration activities are classified as having "restricted compatibility". Activities with restricted compatibility require a detailed assessment to determine whether the recommendation is that they should be permitted (general), permitted subject to additional regulations (consent), or prohibited, depending on a variety of factors. Harris *et al.* (2022) states that as part of the site-specific, context-specific assessment "*particularly careful attention would need to be paid in areas containing irreplaceable to near-irreplaceable features where the activity may be more appropriately evaluated as not permitted. The ecosystem types in which the activities take place may also be a consideration as to whether or not the activity should be permitted, for example. Where it is permitted to take place, strict regulations and controls over and above the current general rules and legislation would be required to be put in place to avoid unacceptable impacts on biodiversity features. Examples of such regulations and controls include exclusions of activities in portions of the zone; avoiding intensification or expansion of current impact footprints; additional gear restrictions; and temporal closures of activities during sensitive periods for biodiversity features.*" Petroleum production is, however, classified as "not compatible" in CBAs, but may be compatible, subject to certain conditions, in ESAs (Harris *et.al*. 2022).

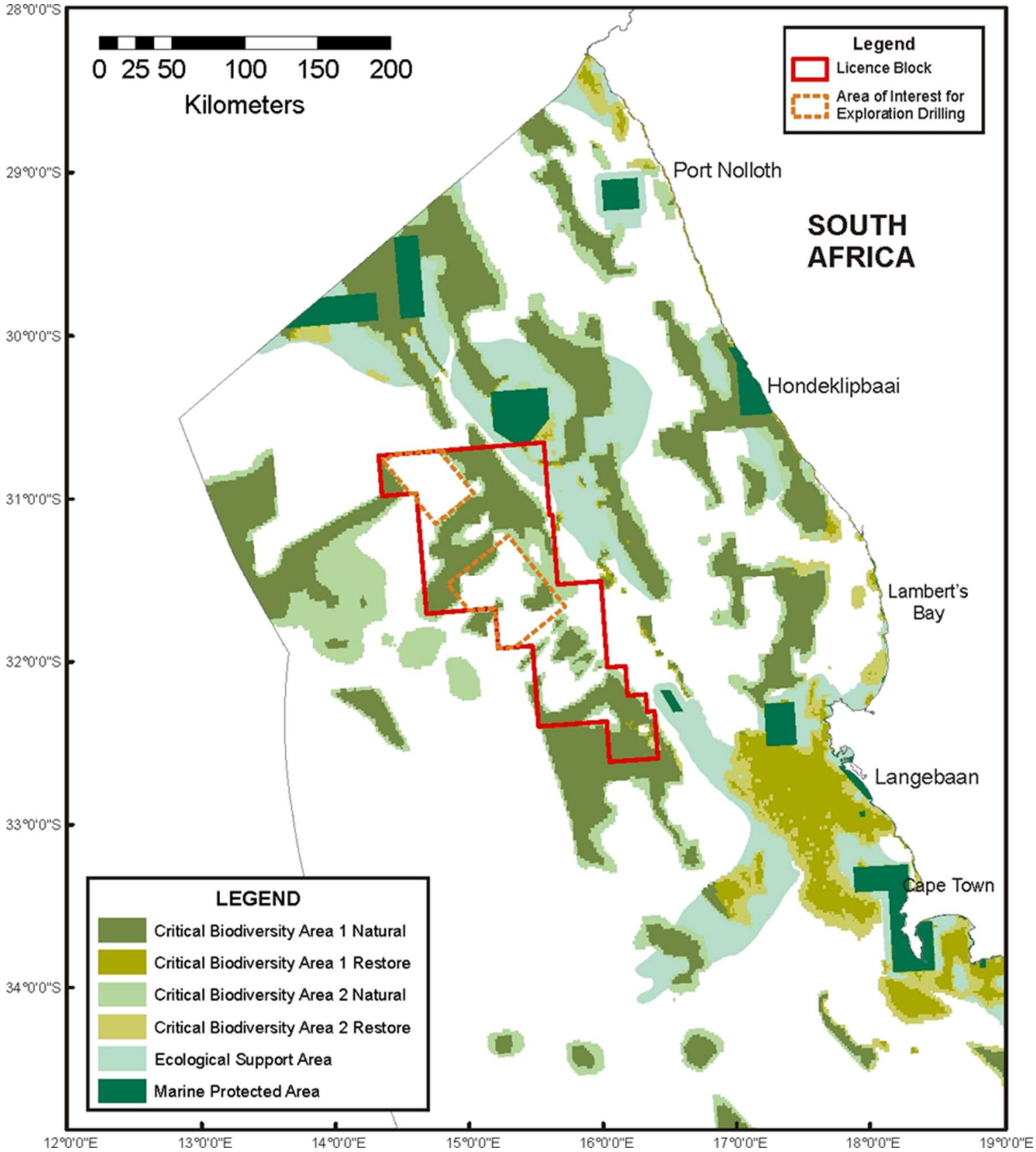


Figure 147: Block 3B/4B (red polygon) and the AOI for exploration drilling (orange dashed polygons) in relation to Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) (Version 1.2) (Harris *et al.* 2022).

8.5.2.8 **IMPORTANT BIRD AREAS (IBAS) AND RAMSAR SITES**

There are numerous coastal Important Bird Areas (IBAs) in the general project area (Table 33) (https://maps.birdlife.org/marineIBAs). These are all located well outside of Block 3B/4B.

Table 33: List of confirmed coastal Important Bird Areas (IBAs) and their criteria listings. (www.BirdLife.org.za). Those incorporating or listed as RAMSAR sites are shaded.

Site Name	IBA Criteria[7]
Orange River Mouth Wetlands (ZA023)	A1, A3, A4i, A4iii
Olifants River Estuary (ZA078)	A3, A4i
Verlorenvlei Estuary (ZA082)	A4i
Berg River Estuary (ZA083)	A4i
West Coast National Park and Saldanha Bay Islands (ZA 084) (incorporating Langebaan RAMSAR site)	A1, A4i, A4ii, A4iii
Dassen Island (ZA088)	A1, A4i, A4ii, A4iii
Robben Island (ZA089)	A1, A4i, A4ii, A4iii
Rietvlei Wetland: Table Bay Nature Reserve (ZA090)	A1, A4i
Boulders Beach (ZA096)	A1
False Bay Nature Reserve (ZA095)	A1, A4i, A4iii

Various marine IBAs have also been proposed in South African territorial waters, with a candidate marine IBA suggested off the Orange River mouth and a further candidate marine IBA suggested in international waters west of the Cape Peninsula. Block 3B/4B does not overlap with any of these proposed marine IBAs.

A Ramsar site is considered wetland designated to be of international importance under the Ramsar Convention, also known as "The Convention on Wetlands", an intergovernmental environmental treaty established by UNESCO in 1971. The convention entered into force in South Africa on 21 December 1975. It provides for national action and international cooperation regarding the conservation of wetlands, and wise sustainable use of their resources. South Africa currently has 27 sites designated as Ramsar Sites, with a surface area of 571 089 hectares. These should in no way be influenced by well-drilling operations in Block 3B/4B.

[7] **A1**. Globally threatened species; **A2**. Restricted-range species; **A3**. Biome-restricted species; **A4**. Congregations; **i**. applies to 'waterbird' species; **ii**. This includes those seabird species not covered under i.; **iii**. modelled on criterion 5 of the Ramsar Convention for identifying wetlands of international importance. The use of this criterion is discouraged where quantitative data are good enough to permit the application of A4i and A4ii.

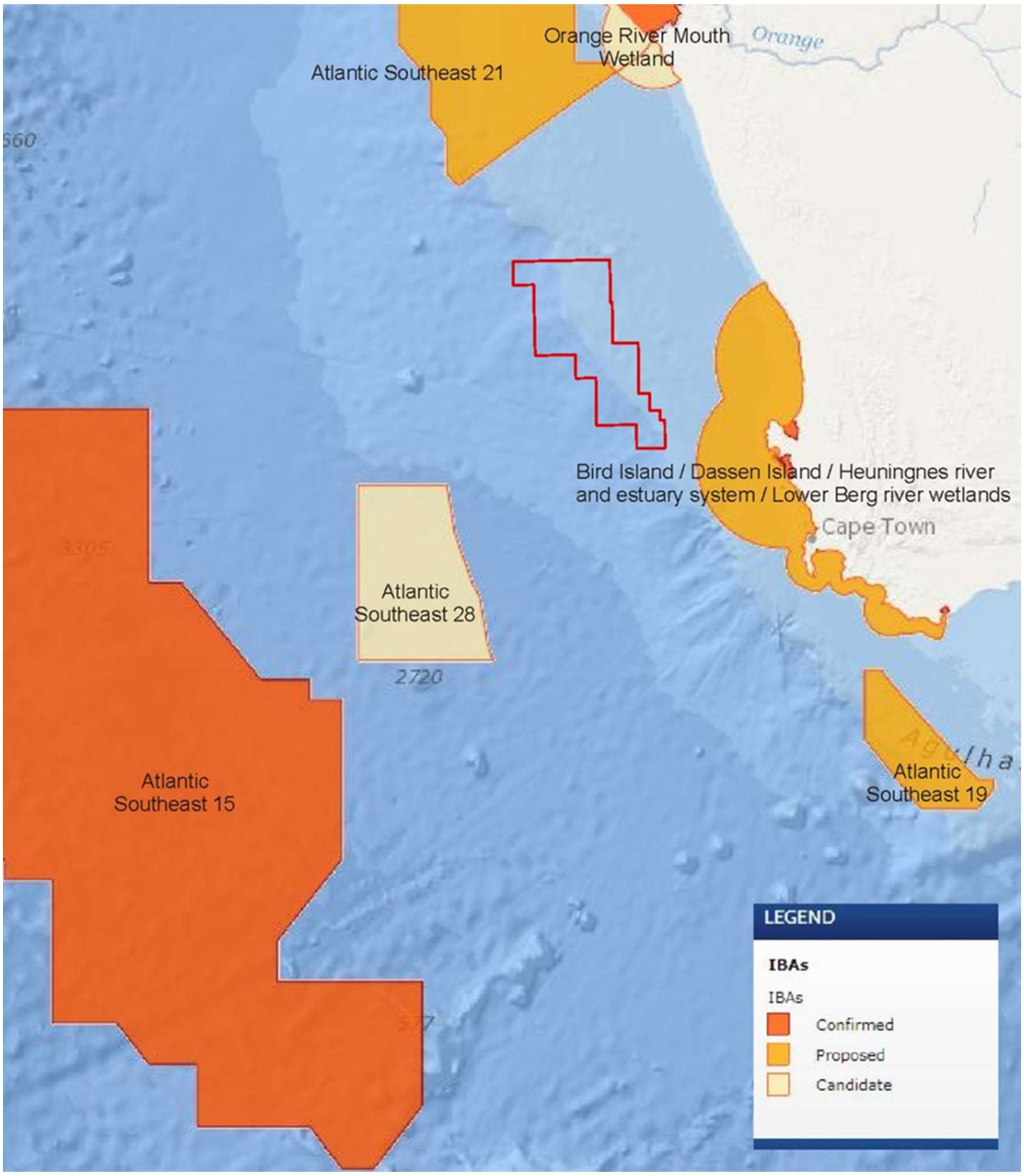


Figure 148: Block 3B/4B (red polygon) in relation to coastal and marine IBAs (Source: https://maps.birdlife.org/marineIBAs).

8.5.2.9 IMPORTANT MARINE MAMMAL AREAS (IMMAS)

Important Marine Mammal Areas (IMMAs) were introduced in 2016 by the IUCN Marine Mammal Protected Areas Task Force to support marine mammal and marine biodiversity conservation. Complementing other marine spatial assessment tools, including the EBSAs and Key Biodiversity Areas (KBAs), IMMAs are identified on the basis of four main scientific criteria, namely species or population vulnerability, distribution and abundance, key life cycle activities and special attributes. Designed to capture critical aspects of marine mammal biology, ecology and population structure, they are devised through a biocentric expert process that is independent of any political and socio-economic pressure or concern. IMMAs are not prescriptive but comprise an advisory, expert-based classification of areas that merit monitoring and place-based protection for marine mammals and broader biodiversity.

Modelled on the BirdLife International process for determining IBAs, IMMAs are assessed against a number of criteria and sub-criteria, which are designed to capture critical aspects of marine mammal biology, ecology and population structure. These criteria are:

- Criterion A – Species or Population Vulnerability
  - Areas containing habitat important for the survival and recovery of threatened and declining species.
- Criterion B – Distribution and Abundance
  - Sub-criterion B1 – Small and Resident Populations: Areas supporting at least one resident population, containing an important proportion of that species or population, that are occupied consistently.
  - Sub-criterion B2 – Aggregations: Areas with underlying qualities that support important concentrations of a species or population.
- Criterion C – Key Life Cycle Activities
  - Sub-criterion C1 – Reproductive Areas: Areas that are important for a species or population to mate, give birth, and/or care for young until weaning.
  - Sub-criterion C2 – Feeding Areas: Areas and conditions that provide an important nutritional base on which a species or population depends.
  - Sub-criterion C3 – Migration Routes: Areas used for important migration or other movements, often connecting distinct life-cycle areas or the different parts of the year-round range of a non-migratory population.
- Criterion D – Special Attributes
  - Sub-criterion D1 – Distinctiveness: Areas which sustain populations with important genetic, behavioural or ecologically distinctive characteristics.
  - Sub-criterion D2 – Diversity: Areas containing habitat that supports an important diversity of marine mammal species
  - Although much of the West Coast of South Africa has not yet been assessed with respect to its relevance as an Important Marine Mammal Areas (IMMA), the coastline from the Olifants River mouth on the West Coast to the Mozambiquan border overlaps with three declared IMMAs (Figure 149) namely the
  - Southern Coastal and Shelf Waters of South Africa IMMA (166 700 km^2),
  - Cape Coastal Waters IMMA (6 359 km^2), and
  - South East African Coastal Migration Corridor IMMA (47 060 km^2).
  - These are described briefly below based on information provided in IUCN-Marine Mammal Protected Areas Task Force (2021) (www.marinemammalhabitat.org).

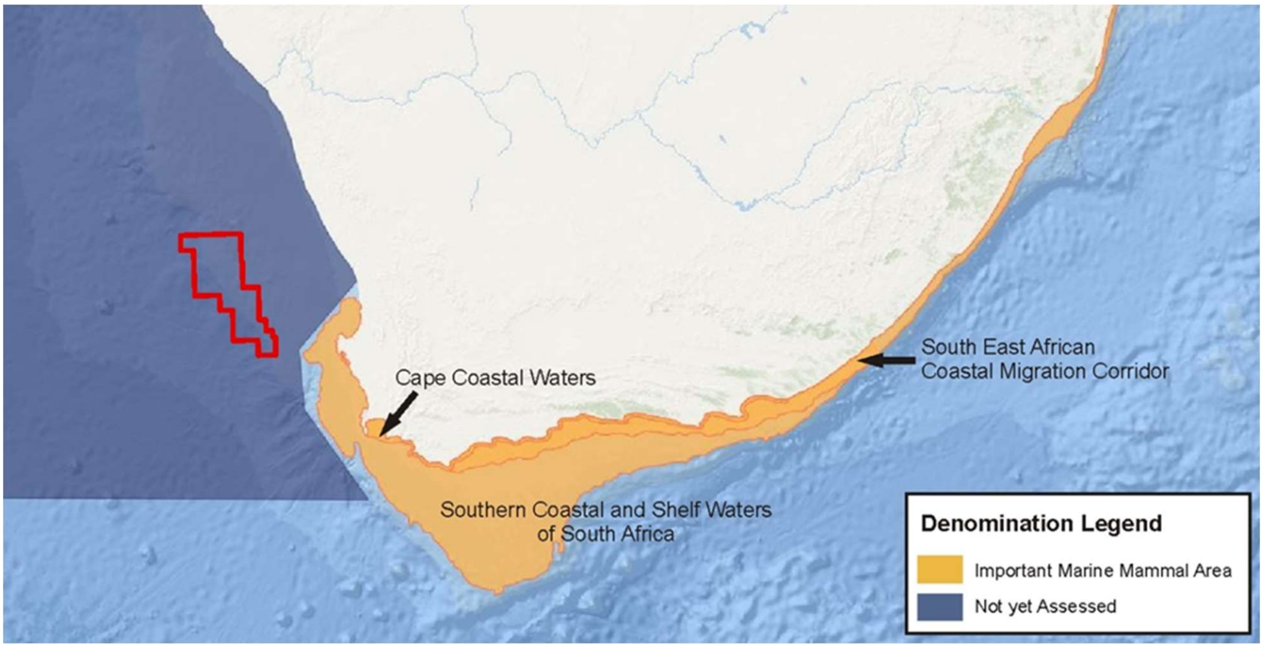


Figure 149: Block 3B/4B (red polygon) in relation to coastal and marine IMMAs (Source: www.marinemammalhabitat.org/imma-eatlas/).

The 166 700 km^2 **Southern Coastal and Shelf Waters of South Africa IMMA** extends from the Olifants River mouth to the mouth of the Cintsa River on the Wild Coast. Qualifying species are the Indian Ocean Humpback dolphin (Criterion A, B1), Bryde's whale (Criterion C2), Indo-Pacific bottlenose dolphin (Criterion B1, C3, D1), Common dolphin (Criterion C2) and Cape fur seal (criterion C2). The IMMA covers the area supporting the important 'sardine run' and the marine predators that follow and feed on the migrating schools (Criterion C2) as well as containing habitat that supports an important diversity of marine mammal species (Criterion D2) including the Indian Ocean humpback dolphin, the inshore form of Bryde's whale, Indo-Pacific bottlenose dolphin, common dolphin, Cape fur seal, humpback whales, killer whales and southern right whales.

The **Cape Coastal Waters IMMA** extends from Cape Point to Woody Cape at Algoa Bay and extends over some 6 359 km^2. It serves as one of the world's three most important calving and nursery grounds for southern right whales, which occur in the extreme nearshore waters (within 3 km of the coast) from Cape Agulhas to St. Sebastian Bay between June and November (Criterion B2, C1). Highest densities of cow-calf pairs occur between Cape Agulhas and the Duivenhoks River mouth (Struisbaai, De Hoop, St Sebastian Bay), while unaccompanied adult densities peak in Walker Bay and False Bay. The IMMA also contains habitat that supports an important diversity of marine mammal species including the Indian Ocean humpback dolphin and Indo-Pacific bottlenose dolphin.

The South East African Coastal Migration Corridor IMMA extends some 47 060 km^2 from Cape Agulhas to the Mozambiquan border and serves as the primary migration route for C1 substock of Southern Hemisphere humpback whales (Criterion C3). On their northward migration between June and August, they are driven closer to shore due to the orientation of the coast with the Agulhas Current, whereas during the southward migration from September to November, they remain further offshore (but generally within 15 km of the coast) utilising the southward flowing Agulhas Current as far west as Knysna. The IMMA also contains habitat that supports an important diversity of marine mammal species including the Indian Ocean humpback dolphin, Common dolphin, Indo-Pacific bottlenose dolphin, Spinner dolphin, Southern Right whale, and killer whale.

There is no overlap of Block 3B/4B with the IMMA's.

8.6 SOCIAL

This section provides and overview of the socio-economic environment for the study area. The information has been sourced from the Social Assessment undertaken by Equispectives (Appendix 4).

The proposed project area is located on the edge of the South African exclusive economic zone in the Atlantic Ocean. The people potentially affected by the proposed project are those living in the areas adjacent to the ocean whose activities could potentially be affected. The following areas are included in the baseline description of the social environment:

- Northern Cape Province
    - Namakwa District Municipality
    - Richtersveld Local Municipality (Wards 2, 3, 4)
    - Nama Khoi Local Municipality (Ward 8)
    - Kamiesberg Local Municipality (Wards 1, 2)
- Western Cape Province
    - West Coast District Municipality
    - Matzikama Local Municipality (Wards 2, 5, 8)
    - Cederberg Local Municipality (Ward 5)
    - Bergrivier Local Municipality (Wards 6, 7)
    - Saldanha Bay Local Municipality (Wards 1, 3, 5, 6, 11, 12, 14)
    - Swartland Local Municipality (Ward 5)
    - City of Cape Town Metropolitan Municipality (Wards 4, 23, 29, 32, 54, 55, 74, 107, 113, 115)

8.6.1 NORTHERN CAPE PROVINCE

The Northern Cape Province is South Africa's largest province. It takes up almost a third of the country and covers an area of 372 889 km^2 (www.municipalities.co.za). It is bordered by the provinces of North West, Free State, Eastern Cape and Western Cape as well as the countries of Namibia and Botswana and the Atlantic Ocean. It consists of the Frances Baard, John Taolo Gaetsewe, Namakwa, Pixley Ka Seme and ZF Mgcawu District Municipalities.

The capital of the province is Kimberley and other towns in the province include Springbok, Kuruman, De Aar, Sutherland, Alexander Bay, Port Nolloth, Kathu, Okiep, Springbok, Aggeneys, Upington, Kakamas, Keimoes and Warrenton.

The economy of the province relies mainly on mining and agriculture. Commodities being mined include iron ore, copper, asbestos, manganese, fluorspar, semi-precious stones, and marble. Alluvial diamonds are being extracted from the beaches and sea in the area around Alexander Bay and Port Nolloth. Agricultural products include sheep, wheat, fruit, grapes, wheat, peanuts, maize, and cotton. The province is known for its dried fruit, wine, and karakul pelt.

The spring-flowers in Namakwaland is a popular tourist attraction. The province also houses the southern hemisphere's largest astronomical observatory at Sutherland.

8.6.1.1 **NAMAKWA DISTRICT MUNICIPALITY**

The Namakwa District Municipality is the largest district municipality in the province and covers an area of 126 836 km^2 (www.municipalities.co.za). It is bordered by the ZF Mgcawu Local Municipality, the Cape Winelands, West Coast, Pixley Ka Seme and Central Karoo District Municipalities, the country of Namibia and the Atlantic Ocean. It is the largest district in the province, making up almost a third of the province.

The district consists of six local municipalities, namely the Hantam, Kamiesberg, Karoo Hoogland, Khai-Ma, Nama Khoi, and Richtersveld Local municipalities. The capital of the province is Springbok and other towns include Aggeneys, Alexander Bay, Brandvlei, Bulletrap, Calvinia, Carolusberg, Concordia, Eksteensfontein, Frasersburg, Garies, Hondeklip Bay, Kamieskroon, Kleinzee, Koingnaas, Komaggas, Kuboes, Leliefontein/Kamiesberg, Loeriesfontein, Middelpos, Nababeep, Nieuwoudtville, O'Kiep, Onderste Doorns, Pella, Pofadder, Port Nolloth, Richtersveld, Sanddrift, Springbok, Steinkopf, Sutherland, and Williston.

The main economic sectors are tourism and agriculture.

8.6.1.2 RICHTERSVELD LOCAL MUNICIPALITY

The Richtersveld municipality is the smallest municipality in the district and covers an area of 9 608 km^2 (www.municipalities.co.za). The municipality borders the Atlantic Ocean and the main towns are Alexander Bay, Eksteensfontein, Kuboes, Port Nolloth, Richtersveld and Sanddrift. Port Nolloth is the main economic centre of the municipality.The main economic sectors are mining, agriculture, fishing and tourism0 Richtersveld Local Municipality IDP 2022/2027).

The main challenges that municipality faces relate to infrastructure, and socio-economic, spatial and housing issues, as well as issues relative to social facilities and services. The Richtersveld Municipal area is earmarked for a massive harbour development at Boegoebaai (about 60 km north of Port Nolloth and 20 km south of the border between Namibia and South Africa). This project is currently in its initial phase, and it is envisaged that this development will serve as an enabler of further development in the Northern Cape (Namakwa District Municipality IDP 2022-2027).

The Boegoebaai port is closely linked to the Northern Cape Green Hydrogen Strategy which was launched to the global community at the COP26 summit in Glasgow in November 2021 (www.globalafricanetwork.com). Green hydrogen refers to the production of hydrogen using renewable energy sources (www.un.org). Black/brown hydrogen is produced using coal and grey/blue hydrogen is derived from methane. Being an energy carrier, green hydrogen would act like a battery that allows the storage of excess energy created by renewable sources and would reduce the intermittency of renewables that cannot generate power all hours of the day, ensuring a sufficient and continuous supply of power for the grid.

8.6.1.3 NAMA KHOI LOCAL MUNICIPALITY

The Nama Khoi Local Municipality covers an area of 17 990 km^2 (www.municipalities.co.za). It is home to Nama, Khoe and San people who have occupied the area for hundreds of years. The municipality borders the Atlantic Ocean, and the main towns are Bulletrap, Carolusberg, Concordia, Kleinzee, Komaggas, Nababeep, O'Kiep, Springbok, Steinkopf. The main economic activities are mining and tourism, but there are also some government departments. This region is known as the land of the Nama people.

8.6.1.4 KAMIESBERG LOCAL MUNICIPALITY

The Kamiesberg Local Municipality covers an area of 14 208 km^2 (www.municipalities.co.za). The municipality borders the Atlantic Ocean and the main towns are Garies, Hondeklip Bay, Kamieskroon, Koingnaas, and Leliefontein/Kamiesberg. Hondeklip Bay has a harbor that serves fishing and diamond boats (Namakwa District Municipality IDP 2022-2027). It is also a mariculture centre and popular with tourists for scenic drives and 4x4 routes. Garies and Kamieskroon are known for wildflowers in spring, while Koingnaas is a mining town for alluvial diamonds.

8.6.2 WESTERN CAPE PROVINCE

The Western Cape Province is located on the southern tip of Africa between the Atlantic and Indian Oceans and is bordered by the Northern Cape and Eastern Cape Provinces. It covers an area of 129 462 km^2 (www.municipalities.co.za). The province is divided into one metropolitan municipality and five district municipalities. The capital of the province is the city of Cape Town and other major cities and towns include George, Knysna, Paarl, Swellendam, Oudtshoorn, Stellenbosch, Worcester, Mossel Bay and Strand.

The province has a well-established industrial and business base. Main economic activities include finance, real estate, Information and Communication Technology , retail, and tourism. Fishing is the most important industry along the west coast and sheep farming in the Karoo. In terms of agriculture main produce include grapes, fruit, vegetables, and wheat. A number of vineyards are located in the Western Cape Province.

8.6.2.1 **WEST COAST DISTRICT MUNICIPALITY**

The West Coast District Municipality covers an area of 31 118 km^2 (www.municipalities.co.za) and is bordered by the Namakwa and Cape Winelands District Municipalities, the City of Cape Town, and the Atlantic Ocean. The municipality consists of five local municipalities, namely the Swartland, Bergrivier, Matzikama, Cederberg and Saldanha Bay Local Municipalities.

The capital of the district is Moorreesburg and other main towns include Abbotsdale, Aurora, Bitterfontein, Chatsworth, Citrusdal, Clanwilliam, Darling, Doring Bay, Ebenhaezer, Eendekuil, Elands Bay, Graafwater, Grotto Bay, Hopefield, Jacobs Bay, Kalbaskraal, Klawer, Kliprand, Koekenaa, Koringberg, Lamberts Bay, Langebaan, Leipoldtville, Lutzville, Malmesbury, Molsvlei, Moorreesburg, Nuwerus, Paternoster, Piketberg, Porterville, Putsekloof, Redelinghuys, Riebeeck Kasteel, Riebeeck West, Rietpoort, Riverlands, Saldanha, St Helena Bay, Stofkraal, Strandfontein, Vanrhynsdorp, Velddrif, Vredenburg, Vredendal, Wupperthal, and Yzerfontein.

Despite lively economic activity in the Swartland, Saldanha and Bergrivier areas, large parts of the district remain impoverished. The district has the second lowest GDP in the Western Cape Province and income inequality has worsened over the years (West Coast District Municipality IDP 2022-2027). The economic activities are mainly driven by activities within the manufacturing; agriculture, forestry and fishing; as well as wholesale and retail trade sector. The recent drought has had a significant impact on the agriculture, forestry and fishery sectors within the district.

8.6.2.2 **MATZIKAMA LOCAL MUNICIPALITY**

The Matzikama Local Municipality borders the Northern Cape Province and the Atlantic Ocean. It is the largest of the five municipalities in the district, making up almost half of the district. It covers an area of 12 981 km^2 (www.municipalities.co.za). There are 18 towns and villages in the municipal area with most of the population being concentrated along the Olifants River and its canal system. The main towns and villages include Bitterfontein, Doring Bay, Ebenhaezer, Klawer, Kliprand, Koekenaa, Lutzville, Molsvlei, Nuwerus, Putsekloof, Rietpoort, Stofkraal, Strandfontein, Vanrhynsdorp,aand Vredendal.

The agriculture, forestry and fishery sector was the main driver of the municipality's economy, followed by the wholesale and retail trade, catering and accommodation sector (Matzikama Local Municipality IDP, May 2022). The municipality is under severe strain with regards to coastal resource use (mining pressure, marine living resources), exploitation of estuarine resources and coastal vulnerabilities (illegal off-road vehicles, illegal camping and coastal erosion). Due to the dwindling fishing stocks the capture fisheries industry closed down more than 10 years ago and the likeliness of it being restored to its original form is unlikely. The only remaining activity of this industry is subsistence and small scale fishing.

Operation Phakisa – Oceans Economy forms part of the Matzikama Coastal Management Plan, also in terms of the socio-economic development of the coastal zones (Matzikama Local Municipality IDP, May 2022). Operation Phakisa – Oceans Economy was launched in July 2014 as a priority programme of the South African Government with the aim to considerably grow the Ocean Economy's contribution to the country's GDP by 2033. It is a results-driven approach that involves clear plans and targets, ongoing monitoring of progress and making these results public. It focuses on bringing key stakeholders from the public and private sectors, academia as well as civil society organisations together to collaborate in (www.dffe.gov.za):

- Detailed problem analysis;
- Priority setting;
- Intervention planning; and
- Delivery.

The project focuses on six growth areas, namely:

- Marine transport and manufacturing;
- Offshore oil and gas exploration;
- Aquaculture;
- Marine protection services and ocean governance;
- Small harbours; and
- Marine tourism.
- The six growth areas are supported by two enablers, namely:
- Skills and capacity building; and
- Research, technology and innovation.

8.6.2.3 **CEDERBERG LOCAL MUNICIPALITY**

The Cederberg Local Municipality covers an area of 8 007 km^2 (www.municipalities.co.za). It is bordered by the Atlantic Ocean and the Cederberg Mountains and is located on the Cape-Namibia corridor. The main towns in the area include Citrusdal, Clanwilliam, Elands Bay, Graafwater, Lamberts Bay, Leipoldtville, and Wupperthal.

The economic activities in the Cederberg Local Municipality are dominated by agriculture and fishing, manufacturing, wholesale and retail trade, catering and accommodation, and transport, storage and accommodation (Cederberg Local Municipality IDP 2022-23). The area consists of a mix of sparsely and densely populated towns with Clanwilliam and Citrusdal serving as the main agricultural centres. The area is characterised by high levels of unemployment, poverty and social grant dependence. The road network is diverse with national, trunk, main and divisional roads of varying quality.

8.6.2.4 **BERGRIVIER LOCAL MUNICIPALITY**

The Bergrivier Local Municipality covers an area of 4 407 km^2 (www.municipalities.co.za). The main towns in the area include Aurora, Eendekuil, Piketberg, Porterville, Redelinghuys, and Velddrif. The agriculture sector is the largest employer in the municipal area with a contribution of 50.4% to total employment (Bergrivier Local Municipality IDP, May 2022). The four pillars for economic development in the municipal area are agriculture and agro processing; tourism; manufacturing; and the development of small and medium enterprises.

8.6.2.5 **SALDANHA BAY LOCAL MUNICIPALITY**

The Saldanha Bay Local Municipality is the smallest of the five municipalities in the district and covers an area of 2 015 km^2 (www.municipalities.co.za). The main towns in the area are Hopefield, Jacobs Bay, Langebaan, Paternoster, Saldanha, St Helena Bay, Vredenburg.

The Saldanha Bay area plays an important role in the broader strategic framework of the South African Government as driven by the National Development Plan and National Growth Plan. It was identified as a special intervention area, attributed to the natural deep-water harbour and industrial development prospects that warrants its designation as a national growth management zone. The Saldanha Bay Industrial Development Zone (IDZ) was launched in October 2013 with the aim of serving as an important mechanism to achieve the government’s aim of sustainable economic development and job creation in the localised economy. Diversification, and transformation of the historically under-developed and under-supported industrial maritime and energy sectors and broadening of the regional and national economic base through industrialisation (Saldanha Bay Local Municipality IDP, May 2022).

St Helena Bay is one of the world’s principal fishing centres. Huge shoals of anchovies and pilchards fed in the area before they were depleted by overfishing. Twelve fish-processing factories were established along the 21 km curve of the shore from West Point to Sandy Point and Stompneus. The bay is also well known for its snoek, especially during the winter months.

Saldanha Bay is the largest natural bay in South Africa and has a huge iron ore quay and is home to a large variety of fishing vessels. The town is not only important for export, but also hosts a number of other industries, such as crayfish, fish, mussels, oysters, seaweed and many more. It is also home to the South African Military Academy as well as SAS Saldanha, a naval training unit.

The largest economic sectors in the municipal area are manufacturing, trade, and finance, while the agricultural sector is the largest contributor to employment. The fishing industry and fish processing are the largest primary and secondary industries in the municipality.

8.6.2.6 **SWARTLAND LOCAL MUNICIPALITY**

The Swartland Local Municipality covers an area of 3 708 km^2 (www.municipalities.co.za). Main towns in the area include Abbotsdale, Chatsworth, Darling, Grotto Bay, Kalbaskraal, Koringberg, Malmesbury, Moorreesburg, Riebeeck Kasteel, Riebeeck West, Riverlands, and Yzerfontein.

The town of Malmesbury fulfils an important niche in the region due to its high development potential that can be attributed to factors like its relative accessibility along the N7 road/rail corridor; proximity to Cape Town; a diversified economic base that not only accommodates agriculture, but also well-developed industrial and commercial sectors; and supportive infrastructure. A number of people moved here and commute to jobs in Cape Town because of the high property rates in the Cape Town Metropolitan area and the tranquil environment that it offers.

Commercial services; Manufacturing; and Agriculture are the biggest contributors to the economy of the municipal area, with Agriculture being the second highest contributor to employment.

8.6.2.7 **CITY OF CAPE TOWN METROPOLITAN MUNICIPALITY**

The City of Cape Town Metropolitan Municipality is situated in the southern peninsula of the Western Cape Province and covers an area of 2 441 km^2 (www.municipality.co.za). It is South Africa's second largest economic centre and the second most populous city after Johannesburg. It is the provincial capital as well as the legislative capital of South Africa. The city is known for its harbour, floral kingdom and well-known landmarks like Table Mountain and Cape Point.

Main towns and cities in the area include Athlone, Atlantis, Belhar, Bellville, Blackheath, Blouberg, Blue Downs, Brackenfell, Cape Point, Cape Town, Delft, Durbanville, Elsies Rivier, Fish Hoek, Goodwood, Gordon's Bay, Grassy Park, Guguletu, Hout Bay, Khayelitsha, Kommetjie, Kraaifontein, Kuils River, Langa, Macassar, Matroosfontein, Melkbosstrand, Milnerton, Mitchells Plain, Muizenberg, Noordhoek, Nyanga, Parow, Philadelphia, Philippi, Robben Island, Scarborough, Simon's Town, Sir Lowry's Pass, Somerset West, Southern Suburbs, Strand, and Table View.

8.6.3 DESCRIPTION OF THE POPULATION

The baseline description of the population will take place on three levels, namely provincial, district and local. Impacts can only truly be comprehended by understanding the differences and similarities between the different levels. The baseline description will focus on the municipal areas along the west coast that are most likely to be affected by the proposed project. Where possible, the data will be reviewed on a ward level. The data used for the socio-economic description was sourced from Census 2011. Census 2011 was a de facto census (a census in which people are enumerated according to where they stay on census night) where the reference night was 9-10 October 2011. The results should be viewed as indicative of the population characteristics in the area and should not be interpreted as absolute.

Although a Census was conducted in 2022, StatsSA could to date upon query not indicate when the results would be released. It is acknowledged that the Census 2011 data is very outdated and as such should be interpreted with care. Where possible, data will be supplemented by data from Community Survey 2016, which is a bit more recent.

The following points regarding Census 2011 must be kept in mind (www.statssa.co.za):

- Comparisons of the results of labour market indicators in the post-apartheid population censuses over time have been a cause for concern. Improvements to key questions over the years mean that the labour market outcomes based on the post-apartheid censuses must be analysed with caution. The differences in the results over the years may be partly attributable to improvements in the questionnaire since 1996 rather than to actual developments in the labour market. The numbers published for the 1996, 2001, and 2011 censuses are therefore not comparable over time and are different from those published by Statistics South Africa in the surveys designed specifically for capturing official labour market results.
- For purposes of comparison over the period 1996–2011, certain categories of answers to questions in the censuses of 1996, 2001 and 2011, have either been merged or separated.
- The tenure status question for 1996 has been dropped since the question asked was totally unrelated to that asked thereafter. Comparisons for 2001 and 2011 do however remain.
- All household variables are controlled for housing units only and hence exclude all collective living arrangements as well as transient populations.
- When making comparisons of any indicator it must be considered that the time period between the first two censuses is five years and that between the second and third census is ten years. Although Census captures information at one given point in time, the period available for an indicator to change is different.

8.6.4 POPULATION AND HOUSEHOLD SIZES

According to the Community Survey 2016, the population of South Africa is approximately 55,7 million and has shown an increase of about 7.5% since 2011. The household density for the country is estimated on approximately 3.29 people per household, indicating an average household size of 3-4 people (leaning towards 3) for most households, which is down from the 2011 average household size of 3.58 people per household. Smaller household sizes are in general associated with higher levels of urbanisation.

The greatest increase in population since 2011 has been in the Swartland and Saldanha Bay Local Municipalities (Table 34) and the increases were well above the national average. The Richtersveld Local Municipality where Port Nolloth is located is the only one of the coastal municipalities in the Northern Cape that showed an increase in population. The Kamiesberg Local Municipality where Hondeklip Bay is located, saw the greatest decrease in population between 2011 and 2016. Population density refers to the number of people per square kilometre and the population density on a national level has increased from 42.45 people per km^2 in 2011 to 45.63 people per km^2 in 2016. The City of Cape Town had the highest population density in 2016, and the Kamiesberg Local Municipality the lowest. Figure 150 gives a comparison of the population density. The municipalities in the rural areas in the Northern Cape are the least densely populated, while the metropolitan areas in Cape Town have the highest population density. Figure 151 shows the number of people per ward. The wards in the rural areas tend to have less people spread over a greater area, while in the urban areas there are more people in a much smaller area.

Table 34: Population density and growth estimates (sources: Census 2011, Community Survey 2016)

Area	Size in km^2	Population 2011	Population 2016	Population density 2011	Population density 2016	Growth in population (%)
Northern Cape	372,889	1,145,861	1,193,780	3.07	3.20	4.18
Namakwa DM	126,836	115,842	115,488	0.91	0.91	-0.31
Richtersveld LM	9,608	11,982	12,487	1.25	1.30	4.21

Area	Size in km²	Population 2011	Population 2016	Population density 2011	Population density 2016	Growth in population (%)
Nama Khoi LM	17,990	47,041	46,512	2.61	2.59	-1.12
Kamiesberg LM	14,208	10,187	9,605	0.72	0.68	-5.71
Western Cape	129,462	5,822,734	6,279,730	44.98	48.51	7.85
West Coast DM	*31,118*	*391766*	*436,403*	*12.59*	*14.02*	*11.39*
Matzikama LM	12,981	67147	71,045	5.17	5.47	5.81
Cederberg LM	8,007	49,768	52,949	6.22	6.61	6.39
Bergrivier LM	4,407	61,897	67,474	14.05	15.31	9.01
Saldanha Bay LM	2,015	99,193	111,173	49.23	55.17	12.08
Swartland LM	3,708	113,762	133,762	30.68	36.07	17.58
City of Cape Town Metropolitan	*2,441*	*3,740,026*	*4,004,793*	*1,532.17*	*1,640.64*	*7.08*

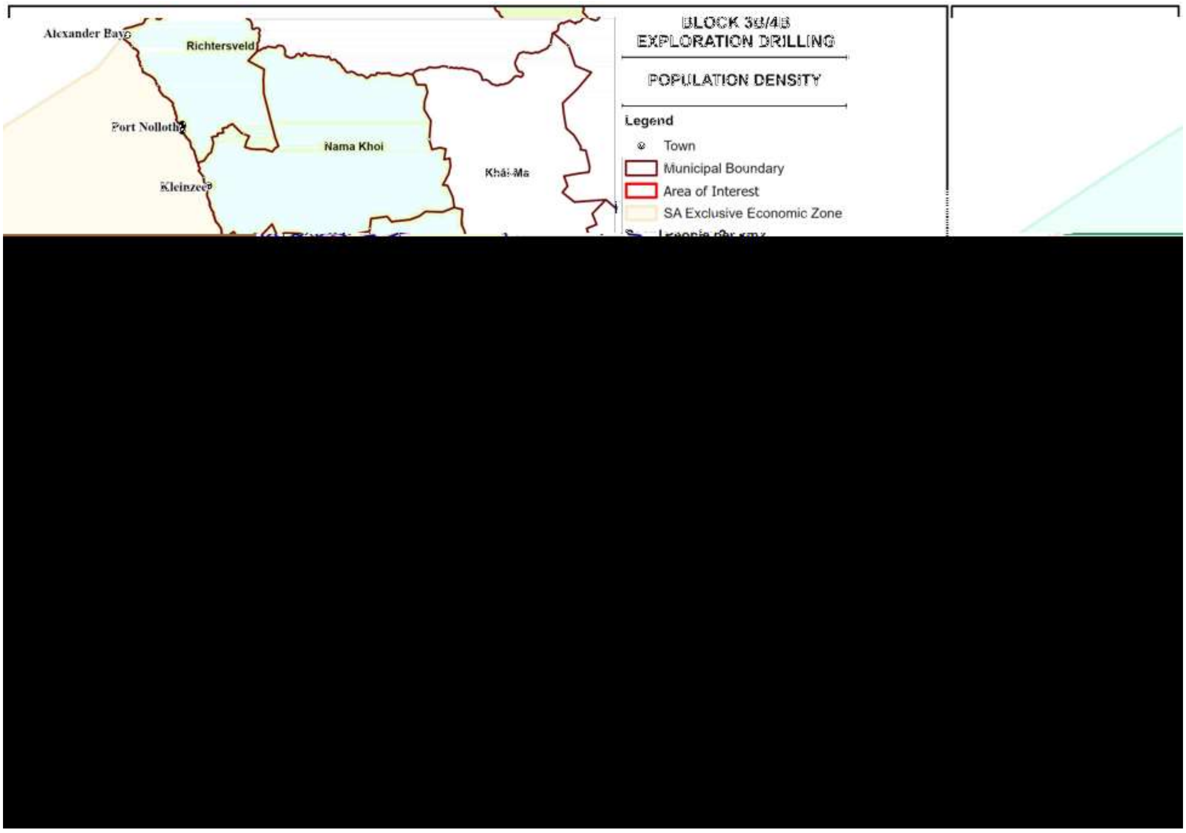


Figure 150: Population density (source: Community Survey 2016)

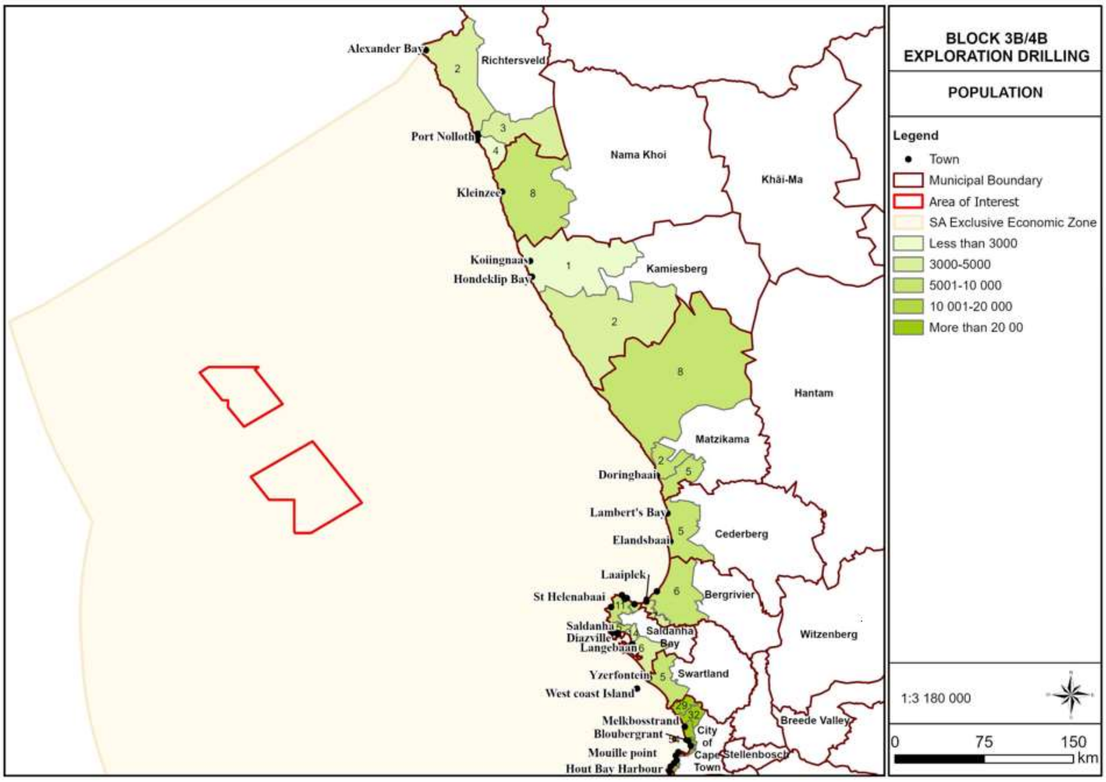


Figure 151: People per ward (source: Census 2011)

The number of households in the study area has increased on all levels (Table 35) The proportionate increase in households were greater than the increase in population on all levels. The greatest proportional increases in households were in the Swartland and Saldanha Bay Local Municipalities. The average household size has shown a decrease on all levels, which means there are more households, but with less members.

Table 35: Household sizes and growth estimates (sources: Census 2011, Community Survey 2016)

Area	Households 2011	Households 2016	Average household size 2011	Average household size 2016	Growth in households (%)
Northern Cape	301,405	353,709	3.80	3.38	17.35
Namakwa DM	*33,856*	*37,669*	*3.42*	*3.07*	*11.26*
Richtersveld LM	3,543	4,211	3.38	2.97	18.85
Nama Khoi LM	13,193	14,546	3.57	3.20	10.26
Kamiesberg LM	3,143	3,319	3.24	2.89	5.60
Western Cape	1,634,000	1,933,876	3.56	3.25	18.35
West Coast DM	*106,781*	*129,862*	*3.67*	*3.36*	*21.62*
Matzikama LM	18,835	20,821	3.57	3.41	10.54
Cederberg LM	13,513	15,279	3.68	3.47	13.07

Area	Households 2011	Households 2016	Average household size 2011	Average household size 2016	Growth in households (%)
Bergrivier LM	16,275	19,072	3.80	3.54	17.19
Saldanha Bay LM	28,835	35,550	3.44	3.13	23.29
Swartland LM	29,324	39,139	3.88	3.42	33.47
City of Cape Town Metropolitan	*1,068,573*	*1,264,849*	*3.50*	*3.17*	*18.37*

Figure 152 shows the number of households per ward. The wards in the Kamiesberg Local Municipality have the fewest people per ward.

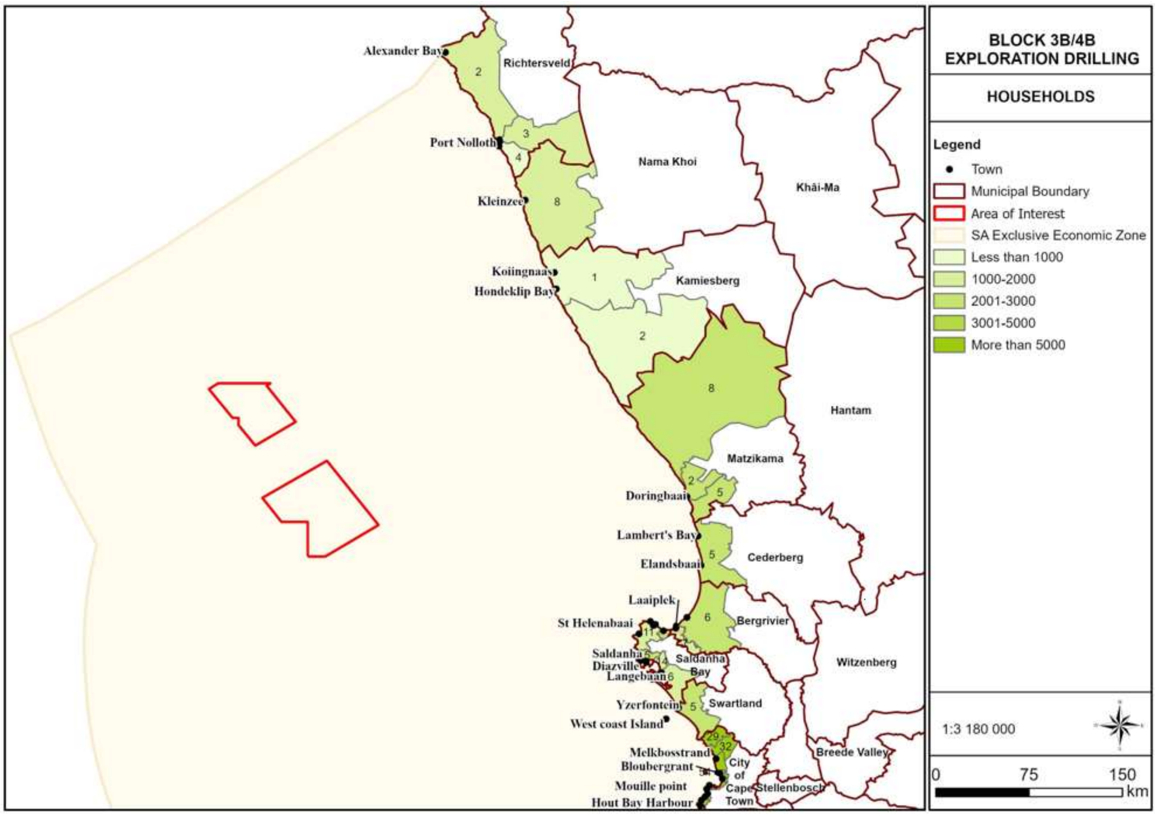


Figure 152: Households per ward (source: Census 2011)

The total dependency ratio is used to measure the pressure on the productive population and refer to the proportion of dependents per 100 working-age population. As the ratio increases, there may be an increased burden on the productive part of the population to maintain the upbringing and pensions of the economically dependent. A high dependency ratio can cause serious problems for a country as the largest proportion of a government's expenditure is on health, social grants and education that are most used by the old and young population.

The Kamiesberg Local Municipality has the highest total dependency ratio (Table 36), while in the Richtersveld Local Municipality have the lowest. Employed dependency ratio refers to the proportion of people dependent on the people who are employed, and not only those of working age. The employed dependency ratio for the Kamiesberg and Nama Khoi Local Municipalities are the highest. This suggests high levels of poverty in these areas. Figure 153 and Figure 154 show the total and employed dependency ratios on a ward level.

Table 36: Total dependency ratios (source: Census 2011).

Area	Total dependency	Youth dependency	Aged dependency	Employed dependency
Northern Cape	55.75	46.94	8.80	75.32
Namakwa DM	*51.23*	*39.01*	*12.22*	*70.92*
Richtersveld LM	*42.51*	*33.96*	*8.55*	*61.38*
Ward 2	36.82	32.89	3.93	56.70
Ward 3	39.54	32.95	6.59	64.57
Ward 4	48.60	35.93	12.67	63.98
Nama Khoi LM	*49.45*	*37.16*	*12.29*	*73.74*
Ward 8	45.05	35.42	9.63	76.99
Kamiesberg LM	*57.89*	*41.84*	*16.05*	*78.37*
Ward 1	54.81	40.19	14.62	79.04
Ward 2	48.90	33.04	15.86	69.06
Western Cape	44.96	36.44	8.52	65.47
West Coast DM	*45.92*	*37.14*	*8.78*	*63.98*
Matzikama LM	*49.39*	*40.05*	*9.34*	*64.55*
Ward 2	48.60	38.35	10.24	67.26
Ward 5	46.38	33.96	12.41	53.32
Ward 8	53.71	41.14	12.57	71.99
Cederberg LM	*46.99*	*37.59*	*9.40*	*62.75*
Ward 5	51.76	38.06	13.70	69.48
Bergrivier LM	*46.89*	*36.62*	*10.27*	*61.61*
Ward 6	46.60	37.11	9.49	65.08
Ward 7	55.44	23.94	31.50	68.70
Saldanha Bay LM	*43.96*	*36.41*	*7.54*	*65.36*
Ward 1	39.71	36.79	2.91	68.76
Ward 3	29.02	23.68	5.35	74.04

Area	Total dependency	Youth dependency	Aged dependency	Employed dependency
Ward 5	39.28	27.63	11.66	54.39
Ward 6	59.99	25.93	34.06	61.44
Ward 11	44.91	32.19	12.73	63.50
Ward 12	45.16	41.60	3.56	67.57
Ward 14	42.82	34.92	7.90	54.68
Swartland LM	*44.68*	*36.21*	*8.47*	*64.27*
Ward 5	50.76	33.31	17.44	58.03
City of Cape Town Metropolitan	*43.61*	*35.65*	*7.97*	*65.39*
Ward 4	35.95	31.80	4.16	52.38
Ward 23	38.49	26.83	11.66	47.23
Ward 29	47.25	40.95	6.30	69.98
Ward 32	44.89	41.04	3.85	68.39
Ward 54	39.01	16.17	22.84	51.04
Ward 55	41.63	26.22	15.41	56.16
Ward 74	40.68	33.04	7.63	58.62
Ward 107	40.60	28.96	11.64	46.30
Ward 113	36.71	26.07	10.64	47.93
Ward 115	26.32	14.33	12.00	60.94

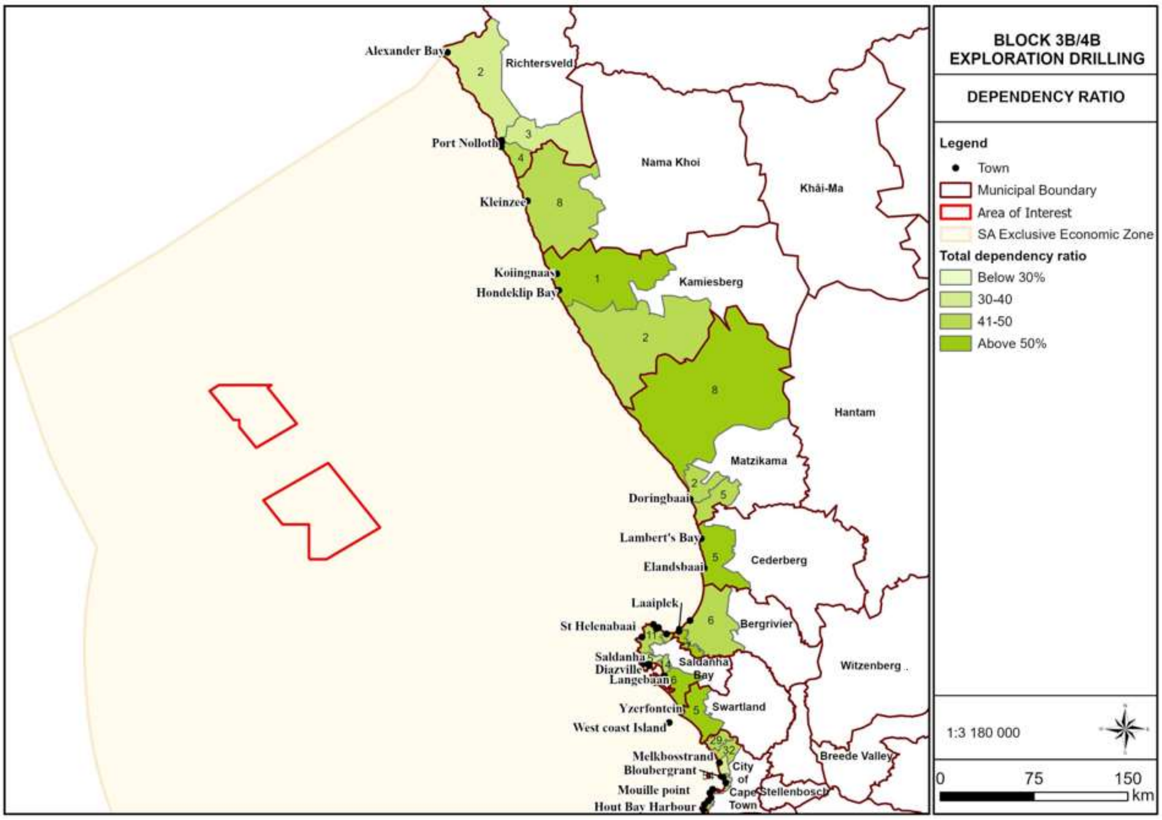


Figure 153: Total dependency ratios (source: Census 2011)

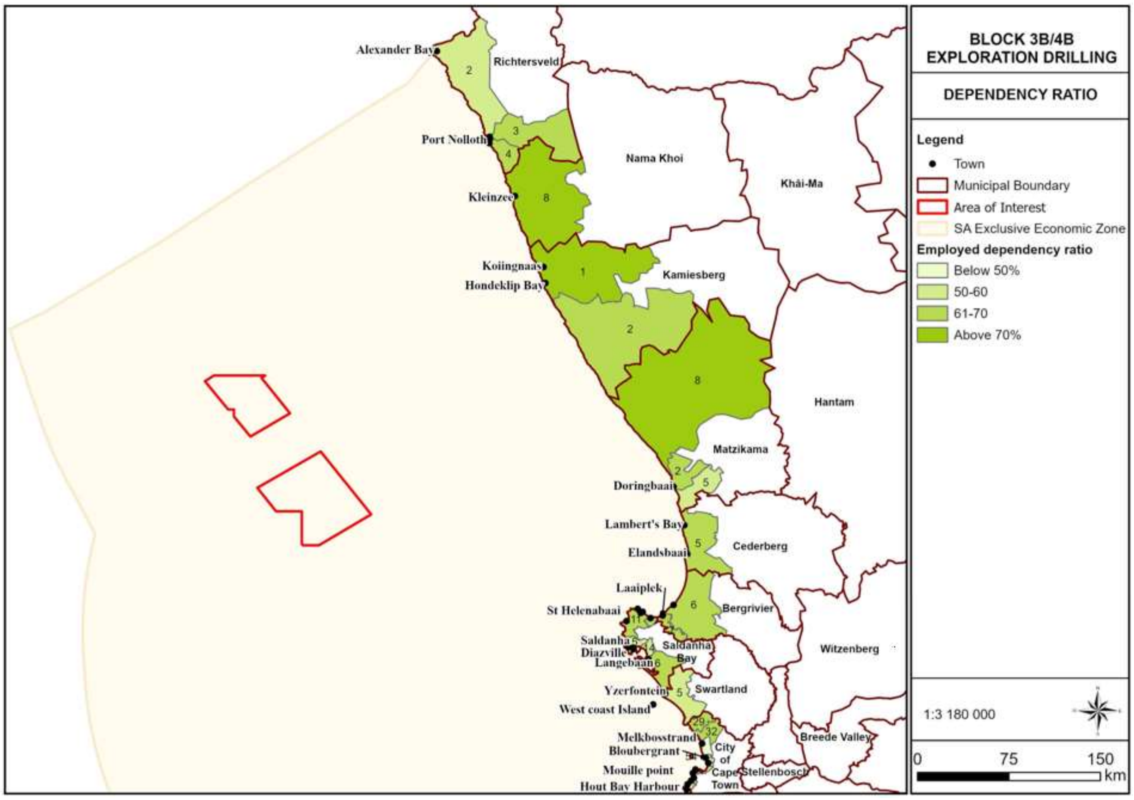


Figure 154: Employed dependency ratio (source: Census 2011).

Poverty is a complex issue that manifests itself in economic, social, and political ways and to define poverty by a unidimensional measure such as income or expenditure would be an oversimplification of the matter. Poor people themselves describe their experience of poverty as multidimensional. The South African Multidimensional Poverty Index (SAMPI) (Statistics South Africa, 2014) assess poverty on the dimensions of health, education, standard of living and economic activity using the indicators child mortality, years of schooling, school attendance, fuel for heating, lighting, and cooking, water access, sanitation, dwelling type, asset ownership and unemployment.

The poverty headcount refers to the proportion of households that can be defined as multi-dimensionally poor by using the SAMPI's poverty cut-offs (Statistics South Africa, 2014). The poverty headcount has increased on all levels since 2011 indicating an increase in the number of multi-dimensionally poor households.

The intensity of poverty experienced refers to the average proportion of indicators in which poor households are deprived (Statistics South Africa, 2014). The intensity of poverty has increased slightly on all levels. The intensity of poverty and the poverty headcount is used to calculate the SAMPI score. A higher score indicates a very poor community that is deprived on many indicators. The SAMPI score has decreased in the Northern Cape as well as the Northern Cape municipalities included in the study. In the Nama Khoi Local Municipality, the score remained the same although there was a slight increase in the intensity of the poverty. In the Western Cape the SAMPI score decreased on a provincial level, but in the West Coast District Municipality it has increased.

8.6.5 POPULATION COMPOSITION, AGE, GENDER AND HOME LANGUAGE

The majority of the people living in wards adjacent to the ocean are classified as belonging to the Coloured population group (Figure 155). The Coloured population group include Khoe and San people who in general find this classification offensive and they do not identify as such.

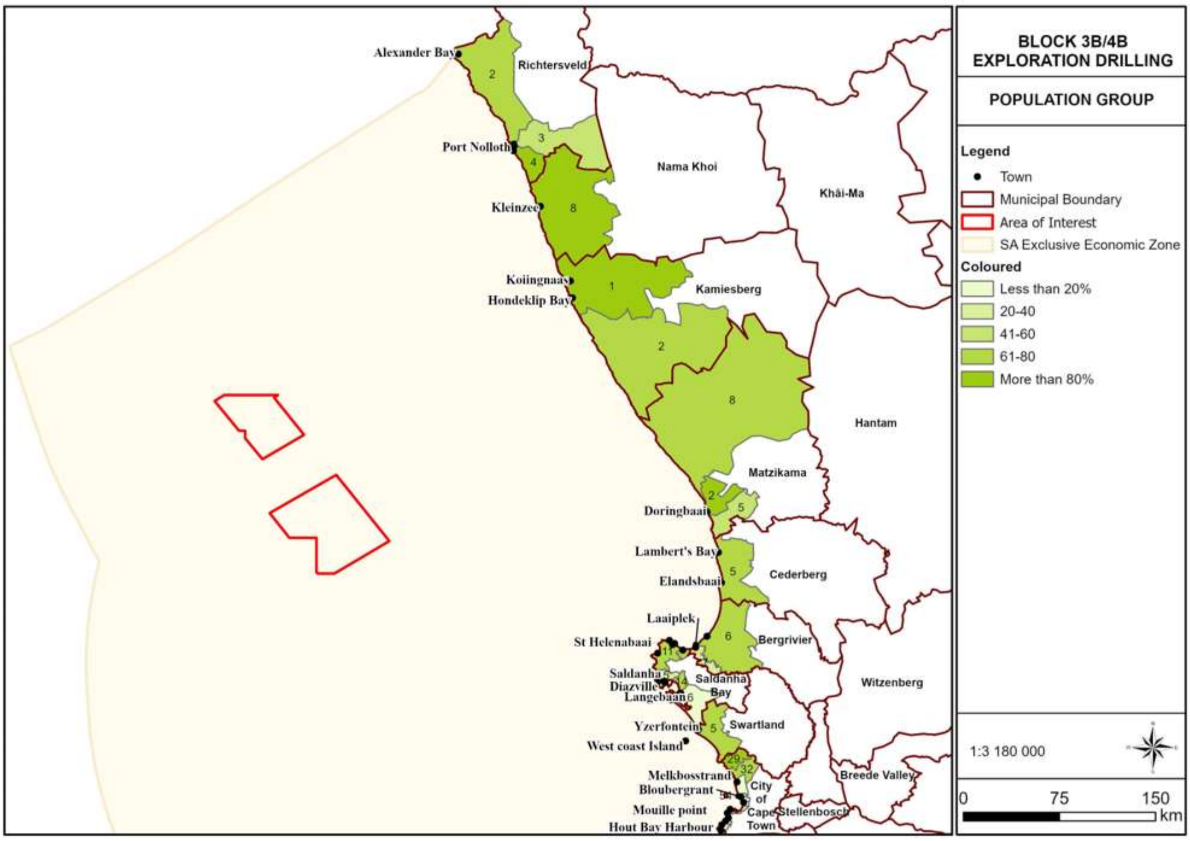


Figure 155: Classified as Coloured (shown in percentage, source: Census 2011)

The Kamiesberg Local Municipality has the highest average age (33.17 years) while the Saldanha Bay Local Municipality has the lowest (29.86 years). Average age varies on a ward level.

The gender distribution is more or less equal in most municipal areas, except for the Richtersveld Local Municipality where there is a bias towards males. This is most likely due to mining activities that are taking place in the area. On a ward level, most people have Afrikaans as home language (Figure 156).

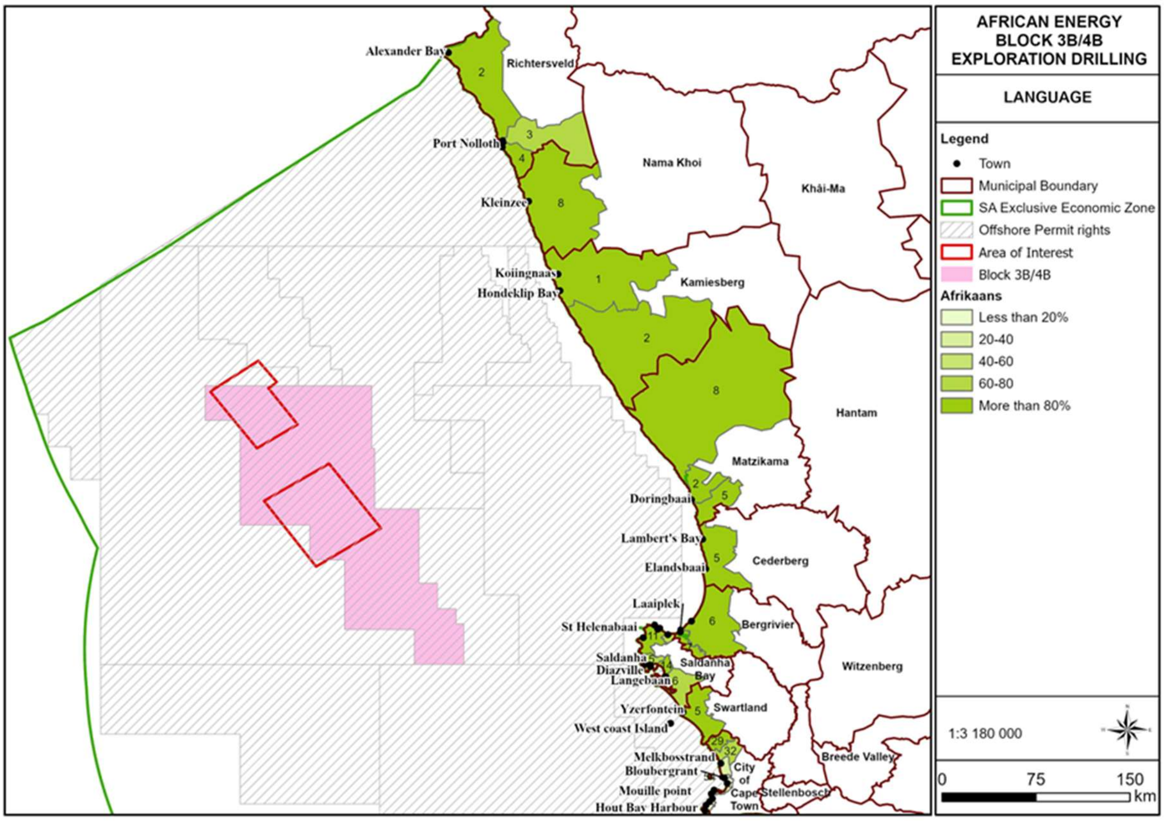


Figure 156: Home language Afrikaans (shown in percentage, source; Census 2011)

8.6.6 EDUCATION

The highest proportion of people who did not complete high school is in the Saldanha Bay (73.59%) and the Swartland (72.83%) Local Municipalities while the Matzikama (32.7%) and Nama Khoi (37.37%) Local Municipalities have the lowest proportion of people that did not complete high school (Figure 157).

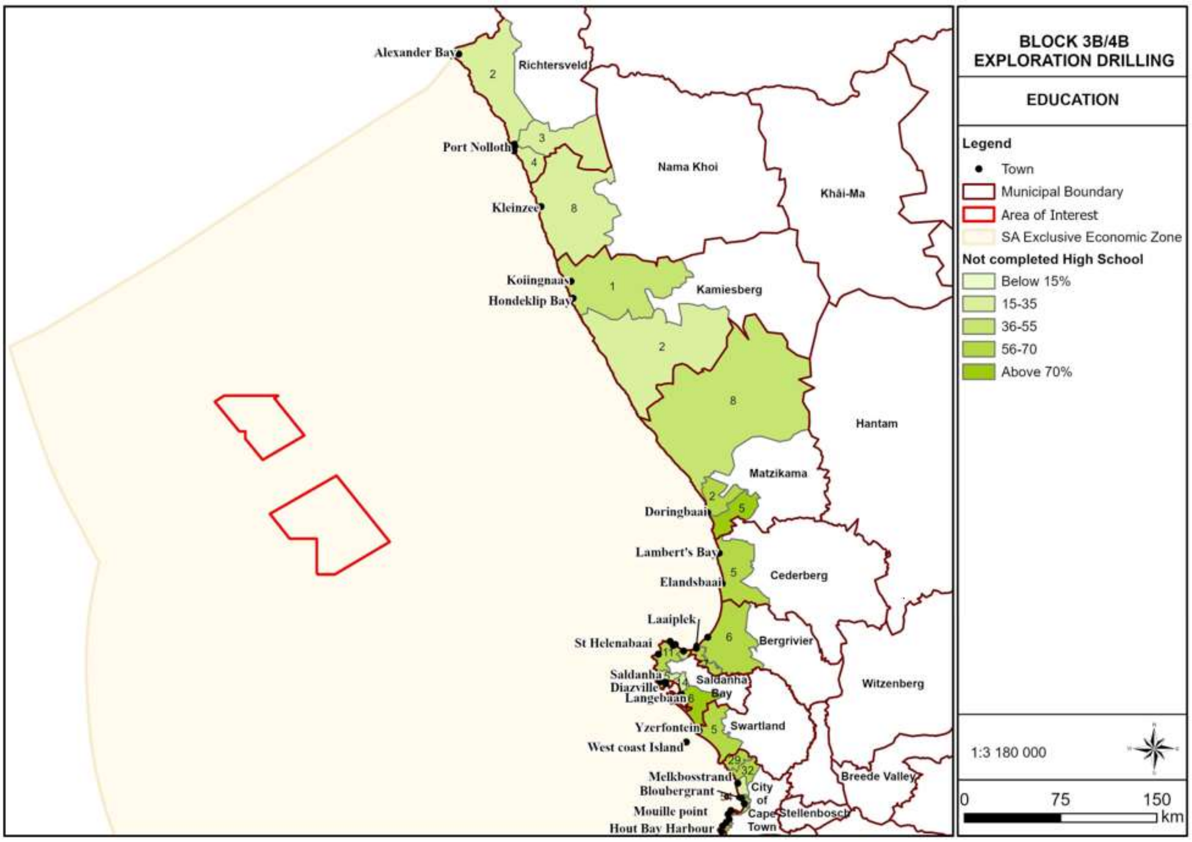


Figure 157: Proportion of people that did not complete secondary school (shown in percentage, source: Census 2011).

8.6.7 EMPLOYMENT

In 2011 the area with the highest proportion of unemployed people was ward 1 in the Kamiesberg Local Municipality where Hondeklip Bay is located (Figure 158). The proportion of unemployed people include those actively seeking for work as well as discouraged work seekers. The majority of people who are working, is employed in the formal sector.

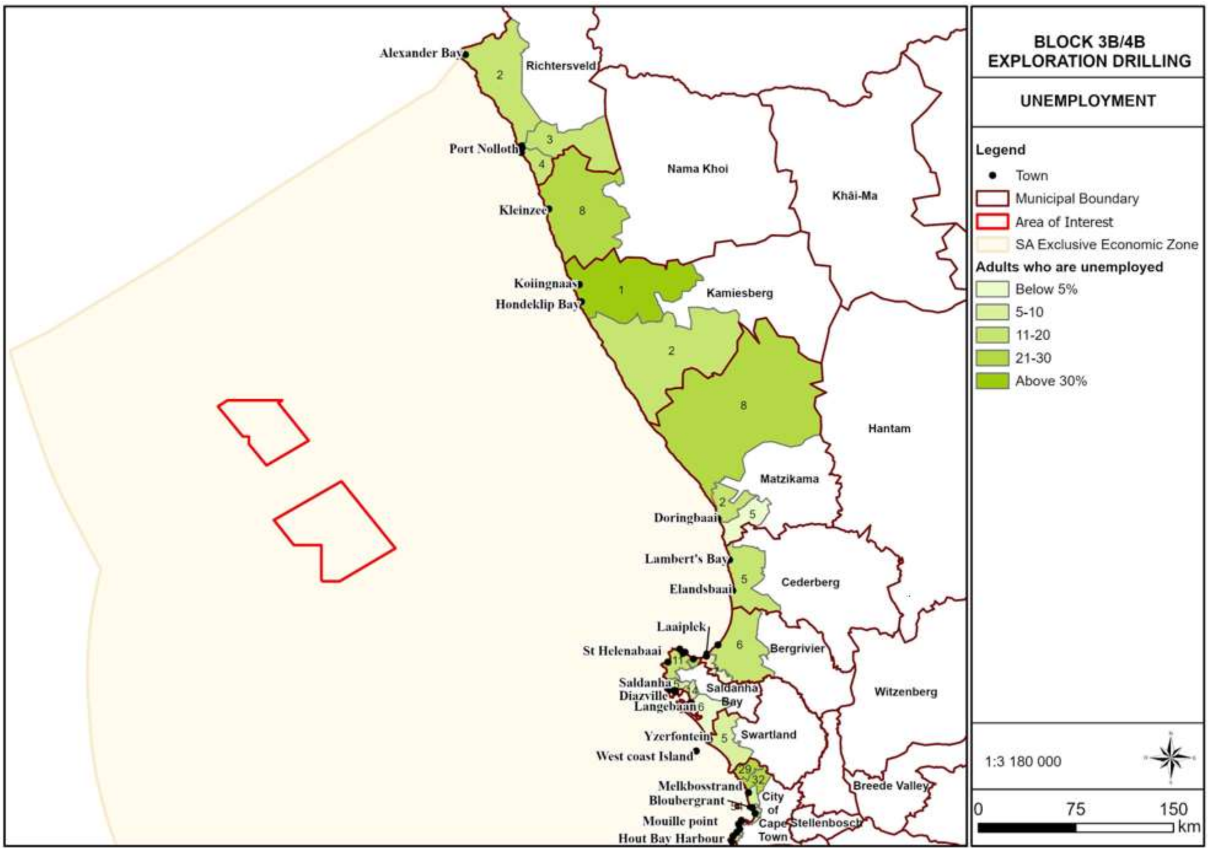


Figure 158: Proportion of adults that are unemployed (shown in percentage, source: Census 2011).

8.6.8 HOUSEHOLD INCOME

In 2011 almost a third of households on municipal level had an annual household income of R19 600 or less, with great variation between wards (Figure 159). Statistics South Africa (2015) has calculated the Food Poverty Line (FPL) for the Northern Cape Province as R310 per capita per month for 2011 where the FPL is the Rand value below which individuals are unable to purchase or consume enough food to supply them with the minimum per-capita-per-day energy requirement for good health. The FPL is one of three poverty lines, the others being the upper bound poverty line (UBPL) and the lower bound poverty line (LBPL). The LBPL and UBPL both include a non-food component. Individuals at the LBPL do not have enough resources to consumer or purchase both adequate food and non-food items and are forced to sacrifice food to obtain essential non-food items, while individuals at the UBPL can purchase both adequate food and non-food items. The LBPL for the Northern Cape Province was R457 per capita per month in 2011 and the UBPL R705 per capita per month respectively. The FPL for Western Cape was R352 per capita per month, the LBPL was R545 and the UBPL was R804. Based on this, a household with four members needed an annual household income of approximately R17 000 in 2011 to be just above the FPL. When comparing this with the SAMPI data it seems as if there are more households below the poverty lines in the area than who are multi-dimensionally poor. This is due to the poverty lines using a financial measure and do not take into consideration payment in kind and livelihood strategies such as subsistence farming. If these were to be converted into a Rand value, the poverty line picture may have a closer resemblance to the SAMPI data.

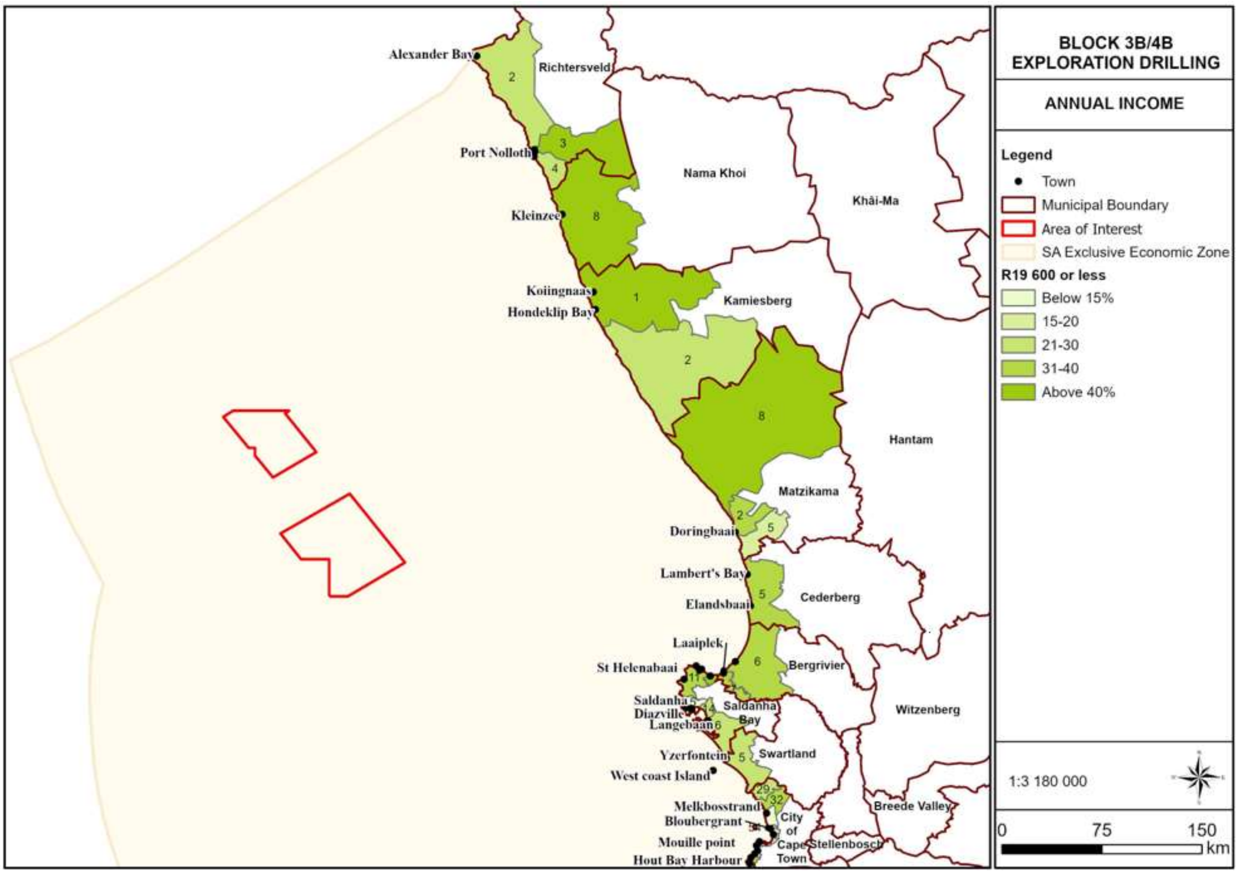


Figure 159: Proportion of households with an annual income of R19 600 or less in 2011 (shown in percentage, source: Census 2011).

8.6.9 HOUSING

The majority of households live in areas that are classified as urban, except in the Matzikama Local Municipality (Figure 160). The majority of people live in formal dwellings that that are houses or structures that are on a separate stand or yard. The incidence of informal dwellings is relatively low (Figure 161), except for Ward 1 of the Saldanha Bay Local Municipality where the majority of people live in informal dwellings. Wards 32 and 74 also have a relatively large proportion of households living in informal dwellings.

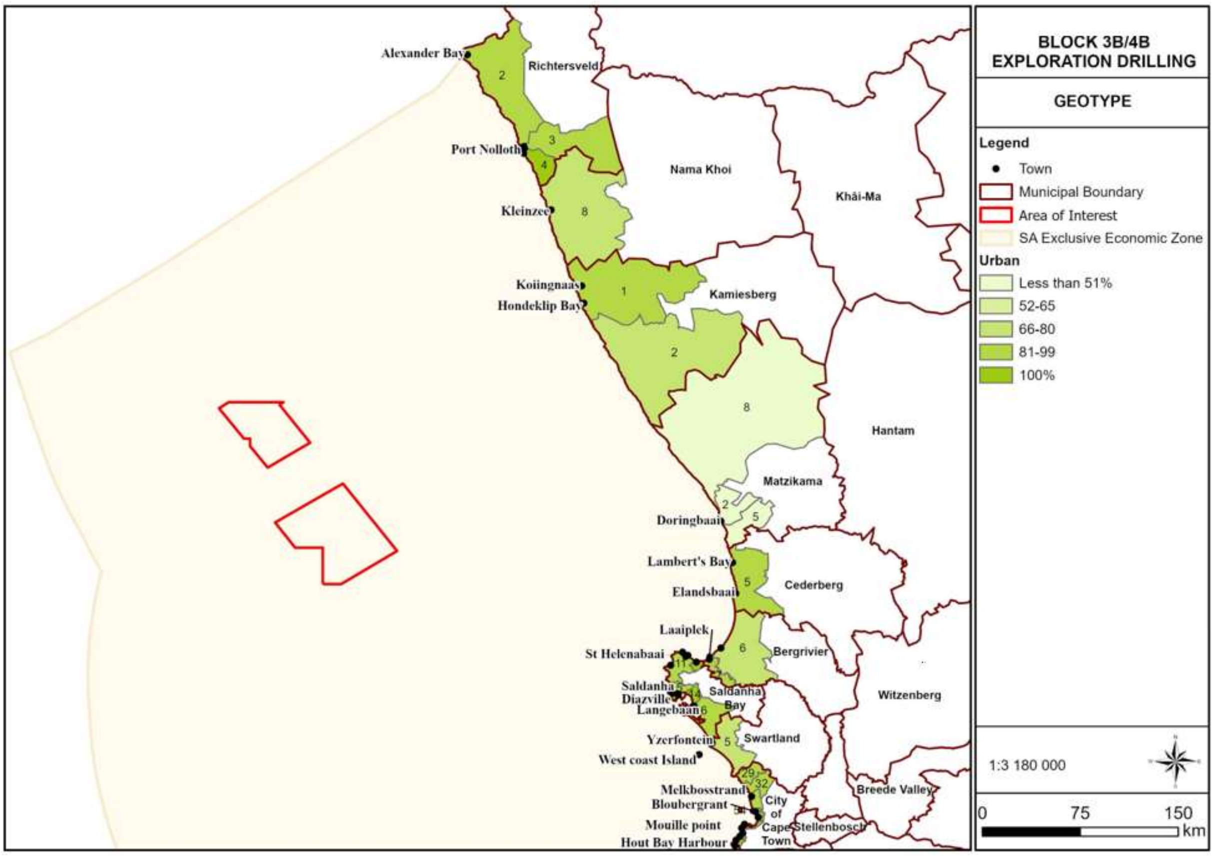


Figure 160: Proportion of households that live in urban areas (shown in percentage, source: Census 2011).

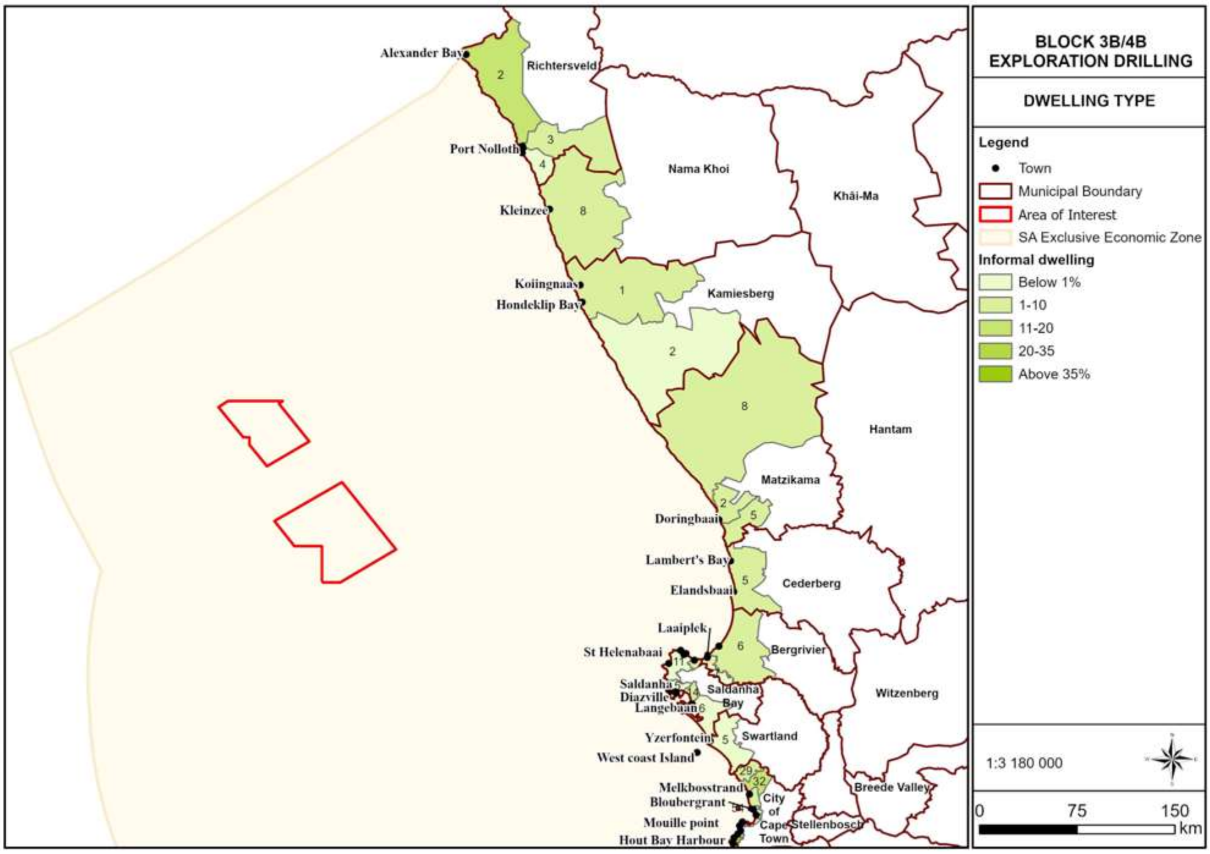


Figure 161: Proportion of households that live in informal dwellings (shown in percentage, source: Census 2011).

8.6.10 HOUSEHOLD SIZE

The average household size in the wards vary between 1.96 people per household and 4.86 people per household (Figure 162).

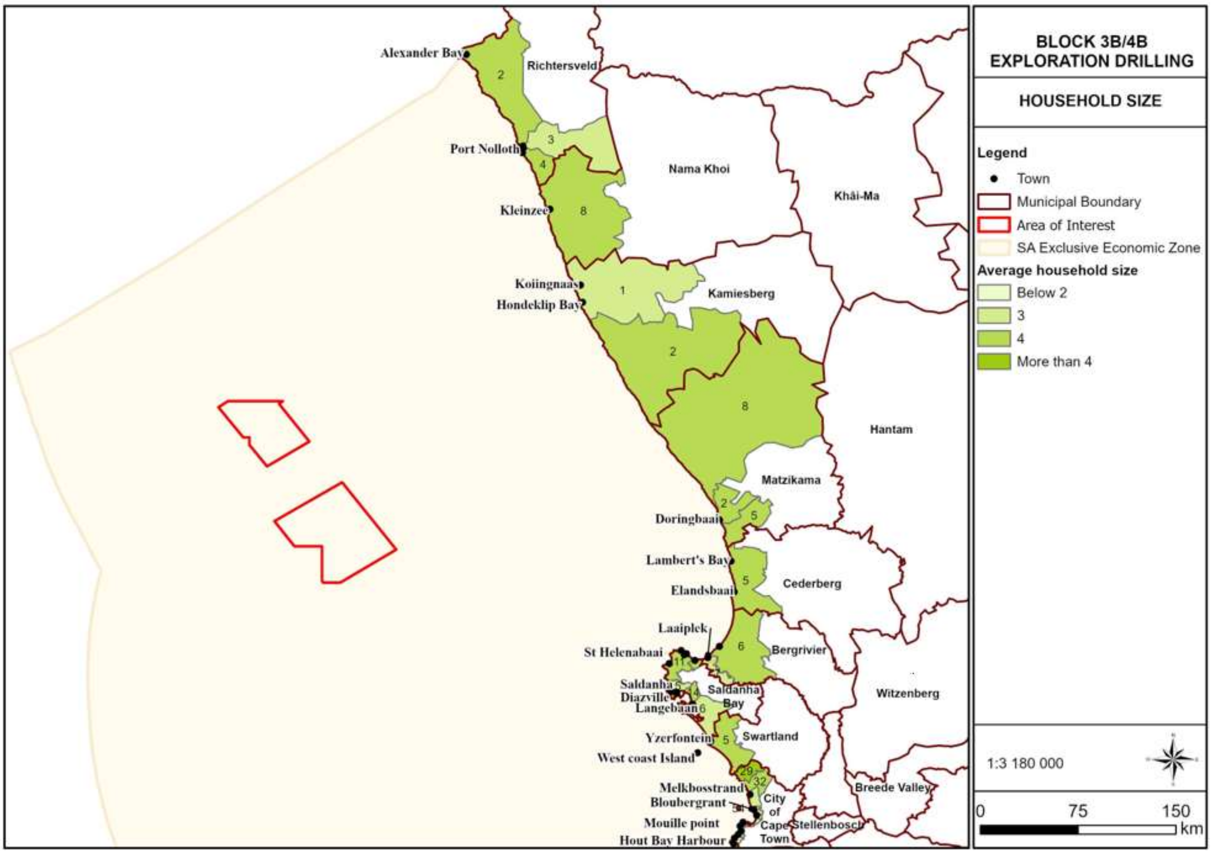


Figure 162: Average household sizes (source: Census 2011).

8.6.11 ACCESS TO WATER AND SANITATION

Access to piped water, electricity and sanitation relate to the domain of Living Environment Deprivation as identified by Noble *et al* (2006). Most households get their water from a regional or local water scheme, with the lowest incidence in Ward 1 of the Kamieskroon Local Municipality where Hondeklip Bay is located (Figure 163).

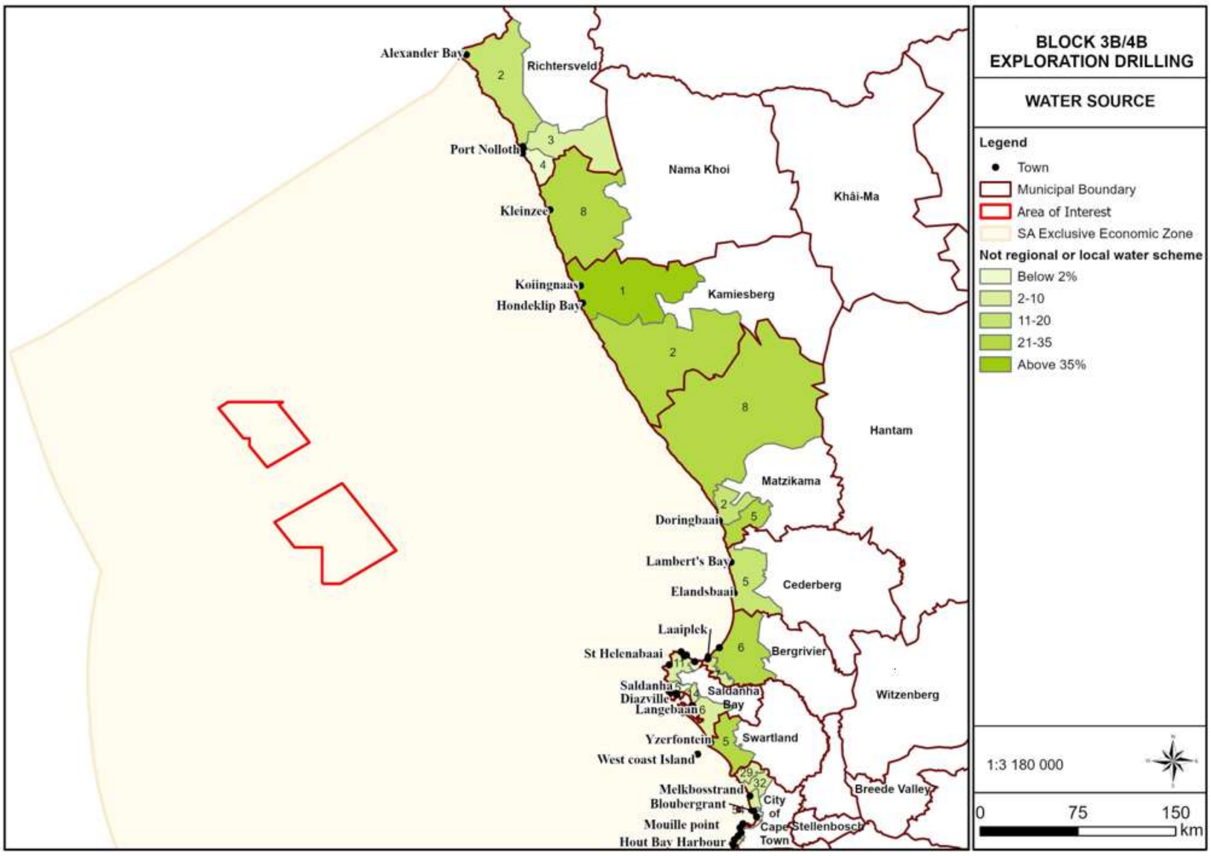


Figure 163: Proportion of households that does not get water from a regional or local water scheme (shown in percentage, source: Census 2011).

The incidence of access to piped water inside the dwelling varies and tend to be lower in the Northern Cape municipalities (Figure 164).

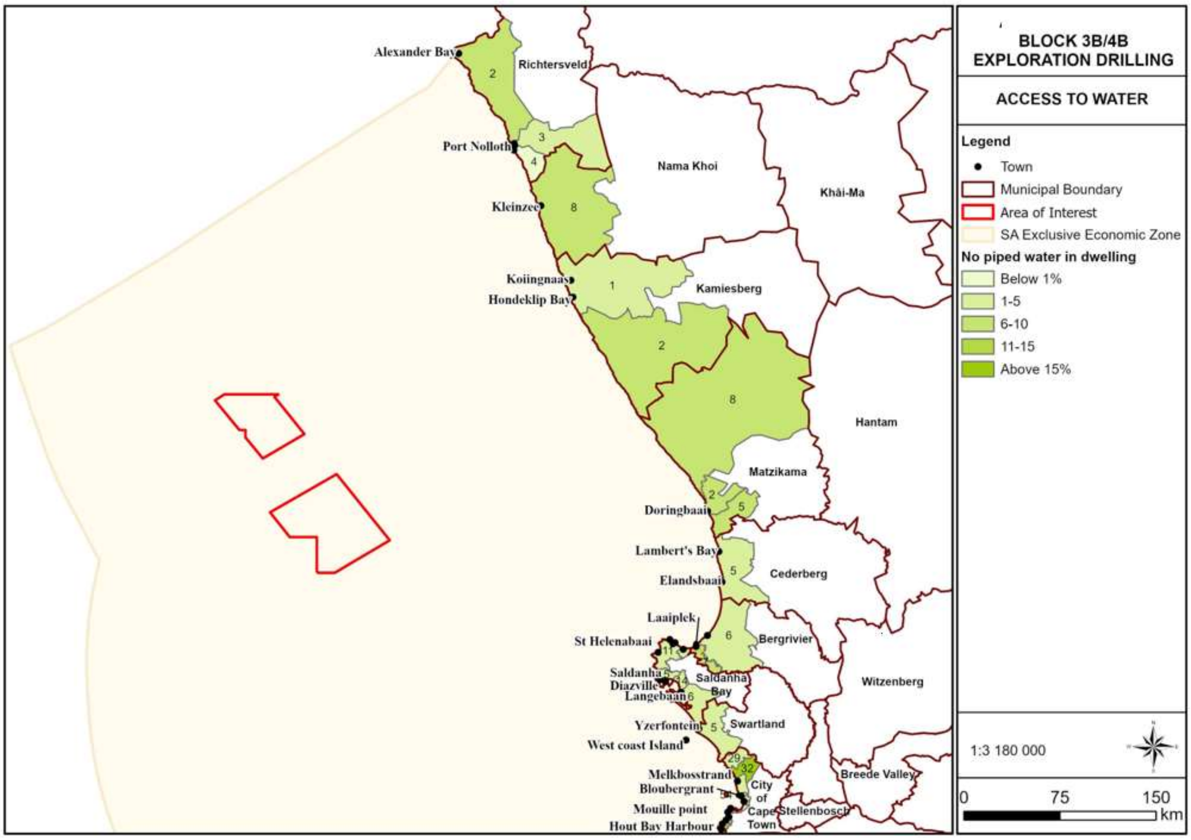


Figure 164: Proportion of households that does not have piped water in the dwelling (shown in percentage, source: Census 2011).

Access to a flush toilet is in general lower in the Northern Cape Municipalities (Figure 165).

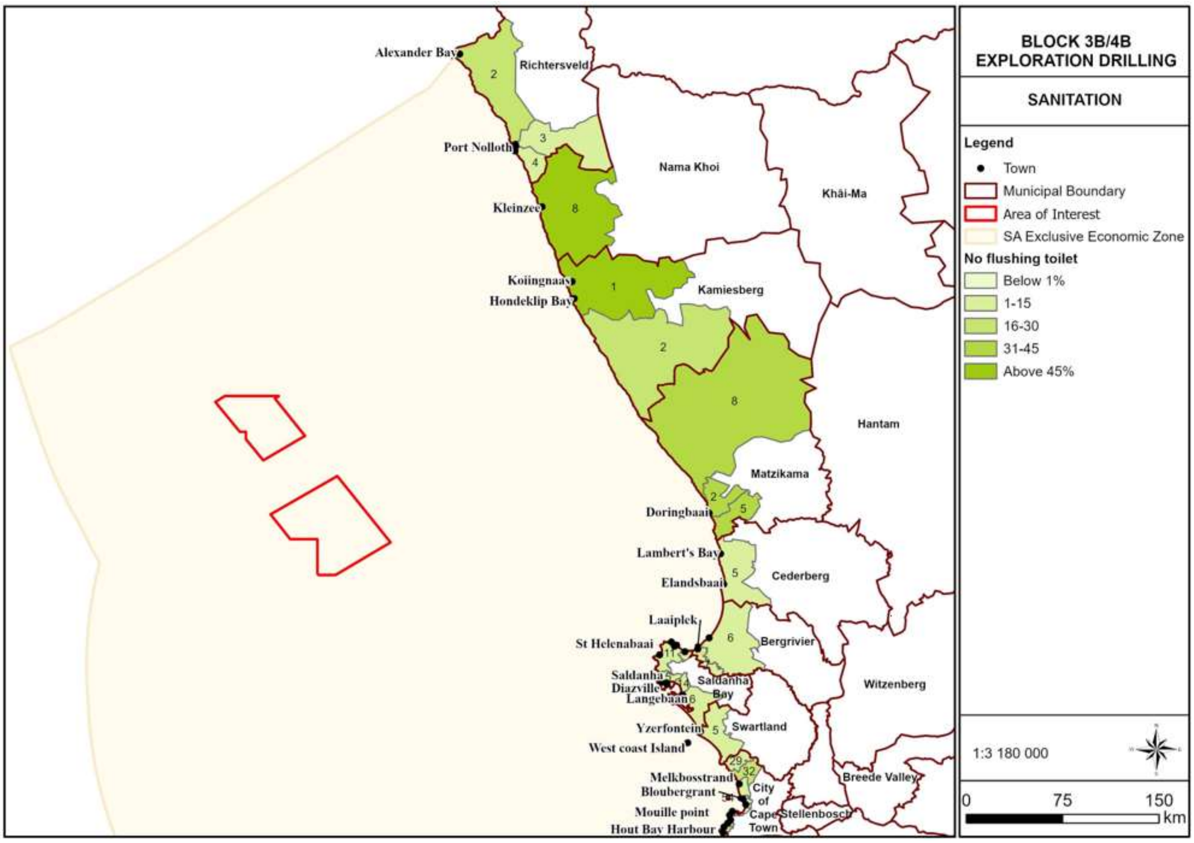


Figure 165: Proportion of households that does not have a flush toilet (shown in percentage, source: Census 2011).

8.6.12 ENERGY

Electricity is seen as the preferred lighting source (Noble *et al*, 2006) and the lack thereof should thus be considered a deprivation. Even though electricity as an energy source may be available, the choice of energy for cooking may be dependent on other factors such as cost. The majority of households have access to electricity for lighting purposes (Figure 166) but a lower proportion use electricity for heating (Figure 167) and cooking (Figure 168) purposes.

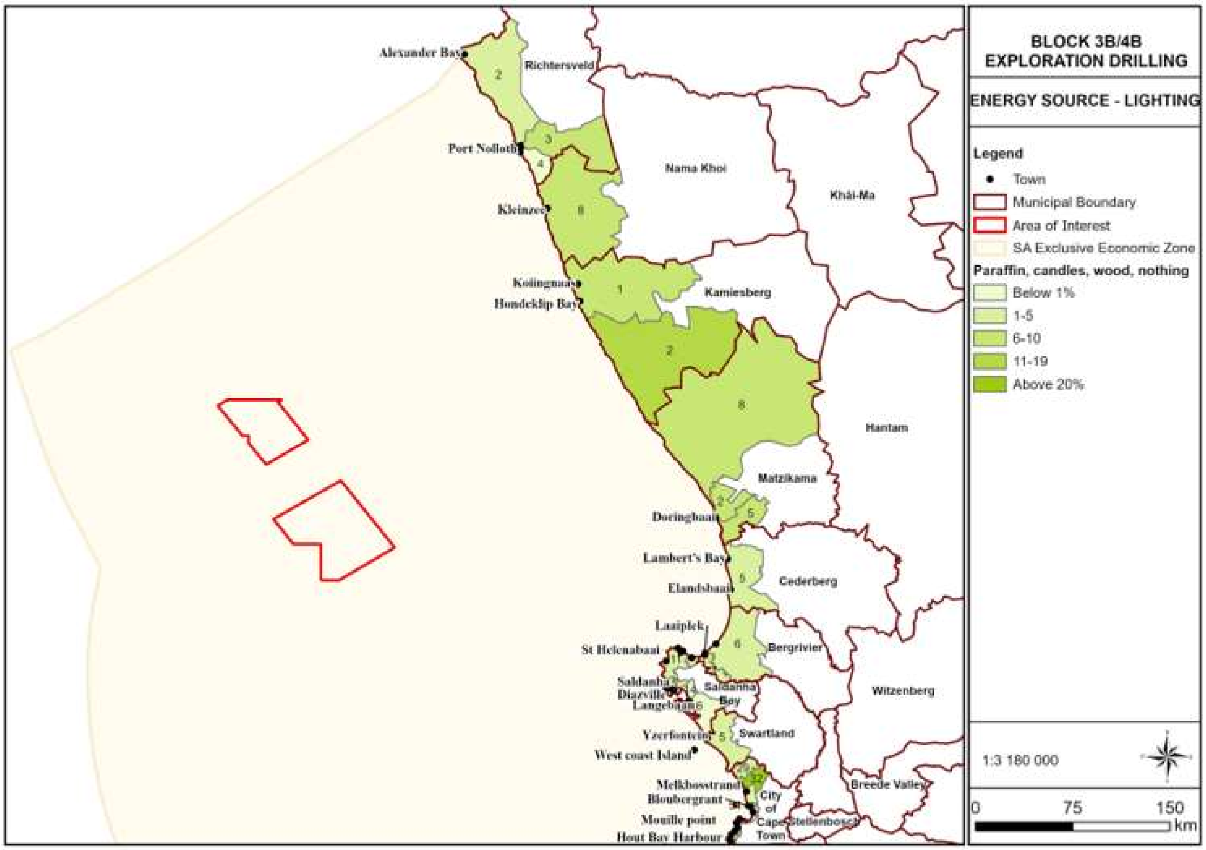


Figure 166: Proportion of households that use paraffin, candles, wood or nothing for lighting purposes (shown in percentage, source: Census 2011).

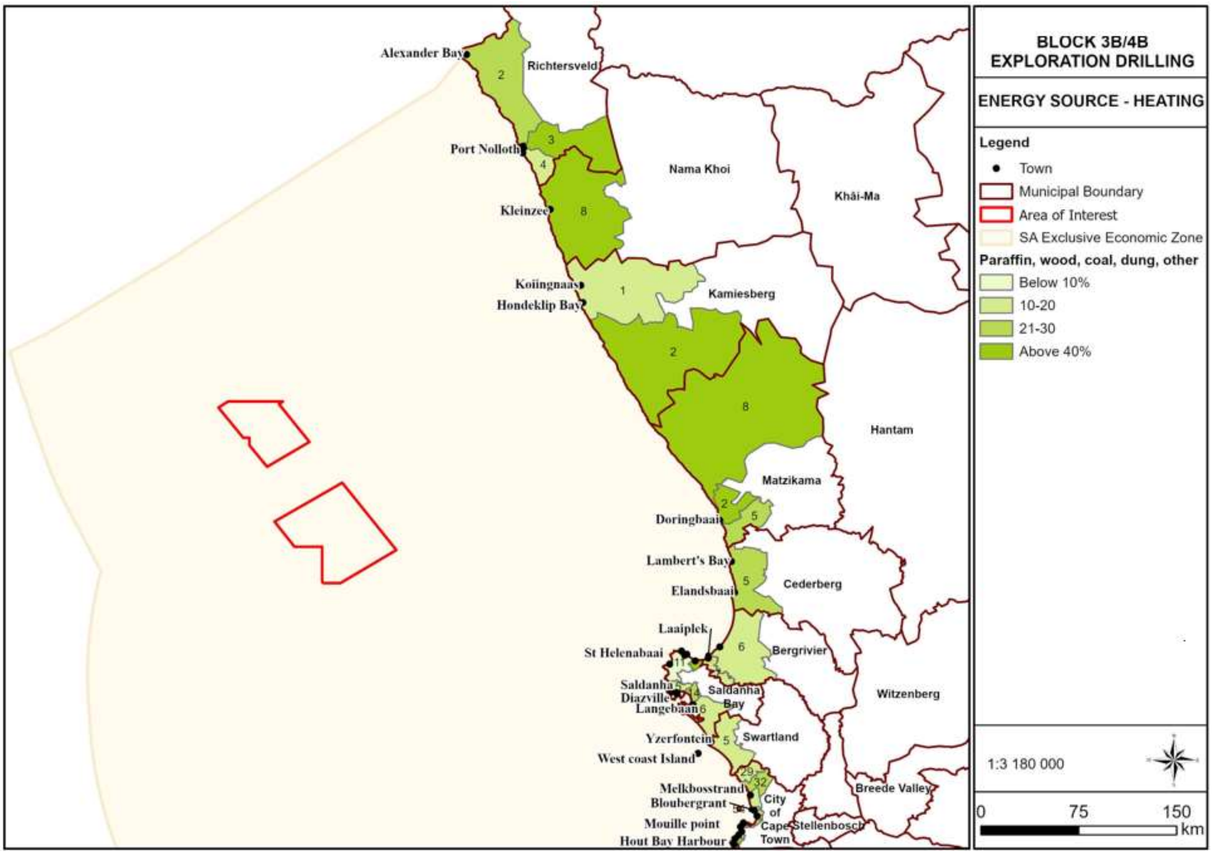


Figure 167: Proportion of households that use paraffin, wood, coal, dung or something else for heating purposes (shown in percentage, source: Census 2011).

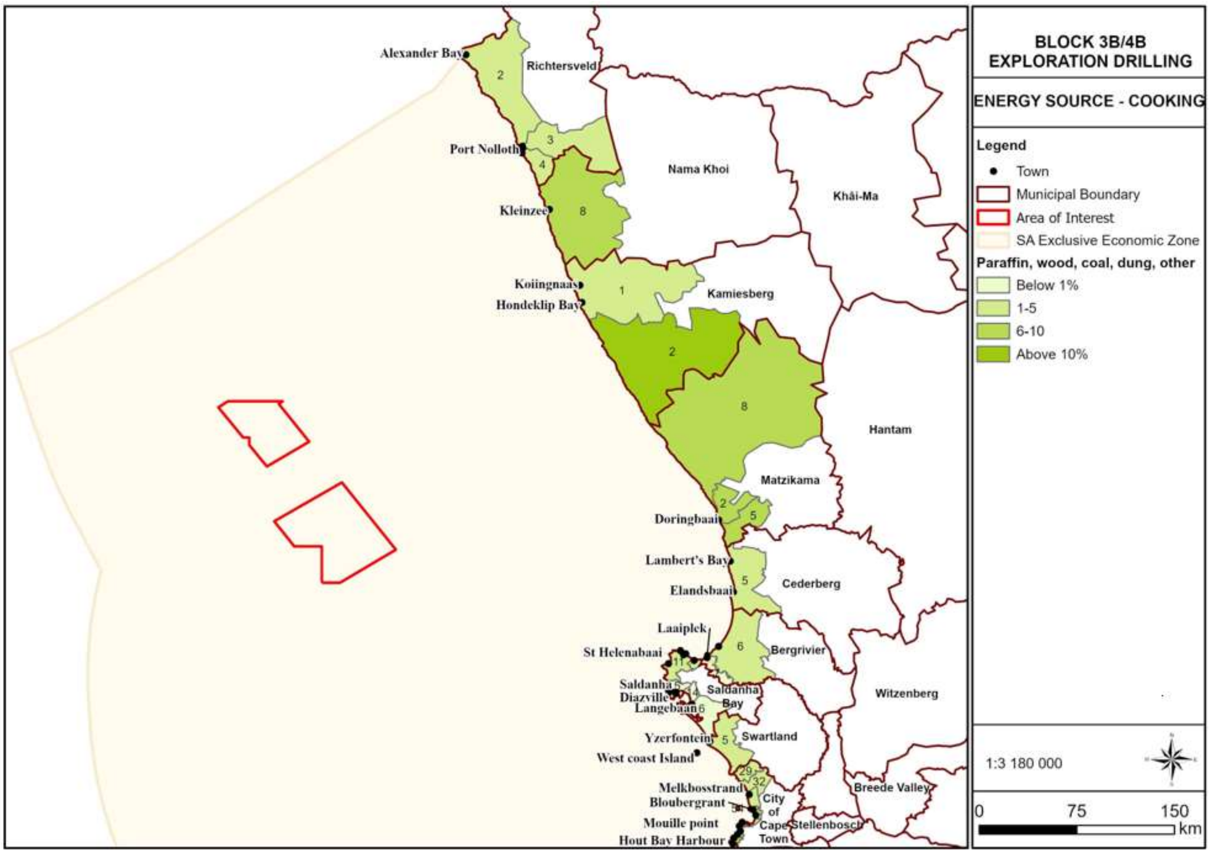


Figure 168: Proportion of households that use paraffin, wood, coal, dung or something else for cooking purposes (shown in percentage, source: Census 2011).

8.7 ECONOMIC

This section provides a description of the economic environment of the application area. The information has been sourced from the Economic Assessment undertaken by Demacon (Appendix 4).

8.7.1 CONTEXTUALISING THE PROJECT WITHIN THE EXISTING GAS EXPLORATION INDUSTRY OF SOUTH AFRICA

In order to understand the economic context of exploration, and more specifically exploration for natural gas, it is necessary to understand how the exploration industry is classified as an economic activity. By understanding the classification of the industry within the broader economy's structural framework, it is possible to continuously assess and review the role that the industry plays as part of the receiving economy's economic output, growth and development.

The Standard Industrial Classification (SIC) is the primary framework within which all economic industries and related activities is classified. In essence, the SIC is a coherent and consistent classification structure of economic activities based on a set of agreed concepts, definitions, principles and classification rules. Each country, including South Africa, develops a version of the SIC based on the classification of industrial activity in the International Standard Industrial Classification of All Economic Activities (fourth edition) published by the United Nations Economic and Social Council.

For the purposes of this assessment, the SIC of All Economic Activities (Fifth Edition) make use of the Fifth Edition to classify economic information. Hence, reference is made to the SIC Fifth Edition until such time that updated economic information becomes available based on alternative SIC iterations.

According to the SIC, exploration activities, which includes exploration for natural gas, is classified as part of the Architectural and Engineering Activities and Related Technical Consultancy Industry. The industry is the function of other business activities within the economy and primarily contributes to the Financial Intermediation, Insurance, Real Estate and Business Services economic sector.

Reference to the prospecting and exploration industry will make use of the afore mentioned classification. The classification does, however, reference all types of exploration and prospecting and therefore serves as a baseline within which an assessment of the economy and the industry as a whole can be done.

8.7.1.1 GAS VALUE CHAIN, PRODUCTION AND CONSUMPTION

The natural gas industry in South Africa represents a small portion of the overall energy mix and petroleum utilisation of the country. The South African Energy Sector Report (2021) identifies that natural gas represented approximately 3% of the energy supply of the country in 2018 (approximately 65% of the energy supply is sourced from coal and 18% from crude oil) and has maintained a steady presence between 2% and 3% since 2007.

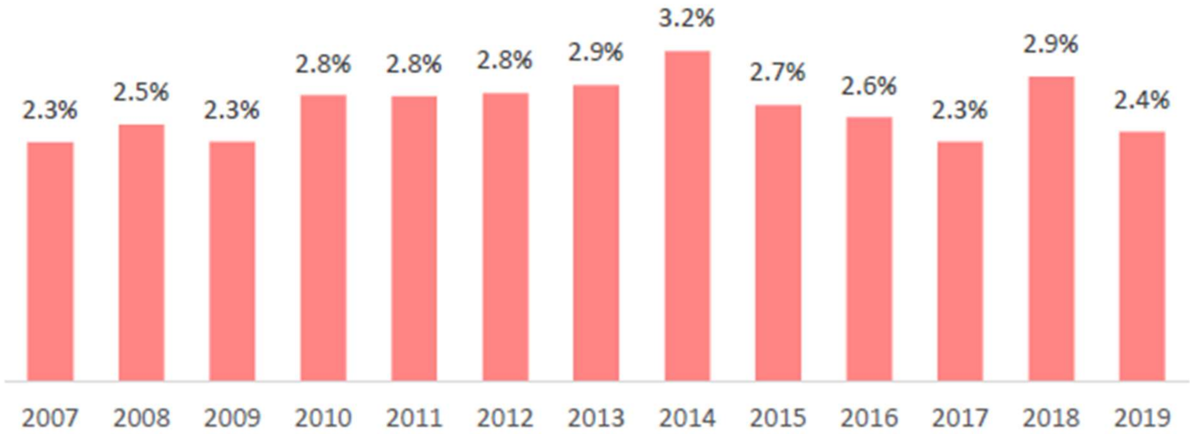


Figure 169: Percentage Contribution of Gas to the South African Energy System

Historic data does however, suggest that the supply of gas may over time reach levels of saturation and under-supply. Data from the Department of Energy shows that since 2013 the demand for gas has steadily been increasing whilst supply has remained consistent. The data suggests that current supply levels are becoming insufficient to accommodate demand for gas.

Given the potential supply deficit, it is important to consider the sourcing of gas supply for production in the domestic market. The bulk of gas used within the domestic energy system (approximately 85%) is imported from Mozambique via the Pande and Temane Gas Pipeline which services the Sasol Gas-to-Liquid refinery in Secunda. Approximately 50% of imported supply is used for petroleum production whilst remaining imported gas supply is distributed to commercial and industrial customers in KwaZulu-Natal, Mpumalanga, Gauteng and the Free State via a network of inland gas networks.

Domestic production (approximately 15.0% of all gas supply in the country) is sourced primarily from the FA Offshore Platform (E-M / F-A Gas Fields) which supplies natural gas from a domestic offshore production area south of the country to the Gas-to-Liquid refinery in Mossel Bay.

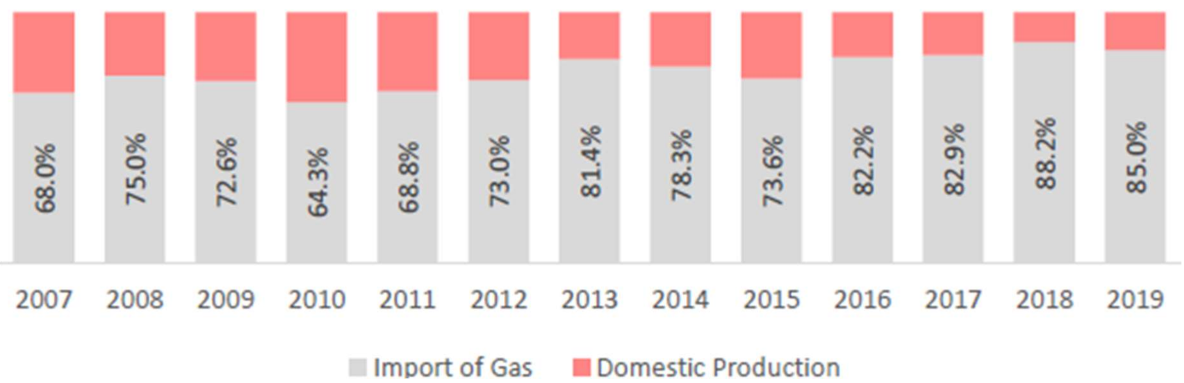


Figure 170: Import versus Domestic Gas Production

Although domestic production represents a small portion of the domestic gas market, the South African value chain does contain the full spectrum of down-, mid- and up-stream industries.

The up-stream gas value chain represents the exploration and production activities of gas fields on- and off-shore. Within the South African context up-stream industries include PetroSA's FA Platform (offshore), Sasol's Pande and Temane Gas field in Mozambique and Tetra4's compressed natural gas production (onshore).

The mid-stream gas value chain represents the transportation, processing and storage of gas. Within South Africa the mid-stream portion of the value chain consists of large-scale gas transmission pipelines (ROMPCO, Lily Pipeline and Sasol Gas), PetroSA's subsea gas transmission pipeline from the FA Platform to the GTL refinery in Mossel Bay and above-ground natural gas holder facilities such as Egoli Gas, Cottesloe and Langlaagte.

The down-stream gas value chain represents the distribution of gas products to end-users. The distribution of natural gas is done via several pipelines to industrial and other commercial users in KwaZulu-Natal, Mpumalanga, Free State and Gauteng, the GTL refinery in Mossel Bay and the GTL plant in Secunda.

Figure 171: Gas Import and Domestic Production Infrastructure

The down-stream gas value chain consists of end users that apply gas resources and products in order to support industrial activity, transportation services and other localised commercial activities. The bulk of gas consumption (99%) occurs within the industrial sector with end users such as the iron and steel industry and chemical and petrochemical industries utilising the majority of final customer consumption. According to the Department of Energy, in 2019 no end-users in the transport sector made use of gas as petroleum resource. The data does however, indicate that approximately 1.0% of gas consumption in South Africa is as a result of commerce and public services and residential uses.

8.7.1.2 GAS EXPLORATION

The offshore petroleum exploration industry in South Africa has been accelerating over the last 5- to 10-years because of continuous new hydrocarbon discoveries. As of March 2023, approximately 50% of the South African Maritime Exclusive Economic Zone (EEZ) has been allocated to either an exploration right, production right or has some form of exploration or production right pending.

Exploration activity occurs along the eastern, southern and western coasts of South Africa with the majority of exploration and production clusters situated along the southern and western coasts. These exploration activities occur in four offshore basins known as the Orange, Bredasdorp, Outeniqua and Durban & Zululand Basins (Figure 173). Approximately 300 exploration, appraisal and production wells exist within the EEZ. More than half of exploration wells were drilled between 1981 and 1990 whereafter the bulk of seismic surveys and drilling activities occurred within the Bredasdorp Basin.

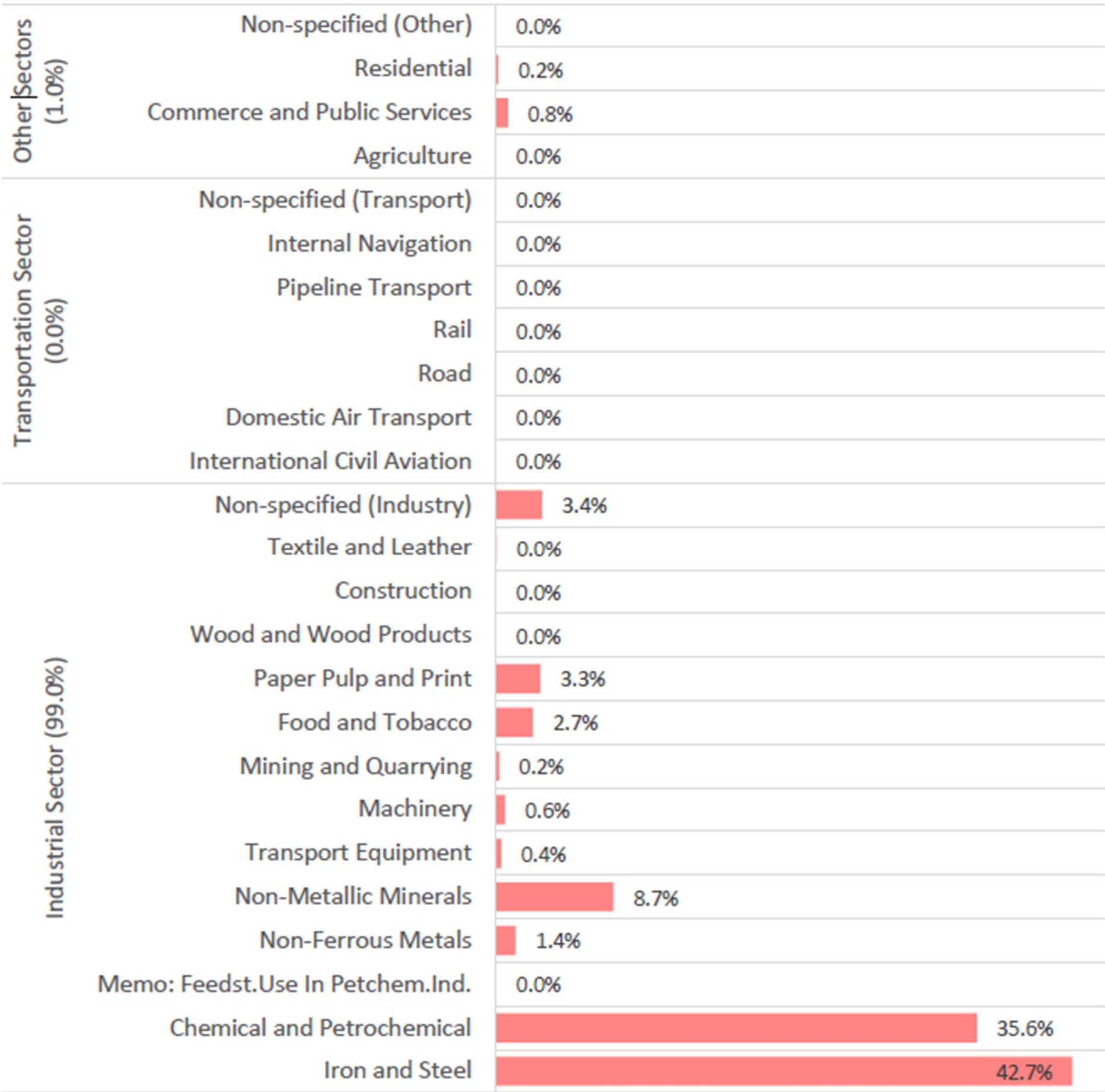


Figure 172: Final Consumption Customers of Gas Supply in South Africa

A number of small oil and gas fields were discovered during this exploration, and oil and gas are now being produced commercially in the Bredasdorp Basin. The Pletmos Basin contains two undeveloped gas fields and six gas discoveries. Orange Basin in South Africa has yielded one oil discovery and several gas discoveries – Production of gas from the Ibhubesi Gas Field could come online in the foreseeable future as well.

Major exploration role-players in the South African offshore market consist of PetroSA, Sunbird, Shell, Total Energies, Impact Africa, Africa Oil, Sungu-Sungu, Silver Wave Energy and Sasol. The gas industry, as noted above, has a variety of forward and backward linkages that deal with the exploration and extraction of gas, transport, processing and storage of gas and the sale of gas. Gas exploration forms part of the gas industries backward linkages which, in itself, has a variety of forward and backward linkages.

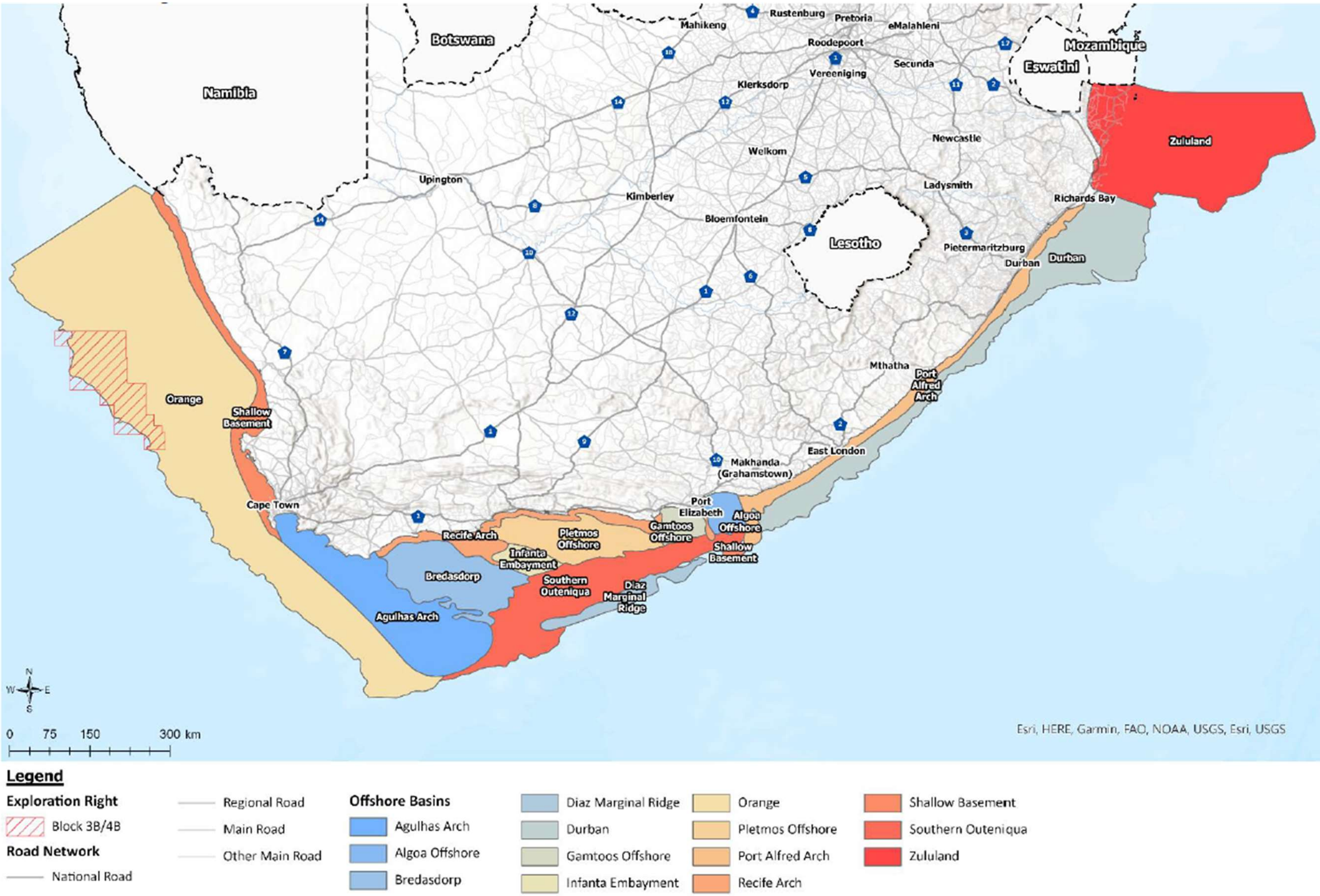


Figure 173: Offshore Basins along the South African Coast (Demacon, 2023)

Gas exploration, as part of the Professional Business Services sector of the economy has forward and backward linkages that support the industry's operation. The Professional Business Services sector draws inputs from the primary, secondary and tertiary economy with the bulk of inputs originating from other professional business services activities, the government sector and transport and storage. The sectors forward linkages concentrate on intermediate products and services where the sector provides inputs to other professional business services industries, wholesale and retail trade, transport and storage and agriculture.

8.7.2 IDENTIFYING AND DEFINING THE RECEIVING ECONOMIC ENVIRONMENT OF THE PROJECT

In terms of the economic environment, the receiving environment is separated into an offshore and onshore area of influence. This distinction is made because, although exploration activities occur offshore, they influence an extended area around exploration locations (offshore area of influence). The economic output produced by exploration activities however, is measured onshore as part of a defined economic geography (onshore area of influence).

The offshore area of influence represents the receiving environment where exploration activities will take place. This includes the AOI where exploration wells will be drilled, as well as offshore areas for refuelling, maintenance, a safety exclusion zone, and marine traffic routes between base harbours and drilling operations. The offshore area of influence also caters for the potential impacts that may result from exploration drilling, such as direct and indirect impacts on ecosystems (e.g., fishing areas, marine mammals, etc.).

The onshore area of influence represents the receiving environment where the output of economic activities/industries are measured and primarily situated. Although exploration activities occur offshore, their economic output is registered within an onshore economic geography, typically based on the port used as the base port of operations or where a business is registered.

In addition to the base port of operations, economic geographies along the extent of the exploration right and AOI are also included as part of the onshore area of influence. These economic geographies are included because exploration operations could influence the normal economic activity of economies that, to some degree, make use of and benefit from sea-based economic resources.

Initial information provided regarding the operational planning of the exploration activity identifies that the base of operations for the project will originate from the existing major ports in the Western Cape, i.e., the Port of Cape Town and/or the Port of Saldanha Bay. The Port of Cape Town is identified as the primary preferred choice from which the operational base of the exploration activity will be managed. The Port of Saldanha Bay is identified as the preferred alternative to the Port of Cape Town.

Furthermore, the exploration right extends between the southern regions of the Northern Cape to Saldanha Bay in the Western Cape. Therefore, the local economies situated along the Western Coast of South Africa could potentially be affected by exploration activities. Given the preceding, the onshore area of influence will primarily represent economic geographies that are situated along the West Coast of the country. Economic profiling will focus on the Western Cape and Northern Cape economies, with reference to regional and sub-regional economies where necessary.

8.7.2.1 RECEIVING ECONOMY SPATIAL STRUCTURE AND PROMINENT NODES

Figure 174 provides an overview of the distribution of economic activity areas in the receiving economy. The map shows that the receiving environment consists of 10 sub-regional economies that primarily represent the West Coast of South Africa (a combination of economic regions from the Western and Northern Cape Provinces). Furthermore, key economic nodes concentrate at strategic locations inland along the western coast. The largest cluster of economic activity areas are found within the Table Bay and Blaauwberg economic sub-regions. These areas form part of the larger metropolitan economy of Cape Town and is influenced by the Port of Cape Town and related manufacturing and business activities. Other major nodes include the Atlantis special economic zone located in the northern most area of the Blaauwberg sub-regional economy, the Saldanha Bay Port and manufacturing hubs, as well as select manufacturing hubs in the St Helena Bay region.

Economic nodes north of the Saldanha Bay sub-regional economy are primarily focused on inland locations and related manufacturing and food processing activities associated with farming. Very few prominent economic nodes are present in the Kamiesberg, Nama Khoi and Richtersveld sub-regional economies.

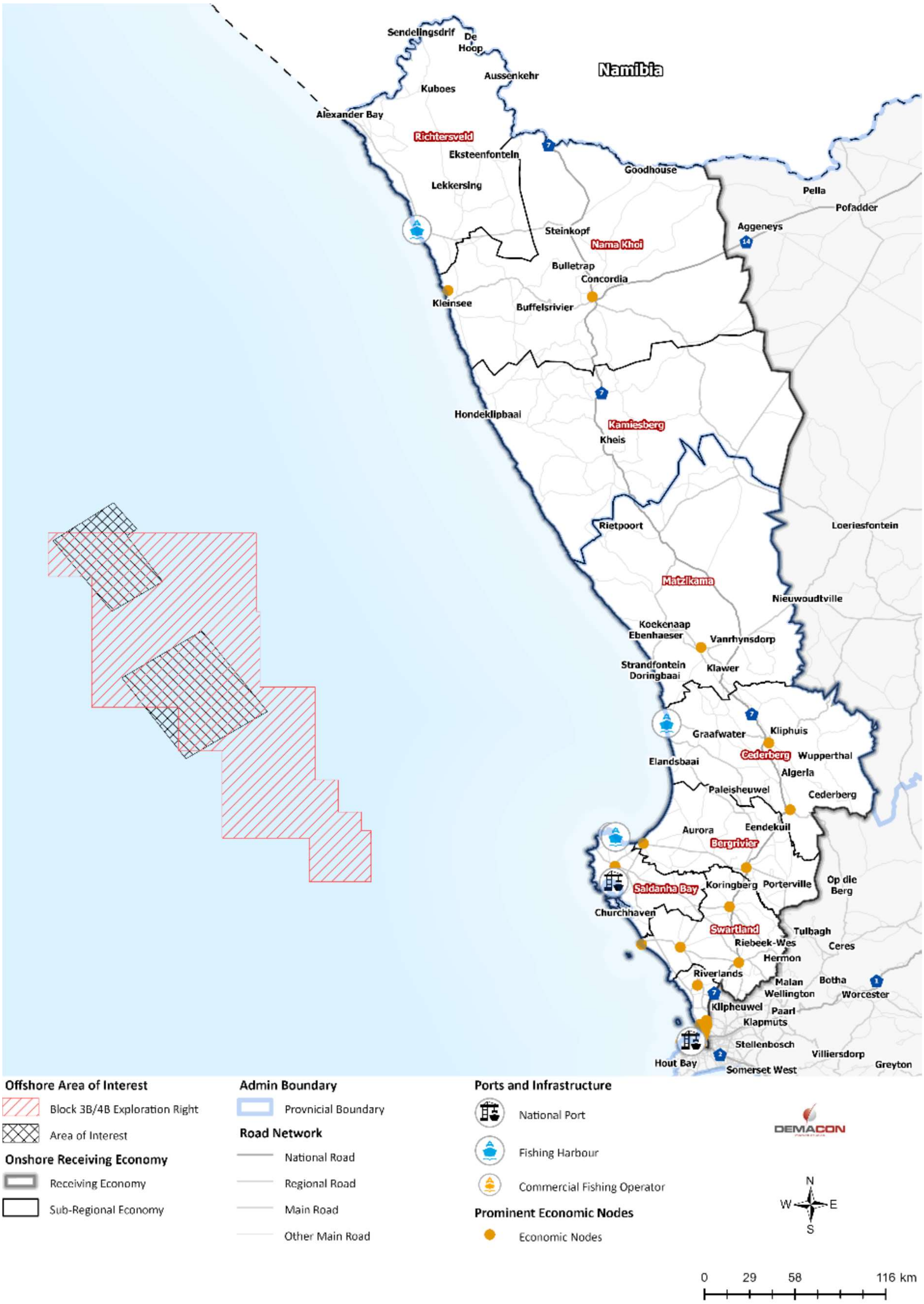


Figure 174: Spatial Description of the Receiving Economy

8.7.2.2 **RECEIVING ECONOMY SIZE AND CONTRIBUTION**

The receiving economy consists of ten sub-regional economies that represent the economic output region of the western coast of South Africa (not to be confused with the West Coast District economy). The receiving economy generated R153.0 billion in current prices Gross Value Added (GVA) in 2021 contributing approximately 2.7% to the National economy and 17.4% to the combined output of the Western and Northern Cape economies. The receiving economy's contribution to the National economy remained consistent between 2015 and 2021, fluctuating between a contribution of 2.74% and 2.77% per annum. The receiving economy's contribution to the combined economies of the Western and Northern Cape has continually increased, reaching 17.4% in 2021. The sub-regional economies of Blaauwberg and Table Bay (situated in the Cape Town Metropolitan Area) are the primary economic output generating regions of the receiving economy, contributing more than 68% to the total receiving economy's GVA (Figure 175). Furthermore, the Saldanha Bay, Swartland and Nama Khoi sub-regional economies represent secondary economic contributors.

Since 2011, all sub-regional economies have increased their proportional contribution to the receiving economy. The Table Bay sub-regional economy is the only exception, as it saw a decrease in its proportional share. The data suggests that two sub-regional economies, Table Bay and Kamiesberg, may have expanded at rates slower than other sub-regional economies. This could likely be due to a decline in economic activity in key sectors affected by, and recovering from, the effects of past and current macro-economic pressures.

The receiving economy (Figure 179) is primarily tertiary economy orientated with the majority of economic output being generated by the business services and wholesale and retail trade sectors. Although almost all sub-regional economies have sizeable business services and wholesale and retail trade sectors, the bulk of these sectors' output is produced in the Table Bay and Blaauwberg sub-regional economies – Table Bay and Blaauwberg sub-regional economies represent nearly 69% of the total output produced by the receiving economy and, therefore, has a significant influence on the structure and functionality of the receiving economy.

Nevertheless, the tertiary economy is supported by a sizeable secondary and primary economy, where manufacturing, especially the production of food products, and agriculture, specifically land based farming and fishing, play vital roles in the output produced by the overarching economy. It is, however, important to note that although sub-regional economies such as Blaauwberg and Table Bay are the largest contributors to the total production of the receiving economy, these areas' influence is primarily concentrated in the tertiary (all sub-sectors) and secondary sectors (all sub-sectors except food production). West Coast sub-regional economies such as Bergrivier, Saldanha and Swartland play important roles in not only agricultural production and fishing industry output but are core locations where the bulk of food production output is concentrated.

An analysis of the receiving economy's comparative advantage of economic sectors shows that the receiving economy, within the context of the Western and Northern Cape economies have a comparative advantage in several sectors, especially fishing, food production and electrical equipment production.

The Tress Index (see Economic Assessment in Appendix 4) for the receiving economy does, however, show that the economy is becoming more concentrated. Data suggests that since 2011 sectors such as mining, mineral production, metals production and other community services have lost their comparative advantage and consequently indicates a move toward a concentrated economy. The receiving economy does, however, have several prominent sectors that maintains a level of diversity in the economy, and that act as the basis for economic production and employment. Core among these is the fishing industry, agriculture, manufacturing, food production and business services.

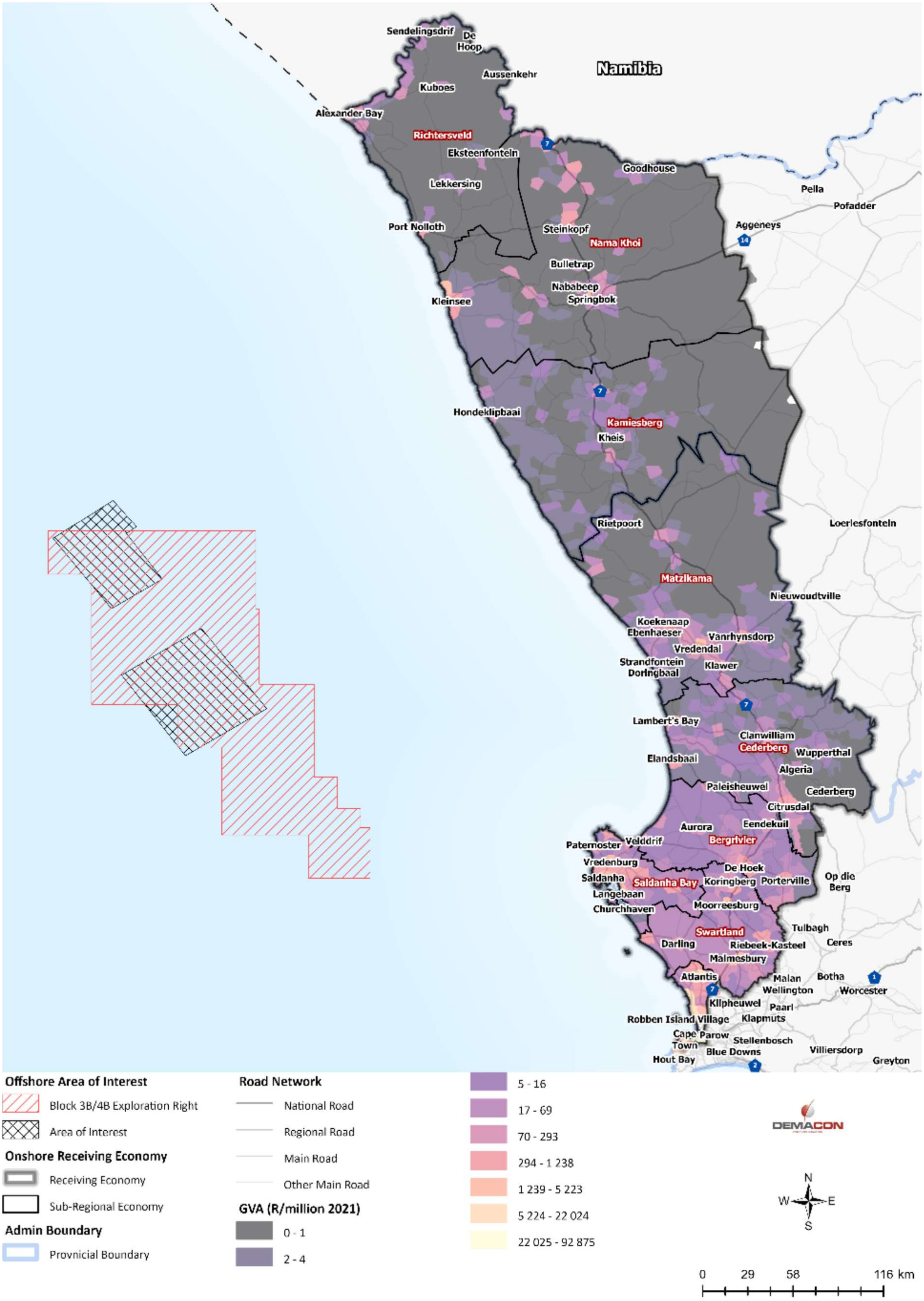


Figure 175: Detailed Distribution of GVA in the Receiving Economy

8.7.2.3 **LABOUR FORCE PARTICIPATION**

An analysis of the structure and growth of the receiving economy has revealed the importance of the primary and tertiary economy (as well as select secondary economy activities such as food production) as core components to the receiving economy and in effect the creation and maintenance of employment opportunities (Figure 180).

Although the receiving economy's average annual growth of economic production has been decelerating, the creation of jobs has remained consistent over the same time period. Up to 2019, the receiving economy maintained a low- to moderate- unemployment rate because the receiving economy was able to create jobs in response to individuals who became new economically active participants. The unemployment rate of the receiving economy has, however, been influenced by the pandemic, which caused a contraction of the economy and subsequently a loss in employment. The labour absorption gap present in the receiving economy in 2019 has been exacerbated by the pandemic and consequently lead to a shortfall of employment in the receiving economy. Present macro-economic conditions and constraints further underpin the incapacity of the macro-economy to create jobs. Macro-economic factors are inhibiting local growth and the historic labour absorption gap in the receiving economy could remain present for the foreseeable future.

The bulk of employment in the receiving economy is located in the Blaauwberg and Table Bay sub-regional economies, with other major economic regions such as Saldanha Bay and Swartland making sizeable contributions as well. Although sub-regional economies such as Cederberg, Bergrivier, Richtersveld and Kamiesberg had average annual employment growth rates in excess of the receiving economy's overall average annual growth rate of 2.0%, these sub-regional economies created only 16% of new employment opportunities in the receiving economy. Major economic regions such as Blaauwberg, Table Bay, Saldanha Bay and Swartland created more than three quarters of employment opportunities in the receiving economy.

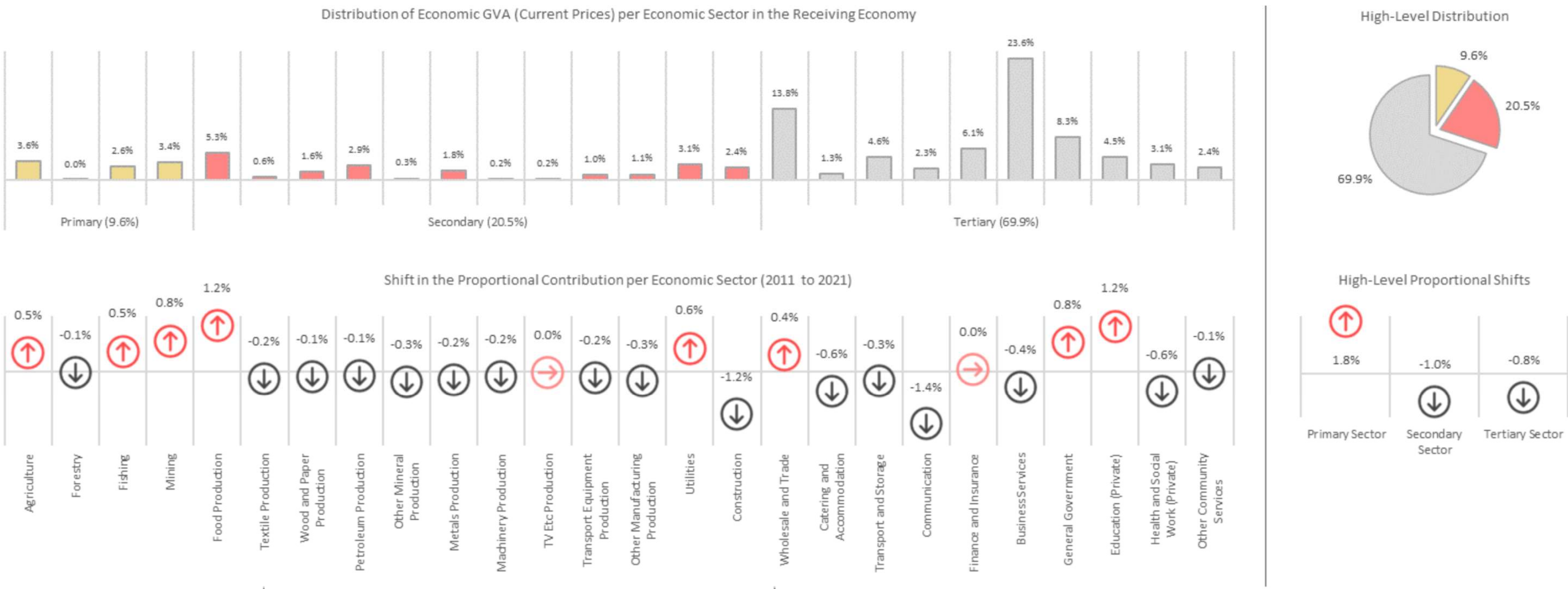


Figure 176: Structure of the Receiving Economy

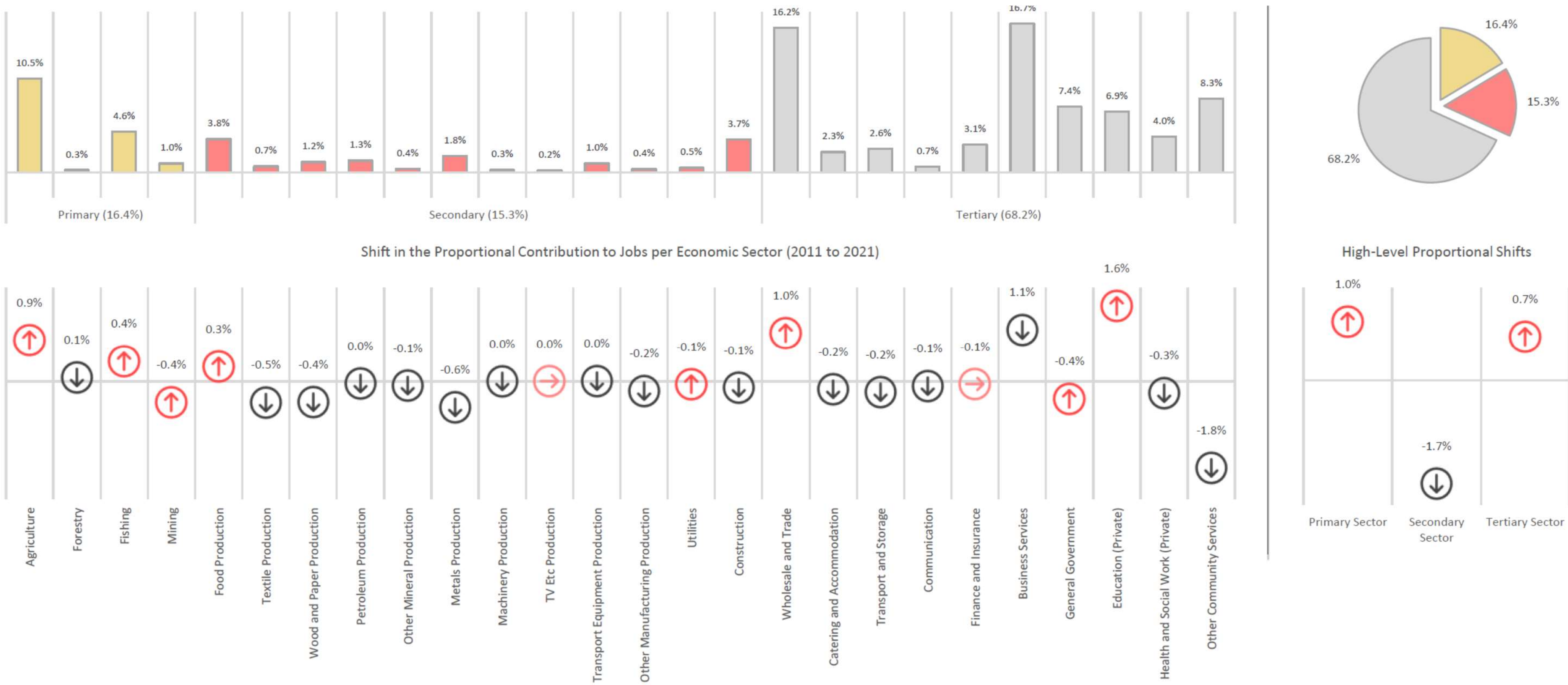


Figure 177: Structure of Employment in the Receiving Economy

8.7.3 KEY SPATIAL CONSIDERATIONS OF THE RECEIVING ECONOMY

8.7.3.1 **EXPLORATION OPERATIONS CONSIDERATIONS**

The proposed exploration activity, although located offshore, will have an onshore base of operations that will facilitate the day-to-day operational requirements of the exploration activity. The primary onshore logistics base will most likely be located at the Port of Cape Town (preferred option), but alternatively at the Port of Saldanha. Logistical operations to and from the exploration activity's AOI will most likely operate from the Port of Cape Town and therefore maritime logistics will be stablished between the Port of Cape Town and the exploration's AOI. The shore base would provide for the storage of materials and equipment that would be shipped to the drilling unit and back to storage for onward international freight forwarding. The shore base would also be used for offices, waste management services, bunkering vessels, and stevedoring / customs clearance services.

According to currently available operational information the drilling schedule has not yet been finalised but is expected to commence between first quarter of 2024 (Q1 2024) and third quarter of 2024 (Q3 2024). The Applicant is proposing to drill 1 exploration well, with the option to drill up to four additional wells. The physical drilling and testing of each well will take approximately 3 to 4 months to complete. Given the information provided, it is assumed that the start of physical drilling of exploration activities will occur between Quarter 1 and Quarter 3 of 2024 and will take up to 4 months per well to complete – taking into account that the first extension of the exploration right expires on 26 October 2024.

Taking into consideration the preceding, the establishment of a base of operations that will operate from the Port of Cape Town will, as a result of the value chain of the exploration activity, directly and indirectly contribute to the economic output produced by the Table Bay sub-regional economy and by extension contribute to the overall economic output produced by the City of Cape Town and Western Cape.

8.7.3.2 **COMMERCIAL AND SMALL-FISHING CONSIDERATIONS**

The identification of the receiving environment noted that economic geographies close to the AOI/exploration right could be influenced by the exploration activity because exploration operations could influence the normal economic activity of economies that, to some degree, make use of and benefit from sea-based economic resources. As a result, the fishing industry represents one of the basic sectors of the receiving economy, i.e., is one of the core industries that supports the receiving economy and produces output that is exported to the broader national and international economy. In 2022 the fishing industry of the receiving economy represented approximately 31.2% of the national fishing industry gross value added and contributed more than 40% to the Western and Northern Cape's fishing industry. Furthermore, the fishing industry of the receiving economy contributes 3.2% to the total gross value added by the receiving economy, 0.6% to the total gross value added by the Western and Northern Cape economies and 0.1% of the total gross value added by the National economy. The receiving economy also plays a critical role in the supply of employment opportunities, contributing 34% to the national fishing industry's employment and 0.1% to nationally available jobs.

The preceding identifies that the fishing industry plays a vital role in the broader receiving economy, and Especially impacts on the economy as a result of its backward and forward linking industries (wholesale and retail trade – backward linking, professional business services – backward linking, fishing industries – backward and forward linking, non-durable goods such as food – forward linking and food manufacturing – forward linking).

Given the location of the areas of interest within the exploration right, the spatial relationship that the areas of interest could have with typical/general commercial and small-scale fishing locations along the West Coast of the receiving economy was considered. Utilizing the general fishing effort data from the Marine Spatial Planning's Decision-Making Tool and National Oceans and Coastal Information Management System (OCIMS), we can ascertain the spatial relationship between the proposed exploration activity's AOI and fishing effort along the West Coast of South Africa.

Spatial data indicates that while there is some overlap between the exploration right area of the proposed activity and general fishing locations along the West Coast, the interaction between the AOI of the exploration activity and general fishing areas is limited. A significant overlap does however, exist between fishing efforts of large pelagic longline catching locations and the areas of interest of the proposed exploration activity. The large pelagic longline sector of the fishing industry focus on the catching of tuna species (albacore, yellowfin, bigeye and bluefin tuna), swordfish and certain shark species (shortfin mako shark and blue shark). According to the

Department of Forestry, Fisheries and the Environment's (DFFE) Status of the South African Marine Fisheries Resources (2020) the fishing pressure status of species targeted by the large pelagic longline sector range from optimal to heavy. Optimal fishing pressure exists for species such as albacore, yellowfin tuna, swordfish, and the southern bluefin tuna. Heavy fishing pressure, however, exists for yellowfin tuna and bigeye tuna. Approximately 3 064.4 tonnes of large longline pelagic species are caught by the fishing industry per year of which Yellowfin Tuna, Bigeye Tuna and Shortfin Mako Sharks are the most common.

8.7.3.3 SEA-BASED LOGISTICS CONSIDERATIONS

The movement of goods and services is an important consideration when identifying the role and function of aspects within an economy or specific economic region. Given that the proposed exploration activity is situated within an offshore location close to two main seaports of the South African economy, the relationship that the AOI of the proposed exploration activity has with sea-based logistics is important.

Approximately 68.1% of the total value of South Africa's imports and 51.1% of the total value of South Africa's exports travel through the 9 main seaports of South Africa. The Port of Cape Town and the Port of Saldanha Bay are key ports within the context of South Africa, as the Port of Cape Town handles approximately 10.3% of South Africa's import value whilst the Port of Saldanha Bay handles approximately 15.6% of the value of South Africa's exports.

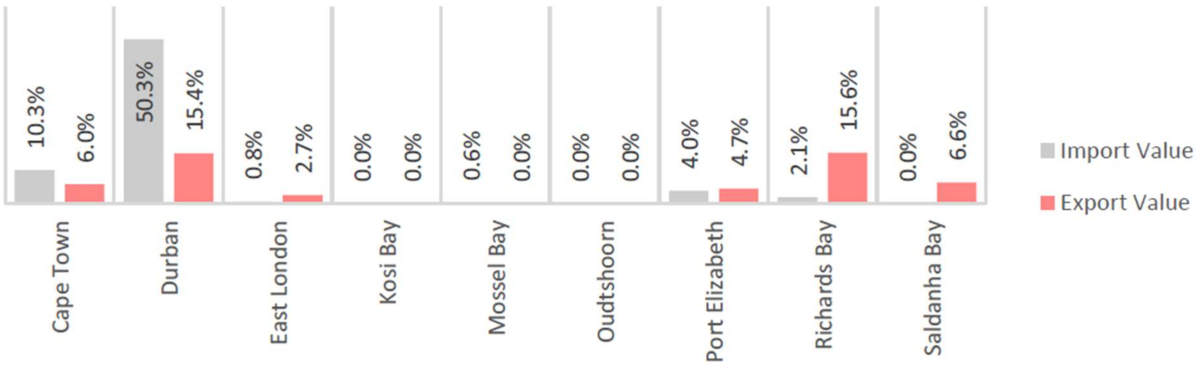


Figure 178: Distribution of the Total Value of South African Imports and Exports per Sea Port (2022)

The Port of Cape Town and the Port of Saldanha Bay are also two ports that have been selected as the preferred and alternative ports from which a base of operations for the proposed exploration activity will be established. The proximity of the Port of Cape Town and Port of Saldanha Bay to the areas of interest for the proposed exploration activity may lead to potential disruptions in normal sea-based logistical operations, such as imports and exports. In this analysis, "disruption" refers to the possibility of altering sea routes due to the proposed exploration activity restricting the use of normal shipping lanes.

Spatial data shows that the proposed exploration activity's areas of interest overlap with established shipping lanes, indicating a potential impact on the normal operations of sea-bearing vessels that traverse these routes.

8.7.3.4 SEA-BASED INFRASTRUCTURE CONSIDERATIONS

The West Coast of South Africa is served by a network of vital underwater telecommunications cables that connect the region to various parts of the world. Some of the key submarine cable systems include:

- SAT3/WASC/SAFE: This extensive cable system consists of two sub-systems, SAT3/WASC in the Atlantic Ocean and SAFE in the Indian Ocean. It links Portugal (Sesimbra) with South Africa (Melkbosstrand). From Melkbosstrand, the cable extends via the SAFE sub-system to Malaysia (Penang), with intermediate landing points at Mtunzini East South Africa, Saint Paul Reunion, Bale Jacot Mauritius, and Cochin India.
- West Africa Cable System (WACS): Stretching over 14,530 km, WACS connects South Africa (Yzerfontein) to the United Kingdom (London). It boasts 14 landing points, with 12 along the western coast of Africa (including Cape Verde and Canary Islands) and 2 in Europe (Portugal and England), concluding on land at a cable termination station in London.
- African Coast to Europe (ACE): Covering an impressive 17,000 km, the ACE submarine communications cable runs along the West Coast of Africa, linking France and South Africa (Yzerfontein).

- Equiano: This private subsea cable, funded by Google, will traverse the West Coast of Africa, connecting Portugal and South Africa with branching units along the route. The first phase, linking South Africa (Melkbosstrand) and Portugal, was expected to be completed by 2021.
- 2Africa: The 2Africa subsea cable project aims to interconnect Europe (eastward via Egypt), the Middle East (via Saudi Arabia), and 21 landings in 16 African countries, including South Africa. The system is expected to go live in 2023/2024.

These underwater telecommunications infrastructure projects play a critical role in ensuring reliable and high-speed communication services, supporting various sectors and reinforcing South Africa's global connectivity. An examination of the spatial relationship between underwater telecommunications cables and the proposed exploration area's AOI reveals that there are no existing cables crossing through this region.

8.7.3.5 **TOURISM CONSIDERATIONS**

The Western and Northern Cape Provinces are prominent tourism destinations for domestic and international travellers. The Western and Northern Cape provinces attract approximately 18% of all international tourists travelling to South Africa and 12% of all domestic trips undertaken by South Africans. Economic data for the receiving economy identifies that the catering and accommodation industry (which represents a portion of the total tourism industry but provides a proxy indication of tourist activity) is a basic sector (foundational sector for the local economy) of the receiving economy and contributes approximately 1.2% to the total economic output produced by the receiving economy. The tourism industry is therefore a key component of the receiving economy.

Tourism is an amalgam of visitors' consumption of goods and services which include transportation, accommodation, food and beverage, recreation and entertainment, travel and tour operations, and souvenirs. Within the context of the proposed exploration activity, interest is afforded to the potential impact that the exploration activity could have on the tourism industry as a whole in the receiving economy. Interest is specifically afforded to the potential of the proposed project to influence sea-based tourist activities.

The exploration right of the project (including its areas of interest) is between 120 km and 150 km from the western coast of South Africa and, therefore, sighting of exploration activities would not have a visual impact on aspects such as the scenic quality of a tourist location (a person standing at sea level will typically only be able to see approximately 4.8 km when looking out to sea), the attractiveness of a location's product offering and the potential of onshore activities to maintain their current functionality and levels of services. The potential for a well blow-out exists but research suggests that no such occurrence has yet been recorded in South Africa and that the chances of such an occurrence is fairly low. Furthermore, spatial data shows that sea-based activities such as whale watching and cage diving do not interact and as a result will not necessarily affect the potential of these industries to maintain operations.

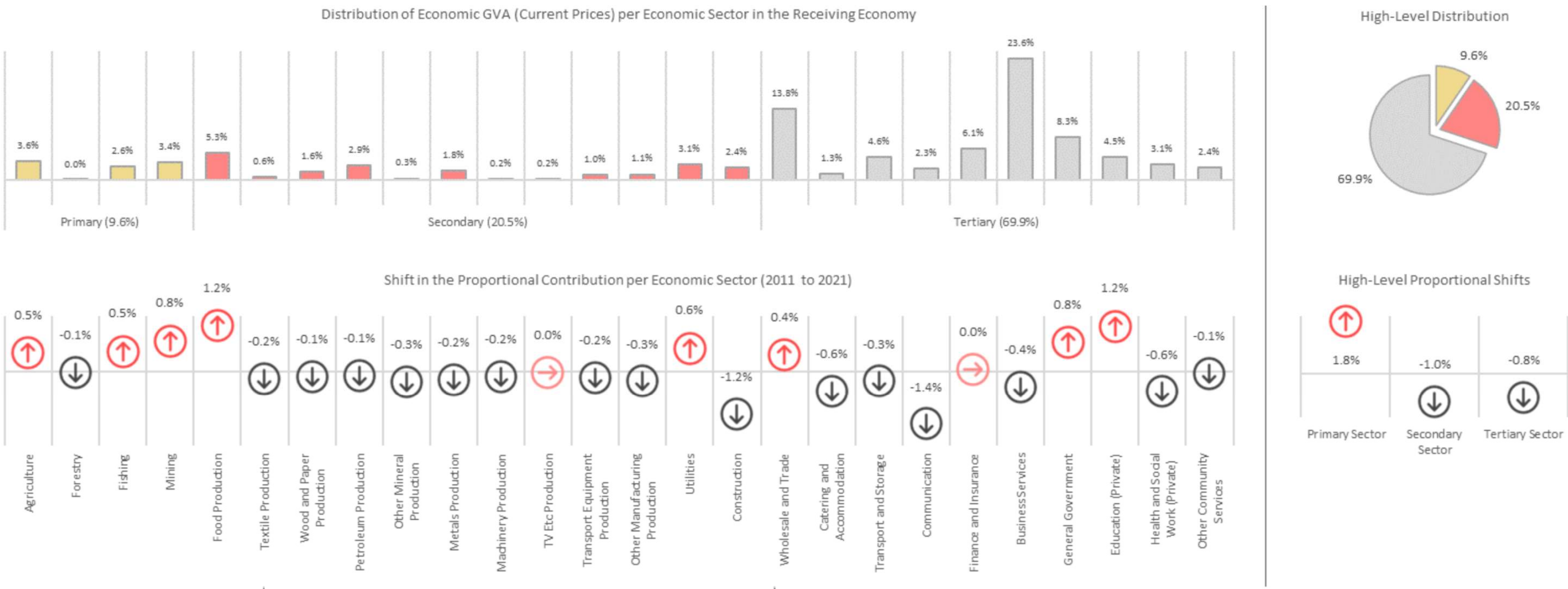


Figure 179: Structure of the Receiving Economy

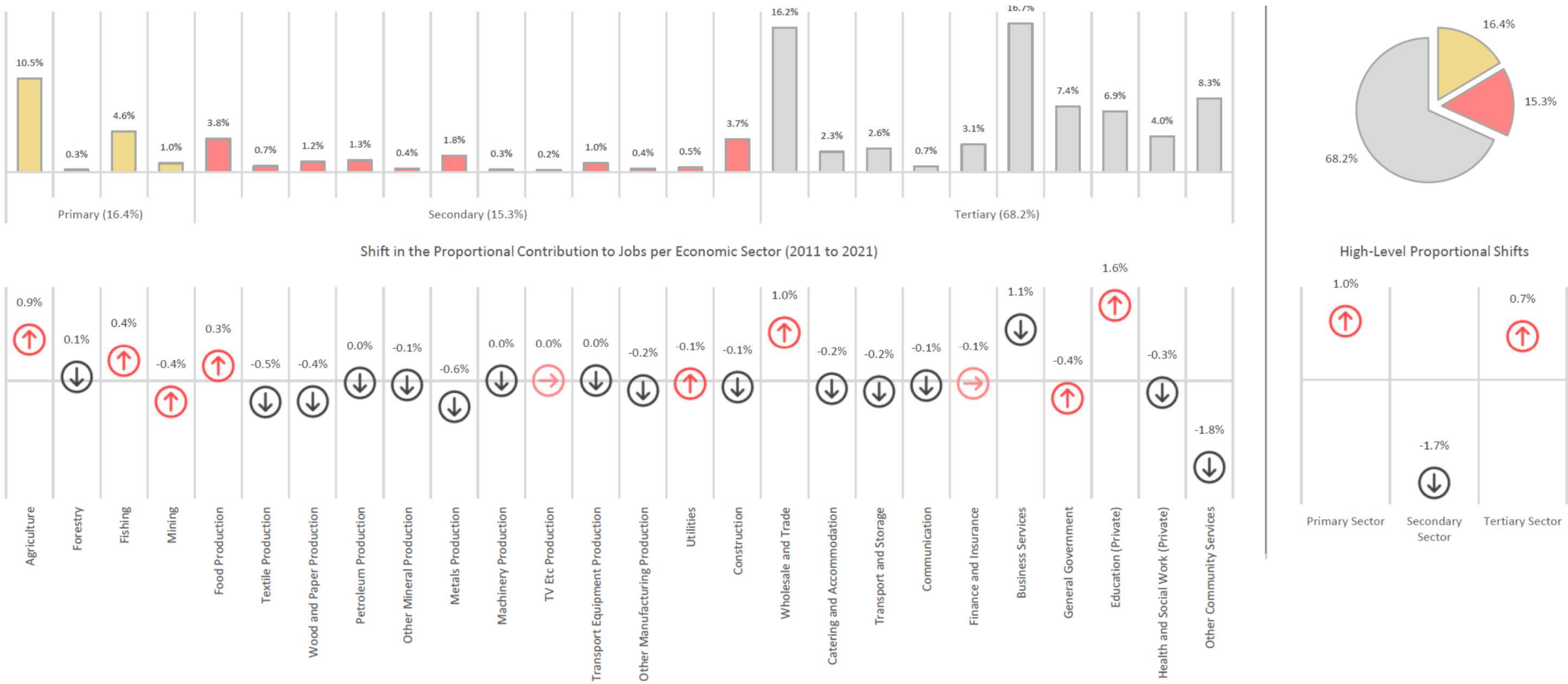


Figure 180: Structure of Employment in the Receiving Economy

8.8 CULTURAL AND HERITAGE RESOURCES

This section provides and overview of the cultural and heritage environment for the study area. The information has been sourced from previous heritage studies undertaken which provide coverage of the study area.

Marine resources have a long history of human exploitation. Evidence from archaeological sites suggest that the West Coast region was occupied from the Early Stone Age (ESA) through to the Middle Stone Age (MSA) and Later Stone Age (LSA), up until the arrival of early European settlers from the 18th century onwards. There are numerous sites (including shell middens, stratified cave deposits, rock art, stone tools, and fish traps) recorded along the coast that demonstrate that the rocky shorelines were attractive to hunter-gatherers through time. Much of what we know about settlement, subsistence strategies and di*et al*ong the coast is linked to these shorelines. Whilst gorges and stone sinkers are probably the best evidence for technical fishing equipment in the LSA, marine shell middens also demonstrate that the coastal zone was particularly favoured by LSA people (Deacon, 1995).

8.8.1 SHELL MIDDENS

Marine shell middens have been identified within 1 km inland of the coastline, near estuaries and in dune fields which lie adjacent to rock shores. While pre-historic people likely favoured the rocky shorelines for ease of access to marine resources, middens have also been found further inland, where people would have been able to exploit additional resources such as game life and fresh water.

In some instances, these shell middens are associated with domestic artefactual debris which suggests that they in fact represent occupation sites of long duration. Whilst the opposite can be said for midden sites that do not contain a formal stone artefact component, and instead may represent visits of short duration. These pre-historic people were the ancestors of the San and Khoikhoi. According to archaeologists, several shell middens in the Vredenburg Peninsula are associated with both San and Khoikhoi groups who were harvesting the shorelines and estuaries of the West Coast in a sustainable and patterned manner.

8.8.2 STONE FISH TRAPS

The remains of fish traps (visvywers; stone-walled tidal fish traps) have been recorded along the South African coastline from St Helena Bay to Mossel Bay. Along the south-western coastline, these traps, which use "the tidal range to allow fish to enter pre-built enclosures and be trapped at low tide", provide evidence of early fishing techniques. The preserved fish traps vary in shape, size, and spatial complexity. Identifying the architects of these traps is, however, a contentious issue.

Initially, researchers believed that the fish traps on the south coast were ancient maritime resource systems that originated among LSA people after 2000 years ago with the arrival of Khoikhoi herders. More recent research suggests that the development of fish traps along the southern and western coasts dates to the 19th century. Furthermore, these structures may have been introduced by European farmers as part of the farming-fishing system when intensive exploitation of inshore fish by local farmers occurred. In 1987, Graham Avery recorded a tidal fish trap in Mauritzbaai, south of Jacobsbaai. Hart and Halkett (1992) have also identified the remains of at least six traps in the intertidal zone at Wilde Varkens Valley, St Helena Bay.

8.8.3 INDIGENOUS PEOPLES

Before the colonial era, there were several diverse ancient tribes who traversed the valleys and plains of the present-day West Coast region of South Africa. The origins of the West Coast fishing communities can be traced back to the San and Khoikhoi peoples who lived within this region. Together, the Khoi and the San are the First Peoples of South Africa. In 1928, a German physical anthropologist Leonard Schultze, created the term 'Khoisan', to stress the similarities between the Khoikhoi and the San.

The settlers used the term 'Bushmen' when referring to the San, and many of whom the colonists' called 'Bushmen' were, in fact, Khoikhoi or former Hottentot. Today, this term is considered derogatory, and instead, scholars would rather refer to hunters and herders together as 'Khoisan'. It should be noted that although Khoi and San Peoples may share some experiences, culturally, they remain two distinct groups, and the general preference amongst both Khoi and San people is to be called by their clan names.

8.8.3.1 **THE SAN**

During almost the entire Holocene period, small groups of San hunter-gatherers were present in southern Africa. The San are the direct descendants of the first peoples of southern Africa. It should be noted that the term “San” is used to cover over a dozen distinct hunter-gatherer groups who speak distinctive “click” languages (incl. the Khwe, !Xun, Ju’hoansi, Naro, !nuu and other groups). These groups lived across Namibia, South Africa, Botswana, and Zimbabwe. The San were small groups of nomadic people who lived by the ethos of “all people are equal”. They hunted and gathered resources and did not keep livestock.

It is generally agreed amongst academics that the San were the first inhabitants of the Cape region. During the latter part of the Holocene, there were hunter-gatherers living on the West Coast who made seasonal use of the coastal resources. Several archaeological sites, including Duyker Eiland, which is in Britannia Bay, confirmed the importance of shellfish, seals, marine birds, crayfish, and beached whales as a food source for the local inhabitants during this time.

8.8.3.1.1 THE INTRODUCTION OF THE KHOIKHOI

For thousands of years, the Khoikhoi people have occupied and moved around Southern Africa as nomadic herders. The Khoikhoi were large groups of nomadic herders who owned substantial herds (incl. cattle and sheep) and migrated for pasture, water, and food resources. It is understood that Khoikhoi peoples have a spiritual connection to land, where land is perceived as a gift from nature to be cared for.

Note that the Khoikhoi term is an umbrella term which refers to different tribes. The Khoikhoi people comprise four historical groupings: the Griqua, Nama, Koranna and Cape Khoi (incl. further subgroupings). Today, the Nama people are primarily located in the Northern Cape. The Griqua are in the Western Cape, Eastern Cape, Kwazulu Natal and Gauteng, and various other parts of the country. The Korana people, live primarily in Kimberly and the Free State. The Cape Khoi are in the Western and Eastern Cape.

Evidence suggests that around 2000 years ago, the pastoralist Khoikhoi entered South Africa along the West Coast into the Cape region. They brought a new way of life, from its northern origins to South Africa. The Khoikhoi introduced domesticated livestock and new material culture (incl. pottery) into the region. They relied more on sheep as a meat resource and hunted and gathered. Groups living close to the coast would also exploit shellfish, seals, and other marine resources. The St Helena Bay (Slipper Bay) region appears to have provided the Khoikhoi with invaluable resources, including whale meat obtained via ‘cetacean traps’.

One of the most important West Coast pastoralist sites, Kasteelberg, is an open-air archaeological site located 4 km from the coast. It provides evidence of occupation by herders between 1800 and 1600 years ago (Klein, 1986). The occupants of the site focused on harvesting seals and the presence of sheep bones also indicated that the inhabitants were most likely herding domestic stock.

It is thought that the indigenous people in the Cape populated a region from Northern Namibia to the Cape of Good Hope and from the Atlantic Ocean to the Fish River in the East. The area between Saldanha and Vredenburg was occupied by the CochoQua and the ChariGuriQua (GuriQua) group occupied the lower Berg River area which included St Helena Bay and regions around Picketberg. Some researchers choose to use the term Peninsular Khoikhoi” when referring to the Gorachoquas, Goringhaiquas and the Goringhaiconas (“strandlopers”) and “Surrounding Khoikhoi” for the Cochoqua, Chainouqua and Hessequa.

In the pre-colonial era, the relations between the Khoikhoi and the San were relatively stable due to a mutual acknowledgement of territories. Although the San and Khoikhoi seemed to have co-existed for a period, it appears that, to some degree, the San groups were displaced. It’s assumed that the Khoikhoi moved into areas that had previously been utilised by the San, thus forcing the San to move into more isolated coastal regions. The San’s settlement and subsistence strategy changed from one based on the large-band occupation of open areas and the hunting of large game towards the more intensive utilisation of rock shelters, in small groups and a foraging-based economy. Unfortunately, indigenous groups who lived on the coast were the first people to be severely impacted by colonial oppression.

8.8.3.2 **COLONIAL DISPOSSESSION**

First contact between indigenous pastoralist groups and Europeans occurred during the 15th and 16th centuries when Portuguese mariners would sail down the coast. Before the Dutch East India Company’s (‘VOC’) governance over the southernmost tip of Africa, European merchants and travellers en route to or from Asia would call in at the natural harbour of Saldanha Bay for refreshment. Encampments were also set up along the coast by survivors of shipwrecks, and in their journals, they would recall how they met and traded with indigenous groups. Written records reveal that in 1497, the GuriQua and the San (SonQua) witnessed the arrival and departure of Vasco da Gama in St Helena Bay. Although the Saldanha Bay harbour was more sheltered than Table Bay and allowed for the crews to trade livestock from the Khoikhoi in the area there was not enough fresh water available to allow for the establishment of large permanent settlements.

It was only in 1652 that the VOC decided to occupy the Cape and establish the first permanent European settlement in South Africa. The VOC established a station at Table Bay to supply Company fleets travelling between Europe and the Indies with refreshments (i.e., meat, wheat, vegetables, and freshwater) (Ward, 2009). When the Dutch colonists arrived, they encountered several Khoikhoi groups. The largest concentration of Khoikhoi lived in the lush pasture lands of the south-western Cape region.

Initially, the relationship between the Dutch and the Khoikhoi was one of cooperation, and the VOC established trading agreements with local chiefs to get regular supplies of fresh meat (Elphick, 1977). As the colony grew, the VOC decided to decrease their dependency on local trade with the Khoikhoi. Their alternative plan was to give land to free burghers to supply meat and grain to the Company.

Khoikhoi and San lives were impacted upon by both internal strife and direct conflict with the Europeans over the disregard of traditional customs, the privatisation of land, and exhausting indigenous resources (i.e., overfishing and farming). As the Dutch took over more of the Khoikhoi's grazing land for farms, much of the Khoikhoi and San peoples' traditional lands were dispossessed. In 1657, the Goringhaiqua tribe were ordered to move to the east of the Liesbeeck boundary and this 'eviction' event would be instrumental for the first war against colonial intrusion (Bredekamp and Newton-King, 1984). The First Khoikhoi-Dutch War lasted the whole of 1659.

According to Sleigh (1993: 148), "In 1672, two sons of the weakened Peninsular Khoisan chiefs signed a contract, which they probably did not fully understand, and sold huge tracts of land from Table Bay to Saldanha Bay in the North and to the Hottentots Hollands mountains in the East to the VOC for an incredible low price (which they did not even fully receive)".

After a few more instances of territories being ignored and further land appropriation, another war of resistance was initiated by the Cochoqua, and the Second Khoikhoi-Dutch War commenced (1673-1677). This led to more Khoikhoi groups being forced to relocate to areas further up the coast. According to writings of early settlers, it appears that some San groups, who pursued a hunting and foraging lifestyle, may have still resided in the mountainous regions of the Cape where they were less likely to clash with the Khoi or Dutch settlers. Regions that were less desirable for the colonists, such as Namaqualand, became places of refuge for the San and Khoikhoi who were able to continue many aspects of their traditional ways of life in this area for some time.

In 1713, the small-pox epidemic led to the death of many Khoikhoi people living in the south-western Cape. The surviving Khoisan became assimilated as domestic/farm workers due to the high demand for labour by the Dutch. In rural areas, the Khoisan were forced into what was referred to as semi-bonded labour. By the late 18th century, the Cape settler colony's territories incorporated the Berg (c. 1700), Olifants (1750), and Buffels (1798) rivers.

8.8.3.3 **THE HISTORY OF FISHING ON THE WEST COAST**

This section describes the history of fishing along the West Coast of South Africa.

8.8.3.3.1 17TH CENTURY

During the 17th century, the VOC established an outpost at St Helena Bay. From 1670, free burgers started to fish regularly in St Helena Bay. They introduced methods to the region that were not previously available to indigenous fishermen, such as metal hooks, boats, nets and bulk processing and storage.

8.8.3.3.2 18TH CENTURY

During the 18th century, the Cape settler's economy was primarily based on slave labour which was imported from Asia and East Africa. The agricultural sector which was maintained by free burghers (freed from Company service) was not stable and due to the trade of the Khoikhoi's livestock being intermittent, the settlers had to make alternative arrangements for food resources. This led to Robben Island being exploited for seals, penguins, and seabirds. Large rural landowners established private coastal fishing posts to supply marine resources to the Company; the local region; passing ships and for export. Soon, Dassen Island, Saldanha Bay and St Helena Bay developed as significant centres to supply the VOC with additional resources to sustain the growing number of people in the Cape colony, including the substantial number of slaves kept by the Company. According to Sleigh (1993), the slaves were given salted fish, seal meat, penguin, and bird eggs whilst the rest of the colony preferred to consume meat.

According to Marincowitz (1985: 40–46) "With exclusive land grants closing the north-western frontier, from the 1740s growing numbers of ex-slaves, dispossessed Khoekhoe, failed farmers, evicted tenants and bywoners (tenant farmers), new immigrants and fugitives from colonial and military justice moved onto the beaches of the west coast". Early fishing, sealing and whaling activities, by European and American whalers, around Saldanha Bay, especially near Marcus Island/Outer Bay and at Salamander Point, have been extensively documented in the archival/historical record. Although the inshore whale population declined after 1830, processing continued at Donkergat in Saldanha Bay.

8.8.3.3.3 19TH CENTURY

By the mid-19th century, scattered subsistence communities had emerged along the West Coast. Before the arrival of industrial fisheries, residents in St Helena Bay employed basic fishing technology (small-scale line fishing, beach seine nets and rowing boats) and fishing activities were informally organized by boat and net owners.

Malay slaves and other residents moved into the region to work as farm labourers. Over time, the unique fishing skills of enslaved Malay people intermingled with the fishing skills of the indigenous people. This led to the establishment of small fishing villages along the West Coast (incl. Saldanha, Langebaan and St Helena Bay).

After the emancipation of slaves, new laws were introduced to control both the freedom of movement and independent livelihoods of people who did not own land. This forced fishermen on the West Coast "to either develop artisanal skills, become wage labourers or squat on coastal government land to eke out a living from small-scale production and seasonal work".

Using business capital in both the local and international markets, entrepreneurs were able to lease Crown land and establish coastal industries along the West Coast. By the 1880s, a Cape Town-based trading company, Stephan Brothers, was able to monopolise the West Coast trade. The company bought the main grain shipping points along the West Coast, including the southern shore of St Helena Bay, where they established Laaiplek (translates to 'loading place') at the mouth of the Berg River.

8.8.3.3.4 20TH CENTURY

Although the local fishing industry on the West Coast employed a substantial number of locals at the start of the 20th century, the industry is associated with a history of hardship. The industry's collapse in the mid-20th century left numerous West Coast communities impoverished. Despite all the obstacles thrown at them, the West Coast fishing communities were resilient and continued their fishing tradition throughout the 20th century.

Historically, small-scale fishers have constantly had to compete against big scale fisheries. For example, Piketberg coastal fisheries used a method of fishing called beach seining to supply inland farmers with cheap ration fish. When there was a decline in snoek sources further south, Italian immigrant fishermen from Cape Town travelled up the West Coast on boats with set nets. Ultimately, their method of fishing impacted the supply of fish for the sedentary fishermen.

By 1900, the Stephan Brothers company were in control of nearly every suitable bay from Saldanha Bay to Lamberts Bay. They also owned numerous farms which were often acquired in exchange for debt. In 1909, the company negotiated an agreement with the State to establish an Exclusive Trek Seine Fishing Zone along the Malmesbury coast. This move meant that the company was able to dominate a new manufacturing industry which further exacerbated resource owners and local fishermen.

During World War One, there was a crayfish canning boom in the Cape. The sourcing of crayfish moved rapidly up the West Coast during this period. By the early 1920s, the overexploitation of crayfish resulted in an exhaustion of crayfish stocks and West Coast factories were forced to close. This meant that the small-scale seine fishermen, and fishermen who netted in the backwaters, were left even more vulnerable to the financial depression of the 1930s.

Then, in 1934, in an act of retaliation, "Saldanha Bay fishermen invaded the Piketberg area on motorboats carrying Italian lampara nets and, with the support of Government, wiped out the non-motorised Berg River inshore fisheries run by consortiums of farmers, fishery owners and canners". In 1951, increasing catches along the West Coast, meant that both skippers and fishermen yielded good financial returns. By 1955, South Africa had the largest fishing industry in the southern hemisphere.

With the Apartheid system arriving, the indigenous identity of the Khoisan was further disrupted through the Race Classification Act and the Populations Registration Act. The Khoisan were forcibly categorised as "Coloured". This label further dispossessed the people from their heritage. Under the Group Areas Act (1950) the towns of the West Coast were divided into segregated residential and business areas. The forced removals marked yet another era of forced removals from areas that indigenous people occupied. Despite the discrimination, the communities continued their tradition of fishing that had been passed on through the generations of fisher families.

8.8.4 MARITIME HERITAGE

South Africa has a rich and diverse underwater cultural heritage. Strategically located on the historical trade route between Europe and the East, South Africa's rugged and dangerous coastline has witnessed more than its fair share of shipwrecks and maritime dramas in the last 500 years. According to SAHRA's records, at least 2,800 vessels are known to have sunk, grounded, or been wrecked, abandoned or scuttled in South African waters since the early 1500s.

This does not include the as yet unproven potential for shipwrecks and other sites that relate to pre-European, Indian Ocean maritime exploration, trade and interactions along the South African east coast, or the potential for wrecks of vessels which simply disappeared between Europe and the East to be present in our waters. Although not applicable to Block 3B/4B, our coastal maritime heritage also includes a largely unexplored, but increasingly acknowledged submerged prehistoric element, consisting of prehistoric terrestrial archaeological sites and palaeo-landscapes which are now inundated by the sea.

This assessment considers the potential for palaeontological resources and historical shipwrecks in Block 3B/4B as detailed in greater detail by in the Maritime Heritage Assessment undertaken by TerraMare Archaeology in Appendix 4.

8.8.4.1 GEOLOGICAL SETTING

The basic composition of the surficial sediments on the shelf and slope (Figure 181) shows that the seabed of the AOIs is largely composed of the shells of planktonic foraminifera microfossils, generally referred to as "foram ooze".

The wider context in terms of shelf edge processes (Figure 182) shows the AOIs situated along the fissured zone of upper slope collapse, with large-scale downslope slumping and sliding and accumulation of turbidite lobes forming the continental rise. The latest slumping appears to be of early Quaternary age. Seismic profiles reveal preceding slumping along the palaeo-shelve edges of early and late Upper Cretaceous ages and of Palaeogene age (Dingle, 1980).

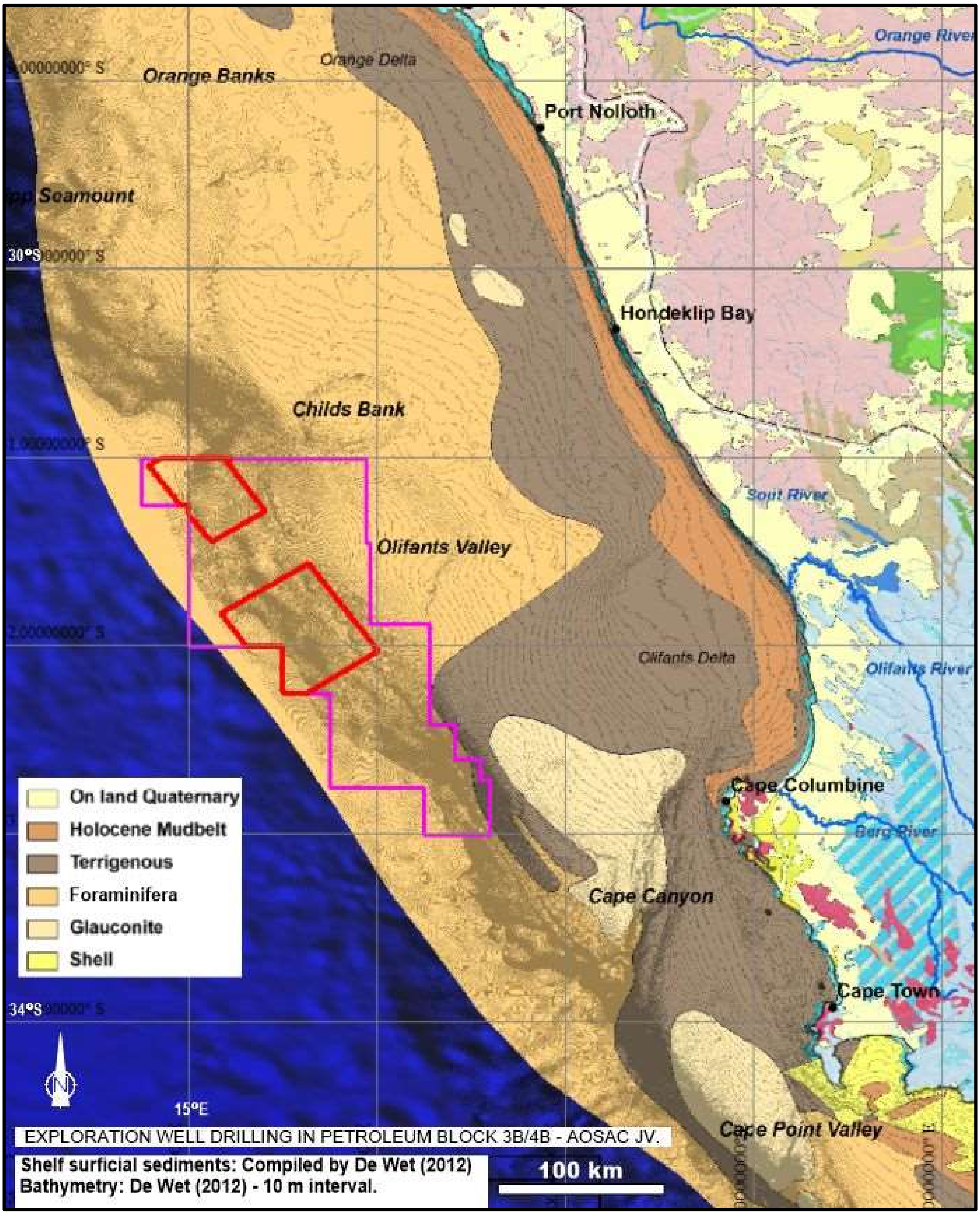


Figure 181: Shaded bathymetry and shelf sediment cover. Block 3B/4B and the AOIs are the pink and red coloured polygons respectively (After De Wet, 2012).

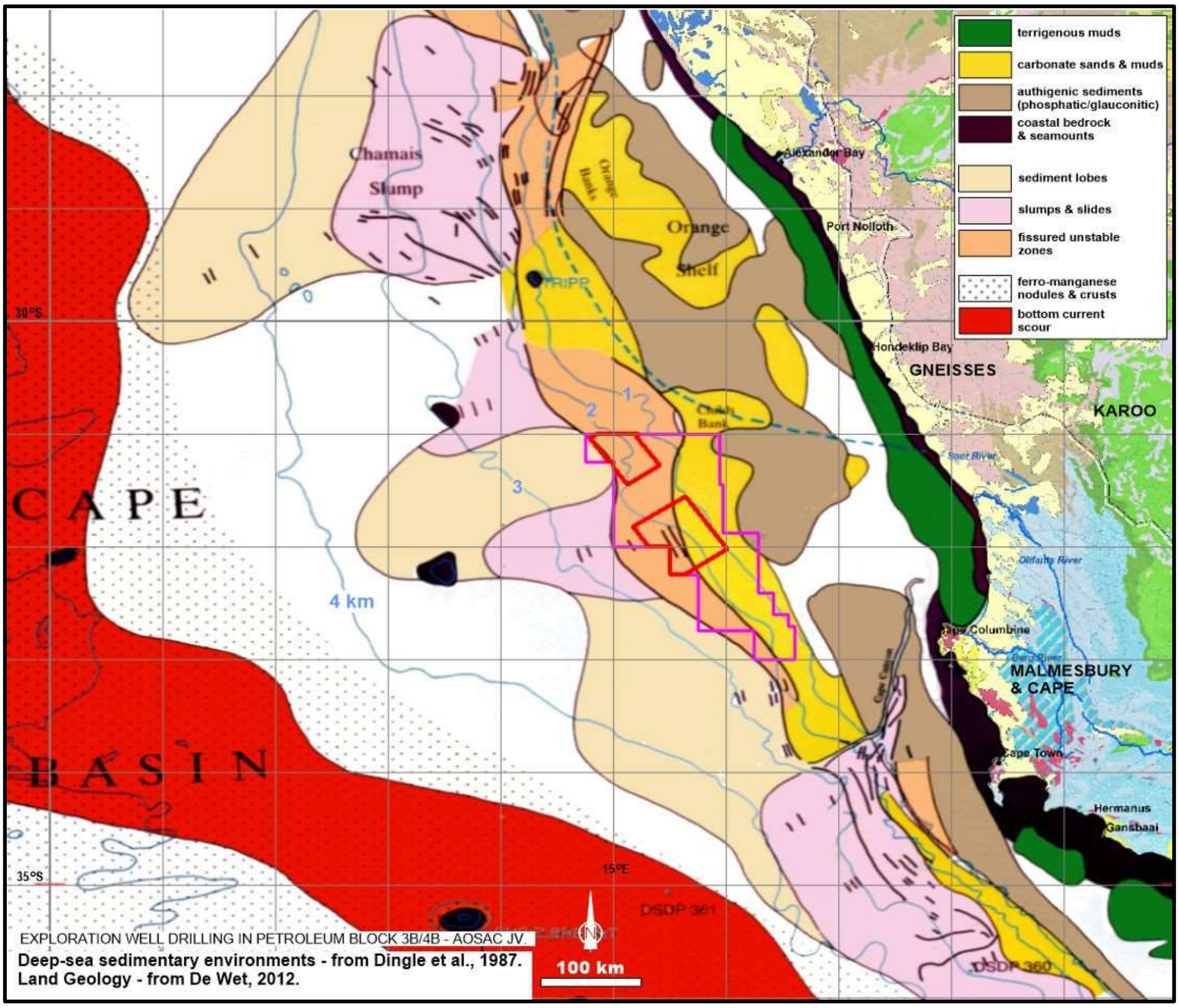


Figure 182: Slumps, slides and turbidite fans on the West Coast margin Block 3B/4B and the AOIs are the pink and red coloured polygons respectively (after De Wet, 2012).

The seabed geology beneath the Quaternary surficial sediment cover is shown in Figure 183. Based on old and very incomplete data (Dingle & Siesser, 1977) this map is very rudimentary, as has been shown further north off Namaqualand by diamond exploration geophysics, coring and drilling revealing greater complexity.

To briefly extrapolate what is not depicted in Figure 183, the Cretaceous formations underlying the middle shelf young seaward in coast-parallel sub-crops successively including the Albian-Cenomanian, Turonian and Coniacian formations and farther offshore there are windows of Santonian. The overlying Paleogene sequence is mostly of Eocene age. Miocene carbonate deposits extend over the outer shelf, with the early Miocene (Burdigalian) overlain seawards by mid-Miocene (Langhian) carbonates, in turn succeeded by late Miocene and Pliocene carbonates accumulated on the slope, in the Block 3B/4B area.

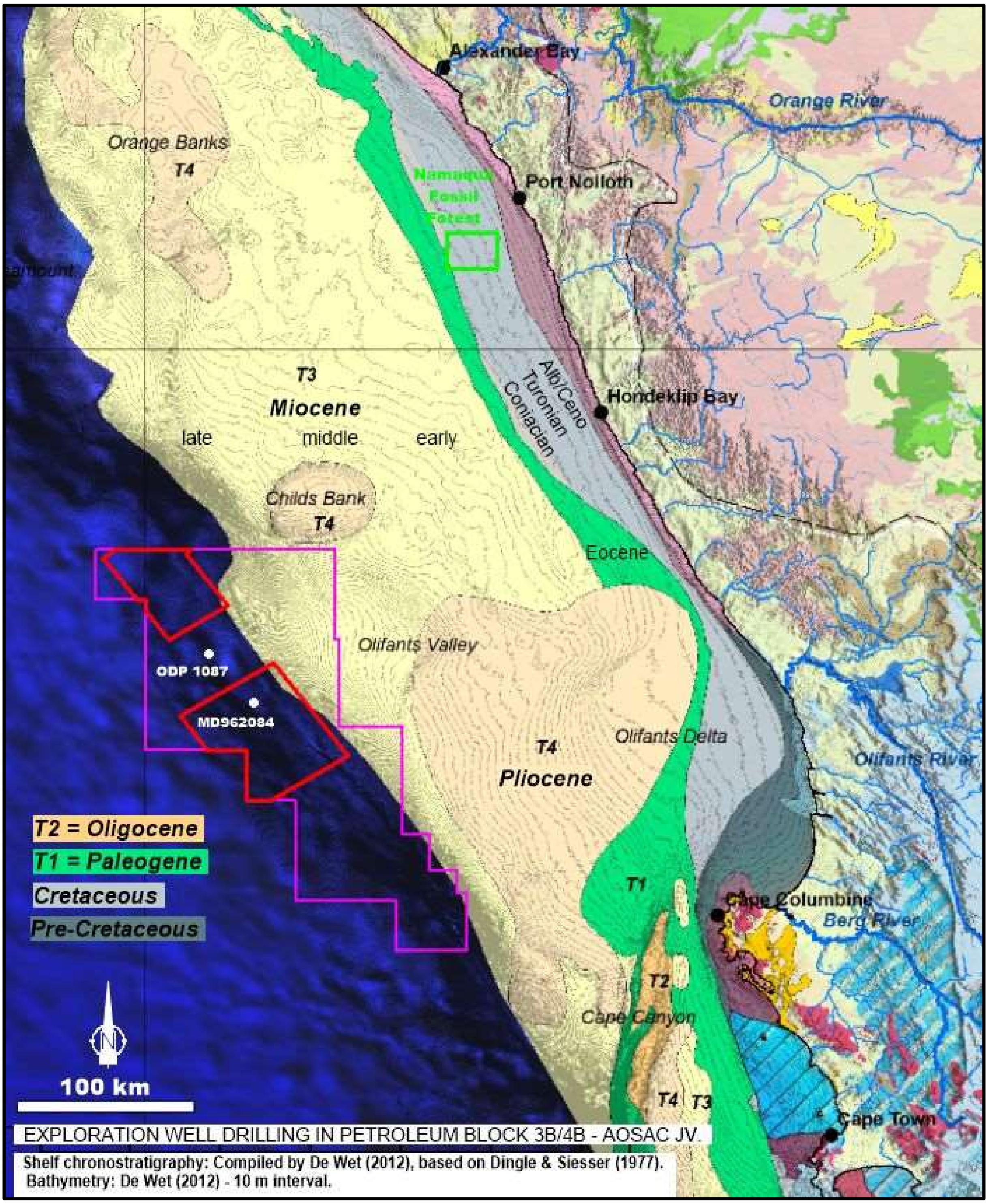


Figure 183: Pre-Quaternary chronostratigraphy of the top of the continental shelf. Block 3B/4B and the AOIs are the pink and red coloured polygons respectively (after De Wet, 2012).

8.8.4.2 THE ORANGE BASIN

The geology of Block 3B/4B from the technical hydrocarbon exploration point of view, based on geophysical seismic data and exploration well data, has been most adequately described in the Scoping Report. A general brief account is presented below.

The Cretaceous strata which comprise the bulk of the continental margin were deposited during and subsequent to the rifting of the Gondwana supercontinent and the opening of the Atlantic Ocean 134-120 million years ago (Ma) (Figure 184). The rifting phase involved down-faulting of the continental crust by extension, forming grabens in which the synrift terrestrial and lacustrine sediments were deposited, while massive outpourings of volcanic flood basalts accumulated in the main rift, the flows now represented by the Seaward Dipping reflectors (Figure 184).

After the rifting phase, from Barremian times, the subsiding rifted landscape was covered sediments delivered to the expanding Cretaceous South Atlantic Ocean during the Drift Phase. Wide coastal plains and deltas formed as many large rivers deposited large volumes of fluvial sediments eroded from the well-watered hinterland. These Albian-Coniacian proximal alluvial/fluvial coastal plain and deltaic formations form the sub-seabed along the inshore of the shelf.

In the offshore marine processes spread the finer sands and muds further to form the deeper shelves extending seawards and slumping at the shelf edges carried sediments downslope into deep water. Successive shelves built out and upwards as the underlying crust subsided. These now fill what is called the Orange Basin, which includes an accumulation of Cretaceous sediments 6 to 8 km thick.

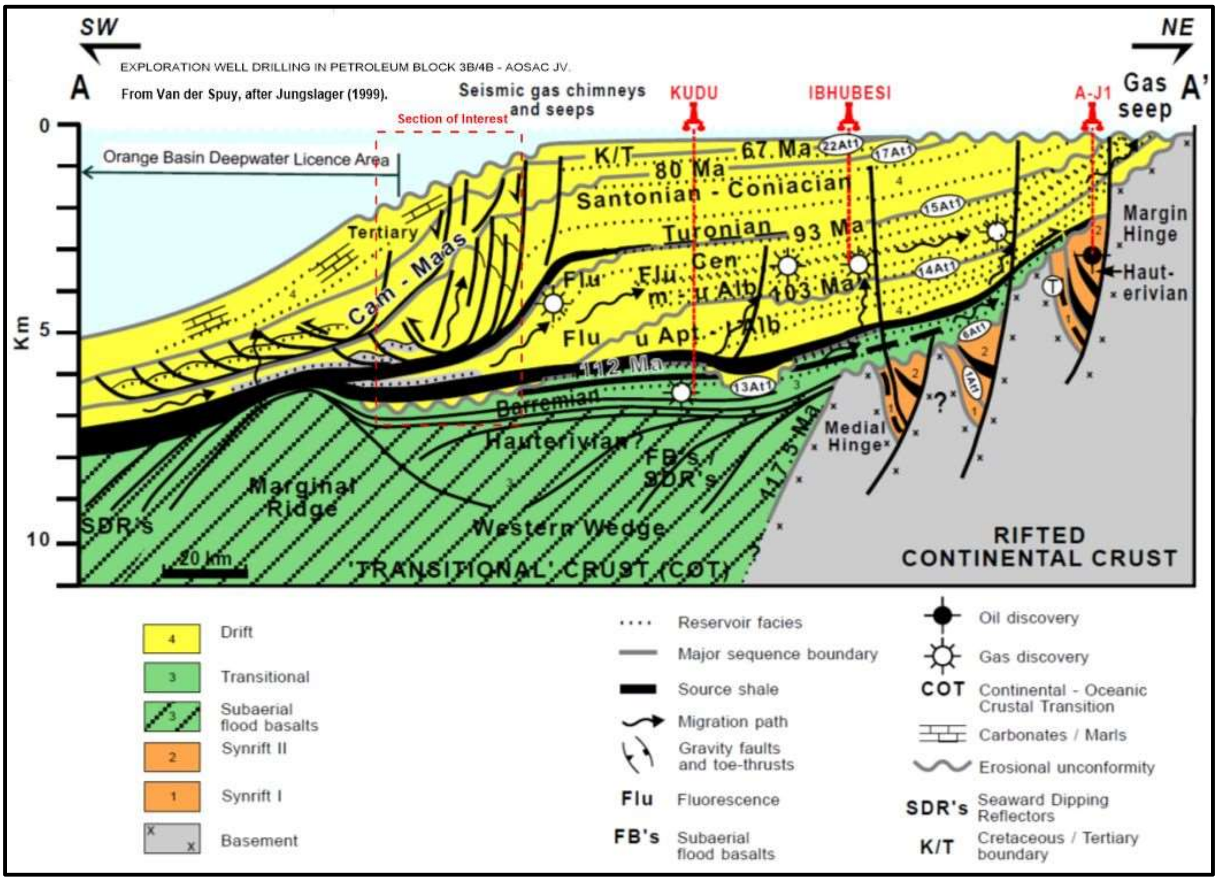


Figure 184: Schematic chronostratigraphic section of the Orange Basin continental shelf.

Overall, after the Cretaceous Period, the supply of land-derived terrigenous sediments to the margin and its rate of subsidence has decreased during the Tertiary/Cenozoic as the subcontinent became more arid, with a concomitant increase in the importance of carbonate biogenic sedimentation and authigenic mineralization (Dingle et al., 1983).

Weak upwelling developed since the middle Cenozoic and intensified from the late Miocene as global climatic deterioration progressed. The effect of late Cenozoic upwelling has been the widespread occurrence of phosphatic and glauconitic authigenic mineralization on the shelf and extensive phosphatization of Tertiary limestones exposed at the seabed (T3 and T4.)

On the shelf the Cenozoic formations, above the K/T contact (Figure 184) are relatively thin, but thicken seawards over the slope, beneath of which Paleocene and Eocene deep marine clays occur. The succeeding Miocene and Pliocene deposits offshore are pale carbonates comprised of forams, bryozoan debris and small molluscs such as scallops (Pecten spp.).

8.8.4.3 **PALAEONTOLOGICAL HERITAGE IN BLOCK 3B/4B**

The fossils which are known to occur on the continental shelf have mainly been found at middle shelf depths where they come to light during diamond mining and sampling. These fossils include Cretaceous fossil wood, Cenozoic shelly macrofauna, the fossil bones and teeth of sharks and other fishes, the skulls of extinct whale species and the occasional remains of land-living animals that roamed the ice-age exposed shelf which have been phosphatized and reworked into the latest, loose Last Transgression Sequence sediments on the seabed, and "sub-fossil" marine shells dating from the Last Transgression Sequence.

Similar contexts do not pertain in the deep-water slope setting of Block 3B/4B. Instead, a research drill core and a giant piston core acquired on the slope in Block 3B/4B provide an indication of the sediments and the expected fossils within the block.

At site ODP 1087 cores were acquired to a depth of nearly 500 m below seabed and the entire sequence consists of an accumulation of microfossils, as a fine-grained foraminiferal-nannofossil ooze (Figure 185, see also Figure 183). Most of the microfossils accumulated since about 9 Ma at a rate of 2-7 cm/1000 yrs. The lowermost 60 m coring penetrated a condensed section with missing intervals ranging back to about 34 Ma.

The giant piston core (gravity drop-core) (Figure 186 see also Figure 183) penetrated to about 36 m below seabed and also consists of foraminiferal-nannofossil ooze (Figure 187 and Figure 188). The core was dated by analysis of the oxygen isotope content of the shells of planktonic microfossils sampled at 10 cm intervals, which mainly records global polar ice volumes (alternating ice ages and warm interglacial periods).

These cores illustrate the prime palaeontological value of the species of microfossils deposited in deep-sea environments: dating by the age ranges of species, palaeo-oceanographic information from the water masses they preferentially occupy, and a variety of oceanic parameter proxies from their geochemistry. Other microfossils which are likely to occur are siliceous radiolarians and diatoms, and terrestrial pollen blown out to sea.

Macrofossils such as molluscs are not recorded from these cores, but certainly occur in the deep-sea environment. Notably, molluscs from deep dredging examined by Barnard (1963) comprised a host of new species, mostly small gastropods. However, to this day the deep-sea fauna is very poorly known. Giant benthic foraminifera may also occur.

Vertebrates will mainly be represented by shark and other fish teeth and bones. The remains of marine mammals such as cetaceans and seals are likely to be very sparsely distributed and are mainly brought up in bottom trawling swaths over a large area.

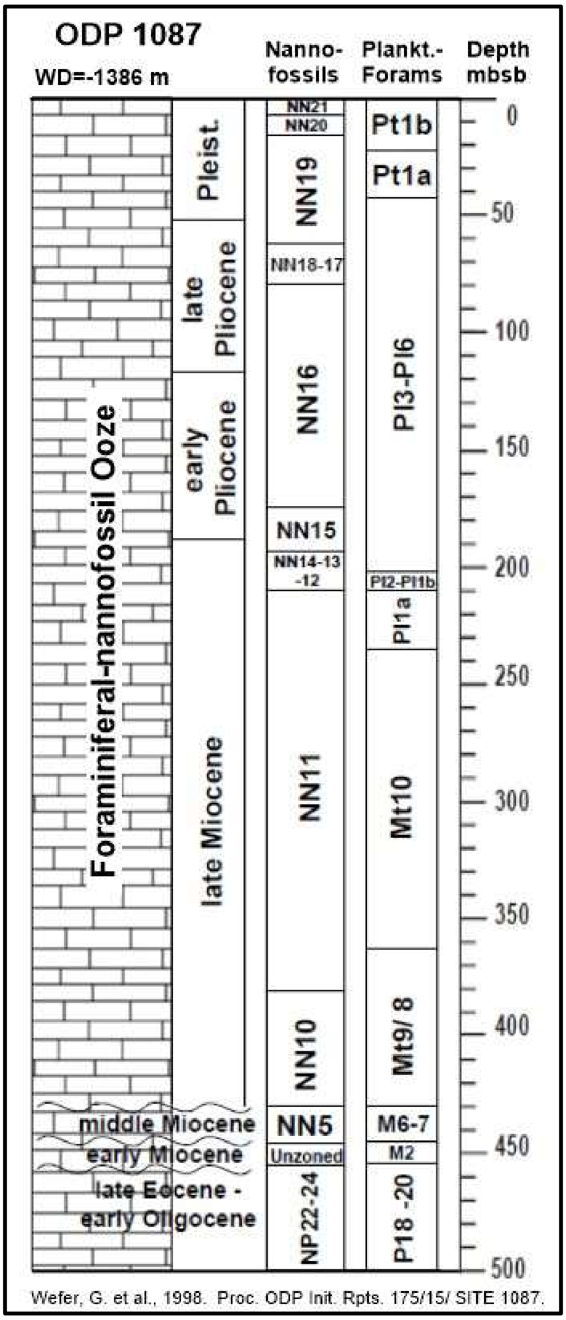


Figure 185: Ocean Drilling Program core 1087 and its biostratigraphy (ages of strata downcore), based on the age ranges of microfossils.

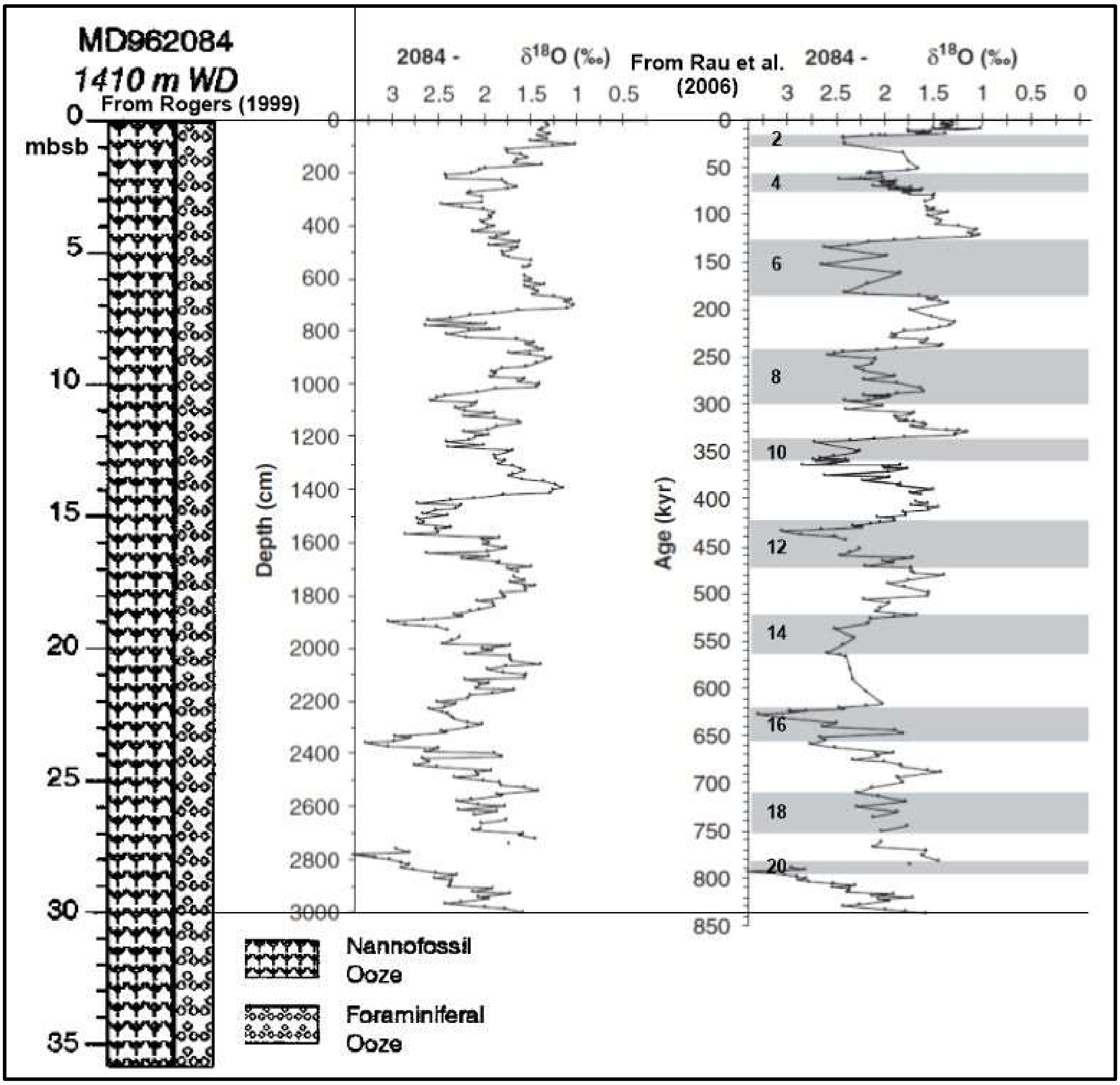


Figure 186: Giant piston core MD96-2084 and its chronostratigraphy (age model downcore) based on the Oxygen-isotopes measured in samples of shells of planktonic microfossils. Grey bars mark ice-age (glacial) intervals labelled according to Marine Isotope Stages (MISs).

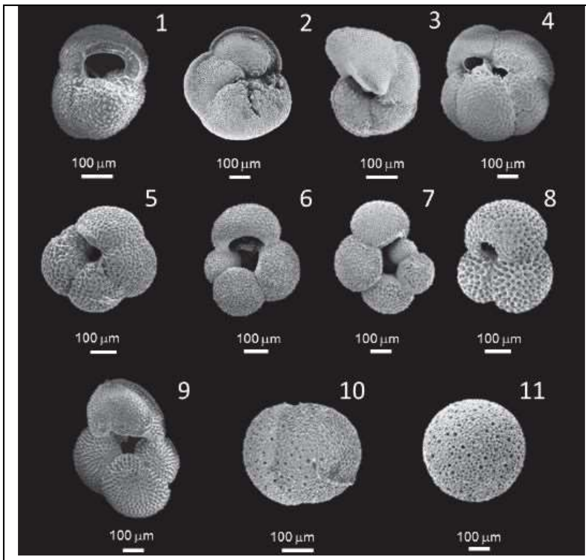


Figure 187: Planktonic foraminifera. 1. *Globoconella inflata*. 2. *Globorotalia menardii*. 3. *Globorotalia truncatulinoides*. 4. *Neogloboquadrina dutertrei*. 5. *Neogloboquadrina incompta*. 6 *Globigerina bulloides*. 7. *Globigerinella siphonifera*. 8. *Globigerinoides ruber*. 9. *Trilobatus sacculifer*. 10. *Orbulina bilobate*. 11. *Orbulina universa*. (Image from Bergh & Compton, 2020).

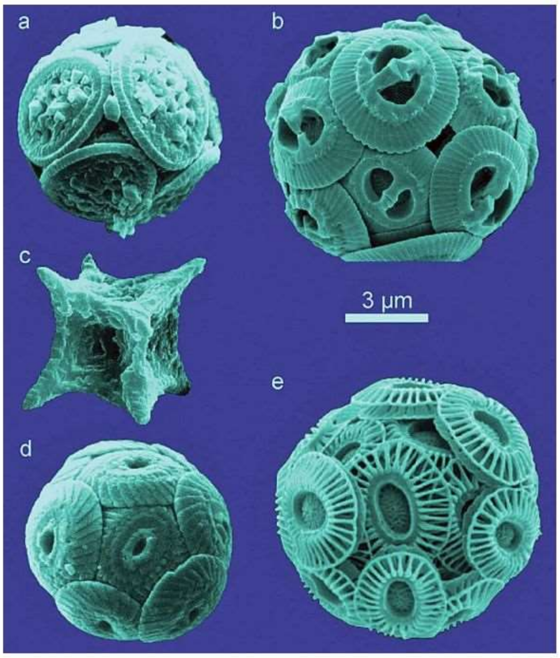


Figure 188: Calcareous nannofossils. Note their mud particle size vs the sand grain size of the foraminifera. (Image from Sturm, 2016).

8.8.4.4 **MARITIME HISTORY OF THE SOUTH AFRICAN COAST**

In 1498 the Portuguese captain Vasco da Gama pioneered the long-sought sea route around Africa from Europe to the East. Since then, the southern tip of the African continent has played a central and vital role in global economic and maritime affairs, and until the opening of the Suez Canal in 1869, represented the most viable route between Europe and the markets of the East (Figure 189) (Axelson, 1973; Turner, 1988; Gribble, 2002; Gribble and Sharfman, 2013).

The South African coast is rugged, and the long fetch and deep offshore waters mean that the force and size of seas around the South African coast are considerable, a situation exacerbated by prevailing seasonal winds. The geographical position of the South African coast on the historical route to the East and the physical conditions mariners could expect to encounter in these waters have, in the last five centuries, been responsible for the large number of maritime casualties which today form the bulk of South Africa's maritime and underwater cultural heritage (Gribble, 2002).

According to the SAHRA MUCH database and TerraMare Archaeology's own shipwreck database, at least 2,800 vessels are known to have sunk, grounded, or been wrecked, abandoned or scuttled in South African waters since the early 1500s. More than 1,900 of these wrecks are more than 60 years old and are thus protected by the NHRA as archaeological resources. This list is by no means complete and does not include the yet unproven potential for shipwrecks and other sites that relate to pre-European, Indian Ocean maritime exploration, trade and interactions along the South African east coast.

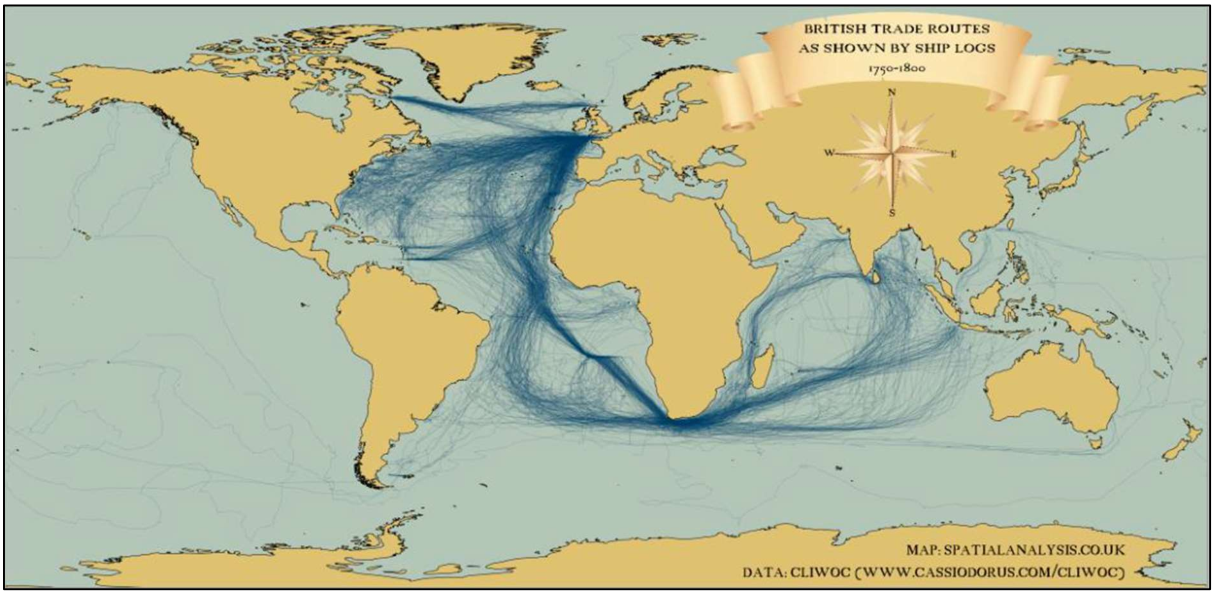


Figure 189: Example of the density of British shipping around the South African coast between 1750 and 1800 (Source: https://www.theguardian.com/news/datablog/2012/apr/13/shipping-routes-history-map).

The earliest known South African wrecks are Portuguese, dating to the sixteenth century when that country held sway over the route to the East. Due to the later, more prolonged ascendancy of first the Dutch and then the British in European trade with the East and control at the Cape, most wrecks along the South African coast are Dutch and British. However, at least 36 other nationalities are represented amongst the other wrecks that litter the coast.

Da Gama's maritime incursion into the Indian Ocean laid the foundation for more than 500 years of European maritime activity in the waters off the South African coast. The Portuguese and other European nations who followed their lead around the Cape and into the Indian Ocean, however, joined a maritime trade network that was thousands of years old and in which east and south-east Africa was an important partner.

This trade spanned the Indian Ocean and linked the Far East, South-East Asia, India, the Indian Ocean islands and Africa. Archaeological evidence from Africa points to an ancient trade in African products – gold, skins, ivory and slaves – in exchange for beads, cloth, porcelain, iron and copper. The physical evidence for this trade includes Persian and Chinese ceramics excavated sites on African Iron Age like Khami, Mapungubwe and Great Zimbabwe (see Garlake, 1968, Huffman, 1972, Chirikure, 2014), glass trade beads found in huge numbers on archaeological sites across eastern and southern Africa (Wood, 2012).

There is shipwreck evidence on the East African coast for this pre-European Indian Ocean trade (see for example Pollard et al 2016) and clear archaeological and documentary evidence that this trade network extended at least as far south as Maputo in Mozambique. This suggests that there is the potential for shipwrecks and other sites that relate to pre-European, Indian Ocean maritime exploration, trade and interactions to exist along the South African east coast and offshore waters.

The more than 2,800 historical shipwrecks that form part of South Africa's underwater cultural heritage are, thus, a huge, cosmopolitan, repository of information about mainly global maritime trade during the last five centuries, and potentially much further back into the past. These sites contain a wealth of cultural material associated with that trade and clues to the political, economic, social and cultural changes that accompanied this trade, and which contributed to the creation of the modern world.

8.8.4.5 **MARITIME HERITAGE OF BLOCK 3B/4B**

The recorded maritime history of the South African west coast dates from the first transit of these waters by Bartholemeu Dias in 1488. The Cape Route was, for centuries thereafter, the only viable maritime way of reaching the East and as indicated by Figure 189 above, was heavily used (Knox-Johnston, 1989). The historical importance of the anchorage in Table Bay, located to the south-east of Block 3B/4B, (and its relative unsuitability as an anchorage) is reflected in the fact that it contains the greatest concentration of historical wrecks in South African waters: more than 400.

North of Table Bay, the early Dutch settlers at the Cape were quick to recognise and exploit the rich marine resources of the West Coast and from almost the first days of the colonial settlement, fishing and sealing flourished, with the catches transported down the coast to supply Cape Town.

This industry led to the development of fishing villages at Saldanha Bay and Lamberts Bay, the former, together with places like Elands Bay, also later becoming ports for the export of grain and other produce from the Swartland and Cederberg (Ingpen, 1979).

During the early nineteenth century the West Coast islands became the focus of an international 'white gold' rush to exploit their rich guano resources (Watson, 1930) (Snyders, 2011). The guano was soon depleted but the discovery of rich copper deposits in Namaqualand and the Richtersveld led to the use of Alexander Bay, Robbe Bay (now Port Nolloth) and Hondeklip Bay by the early 1850s and the development of local, coasting shipping services to support this new industry (Ingpen, 1979)

Except for Saldanha Bay, the West Coast historically lacked good harbours and this, combined with the regular coastal fogs, a largely rocky shoreline and dangerous inset currents, meant that there were numerous shipping casualties along the coast adjacent to Block 3B/4B, especially since particularly much of the maritime traffic, tended to stay close to the coast rather than sailing large and out into deeper offshore waters, within which Block 3B/4B is located.

According to) the shipwreck database maintained by TerraMare Archaeology and records held by SAHRA and curated on the South African Heritage Resources Information System (SAHRIS) (http://www.sahra.org.za/sahris), there are numerous wrecks recorded between the Saldanha Bay at the southern end of Block 3B/4B and Kreefte Baai at the northern end of the block.

The bulk of these vessels were lost while involved in coastal trade and fishing and most are known to be on or close to the shore along the stretch of coastline landward of Block 3B/4B as indicated on Figure 190. These wrecks are well outside of Block 3B/4B and the study area for this assessment and will not interfere with or be impacted by the proposed exploration activities in the block.

The records consulted for this study do contain records of shipping casualties further offshore, in the vicinity of Block 3B/4B, but none of these are within the block. Potentially the closest to the block is the Kalewa, a British freighter which sank after a collision with the Boringia in August 1942 approximately 300 miles north of Cape Town, placing the wreck just north of Block 3B/4B (see Figure 190). There are conflicting records of this loss, however, and there is a suggestion that the vessel may have been lost 300 miles south of Cape Town instead.

German U-boat activity around the South African coats during World War II accounts for many of the deep water wrecks in the shipwreck record, one of which is the Columbine, a steamship torpedoed and sunk by U-198 approximately 72 km east of the southern end of Block 3B/4B in June 1944. Lastly, it must be stated that although unlikely, the possibility does exist for the remains of currently unknown and unrecorded wrecks to be present in Block 3B/4B.

The historical record contains many references to vessels that were lost without trace between their points of departure and arrival. Where survivors of such events were subsequently rescued, the loss was recorded, but in many cases, vessels simply never arrived at their destination and could thus lie anywhere along their intended route.

The potential for the occurrence of such unrecorded wrecks was illustrated in 2008 when a 16th century Portuguese wreck, since identified as the Bom Jesus, was unexpectedly found during the diamond mining south of Oranjemund in Namibia (see Alves 2011).

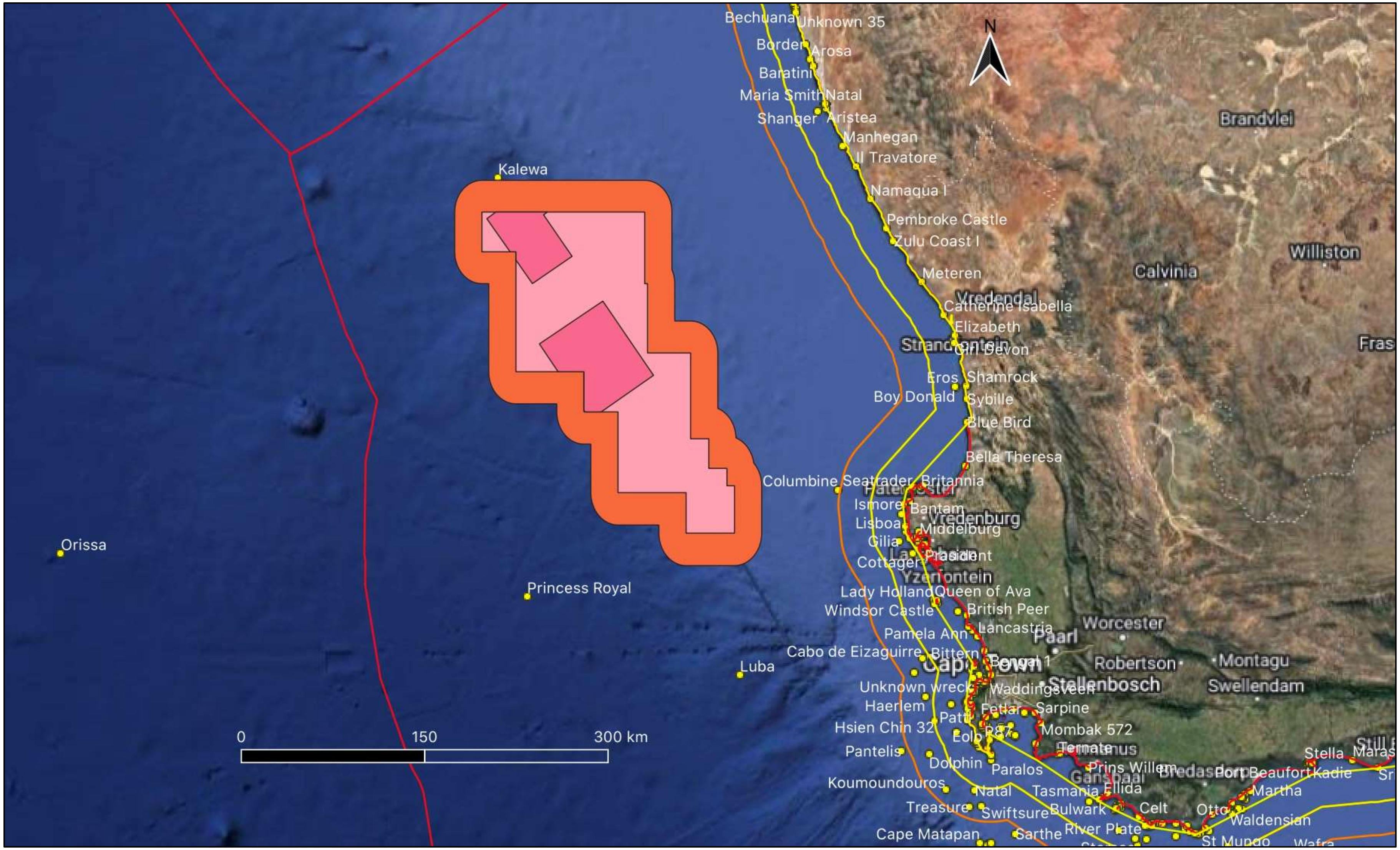


Figure 190: Indication of the number of recorded shipwrecks between Cape Agulhas in the south and Hondeklip Bay in the north. Note the Kelewa north of block 3B/4B and the Columbine to the east (Source: TerraMare Archaeology Shipwreck Database).

8.8.5 INTANGIBLE HERITAGE

Intangible heritage' (also referred to as 'Living Heritage') is a term which is used to describe "aesthetic, spiritual, symbolic or other social values people may associate with a site, as well as rituals, music, language, know-how, oral traditions and the cultural spaces in which these 'living heritage' traditions are played out." Through its efforts to safeguard Intangible heritage, UNESCO and its member states developed the Convention for the Safeguarding of the Intangible Cultural Heritage (ICHC). The following section is extracted from a UNESCO webpage that explains the importance of Intangible Heritage:

"While fragile, intangible cultural heritage is an important factor in maintaining cultural diversity in the face of growing globalization. An understanding of the intangible cultural heritage of different communities helps with intercultural dialogue and encourages mutual respect for other ways of life.

The importance of intangible cultural heritage is not the cultural manifestation itself but rather the wealth of knowledge and skills that is transmitted through it from one generation to the next. The social and economic value of this transmission of knowledge is relevant for minority groups and for mainstream social groups within a State and is as important for developing States as for developed ones.

Intangible heritage is:

- Traditional, contemporary, and living at the same time: intangible cultural heritage does not only represent inherited traditions from the past but also contemporary rural and urban practices in which diverse cultural groups take part.
- Inclusive: we may share expressions of intangible cultural heritage that are similar to those practised by others. Whether they are from the neighbouring village, from a city on the opposite side of the world or have been adapted by peoples who have migrated and settled in a different region, they all are intangible cultural heritage. They have been passed from one generation to another, have evolved in response to their environments and they contribute to giving us a sense of identity and continuity, providing a link from our past, through the present, and into our future. Intangible cultural heritage does not give rise to questions of whether or not certain practices are specific to a culture. It contributes to social cohesion, encouraging a sense of identity and responsibility which helps individuals to feel part of one or different communities and to feel part of society at large.
- Representative: intangible cultural heritage is not merely valued as a cultural good, on a comparative basis, for its exclusivity or its exceptional value. It thrives on its basis in communities and depends on those whose knowledge of traditions, skills and customs are passed on to the rest of the community, from generation to generation, or to other communities.
- Community-based: intangible cultural heritage can only be heritage when it is recognized as such by the communities, groups or individuals that create, maintain and transmit it – without their recognition, nobody else can decide for them that a given expression or practice is their heritage."

Intangible Cultural Heritage (ICH) consists of the folklore, ritual practice, beliefs, symbolism, social attachment, as well as associated human sensory engagement with the coast and sea. ICH is also found underwater, as part of the tangible heritage associated with maritime artefacts that remain on the sea floor after a shipwreck for example.

In this regard to Block 3b/4b, there is need to consider the potential impacts on Areas Beyond National Jurisdiction (ABNJ), which 3b/4b will 'touch' on as its potential impacts can go beyond the South African EEZ. South Africa has several World Heritage Sites (WHS) in which the tangible natural and intangible cultural elements are recognised and valued. The government also recognises ICH in its reference to living heritage in the National Heritage Resources Act 25 of 1999. The recognition of ICH is also evident in the SA Constitution. ICH is diversely considered by stakeholder groups situated at the coast, in the different provinces of South Africa. The ICH maintained reflects the cultural diversity of South Africa.

ICH and Tangible Heritage (TH) are contested by stakeholder groups because the practices associated with both reflect the specific cultural interests and values of each group. Despite contestation however, the anthropological research (henceforth referred to as the 'research') revealed that there are shared and often converging values regarding the conservation of the ocean and coasts.

ICH is recognized by the First Peoples of South Africa, the various groups defined within the Khoisan collective. This includes the Nama, Griqua/Guriqua, Gamtkwa, Korana and other Khoisan peoples. It is also expressed by Nguni descendants the majority population in South Africa, as well as the descendant groups of Europeans and Asians in the country.

8.8.5.1 **LOCATION OF COASTAL TANGIBLE AND INTANGIBLE CULTURAL HERITAGES**

The research undertaken as part of this Environmental Impact Assessment, found that ICH related to the coast and sea overlaps with immigrant (specifically southern African and Central African) beliefs and ritual practices at the coast. The research also revealed that coastal and oceanic ICH is holistic. It includes a variety of waterways that ultimately lead to the sea, these include streams, rivers, pools, lakes and estuaries. These waterways are described as 'living' waters and are believed to play a critical role in spiritual and health management in indigenous (First Nations and Nguni) groups specifically.

The specific beliefs concerning these 'living' waters can be summarized as follows:

- That the waters contain the ancestral spirits of the cultural communities noted;
- That the waters offer a spiritual domain to which people in the present realm can travel to (intentionally or otherwise) and from which they can return if the correct ritual activities are performed to ensure safe return;
- That while the lesser waterways such as streams, rivers and pools may contain a community's specific ancestral spirits, the ocean itself contains the ancestral spirits of the African continent and arguably the ancestral spirits of all humanity;
- That the ancestral spirits in the ocean reside on the seabed or seafloor;
- That indigenous peoples should always approach the sea and coast, as well as lesser waterways with reverence and sometimes, fear;
- That belief in the ancestral world and the place of ancestors in waterways and other ecologically sacred places does not require a relinquishing of belief in an omnipresent God. The ancestors form part of a complex genealogy of which God is the head;
- That regular, consistent and frequent interaction take place with the coast and sea in order to secure the guidance and benevolence of living communities, ancestors, as well as spirits that reside in such living waters; and
- That for First Nation peoples there is belief in the natural connection (i.e., no division) between humans and nature and that all alterations (including development) in natural settings must be preceded by rituals of respect and recognition of the divine creation and its contribution to human survival. The location of ICH for First Nations appears to exist across the territorial and aqueous domains, for example, across mountains and sea.

8.8.5.2 **SUMMARY OF RESEARCH FINDINGS**

The coastline considered part of the area of indirect influence, is from Port Nolloth in the Northern Cape and down the West Coast of the Western Cape Province to False Bay. These are areas with rich intangible cultural heritage. These heritages were noted and discussed by participants during fieldwork from March 2022 to May 2023. SSF and SSF families displayed high regard of the sea as well their spiritual and cultural connection with the ocean. The communities were concerned about the impact of offshore exploration including drilling in the ocean on fish stocks and on the natural environment but there were also those who desired the development that may come to South Africa as a result of these activities. Of the SSF interviewed, more than 50 percent indicated their worry about the effects of offshore oil and gas operations on fish stocks.

The team also found First Peoples' revivals of identity and remembering of coastal ICH. These stories revealed the cultural and ecological sensitivity of these coastlines, as well as their cultural value. MPA studies, the reliance of SSF families on these coastlines for subsistence, the role of the coastline in fish spawning, as well as studies of aquatic biodiversity further reveal socioeconomic reliance on coastal sites.

Secondary data to ascertain the archaeological and tangible cultural heritage at the coast indicates that, in Namaqualand (and therefore some of the Northern Cape towns selected for the fieldwork presented here), there are rich coastal and inland archaeological sites, which may be both of regional and national value (see Demset 1996, 13-14). However, these are not coastal sites, nor are they sites in the area of operation/proposed.

Secondary data analysis also revealed a similarly rich tangible (and archaeological) coastal heritage along the West Coast of the country and in the south Cape Coast. These are mainly inland sites. Indigenes' complex and holistic consideration and valuation of the sea and coast presents a different 'use' metric and valuation of the sea and coast. The ocean is not merely an asset, it is a living organism and integral part of the global ecological system. For these communities, the whole ocean forms part of a cultural complex in which local, living communities must be consulted and ancestral blessing must be obtained for development to take place. In this regard, the people interviewed consider the whole ocean to be highly sensitive regardless of industrial or other activities happening inshore.

A further finding of the May 2023 research was that for aboriginal peoples, otherwise self-describing as Khoisan, nature itself (including the ocean) is believed to have agency and is therefore deserving of specialized ritual request to the ocean itself, prior to offshore operations that involve extraction of natural resources from the sea.

In the research and engaging with people of Khoisan ancestry, it was found that, regarding ICH specifically, there are deep First Peoples' relations with the sea and nature. For the First Peoples or Khoisan, humans live in a symbiotic and holistic relationship with the sea. This is a relationship that must be conserved, and it is key to the full development of persons who are part of a larger, critically balanced ecosystem. Khoisan and Nguni peoples regularly and consistently engage with the ocean and nature, drawing on fynbos and coastal plants for healing and using the sea to commune with the ancestral world. For the Xhosa in particular, the ocean seabed is the final resting place of ancient ancestors and there is belief (even among Zimbabwean immigrants) that the sea is living water and has the possibility of healing many physical and spiritual ailments.

Under apartheid many people of mixed 'racial' descent were categorised as Coloured. This denied them expression of their Khoisan ancestry or, of any ancestry (including European ancestry) which they may have wished to publicly articulate. Since 1994, the Khoisan revival has seen many people, categorised as Coloured, taking the 'liberation walk', to reconnect with their Khoi ancestry and the spirit world denied to them in Christianity and under apartheid. The majority population of colour in the Northern Cape and Western Cape are Coloured and African Black (Nguni descendants), meaning that a majority believe in, and or engage in ritual activity that expresses a deep relationship with the ancestral world. Ancestors reside on the seabed, in flowing rivers, waterfalls, streams and estuaries. Hence the environmental conservation of all these flowing waters is perceived to be critical for the maintenance of beliefs and ritual practice. There is a substantive and valuable literature on the dynamics of Coloured and Khoisan identity in South Africa and this is succinctly assessed and presented in an annotated bibliography that clearly shows the dynamic and constructed nature of all cultural identities (Verbuyst 2022a and 2022b).

A further finding regards the twinning of diverse ecological niches in the coastal biome (sea and desert for example in the Northern Cape) and the consequent expression of dual cultural heritages that showcase the holistic nature of coastal cultural heritage. These contribute to biocultural heritage (Boswell 2022b), since they intertwine floral/faunal expressions of marine biodiversity, geological markers and human engagement with such diversity.

It is also found that in Port Nolloth, an atmospheric cultural heritage was identified in relation to the desert and coast, namely that the sea air turned to fog and mist at the coast and that this produced ideal conditions for the sustenance of coastal natural flora, as well as the requisite atmosphere for coastal leisure and sporting activity in an otherwise hot coastal setting. Although culturally interesting, it is unlikely that this aspect will be affected by drilling of the Earth's crust.

In Paternoster, Kalk Bay, Langebaan and St James, board and kite surfers, as well as SSF and swimmers spoke of the interplay of Earth/moon gravity and the tides, their impacts on surf swells and winds, as well as the abundance of fish. These comments emphasised the holistic and rhythmic/cyclical nature of cultural heritage expression and experience at the coast, as well as the physics of water, which was indicated to offer balance and wellbeing to humans.

In interviews, SSF and other community members were identified who identify as Xhosa but do not use the ocean for cultural purposes. This finding tells that it is important to consider that not all who are able to, will necessarily find cultural heritage important or more important than socioeconomic survival.

Secondary data analysis reveals ancient shell middens and caves with ancient rock art (produced by the First Peoples) in the Northern Cape coast and the Western Cape of South Africa, specifically in the area of Paternoster and St-Helena Bay. These are inshore sites of archaeological and tangible heritage significance, recently (February 2022) nominated by the South African government for World Heritage consideration. Even those sites not nominated for either national or World Heritage status are considered valuable and worthy of conservation, as noted in the principles set out in Section 5 of NHRA.

Secondary data analysis revealed the archaeological significance of the northern cape coast and the West Coast of the country. Orton, Hart and Halkett (2005) discuss the proliferation of shell middens in the areas of Kleinsee, Hondeklipbaai and further down the West Coast to Langebaan. The middens offer evidence of early coastal human occupation and thus, the earliest tangible cultural heritage of South Africa. As yet, early human history/archaeological prehistory is not fully attended to/considered for conservation by the South African National Heritage Council (NHC) or the South African Heritage Resources Agency (SAHRA), the implementation body of the NHC. There is expressed interest however, from the Western Cape provincial government to nominate large parts of the West Coast as a site expressive of prehistorical human heritage. A close look at the 5 June Heritage Western Cape Council Committee meeting Agenda however, reveals that more than 60 percent of this Agenda concerns inshore and tangible heritages (sites, monuments and buildings) alterations. Thus, despite the call for recognition of ICH in local communities, more attention is still being given to TH and inshore heritage conservation in South Africa.

Inshore and archaeologically significant sites are also connected to coastal cultural heritages, since some rock art in these sites express the coastal activity of aquatic hunter gatherers, showing that historically, Khoisan peoples moved between inland sites and coastal sites. The sites are directly on the shore and experience to varying degrees, various existing impacts (property development, urban regeneration). The archaeological sites cannot be dismissed as mere expression of past relationships in specific ecological niches. For, the research found that present day Khoisan descendants are recently and currently remembering and re-establishing connection with this history and are reviving pilgrimages to the sea to reconnect with histories suppressed under colonial and apartheid rule. Archaeological sites are noted in Figure 7 and are worth considering for the CHIA.

Relatedly, the indigenous peoples of South Africa, who are considered Nguni descendants (i.e., Xhosa peoples), have both historical and contemporary coastal cultural heritage. As explained next, they believe that living waterways house ancestral spirits and that regular and sustained communion with such spirits and the ecological spaces noted, nourish and support benevolent relationships with the ancestral world. The ancestors are consulted for a diversity of reasons, such as explanation of ill health, a venture to be undertaken, for significant life cycle rituals (birth, marriage and circumcision for instance).

Thus, living waters (rivers, streams, pools, lakes, estuaries and seas) should be kept pristine for ease of and successful communication with the ancestors. Indigenous peoples (and some of those defined as Coloured under the apartheid regime), also imbibe sea water, as part of a complex set of ritual practices that facilitate contact with the ancestral world. Thus estuaries, rivers and streams fed by oceanic waters are sites as well. These are cultural and sacred landscapes, and their waters (as well as seawater) are used for ritual purposes.

European descendants in the research sites also cultivate a cultural relationship with ocean and coast. While the majority of responses focused on leisure pursuits at the coast, interviews on these subjects revealed that coastal sporting/leisure activities had become ICH for these communities, since the activities contained strong cultural elements (i.e. social grouping, ritual practices, commensality, unique identity, shared histories) and that these were practiced on a regular and continuing basis.

The research also revealed the role of other stakeholder groups in recognising and protecting coastal cultural heritage. These groups included municipalities and property developers who focus on the unique features of coastal towns (Tangible and Intangible cultural heritage) and leverage these features for infrastructure development and investment respectively. For instance, it was found that, the Western Cape government has produced a series of feasibility studies in 2021, including a World Heritage Site (WHS) socioeconomic study. The study has been commissioned *"… under part 3(h) of schedule 1033 of the South African World Heritage Convention Act No. 49 of 1999 (SAWHCA) Format and Procedure for The Nomination of World Heritage Sites in The Republic of South Africa. The general purpose of the Study is to identify the possible socio-economic and tourism benefits to the local community derived from the declaration of the serial nomination as World Heritage Site. More specifically, the Study should determine the potential community benefits to be derived from the serial nomination; the projected jobs to be created, as a direct and indirect result of the nomination; potential funding* *sources, present and future, to support the programmes at the World Heritage Site and the sustainability thereof."*

In the Socioeconomic study, the Diepkloof Rock Shelter in Langebaan and the Pinnacle Point Site Complex in the Southern Cape are noted as archaeologically significant sites (and therefore mixed tangible/intangible cultural heritage sites) worthy of world heritage status. In February 2022, the South African government approved the nomination of these sites for World Heritage consideration, as well as four other sites (including sites in the southern cape coast and in Kwazulu-Natal). The sites are already declared as national heritage sites. The South African cabinet noted that the nominated sites 'collectively contribute to the understanding of the evolution of humankind and they showcase the long sequences of human occupation over tens of thousands of years with evidence dating the period of the emergence of modern humans.' The submission of the sites for nomination is said to be 'aligned to the World Heritage Convention Act, 49 of 1999, which provides for countries to make these submissions as part of the global understanding of the evolution of humans.' In May 2023, research in the Mossel Bay area revealed the establishment of an educational and 'identity restoration' center, the Point Discovery Centre. It is envisaged that the area behind the Centre will contain areas for activities that will enhance remembrance of Khoisan identity and cultural heritage. Interviews at the site indicated the potential for discovery of further inshore tangible cultural sites. Mossel Bay and the Pinnacle Point site complex, important to Khoi and the broader South African cultural history, are however, far from potential impacts from Block 3b/4b.

Some of the groups encountered in the area of indirect influence noted in this report, such as SSF, demonstrated greater cultural proximity to the ocean and coast. Thus, they personalised the ocean and coasts more, recognised the agency of the sea itself and the social personalities of marine life. This is also noted in Sunde's (2014) PhD Thesis. However, and as laid out in the Baseline report for Block 3b/4b, one needs to consider the dynamism of culture and the situational nature of cultural identity, as well as consider coastal cultural heritage collectively and along with other desires and needs for South Africa's coastal areas. There are competing values and plans for the advancement of the South African nation. Thus, even though the CHIA research finds the twinning of diverse ecological niches in the coastal biome and the consequent expression of dual cultural heritages that showcase the holistic nature of coastal cultural heritage – it still needs to be asked, do all coastal South Africans share this perspective and does this valuation of the coast supersede other forms of cultural valuation and cultural diversity found along the coast? There are diverse forms of biocultural heritage, since they intertwine floral/faunal expressions of marine biodiversity, geological markers and human engagement with such diversity.

In Pringle Bay, Hangklip and broader Cape Town, residents twinned the cultural heritage of the mountain with that of the sea. They spoke of the invigorating atmospheric natural heritage engendered by sea air in the coastal areas and how the mountain-sea climatic system was a holistic one leading to specific fauna and flora that formed part of the natural-cultural heritage of the coast.

In Cape Town Central Business District (CBD) we learned of the integral part of seafood in culture and heritage. Interviewing a Malay woman from the city, she told us that, at Eid every year, families who can afford it will make a crayfish curry – this signals both the importance of Eid itself, as well as the high cultural value of crayfish in the community.

The team learned that all fish or seafood are not equal, abalone and crayfish are of much higher value and have the potential to improve the lives of those who fish for it. Interviews with SSF in Port Nolloth and St Helena Bay revealed that SSF have to now travel much further than before, because fish commonly pursued, such as sardines, are no longer readily available in the waters near these towns. The dangerous nature of fishing in open waters was also shared with the team, including beliefs that local communities have cultivated to explain miraculous situations where they were saved by mythical creatures, such as mermaids, at sea.

In Lambert's bay and in Port Nolloth, the team came across people who affirmed the existence of mermaids that saved them from drowning. These experiences strengthened belief in the other worldly nature of the sea, and of its intrinsic agency. In other words, the sea is not merely a resource, it is a living entity, containing species that are not yet known by humans.

These comments also confirmed the holistic and rhythmic/cyclical nature of cultural heritage expression and experience at the coast, as well as the physics of water, which refers to the viscosity of the sea, the regularity and shape of waves as well the regularity of marine species' shapes – which are perceived as evidence of intelligent design – of the *raison d'être* of the sea – being an integral element in a symbiotic ecologically-sound whole. The sea, to put it simply, offers physical and psychosocial balance and wellbeing to humans.

The research also found that ICH was gendered and that it had a generational dimension. Women had their own ICH with the sea and coast. For women the sea was a provider of health and healing, both physical and emotional. Women routinely and ritually took to the sea for both physical and psychological healing, engaging for example, in moon-baths at high tide. Secondly, the oceans and coasts formed part of the early socialisation of boys and young men, drawing them into the coastal ecological niche as part of a locally embedded, masculine socialisation. There are gendered cultural heritage with the oceans and coast.

Finally, the research found that coastal cultural heritages are similarly considered by indigenous South Africans and some southern African immigrant groups. An interview with a Zimbabwean woman, as well as secondary data on southern African water rituals, revealed that southern Africans share in their veneration of the ancestors and in belief regarding ancestral worlds. They also share in belief regarding living water 'housing' ancestral spirits and realms. Specifically, the secondary data analysis tells of Mami Wata – a feminine goddess, who resides in rivers and at the bottom of the ocean. Belief in Mami Wata is apparent across many African countries, not just southern Africa. An incarnation of Mami Wata is also said to be apparent in Yemanja/Lemanja, the goddess of the sea, who is revered in the African-American diaspora of Brazil, the Caribbean and the United States. Thus, heritages are not merely national or global, they are also continental and regional. Conservation of heritage therefore, may have positive implications for the restoration of African and diaspora human dignity, history and indigenous knowledge forms.

8.9 SHIPPING DENSITY

A large number of vessels navigate the major shipping lanes along the South African Coastline. Approximately 96% of the country's exports are conveyed by sea through eight commercial ports. These ports are the conduits for trade between South Africa and its southern African partners as well as hubs for traffic to and from Europe, Asia, the Americas and the east and west coasts of Africa. Figure 191 provides an indication of the annual shipping density along the South African Coast. It can be observed that the shipping density is generally low to medium over the majority of the proposed exploration area within Block 3B/4B.

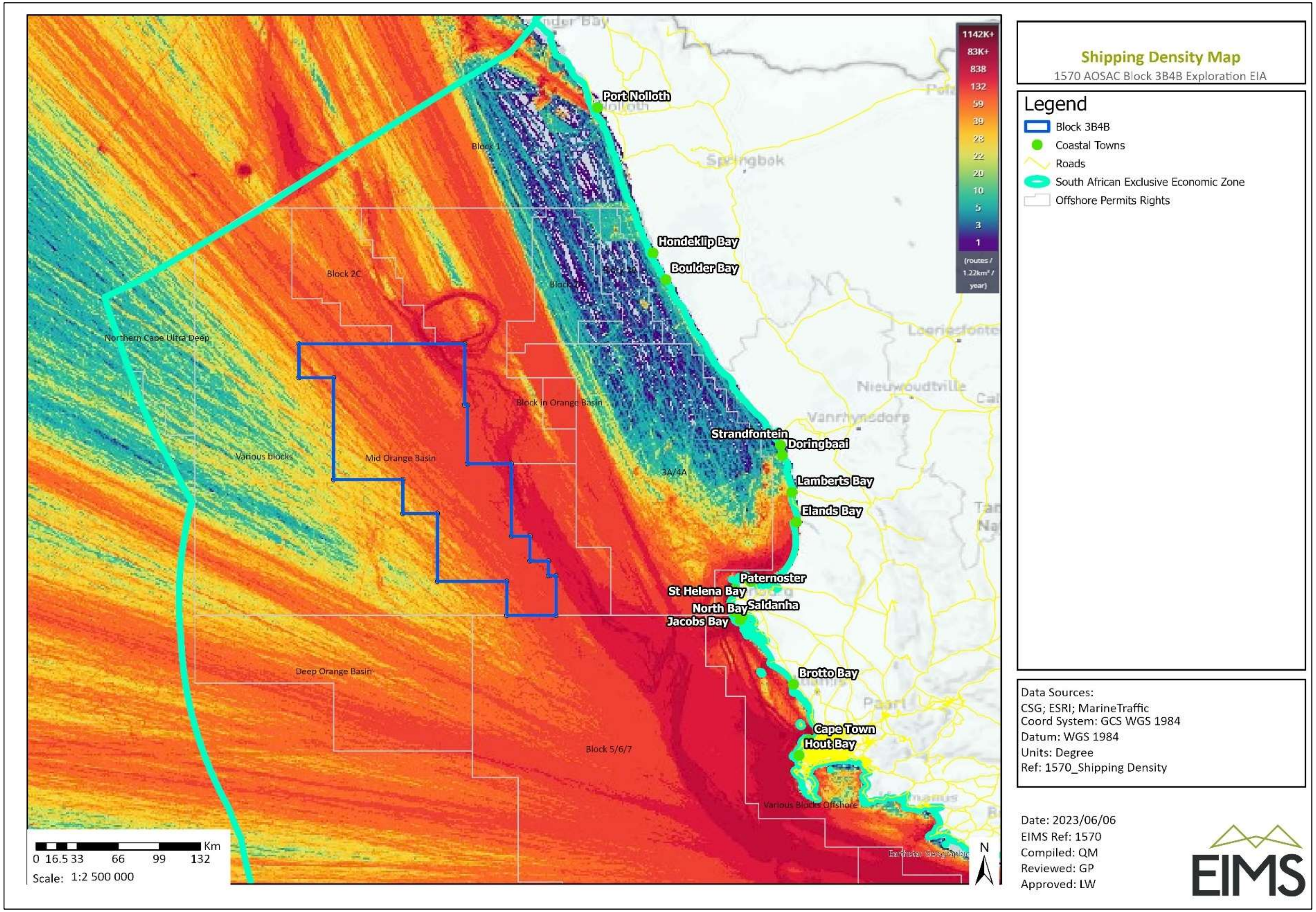


Figure 191: Annual shipping density along the South African Coast.

8.10 AIR QUALITY

This section provides a description of the air quality characteristics of the application area. The information has been sourced from the Air Quality Assessment undertaken by Airshed (Appendix 4).

8.10.1 AIR QUALITY SENSITIVE RECEPTORS

With the exploration being offshore, the nearest identified Air Quality Sensitive Receptors (AQSRs) include coastal towns along the west coast, with the nearest town being Paternoster and Saldanha Bay (120 km from the closest point). AQSRs generally include places of residence and areas where members of the public may be affected by atmospheric emissions generated by industrial activities.

8.10.2 ATMOSPHERIC DISPERSION POTENTIAL

The atmosphere conditions have traditionally been categorised into six stability classes, as summarised in Table 37. Whilst the atmospheric condition over land generally exhibits a strong diurnal variation of atmospheric stabilities, with alternating stable night-time and unstable daytime conditions, the atmospheric condition over the ocean is generally more neutral and stable than unstable. The highest concentrations for low level emission sources would occur during weak wind speeds and stable atmospheric conditions. For elevated releases, unstable conditions can result in high concentrations of poorly diluted emissions close to the point of release. Neutral conditions disperse the plume equally in both the vertical and horizontal planes, whereas stable conditions minimise the plume from mixing vertically, although it can still spread horizontally.

Table 37: Atmospheric stability classes

Atmospheric Stability	Pasquill-Gifford Stability Classification	Atmospheric Condition
Very unstable	A	calm wind, clear skies, hot daytime conditions
Moderately unstable	B	clear skies, daytime conditions
Unstable	C	moderate wind, slightly overcast daytime conditions
Neutral	D	high winds or cloudy days and nights
Stable	E	moderate wind, slightly overcast night-time conditions
Very stable	F	low winds, clear skies, cold night-time conditions

A location approximately 120 km offshore from Paternoster and Saldanha Bay (-32.998°, 16.602) was selected as a representative area to provide typical wind conditions in the study area. The study area is characterised by strong wind conditions with an annual mean wind speed of 7 m/s. As shown in the annual average wind rose (Figure 192) the most prevalent wind direction is from south-southeast (SSE) (35%), followed by winds from the south (S) (20%). Of importance to the current assessment are the conditions leading to impacts of air pollution emissions from the project that may impact on the West coast. The closest shoreline is 120 km from the study area at Paternoster and Saldanha Bay. For a direct impact, the wind must come from a westerly direction. According to the GWA, the probability is about 7% of the year.

Two atmospheric conditions were included in the dispersion simulations:

- Worst-case meteorological conditions would be during low wind speed and stable atmospheric periods, typically during the night. This meteorological scenario is represented by “F” Pasquill-Gifford class with a wind speed of 1.5 m/s.
- The second meteorological scenario was “D” Pasquill-Gifford class and a wind speed of 3 m/s, a typical daytime condition represented by neutral atmosphere with a more defined wind speed of 3.0 m/s or greater.

As discussed above, the probability of the wind blowing toward the coastline from the Project is estimated to be a maximum of 7% per year. The annual average wind speed is about 7 m/s. Calm wind conditions (≤1.5 m/s) represent the worst case for atmospheric dispersion is expected to occur less than 2% of the year.

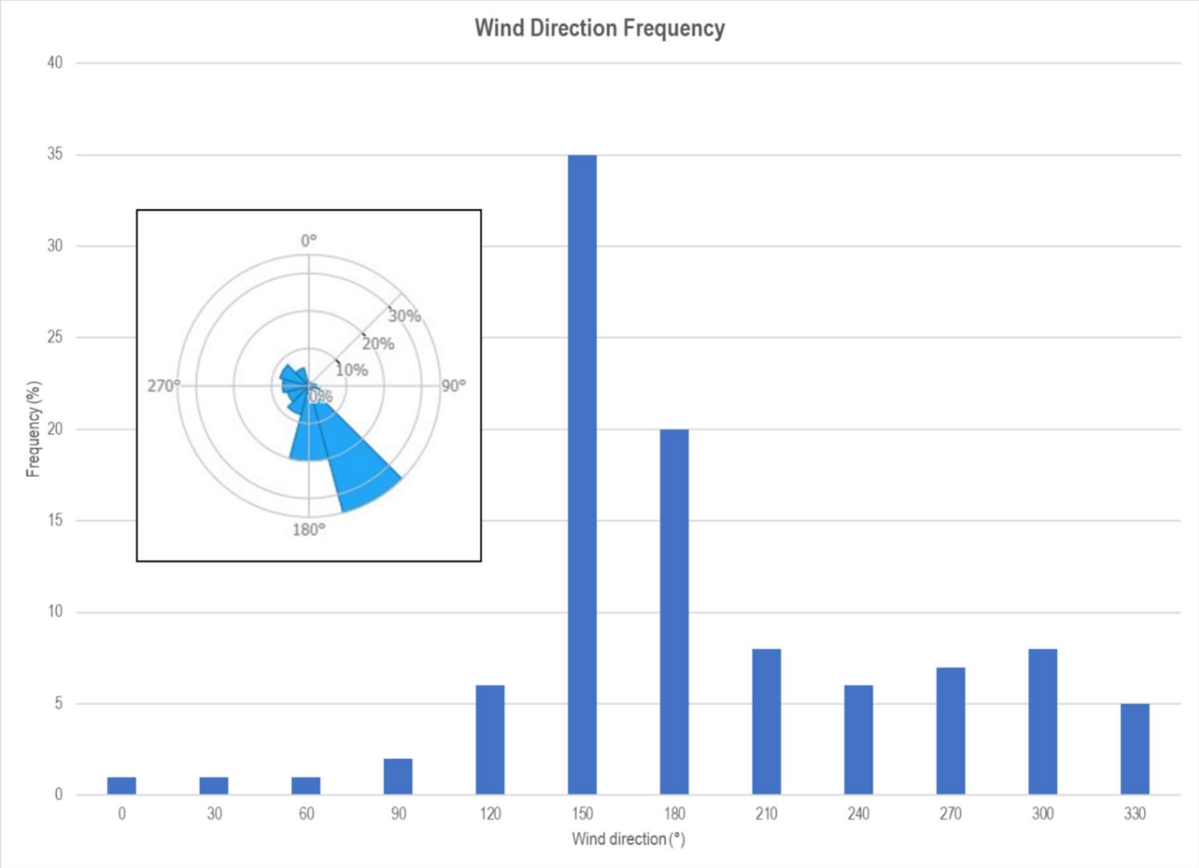


Figure 192: Wind rose using 10-year (2008-2017) hindcast data for the study area (Global Wind Atlas 2022)

8.11 CLIMATE CHANGE

This section provides a description of the climate change characteristics associated with the proposed project. The information has been sourced from the Climate Change Assessment undertaken by Airshed (Appendix 4).

The inclusion of climate change considerations into the mitigation context might mean providing recommendations for the reduction of GHG emissions associated with the proposed project, whereas adaptation, on the other hand, might lead to recommendations on how to modify the project considering potential climate change impacts. In this respect, it is necessary to understand future projections of weather conditions, typically including changes in rainfall patterns, ambient temperature variations, sea rise, etc.

8.11.1 TEMPERATURE AND RAINFALL PROJECTIONS: SAWS CCRA

The South African Weather Service (SAWS) study based its climate change scenarios on the seven Representative Concentration Pathways (RCPs) as discussed in AR5 (IPCC, 2013) with a summarised version in Appendix A of the Climate Change Assessment Report in Appendix 4. This section summarises the projections for the two most referenced RCPs, i.e.:

- RCP4.5 – described by the IPCC in AR5 as an “intermediate” pathway” and is based on the assumption that current interventions to reduce GHG emissions are sustained (after 2100 the concentration is expected to stabilise or even decrease) and is likely to result in global temperature rise between 1.1°C and 2.6°C, by 2100. The emission scenarios are biased towards exaggerated availability of fossil fuels reserves and is considered to be the most probable baseline scenario taking into account the exhaustible character of non-renewable fuels.

- RCP8.5 – representing the worst-case pathway, based on the assumption that no interventions to reduce GHG emissions are implemented (after 2100 the concentration is expected to continue to increase) and is likely than to result in global temperature rise between 2.6°C and 4.8°C, by 2100.

8.11.1.1 RCP4.5 PROJECTION

Based on the median, for the west coast region in which the Project is situated, the annual average near surface temperatures (2 m above sea surface) are expected to increase by between 1.0°C and 1.5°C for the near future (2036 to 2065) and between 1.0°C and 2.0°C for the far future (2066 to 2095). The seasonal average temperatures are expected to increase for all seasons, in the same order as the annual average increases with slightly lower increases in autumn (March to May) and winter (June to August), as summarised in Table 38.

Table 38: Projected increase in seasonal temperature in the project region in RCP4.5

Season	Near future (2036-2065)	Far future (2066-2095)
Summer (December to February)	1.0°C to 1.5°C	1.0°C to 2.0°C
Autumn (March to May)	1.0°C to 1.5°C	1.0°C to 1.5°C
Winter (June to August)	1.0°C to 1.5°C	1.0°C to 1.5°C
Spring (September to November)	0.5°C to 1.5°C	1.0°C to 2.0°C

The total annual rainfall over the region is expected to decrease by between 0 mm and 20 mm (Cape Town), between 0 mm and 10 mm (Saldanha Bay) and between 0 mm and 5 mm (Port Nolloth) for the near and far future. Predicted reduction in seasonal rainfall is shown in Table 39, indicating the same rainfall reduction for near and far future scenarios except for the coast off Cape Town with a projected higher reduction for winter.

Table 39: Projected reduction in seasonal rainfall in the project region in RCP4.5

Season	Location	Near future (2036-2065)	Far future (2066-2095)
Summer (December to February)	Port Nolloth	0 mm to 5 mm	0 mm to 5 mm
	Saldanha Bay	0 mm to 5 mm	0 mm to 5 mm
	Cape Town	0 mm to 5 mm	0 mm to 5 mm
Autumn (March to May)	Port Nolloth	0 mm to 5 mm	0 mm to 5 mm
	Saldanha Bay	5 mm to 10 mm	5 mm to 10 mm
	Cape Town	10 mm to 20 mm	10 mm to 20 mm
Winter (June to August)	Port Nolloth	0 mm and 5 mm	0 mm and 5 mm
	Saldanha Bay	5 mm to 10 mm	5 mm to 10 mm
	Cape Town	0 mm to 5 mm	5 mm to 20 mm
Spring (September to November)	Port Nolloth	0 mm to 5 mm	0 mm to 5 mm
	Saldanha Bay	5 mm to 10 mm	5 mm to 10 mm
	Cape Town	10 mm to 20 mm	10 mm to 20 mm

8.11.1.2 **RCP8.5 PROJECTION**

Based on the median, the region in which the Project is situated, the annual average near surface temperatures (2 m above the surface) are projected to increase by between 1.5°C and 2.0°C for the near future (2036 to 2065) and between 2.0°C and 3.0°C for the far future (Table 40). The seasonal annual rainfall projections are summarised in Table 41.

Table 40: Projected increase in seasonal temperature in the project region in RCP8.5

Season	Near future (2036-2065)	Far future (2066-2095)
Summer (December to February)	1.0°C to 2.0°C	2.0°C to 3.0°C
Autumn (March to May)	1.0°C to 2.0°C	2.0°C to 3.0°C
Winter (June to August)	1.0°C to 1.5°C	2.0°C to 3.0°C
Spring (September to November)	1.0°C to 1.5°C	2.0°C to 3.0°C

Table 41: Projected reduction in seasonal rainfall in the project region in RCP8.5

Season	Location	Near future (2036-2065)	Far future (2066-2095)
Summer (December to February)	Port Nolloth	0 mm to 5 mm	0 mm to 5 mm
	Saldanha Bay	0 mm to 5 mm	0 mm to 5 mm
	Cape Town	5 mm to 10 mm	5 mm to 10 mm
Autumn (March to May)	Port Nolloth	0 mm to 5 mm	0 mm to 10 mm
	Saldanha Bay	5 mm to 10 mm	10 mm to 20 mm
	Cape Town	5 mm to 10 mm	20 mm to 30 mm
Winter (June to August)	Port Nolloth	0 mm and 10 mm	5 mm and 20 mm
	Saldanha Bay	10 mm to 20 mm	10 mm to 50 mm
	Cape Town	5 mm to 20 mm	10 mm to 50 mm
Spring (September to November)	Port Nolloth	0 mm to 10 mm	0 mm to 5 mm
	Saldanha Bay	10 mm to 20 mm	10 mm to 20 mm
	Cape Town	10 mm to 20 mm	20 mm to 30 mm

8.11.2 TEMPERATURE AND RAINFALL PROJECTIONS: AR6

AR6 based its climate change on the five Shared Socioeconomic Pathway (SSP) scenarios as discussed in AR6 (IPCC 2022a) with a summarised version in Appendix D of the Climate Change Assessment Report in Appendix 4. To compare with the CCRA projections the following two scenarios apply:

- SSP2-4.5 is a "middle of the road" scenario. CO_2 emissions hover around current levels before starting to fall mid-century, but do not reach net-zero by 2100. Socioeconomic factors follow their historic trends, with no notable shifts. Progress toward sustainability is slow, with development and income growing unevenly. In this scenario, temperatures rise 2.7°C by the end of the century.

- SSP5-8.5 is a future to "avoid at all costs". Current CO_2 emissions levels roughly double by 2050. The global economy grows quickly, but this growth is fuelled by exploiting fossil fuels and energy-intensive lifestyles. By 2100, the average global temperature is a scorching 4.4°C higher.

The AR6 projections for the study area for the "middle of the road" scenario (SSP2-4.5) indicate an increase in annual average temperatures from +1.4°C for the period 2041 to 2060, to +2.2°C for the period 2081 to 2100. The projections for the "avoid at all cost"-scenario (SSP5-8.5) indicate an increase in annual average temperatures from +1.8°C for the period 2041 to 2060 (defined in AR6 as "mid-term"), to +4.2°C for the period 2081 to 2100 (defined in AR6 as "long-term"). Although the CCRA and AR6 projections are based on different baselines, with the former earlier by a decade, and the definitions of the scenarios not exactly the same, the temperature projections are similar, as shown in Table 42.

Table 42: Comparison of projected increase in annual average temperature in the project region

Study/Report	Base Period	Scenario	Near future/Mid-Term	Far future/Long-Term
CCRA (SAWS downscaled simulations)	1975-2005	RCP4.5	1.0°C to 1.5°C	1.0°C to 2.0°C
		RCP8.5	1.5°C to 2.0°C	2.0°C to 3.0°C
AR6 (Climate Knowledge Portal CMIP6)	1995-2014	SSP2-4.5	1.2°C	1.83°C
		SSP5-8.5	1.83°C	3.69°C

8.11.3 TEMPERATURE AND RAINFALL PROJECTIONS: SMARTAGRI REPORT

The SmartAgri Report concludes that as a whole, the region has experienced significant increases in temperature across all zones and all seasons over the past century, with more rapid warming over the past 30 years. While the report acknowledges that some uncertainty and complexity remain, especially with regard to changes in rainfall, the region encompasses a number of somewhat independent climatic conditions. Future projected changes in rainfall indices show some variation across the province so that, while reductions in rainfall are strongly dominant, it is possible that different patterns of change may unfold. Different dynamics are involved in producing changes in summer rainfall over the northern/eastern parts of the province versus the southern regions and the western regions. The clear message is that reductions in rainfall should be anticipated across the region, but some subregions may experience much stronger reductions than other subregions. Albeit the uncertainty around projected changes in rainfall, the analysis of projected changes in water balance and potential evapotranspiration is clear due to the projected increases in temperature, involving very little uncertainty. The report found that the projected changes for the regions derived from CMIP6 do not vary significantly to those derived from CMIP5 over the southern African region, though CMIP6 on average projects stronger temperature increases globally and there are some differences in regional patterns of rainfall change.

8.11.4 SEA LEVEL RISE: AR6

Figure 193 illustrates the latest projected sea level rise under different SSP scenarios as reported in AR6 (IPCC, 2021) for two locations along the west coast, namely Port Nolloth in the north and Granger Bay in the south. Projections are relative to a 1995-2014 baseline and summarised in Table 43 for the mid-term (2041 to 2060) and long-term (2081 to 2100) periods. The projections for the sea level rise at Port Nolloth for SSP2-4.5 indicate an increase of 0.29 m for the mid-term to 0.60 m for the long-term. The projections for SSP5-8.5 indicate an increase of 0.34 m for the mid-term to 0.82 m for the long-term. The sea level rise at Granger Bay (Cape Town) for SSP2-4.5 indicate an increase of 0.26 m for the mid-term to 0.55 m for the long-term. The projections for SSP5-8.5 indicate an increase of 0.31 m for the mid-term to 0.77 m for the long-term.

Table 43: Projected increase in mean sea level in the project region

Study/Report	City	Scenario	Mid-term (2041-2060)	Long-Term (2081-2100)
AR6	Port Nolloth	SSP2-4.5	0.29 m	0.60 m

Study/Report	City	Scenario	Mid-term (2041-2060)	Long-Term (2081-2100)
		SSP5-8.5	0.34 m	0.82 m
AR6	Granger Bay	SSP2-4.5	0.26 m	0.55 m
		SSP5-8.5	0.31 m	0.77 m

8.11.5 RARE AND EXTREME EVENTS

Musekiwa, Cwthra, Unterner, & van Zyl (2015) synthesised existing literature on coastal vulnerability both from South Africa and from international studies and communications with experts to determine the parameters relevant for the classification of coastal vulnerability. The Coastline Vulnerability Index (CVI) ranges from 1 (very low) to 5 (very high). The CVI was based on ten physical coastal parameters, including elevation, beach width, tidal range, maximum wave height, geology (magmatic, metamorphic sedimentary and unconsolidated sediments), anthropogenic activities (with or without stabilisation intervention), distance to 20m isobaths, relative sea-level change, mean wave height and beach geomorphology. The study concluded with the CVIs ranging predominantly 3, south of Koingnass to Cape Town, with some coastline areas reporting as 1 and 5. North of Koingnaas, the CVI are mostly 1 and 5, with occasional areas between these two extremes.

According to Theron (2011), cited in Davis-Reddy and Vincent (2017), coastal residents may be more affected by the increased occurrence or intensity of storms than by relatively slow shoreline migration as result of sea level rise. The most noticeable effects will mostly be in the form of higher tidal regimes and increased wind speeds associated with storm surges.

Extreme weather events affecting southern Africa, including heat waves, flooding due to intensified rainfall due to large storms, and drought, have been shown to increase in number since 1980 (Davis-Reddy & Vincent, 2017). Projections indicate (Davis-Reddy and Vincent 2017):

- With high confidence: heat wave and warm spell durations are likely to increase, while cold extremes are likely to decrease. Up to 80 days above 35°C are projected by the end of the century under the AR6 RCP4.5 scenario; and
- With medium confidence: droughts are likely to intensify due to reduced rainfall and/or an increase in evapotranspiration.

Tropical cyclones are generated in areas where the ocean surface temperature is greater than 27°C and between latitudes 5°S to 30°S. Since the AOI is located in an area where the ocean surface temperature is colder than 27°C, and south of 34°-degree latitude it is therefore not subject to tropical cyclones.

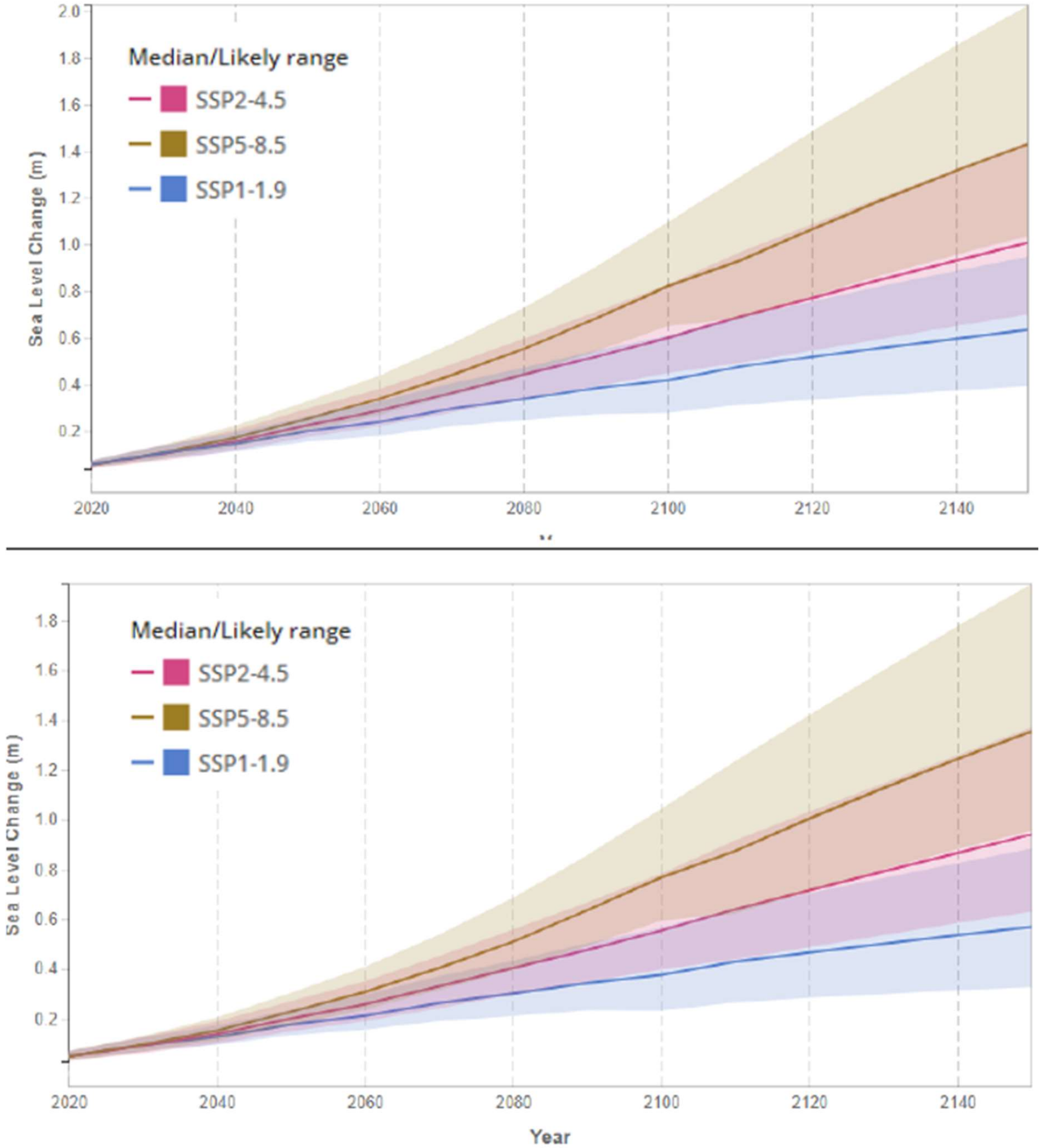


Figure 193: Sea level projections for Port Nolloth and Granger Bay (Cape Town) as per the AR6 results (IPCC – Sea Level Projection Tool)

9 ENVIRONMENTAL IMPACT ASSESSMENT

9.1 IMPACT ASSESSMENT METHODOLOGY

The impact assessment process is broken down as follows:

- Identification of proposed activities including their nature and duration: Impacts were identified through various methods including a desktop analysis; specialist studies and the public participation process;
- Screening of activities likely to result in impacts or risks;
- Utilisation of the EIMS methodology to assess and score impacts and risks identified;
- Inclusion of I&AP comments received through the public participation process regarding impact identification and assessment; and
- Finalisation of impact identification and scoring.

The impact significance rating methodology is guided by the requirements of the NEMA Environmental Impact Assessment (EIA) Regulations, 2014. The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/ likelihood (P) of the impact occurring. This determines the environmental risk. In addition, other factors, including cumulative impacts and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER). The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and reversibility (R) applicable to the specific impact.

9.1.1 DETERMINATION OF ENVIRONMENTAL RISK

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER). The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$\boldsymbol{C} = \frac{(\boldsymbol{E} + \boldsymbol{D} + \boldsymbol{M} + \boldsymbol{R}) * \boldsymbol{N}}{\boldsymbol{4}}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 44 below.

Table 44: Criteria for Determining Impact Consequence.

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary),
	3	Local (i.e. the area within 5 km of the site),

Aspect	Score	Definition
	4	Regional (i.e. extends between 5 and 50 km from the site
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years),
	3	Medium term (6-15 years),
	4	Long term (the impact will cease after the operational life span of the project),
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction).
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected),
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected),
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way),
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring prohibitively high time and cost.
	5	Irreversible Impact

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/ scored as per Table 45.

Table 45: Probability Scoring.

Probability	1	Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%),
	2	Low probability (there is a possibility that the impact will occur; >25% and <50%),
	3	Medium probability (the impact may occur; >50% and <75%),

	4	High probability (it is most likely that the impact will occur- > 75% probability), or
	5	Definite (the impact will occur),

The result is a qualitative representation of relative ER associated with the impact. ER is therefore calculated as follows:

ER= C x P

Table 46: Determination of Environmental Risk.

Consequence	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
	Probability					

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table 47.

Table 47: Significance Classes.

Risk Score	Description
< 9	Low (i.e. where this impact is unlikely to be a significant environmental risk).
≥ 9; < 17	Medium (i.e. where the impact could have a significant environmental risk),
≥ 17	High (i.e. where the impact will have a significant environmental risk).

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/mitigated.

9.1.2 IMPACT PRIORITISATION

Further to the assessment criteria presented in the section above, it is necessary to assess each potentially significant impact in terms of:

1. Cumulative impacts; and
2. The degree to which the impact may cause irreplaceable loss of resources.

To ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impact ER (post-mitigation). This prioritisation factor does not aim to detract from the risk ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the ER score based on the assumption that relevant suggested management/mitigation impacts are implemented.

Table 48: Criteria for Determining Prioritisation.

Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/ definite that the impact will result in spatial and temporal cumulative change.
Irreplaceable Loss of Resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 48. The impact priority is therefore determined as follows:

Priority = CI + LR

The result is a priority score which ranges from 2 to 6 and a consequent PF ranging from 1 to 1.5 (Refer to Table 49).

Table 49: Determination of Prioritisation Factor.

Priority	Ranking	Prioritisation Factor
2	Low	**1**
3	Medium	**1.125**
4	Medium	**1.25**
5	Medium	**1.375**
6	High	**1.5**

In order to determine the final impact significance, the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is an attempt to increase the post mitigation environmental risk rating by a full ranking class, if all the priority attributes are high (i.e. if an impact comes out with a medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance). Table 50 presents the environmental significance rating categories.

Table 50: Environmental Significance Rating

Value	Description
≥ -17	High negative (i.e. where the impact must have an influence on the decision process to develop in the area).
≥ -9 < -17	Medium negative (i.e. where the impact could influence the decision to develop in the area).
< -9	Low negative (i.e. where this impact would not have a direct influence on the decision to develop in the area).
0	No impact
< 9	Low positive (i.e. where this impact would not have a direct influence on the decision to develop in the area).
≥ 9 < 17	Medium positive (i.e. where the impact could influence the decision to develop in the area).
≥ 17	High positive (i.e. where the impact must have an influence on the decision process to develop in the area).

The significance ratings and additional considerations applied to each impact will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.

9.2 IMPACTS IDENTIFIED

This section presents the potential impacts that have been identified throughout the EIA. It should be noted that this report will be made available to I&AP's for review and comment and their comments and concerns will be addressed in the final EIA Report submitted to the PASA/DMRE for adjudication. The results of the public consultation will be used to update the identified potential impacts, where required.

These impacts were identified by the EAP, the appointed specialists, as well as the input from the public. Table 51 provides the list of potential impacts identified.

Without proper mitigation measures and continual environmental management, most of the identified impacts may potentially become cumulative, affecting areas outside of their originally identified zone of impact. The potential cumulative impacts have been identified, evaluated, and mitigation measures suggested where appropriate.

When considering cumulative impacts, it is important to bear in mind the scale at which different impacts occur. There is potential for a cumulative effect at a broad scale, such as regional deterioration of air quality, as well as finer scale effects occurring in the area surrounding the activity. The main impacts which have a cumulative effect on a regional scale are related to the transportation vectors that they act upon. For example, air movement patterns result in localised air quality impacts having a cumulative effect on air quality in the region.

Similarly, water acts as a vector for distribution of impacts such as contamination across a much wider area than the localised extent of the impacts source. At a finer scale, there are also impacts that have the potential to result in a cumulative effect, although due to the smaller scale at which these operate, the significance of the cumulative impact is lower in the broader context.

Table 51: Identified environmental impacts

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
Marine Ecology	Mobilisation	**Alternative 1**	Routine Operational Discharges to Sea	-4.00	-3.00	-3.00
	Operation	**Alternative 1**	Routine Operational Discharges to Sea	-4.00	-3.00	-3.00
	Decommissioning	**Alternative 1**	Routine Operational Discharges to Sea	-4.00	-3.00	-3.00
	Mobilisation	**Alternative 1**	Discharge of Ballast Water from Vessels	-4.00	-1.25	-1.25
	Operation	**Alternative 1**	Noise from Helicopters	-4.00	-3.00	-3.00
	Mobilisation	**Alternative 1**	Lighting from Drill Unit and Vessels	-4.00	-3.00	-3.00
	Operation	**Alternative 1**	Lighting from Drill Unit and Vessels	-4.00	-3.00	-3.00
	Decommissioning	**Alternative 1**	Lighting from Drill Unit and Vessels	-4.00	-3.00	-3.00
	Operation	**Alternative 1**	Drilling and Placement of Infrastructure on the Seafloor	-4.00	-3.00	-3.00
	Rehab and Closure	**Alternative 1**	Drilling and Placement of Infrastructure on the Seafloor	-4.00	-3.00	-3.00
	Operation	**Alternative 1**	Disturbance and/or Smothering of soft-sediment benthic communities due to drilling solids discharge	-15.00	-15.00	-15.00
	Operation	**Alternative 1**	Disturbance and/or Smothering of hardgrounds / deep-water reef communities due to drilling solids discharge	-17.50	-9.75	-9.75
	Operation	**Alternative 1**	Biochemical Impacts of residual WBMs, NADFs and cements additives on marine organisms in unconsolidated sediments	-4.00	-1.25	-1.25
	Operation	**Alternative 1**	Biochemical Impacts of residual WBMs, NADFs and cements additives on marine organisms on hard grounds	-9.75	-9.75	-9.75

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
	Operation	**Alternative 1**	Biochemical Impacts of residual WBMs, NADFs and cements additives on marine organisms in the water column	-1.25	-1.25	-1.25
	Operation	**Alternative 1**	Increased Water Turbidity and reduced Light Penetration on marine ecology	-1.25	-1.25	-1.25
	Operation	**Alternative 1**	Reduced physiological functioning of marine organisms due to indirect biochemical effects in the sediments	-4.00	-1.25	-1.25
	Mobilisation	**Alternative 1**	Disturbance, behavioural changes and avoidance of feeding and/or breeding areas in seabirds, seals, turtles and cetaceans due to drilling and vessel noise (continuous noise)	-4.00	-3.00	-3.00
	Operation	**Alternative 1**	Disturbance, behavioural changes and avoidance of feeding and/or breeding areas in seabirds, seals, turtles and cetaceans due to drilling and vessel noise (continuous noise)	-4.00	-3.00	-3.00
	Decommissioning	**Alternative 1**	Disturbance, behavioural changes and avoidance of feeding and/or breeding areas in seabirds, seals, turtles and cetaceans due to drilling and vessel noise (continuous noise)	-4.00	-3.00	-3.00
	Operation	**Alternative 1**	Disturbance and behavioural changes in seabirds, seals, turtles and cetaceans due to Geophysical Surveys and Vertical Seismic Profiling (impulsive noise)	-6.75	-6.00	-6.75
	Operation	**Alternative 1**	Impacts of infrastructure and residual cement on marine biodiversity - Wellhead removal	-1.25	-1.25	-1.25
	Decommissioning	**Alternative 1**	Impacts of infrastructure and residual cement on marine biodiversity - Wellhead removal	-1.25	-1.25	-1.25
	Operation	**Alternative 2**	Impacts of infrastructure and residual cement on marine biodiversity - Wellhead Abandonment	-2.75	-2.25	-2.25
	Decommissioning	**Alternative 2**	Impacts of infrastructure and residual cement on marine biodiversity - Wellhead Abandonment	-2.75	-2.25	-2.25

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
	Operation	**Alternative 1**	Impacts of flare lighting on marine fauna	-4.00	-3.00	-3.00
	Operation	**Alternative 1**	Impact on marine fauna from the discharge of treated produced water	-4.00	-3.00	-3.00
	Operation	**Alternative 1**	Impact on marine fauna from hydrocarbon 'drop-out'	-4.00	-3.00	-3.00
	Mobilisation	**Unplanned**	Unplanned Collision of Vessels with Marine Fauna	-4.00	-3.00	-3.00
	Operation	**Unplanned**	Unplanned Collision of Vessels with Marine Fauna	-4.00	-3.00	-3.00
	Decommissioning	**Unplanned**	Unplanned Collision of Vessels with Marine Fauna	-4.00	-3.00	-3.00
	Mobilisation	**Unplanned**	Unplanned Loss of Equipment	-1.25	-1.25	-1.25
	Operation	**Unplanned**	Unplanned Loss of Equipment	-1.25	-1.25	-1.25
	Decommissioning	**Unplanned**	Unplanned Loss of Equipment	-1.25	-1.25	-1.25
	Mobilisation	**Unplanned**	Unplanned Oil release to the sea due to vessel collisions, bunkering accident and line / pipe rupture	-9.75	-3.00	-3.00
	Operation	**Unplanned**	Unplanned Oil release to the sea due to vessel collisions, bunkering accident and line / pipe rupture	-9.75	-3.00	-3.00
	Decommissioning	**Unplanned**	Unplanned Oil release to the sea due to vessel collisions, bunkering accident and line / pipe rupture	-9.75	-3.00	-3.00
	Operation	**Unplanned**	Unplanned Well Blow-out	-16.00	-15.00	-15.00
Fisheries	Operation	**Alternative 1**	Impacts on the fishing sector catch rates (tuna pole and large pelagic longline.	-3.50	-3.50	-3.50
	Operation	**Alternative 1**	Exclusion from Fishing Ground Due to Temporary Safety Zone around Vessels - Large Pelagic Longline	-8.00	-5.00	-5.63

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
	Operation	**Alternative 1**	Discharge of Drill Cuttings	-2.50	-2.50	-2.50
	Mobilisation	**Alternative 1**	Vessel and Drilling Noise	-5.25	-5.25	-5.25
	Operation	**Alternative 1**	Vessel and Drilling Noise	-5.25	-5.25	-5.25
	Decommissioning	**Alternative 1**	Vessel and Drilling Noise	-5.25	-5.25	-5.25
	Operation	**Alternative 1**	Vertical Seismic Profiling Noise	-7.00	-3.50	-3.50
	Operation	**Alternative 1**	Sonar Survey (MBES) Noise	-7.00	-4.50	-4.50
	Operation	**Unplanned**	Impact on fisheries of small scale hydrocarbon spill	-9.00	-6.00	-6.00
	Operation	**Unplanned**	Impact on fisheries of large-scale hydrocarbon spill (condensate)	-10.50	-10.50	-14.44
	Operation	**Unplanned**	Impact on fisheries of large-scale hydrocarbon spill (crude oil)	-20.00	-10.50	-14.44
	Operation	**Unplanned**	Loss of Equipment	-6.00	-3.50	-3.50
Maritime Heritage	Operation	**Alternative 1**	Damage to or Loss of Palaeontological Materials	3.00	3.00	3.00
	Operation	**Alternative 1**	Damage to or Loss of Maritime Archaeological Sites or Material	-1.00	-1.00	-1.00
Cultural Heritage	Operation	**Alternative 1**	Cultural heritage impact of drilling - Normal Operations	-13.00	-8.25	-9.28
	Operation	**Unplanned**	Cultural heritage impact of drilling - Unplanned Events	-18.75	-7.50	-9.38
Social	Operation	**Unplanned**	Impact of oils spills or unplanned events on the livelihoods of the fishers	-10.50	-5.00	-6.25
	Operation	**Unplanned**	Impact of well blow out on the fishing industry (worst case scenario)	-21.25	-7.5	-9.375
	Operation	**Alternative 1**	Uncertainty/Confusion related to different processes	-13.00	-8.25	-10.31

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
	Operation	**Alternative 1**	Impact on the cohesion in the community	-14.00	-11.00	-13.75
Economic	Planning	**Alternative 1**	Stimulation of economic activity (additional business sales) throughout the exploration industry's value chain for the duration of the survey operations	1.50	1.50	1.50
	Planning	**Alternative 1**	Impact on commercial fishing operators targeting large pelagic longline fish species because of reduced fishing grounds and potential lowered catch potential	-1.50	-1.25	-1.25
	Planning	**Alternative 1**	Impact on maritime logistics operations because of disrupted shipping routes to major ports along the South African coast. Alternate routes could impact on the economic efficiency of maritime logistics	-1.50	-1.25	-1.25
	Mobilisation	**Alternative 1**	The establishment of the onshore logistics base will create temporary employment opportunities for skilled labour	8.00	10.00	11.25
	Mobilisation	**Alternative 1**	Employment opportunities created by the logistics base will provide compensation to employees that will contribute toward household livelihoods and their access to services and amenities	6.75	7.50	8.44
	Mobilisation	**Alternative 1**	The economic activity stimulated by the sourcing of inputs for exploration activities will increase the fiscus of government through fiscal benefits in the form of taxation (personal, business, production, product, imports, etc)	10.00	11.00	12.38
	Mobilisation	**Alternative 1**	The sourcing of materials, equipment and associated services will generate additional business sales throughout the exploration industry's value chain – businesses providing inputs to the exploration industry will benefit from an increase in sales and economic output	10.00	11.00	12.38
	Mobilisation	**Alternative 1**	Additional employment opportunities could be created throughout the exploration industry's value chain due to increased demand generated for goods and services	5.00	5.00	5.63
	Mobilisation	**Alternative 1**	The demand for bulk services contributes to the fiscus of the local authority or providing agent	7.00	8.00	9.00

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
	Mobilisation	**Alternative 1**	The increased demand on bulk infrastructure requires additional investment to accommodate additional demand. Additional demand is accompanied by an increased maintenance burden	-5.25	-5.25	-5.91
	Operation	**Alternative 1**	The operational phase of the exploration activity will generate demand for goods and services necessary to sustain operational activities. This sustained demand over the operational period of exploration could lead to additional business sales throughout the exploration industry's value chain (increased economic output, production and gross value added)	12.00	13.00	14.63
	Operation	**Alternative 1**	New employment opportunities throughout the exploration industry's value chain could be stimulated as a result of the increased demand generated by the proposed exploration activity	8.25	9.00	10.13
	Operation	**Alternative 1**	The logistics base of the exploration activity sustains skilled employment opportunities for the duration of exploration activities	8.00	9.00	10.13
	Operation	**Alternative 1**	The employment opportunities created directly (i.e. through the projects logistics base) or indirectly (i.e. throughout the exploration industry's value chain) by the proposed exploration activity provides compensation to employees which in turn assists with maintaining household livelihoods (i.e. access to services and amenities)	8.25	12.00	13.50
	Operation	**Alternative 1**	The exploration activity through its expenditure during its operation phase stimulates economic activity throughout its value chain and as a result increases the fiscal value (i.e. taxes) collected by government	12.00	12.00	13.50
	Operation	**Alternative 1**	The exploration activity further contributes toward a basic sector of the economy and therefore assists with maintaining the economic functionality of the receiving economy by providing a basis from which SMME development could occur	4.50	7.50	8.44
	Operation	**Alternative 1**	The demand for bulk services contributes to the fiscus of the local authority or providing agent	7.00	8.00	9.00

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
	Operation	**Alternative 1**	The increased demand on bulk infrastructure requires additional investment to accommodate additional demand. Additional demand is accompanied by an increased maintenance burden	-5.25	-5.25	-5.91
	Operation	**Alternative 1**	The proposed exploration activity could lead to reduced fishing grounds and catch potential for the large pelagic longline fishing industry, which, in turn, may result in decreased economic productivity for the receiving economy's fishing industry. As a consequence, the demand for inputs to the fishing industry and the outputs from the industry may be impacted (limiting business sales, economic output and gross value added). The impact is viewed as a temporary impact given that exploration activities will not be a long-term sustained operation	-5.50	-2.50	-2.81
	Operation	**Alternative 1**	Due to the temporary decrease of economic productivity in the receiving economy's large pelagic longline fishing industry, the demand for employment throughout the industry's value chain could be lowered, affecting the availability of employment opportunities	-5.50	-2.25	-2.53
	Operation	**Alternative 1**	Due to the temporary decreased of economic productivity in the receiving economy's large pelagic longline fishing industry and the subsequent lowering of demand for employment in the industry, the compensation of employees and income of households dependent on the industry could be lowered, impacting on the capability of households to sustain livelihoods	-5.50	-5.00	-5.63
	Operation	**Alternative 1**	Due to the temporary decreased of economic productivity in the receiving economy's large pelagic longline fishing industry, the fiscal value that government receives (e.g. taxation of productions, production, businesses and employees) as a result of economic activity throughout the industry's value chain could be diminished	-5.00	-5.00	-5.63
	Operation	**Alternative 1**	The temporary decrease of economic productivity in the receiving economy's large pelagic longline fishing industry could temporarily diminish the demand for new business (SMME) development due to limited scope with which business sales can be stimulated	-2.25	-2.25	-2.53

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
	Operation	**Alternative 1**	The proposed exploration activities' area of interest overlaps with established and commonly used shipping routes. This overlap may result in disruptions to shipping operations, as vessels may need to use alternative routes. Such deviations can diminish operational efficiency and subsequently reduce the economic output (limiting business sales, economic output and gross value added) within the receiving economy's transport and storage industry. The impact is viewed as a temporary impact given that exploration activities will not be a long-term sustained operation	-8.25	-5.00	-5.63
	Operation	**Alternative 1**	Due to the temporary decrease of economic productivity in the receiving economy's transport and storage industry, the demand for employment throughout the industry's value chain could be lowered, affecting the availability of employment opportunities	-5.00	-2.25	-2.53
	Operation	**Alternative 1**	Due to the temporary decreased of economic productivity in the receiving economy's transport and storage industry and the subsequent lowering of demand for employment in the industry, the compensation of employees and income of households dependent on the industry could be lowered, impacting on the capability of households to sustain livelihoods	-5.50	-5.00	-5.63
	Operation	**Alternative 1**	Due to the temporary decreased of economic productivity in the receiving economy's transport and storage industry, the fiscal value that government receives (e.g. taxation of productions, production, businesses and employees) as a result of economic activity throughout the industry's value chain could be diminished	-5.50	-5.50	-6.19
	Operation	**Alternative 1**	The temporary decrease of economic productivity in the receiving economy's transport and storage industry could temporarily diminish the demand for new business (SMME) development due to limited scope with which business sales can be stimulated	-2.25	-2.25	-2.53
	Operation	**Unplanned**	The oil spill response activity could generate demand for goods and services necessary to sustain operational activities. This sustained demand over the response period of exploration could lead to additional business sales throughout the response industry's value chain (increased economic output, production and gross value added) (condensate)	2.25	2.5	2.81

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
	Operation	**Unplanned**	The oil spill response activity could generate demand for goods and services necessary to sustain operational activities. This sustained demand over the response period of exploration could lead to additional business sales throughout the response industry's value chain (increased economic output, production and gross value added) (crude oil)	2.25	2.5	2.81
	Operation	**Unplanned**	New employment opportunities throughout the response industry's value chain could be stimulated as a result of the increased demand generated by the response activity (condensate)	6.00	6.00	6.75
	Operation	**Unplanned**	New employment opportunities throughout the response industry's value chain could be stimulated as a result of the increased demand generated by the response activity (crude oil)	6.00	6.00	6.75
	Operation	**Unplanned**	The employment opportunities created directly or indirectly by the response activity provides compensation to employees which in turn assists with maintaining household livelihoods (i.e., access to services and amenities) (condensate)	2.00	2.25	2.53
	Operation	**Unplanned**	The employment opportunities created directly or indirectly by the response activity provides compensation to employees which in turn assists with maintaining household livelihoods (i.e., access to services and amenities) (crude oil)	2.00	2.25	2.53
	Operation	**Unplanned**	A well blow-out event could lead to reduced fishing grounds and catch potential for the large pelagic longline fishing industry, which, in turn, may result in decreased economic productivity for the receiving economy's fishing industry. As a consequence, the demand for inputs to the fishing industry and the outputs from the industry may be impacted (limiting business sales, economic output and gross value added). The impact is viewed as a temporary impact given that the well blow-out event might not be a long-term sustained event (condensate)	-2.00	-2.25	-2.53
	Operation	**Unplanned**	A well blow-out event could lead to reduced fishing grounds and catch potential for the large pelagic longline fishing industry, which, in turn, may result in decreased economic productivity for the receiving economy's fishing industry. As a consequence, the demand for inputs to the fishing industry and the outputs from the industry may be impacted (limiting business sales, economic output and gross	-2.00	-2.25	-2.53

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
			value added). The impact is viewed as a temporary impact given that the well blow-out event might not be a long-term sustained event (crude oil)			
	Operation	**Unplanned**	The potential area that is affected by a well blow-out event overlaps with established and commonly used shipping routes. This overlap may result in disruptions to shipping operations, as vessels may need to use alternative routes. Such deviations can diminish operational efficiency and subsequently reduce the economic output (limiting business sales, economic output and gross value added) within the receiving economy's transport and storage industry. The impact is viewed as a temporary impact given that exploration activities will not be a long-term sustained operation (condensate)	-2.25	-2.75	-3.09
	Operation	**Unplanned**	The potential area that is affected by a well blow-out event overlaps with established and commonly used shipping routes. This overlap may result in disruptions to shipping operations, as vessels may need to use alternative routes. Such deviations can diminish operational efficiency and subsequently reduce the economic output (limiting business sales, economic output and gross value added) within the receiving economy's transport and storage industry. The impact is viewed as a temporary impact given that exploration activities will not be a long-term sustained operation (crude oil)	-3.50	-3.00	-3.38
	Operation	**Unplanned**	The potential area that is affected by a crude oil well blow-out event overlaps with established and commonly used cruise tourism routes. This overlap may result in disruptions to cruise line operations, as vessels may need to use alternative routes, or temporarily postpone trips along popular routes. Such deviations can diminish operational efficiency and subsequently affect economic activity (limiting business sales, economic output and gross value added) within the receiving economy's tourism and transport and storage industry. The impact is viewed as a temporary impact given that the majority of surface oil has evaporated, biodegraded and dispersed after 60 days thereby reducing the area affected by an oil spill event (crude oil)	-3.25	-2.75	-3.09
Air Quality	Operation	**Alternative 1**	Atmospheric Emissions (routine)	-6.75	-6.75	-6.75
Air Quality	Operation	**Alternative 1**	Atmospheric Emissions (upset)	-5.00	-5.00	-5.00

Discipline	Phase	Alternative	Impact	Pre-Mitigation ER	Post-mitigation ER	Sum of Final score
Climate Change	Operation	**Alternative 1**	Climate Change (routine)	-8.25	-8.25	-8.25
Climate Change	Operation	**Alternative 1**	Climate Change (upset)	-5.00	-5.00	-5.00
No-Go	Operation	**No-Go**	No-Go Alternative	-8.00	-8.25	-8.25

9.3 DESCRIPTION AND ASSESSMENT OF IMPACTS

This section lists the potential impacts were identified during the EIA based on the methodology described above. The impact assessment matrix is included in Appendix 3 and the below subsections describe each impact in more detail.

No separate noise, drill cutting or oil spill impact assessment ratings are included in this report. The modelling results from these assessments are used entirely to inform the other specialist impacts, specifically the impacts on marine ecology, fisheries, economic, heritage and social assessments. Refer to Section 11.1.

9.3.1 MARINE ECOLOGY

This section provides a description of the Marine Ecological Impacts identified by in the Marine Ecological, Sound Transmission Loss Modelling, Oil Spill Modelling and Drill Cutting Modelling Studies. For a more detailed description of the impacts, please refer to these studies included in Appendix 4.

9.3.1.1 **POTENTIAL IMPACTS RELATED TO OPERATION OF DRILL UNIT, VESSELS AND HELICOPTERS**

This section provides a description of the potential impacts related to the Marine Ecology in terms of the operation of the drill unit, support vessels and helicopters.

9.3.1.1.1 ROUTINE OPERATIONAL DISCHARGES TO SEA

The routine liquid and solid discharges to sea could create local reductions in water quality, both during transit to and within the AOI for drilling. Deck and machinery space drainage may result in small volumes of oils, detergents, lubricants and grease, the toxicity of which varies depending on their composition, being introduced into the marine environment. Sewage and galley waste will place a small organic and bacterial loading on the marine environment, resulting in an increased biological oxygen demand.

These discharges will result in a local reduction in water quality, which could impact marine fauna (indirect impact) in a number of different ways:

- Physiological effects: Ingestion of hydrocarbons, detergents and other waste could have adverse effects on marine fauna, which could ultimately result in mortality.
- Increased food source: The discharge of galley waste and sewage will result in an additional food source for opportunistic feeders, speciality pelagic fish species.
- Increased predator - prey interactions: Predatory species, such as sharks and pelagic seabirds, may be attracted to the aggregation of pelagic fish attracted by the increased food source.

The contracted vessels and drilling unit must have the necessary sewage treatment systems in place, and must have oil/water separators and food waste macerators to ensure compliance with MARPOL 73/78 standards. Compliance with MARPOL means that intermittent operational discharges introduce relatively small amounts of nutrients and organic material to oxygenated surface waters, which will result in a minor contribution to local marine productivity and possibly of attracting opportunistic feeders. The intermittent discharge of sewage is likely to contain a low level of residual chlorine following treatment, but given the relatively low total discharge and rapid dilution in surface waters this is expected to have a minimal effect on seawater quality.

Furthermore, the AOI is suitably far removed from sensitive coastal receptors (>250 km) and the dominant wind and current direction will ensure that any discharges are rapidly dispersed north-westwards and away from the coast. The transit route to the AOI overlaps with various MPAs between Cape Town and the AOI; however, the habitat and biota are unlikely to be impacted by intermittent surface discharges, which rapidly disperse to very low concentrations. There is no potential for accumulation of substances discharged leading to any detectable long-term impact.

Due to the distance offshore, it is only pelagic fish, birds, turtles and cetaceans that may be affected by the discharges, and these are unlikely to respond to the minor changes in water quality resulting from vessel discharges. The most likely animal to be attracted to project vessels / drilling unit will be large pelagic fish species, such as the highly migratory tuna and billfish, as well as sharks and odontocetes (toothed whales). Pelagic seabirds that feed primarily by scavenging would also be attracted.

Other types of wastes generated during the exploration activities will not be discharged at sea, but will be transported to shore for disposal at a licensed waste management facility . The disposal of all waste onshore will be fully traceable.

Based on the relatively small discharge volumes and compliance with MARPOL 73/78 standards, offshore location and high energy sea conditions, the potential impact of normal discharges from the project vessels / drilling unit will be of MINOR intensity, IMMEDIATE duration and REGIONAL (although localised at any one time around the project vessels). As the impact is fully reversible with a low probability of occurring, the environmental risk of the impact magnitude is therefore considered VERY LOW.

The impacts associated with routine operational discharges from project vessels / drilling unit are deemed to be of VERY LOW significance, due to the medium sensitivity of the offshore receptors and the very low magnitude.

This potential impact cannot be eliminated because project vessels / drilling unit are needed to undertake the exploration activities and will generate routine discharges during operations. With the implementation of the project controls and mitigation measures, the residual impact will remain of VERY LOW significance.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Routine Operational Discharges to Sea	Mobilisation	Low	Low	Low
	Operation	Low	Low	Low
	Decommissioning	Low	Low	Low

Mitigation Measures

- Implement a waste management system that addresses all wastes generated.
- Use drip trays to collect run-off from equipment that is not contained within a bunded area and route contents to the closed drainage system.
- Implement leak detection and repair programs for valves, flanges, fittings, seals, etc.
- Use a low-toxicity biodegradable detergent for the cleaning of all deck spillages.
- Prohibit operational discharges within MPAs during transit to and from the drill site.
- Contractors will ensure that the proposed exploration campaign is undertaken in compliance with the applicable requirements in MARPOL 73/78, as summarised below.
- The discharge of biodegradable food wastes (excluding cooking oils and grease) from vessels is regulated by MARPOL 73/78 Annex V, which stipulates that:
  - No disposal to occur within 3 nm (± 5.5 km) of the coast.
  - Disposal between 3 nm (± 5.5 km) and 12 nm (± 22 km) needs to be comminuted to particle sizes smaller than 25 mm.
  - Disposal overboard without macerating can occur greater than 12 nm from the coast. As the drilling unit will be stationary, food waste will need to be comminuted prior to discharge at the drilling site.
- Discharges of oily water (deck drainage, bilge and mud pit wash residue) to the marine environment are regulated by MARPOL 73/78 Annex I, which stipulates that vessels must have:
  - A Shipboard Oil Pollution Emergency Plan (SOPEP).
  - A valid International Oil Pollution Prevention Certificate, as required by vessel class.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance

- Equipment for the control of oil discharge from machinery space bilges and oil fuel tanks, e.g. oil separating/filtering equipment and oil content meter. Oil in water concentration must be less than 15 ppm prior to discharge overboard.
- Oil residue holding tanks.
- Oil discharge monitoring and control system. The system will ensure that any discharge of oily mixtures is stopped when the oil content of the effluent exceeds 15 ppm.

- Sewage and grey water discharges from vessels are regulated by MARPOL 73/78 Annex IV, which specifies the following:
  - Vessels must have a valid International Sewage Pollution Prevention Certificate (ISPPC).
  - Vessels must have an onboard sewage treatment plant providing primary settling, chlorination and dechlorination before discharge of treated effluent.
  - The discharge depth is variable, depending upon the draught of the seismic vessel / support vessel at the time, but will be in accordance with MARPOL 73/78 Annex IV.
  - Discharge of sewage beyond 12 nm requires no treatment. However, sewage effluent must not produce visible floating solids in, nor cause the discolouration of, the surrounding water.
  - Sewage must be comminuted and disinfected for discharges between 3 nm (± 6 km) and 12 nm (± 22 km) from the coast. This will require an onboard sewage treatment plant or a sewage comminuting and disinfecting system.
  - Disposal of sewage originating from holding tanks must be discharged at a moderate rate while the ship is proceeding on route at a speed not less than 4 knots.
- Sewage will be treated using a marine sanitation device to produce an effluent with:
  - A biological oxygen demand (BOD) of <25 mg/ℓ (if the treatment plant was installed after 1/1/2010) or <50 mg/ℓ (if installed before this date).
  - Minimal residual chlorine concentration of 0.5 mg/ℓ.
  - No visible floating solids or oil and grease.
- Cooling water and freshwater surplus would be tested prior to discharge and would comply with relevant South African Water Quality Guidelines for residual chlorine, salinity and temperature relative to the receiving environment.
- Contractors will be required to develop a Waste and Discharge Management Plan for all wastes generated at the various sites and a Chemical Management Plan detailing the storage and handling of chemicals, as well as measures to minimise potential pollution. These plans will include / address the following:
  - Environmental awareness to ensure wastes are reduced and managed as far as possible.
  - Avoidance of waste generation, adopting the Waste Management Hierarchy (reduce, reuse, recycle, recover, residue disposal), and use of Best Available Technology (BAT).
  - Treatment of wastes at source (including maceration of food wastes, compaction, incineration, treatment of sewage and oily water separation).
  - Development of a waste inventory that classifies (hazardous, non-hazardous or inert) and quantifies waste, and identifies treatment and disposal methods.
  - Waste collection and temporary storage, which is designed to minimise the risk of escape to the environment (for example by particulates, infiltration, runoff or odours).
  - On-site waste storage, which is limited in time and volume.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
o Provision of dedicated, clearly labelled, containers (bins, skips, etc.) in quantities adequate to handle anticipated waste streams and removal frequency. • Chemicals will be appropriately stored onboard the project vessels (segregation, temperature, ventilation, retention, etc.).				

9.3.1.1.2 DISCHARGE OF BALLAST WATER FROM VESSELS

Artificial structures deployed at sea serve as a substrate for a wide variety of larvae, cysts, eggs and adult marine organisms. The transportation of vessels and equipment from other regions would therefore facilitate the transfer of the associated marine organisms. Similarly, depending on where the ballast water is loaded, it may contain larvae, cysts, eggs and adult marine organisms from other regions. Thus, ballasting and de-ballasting of these vessels / drilling unit may lead to the introduction of exotic species and harmful aquatic pathogens to the marine ecosystems (Bax *et al*. 2003). This would be an indirect, negative impact.

The marine invertebrates that colonize the surface of vessels or those in discharged ballast water can easily be introduced to a new region, where they may become invasive by outcompeting and displacing native species. Marine invasive species are considered primary drivers of ecological change in that they create and modify habitat, consume and outcompete native fauna, act as disease agents or vectors, and threaten biodiversity and ecosystem function (indirect negative impact). Once established, an invasive species is likely to remain in perpetuity (Bax *et al*. 2003).

The most important pathways in the transfer of marine alien species have always been related to shipping (Hewitt *et al*. 1999; Ruiz *et al*. 2000; Ruiz & Carlton 2003), with primary introduction events arising mainly from ships moving between major international ports and secondary local spread occurring via regional vessels (Wasson *et al*. 2001; Lacoursière-Roussel *et al*. 2012).

The principal vectors responsible for transfer of alien invasive species are ballast water and external hull fouling (Carlton 1987, 1999; Hewitt *et al*. 2009). Following the prohibition of harmful organotins, such as tributyltin (TBT), in anti-fouling paints (IMO 2001), hull fouling remains responsible for a large proportion of current alien introductions. More than half of the recognised marine alien species in the United Kingdom have been associated with shipping, with the main vector being fouling (Eno 1996), with Australia demonstrating a similar pattern (Thresher 1999).

In South Africa the first review of marine alien species was published in 1992 and listed 15 introduced species (Griffiths *et al*. 1992). This number has grown rapidly since, with the National Biodiversity Assessment (Sink *et al*. 2019) reporting 96 introduced marine species including 55 that are considered to be invasive. Invasive species were more prevalent on rocky shores than in other broad ecosystem groups, and in the Southern Benguela than in other ecoregions. Shipping activity has been responsible for 86% of these marine introductions, 48% of which are due to fouling (Mead *et al*. 2011).

Alien species have the potential to displace native species, cause the loss of native genotypes, modify habitats, change community structure, affect food web properties and ecosystem processes, impede the provision of ecosystem services, impact human health and cause substantial economic losses (Katsanevakis *et al*. 2014).

The drilling unit, and possibly the other project vessels, will more than likely have spent time outside of South Africa's EEZ prior to commencing drilling activities. This exposure to foreign water bodies and possible loading of ballast water increases the risk of introducing invasive or non-indigenous species into South African waters. The risk of this impact is, however, significantly reduced due by the implementation of ballast water management measures in accordance with the International Maritime Organization (IMO) guidelines. The risk is further reduced due to the far offshore location of the AOI, and the dominant wind and current direction will ensure that any invasive species drift mainly in a north-westerly away from the coast. In addition, the water depths in the AOI (500 m to 2 600 m) will ensure that colonisation of invasive species on the seabed is unlikely.

De-ballasting in the AOI, complying with IMO requirements, will thus not pose an additional risk to the introduction of invasive species.

In terms of hull fouling, the AOI is located in the main traffic routes that pass around southern Africa. Thus, the introduction of invasive species into South African waters due to hull fouling of project vessels is unlikely to add to the current risk that exists due to the numerous vessels that operate in or pass through South African coastal waters on a daily basis.

Considering the remote location of the AOI and compliance with the IMO guidelines for ballast water, the impact related to the introduction of alien invasive marine species is considered to be of MEDIUM intensity (due to it having a minimal effect on receptors) in the SHORT-TERM (due to invasive species not being able to establish) and of REGIONAL extent. As the impact is fully reversible with a low probability of occurring, the environmental risk of the impact is therefore considered LOW.

The potential for introductions of non-native marine species through hull fouling or ballast water discharge is deemed to be of VERY LOW significance, due to the very low sensitivity of the offshore receptors and the low environmental risk.

This potential impact cannot be eliminated due to the necessity of bringing the drilling unit and drilling equipment to the AOI from other parts of the world, and the need for de-ballasting once on site. Ballasting of a semi-submersible rig would only occur on set-up at or close to the drill site, with deballasting on departure also occurring at site. With the implementation of the mitigation measures above, the residual impact would reduce to low environmental risk and be of NEGLIGIBLE significance.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Discharge of Ballast Water from Vessels	Mobilisation	Low	Negligible	Negligible
Mitigation Measures				
• Avoid the unnecessary discharge of ballast water. • Use filtration procedures during loading in order to avoid the uptake of potentially harmful aquatic organisms, pathogens and sediment that may contain such organisms. • Ensure that routine cleaning of ballast tanks is carried out, where practicable, in mid-ocean or under controlled arrangements in port or dry dock, in accordance with the provisions of th' ship's Ballast Water Management Plan. • Ensure all equipment (e.g. drill string, wellhead, BOP etc.) that has been used in other regions is thoroughly cleaned prior to deployment. • Ballast water discharged will follow the requirements of the International Maritime Organisation's (IMO) 2004 International Convention for the Control and Management of Ships' Ballast Water and Sediments. By establishing standards and procedures for the management and control of'ships' ballast water and sediments, the Convention aims to prevent the spread of harmful aquatic organisms from one region to another. • The Convention stipulates that all ships are required to implement a Ballast Water Management Plan, which includes a detailed description of the actions to be taken to implement the Ballast Water Management requirements. • All ships using ballast water exchange should, wherever possible, do so at least 200 nautical miles (± 370 km) from nearest land in waters of at least 200 m deep. Where this is not feasible, the exchange should be as far from the nearest land as possible, and in all cases a minimum of 50 nm (± 93 km) from the nearest land and preferably in water at least 200 m in depth.				

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
• Ships will also have a Ballast Water Record Book to record when ballast water is taken on board; circulated or treated for Ballast Water Management purposes; and discharged into the sea. Project vessels would be required to comply with this requirement.				

9.3.1.1.3 NOISE FROM HELICOPTERS

Possible crew transfers by helicopter from Cape Town to the drilling unit will generate noise in the atmosphere that may disturb coastal species such as seabirds and seals. It is estimated that there could be up to four trips per week between the drilling unit and the helicopter support base at Cape Town or Springbok (i.e. up to 68 trips per well over a 4 month period). Noise source levels from helicopters flying at an altitude of 150 m or more above sea level are expected to be around 109 dB re 1µPa at the most noise-affected point (SLR Consulting Canada 2023). Elevated aerial noise levels from helicopters may disturb faunal species resulting in behavioural changes or displacement from important feeding or breeding areas (direct negative impact).

The ocean is a naturally noisy place and marine animals are continually subjected to both physically produced sounds from sources such as wind, rainfall, breaking waves and natural seismic noise, or biologically produced sounds generated during reproductive displays, territorial defence, feeding, or in echolocation (see references in McCauley 1994). Such acoustic cues are thought to be important to many marine animals in the perception of their environment as well as for navigation purposes, predator avoidance, and in mediating social and reproductive behaviour. Anthropogenic sound sources in the ocean can thus be expected to interfere directly or indirectly with such activities thereby affecting the physiology and behaviour of marine organisms (NRC 2003). Natural ambient noise will vary considerably with weather and sea state, ranging from about 80 to 120 dB re 1 µPa for the frequency range 10 – 10k Hz (Croft & Li 2017).

Noise propagation represents energy travelling either as a wave or a pressure pulse through a gas or a liquid. Due to the physical differences between air and water (density and the speed at which sound travels), the decibel units used to describe noise underwater are different from those describing noise in air. Furthermore, hearing sensitivities vary between species and taxonomic groups. Underwater noise generated in the air is therefore treated separately from noise generated by drilling activities (see Section 4.4.6). The dominant low-frequency components of aircraft engine noise (10-550 Hz) penetrate the water only in a narrow (26° for a smooth water surface) sound cone directly beneath the aircraft, with the angle of the cone increasing in Beaufort wind force >2 (Richardson *et al*. 1995). The peak sound level received underwater is inversely related to the altitude of the aircraft. More recently, Erbe *et al*. (2018) established that commercial passenger airplanes in a coastal underwater soundscape exhibited broadband received levels of 84–132 dB re 1 µPa rms, detectable at between 12 Hz and 10 kHz and exceeding underwater ambient levels by up to 36 dB. Planes were on flight paths approaching (400-800 m altitude) and leaving (400-800 m altitude) airports. Underwater noise from commercial airplanes would thus be audible to a variety of marine fauna, including seals and dolphins.

Available data indicate that the expected frequency range and dominant tones of sound produced by smaller, fixed-wing aircraft and helicopters also overlap with the hearing capabilities of most odontocetes and mysticetes (Richardson *et al*. 1995; Ketten 1998; Erbe *et al*. 2017). Determining the reactions of cetaceans to over flights is difficult, however, since most observations are made from either the disturbing aircraft itself (Richardson & Würsig 1997), or from a small nearby vessel. Reactions to aircraft flyovers vary both within and between species, and range from no or minimal observable behavioural response (Belugas: Stewart *et al*. 1982; Richardson *et al*. 1991; Sperm: Clarke 1956; Gambell 1968; Green *et al*. 1992), to avoidance by diving, changes in direction or increased speed of movement away from the noise source (Gray: Withrow 1983; Belugas: Richardson *et al*. 1991, Patenaude *et al*. 2002; Sperm: Clarke 1956; Fritts *et al*. 1983; Mullin *et al*. 1991; Würsig *et al*. 1998; Minke: Leatherwood *et al*. 1982; Bowhead: Patenaude *et al*. 2002; Humpbacks: Smultea *et al*. 1995), separation of cow-calf pairs (Gray: Withrow 1983), increased surface intervals (Belugas: Awbrey & Stewart 1983; Stewart *et al*. 1982; Patenaude *et al*. 2002), changes in vocalisation (Sperm whales: Watkins & Schevill 1977; Richter *et al*. 2003, 2006) and dramatic behavioural changes including breaching and lobtailing (Minke: Leatherwood *et al*.

1982; Sperm: Fritts *et al*. 1983; Bowhead: Patenaude *et al*. 2002; Beluga: Patenaude *et al*. 2002), and active and tight clustering behaviour at the surface (Sperm: Smultea *et al*. 2008).

Most authors established that the reactions resulted from the animals presumably receiving both acoustic and visual cues (the aircraft and/or its shadow). As would be expected, sensitivity of whales to disturbance by an aircraft generally lessened with increasing distance, or if the flight path was off to the side and downwind, and if its shadow did not pass directly over the animals (Watkins 1981; Smultea *et al*. 2008). Smultea *et al*. (2008) concluded that the observed reactions of whales to brief over flights were short-term and isolated occurrences were probably of no long-term biological significance and Stewart et al. (1982) suggested that disturbance could be largely eliminated or minimised by avoiding flying directly over whales and by maintaining a flight altitude of at least 300 m. However, repeated or prolonged exposures to aircraft over flights have the potential to result in significant disturbance of biological functions, especially in important nursery, breeding or feeding areas (Richardson et al. 1995)

The reactions of pinnipeds to aircraft noise were reviewed by Richardson et al. (1995). As the frequency of aircraft engine noise overlaps with the hearing ranges of seals, these will likely similarly receive both acoustic and visual cues from aircraft flyovers. Richardson et al. (1995), however, point out that in very few cases was it determined that responses were specifically to aircraft noise as opposed to visual cues. Furthermore, most reported observations relate to pinnipeds on land or ice, with few data specifically on the reactions of pinnipeds in water to either airborne or waterborne sounds from aircraft. Reactions to flyovers vary between species, ranging from stampeding into the water, through temporary abandonment of pupping beaches to alertness at passing aircraft. When in the water, seals have been observed diving when the aircraft passes overhead. Pinnipeds thus exhibit varying intensities of a startle response to airborne noise, most appearing moderately tolerant to flyovers and habituating over time (Richardson *et al*. 1995; Laws 2009). The rates of habituation also vary with species, populations, and demographics (age, sex). Any reactions to over flights would thus be short-term and, except for cases where commercial airports are located close to the coast and overflights are frequent (Erbe *et al*. 2018), isolated occurrences around the drill site(s) would unlikely be of any long-term biological significance or have population-level effects.

The hazards of aircraft activity to birds include direct strikes as well as disturbance, the degree of which varies greatly. The negative effects of disturbance of birds by aircraft were reviewed by Drewitt (1999) and include loss of usable habitat, increased energy expenditure, reduced food intake and resting time and consequently impaired body condition, decreased breeding success and physiological changes. Nesting birds may also take flight and leave eggs and chicks unattended, thus affecting hatching success and recruitment success (Zonfrillo 1992). Differences in response to different types of aircraft have also been identified, with the disturbance effect of helicopters typically being higher than for fixed-wing aeroplanes. Results from a study of small aircraft flying over wader roosts in the German Wadden Sea showed that helicopters disturbed most often (in 100% of all potentially disturbing situations), followed by jets (84 %), small civil aircraft (56 %) and motor-gliders (50 %) (Drewitt 1999).

Sensitivity of birds to aircraft disturbance are not only species specific, but generally lessened with increasing distance, or if the flight path was off to the side and downwind. However, the vertical and lateral distances that invoke a disturbance response vary widely, with habituation to the frequent loud noises of landing and departing aircraft without ill effects being reported for species such as gulls, lapwings, ospreys and starlings, amongst others (reviewed in Drewitt 1999). Further work is needed to examine the combined effects of visual and acoustic stimuli, as evidence suggests that in situations where background noise from natural sources (e.g. wind and surf) is continually high, the visual stimulus may have the greater effect.

Southern Right whales migrate to the southern Africa subcontinent to breed and calve, where they tend to have an extremely coastal distribution mainly in sheltered bays. Winter concentrations have been recorded all along the southern and eastern coasts of South Africa, with the most significant concentration currently on the South Coast between Cape Town and Gqeberha (Port Elizabeth). They typically arrive in coastal waters off the South Coast between June and November, although animals may be sighted as early as April and as late as January. When moving from the South Coast breeding ground directly to the West Coast feeding ground, southern right whales would display a clear peak in numbers on the West Coast (Table Bay to St Helena Bay) between February and April. When departing from the feeding grounds between April and June animals take a direct south-westward track. The southern portions of the Block would therefore lie to the north of this migration route. Southern right calving and nursing activities off the Cape Peninsula would thus fall within the direct flight path to the AOI for drilling. Smaller cetaceans in the area include the common dolphin and dusky dolphin both of which can occur in large group sizes. The level of disturbance of cetaceans by aircraft depends on the distance and altitude of the aircraft from the animals (particularly the angle of incidence to the water surface) and the prevailing sea conditions.

Noise generated by helicopters undertaking crew transfers between Cape Town or Springbok and the drill rig could affect seabirds and seals in breeding colonies and roosts on the mainland coast. The nearest seabird colonies to Cape Town airport are at Robben Island, Dassen Island and the Saldanha Bay Islands. Of these, Robben Island potentially falls within the flight paths between the airport and the AOI for drilling and flight paths would need to be planned to avoid these colonies. The seal colonies in False Bay, at Robbesteen near Koeberg and at Cape Columbine all do not fall within the potential flight path to the AOI. The seal colony at Strandfontein Point (south of Hondeklipbaai) falls within the flight paths between the airport and the AOI for drilling and flight paths would need to be planned to avoid these colonies (Figure 194).

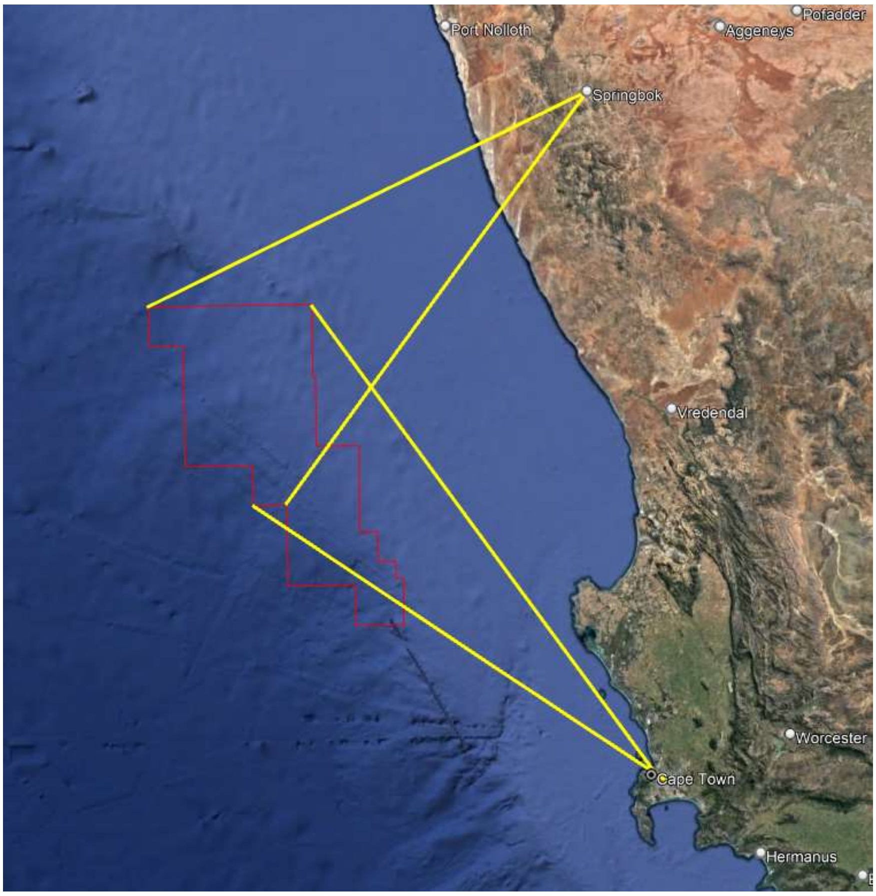


Figure 194: Area of potential flight paths (within yellow lines) from Cape Town and Springbok airports to the north-eastern and south-western extremes of the AOI for exploration drilling in Block 3B/4B

Indiscriminate low altitude flights over whales, seals, seabird colonies and turtles by helicopters used to support the drilling unit could thus have an impact on behaviour and breeding success. The intensity of disturbance would depend on the distance and altitude of the aircraft from the animals (particularly the angle of incidence to the water surface) and the prevailing sea conditions and could range from low to high intensity for individuals but of MINOR intensity for the populations as a whole. As such impacts would be REGIONAL (although temporary in nature a few minutes in every week while the helicopter passes overhead), IMMEDIATE (4 months per well), fully reversible and with a low probability of occurring, the environmental risk of the impact is therefore considered LOW.

The potential impact of aircraft noise causing physiological injury to, or behavioural avoidance by, pelagic and coastal sensitive species, is deemed to be of LOW significance considering their high sensitivity and the low environmental risk. Aircraft noise would, however, likely contribute to the growing suite of cumulative acoustic impacts to marine fauna in the area, but assessing the population level consequences of multiple smaller and more localised stressors (see for example Booth et al. 2020; Derous et al. 2020) is difficult.

The generation of noise from helicopters cannot be eliminated if helicopters are required for crew changes. With the implementation of the mitigation measures above, the residual impact would remain of low environmental risk and LOW significance.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Noise from Helicopters	Operation	Low	Low	Low

Mitigation Measures

- Pre-plan flight paths to ensure that no flying occurs over seal colonies and seabird nesting areas.
- Avoid extensive low-altitude coastal flights.
- Maintain a flight altitude >1 000 m to be maintained at all times, except when taking off and landing or in a medical emergency.
- Maintain an altitude of at least 762 m or 2 500 ft above the highest point of a National Park or World Heritage Site.
- Comply fully with aviation and authority guidelines and rules.
- Brief all pilots on the ecological risks associated with flying at a low level along the coast or above marine mammals.
- The drilling contractor will ensure that the proposed drilling campaign is undertaken in a manner consistent with good international industry practice and Best Available Techniques (BAT).
- All whales and dolphins are given protection under the South African Law. The Marine Living Resources Act (Act No. 18 of 1998) states that no whales or dolphins may be harassed, killed or fished. No vessel or aircraft may, without a permit or exemption, approach closer than 300 m to any whale and a vessel should move to a minimum distance of 300 m from any whales if a whale surfaces closer than 300 m from a vessel or aircraft.
- The operation of helicopters aircraft is governed by the Civil Aviation Act (Act No. 6 of 2016) and associated regulations.

9.3.1.1.4 LIGHTING FROM DRILLING UNIT AND VESSELS

The operational lighting of support vessels during transit and well-drilling can be a significant source of artificial light in the offshore environment increasing the ambient lighting in offshore areas. The strong operational lighting used to illuminate the project vessels and especially the drill rig at night increase ambient lighting in offshore areas. Increased ambient lighting may disturb and disorientate pelagic seabirds feeding in the area (direct negative impact). Operational lights may also result in physiological and behavioural effects of fish and cephalopods (direct negative impact), as these may be drawn to the lights at night where they may be more easily preyed upon by other fish and seabirds.

Offshore platform structures are known to concentrate both seabirds and their prey due to structural stimuli, food concentrations, oceanographic processes and lights and flares (Wiese *et al*. 2001). Potential attraction may increase during fog when greater illumination is caused by refraction of light by moisture droplets. The strong operational lighting used to illuminate drilling units or vessels at night have been reported to attract primarily passerines (Hüppop *et al*. 2016), but also Little Auks, Storm-petrels and Shearwaters (Wiese *et al*. 2001), with documented mortalities being higher during migration periods. However, in relation to the huge numbers of migrant birds overflying the seas, collisions with man-made structures seem to be rare, although sometimes several thousand birds may be affected in a single event, particularly during adverse weather conditions (Hüppop *et al*. 2016). It is expected, however, that seabirds and marine mammals in the area would become accustomed to the presence of the project vessels and drill rig within a few days. Since the drilling area is located within the main traffic routes that pass around southern Africa, which experience high vessel traffic, animals in the area should be accustomed to vessel traffic and associated lighting.

Although little can be done on the project vessels and drill rig to prevent seabird collisions, reports of collisions or death of seabirds on vessels associated with exploration drilling are rare (TEEPSA, pers.comm). Should they occur, the light impacts would primarily take place in the drilling area and along the route taken by the support vessels between the drilling area and Cape Town.

Operational lights may also result in physiological and behavioural effects on fish and cephalopods, as these may be drawn to the lights at night where they may be more easily preyed upon by other fish, marine mammals and seabirds. This would be more of an issue for a stationary drilling unit than for a support vessel, which would be constantly moving. Although seals are known to forage up to 120 nautical miles (~220 km) offshore, the proposed AOI falls beyond the foraging range of seals from the West Coast colonies. Odontocetes, however, are also highly mobile, supporting the notion that various species are likely to occur in the AOI and could thus potentially be attracted to the area.

Due to the proximity of drilling area to the main traffic routes, the increase in ambient lighting in the offshore environment would be of LOW intensity and limited to the area in the immediate vicinity of the vessel / drilling unit (SITE SPECIFIC for drilling unit within the AOI to REGIONAL for project vessels) over the IMMEDIATE term (3-4 months for drilling). For support vessels travelling from Cape Town increase in ambient lighting would likewise be restricted to the immediate vicinity of the vessel over the immediate-term. As the impact is fully reversible with a low probability of occurring, the environmental risk of the impact is therefore considered LOW. The potential for behavioural disturbance by vessel lighting is deemed to be of LOW significance, due to the medium sensitivity of the receptors and the low environmental risk.

The potential for behavioural disturbance by vessel lighting is deemed to be of VERY LOW significance, due to the medium sensitivity of the receptors and the low magnitude. With the implementation of the mitigation measures above, the residual impact would remain of LOW significance.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Lighting from Drill Unit and Vessels	Mobilisation	Very Low	Very Low	Very Low
	Operation	Very Low	Very Low	Very Low
	Decommissioning	Very Low	Very Low	Very Low
Mitigation Measures				
• The lighting on the support vessels, and drill rig, should be reduced to a minimum compatible with safe operations whenever and wherever possible. • Light sources should, if possible and consistent with safe working practices, be positioned in places where emissions to the surrounding environment can be minimised. • Designated personnel receive training on the handling of affected seabirds from a suitably qualified facility/ organisation. • Keep disorientated, but otherwise unharmed, seabirds in dark containers (e.g. cardboard boxes) for subsequent release during daylight hours. **Capturing and transportation of seabirds must be**				

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance

undertaken according to specific protocols as outlined in the OWCP. Specifical personnel onboard must be trained in this regard.

- Report ringed/banded birds to the appropriate ringing/banding scheme (details are provided on the ring).
- Contractors will ensure that the proposed exploration campaign is undertaken in a manner consistent with good international industry practice and BAT.

9.3.1.2 POTENTIAL IMPACTS RELATED TO DRILLING AND ASSOCIATED ACTIVITIES

Apart from Sink *et al*. (2010), who reported significant differences in benthic infaunal assemblages at distances up to 250 m from a well head in ~120 m depth off Mossel Bay on the South Coast, there are few studies that have examined the impacts of hydrocarbon infrastructure and well drilling on deepwater benthic communities in Southern Africa. In their assessment of impacts associated with hydrocarbon exploration, Biccard *et al*. (2018) concluded that the direct and indirect risks associated with drilling discharges during exploration well drilling were mostly very low or low, with only the disturbance and/or destruction of hard-bottom communities being high. Due to limited opportunities for sampling, the benthic biota of the outer shelf, continental slope and beyond into the abyss are very poorly known, and quantitative data on the biota from depths beyond the shelf break are largely lacking.

Although not directly comparable to Southern Africa, several studies have been conducted in other parts of the world (USA, Mexico, North Sea) where there has been full oil and gas field production since the 1970s (Neff 2005; IOGP 2003; Trefry *et al*. 2013; IOGP 2016, to name a few). These studies provide a good indication of possible impacts to benthic habitats that might be expected in future petroleum exploration and production activities on the South African West Coast. The identified environmental aspects and the related potential impacts are discussed and assessed below using information from the international literature.

9.3.1.2.1 DRILLING AND PLACEMENT OF INFRASTRUCTURE ON THE SEAFLOOR

The following activities are anticipated to be undertaken that could have any impact on the seafloor:

- During pre-drilling surveys, piston coring and box coring will be undertaken to obtain samples of the seabed sediments. The recovered piston cores will be visually examined for indications of hydrocarbons (gas hydrate, gas parting or oil staining) and sub-samples retained for further geochemical analysis onshore. Box core samples will be subsampled and analysed for sediment size distribution and invertebrate macrofauna. Such sampling will remove seabed sediments in the sampling footprint and the drop-weight of the piston corer can crush benthic biota as it hits the seabed.
- During pre-drilling surveys, video footage (using available equipment e.g. ROV, sledge cameras) of the seabed at the proposed well location will be obtained. Although the standard operating procedure is not to land or rest the ROV on the seabed, the ROVs thrusters can stir up the soft or silty sediments when operating close to the seabed. This resuspension of fine sediments would temporarily disturb seabed communities and result in localised increased turbidity.
- The current well-design parameter is to have a wellbore diameter of 42 inches (107 cm) during spudding. The penetration of the seabed by the drill bit would physically disturb a maximum surface area of 0.9 m^2 per well (i.e. 4.5 m^2 cumulatively for 5 wells), and displace deeper sediments into a conical cuttings pile around the wellhead. Casing of the hole and installation of the wellhead and BOP would potentially also result in localised direct disturbance of an area of about 3 m^2 around the well site (i.e. 15 m^2 cumulatively for 5 wells).
- Before demobilisation, the BOPs would be removed and the well(s) would be plugged, tested for integrity and abandoned, irrespective of whether hydrocarbons have been discovered in the reserve sections. Cement plugs would be set inside the well bore and across any reserve sections. Excess cement used

during plugging is similarly discarded on the seabed. Removal of the BOP (which will include the use of a ROV) and plugging would result in localised direct disturbance of the seabed around the well site.

Any benthic biota in the footprint of the ROV skids or equipment lost to the seabed, would either be disturbed or crushed (ROV, lost equipment) or would be completely eliminated (drilling, installation of casing, wellhead and over trawlable cap) (direct negative impact). Drilling of exploration wells in the AOI would result in the direct physical disturbance and removal of sediments, with potential changes in sediment characteristics and condition. Casing of the hole and installation of the wellhead may further disturb or crush benthic biota present on the seabed and in the sediments.

Physical disturbance of the seabed, through the resuspension of sediments by ROV thrusters may also occur during ROV surveys, resulting in increased turbidity near the seabed, potentially with physiological effects on benthic communities (indirect negative impact). Disturbance of seabed sediments during pre-drilling ROV surveys could potentially increase turbidity of the near-bottom water layers thereby placing transient stress on sessile and mobile benthic organisms, by negatively affecting filter-feeding efficiency of suspension feeders or through disorientation of mobile species due to reduced visibility (reviewed by Clarke & Wilber 2000).

Disturbance of sediments due to ROV Surveys: Any disturbance of benthic biota through increased turbidity and elevated suspended sediment concentrations in near-bottom waters would be of VERY LOW intensity, and limited to the turbidity plume generated by the ROV thrusters (SITE SPECIFIC) (a few metres around the ROV and/or ROV flight track). However, in most cases sub-lethal or lethal responses would occur only at concentrations well in excess of those anticipated due to resuspension of sediments by ROV thrusters. Marine communities of continental shelf waters along the South African West Coast can be expected to have behavioural and physiological mechanisms for coping with increased turbidity in their near bottom habitats. Any turbidity effects would be transient only as sediments would redeposit after the ROV has departed the area. Any impacts would thus persist over the SHORT-TERM (hours) only resulting in the impact being of VERY LOW magnitude. Loss or disturbance of the benthos due to smothering under the spoil mounds generated by disposal of drilling muds and cuttings are discussed further under Section 9.3.1.2.2.

Disturbance of sediments due to coring and drilling (spudding and associated works): The immediate effect of the physical disturbance and removal of seabed sediments on the benthos during coring and well spudding depends on their degree of mobility, with sedentary and relatively immobile species likely to be physically removed, damaged or destroyed during the disturbances associated with seabed sampling and well drilling. Considering the available area of similar habitat on and off the edge of the continental shelf off the West Coast and the 'Least Threatened' status, and avoidance of possible hardgrounds through the ROV survey (project control), this disturbance of and reduction in benthic biodiversity can be considered of LOW intensity, and limited to the immediate vicinity of the well site (ACTIVITY SPECIFIC). As the wellhead would become colonised by successional communities after abandonment, any impacts to benthic communities would persist over the SHORT-TERM only. The impact is reversible without incurring significant time and cost but with a high probability of occurring. The environmental risk of the impact is therefore considered LOW. As siting of the well(s) will specifically avoid hardgrounds this is not assessed further here. Further loss or disturbance of the benthos in unconsolidated sediments due to smothering under the spoil mounds generated by disposal of drilling muds and cuttings are discussed further under Section 9.3.1.2.2.

Due to the medium sensitivity of the receptors and the low environmental risk for each of the impacts considered above, the disturbance of sediments and potential loss of associated benthic communities is deemed to be of NEGLIGIBLE significance. This potential impact cannot be eliminated due to the necessity for pre-drilling ROV seabed surveys, and spudding. The impact thus remains NEGLIGIBLE for increased seabed turbidity from ROV surveys.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
	Operation	Low	Low	Low

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Drilling and Placement of Infrastructure on the Seafloor	Decommissioning	Low	Low	Low
Mitigation Measures				

- Implement procedures for ROVs that stipulate that the ROV does not land or rest on the seabed as part of normal operations.
- Design of pre-drilling site surveys to ensure there is sufficient information on seabed habitats, including the mapping of sensitive and potentially vulnerable habitats within 1 000 m of a proposed well site.
- The mapping of the sensitive and potentially vulnerable habitats should be done in conjunction with independent researchers, the DFFE and the South African National Biodiversity Institute (SANBI) in order to ensure that the results could be made available to other researchers.
- If sensitive and potentially vulnerable habitats are detected, adjust the well position accordingly to beyond 1 000 m or implement appropriate technologies, operational procedures and monitoring surveys to reduce the risks of, and assess the damage to, vulnerable seabed habitats and communities.
- Limit the area directly affected by physical contact with infrastructure to the smallest area required.
- Based on pre-drilling survey(s), the well(s) will specifically be sited to avoid sensitive hardgrounds, as the preference will be to have a level surface area to facilitate spudding and installation of the wellhead.
- Contactors will also ensure that the proposed drilling campaign is undertaken in a manner consistent with good international industry practice and BAT.

9.3.1.2.2 DISCHARGE OF CEMENT, CUTTINGS AND DRILLING FLUIDS

The project activities that will result in impacts to benthic biota as a consequence of sediment disturbance and smothering by accumulation of cement, drill cuttings and drilling fluids during the operational phase include:

- Discharge of drilling cuttings and water based muds (WBM) during the initial riserless drilling phase;
- Discharge of residual cement during casing installation at the end of the riserless stage;
- Discharge of drill cuttings and Non-Aqueous Drilling Fluids (NADFs) below sea surface during the risered drilling phase; and
- Discharge of excess fluids and residual cement during plugging of well.

These activities and their associated aspects are described further below.

- The cuttings from the initial (riserless) top-hole sections of the well (drilled with WBMs) are discharged onto the seafloor where they would accumulate in a conical cuttings pile around the wellhead, as per Table 5. In addition to the cuttings, WBM will be discharged onto the seafloor over a period of 2.5 days (60 hrs in 2 batches plus lagtime between operations) (see Table 5). Further muds are released from the drilling unit during the displacement phase, at the end of the 26˝ section. The mud used during these processes is a High Viscous Gel sweeps / KCl Polymer PAD mud, of which releases would occur over a period of a few hours.
- After the surface casing string is set in a well, specially designed cement slurries are pumped into the annular space between the outside of the casing and the borehole wall. To ensure effective cementing, an excess of cement is usually used. This excess (50 m^3 in the worst case) emerges out of the top of the

well onto the cuttings pile, where it does not usually set and dissolves slowly into the surrounding seawater.

- During the risered drilling stage, the primary discharge from the drilling unit would be the drill cuttings. The chemistry and mineralogy of the rock particles reflects the types of sedimentary rocks penetrated by the bit. Cuttings from lower hole sections (drilled with NADF) are lifted up the marine riser to the drilling unit and separated from the drilling fluid by the on-board solid control systems. The solids waste stream is discharged overboard through the cutting chute, which would be located 10 m below the sea surface. Cuttings released from the drilling unit would be dispersed more widely around the drill site by prevailing currents. Cuttings and mud released during the risered stage would be discharged over a period of ~45 days (1 080 hrs in 3 batches plus lagtime between operations).

- Before demobilisation, the well(s) would be plugged, tested for integrity and abandoned, irrespective of whether hydrocarbons have been discovered in the reserve sections. Cement plugs would be set inside the well bore and across any reserve sections.

Smothering of benthic biota/habitats by cuttings, drilling fluid and cement on seabed

The discharge of cuttings and WBM onto the seabed from the top-hole section of the well and the discharge of treated cuttings with high performance WBM or NADF from the drill rig during the risered drilling stage would have both direct and indirect effects on benthic communities in the vicinity of the wellhead and within the fall-out footprint of the cuttings plume discharged from the drill rig.

The cuttings and WBMs from the top-hole sections of the well are discharged onto the seafloor at the wellbore where they would accumulate in a conical cuttings pile around the wellbore thereby smothering or crushing invertebrate benthic communities living on the seabed or within the sediments (direct negative impact). Cuttings and associated drilling muds discharged at the surface from the drill rig would disperse and settle over a wider area around the wellhead resulting in changes in sediment structure and community composition within the fall-out footprint of the cuttings plume.

The discharge of residual cement during cementing of the first string (surface casing) and plugging of the well on demobilisation would result in accumulation of cement on the seabed and on the cuttings pile, respectively. Any benthic biota present on the seabed may potentially be smothered (direct impact) by the residual cement or suffer indirect toxicity and bioaccumulation effects due to leaching of potentially toxic cement additives. As this would be in the area already affected by top hole cuttings, no additional effect except for possible cement toxicity would be expected.

Disturbance and/or Smothering of the Seabed due to discharge of Drilling Muds and Cuttings

The effects of drilling mud and cuttings discharges on the benthic environment are related to the total mass of drilling solids discharged, whether these are discharged at the seabed or off the drilling unit, and the relative energy of the water column and benthic boundary layer at the discharge site. The total volume of cuttings discharged during the drilling of a well would be dependent upon the well depth and the drilling conditions encountered. With increasing well depth and concomitant decrease in both penetration rate and wellbore diameter, the rate of cuttings discharged decreases.

The cuttings discharged at the seabed during the spudding of a well would form a highly localised spoil mound around the wellbore, thinning outwards. In contrast, the cuttings discharged from the drilling unit form two plumes as they are discharged. The larger particles and flocculated solids, which constitute ~90% of the discharge, settle to the seabed nearest the wellbore, while the fine-grained unflocculated solids and soluble components of the mud (10% of the discharge) are rapidly diluted in the receiving waters and dispersed in the water column at increasing distances from the drill unit (Figure 195) (Neff 2005). The dispersion pattern and degree of accumulation depends on water depth, current strength and the frequency of storm surges (Buchanan *et al*. 2003).

In high energy environments, where surface currents are strong and highly variable directionally but bottom currents are weaker with less directional variability, accumulation of drilling discharges on the seabed is minimal as the drilling solids are rapidly dispersed and redistributed. Under such conditions adverse effects of the discharges on benthic community composition are difficult to detect above the natural variability (Lees & Houghton 1980; Houghton *et al*. 1980; Bothner *et al*. 1985; Neff *et al*. 1989; Daan & Mulder 1993, 1996). Where changes in abundance and diversity of macrofaunal communities were detected in other studies, these were typically restricted to within about 100 m of the discharge, but did not persist much beyond six months after drilling operations had ceased (Chapman *et al*. 1991; Carr *et al*. 1996; Currie & Isaacs 2005).

However, in low-energy, deep-water environments, such as those in the Block 3B/4B, the effects of drilling discharges on benthic ecosystems are more severe and long-lasting. Typically, the coarse cuttings accumulate within 200 m of the drilling unit, although depending on the strength of prevailing current, some may disperse as far as 800 m from the drilling unit. Some authors report that cuttings piles near a rig can be 1-2 m high (Hinwood *et al*. 1994; Hartley *et al*. 2003; Neff 2005), but these were usually associated either with the disposal of NADF cuttings, which tend to aggregate once discharged and thus disperse less readily resulting in a smaller area but thicker deposition on the seabed, or with cuttings shunted to and discharged near the seabed. The results of international modelling studies and physical sampling exercises have indicated that the majority of discharges would have a maximum accumulated height of less than 8 cm around the well bore during and immediately after drilling, with fine-sediment cover of less than 2 mm thickness likely to extend to ~0.5 km from the discharge point (Perry 2005).

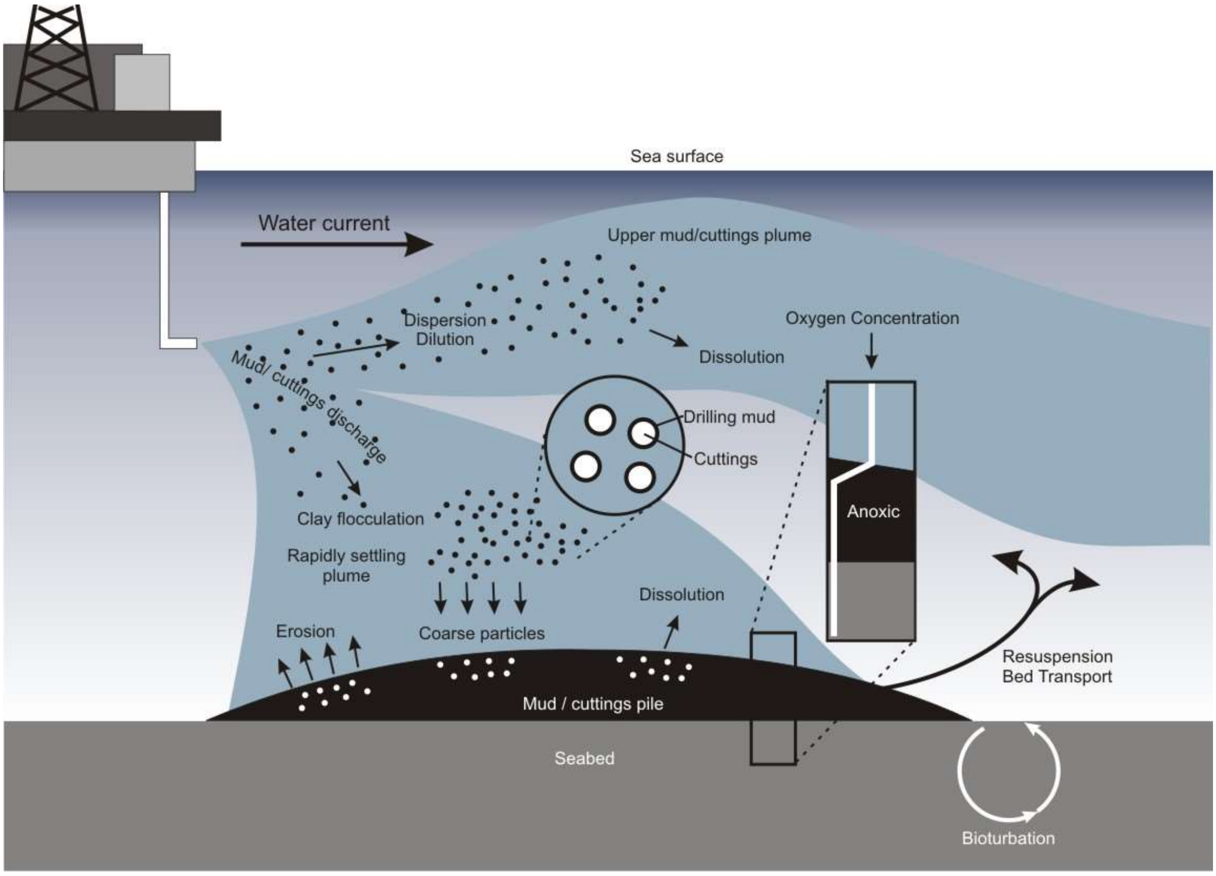


Figure 195: Hypothetical dispersion and fates of cuttings following discharge to the ocean, from a drilling unit. The solids undergo dispersion, dilution, dissolution, flocculation, and settling in the water column. If the discharge contains a high concentration of organic matter, the cuttings pile may become anaerobic near the surface, before being altered by redox cycling, bioturbation, and bed transport (adapted from Neff 2005).

Ecological impacts in response to cuttings disposal are typically characterised by reduced species diversity, enrichment of opportunistic and/or pollution-tolerant fauna and a loss of more sensitive species (Ellis *et al*. 2012; Paine *et al*. 2014). A recent study by Jones *et al*. (2012), however, reported significant increases in densities and richness of motile megabenthic epifauna immediately after drilling, presumably attracted to available carcasses of sessile organisms killed by drilling disturbance (see also Jones *et al*. 2007; Hughes *et al*. 2010). Sessile megafaunal densities and richness increased significantly with increasing distance from drilling, with partial megabenthic recovery between 3 and 10 years post-disturbance (Gates & Jones 2012; Jones *et al*. 2012). Such community changes are, however, rarely measurable beyond 500 m of the drilled area (Neff *et al*. 1992; Ranger 1993; Montagna & Harper 1996; Schaanning *et al*. 2008; Sink *et al*. 2010), with recovery of the benthos observed to take from several months to several years after drilling operations had ceased (Husky 2000, 2001a, 2001b; Buchanan *et al*. 2003; Neff 2005; Currie & Isaacs 2005; Netto *et al*. 2010; Gates & Jones 2012; Jones *et al*. 2012). Exceptions to this have, however, been reported especially for sensitive species (reviewed by Ellis *et al*. 2012; Cordes *et al*. 2016). The potential environmental effects (both smothering and toxicity) of drilling solids discharges have been discussed in several studies (Morant 1999; Husky 2000, 2001a; CAPP 2001; Hurley & Ellis 2004), all of which concluded that exploratory drilling with WBMs has no enduring ecological impacts on the marine environment.

The main impacts associated with the disposal of drilling solids would be smothering of sessile benthic biota, physical alteration of the benthic habitat (changes in sediment properties) in the immediate vicinity (<200 m) of the well. The effects of smothering on the receiving benthic macrofauna are determined by 1) the depth of burial; 2) the nature of the depositing sediments; 3) the tolerance of species (life habitats, escape potential, tolerance to hypoxia etc.) and 4) duration of burial (which is linked to the species tolerance) (Kranz 1974; Maurer *et al*. 1981a, 1981b, 1982, 1986; Bijkerk 1988; Hall 1994; Baan *et al*. 1998; Harvey *et al*. 1998; Essink 1999; Schratzberger *et al*. 2000b; Baptist *et al*. 2009).

Many benthic infaunal species are able to burrow or move through the sediment matrix, and some infaunal species are able to actively migrate vertically through overlying deposited sediment thereby significantly affecting the recolonisation and subsequent recovery of impacted areas (Maurer *et al*. 1979, 1981a, 1981b, 1982, 1986; Ellis 2000; Schratzberger *et al*. 2000a; Harvey *et al*. 1998; Blanchard & Feder 2003). Maurer *et al*. (1979) reported that some animals are capable of migrating upwards through 30 cm of deposited sediment. In contrast, consistent faunal declines were noted during deposition of mine tailings from a copper mine in British Columbia when the thickness of tailings exceeded 15-20 cm (Burd 2002), and Schaffner (1993) recorded a major reduction in benthic macrofaunal densities, biomass, and species richness in shallow areas in lower Chesapeake Bay subjected to heavy disposal (>15 cm) of dredged sediments. Similarly, Roberts *et al*. (1998) and Smith and Rule (2001) found differences in species composition detectable only if the layer of instantaneous applied overburden exceeded 15 cm (see also Bakke *et al*. 1986; Trannum *et al*. 2011). In general, mortality tends to increase with increasing depth of deposited sediments, and with speed and frequency of burial.

The survival potential of benthic infauna, however, also depends on the nature of the deposited non-native sediments (Turk & Risk 1981; Chandrasekara & Frid 1998; Schratzberger *et al*. 2000a). Although there is considerable variability in species response to specific sediment characteristics (Smit *et al*. 2006), higher mortalities were typically recorded when the deposited sediments have a different grain-size composition from that of the receiving environment (Cantelmo *et al*. 1979; Maurer *et al*. 1981a, 1981b, 1982, 1986; Smit *et al*. 2006; Smit *et al*. 2008), which would be the case in the discharge of drill cuttings. Migration ability and survival rates of organisms are generally lower in silty sediments than in coarser sediments (Hylleberg *et al*. 1985; Ellis & Heim 1985; Maurer *et al*. 1986; Romey & Leiseboer 1989, cited in Schratzberger *et al*. 2000a; Schratzberger *et al*. 2000b). Some studies indicate that changes to the geomorphology and sediment characteristics may in fact have a greater influence on the recovery rate of invertebrates than direct burial or mortality (USDOI/FWS 2000). The availability of food in the depositional sediment is, however, also influential.

The duration of burial would also determine the effects on the benthos. Here a distinction must be made between incidental deposition, where species are buried by deposited material within a short period of time (as would occur during drilling solids disposal), and continuous deposition, where species are exposed to an elevated sedimentation rate over a long period of time (e.g. in the vicinity of river mouths). Provided the sedimentation rate of incidental deposition is not higher than the velocity at which the organisms can move or grow upwards, such deposition need not necessarily have negative effects. The sensitivity to short-term incidental deposition is species dependent and also dependent on the sediment type, with deposition of silt being more lethal than a deposition of sand.

The nature of the receiving community is also of importance. In areas where sedimentation is naturally high (e.g. wave-disturbed shallow waters) the ability of taxa to migrate through layers of deposited sediment is likely to be well developed (Roberts et al. 1998). In the case of sedentary and relatively immobile species that occur in waters beyond the influence of aeolian and riverine inputs (such as offshore waters in the AOI), they will be more susceptible to smothering. While some of the benthic communities would comprise fast-growing species able to rapidly recruit into areas that have suffered natural environmental disturbance, the environmental stability of the deep sea suggests that much of the benthos may comprise longer-lived species. Similarly, the benthos associated with hard substrata is typically vulnerable to disturbance due to their long generation times.

There has recently been increasing focus on the potential impacts of drilling solids disposal on vulnerable deep-water coral communities in the Northeast Atlantic (Rogers 1999; Colman *et al*.). As deep-water corals tend to occur in areas with low sedimentation rates (Mortensen *et al*. 2001), these benthic suspension-feeders and their associated faunal communities are likely to show particular sensitivity to increased turbidity and sediment deposition associated with cuttings discharges. Exposure of corals to drilling solids can result in mortality of the colony due to smothering, alteration of feeding behaviour and consequently growth rate, disruption of polyp expansion and retraction, physiological and morphological changes, and disruption of calcification (Dodge & Szmant-Froelich 1985; Roberts *et al*. 2006; Larsson & Purser 2011; Larsson *et al*. 2013. While tolerances to increased suspended sediment concentrations will be species specific, drilling mud concentrations as low as 100 mg/ℓ have been shown to have noticeable effects on coral function (Roger 1999). Lepland and Mortensen (2008) identified that deep-water corals on the Norwegian shelf, downcurrent of a test well discharge, did not show clear differences in health status, although barite crystals derived from the drilling mud were present among trapped sediments in the skeleton cavities of dead coral polyps older than six years, with highest barite concentration found in a polyp older than 13 years. The impacts of drilling discharges on more fragile ecosystems such as cold-water corals are thought to persist for longer than recorded for soft-sediment communities (Fisher *et al*. 2014; Cordes *et al*. 2016). Such sensitive deep-water ecosystems have not been reported for the Block 3B/4B. International best practice recommends that pre-drilling site surveys be carefully designed to provide sufficient information on seabed habitats on and in the vicinity of the proposed drill sites, and appropriate technologies and monitoring surveys implemented to reduce the risks of, and assess the damage to, vulnerable seabed habitats and communities should they occur in the target area (Jødestøl & Furuholt 2010; Purser & Thomsen 2012; Purser 2015). In this regard, a set-back distance of 610 m (2 000 ft) for sea surface discharge of drilling discharges from sensitive deep-water communities is mandated in US territorial waters.

The life-strategies of organisms are a further aspect influencing the susceptibility of the fauna to mortality. Benthic and demersal species that spawn, lay eggs or have juvenile life stages dependent on the seafloor habitat (e.g. hake, kingklip; all of which spawn inshore of the AOI for drilling and potential depositional footprints of riseless discharges, which for the highest values (>0.1 mm) extend a maximum distance of 765 m to the N of the Discharge Point) may be negatively affected by the smothering effects of drill cuttings. Studies on the burrowing habits of 30 species of bivalves showed that mucous-tube feeders and labial palp deposit-feeders were most susceptible to sediment deposition, followed by epifaunal suspension feeders, boring species and deep-burrowing siphonate suspension-feeders, none of which could cope with more than 1 cm of sediment overburden. Infaunal non-siphonate suspension feeders were able to escape 5 cm of burial by their native sediment, but normally no more than 10 cm (Kranz 1972, cited in Hall 1994). The most resistant species were deep-burrowing siphonate suspension-feeders, which could escape from up to 50 cm of overburden. Meiofaunal species appear to be less susceptible to burial than macrofauna (Menn 2002).

The results of the cuttings dispersion modelling studies undertaken as part of this project (HES Expertise Services 2023) largely confirm the reports of international studies that predicted that the effects of discharged cuttings are localised (see Perry 2005). Two scenarios were modelled namely 1) using WMBs only at release point D and 2) using NADFs for the deeper well sections for release point A. For the current project, and assuming drilling using high performance WBMs only 278 m^3 of cuttings would be generated, of which 116 m^3 would be discharged directly at the seafloor (42% of the total volume of cuttings generated), with the remaining 162 m^3 discharged off the drill unit, after treatment to reduce oil content to <6% Oil On Cutting, into the water column. In addition, approximately 374 tons of WBM (riserless: 344 m^3; displacement: 30 m^3) will be discharged onto the seafloor at the wellbore with an additional 444 tons of high-performance KCl/glycol mud discharged from the drilling unit. These discharges are pulsed throughout the drilling campaign (Base case: 60 days), reflecting the five periods corresponding to the different wellbore diameters. Four seasons were modelled for a single discharge location (Discharge Point D).

For scenario 2 using NADFs during the risered sections at release point A, 1 876 tons of cuttings would be generated, of which 1 039 tons would be discharged directly at the seafloor (55% of the total volume of cuttings generated), with the remaining 837 tons discharged off the drill unit, after treatment to reduce oil content to <6% Oil On Cutting, into the water column. In addition, approximately 1 926 tons of WBM will be discharged onto the seafloor at the wellbore during riserless drilling with an additional 116 tons of NADFs discharged from the drilling unit. These discharges are pulsed throughout the drilling campaign (Base case: 60 days), reflecting the five periods corresponding to the different wellbore diameters. Four seasons were modelled for a single discharge location (Discharge point A).

The cuttings discharged at the seabed during the riserless drilling stage typically create a cone close to the wellbore, thinning outwards. The spatial extent of the cuttings pile depends on the volume of cuttings discharged and the local hydrodynamic regime: in areas with strong currents, the cuttings piles often have an elliptical footprint with the long axis of the ellipse aligned with the predominant current direction (Breuer *et al*. 2004).

For the current project the cuttings mound at the wellbore at the modelled discharge point D at the end of drilling operations for WBM only (i.e. at the end of both the riserless and risered drilling stages) is predicted to amount to a maximum depositional thickness of 5.4 mm, progressively thinning out in a NW to SE direction to 0.5 mm at a maximum distance of 175 m from the discharge point (Season 2) (Figure 196 and Figure 197). The threshold depositional thickness of >6.5 mm was not reached. For discharge point D using NADFs during the risered stages, maximum cumulative thickness values of between 65.2 mm and 69.2 mm are predicted at the discharge point, progressively thinning out in a NW to SE direction to 0.5 mm at a maximum distance of 259 m from the discharge point (Season 4) (Figure 198). The thickness deposit 10 years after the operations is still ~30 mm, which exceeds the 6.5 mm threshold value. For discharge point A using NADFs during the risered stages, maximum cumulative thickness values of between 65.2 mm and 69.2 mm are predicted at the discharge point, progressively thinning out in a NW to SE direction to 0.5 mm at a maximum distance of 259 m from the discharge point (Season 4) (Figure 199). The thickness deposit 10 years after the operations is still ~30 mm, which exceeds the 6.5 mm threshold value.

Most of the deposit (60%) is attributable to the riserless discharges at the seabed from drilling of the top hole sections (42” and 26”), remaining close to the discharge points due to the low current speeds at the seabed. The cuttings deposit thickness does not show significant recovery with time, showing negligible decrease in thickness 10 years after the operations. This can primarily be attributed to weak bottom currents at the well locations. The environmental risks[8] associated with the riserless drilling stage are primarily physical, induced by the thickness deposit at the modelled discharge and contributing a maximum of 65% to the risk factor (Season 2) at the modelled discharge point D. For discharge point A, the environmental risk of changes in grain size and thickness deposit together contribute a, 10% of the total risk. At discharge point A, oxygen depletion in the sediment in response to physical and chemical impacts is responsible for ~15% to the total risk.

[8] The environmental risk assessment used in the drillings discharge modelling uses the conventional PEC (Predicted Environmental Concentration) / PNEC (Predicted No Effect Concentration) ratio approach. This ratio gives an indication of the likelihood of adverse environmental effects occurring as a result of exposure to the contaminants and is based on the comparison of the ecosystem exposure to a compound (or deposition thickness) with the ecosystem sensitivity for this compound (or deposition thickness). A significant risk corresponds to a calculated concentration (or thickness) in the environment (exceeding the predicted no effect concentration to a level likely to potentially impact 5% of species in a typical ecosystem.

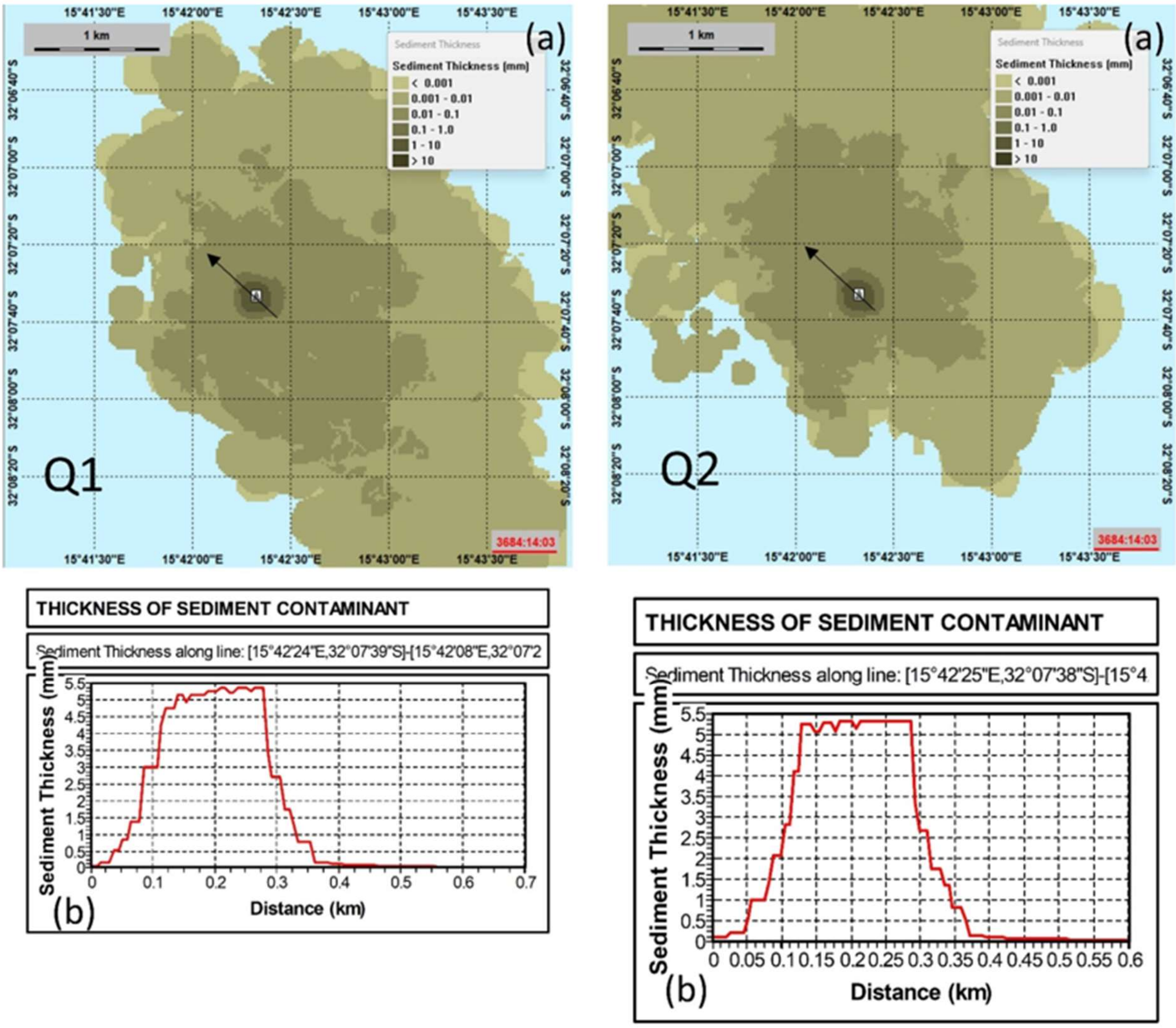


Figure 196: Maximum thickness deposit on the seabed for Quarters 1 and 2, 10 years after operations (right) for discharge point D using WBMs only (Source Livas 2023a).

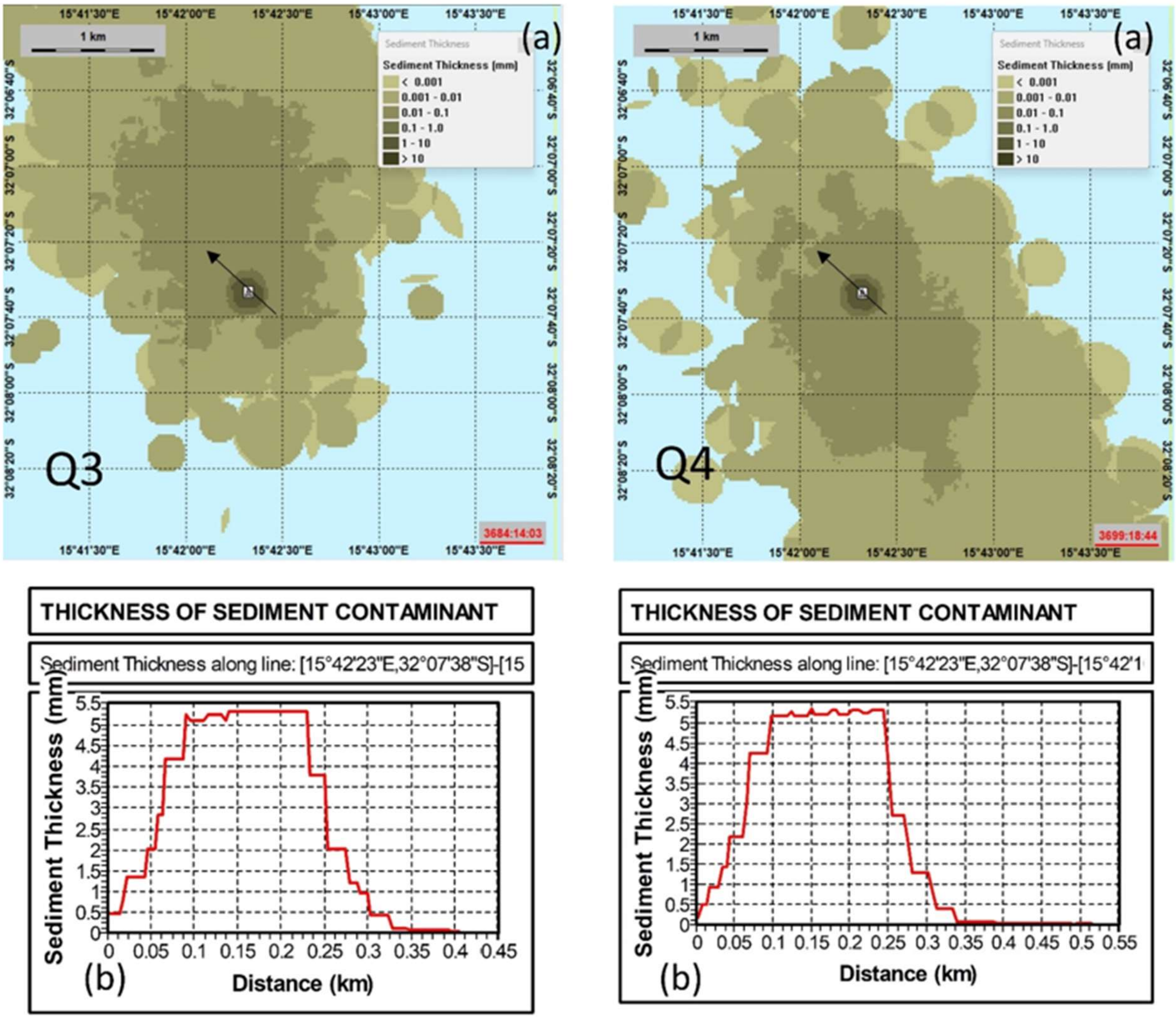


Figure 197: Maximum thickness deposit on the seabed for Quarters 3 and 4, 10 years after operations (right) for discharge point D using WBMs only (Source Livas 2023a).

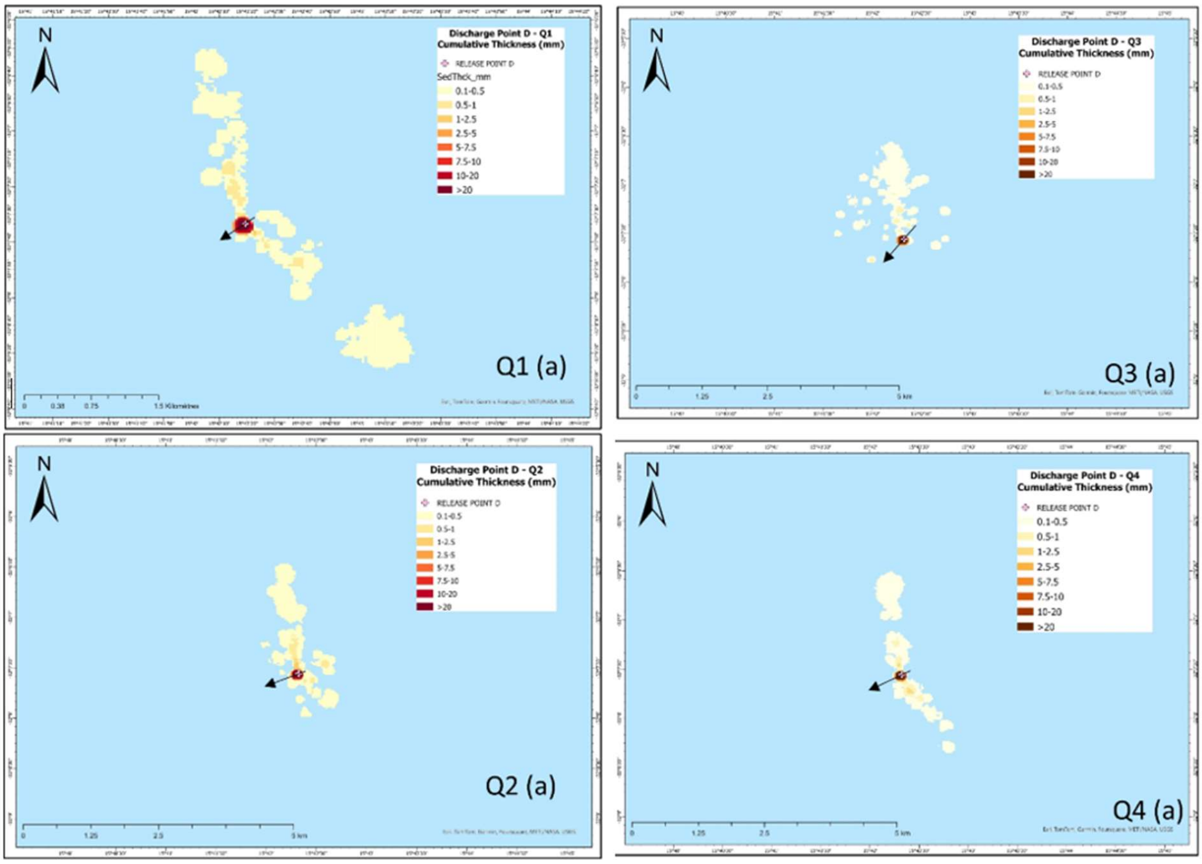


Figure 198: Maximum thickness deposit on the seabed for discharge point D using NADFs, 10 years after operations (right) (Source Livas 2023a)

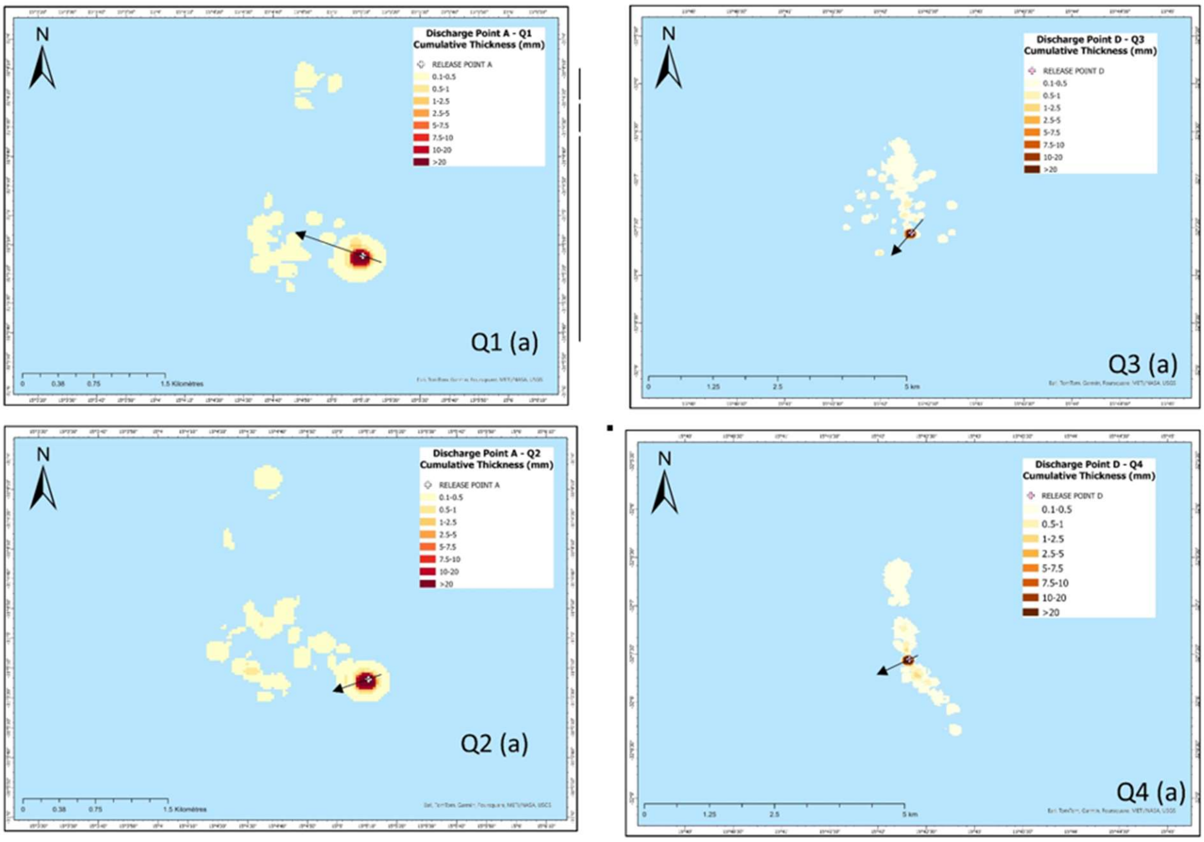


Figure 199: Maximum thickness deposit on the seabed for discharge point A using NADFs, 10 years after operations (right) (Source Livas 2023a).

As would be expected, in the model the riserless discharges resulted in the greatest variation in grain size in surficial sediments to those originally present, with the maximum variation recorded at the discharge point at the end of operations varying between 1 700% and 1 900% (compared to a natural median grain size of 7 µm) and that for discharge point A varying between 4 300% and 5 000%. Grain size variation is insignificant beyond 150 m from discharge point D and beyond 140 m from discharge point A. The grain size change is mostly due to discharges from drilling of the risered sections. Change in grain size around the wellbore associated with the riserless drilling stage are primarily physical, contributing a maximum of 48% (Season 4) to the overall Environmental Impact Factor for the sediments during drilling of the riserless sections at discharge point D.

Although information on benthic communities beyond the shelf break is lacking, those on the shelf in the region show a high natural variability (Steffanie *et al*. 2015; Biccard *et al*. 2019; Gihwala *et al*. 2019), mainly determined by sediment structure. Similarly, the structure of the community developing after an impact depends on (1) the nature of the impacted substrate, (2) environmental factors such as bedload transport, near-bottom dissolved oxygen concentrations etc., and (3) differential re-settlement of larvae into the area, migration of mobile species into the area and from burrowing species migrating upwards back to the surface. The structure of the recovering communities beyond the shelf will thus likely be highly spatially and temporally variable. Where grain size variation relative to the original sediment structure is low, relatively rapid recolonisation of benthic infauna can thus be expected (see for example Kingston 1987, 1992; Trefry *et al*. 2013), with subsequent bioturbation playing an important role in the physical recovery of the seabed (Munro *et al*. 1997). However, near the wellbore where cumulative deposition thickness and grain size variability are high, and the original fauna was severely disturbed or eliminated through smothering, the benthos would take longer to recover to functional similarity as re-establishment of benthic communities depends on recolonisation (Trannum *et al*. 2011).

Risk of smothering of unconsolidated sediments: in assessing this impact, it is important to note, that the depositional footprints on the seabed of the drilling discharges are located in mid- and lower slope habitats rated as ‘Least Threatened’. The depositional footprints are also highly localised, and overlap of concentrations of total discharge in the superficial layers of seabed sediments with any potential sensitive ecosystem types would be negligible. Benthic and demersal species that spawn, lay eggs or have juvenile life stages dependent on the seafloor habitat may be negatively affected by smothering effects. However, the major fish spawning areas for commercial species such as hake and kingklip, occur on the Agulhas Bank, with eggs and larvae occurring along the West Coast but further inshore on the shelf to the east of the AOI and beyond the chemical footprint (see Figure 52 and Figure 53). The smothering effects resulting from the discharge of drilling solids at the wellbore is assessed to have an impact of MEDIUM intensity on the benthic macrofauna of unconsolidated sediments in the cuttings footprint due to the higher deposit thickness and grain size variation associated with riserless discharges. This applies to cuttings with both WBMs and NADFs. Mortality of most fauna can be expected if deposit thickness of drilling solids at the well bore is >30 mm; this would, however, be expected only within a few metres around the well bore. Discharges from the drilling unit would have a LOW intensity impact as the depositional footprint would have a considerably lower deposit thickness, but be spread over a larger area (although outside of key spawning areas). Some biota will be smothered, but many will be capable of burrowing up through the deposited drilling solids. For the discharge of drilling solids at the wellbore the impact is highly localised (SITE SPECIFIC maximum cumulative thickness of 5.4 mm located on the discharge point), whereas discharges from the drilling unit would have LOCAL impacts (up to 175 m from the drilling unit per well). Since the model predicts that physical changes to the sediment structure within the deposition footprint would persist for over 10 years, recovery of benthic communities in the stable deep sea environment to functional similarity is expected to occur within the LONG TERM. The impact would be reversible only by incurring significant time and will definitely occur. Impacts from riserless and risered drilling are thus assessed to be of MEDIUM environmental risk for all 5 wells regardless of season.

Risk of smothering of sensitive hard substrata: Considering the avoidance of possible hardgrounds through the pre-drilling surveys using available equipment (e.g. ROV, sledge cameras) (project control) the wells would be sited in unconsolidated sediments beyond the shelf edge. Modelling shows that the deposition footprints extend primarily in a northerly direction away from a drill site. The depositional footprint does not overlap with any MPAs, EBSAs or CBAs. The riserless drilling stage, which results in the majority of the deposit (95%), is unlikely to affect sensitive hardgrounds. Should the cuttings footprint (from discharge at the surface) overlap with unknown vulnerable communities on hard substrates the smothering effects would potentially have a LOCALISED impact (limited to a maximum distance of 3.6 km for discharge point D and 4.6 km from discharge point A from the drilling unit per well assuming the use of NADFs for the risered sections) of HIGH intensity due to the sensitivity of these long-lived, slow-growing biota to physical disturbance. Recovery would only be expected over the LONG-TERM due to the long generation times of vulnerable hard-ground communities. The impact would be reversible only by incurring prohibitively high time but with a high probability of occurring. The environmental risk of the impact is therefore considered HIGH for up to 5 wells regardless of season.

Disturbance and/or Smothering of the Seabed due to Cement Release

The disturbance of and reduction in benthic biodiversity due to smothering following cementing would result in no additional impact as the cement will be discharged in an area already affected by drill cuttings in the near vicinity of the wellbore.

For biota inhabiting unconsolidated sediments on the continental slope and in the abyss, the smothering effects resulting from the discharge of cuttings both at the wellbore and from the drilling unit are deemed to be of MEDIUM significance due to the medium sensitivity of the receptors and the medium environmental risk for the impacts of smothering. However, the potential smothering effects of drilling discharges and cement on deep-water reef communities (should they occur) are considered of HIGH significance due to the high sensitivity of the biota and the high environmental risk.

This potential impact cannot be eliminated due to the nature of the drilling approach and the need for and nature of the cuttings discharge. As no mitigation is proposed for communities in unconsolidated sediments (except for monitoring and the minimising discharge of cement), the significance of residual impacts would not change. For vulnerable seabed communities, however, the implementation of the above-mentioned mitigation measures would lower the intensity and probability of the impacts being realised, and the residual impact would drop to MEDIUM significance.

As pre-drilling surveys would reveal the presence of hard grounds and AOSAC will actively avoid known sensitive seabed communities by >1 000 m, the likelihood of such occurring in the AOI for drilling is low.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Disturbance and/or Smothering of soft-sediment benthic communities due to drilling solids discharge	Operation	Medium	Medium	Medium
Disturbance and/or Smothering of hardgrounds / deep-water reef communities due to drilling solids discharge	Operation	High	Medium	Medium
Mitigation Measures				

- **Ensure there is meticulous design of pre-drilling site surveys and Ecological Baseline Surveys to provide sufficient information on seabed habitats, and to map sensitive and potentially vulnerable habitats (particularly in the modelled cuttings footprints) thereby preventing potential conflict with the well site.**
- Ensure that, based on the pre-drilling site survey and expert review, drilling locations are not located within a 1 000 m radius of any sensitive and potentially vulnerable habitats (e.g. hard grounds), species (e.g. cold corals, sponges) or sensitive structural features (e.g. rocky outcrops).
- If sensitive and potentially vulnerable habitats are detected, **seek the advice of a benthic specialist and**, adjust the well position accordingly or implement appropriate technologies, operational procedures and monitoring surveys to reduce the risks of, and assess the damage to, vulnerable seabed habitats and communities.
- Monitor (using ROV) cement returns and if significant discharges are observed on the seafloor terminate cement pumping.
- **As information gathered during surveys is of high scientific value, such information should be made available (inter alia to SANBI, SAEON, and the DFFE) to contribute to the knowledge base of deep-water environments.**
- The operator will also ensure that the proposed drilling campaign is undertaken in a manner consistent with good international industry practice and BAT. The following controls will be implemented:
  - Based on pre-drilling survey(s), the well(s) will specifically be sited to avoid sensitive or potentially vulnerable hardground habitats as the preference will be to have a level surface area to facilitate spudding and installation of the wellhead.
  - Should high-performance WBMs not be able to provide the necessary characteristics for drilling during the risered stage, a low toxicity Group III NADF must be used. In this instance, an “offshore treatment and disposal” strategy will be implemented (i.e. cuttings will be treated offshore to reduce oil content to <6% Oil On Cutting (OOC) and discharged overboard).
  - Discharge of risered cuttings via a caisson at greater than 10 m below surface to reduce dispersion of the cuttings in surface currents.

9.3.1.2.3 SEABED AND WATER COLUMN TOXICITY AND BIOACCUMULATION EFFECTS ON MARINE BIOTA

Cement: Various chemical additives are used in the cementing programme to control its properties, including setting retarders and accelerators, surfactants, stabilisers and defoamers. The formulations are adapted to meet the requirements of a particular well. Their concentrations, however, typically make up <10% of the overall cement used. There is potential for the leaching of the additives into the surrounding water column, where they would potentially have toxic effects on benthic communities, or the potential for bioaccumulation.

Drilling fluids and cuttings: The disposal of cuttings and muds at the wellbore and from the drilling unit would have various direct and indirect biochemical effects on the receiving environment (seabed sediments and water column). The direct effects are associated with the contaminants contained in the drilling muds used during drilling operations (direct negative impact). The indirect effects result from changes to water and sediment quality. Although the cuttings themselves are generally considered to be relatively inert, the drilling muds are a specially formulated mixture of natural clays, polymers, weighting agents and/or other materials suspended in a fluid medium. The constituents and additives of the discharged muds may potentially have ecotoxicological effects on the water column and sediments. The effects may be of significance in terms of:

- Chronic accumulation of persistent contaminants in the marine environment;
- Acute or chronic effects on biota, including effects on productivity; and
- Acute or chronic effects on other biota (i.e. indirect effects on biodiversity).

With implementation of NADFs at the start of the 17.5˝ section during the risered stages, the contaminant contributions in the muds increase significantly, producing a footprint that extends through the entire water column from the surface to the seabed for all seasons except Season 4, due to dispersion and dilution of the drilling fluid additives following release of drilling cuttings from the drill rig. The cumulative significant environmental risk in the water column for the risered discharges of NADFs at the modelled discharge point is shown in Figure 200.

- A significant environmental risk (i.e. >5%) from the discharge during risered drilling is reached in the plume at the surface during all of the seasons, extending a maximum distance of 13.2 km to the NW during Season 2.
- The cumulative risk in the water column is short-term being concentrated around the discharge point and decreasing rapidly with distance as the plume dilutes and disperses in surface currents. The highest concentrations are reached during the drilling of the 17.5˝ section 9-10 days after the start of operations.
- Plumes are not detectable beyond the cessation of drilling operations. Chemical footprints are therefore ephemeral only due to the strong dispersion and dilution of the chemicals. As was the case near the seabed, the area at risk in the water column is not centred around the discharge point but extends in the direction of the prevailing currents.
- The main contributors to the environmental risk to the water column during the risered stages constitute bentonite, which contributes 90% to the risk for the riserless section. During the risered section, bentonite contributes 6-13% to the risk in the water column.
- The maximum environmental risk throughout the water column is reached during the drilling of the 17.5˝ and 12.5˝ sections, due to the presence of the highly toxic hydrotreated light petroleum distillate present in the base oil (EDC-99DW). This component is responsible to 68% to 73% of the environmental risk during risered discharges.

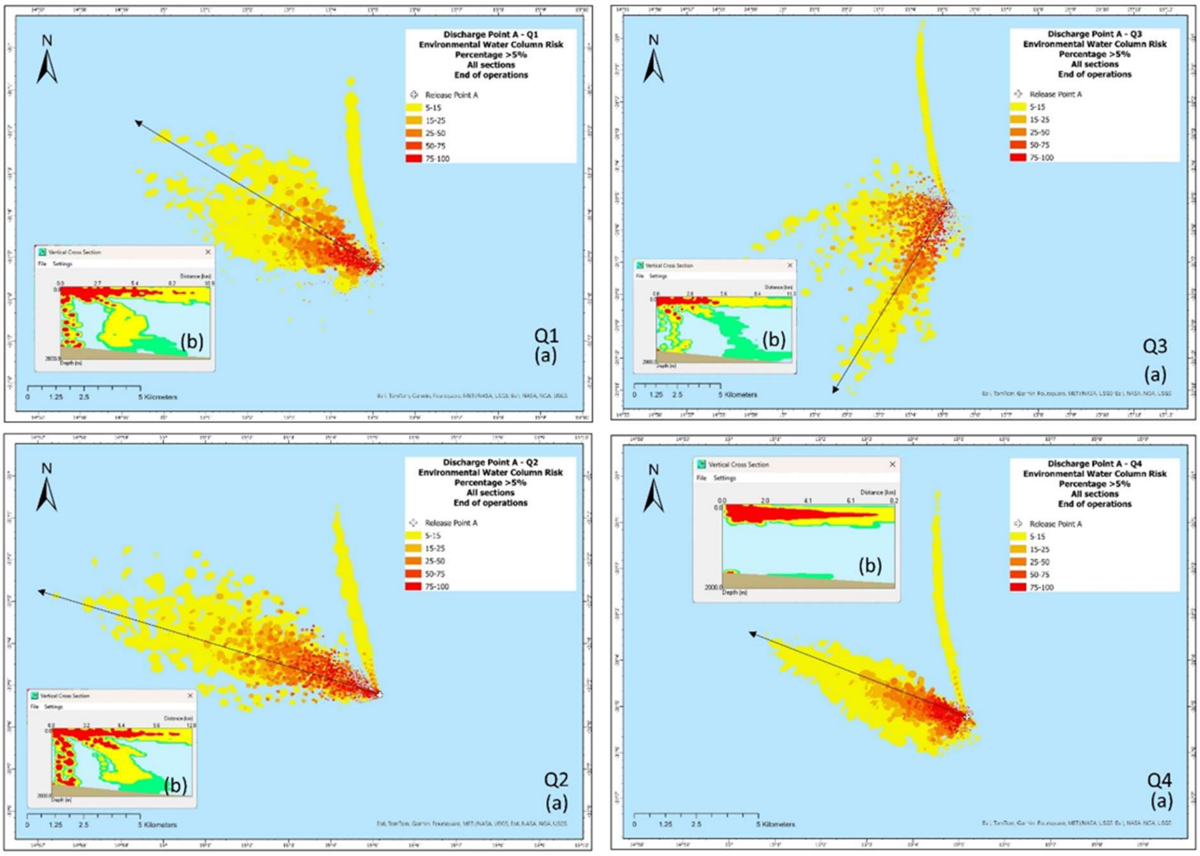


Figure 200: Maximum cumulative environmental risk throughout the water column at any time for the discharge using NADFs during the risered sections at discharge point A (a) Risk map – (b) Vertical cross section of the water column for all four Seasons (Source: Livas 2023a).

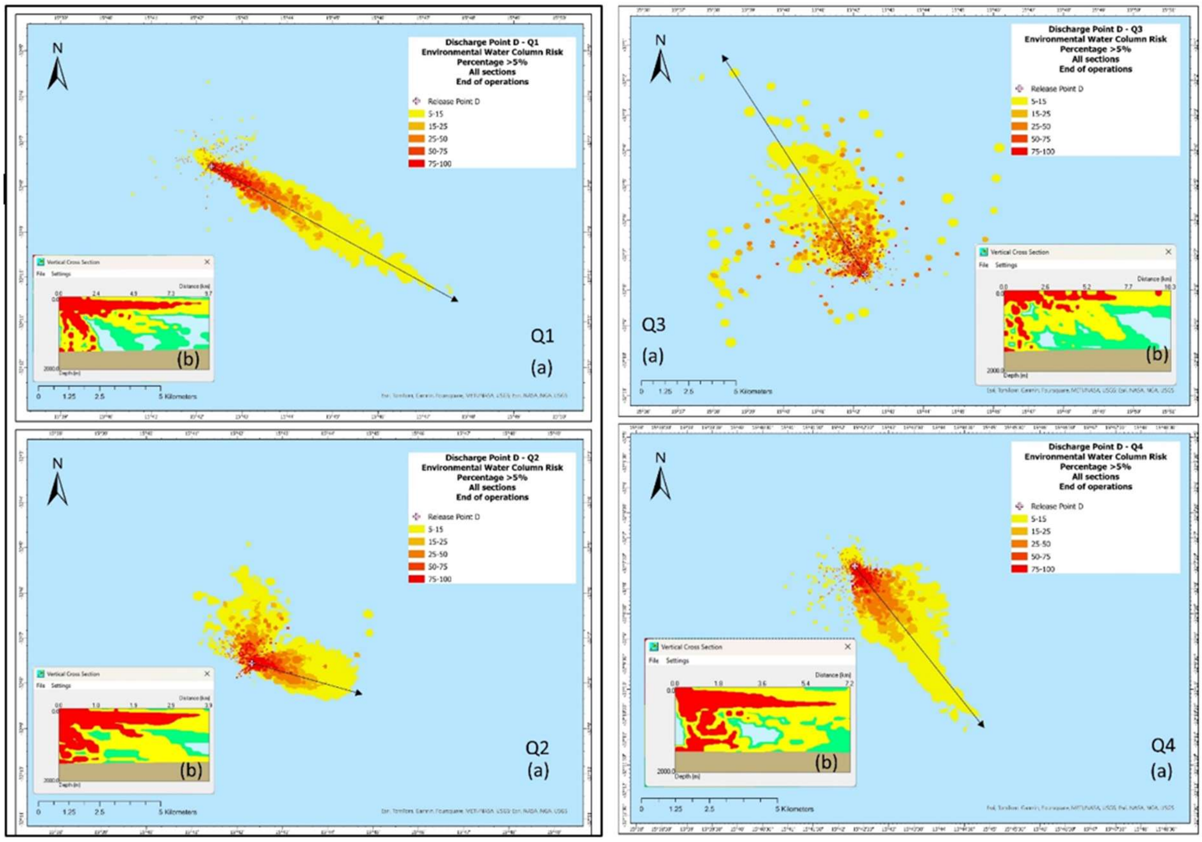


Figure 201: Maximum cumulative environmental risk throughout the water column at any time for the discharge using NADFs during the risered sections at discharge point D (a) Risk map – (b) Vertical cross section of the water column for all four Seasons (Source: Livas 2023a).

In the case of discharges of cements and WBM at the well bore and NADFs below the sea surface, the potential toxicological effects of drilling mud constituents and cement additives on the medium-sensitivity receptors expected in the unconsolidated sediments on the continental slope and in the water column are deemed to be of LOW significance for sediment toxicity due to the high magnitude, and LOW significance for the water column. However, should near-bottom currents disperse the drilling muds into the ESA located within the AOI, the significance of potential toxicological effects would be deemed of MEDIUM significance due to the potentially high sensitivity of long-lived receptors and the high magnitude on the ESA communities, which are expected to have greater support functions than those in non-ESA areas.

This potential impact cannot be eliminated due to the nature of the drilling approach and the necessity for cementing and the use of WBMs and NADFs in the drilling process. For communities in unconsolidated sediments and on hardgrounds, the residual impact on marine fauna will have a lower intensity, but the significance of residual impacts would remain at LOW significance (unconsolidated sediments) and MEDIUM significance (sensitive hardgrounds and EBSAs), and of LOW significance for the water column. As pre-drilling surveys would reveal the presence of hard grounds, the likelihood of such occurring in the AOI for drilling is low.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Biochemical Impacts of residual WBMs, NADFs and cements additives on marine organisms in unconsolidated sediments	Operation	Low	Low	Low

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Biochemical Impacts of residual WBMs, NADFs and cements additives on marine organisms on hard grounds	Operation	Medium	Medium	Medium
Biochemical Impacts of residual WBMs, NADFs and cements additives on marine organisms in the water column	Operation	Low	Low	Low

Mitigation Measures

The operator will ensure that the proposed drilling campaign is undertaken in a manner consistent with good international industry practice and BAT. In this regard AOSAC has various project controls in place for the proposed drilling operations. These include:

- If sensitive and potentially vulnerable habitats are detected, seek the advice of a benthic specialist and, adjust the well position accordingly or implement appropriate technologies, operational procedures and monitoring surveys to reduce the risks of, and assess the damage to, vulnerable seabed habitats and communities.
- **AOSAC has indicated it plans to use WBMs (riserless sections) and high-performance KCl/Glycol WBMs for the risered sections. Should low toxicity Group III NADFs be used as an alternative for the risered sections, an "offshore treatment and disposal" strategy will be implemented (i.e. cuttings will be treated offshore to reduce oil content to <6% Oil On Cutting (OOC) and discharged overboard).**
- **Cuttings will be discharged 10 m below surface during risered drilling.**
- **Careful selection of drilling fluid additives taking into account their concentration, toxicity, bioavailability and bioaccumulation potential; Ensure only low-toxicity, low bioaccumulation potential and partially biodegradable additives are used.**
- **Maintain a full register of Material Safety Data Sheets (MSDSs) for all chemical used, as well as a precise log file of their use and discharge.**
- **If NADFs are used for drilling the risered sections, ensure regular maintenance of the onboard solids control package and avoid inappropriate discharge of NADF cuttings.**
- **Monitoring requirements:**
    - **Test drilling fluids for toxicity, barite contamination and zero oil content to ensure the specified discharge standards are maintained.**
    - **Monitor (using ROV) cement returns and if significant discharges are observed on the seafloor terminate cement pumping, as far as possible.**
    - **Monitor (using ROV) hole wash out to reduce discharge of fluids, as far as possible.**

9.3.1.2.4 INCREASED WATER TURBIDITY AND REDUCED LIGHT PENETRATION ON MARINE ECOLOGY

Cuttings discharged from the drill rig would lead to increased water turbidity and reduced light penetration resulting in both direct and indirect effects on primary producers (phytoplankton) in surface waters, and direct effects on pelagic fish and invertebrate communities in the water column. The heavier cuttings and particles discharged at the seabed or from the drilling unit would settle near the wellbore where a localised smothering effect can be expected. The finer components of the surface discharge generate a plume in the upper water column, which is dispersed away from the drilling unit by prevailing currents, diluting rapidly to background levels at increasing distances from the drill unit. The finer components of discharges on the seabed would generate a plume near the seabed, which would persist for longer due to weaker bottom currents. Increased turbidity near the surface may limit light penetration thereby negatively affecting primary productivity of phytoplankton communities (indirect negative impact). In contrast, increased turbidity near the seabed may have direct physiological effects on filter-feeding organisms and/or indirect effects on predation success of demersal species.

Due to the low sensitivity of the receptors expected in the offshore pelagic and soft-sediment benthic environment and the low environmental risk, the impact is deemed to be of LOW significance. In the case of benthic communities from deep-water hard grounds, the sensitivity to increased turbidity is also considered to be low, despite their high sensitivity to physical disturbance. The impact of increased turbidity on deep-water reef communities is therefore also deemed to be of LOW significance. This potential impact cannot be eliminated due to the necessity of disposal of drill cuttings. Thus, the impact remains NEGLIGIBLE.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Indirect impacts of drill cuttings discharge on the water column (turbidity and light) and seabed (turbidity)	Operation	Negligible	Negligible	Negligible
Mitigation Measures				
The operator will ensure that the proposed drilling campaign is undertaken in a manner consistent with good international industry practice and BAT. In this regard AOSAC has various project controls in place for the proposed drilling operations. These include: • AOSAC has indicated it plans to use WBMs (riserless sections) and high-performance KCl/Glycol WBMs for the risered sections. Should low toxicity Group III NADFs be used as an alternative for the risered sections, an “offshore treatment and disposal” strategy will be implemented (i.e. cuttings will be treated offshore to reduce oil content to <6% Oil On Cutting (OOC) and discharged overboard). • Cuttings will be discharged 10 m below surface during risered drilling.				

9.3.1.2.5 REDUCED PHYSIOLOGICAL FUNCTIONING OF MARINE ORGANISMS DUE TO INDIRECT BIOCHEMICAL EFFECTS IN THE SEDIMENTS

An indirect impact associated with cuttings disposal is the potential development of hypoxic conditions in the near-surface sediment layers through bacterial decomposition of organic matter (indirect negative impact). Generally speaking, biodegradable organic matter in cuttings piles often has a greater effect on the structure and function of benthic communities than sediment texture, deposition rate or, in some cases, chemical toxicity (Hartley et al. 2003). Bacterial decomposition of organic matter may deplete oxygen in the near-surface sediment layers, thereby changing the chemical properties of the sediments by generating potentially toxic concentrations of sulphide and ammonia (Wang & Chapman 1999; Gray et al. 2002; Wu 2002). The rapid biodegradation of drilling solids (particularly those containing NADFs) may therefore lead indirectly yet rapidly to sediment toxicity, particularly in fine-grained sediments (Munro et al. 1998; Jensen et al. 1999; Trannum et al. 2010). Organically enriched sediments are often hypoxic or anoxic, and consequently harbour markedly different benthic communities to oxygenated sediments (Pearson & Rosenberg 1978; Gray et al. 2002; Tait et al. 2016). Organic matter concentration in the sediments would decrease in response to microbial degradation, resulting in increases in oxygen concentration in the surface-sediment layers leading to succession in the benthic community structure toward a more stable state. Such biochemical effects in the sediments can have substantial effects on the structure and function of benthic communities.

Due to the low sensitivity of the receptors expected in the offshore soft-sediment environment and the very low magnitude, the impact is deemed to be of VERY LOW significance. This potential impact cannot be eliminated due to the necessity of disposal of drill cuttings. Thus, the impact remains of NEGLIGIBLE significance.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Indirect Impacts of Cuttings Discharges: development of anoxic sediments in unconsolidated sediments around the wellbore	Operation	Low	Low	Low
Mitigation Measures				
The operator will ensure that the proposed drilling campaign is undertaken in a manner consistent with good international industry practice and BAT. In this regard AOSAC has various project controls in place for the proposed drilling operations. These include: • AOSAC has indicated it plans to use WBMs (riserless sections) and high-performance KCl/Glycol WBMs for the risered sections. Should low toxicity Group III NADFs be used as an alternative for the risered sections, an "offshore treatment and disposal" strategy will be implemented (i.e. cuttings will be treated offshore to reduce oil content to <6% Oil On Cutting (OOC) and discharged overboard). • Cuttings will be discharge**d** 10 m below surface during risered drilling.				

9.3.1.2.6 GENERATION OF UNDERWATER NOISE

The activities that would lead to the generation of underwater noise are described below:

- Single and multibeam echo sounding and sub-bottom profiling are standard methods used in geophysical surveying to obtain images of the seafloor at a resolution and accuracy sufficient to image the typical scale of active seafloor seeps. The multi-beam echo sounder emits a fan of acoustic beams on either side of the vessel's track across a swath width of approximately two times the water depth. The beams are emitted from a transducer at frequencies ranging from 70 kHz to 100 kHz and typically produces sound levels in the order of 200 dB re 1 µPa at 1 m. Single beam echo sounders operate in the frequency range of 38 to 200 kHz. Sub-bottom profilers (boomers and sparkers) emit an acoustic pulse from a transducer at frequencies ranging from 2 -16 kHz and typically produces sound levels in the order of 200-230 dB re 1 µPa at 1 m[9].
- The presence and operation of the survey vessel, drilling unit and support vessels during transit to the drill site, during the proposed surveying and drilling activities and during demobilisation will introduce a range of underwater noises into the surrounding water column that may potentially contribute to and/or exceed ambient noise levels in the area. For non-impulsive noise, the overall noise level from combined noise emissions from drilling unit and up to three support vessels is approximately 201.9 dB re 1 µPa @ 1 m (or dB re 1 µPa2·S @ 1 m) (SLR Consulting Canada 2023).

[9] For the purposes of the acoustic modelling for the sonar survey, the Kongsberg EM 712 MBES system with similar specifications to those proposed by AOSAC is used. The EM 712 MBES is a high-resolution seabed mapping system with a frequency range of 40 – 100 kHz. The source levels for the Kongsberg EM 712 MBES system show a Pk SPL of 240 dB, an RMS SPL of 237 dB, and a SEL of 210 dB.

- Vertical seismic profiling (VSP) is a standard method used during well logging and can generate noise that could exceed ambient noise levels. VSP source generates a pulse peak sound pressure level around 245.5 dB re 1 µPa @ 1 m, the root-mean-square sound pressure level (RMS SPL) 231.5 re 1 µPa @ 1 m, and the sound exposure level (SEL) 223.7 dB re µPa2·s @ 1 m, decreasing rapidly with distance from the source. VSP uses a small airgun array; volumes and the energy released into the marine environment are significantly smaller than what is required or generated during conventional seismic surveys. The airgun array would be discharged approximately five times at 20 second intervals. This process is repeated, as required, for different sections of the well. A VSP is expected to take approximately 9 hours and ~250 shots per well to complete, depending on the well's depth and number of stations being profiled[10].

The cumulative impact of increased background anthropogenic noise levels in the marine environment is an ongoing and widespread issue of concern (Koper & Plön 2012). The sound level generated by drilling operations fall within the 120-190 dB re 1 µPa range at the drilling unit, with main frequencies less than 0.2 kHz. For the current project, noise would be generated by a number of sources (e.g. heavy lift vessel, drill ship in transit and operational, semi-submersible drill rig, support vessels and drill ship maintenance) with the noise levels ranging from 197 – 200 dB re 1 µPa @ 1m depending on the drill unit and support vessels used. The noise generated by vessels and well-drilling operations in general, therefore falls within the hearing range of most fish and marine mammals, and would be audible for considerable ranges before attenuating to below threshold levels. The audibility is determined by the individual's threshold of hearing (i.e. the sound level at which a sound is just detectable by a particular species), which varies with frequency.

The operating frequencies of the single beam and multi-beam sonar falls into the high frequency kHz range, and is thus beyond the low frequency hearing ranges of fish species and sea turtles (from below 100 Hz to up to a few kHz). The high frequency active sonar sources, however, have energy profiles that clearly overlap with cetacean's hearing sensitivity frequency range, particularly for cetaceans of High Frequency and Very High Frequency hearing groups, and would be audible for considerable distances (in the order of tens of km) before attenuating to below threshold levels. The noise emissions from the multibeam echosounder MBES sources are highly directional, spreading as a fan from the sound source, predominantly in a cross-track direction. The noise impact would therefore be highly localised for the majority of marine mammal species. The sonar survey area is expected extend over an area of approximately 50 km^2 (approximately 7 km x 7 km) over a period of approximately 15 days.

In the case of VSP, the frequency of the pulse is below the peak hearing sensitivity of most odontocetes, but overlaps broadly with the vocalisation frequency and peak hearing sensitivity of many mysticetes (Erbe *et al*. 2017). Humpback and Southern right whales mostly communicate at frequencies above 100 Hz while the calls of Sei, Blue and Fin whales (from ~20 Hz upwards) overlaps more directly with the VSP frequency band (McDonald *et al*. 2001, 2005, 2006; Hofmeyr-Juritz & Best 2011; Erbe *et al*. 2017). The received level of noise (and risk of physiological injury or behavioural changes) would depend on the animal's proximity to the sound source. Nonetheless, the underwater noise generated during the project could affect a wide range of fauna; from demersal species residing on the seabed in the vicinity of the wellhead, to those occurring throughout the water column and in the pelagic habitat near the surface.

Elevated noise levels could impact marine fauna by:

- Causing direct physical injury to hearing or other organs (direct negative impact), including permanent (PTS)[11] or temporary threshold shifts (TTS)[12];

[10] For the purposes of the acoustic modelling the following VSP specifications were used: VSP airgun array (i.e, 150 cubic inch GGUN-II); operating depth 8 m with a pressure of 450 PSI. The source levels for the VSP G-Gun array show the Pk SPL to be 226,0 dB re 1 µPa @ 1 m, the RMS SPL 208,5 dB re 1 µPa @ 1 m, and the SEL 206,0 dB re µPa2·s @ 1 m.

[11] A permanent threshold shift is a shift in the auditory threshold, which results in permanent hearing loss.

[12] A temporary threshold shift is a shift in the auditory threshold, which results in temporary hearing loss.

- Masking or interfering with other biologically important sounds (e.g. communication, echolocation, signals and sounds produced by predators or prey) (indirect negative impact); and
- Causing disturbance to the receptor resulting in behavioural changes or displacement from important feeding or breeding areas (direct negative impact).

Exposure to high sound levels can result in physiological injury to marine fauna through a number of avenues, including shifts of hearing thresholds (as either permanent (PTS) or temporary threshold shifts (TTS)), tissue damage, acoustically induced decompression sickness (particularly in beaked whales), and non-auditory physiological effects. Both PTS and TTS represent actual changes in the ability of an animal to hear, usually at a particular frequency, whereby it is less sensitive at one or more frequencies as a result of exposure to sound. In assessing injury from noise, a dual criterion is adopted based on the peak Sound Pressure Level (SPL) and sound exposure level (SEL) (a measure of injury that incorporates the sound pressure level and duration), with the one that is exceeded first used as the operative injury criterion. PTS-onset and TTS-onset thresholds differ between impulsive and non-impulsive noise, with ranges for marine mammals summarised in Table 14 of the Marine Ecology Assessment in Appendix 4. The assessment criterion for the onset of behavioural disruption in marine mammals of all hearing groups is root-mean-square (RMS) SPL of 160 dB re 1µPa for impulsive noise and 120 dB re 1µPa for non-impulsive noise (NMFS 2013). Peak sound pressure levels for impulsive noise resulting in mortality or potential mortal injury for fish eggs and larvae, and fish range from– 207 - 213 dB re 1 µPa, with TTS in fish occurring at cumulative sound exposure levels of above 186 dB re 1 µPa2·s (see Table 4 in SLR Canada 2023 for details). For turtles, peak sound pressure levels for impulsive noise resulting in mortality or potential mortal injury are 232 dB re 1 µPa and 226 dB re 1 µPa, respectively, with PTS onset in response to non-impulsive noise events occurring at cumulative sound exposure levels of above 220 dB re 1 µPa2·s (see Tables 5 and 6 in SLR Canada 2023 for details). The behavioural threshold for impulsive sound events for sea turtles was established at RMS SPL 175 dB re 1µPa by Finneran *et al*. (2017).

The risk of TTS close to continuous shipping sounds is generally low, however, although masking of calls and behavioural changes would be likely. For VSP in particular, masking of calls is likely for those species of baleen whales whose calls overlaps with the VSP frequency band.

Geophysical Survey Noise

The noise generated by the acoustic equipment utilized during geophysical surveys falls within the hearing range of most fish, turtles and marine mammals and at source levels of between 200 to 240 dB re 1 µPa at 1 m, will be audible for considerable distances (in the order of tens of km) before attenuating to below threshold levels (Findlay 2005). High frequency active sonar sources, in particular, have energy profiles that clearly overlap with cetacean's hearing sensitivity frequency range, particularly for cetaceans of High Frequency (e.g. odontocetes: dolphins, toothed whales (e.g. sperm), beaked whales, bottle-nose whales) and Very High Frequency (e.g. Heavisides dolphins, pygmy sperm and dwarf sperm whales) hearing groups. However, unlike the noise generated by airguns during seismic surveys, the emission of underwater noise from geophysical surveying and vessel activity is not considered to be of sufficient amplitude to cause auditory or non-auditory trauma in marine animals in the region.

As surveys using single- and multi-beam echo sounder (MBES) sources have much lower noise emissions compared with seismic airgun sources, no specific considerations have been put in place in developing assessment criteria for MBES sources. For the proposed Kongsberg MBES, a cross-track beam fan width 140° and an along-track beam width up to 2° is expected. The noise emissions are thus highly directional, spreading as a fan from the sound source, predominantly in a cross-track direction, and only directly below or adjacent to the systems (within 10 m of the source) would sound levels be in the 230 dB range where exposure would result in PTS. In the case of the most sensitive very-high-frequency cetaceans the maximum zones of PTS effects were predicted to occur at a range of 66 m from the source along the cross-track direction (SLR Consulting Canada 2023), with TTS onset expected at 124 m from the source. For the other hearing groups TTS and PTS onset occurred at between 2 m and 24 m. Noise impacts related to PTS and TTS on sea turtles are similarly expected to occur along the cross-track direction from the MBES source. The maximum zones of impact are predicted to range within 2 m for PTS and 4 m for TTS. Therefore, only directly below or within the sonar beam would received sound levels be in the range where exposure results in trauma or physiological injury. As most pelagic species likely to be encountered within the area of interest are highly mobile, they would be expected to flee and move away from the sound source before trauma could occur. Furthermore, the statistical probability of crossing a cetacean, pinniped or turtle with the narrow moving multi-beam fan several times, or even once, is very small.

The underwater noise from the survey systems may, however, induce localised behavioural changes (e.g. avoidance of the source) in some marine mammals, turtles and fish but there is no evidence of significant behavioural changes that may impact on the wider ecosystem (Perry 2005) and no evidence of physical damage (i.e. PTS and TTS) (Childerhouse & Douglas 2016). The maximum impact distance for the behavioural disturbance caused by the immediate exposure to individual MBES pulses was predicted to occur within 290 m from the source for marine mammals of all hearing groups and up to 70 m from the array source for turtles at cross-track directions.

Vessel and Drilling Noise: Physiological Injury

The overall sound level generated by drilling operations (drill rig and support vessels) is ~198 dB re 1 µPa. The noise generated by the drill rig thus falls within the hearing range of most fish and marine mammals, and would be audible for considerable ranges before attenuating to below threshold levels. However, the sound emissions are not considered to be of sufficient amplitude to cause direct physical injury or mortality to marine life, except at close range.

For the current proposed well-drilling project in Block 3B/4B it was estimated that the zones of cumulative impact for 24 hours exposure duration of non-impulsive noise from drilling activities could potentially lead to TTS and PTS, but that effects did not extend beyond 8 160 m and 280 m from the drill site, respectively for marine mammals. LF and VHF cetaceans had the highest PTS-onset and TTS-onset impact zones among the marine mammal hearing groups. As most pelagic species likely to be encountered within the AOI are highly mobile, they would be expected to move away from the sound source before trauma could occur. With a decreased exposure of 0.5 hours, the zones of impact would be significantly reduced, with TTS- and PTS-onset zones within 400 m and 60 m, respectively for the highest impact zones for VHF cetaceans. Therefore, if marine mammals only pass through the site near the non-impulsive stationary noise sources in a very short period of time their noise exposure is not expected to exceed PTS-onset thresholds. The extent of the noise impacts would, however, also depend on the variation in the background noise level with weather and with the proximity of other vessel traffic (not associated with the project), the depth of the drill site and the marine mammal hearing group, with low frequency cetaceans (i.e. mysticetes: southern right, humpback, sei, fin, blue, Bryde's, minke) showing the highest sensitivity.

Temporary threshold shifts may occur at close range for fish species lacking swim bladders or where the swim bladders are not involved in hearing, but generally the non-impulsive drilling noise is predicted to have low physiological impacts (both mortality and recovery injury) on fish (SLR Consulting Canada 2023). For turtles the zones of cumulative impact for TTS and PTS were predicted to be 320 m and 60 m, respectively, over a 24 hour exposure, decreasing to 60 m and 20 m of the drilling location, respectively for continuous exposure over 0.5 hours.

The AOI for drilling overlaps with the distributions of a number of pelagic seabirds. As the AOI lies offshore of the distribution of small pelagic fish species that constitute the main prey of these seabirds, numbers are expected to be low.

Due to their extensive distributions, the numbers of pelagic species (large pelagic fish, turtles and cetaceans) encountered during the drilling campaign is expected to be low and considering they are highly mobile and able to move away from the sound source before trauma could occur, the intensity of potential physiological injury as a result of drilling and vessel noise would be rated as LOW.

Vessel and Drilling Noise: Behavioural Avoidances

The underwater noise from well drilling operations may induce localised behavioural changes or masking of biologically relevant sounds in some marine fauna, but there is no evidence of significant behavioural changes that may impact on the wider ecosystem (Perry 2005). For the current proposed well-drilling project in Block

3B/4B it was estimated that non-impulsive noise from drilling activities could result in behavioural disturbance in cetaceans to distances of between 21.8 km (1 645 m Water Depth) and 27.5 km (2 100 m Water Depth). Whales such as humpbacks and southern rights migrating and/or breeding along the coast are therefore not expected to be affected by the drilling noise. However, whales potentially associated with Tripp Seamount located ~25 km north-west of the AOI, may be affected by the vessel and drilling noise. For fish and turtles, the maximum threshold distances were two to three orders of magnitude lower (420 m and 60 m, respectively).

In a study evaluating the potential effects of vessel-based diamond mining on the marine mammal community off the southern African West Coast, Findlay (1996) concluded that the significance of the impact is likely to be minimal based on the assumption that the radius of elevated noise level would be restricted to ~20 km around the mining vessel. The responses of cetaceans to noise sources are often also dependent on the perceived motion of the sound source as well as the nature of the sound itself. For example, many whales are more likely to tolerate a stationary source than they are one that is approaching them (Watkins 1986; Leung-Ng & Leung 2003), or are more likely to respond to a stimulus with a sudden onset than to one that is continuously present (Malme *et al*. 1985).

According to Popper *et al*. (2014), for non-impulsive noise sources in general, relatively high to moderate behavioural risks are expected for fish species at near to intermediate distances (tens to hundreds of meters) from the source location. Relatively low behavioural risks are expected for fish species at far field distances (thousands of meters) from the source location. The major spawning areas, as well as egg and larval drift pathways of commercially important species, such as hake, pilchards, horse mackerel and anchovy lie inshore of the AOI for drilling, and are unlikely to be impact by the behavioural disturbance zone. Thus, the intensity of the impact on fish and turtles is considered to be low.

Since the AOI is located in a main marine traffic route experiencing increased vessel noise and as the sound source during drilling operations will be stationary, the intensity of the impact of potential behavioural disturbance as a result of drilling and vessel noise on cetaceans is considered to be LOW. Being highly mobile, cetaceans would also be able to move away from the sound source before injury occurs.

Furthermore, the AOI is located in a main marine traffic route and thus is in an area already experiencing increased marine traffic and vessel noise. The duration of the impact on the populations would be limited to the short-term (3-4 months per well) and extend LOCALLY (behavioural disturbances would be expected within ±33 km from the drill site, as well as vessel movement between the drilling area and the logistics base in Cape Town). The potential physiological injury or behavioural disturbance as a result of drilling and vessel noise would thus be of VERY LOW magnitude for up to 5 wells.

Vertical Seismic Profiling: Physiological Injury

The peak pressure levels from VSP seismic pulses, are likely to cause both PTS and TTS on-set in marine mammals, and potential mortal injury in fish, turtles and plankton. The animals would, however, need to be directly adjacent to or below the VSP source (marine mammals: 20 m; fish: 40 m and turtles: <20 m) to be affected. An exception are the very high-frequency cetaceans, which are predicted to experience PTS-onset within 60 m from a single VSP pulse, and TTS-onset within 80 m from the VSP source (SLR Consulting Canada 2023).

There is growing recognition that the sub-lethal effects of noise disturbance, which are both difficult to identify and measure, are likely to be relatively widespread and may have a greater impact than direct physical injury (Forney *et al*. 2017). Due to the highly localised and extremely short-term noise generated by VSP, sub-lethal effects (should they occur) would likely be acute rather than chronic (longer-term and associated with many overlapping activities). These authors point out that a lack of observed response to the various faunal groups does not imply an absence of costs such as physiological stress and reduced reproduction, survival or feeding success. Apparent tolerance of disturbance may in fact have population-level impacts that are more subtle and difficult to record with conventional methodologies. As most pelagic species likely to be encountered within the licence area are highly mobile, they would be expected to flee and move away from the sound source before trauma could occur. However, assuming the animal does not move away from the noise source, the cumulative maximum threshold distances would apply. Considering the cumulative impact (125 discharges within 6 hours) on marine mammals, the maximum threshold distances will be in the order of up to 80 m and 40 m for TTS- and PTS-onset, respectively for the most sensitive LF cetaceans, with the threshold distances for the remaining hearing groups being considerably lower or not being reached at all. For turtles, the cumulative impact (125 discharges within 6 hours) will result in PTS and TTS onset at maximum distances of 20 m and 80 m, respectively. For fish and ichtyoplankton maximum distances were predicted to be in the order of 60 m for recovery injury and 260 m for TTS-onset, with mortality or potential mortal injury reached at maximum distances of 40 m.

The zone of impact for zooplankton to suffer physiological injury is in relatively close proximity to the operating sound source. This faunal group, however, cannot move away from the approaching sound source, and is therefore likely to suffer mortality and/or physiological injury within the zone of impact. Potential impacts on ichthyoplankton and pelagic invertebrates would thus be of high intensity at close range, but highly localised and transient due to the localised and short-term nature of the VSP operations. Impacts are therefore not comparable to the significant declines in zooplankton abundance within a maximum range of 1.2 km of an airguns' passage as reported by McCauley *et al*. (2017). For large seismic arrays, mortalities and physiological injuries to zooplankton are reported to occur only at very close range (<5 m) (reviewed in Carroll *et al*. 2017 and Sivle *et al*. 2021). The major spawning areas, as well as egg and larval drift pathways of commercially important species, such as hake, pilchards, horse mackerel and anchovy, however, all lie inshore of the AOI, and should in no way be affected by the highly localised VSP operations. Declines in zooplankton abundance as a result of VSP operations are therefore likely to be negligible.

It is evident from Table 52 that animals would need to be in relatively close proximity to the operating sound source (VSP) to suffer physiological injury, and in reality, marine fauna in the offshore habitat of Block 3B/4B would not stay in the same location for the entire period and therefore cumulative effects would not be expected. It is thus considered likely that most would avoid sound sources at distances well beyond those at which injury is likely to occur.

In the case of noise generated during VSP, the effects on marine fauna (ichthyoplankton, fish, diving seabirds, turtles, marine mammals) are considered to be of MODERATE intensity, with the worst case being possible TTS onset in cetaceans within 180 m of the sound source. Effects would, however, remain LOCAL and for the duration of the VSP activities (IMMEDIATE TERM; 9 hours per well). In the case of other marine fauna effects would be even more localised (ACTIVITY SPECIFIC) and confined to a few 10s of metres from the VSP array. The impact would be fully reversible and with a medium probability of occurring. The environmental risk of potential physiological injury or behavioural disturbance as a result of drilling and vessel noise is therefore considered LOW for up to five wells.

Vertical Seismic Profiling: Behavioural Avoidance and Masking of Sounds

Potential behavioural disturbance from single VSP pulses is predicted to occur for marine mammals of all hearing groups within a maximum of 580 m from the source. In the case of turtles, potential behavioural disturbance is predicted to occur within 80 m from the drilling location, with potential behavioural disturbance in fish occurring at between 600 m and 2 240 m from the drilling locations.

According to Popper et al. (2014), for impulsive noise sources in general, relatively high to moderate behavioural risks are expected for fish species at near to intermediate distances (tens to hundreds of meters) from the source location. Relatively low behavioural risks are expected for fish species at far field distances (thousands of meters) from the source location. Behavioural responses of fish, such as avoidance of seismic survey areas and changes in feeding behaviours in response to seismic sounds, have been documented to occur at received levels of between 130 and 180 dB re 1 μPa, with disturbance ceasing at noise levels below this (Slabbekoorn et al. 2019). Only in cases where animals remain in specific coastal areas for the purposes of calving or spawning, or are associated with specific oceanic focal features such as seamounts, may cumulative effects on behaviour be realised. This said, the key Southern Right calving and nursing areas, and major fish spawning areas fall outside of the maximum threshold distances for TTS, PTS and behaviour. Therefore, the zones of impact represent the worst case consideration and as the exposure time decreases, the impact decreases even faster.

The potential impact of vessel and drilling noise causing physiological injury to, or behavioural avoidance by, pelagic and coastal sensitive species, is deemed to be of LOW significance considering their medium sensitivity and low environmental risk.

The potential impact of VSP noise causing physiological injury to, or behavioural avoidance by, pelagic and coastal sensitive species, is deemed to be of LOW significance considering their high sensitivity and low environmental risk.

The generation of noise from the drilling unit and support vessels cannot be eliminated due to the operating requirements of dynamic positioning. Despite mitigation for drilling and vessel noise, the intensity, extent or duration of the impact remains unchanged; thus, impact remains VERY LOW. With the implementation of the above-mentioned mitigation measures for VSP, although the intensity decreases, the residual impact on marine fauna would remain LOW due to the sensitivity of the receptors.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Disturbance, behavioural changes and avoidance of feeding and/or breeding areas in seabirds, seals, turtles and cetaceans due to drilling and vessel noise (continuous noise)	Mobilisation	Very Low	Very Low	Very Low
	Operation	Very Low	Very Low	Very Low
	Decommissioning	Very Low	Very Low	Very Low
Disturbance and behavioural changes in seabirds, seals, turtles and cetaceans due to Geophysical Surveys and Vertical Seismic Profiling (impulsive noise)	Operation	Low	Low	Low

Mitigation Measures

- For Sonar Surveys, recommendations for mitigation include:
  - Appoint a minimum of two dedicated Marine Mammal Observer (MMO)[13], with a recognised MMO training course, on board for marine fauna observation (360 degrees around survey vessel), distance estimation and reporting. One MMO should also have Passive Acoustic Monitoring (PAM) training. The MMO must ensure compliance with mitigation measures during seismic geophysical surveying.
  - Ensure survey vessel is fitted with PAM technology (one or more hydrophones), which detects animals through their vocalisations, should it be possible to safely deploy PAM equipment.
  - Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment.
  - "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 to give adequate time for marine mammals to leave the vicinity.

[13] Non-dedicated MMOs can be implemented for short surveys using low-energy sources. Such personnel are trained MMOs who may undertake other roles on the vessel when not undertaking their mitigation role (JNCC 2017).

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance

- If several types of sonar equipment are to be started sequentially or interchanged during the operation, only one pre-shoot search is required prior to the start of acoustic output. A pre-shoot search will, however, be required for gaps in data acquisition of greater than 10 minutes.
- 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.
- **Although operations can be undertaken year-round, preference should be given to** planning sonar surveys **to avoid** movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (beginning of June to end of November).
- Ensure that PAM is incorporated into any surveying taking place between June and November
- No sonar survey-related activities are to take place within declared Marine Protected Areas.

- For Drilling Operations, recommendations for mitigation include:
  - The drilling contractor will ensure that the proposed exploration activities are undertaken in a manner consistent with good international industry practice and BAT.
  - All whales and dolphins are given protection under the South African Law. The Marine Living Resources Act, 1998 (No. 18 of 1998) states that no whales or dolphins may be harassed, killed or fished.
  - No vessel or aircraft may, without a permit or exemption, approach closer than 300 m to any whale and a vessel should move to a minimum distance of 300 m from any whales if a whale surfaces closer than 300 m from a vessel or aircraft.
  - The generation of vessel noise and drilling noise cannot be eliminated due to the nature of the drilling operations. The following measures will be implemented to reduce noise at the source:
    - Implement a maintenance plan to ensure all diesel motors and generators receive adequate maintenance to minimise noise emissions.
    - Ensure vessel transit speed between the AOI and port is a maximum of 12 knots (22 km/hr), except within 25 km of the coast where it is reduced further to 10 knots (18 km/hr).
- For VSP, recommendations for mitigation include:
  - Key personnel and equipment:
    - Appoint a minimum of two dedicated Marine Mammal Observer (MMO), with a recognised MMO training course, on board for marine fauna observation (360 degrees around drilling unit), distance estimation and reporting. One MMO should also have Passive Acoustic Monitoring (PAM) training should a risk assessment, undertaken ahead of the VSP operation, indicate that the PAM equipment can be safely deployed considering the metocean conditions (specifically current).
    - Ensure drilling unit vessel is fitted with PAM technology (one or more hydrophones), which detects animals through their vocalisations, should it be possible to safely deploy PAM equipment.
  - Pre-start Protocols for airgun testing and profiling:
    - VSP profiling should, as far as possible, only commence during daylight hours with good visibility. However, if this is not possible due to prolonged periods of poor visibility (e.g. thick fog) or unforeseen technical issue which results in a night-time start, refer to "periods of low visibility" below.
    - Undertake a 1-hr (as water depths > 200 m) pre-shoot visual and possible acoustic scan (prior to soft-starts / airgun tests) within the 500 m radius mitigation zone in order to

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance

confirm there is no cetaceans, turtles, penguins and shoaling large pelagic fish activity close to the source.

- Implement a "soft-start" procedure of a minimum of 20 minutes' duration when initiating the acoustic source (except if testing a single airgun on lowest power). This requires that the sound source be ramped from low to full power rather than initiated at full power, thus allowing a flight response by marine fauna to outside the zone of injury or avoidance.
- Delay "soft-starts" if cetaceans, turtles and shoaling large pelagic fish are observed / detected within the mitigation zone during the pre-shoot visual / acoustic scan. A "soft-start" should not begin until 20 minutes after cetaceans depart the mitigation zone or 20 minutes after they are last seen or acoustically detected by PAM in the mitigation zone. In the case of penguins, shoaling large pelagic fish and turtles, delay the "soft-start" until animals move outside the 500 m mitigation zone.
- Maintain visual and possibly acoustic observations within the 500 m mitigation zone continuously during VSP operation to identify if there are any cetaceans present.
- Keep VSP operations under 200 pulses to remain within the 500 m exclusion zone for LF cetaceans.

o Shut-Downs

- Shut down the acoustic source if cetaceans, penguins, shoaling large pelagic fish or turtles are sighted within 500 m mitigation zone until such time as the mitigation zone is clear of cetaceans for 20 minutes or in the case of penguins, shoaling large pelagic fish or turtles, the animals move outside the 500 m mitigation zone before the soft-start procedure and production may commence.

o Breaks in Airgun Firing

- Breaks of less than 20 minutes:
  - there is no requirement for a soft-start and firing can recommence at the same power level as at prior to the break (or lower), provided that continuous monitoring was ongoing during the silent period and no cetaceans, penguins, shoaling large pelagic fish or turtles were detected in the mitigation zone during the breakdown period.
  - If a cetaceans are detected in the mitigation zone during the breakdown period, there must be a minimum of a 20-minute delay from the time of the last detection within the mitigation zone and a soft-start must then be undertaken. In the case of penguins, shoaling large pelagic fish or turtles, the animals move outside the 500 m mitigation zone within the 20 minute period.
- Breaks of longer than 20 minutes:
  - If it takes longer than 20 minutes to restart the airguns, a full pre-watch and soft-start process should be carried out before the survey re-commences. If an MMO/PAM operator has been monitoring during the breakdown period, this time can contribute to the 60-minute pre-watch time.

o Period of low visibility

- Ensure that during periods of low visibility (where the mitigation zone cannot be clearly viewed out to 500 m), including night-time, the VSP source is only used if PAM technology is in place to detect vocalisations (subject to a risk assessment indicating that the PAM equipment can be safely deployed considering the metocean conditions) or:
  - there have not been three or more occasions where cetaceans, penguins, shoaling large pelagic fish or turtles have been sighted within the 500 m mitigation zone during the preceding 24-hour period; and

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
• a two-hour period continual observation of the mitigation zone was undertaken (during a period of good visibility) prior to the period of low visibility and no cetaceans, penguins, shoaling large pelagic fish or turtles were sighted within the 500 m mitigation zone. ▪ **The operations will be managed in compliance with the IFC EHS Guidelines for Offshore Oil and Gas Development, 2015.**				

9.3.1.2.7 PRESENCE OF SUBSEA INFRASTRUCTURE ON MARINE FAUNA

The project activities that will result in an increase in hard substrata on the seabed include placement of wellhead on the seabed, discharge of residual cement during riserless casing and plugging stages, abandonment of the wellhead on the seabed and installation of over-trawlable structures (if required).

During initial riserless cementing of the conductor pipe, excess cement (100 m^3 in the worst case for all cementing / plugging operations) emerges out of the top of the well onto the cuttings pile or is discarded on the seabed, where (depending on its mix) it may set and remain in a pile to subsequently be colonised by epifauna and attract fish and other mobile predators (Buchanan *et al*. 2003). Excess cement may therefore act as an artificial reef.

The risered drilling stage commences with the installation of a wellhead on top of the 20-inch casing. Once the wellhead has been installed a BOP is lowered to the seabed and installed onto the wellhead. The BOP stack extends ~10 m above the seabed into the water column, thereby providing a pillar of hard substrate in an area of otherwise unconsolidated sediments. The BOP will be removed during decommissioning.

After the exploration wells have been sealed, tested for integrity and abandoned, the wellheads (with a height of 3 m and a diameter of 1 m) will be left on the seafloor, where it is deemed safe to do so, thereby providing hard substrate in an area of otherwise unconsolidated sediments. If deemed unsafe, the wellheads will be removed.

If the abandoned wellheads are located within the footprint of the demersal trawl fishery, over-trawlable abandonment caps would be installed. These are estimated to measure approximately 5.2 m x 5.2 m, with a height of 4.4 m, and would add structural complexity to otherwise uniform unconsolidated seabed habitats thereby creating areas of higher biological diversity. As the Area of Interest for drilling lies beyond the trawling grounds, installation of these caps is unlikely.

Placement of the wellheads on the seabed and subsequent abandonment provide islands of hard substrata in an otherwise uniform area of unconsolidated sediments. The availability of hard substrata on the seabed provides opportunity for colonisation by sessile benthic organisms and provides shelter for demersal fish and mobile invertebrates thereby potentially increasing the benthic biodiversity and biomass in the continental slope region. Although the impact is direct, it can be considered neutral.

Due to the low sensitivity of benthic communities of unconsolidated sediments and the low (well abandonment) to very low (wellhead removal) magnitude of the impact, the presence of sub-sea structures on seabed biodiversity is deemed to be NEGLIGIBLE (wellhead removal) or of VERY LOW (well abandonment) significance. This potential impact cannot be eliminated if the wellheads are abandoned on the seafloor. The residual impact remains NEGLIGIBLE (wellhead removal) or of VERY LOW (well abandonment) significance.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Alternative 1: Impacts of petroleum infrastructure and	Operation	Negligible	Negligible	Negligible

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
residual cement on marine biodiversity: Wellhead Removal	Decommissioning	Negligible	Negligible	Negligible
Alternative 2: Impacts of petroleum infrastructure and residual cement on marine biodiversity: Wellhead Abandonment	Operation	Very Low	Very Low	Very Low
	Decommissioning	Very Low	Very Low	Very Low

Mitigation Measures

- Monitor (by ROV) cement returns and if significant discharges are observed on the seafloor terminate cement pumping.
- Undertake a post drilling ROV survey to scan seafloor for any dropped equipment and other removable features (e.g. excess cement) around the well site. Retrieve these objects, where practicable, after assessing the safety and metocean conditions.
- As information gathered during surveys is of high scientific value, such information should be made available (inter alia to SANBI, SAEON, and the DFFE) to contribute to the knowledge base of deep-water environments.
- Ensure any excess cement onboard the drilling unit is shipped to shore for storage or disposal.
- The contractors will ensure that the proposed drilling campaign is undertaken in a manner consistent with good international industry practice and BAT. Based on pre-drilling survey(s), the well(s) will specifically be sited to avoid sensitive hardgrounds, as the preference will be to have a level surface area to facilitate spudding and installation of the wellhead.
- **Install over-trawlable abandonment caps over the wellheads only if these fall within the footprint of the demersal trawl fishery.**

9.3.1.2.8 WELL TESTING

The well flow activities that will have a potential impact in terms of the marine ecology include the following:

- Well (flow) testing is undertaken to determine the economic potential of any discovery before the well is abandoned or suspended. During well testing it may be necessary to flare off some of the oil and gas brought to the surface. Flaring produces a flame of intense light at the drill unit. One test would be undertaken per exploration well if a resource is discovered and up to two tests per appraisal well. Each test would take up to 7 days to complete (5 days of build-up and 2 days of flowing and flaring) and involves burning hydrocarbons at the well site. A high-efficiency flare is used to maximise combustion of the hydrocarbons. The amount of hydrocarbons produced would depend on the quality of the reservoir but is kept to a minimum to minimise the impact on the environment and avoid wasting potentially marketable oil and/or gas. However, an estimated 100 to 1 000 bbl oil could be flared per day but only for a maximum duration of 4 hours, i.e. up to 2 000 bbl over the two tests associated with an appraisal well.

- If produced water arises during well flow testing, these would be separated from the oily components and treated onboard to reduce the remaining hydrocarbons from these produced waters and discharged overboard, or be shipped to shore for disposal.

Flaring during well testing produces a flame of intense light and heat at the drill unit. Increased ambient lighting may disturb and disorientate pelagic seabirds feeding in the area (direct negative impact). This increase lighting may also result in indirect physiological and behavioural effects on fish and cephalopods, as these maybe drawn to the lights at night where they maybe more easily preyed upon by other fish and seabirds (indirect negative impact).

If water flows during well testing, the hydrocarbon component will be separated and piped to a flare boom where it would be incinerated, while the water will be treated and possibly discharged. This product water contains hydrocarbons, which if released overboard without treatment would have toxic effects on marine fauna (indirect negative impact). Inefficient combustion of hydrocarbons can result in the release of unburnt hydrocarbons, which 'drop-out' onto the sea surface and may form a visible slick of oil (indirect negative impact).

Impacts on Marine Fauna from Lighting from Flare

Drilling activities would be undertaken in the offshore marine environment, over 190 km from the shore at its closest points and thus far removed from any sensitive coastal receptors (e.g. bird or seal colonies) and range of most coastal seabirds (10-30 km), but could still directly affect some migratory pelagic species (pelagic seabirds, marine mammals and fish) transiting through the AOI for drilling. The taxa most vulnerable to ambient lighting are pelagic seabirds, although turtles, large migratory pelagic fish, and both migratory and resident cetaceans may also be attracted by the lights. The intense lighting flaring at night may disturb and disorientate pelagic seabirds feeding in the area.

Flare lighting may also result in physiological and behavioural effects of fish and cephalopods, as these may be drawn to the increased lighting at night where they may be more easily preyed upon by other fish, marine mammals and seabirds. As seals are known to forage up to 220 km offshore, the extreme eastern corner of the AOI for drilling falls within the foraging range of seals from the seal colony at Kleinzee, which lie about 200 km inshore of the AOI. Odontocetes, however, are also highly mobile, supporting the notion that various species are likely to occur in the licence area and thus potentially be attracted to the area.

The increase in ambient lighting in the offshore environment due to flaring would be of LOW intensity and limited to the area in the immediate vicinity of the drill rig (ACTIVITY SPECIFIC) over the IMMEDIATE-term (4 days of flaring over a period of up to 14 days assuming two tests). The potential for behavioural disturbance as a result of flaring would be fully reversible once operations are completed and with a low probability of the impact occurring, and is thus considered of LOW environmental risk for all five wells.

Impact on Marine Fauna from Discharge of Produced water

Some produced water is expected per well. Following combustion of the hydrocarbon components, the water will be collected in a slop tank and either transferred to shore for treatment or it would be treated on board in a dedicated treatment unit. If following onboard treatment the hydrocarbon content is <30 mg/l, the produced water would be discharged overboard. If the content is >30 mg/l it would either undergo a second treatment or be transferred to shore. The AOI for drilling would be located approximately 190 km from the coast at its closest point and is thus far removed from any coastal receptors. The dominant wind and current direction will also ensure that any discharges will disperse rapidly mainly in a north-westerly direction away from coast (refer to drilling discharge modelling results in Appendix 4).

The overboard discharge of treated product water would be of MINOR intensity and limited to the area in the immediate vicinity of the drill rig (ACTIVITY SPECIFIC) over the IMMEDIATE-term (4 days of flaring over a period of up to 14 days). The potential for toxic effects on marine fauna would be fully reversible once operations are completed and with a low probability of the impact occurring, and is thus considered of LOW environmental risk for all five wells.

Impacts on Marine Fauna from Hydrocarbon 'drop-out' during flaring

The AOI is located approximately 190 km from the coast at its closest point and is thus far removed from any coastal receptors. The dominant wind and current direction will also ensure that any discharges move mainly in a north-westerly direction away from coast (refer to drilling discharge modelling results in Appendix 4). Given the offshore location of the AOI, hydrocarbon 'drop-out' is expected to disperse rapidly and is unlikely to have an impact on sensitive coastal receptors. Due to the distance offshore, it is only likely to be pelagic species of fish, birds, turtles and cetaceans that may be affected by potential hydrocarbon 'drop-out', some of which are species of conservation concern, but they are unlikely to respond to the minor changes in water quality.

The impact of hydrocarbon 'drop-out' during flaring would be of LOW intensity and limited to the drilling location (ACTIVITY SPECIFIC) over the IMMEDIATE-TERM (4 days of flaring over a period of up to 14 days). Impacts of 'drop-out' would be fully reversible once flaring is completed, with a low probability of the impact being realised. The impact of well testing is therefore considered of LOW environmental risk.

Due to the medium sensitivity of the receptors and the very low magnitude of the impact, the flaring of hydrocarbons, generation of product water and drop-out during well testing is deemed to be of VERY LOW significance. Should flow-testing be required, the need for flaring and discharge of treated product water (if not shipped to shore) cannot be eliminated. Despite the implementation of best management practices, the residual impact remains VERY LOW.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Impacts of flare lighting on marine fauna	Operation	Low	Low	Low
Impact on marine fauna from the discharge of treated produced water	Operation	Low	Low	Low
Impact on marine fauna from hydrocarbon 'drop-out'	Operation	Low	Low	Low

Mitigation Measures

- Use high efficiency burners for flaring **(in this case non-routine flaring)** to optimise combustion of the hydrocarbons in order to minimise emissions and hydrocarbon 'drop-out' during well testing.
- Optimise well test programme to reduce flaring as much as possible during the test.
- Commence with well testing during daylight hours, as far as possible.
- Monitor flare (continuous) for any malfunctioning, etc. (including any drop-out).
- Keep disorientated, but otherwise unharmed, seabirds in dark containers (e.g. cardboard box) for subsequent release during daylight hours. **Capturing and transportation of seabirds must be undertaken according to specific protocols as outlined in the OWCP. Specifical personnel onboard must be trained in this regard.**
- The operator will ensure that the proposed drilling campaign is undertaken in a manner consistent with good international industry practice and BAT.
- Once the produced water has been separated from the hydrocarbon component, the hydrocarbon component will be burned off via the flare booms, while the water will be temporarily collected in a slop tank. The product water is then either directed to:
  - a settling tank prior to transfer to **support** vessel for onshore treatment and disposal; or
  - a dedicated treatment unit where, after treatment, it is either:
    - if hydrocarbon content is < 30 mg/l, discharged overboard; or

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance

- if hydrocarbon content is > 30 mg/l, subject to a 2nd treatment or directed to tank prior to transfer to **support** vessel for onshore treatment and disposal.
- **If radioactive sources are used, these will be contained sources for use for x-ray and other purposes and will be managed according to requisite national and international regulation, as well as the operators procedures.**

9.3.1.3 **POTENTIAL IMPACTS RELATED TO UNPLANNED EVENTS**

This section provides a description of the potential impacts related to the Marine Ecology in terms of the unplanned events associated with vessel strikes, accidental loss of equipment, accidental oil release to the sea due to vessel collisions, bunkering accident and line / pipe rupture and well blowout.

9.3.1.3.1 VESSEL STRIKES

During the passage of the drill rig and support vessels to and from the AOI for drilling collisions with turtles or marine mammals basking or resting on the sea surface may occur. The potential effects of vessel presence on marine fauna (especially turtles and cetaceans) include physiological injury or mortality due to the drill rig or support vessels colliding with animals basking or resting at the sea surface (direct negative impact).

The potential for collision with marine fauna (primarily turtles and cetaceans) during the transit of the vessel to or from the drilling area is deemed to be of LOW significance, due to the high sensitivity of the receptors and the very low environmental risk. With the implementation of the mitigation measures above, the residual impact would remain LOW.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Impacts on turtles and cetaceans due to ship strikes	Mobilisation	Low	Low	Low
	Operation	Low	Low	Low
	Decommissioning	Low	Low	Low

Mitigation Measures

- Keep a constant watch from all vessels (Vessel Captain and crew) for cetaceans and turtles in the path of the vessel. Alter course and avoid animals when necessary.
- Ensure vessel transit speed between the AOI and port is a maximum of 12 knots (22 km/hr), except within 25 km of the coast where it is reduced further to 10 knots (18 km/hr) as well as when sensitive marine fauna are present in the vicinity.
- Report any collisions with large whales to the International Whaling Commission (IWC) database, which has been shown to be a valuable tool for identifying the species most affected, vessels involved in collisions, and correlations between vessel speed and collision risk (Jensen & Silber 2003).
- Contractors will ensure that the proposed drilling campaign is undertaken in a manner consistent with good international industry practice and BAT.
- All whales and dolphins are given protection under the South African Law. The Marine Living Resources Act, 1998 (No. 18 of 1998) states that no whales or dolphins may be harassed, killed or fished. No vessel or aircraft may, without a permit or exemption, approach closer than 300 m to any whale and a vessel should move to a minimum distance of 300 m from any whales if a whale surfaces closer than 300 m from a vessel or aircraft.

9.3.1.3.2 ACCIDENTAL LOSS OF EQUIPMENT

The potential impacts associated with lost equipment include (direct negative impact):

- Potential disturbance and damage to seabed habitats and associated fauna within the equipment footprint.
- Potential physiological injury or mortality to pelagic and neritic marine fauna due to collision or entanglement in equipment drifting on the surface or in the water column.
- The accidental loss of equipment onto the seafloor would provide a localised area of hard substrate for colonisation by benthic organisms.

The impacts associated with the accidental loss of equipment are deemed to be of NEGLIGIBLE significance, due to the low sensitivity of the offshore receptors and the negligible environmental risk. In the case of large lost items such as cables, anchors, drill string sections etc, this potential residual impact could be mitigated by retrieval of the lost item (if possible and safe to do so) or if it becomes buried over time. This would, however, only occur within the programmed exploration-drilling period due to the financial and environmental risk of the rig staying on site longer than scheduled. The environmental impact of retrieving lost equipment (disturbance of seabed habitats through dragging snag anchors) must also be weighed up against the impact of leaving the lost equipment in place. With the implementation of the above-mentioned mitigation measures, the residual impact is considered to remain of NEGLIGIBLE significance.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Impacts on benthic and pelagic fauna due to accidental loss of equipment to the seabed and water column	Mobilisation	Negligible	Negligible	Negligible
	Operation	Negligible	Negligible	Negligible
	Decommissioning	Negligible	Negligible	Negligible

Mitigation Measures

- Ensure containers are sealed / covered during transport and loads are lifted using the correct lifting procedure and within the maximum lifting capacity of crane system.
- Minimise the lifting path between vessels.
- Maintain an inventory of all equipment and undertake frequent checks to ensure these items are stored and secured safely on board each vessel.
- Undertake a post drilling ROV survey to scan seafloor for any dropped equipment and other removable features around the well site. In the event that equipment is lost during the operational stage, assess safety and metocean conditions before performing any retrieval operations.
- Notify SAN Hydrographer of any hazards left on the seabed or floating in the water column, with the dates of abandonment/loss and locations and request that they send out a Notice to Mariners with this information.
- Contractors will ensure that the proposed drilling activities undertaken in a manner consistent with good international industry practice and BAT. **All loose gear on deck should be fully secured and if lost overboard, either on site or in transit, be recovered as soon as practically possible and when safety and metocean conditions allow.**
- Establish a hazards database listing the type of gear left on the seabed and/or in the licence area with the dates of abandonment/loss and location, and where applicable, the dates of retrieval.

9.3.1.3.3 ACCIDENTAL OIL RELEASE TO THE SEA DUE TO VESSEL COLLISIONS, BUNKERING ACCIDENT AND LINE / PIPE RUPTURE

The movement of the support vessel between the survey area and the port of Cape Town, and presence of drilling unit, may result in limited interaction with commercial, recreational and fishing boats and other marine recreational activities during their approach to the ports. Such interaction may cause a vessel strike or collision resulting in oil tank damage. Instantaneous spills of marine gas/oil at the surface of the sea can potentially occur during bunkering of fuel and such spills are usually of a low volume. Similarly, there could be small spills of hydraulic fluid due to line/ pipe ruptures. Larger volume spills of marine diesel would occur in the event of a vessel collision or vessel accident.

Marine gas/oil spilled in the marine environment would have an immediate detrimental effect on water quality, with the toxic effects potentially resulting in mortality (e.g. suffocation and poisoning) of marine fauna or affecting faunal health (e.g. respiratory damage) (direct negative impact). Sub-lethal and long-term effects can include disruption of physiological and behavioural mechanisms, reduced tolerance to stress and incorporation of carcinogens into the food chain. If the spill reaches the coast, it can result in the smothering of sensitive coastal habitats.

Based on the high sensitivity of receptors and the low (offshore) and medium environmental risk magnitude (nearshore), the potential impact on the marine fauna is considered to range from LOW significance (offshore) to MEDIUM significance (nearshore) without mitigation. It must be pointed out that the probability of a spill or collision is low. With the implementation of the project controls and mitigation measures, which would reduce the intensity of a nearshore impact to low, the residual impact will be of very low magnitude and of LOW significance for both offshore and nearshore spills.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Impacts of an operational spill on marine fauna	Mobilisation	Low	Low	Low
	Operation	Low	Low	Low
	Decommissioning	Low	Low	Low

Mitigation Measures

- Ensure personnel are adequately trained in both accident prevention and immediate response, and resources are available on each vessel.
- Obtain permission from DFFE to use low toxicity dispersants should these be required; Use cautiously.
- As far as possible, and whenever the sea state permits, attempt to control and contain the spill at sea with suitable recovery techniques to reduce the spatial and temporal impact of the spill.
- Ensure adequate resources are provided to collect and transport oiled birds to a cleaning station.
- Ensure offshore bunkering is not undertaken in the following circumstances:
    - Wind force and sea state conditions of ≥6 on the Beaufort Wind Scale;
    - During any workboat or mobilisation boat operations;
    - During helicopter operations;
    - During the transfer of in-sea equipment; and
    - At night or times of low visibility.
- Compliance with COLREGS (the Convention dealing with safety at sea, particularly to reduce the risk of collisions at sea) and SOLAS (the Convention ensuring that vessels comply with minimum safety standards).

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance

- A 500 m safety zones will be enforced around the drilling unit within which fishing and other vessels would be excluded.
- Regulation 37 of MARPOL Annex I will be applied, which requires that all ships of 400 gross tonnage and above carry an approved Shipboard Oil Pollution Emergency Plan (SOPEP). The purpose of a SOPEP is to assist personnel in dealing with unexpected discharge of oil, to set in motion the necessary actions to stop or minimise the discharge, and to mitigate its effects on the marine environment.
- As standard practice, an Emergency Response Plan (ERP) and an Oil Spill Contingency Plan (OSCP) will be prepared and available at all times during the drilling operation.
- Project vessels will be equipped with appropriate spill containment and clean-up equipment, e.g. booms, dispersants and absorbent materials. All relevant vessel crews will be trained in spill clean-up equipment use and routine spill clean-up exercises.

9.3.1.3.4 WELL BLOWOUT

The greatest environmental threat from offshore drilling operations is the risk of a major spill of crude oil occurring either from a blow-out or loss of well control. A blow-out is the uncontrolled release of crude oil and/or natural gas from a well after pressure control systems have failed.

Oil spilled in the marine environment would have an immediate detrimental effect on water quality, with the toxic effects potentially resulting in mortality (e.g. suffocation and poisoning) of marine fauna or affecting faunal health (e.g. respiratory damage). If the spill reaches the coast, it can result in the smothering of sensitive coastal habitats.

Sensitivity of Receptors

Although the AOI is located in the marine environment, more than 180 km offshore, far removed from coastal MPAs and any sensitive coastal receptors (e.g. key faunal breeding/feeding areas, bird or seal colonies and nursery areas for commercial fish stocks), a large spill could still directly affect sensitive coastal receptors further north in Namibia, sensitive receptors in the adjacent Orange Shelf Edge MPA, Tripp Seamount, as well as migratory pelagic species transiting through the AOI.

Assuming that the released product is condensate, which rises rapidly, the benthic biota inhabiting unconsolidated sediments of the outer shelf and deep-water reefs are unlikely to be affected by a blow-out. Similarly, the modelling study suggests that the spill would not reach the shore to impact sensitive coastal receptors.

Being highly toxic, oil released during a blow-out would negatively affect any marine fauna it comes into contact with. The taxa most vulnerable to hydrocarbon spills are coastal and pelagic seabirds. Some of the species potentially occurring in the AOI, are considered regionally 'Endangered' (e.g. African Penguin, Cape Gannet, Cape Cormorant, Bank Cormorant, Roseate Tern, Atlantic and Indian Yellow-nosed Albatross, Northern Royal Albatross, Sooty Albatross, Grey-headed Albatross) or 'Vulnerable' (e.g. White Pelican, Caspian Tern, Damara Tern, Wandering Albatross, Southern Royal Albatross, Leach's Storm Petrel, White-chinned Petrel, Spectacled Petrel). Numerous species of fish, turtles and cetaceans occurring in the project area are also considered regionally 'Critically Endangered' (e.g. Leatherback turtle, blue whale), 'Endangered' (e.g. loggerhead and green turtles, Fin and Sei whales, shortfin mako, whale shark, southern bluefin tuna) 'Vulnerable' (e.g. longfin mako, great white shark, whitetip sharks, sperm whale) or 'Near threatened' (e.g. blue shark). Although species listed as 'Endangered' or 'Vulnerable' may potentially occur in the AOI, due to their extensive distributions their numbers are expected to be low. Overall sensitivity of offshore receptors to a large oil spill is considered to be HIGH.

The worst-case stochastic scenario modelled was for a release duration of 20 days before capping with no surface response. The oil was predicted to not reach the shore, regardless of the season. Sensitive nearshore and coastal receptors were thus not considered in the assessment. This, however, makes the crucial assumption that the released liquid hydrocarbon is ONLY condensate with no crude oil being present. The overall sensitivity of marine ecology/environment to a large oil spill is considered HIGH.

Environmental Risk

Oil Spill Behaviour

There is a probability that the hydrocarbon resource targeted by the proposed exploration wells is condensate rather than crude oil. Condensate and crude oil have the same rock source and would have a similar composition, but would be produced in different volumes with gas taking the place of the liquid component should the resource be condensate. The release quantities for condensate are typically significantly lower and the persistence of the condensate at sea much lower than oil. The environmental impacts realised during a condensate blowout would therefore also be much lower. For the current project, the estimated potential blowout rate of condensate would be 238.8 m^3/day and 930 000 S m^3 of gas per day. However, to ensure that all potential worst-case scenarios were covered (i.e. of the potential five well locations identified), a further model assuming the release of crude oil was run.

Two oil spill modelling studies were undertaken assuming the following scenarios:

1) a continuous blowout of 238.8 m^3/d of condensate and 930 000 Sm^3/d of gas for a period of 20 days assuming the characteristics of Condensate SKARV 13 DEG -2014 as the closest equivalent of the condensate expected from an exploration well in Block 3B/4B. A single release point was modelled.
2) a continuous blowout of 5 405.6 m^3/d of crude oil and 1 443 243 Sm^3/d of gas for a period of 20 days assuming a crude oil analogous with OSEBERG BLEND 2006 as the closest equivalent of the crude oil from an exploration well in Block 3B/4B. Two release points were modelled.

The environmental impacts associated with the oil spill scenarios modelled by Livas (2023b) for two potential well sites in 1 499 m depth (Release Point D) and 1 626 m depth (Release Point A) are assessed separately below, based on the worst-case footprints (i.e. of the potential five well locations identified) for the probability of surface oiling from spill events of both condensate and crude oil.

Various factors determine the impacts of oil released into the marine environment. The physical properties and chemical composition of the oil, local weather and sea state conditions and currents greatly influence the transport and fate of the released product. The physical properties that affect the behaviour and persistence of an oil spilled at sea Area Specific Gravity (API), viscosity and pour point, all of which are dependent on the oils chemical composition (e.g. the amount of asphaltenes, resins and waxes). As soon as oil is spilled, it undergoes physical and chemical changes (collectively termed 'weathering') (Figure 202 top), which in combination with its physical transport, determine the spatial extent of oil contamination and the degree to which the environment will be exposed to the toxic constituents of the released product. It is estimated that of the oil forming surface layers during a spill, ~40% is rapidly lost to weathering (McNutt *et al*. 2012). Although the individual weathering processes may act simultaneously, their relative importance varies with time (Figure 202 bottom). Whereas spreading, evaporation, dispersion, emulsification and dissolution are most important during the early stages of a spill, the ultimate fate of oil is determined by the longer term processes of oxidation, sedimentation and biodegradation.

The components of oil known to be toxic to marine organisms include volatile organic compounds (VOCs) such as benzene, toluene, ethylbenzene, and xylene, collectively known as BTEX, as well as polycyclic aromatic hydrocarbons (PAHs), which are known for their persistence in the environment. The polar components of oil (defined as the nitrogen-sulfur-oxygen (NSO)- containing compounds), have a less established toxicity, but can account for ~70% of all oil compounds dissolved in water and are therefore thought to be more toxic to marine organisms and more persistent in the environment than other crude oil components (Liu & Kujawinski 2015). When considering the impact of oil on marine organisms, it is important to consider the composition and comparative toxicity of the specific oil compounds that are present as well as the amount and duration of the oil exposure and the bioavailability of the oil (Saadoun 2015). Oil is most toxic in the first few days after the spill, losing some of its toxicity as it begins to weather and emulsify (Reddy *et al*. 2012; Gros *et al*. 2014). Most of the toxic effects are associated with the monoaromatic compounds and low molecular weight polycyclic hydrocarbons, as these are the most water-soluble components of the oil (NRC 2003). When the additive toxic levels of hydrocarbons exceed the threshold concentration, their effects can lead to mortality. On ingestion, oil hydrocarbons travel to the liver where the resulting metabolites of PAHs become highly toxic and carcinogenic due to their ability to attack and bind to DNA and proteins. As hydrocarbons are highly volatile, the inhalation of concentrated petroleum vapours by mammals, turtles and birds can results in the inflammation of and damage to the mucus membranes of airways, lung congestion or even pneumonia. Inhalation of benzene and toluene, results in these volatiles being rapidly transferred into the bloodstream where accumulation in the brain and liver, can cause neurological disorders (e.g. narcosis) and hepatic damage (Saadoun 2015). Physical contact with the oil is the major route of exposure usually affecting birds and furred mammals at the sea surface. As these rely on their coats for buoyancy and warmth, they typically succumb to hypothermia, drowning and smothering when oil adheres to them.

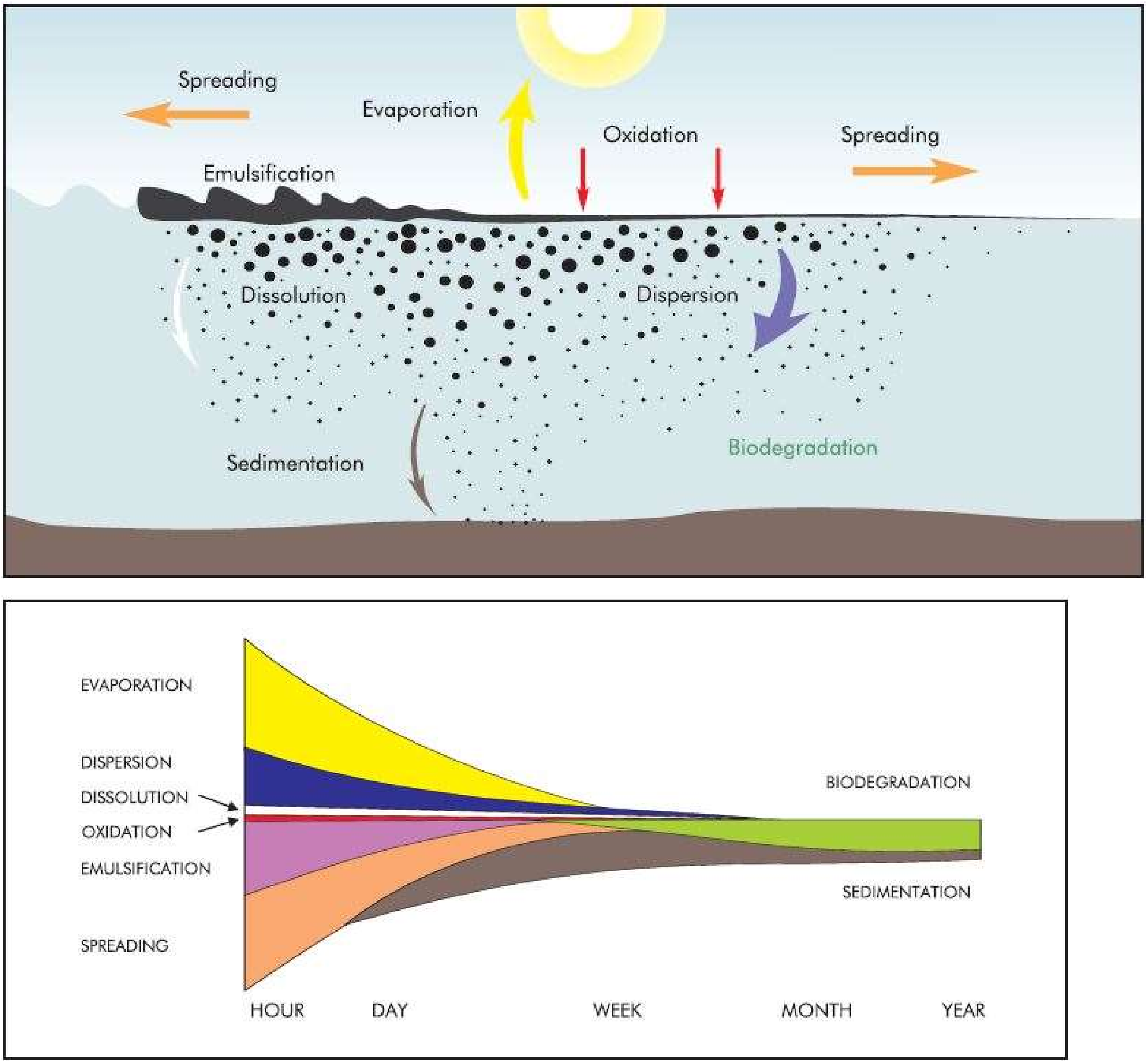


Figure 202: The weathering processes acting on spilled crude oil (Top), and the fate of a typical medium crude oil under moderate sea conditions - the width of each band indicates the importance of the process (Bottom) (ITOPF 2002).

Oil spilled in the marine environment will have an immediate detrimental effect on water quality. Any release of liquid hydrocarbons thus has the potential for direct, indirect and cumulative effects on the marine environment. The catastrophic Deepwater Horizon (DWH) blow-out in the Gulf of Mexico in 2010 provided opportunity for increasing our understanding of how an oil spill impacts the marine environment. Beyer *et al*. (2016) provide an excellent review of the plethora of research papers emanating from the research programmes initiated following the spill. The biological effects of the DWH spill are summarised in the conceptual Figure 203. This figure illustrates the biological effects as a constellation of relationships between oil exposure and toxicological effects in organisms affected by the spill. All exposure and effect elements shown are supported by information in the DWH oil spill research literature (Source: Beyer *et al*. 2016).

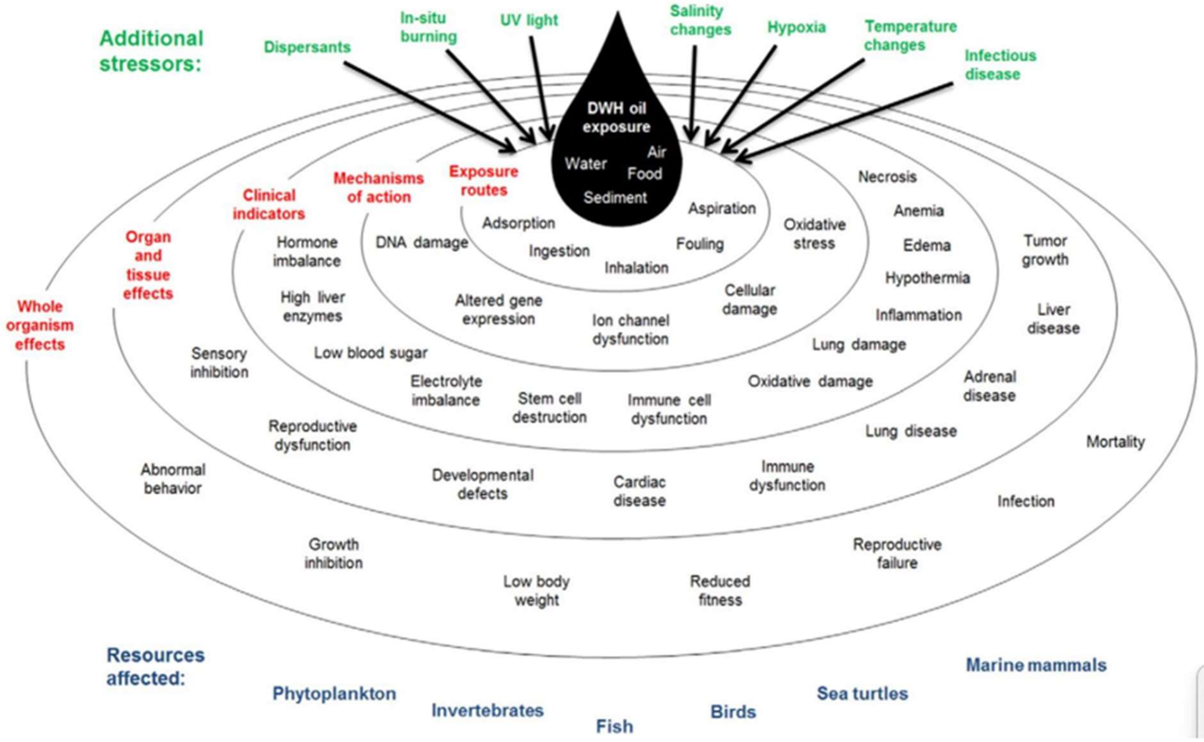


Figure 203: Conceptual figure illustrating the biological effects of the Deepwater Horizon oil spill (Source: Beyer *et al*. 2016).

The fate of the released hydrocarbons during DWH was influenced by an array of factors including the great depth, the composition and magnitude of the blow-out, high sea surface temperature, strong solar irradiation, the presence of a community of indigenous oil degrading microbes, the oceanic circulation pattern in deep and surface waters during the spill and the extensive use of dispersants (both deep and surface applied). It must be pointed out that, as the factors influencing the fate of the hydrocarbons were thus fairly site specific, some of the biological effects described for the DWH spill may not be applicable to a potential blow-out of the continental slope of the South African West Coast. For example, sea surface temperatures off the West Coast are likely to be lower, and communities of oil degrading microbes less well established (if present at all) (see Blaizot 2019). Furthermore, many of the ecological impacts reported for the DWH spill were the result of the application of dispersants, both at the leaking well head and at the sea surface. Dispersants applied to the DWH spill modified the spreading, dispersal, weathering, biodegradation, and toxicity of the spilled oil, and their use is now thought to have negatively influenced the total environmental impact of the DWH spill as some of the components proved to be considerably more persistent than originally thought (Kujawinski *et al*. 2011; White *et al*. 2014).

Plankton: Crude oil spills affect phytoplankton communities in a variety of ways and estimates of toxicity varies widely depending on the species involved (Abbriano *et al*. 2011; Zhou *et al*. 2013; Buskey *et al*. 2016). Oil toxicity can impact both phytoplankton community composition and abundance, but while productivity and growth may be reduced (Hallare *et al*. 2011), some species appear to be highly tolerant of oil exposure, and in some cases it may even stimulate their growth (Ozhan *et al*. 2015; D'Souza *et al*. 2016; Tang *et al*. 2019).

Zooplankton similarly respond to oil in a variety of ways ranging from significant but short-term impacts on zooplankton assemblages (Almeda *et al*. 2013b, 2014a, 2014b; Carassou *et al*. 2014; Cohen *et al*. 2014), with some taxa decreasing in density, while others increased. The stimulation of microbial activity in response to oil may also result in increased production of zooplankton. Small ciliates and copepods are particularly sensitive to oil exposure responding by reduced egg production rates, faecal pellet production rates, and egg hatching.

Copepods, euphasiids and mysids will ingest emulsified oil droplets leading to acute toxicity, bioaccumulation and transfer to hydrocarbon contaminants to higher order consumers (Buskey *et al*. 2016) and to benthic detritivores (Almeda *et al*. 2015). Larger gelatinous zooplankton are also sensitive to bioaccumulation effects (Almeda *et al*. 2013a), potentially acting as vehicles for contaminant transfer up the food web to apex predators such as turtles. However, there is still insufficient evidence of the extent to which oil transfers to the next trophic level.

A further consideration regarding impacts on plankton is photo-enhanced toxicity, especially where drilling is proposed in areas known as fish spawning habitats. Certain PAHs are classified as phototoxic, raising an additional level of complexity regarding the exact chemical composition of different oils. Photo-enhanced toxicity occurs when certain wavelengths enhance the observed toxicity of a compound, thereby posing additional risks to the buoyant eggs of pelagic fish and the shallow spawning habitat of many nearshore species, as these areas are likely to receive higher intensities of ultraviolet light.

The time of year during which a large spill takes place will significantly influence the magnitude of the impact on plankton and pelagic fish eggs and larvae. Should the spill coincide with a major spawning peak in the kingklip, squid, hake, anchovy and pilchard spawning areas during spring and summer, it could result in severe mortalities and consequently a reduction in recruitment (Baker *et al*. 1990; Langangen *et al*. 2017), although Neff (1991) maintains that temporally variable and environmental conditions are likely to have a far greater impact on spawning and recruitment success than a single large spill. Sensitivity of fish eggs and larvae was thought to be primarily associated with exposure to fresh (unweathered) oils (Teal & Howarth 1984; Neff 1991), but recent studies have demonstrated that the weathered water accommodated fraction of the spill results in increased toxicity (Esbaugh *et al*. 2016).

Benthic biota: In a deep-water blow-out, oil can reach the sediments by a number of pathways (reviewed in NRC 2003). The hydrocarbon mixture escaping from the well has a density lower than that of seawater and rises towards the surface. Typically, some of the rising hydrocarbons split off and form a subsurface plume of neutrally buoyant oil droplets that are distributed by deep currents and may become trapped at depth by stratification of the water column. The finely dispersed oil droplets in the subsurface plume stay suspended in the water column and undergo microbial degradation or are sorbed onto suspended sediments that are then deposited on the seabed. Depending on the characteristics of the deep currents these deep plumes may extend over substantial distances and cover large areas before the hydrocarbons settle out thereby potential impacting habitats far removed from the well site (Gong *et al*. 2014; Payne & Driskell 2015; Stout *et al*. 2017). Following the DWH spill, it was discovered that a substantial fraction of the hydrocarbons that reached the surface, were returned to the seabed over a period of weeks as bacteria-mediated, mucous-rich marine snow that had proliferated in the near surface waters during the spill (Passow 2014, 2016). Several mechanisms have been proposed to explain the formation of the marine snow, including coagulation of phytoplankton and/or suspended matter with oil droplets and production of mucosoid material from bacterial degradation of the oil both at the surface and at depth. Oil-degrading microbial communities, present naturally in the area due to deep-water hydrocarbon seeps, grew and multiplied rapidly following the spill event (Passow *et al*. 2012), with successions of diverse oil-degrading bacterial communities responding to post-spill conditions (Arnosti *et al*. 2016; Yang *et al*. 2016).

Oil may be transported to the seabed via oil–particle aggregates (Khelifa *et al*. 2005; Niu *et al*. 2011) or sink directly in the form of tar-like residues from weathered oil. As the use of dispersants can enhance the formation of sediment aggregates, oil-particle interactions can play a significant role in more ecologically sensitive nearshore areas where suspended sediment concentrations are typically higher than in offshore waters (NRC 2005; Gong *et al*. 2014; Cai *et al*. 2017). Following the DWH event, oil deposited in deep-sea sediments was estimated to cover an area in excess of 2 000 km^2 (Stout *et al*. 2017). This pulse in sedimentation resulted in changes in sedimentary redox conditions over a period of two years (Hastings *et al*. 2016) with concomitant changes in benthic communities.

A wide range of effects of oil on benthic invertebrates has been recorded, with much of the research focussing on meiofauna and the various life stages of polychaetes, molluscs and crustaceans (Elmgren *et al*. 1983; Frithsen *et al*. 1985; Volkman *et al*. 1994; Qu *et al*. 2016). Following the DWH spill Montagna *et al*. (2013) reported severe reduction in abundance and diversity of soft-bottom benthic macrofauna and meiofauna extending 3 km from the wellhead in all directions and covering an area of 24 km^2 with moderate impacts extending over 148 km^2 (see also Fisher *et al*. 2014a). Effects over larger spatial scales were, however, also reported (Salcedo *et al*. 2017). However, as tolerances and sensitivities vary greatly, generalisations cannot be confidently made. Some burrowing infauna show high tolerances to oils, as the weathered product serves as a source of organic material that is suitable as a food source. Deposit- and suspension-feeding polychaetes in particular can take advantage of bioturbation and degradation of oiled sediments (Scholtz *et al*. 1992; Kotta *et al*. 2007). Volkman *et al*. (1994) suggest that some epifauna produce complex responses to oiling and that bioaccumulation of petroleum hydrocarbons can in some cases readily occur, with cascade effects to higher order consumers. Sessile and motile mussels and crustaceans are frequent victims of direct oiling or coating, although the latter appear capable of metabolising and excreting accumulated hydrocarbons quite rapidly due to a well-developed mixed-function oxygenase system. Filter-feeders in particular are susceptible to ingestion of oil in solution, in dispersion or adsorbed on fine particles (Saadoun 2015). Chronic oiling is known to cause a multitude of sub-lethal responses in taxa at different life stages, variously affecting their survival and potential to re-colonise oiled areas. Tolerances to oil vary between life stages, with larvae and juvenile stages generally being more sensitive to the water-soluble fractions of oil than adults. This results in highly modified benthic communities with (potentially lethal) 'knock-on' effects for higher order consumers.

Abundance and diversity of megafauna (Valentine & Benfield 2013; Felder *et al*. 2014; McClain *et al*. 2019) were also reported to be negatively affected by oiling, with significant toxicity effects from both oil and dispersants reported for deep-water corals (White *et al*. 2012; Fisher *et al*. 2014a, b; Prouty *et al*. 2014; DeLeo *et al*. 2016). In Block 3B/4B, the fauna inhabiting unconsolidated sediments is expected to be relatively ubiquitous, usually comprising fast-growing species able to rapidly recruit into disturbed areas. In contrast, benthic biota associated with hard grounds are typically more vulnerable to disturbance due to their long generation times.

Sandy shores: Although only a portion of the oil spilled from an offshore well typically reaches the shoreline, even small amounts can cause widespread contamination of coastal habitats and ecosystems, including estuaries and wetlands. Landfall of oil is generally considered an unfavourable situation as stranding causes a multitude of new environmental impacts compared to those experienced in the offshore environment. Kostka *et al*. (2011) reported a rapid response in the development of oil-degrading microbial communities in beach sands following the DWH spill (see also Mortazavi *et al*. 2013), resulting in a significant fraction of the oil buried in beaches expected to have biodegraded within 5 years. Following a spill, weathered oil can appear on beaches as tar mats, and despite clean-up efforts can remain on sandy shorelines for a number of years, as smaller oil fragments and mats can become buried in the sediments to depths of over a metre through accretion (Fernández-Fernández *et al*. 2011; Michel *et al*. 2013). Heavy weather conditions and littoral drift can re-expose these deposits, redistributing the oil particles and mats along the shore and resulting in the re-oiling of beaches even three years after the initial oil stranding (Bejarano & Michel 2016; Beyer *et al*. 2016). On sheltered sandy beaches, buried oil can persist for decades (Bejarano & Michel 2010; Bernabeu *et al*. 2013). Oil burial and persistence is strongly influenced by beach erosion and deposition cycles, with the grain characteristics and degree of shoreline exposure influencing the penetration and weathering of the oil.

From the comprehensive review of Bejarano and Michel (2016) it becomes evident that oil spilled on beaches results in significant declines in abundance, biomass and diversity of meiofaunal and macrofaunal communities, with recovery of macrofaunal communities typically occurring at between 2-5 years but with recovery of burrowing and long-lived species potentially taking up to 10 years on heavily oiled beaches. Recovery of meiobenthos is typically more rapid. In some cases, recovery of the invertebrate communities was hampered by both re-oiling frequency and the type and degree of beach clean-up following the spill, while in other cases clean-up attempts promoted recovery.

Rocky shores: In the case of oiling of rocky shores, natural recolonisation begins after the processes of physical and chemical degradation have started, with recovery of benthic communities typically occurring within three years. Active clean-up operations of the shores can have a negative or marginal influence on the rate of recovery by sterilising the substratum by removing or killing those biota that survived the initial effects of oiling and would have formed the basis of the subsequent recovery process (Sell *et al*. 1995). In high-energy environments, where the natural removal and degradation of oil is relatively rapid, non-intervention is considered the most effective means of ensuring recovery. Alternatively, adding nutrients to the affected area enriches oil-degrading microorganisms thereby enhancing biodegradation of the oil while preserving the substratum (Serrano *et al*. 2011).

Fish: Adult free-swimming fish in the open sea seldom suffer long-term damage from oil spills because oil concentrations in the water column decline rapidly following a spill, rarely reaching levels sufficient to cause mortality or significant harm. Adult pelagic fish are expected to actively avoid very contaminated waters, and consequently documented cases of fish-kills in offshore waters are sparse (ITOPF 2014). Only in extreme cases of coastal spills when gills become coated with oil can effects be lethal, particularly for benthic or inshore species. Sub-lethal and long-term effects can include disruption of physiological and behavioural mechanisms, reduced tolerance to stress and opportunistic pathogens, and incorporation of PAHs through ingestion of contaminated sediments or prey that has accumulated oil (Thomson *et al*. 2000; Beyer *et al*. 2016).

Following the DWH spill, high Polycyclic Aromatic Hydrocarbons (PAH) metabolites were recorded in the bile of certain fish species, with higher concentrations closer to the spill. However, as metabolites, as chemical markers of oil exposure, were inconsistent among species surveyed and the metabolites measured, their validation is required before use as an indicator of oil contamination (Weisberg *et al*. 2016). In contrast, gene expression and potential effects on sex determination, sexual differentiation, growth regulation and DNA damage in fish was found to be a robust indicator of oil exposure in fish (Beyer *et al*. 2016). Furthermore, the well-developed hepatic Mixed Function Oxygenase (MFO) system in fish ensures that accumulation and retention of high concentrations of petroleum hydrocarbons does not occur and hydrocarbons are thus unlikely to be transfered to predators (Saadoun 2015). Experimental exposure of fish to oil-contaminated sediments was found to reduced fitness and thereby increase the potential for population-level impacts, but field studies of population impacts related to sediment contamination are lacking (Pearson 2014). In a comprehensive field study to determining PAH exposures in demersal fish species in the Gulf of Mexico, Pulster *et al*. (2020) recently concluded that complex interactions exist between multiple hydrocarbon input sources and possible re-suspension or bioturbation of oil-contaminated sediments.

The embryonic and larval life stages of fish, however, show acute toxicity to PAHs, even at low concentrations, although effects vary depending on the species and the extent of exposure. Toxicity effects on the early life stages of fish are generally defined by the occurrence of pericardial edema, which is often accompanied by reduced heart rate and atrial contractility, particularly in large predatory pelagic species such as tunas and billfish (Incardona *et al*. 2014; Esbaugh *et al*. 2016). The cardiotoxic effect may also be accompanied by spinal curvature, finfold damage, and craniofacial malformations (Incardona *et al*. 2014). Impaired cardiovascular development in fish embryos thought to reduce individual cardiovascular performance reduced swimming performance in later life and therefore a high risk for reduced productivity of these commercially-important species.

Seabirds: Chronic and acute oil pollution is a significant threat to both pelagic and inshore seabirds, many of which breed on the Saldanha Bay Islands, Dassen Island, Robben Island and Dyer Island, which could be impact by a large spill. Diving sea birds that spend most of their time on the surface of the water are particularly likely to encounter floating oil and will die as a result of even moderate oiling, which damages plumage and eyes. The majority of associated deaths are as a result of the properties of the oil and damage to the water repellent properties of the’birds' plumage. This allows water to penetrate the plumage, decreasing buoyancy and leading to sinking and drowning. In addition, thermal insulation capacity is reduced requiring greater use of energy to combat cold. Oil is also ingested as the birds preen in an attempt to clear oil from plumage and may furthermore be ingested over the medium to long term as it enters the food chain (Integral Consulting Inc. 2006). The effects of ingested oil include anaemia, pneumonia, intestinal irritation, kidney damage, altered blood chemistry, decreased growth, impaired osmoregulation, and decreased production and viability of eggs (Scholz *et al*. 1992; Finch 2011, 2012). Furthermore, even small concentrations of oil transferred from adult birds to the eggs can cause embryo mortalities and significantly reduce hatching rate. Oil spills can thus affect shorebirds through direct acute mortality, as well as indirectly or long term by sub-lethal effects on bird health and behaviour. Habitat degradation of distant feeding or breeding areas may affect bird populations in ways that carry over to subsequent seasons.

Turtles: Impacts of oil spills on turtles is thought to primarily affect hatchling survival (CSIR & CIME 2011), but direct coating of nesting females, contamination of nests and absorption of oil by eggs and hatchlings will occur with heavy shoreline oiling (Hale *et al*. 2017), potentially with far-reaching effects on recruitment success and population status (Putman *et al*. 2015). As the nesting sites in South Africa are all located over 1 500 km away on the KwaZulu Natal coastline, these would not be affected in the event of a spill, but hatchlings carried southwards in the Agulhas Current and into the Agulhas retroflection zone may become oiled. As turtles spend much of their time at the surface, inhalation of the volatile oil fractions will occur leading to respiratory stress, while coating of eyes, nostrils and mouths with oil will cause vision loss, inhalation and ingestion. Indirect ingestion of oil through contamination of their gelatinous prey or coastal foraging sites is also possible. As turtles often feed in convergence zones, they are particularly at risk to oiling as such oceanic features tend to accumulate oil (NOAA 2010; Wallace *et al*. 2016). Direct miring in oil is the most likely impact, decreasing an animal's ability to move and dive, causing exhaustion, dehydration, overheating, and eventually death. Any turtle deaths from oil exposure would remove them from the breeding population. For species considered 'endangered' or 'critically endangered' such a loss can be significant.

Seals: Little work has been done on the effect of an oil spill on fur seals and sea lions (pinnipeds), but they are expected to be particularly vulnerable as oil would clog their fur and depending on how they maintain their core body temperature, they may die of hypothermia. Seal colonies within the broader project area that may be affected by a spill are at Kleinzee Bucchu Twins near Alexander Bay, approximately 250 km northeast of the AOI representing the largest colony on the West Coast, with smaller colonies at at Bucchu Twins near Alexander Bay, and Cliff Point (~17 km north of Port). The following description is summarised from Helm *et al*. (2015). Although pinnipeds should be able to detect oil through vision and/or smell, they apparently do not actively avoid oil, and are therefore likely to come in contact with it if it comes into their habitat. Acute and long-term chronic exposure to oil in pinnipeds negatively affects the mucous membranes, eyes, ears, external genitalia, and internal organ systems. However, due to small sample sizes, the magnitude of the harm and its long-term consequence to individuals and local populations remain unknown. For those pinnipeds that rely primarily on blubber for insulation (sea lions, seals, walrus), external oiling does not significantly impact their ability to maintain their core body temperature. In fur seals and sea lions, the vulnerability to an oil spill will probably be determined by the degree and time of exposure. Wide-ranging species (e.g. elephant seals) that do not congregate in nearshore waters except to breed and moult, are likely less vulnerable than fur seals and sea lions that spend most of their time nearshore. Fur seals rely mostly on air trapped in their fur, rather than blubber for insulation. Individuals would likely face a serious challenge in maintaining their core body temperature if oiled. Population-level impacts are also likely if spilled oil reaches the haul-out sites and rookeries where these seals rest or annually mass to breed. An ill-timed large spill in the vicinity of a fur seal breeding colony would thus likely be devastating. The feeding and movement pattern of pinnipeds would also directly affect their susceptibility to an oil spill, especially in species that forage at great distances from their breeding colonies. Fur seals tend to forage in the coastal zone along the continental shelf and will thus be more susceptible to both the acute and chronic effects of an oil spill, especially where the oil is transported to the coast. Differences in foraging behaviour will also result in differences in exposure after an oil spill, with benthic foragers being more susceptible to chronic exposure through bioaccumulation of PAHs in their prey than pelagic-feeding species.

Cetaceans: The effects of oil pollution on cetaceans are poorly understood (White *et al*. 2001), but their low vulnerability to oil has also been attributed to their ability to detect and avoid slicks (Helm *et al*. 2015), although conflicting reports exist (see for example Evans 1982; Smultea & Würsig 1995; Matkin *et al*. 2008; Helm *et al*. 2015). Field observations record few, if any, adverse effects among cetaceans from direct contact with oil, and some species have been recorded swimming, feeding and surfacing amongst heavy concentrations of oil (Scholz *et al*. 1992) with no apparent effects. As oil does not adhere to the skin of cetaceans, is not expected to accumulate in or around the eyes, mouth, blow hole, or other potentially sensitive external areas. The skin is thought to contain a resistant dermal shield that acts as a barrier to the toxic substances in oil, and direct oiling of cetaceans is thus not considered a serious risk to the thermoregulatory capabilities. Dispersants added to oil spills have, however, been found to be cytotoxic and genotoxic to whale skin fibroblast cells (Wise *et al*. 2014a, 2014b).

The most likely immediate impact of an oil spill on cetaceans is the risk of inhalation of volatile, toxic benzene fractions when the oil slick is fresh and unweathered (Geraci & St Aubin 1990, cited in Scholz *et al*. 1992). Common effects attributable to the inhalation of such compounds include absorption into the circulatory system leading to narcosis and drowning (St Aubin & Geraci 1994; Matkin *et al*. 2008), inflame mucous membranes, lung congestion leading to pneumonia, neurological damage and liver disorders (Matkin *et al*. 2008), compromised health status and increased disease prevalence (Venn-Watson *et al*. 2015), and mild irritation to permanent damage to membranes of eyes, mouth and respiratory tract. For certain species that frequent or live in nearshore waters, a spill may pose significant risk. For example, populations of coastal-oriented odontocetes that show strong site fidelity restricted to nearshore habitats could be significantly impacted by a spill oiling nearshore waters. If those habitats were oiled, the animals would experience both acute and chronic exposure through their respiratory system and through ingestion of oil-contaminated prey. This may have long-term effects on population structure and size (Matkin *et al*. 2008; Beyer *et al*. 2016; Frasier *et al*. 2019). In contrast, in highly mobile, wide-ranging species, the contact with an oil spill would be relatively brief.

In offshore species, the potential for oil disrupting the reproductive behaviour is remote. However, it is a concern for inshore reproducers, particularly in highly social species, where the disruption of social groups through loss of some key individuals could potentially impact reproductive success over the long-term (see for example Matkin *et al*. 2008).

The impact of oil pollution on local and migrating cetacean populations will obviously depend on the timing and extent of the spill. It is assumed that the majority of cetaceans will be able to avoid oil pollution, though effects on the population could occur where the region of avoidance is critical to population survival. However, oil pollution in areas of cetacean critical habitat (areas important to the survival of the population), such as the extreme near-shore calving / nursing grounds of the humpback whale (e.g. in Elizabeth Bay), could be the most likely to impact populations.

Oil Spill Modelling

In the order of 47 wells have been drilled on the West Coast offshore environment to date and no well blow-outs have been recorded. Global data maintained by Lloyds Register indicates that frequency of a blow-out from normal exploration wells is in the order of 1.43 x 10^{-4} (0.000143) per well drilled. While the probability of a major spill happening is thus extremely small, the impact nonetheless needs to be considered as it could have devastating effects on the marine environment. Following the DWH incident, however, Muehlenbachs *et al*. (2013) undertook an empirical analysis of performance indicators on offshore platforms in the Gulf of Mexico and identified that water depth played a statistically significant role in determining the probability of all incidents (including blowouts, fatalities, injuries, spills, etc. on the production platforms. It should be noted, however, that this applies to production platforms, which have different activities and durations compared to the drilling of an exploration well. Furthermore, Muehlenbachs *et al*. (2013) showed that for blowout incidents specifically, there was no increase in risk with an increase in depth.

Condensate and Gas

The assessment below assumes the worst-case scenario of a 20-day blow-out of condensate and gas at a rate of 238.8 m^3/d and 930 000 Sm^3/d, respectively. The modelling assumed various spill response combinations, namely:

- Capping stack only on 20th day; and
- Subsea dispersant injection (SSDI) kit after 15th day and surface dispersion using aircrafts and vessels for chemical dispersion and vessels for containment and recovery.

Two scenarios were modelled, namely:

- Capping stack only; and
- Combination of surface response + SSDI + capping stack

Threshold values applied to illustrate modelling output results are 58 ppb for oil in the water column, 0.04 µm for the surface oil thickness and 10 g/m^2 for shoreline oiling (see Livas 2023b for details).

The discussion of modelling results and impact assessment below is based on the worst-case scenario of assuming capping only in the event of a blow-out. Should a combination of surface response, capping and SSDI be implemented in the unlikely event of a blow out, spill footprints would be reduced.

Stochastic Modelling Results:

It is important to note that the stochastic model outputs do not represent the extent of any one oil spill event (which would be substantially smaller) but rather provides a probability summary of the total individual simulations for a given scenario.

Surface Layer and Water Column Probability of Contamination

Stochastic simulation results of the oil spill modelling study indicated that the hydrocarbon mixture escaping from the well reaches the higher probability for contamination of the surface (**capping only**) forming a plume that is transported in a N to NNW direction by the current. For this surface layer, 80 - 100% probability of surface oiling is reached at a maximum distance of 42 km to the N to the NW (Season 1) (Figure 204) spreading to a maximum of ~300 km towards the Namibian EEZ (<10% probability). No oil reaches the shore. The spread of the 80-100% probability to the N does not overlap with the Child's Bank or Orange Shelf Edge MPAs, or the Orange Seamount and Canyon Complex and Child's Bank and Shelf Edge EBSAs.

In the event of a blow-out the oil would reach the surface above the release point within 3 hrs spreading a maximum of 71 km to the NW of the release point within a day (Season 2). The maximum emulsion thickness at the surface is 76 µm, reached at localised spots immediately above the release point (Season 2). Once at the surface, the condensate is rapidly evaporated, dispersed and biodegraded and no oil remained at the surface at the end of the simulations modelled (60 days). Oil dispersed on the surface will affect the upper water layers, but modelling results suggest that the probability of oil presence on the surface is <10%. The high proportion of gas contained in the release results in rapid ascent up to 600 m off the seabed. Consequently, there is no contamination of the deep layers (900 – 1 499 m). The most contaminated layer occurs in mid-water (725 – 900 m depth), but remains relatively contained around the release point (Figure 204). The spread of the mid-water plume does not overlap with the Child's Bank or Orange Shelf Edge MPAs, or the Orange Seamount and Canyon Complex and Child's Bank and Shelf Edge EBSAs, but may extend into CBA1 areas, depending on the final position(s) of the well (s).

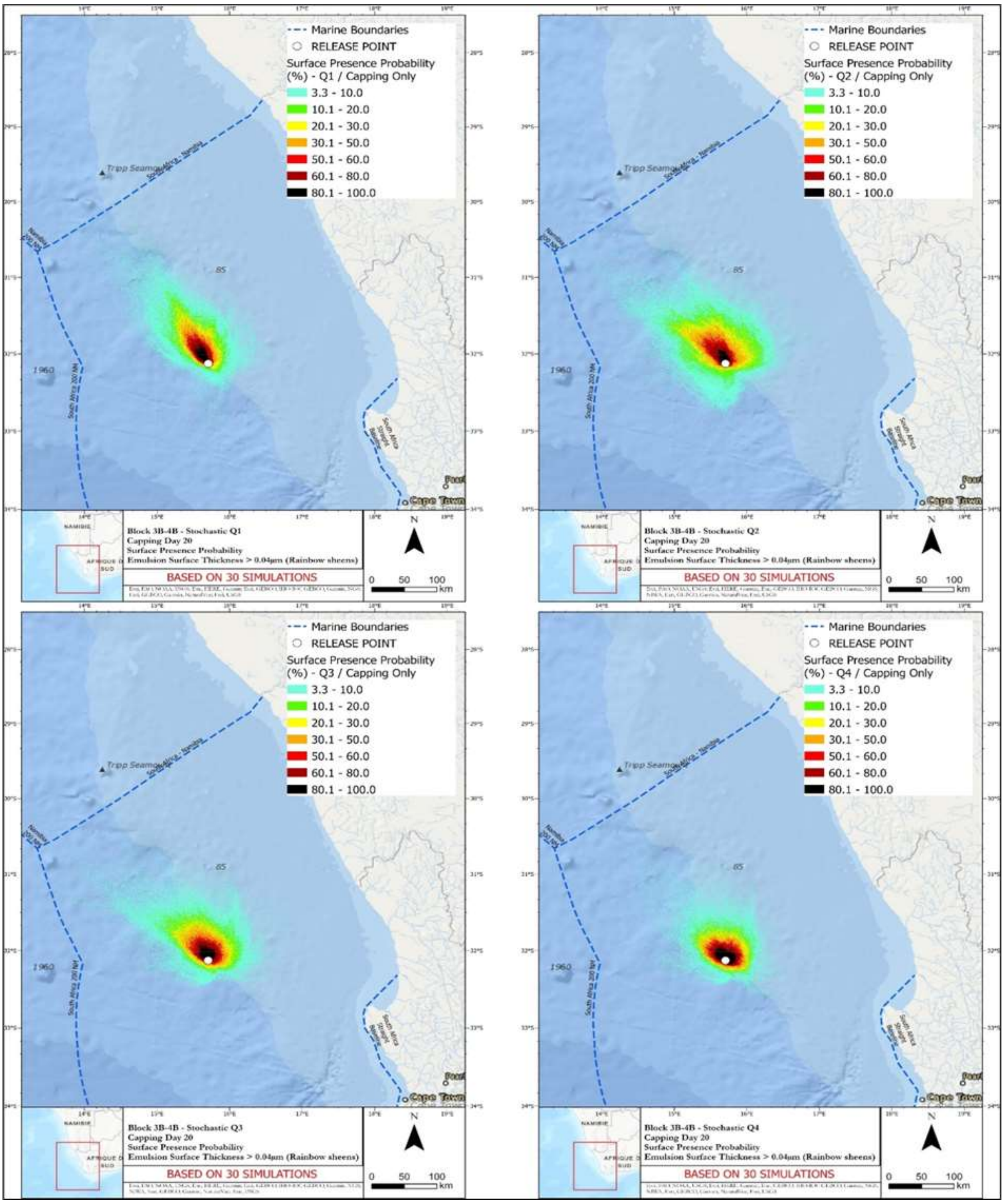


Figure 204: Surface probability of contamination >0.04 µm surface oil thickness for worst case 80-100% probability for all four seasons with capping only (Source: Livas 2023b)

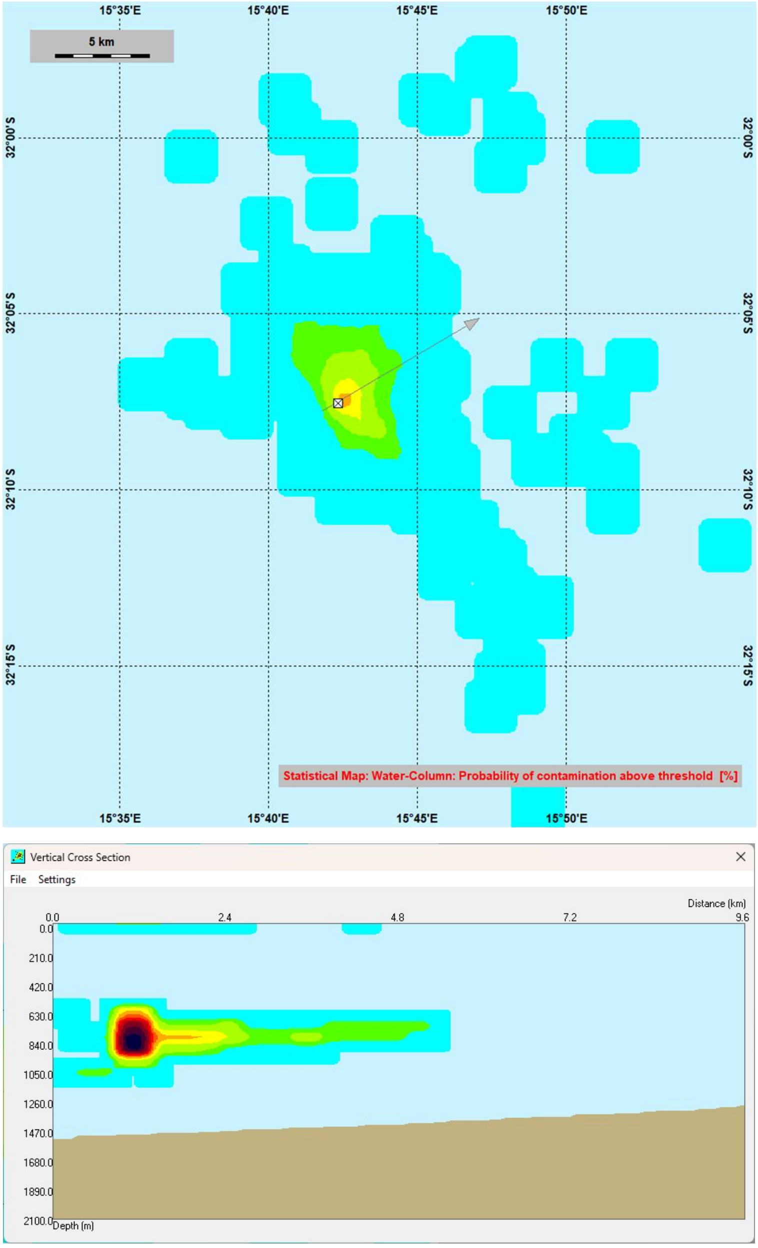


Figure 205: Water column probability of contamination >58 ppb (Season 3) with capping only (Source: Livas 2023b).

Crude Oil

The assessment below assumes the worst-case scenario of a continuous blowout of 5 405.6 m^3/d (34 000 barrels per day) and 1 443 243 Sm^3/d of crude oil and gas, respectively. The modelling assumed the following spill response, namely:

- Capping stack only on 20th day

Threshold values applied to illustrate modelling output results are 58 ppb for oil in the water column, 0.04 µm for the surface oil thickness and 10 g/m2 for shoreline oiling (see Livas 2023b for details). The discussion of modelling results and impact assessment below is based on the worst-case scenario of assuming capping only in the event of a blowout.

Stochastic Modelling Results:

It is important to note that the stochastic model outputs do not represent the extent of any one oil spill event (which would be substantially smaller) but rather provides a probability summary of the total individual simulations for a given scenario.

Surface Layer and Water Column Probability of Contamination (Release Point D)

Stochastic simulation results of the oil spill modelling study indicated that the crude oil and gas mixture escaping from the well reaches the higher probability for contamination of the surface (capping only) forming a plume that is transported in a WNW to NNW direction by the current. For this surface layer, 80 - 100% probability of surface oiling is reached at a maximum distance of 687 km to the NW (Season 1) (Figure 206) spreading to a maximum of ~850 km NW through Namibian EEZ to the Walvis Ridge (<10% probability).

The spread of the 80-100% probability to the NW overlaps with both the Child's Bank and Orange Shelf Edge MPAs, as well as the Orange Seamount and Canyon Complex and Child's Bank and Shelf Edge EBSAs.

In the event of a blowout the oil would reach the surface between 900 m and 1 200 m to the S and SW of the release point within 3 hrs of the blowout. The maximum emulsion thickness reached at the surface is 619 µm, at localised spots to a maximum of 40 km W from the release point (Season 2). Although the oil is evaporated, dispersed and biodegraded once at the surface, some oil remains at the surface at the end of the simulations modelled (60 days) between 700 km and 1 000 km to the NW of Release Point D. Oil dispersed on the surface will affect the upper water layers. The high proportion of gas contained in the release results in rapid ascent to the surface. Consequently, there is no contamination of the deep layers (900 – 1 499 m), but some oil does remain in the water column as long as 20 days following release.

Surface Layer and Water Column Probability of Contamination (Release Point A)

Stochastic simulation results of the oil spill modelling study indicated that the crude oil and gas mixture escaping from the well reaches the higher probability for contamination of the surface (capping only) forming a plume that is transported in a WNW to NNW direction by the current. For this surface layer, 80 - 100% probability of surface oiling is reached at a maximum distance of 580 km to the NW (Season 1) (Figure 207) spreading to a maximum of ~850 km NW through Namibian EEZ and across the Walvis Ridge in international waters (<10% probability). For probabilities >10%, no oil reaches the shore, but for Seasons 2 oil presence with low probabilities (<10%) occur east of the release point towards the shoreline, probably in response to short periods of westerly winds. The winds, however, do not persist for long enough to drift the oil to the coast.

The spread of the 80-100% probability to the NW overlaps with both the Child's Bank and Orange Shelf Edge MPAs, as well as the Orange Seamount and Canyon Complex and Child's Bank and Shelf Edge EBSAs.

In the event of a blowout the oil would reach the surface between 3 000 m to the S and 7 000 m to the N of the release point within 3 hrs of the blowout. The maximum emulsion thickness reached at the surface is 574 µm, at localised spots to a maximum of 19 km W of the release point (Season 2). Although the oil is evaporated, dispersed and biodegraded once at the surface, some oil remains at the surface at the end of the simulations modelled (60 days) between 920 km and 1 090 km to the NW of Release Point A. Oil dispersed on the surface will affect the upper water layers. The high proportion of gas contained in the release results in rapid ascent to the surface. Consequently, there is no contamination of the deep layers (1 200 – 1 600 m), but some oil does remain in the water column as long as 20 days following release.

Surface and Shoreline Oil Presence Probability

For Release Point D, and assuming that the oil on the surface is recovered within 60 days of the start of the spill, the stochastic modelling results indicate that no oil reaches the shore for probabilities >10%. In the case of Season 2 and Season 3, however, oil presence with low probabilities (<10%) occurs east of the release point towards the shoreline, probably in response to short periods of westerly winds. If the oil is not recovered from the surface, there is potential for it reaching the shoreline north of Saldanha Bay.

For Release Point A, the stochastic modelling results indicate that even for the capping only response to a blowout at the Release Points modelled, there is no probability of shoreline oiling, with the slick extending offshore in a N direction into Namibian and International waters. In the case of Season 2, however, if the oil is not recovered from the surface, there is potential for it extending towards the shoreline between the mouth of the Sout River and Hondeklipbaai. Assuming the worst-case scenario, the intensity of the potential impact of a blowout of crude oil varies depending on the faunal group affected ranging from HIGH for marine mammals, turtles, shoreline benthic communities, spawning areas and cetacean and seal breeding areas, to VERY HIGH for pelagic seabirds. As the spill will rise rapidly to the sea surface where it will disperse and evaporate over time, impacts of deposited oil on benthic communities associated with unconsolidated seabed or deep-water reefs are likely to be negligible, but should deposition of oil on the seabed occur the impacts of deposited oil is likely to persist over the MEDIUM- to LONG-TERM. Oil reaching the shore would likely also persist over the medium- to long-term. Impacts to pelagic fauna and seabirds would persist over the SHORT to MEDIUM-TERM and potentially be only partially reversible, but with impacts to marine fauna being of high probability considering the extensive area of the slick. In the unlikely event of a blowout the slick would spread into Namibia and International waters beyond the EEZ and thus be of INTERNATIONAL extent. The environmental risk would therefore range from MEDIUM to HIGH depending on the faunal group affected. However, collectively, the impact on marine fauna is assessed to be of HIGH environmental risk.

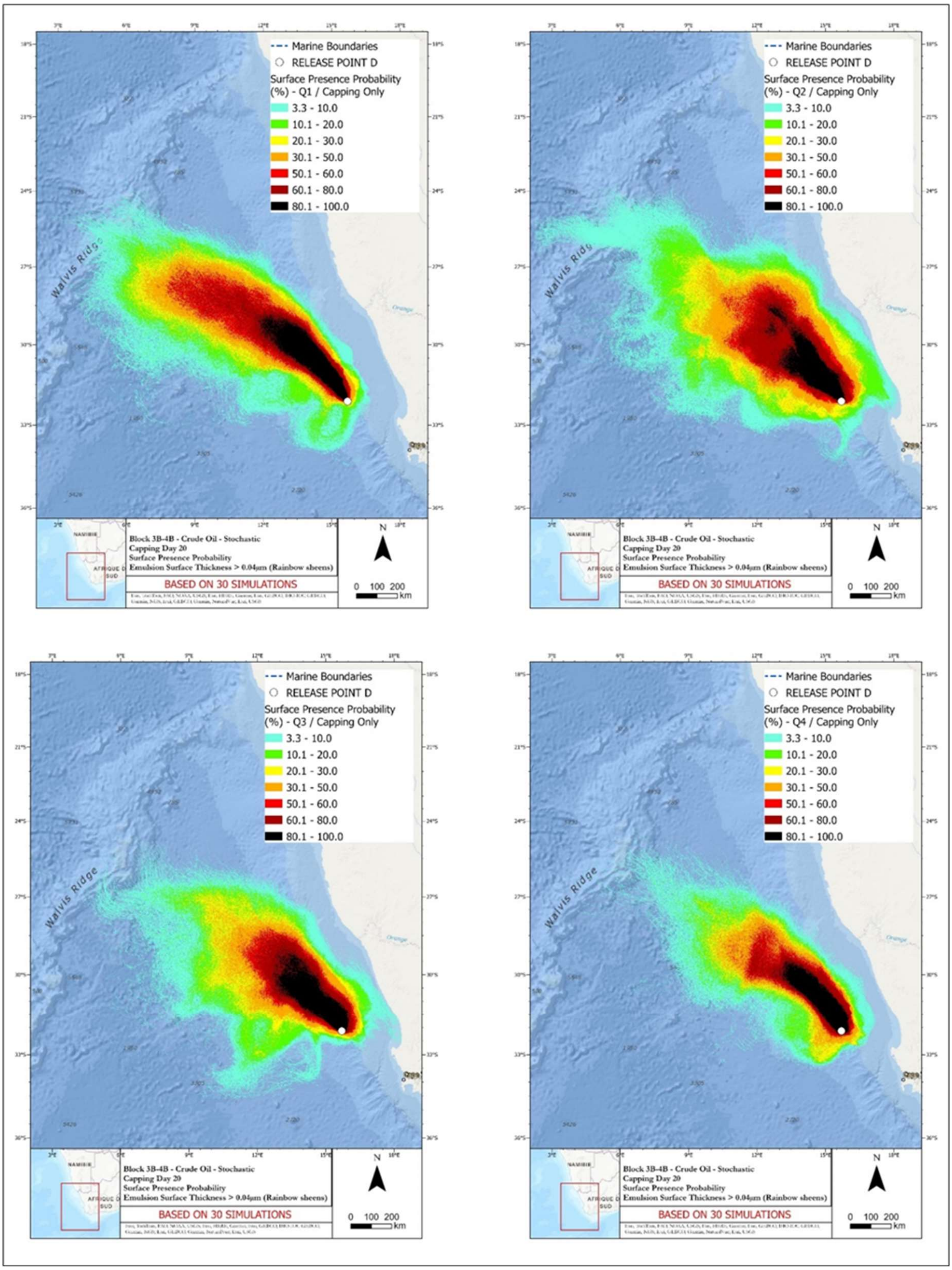


Figure 206: Surface presence probability of contamination >0.04 µm surface oil thickness for worst case 80-100% probability of crude oil for all four seasons with capping only from Release Point D (Source: Livas 2023b).

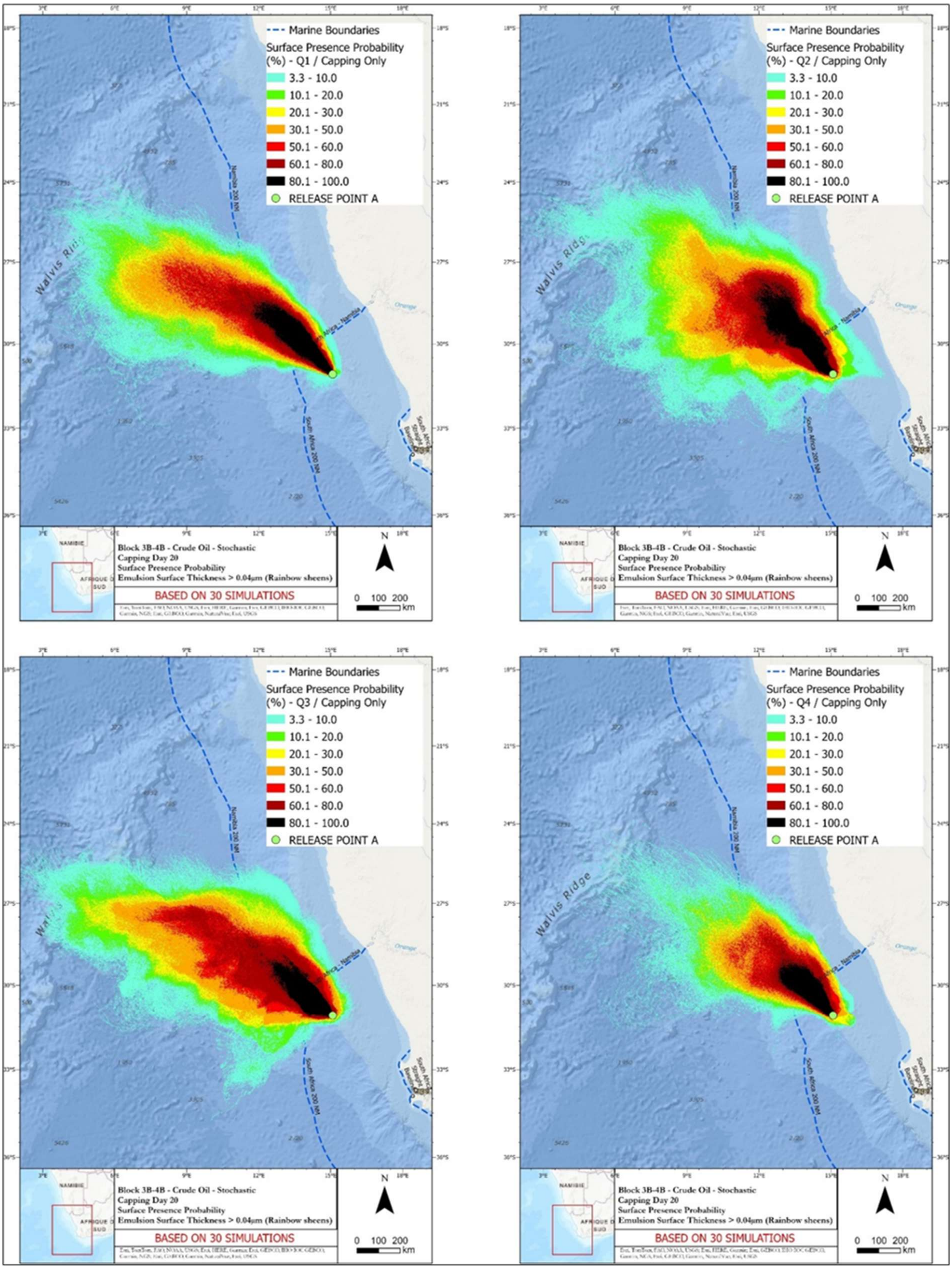


Figure 207: Surface presence probability of contamination >0.04 µm surface oil thickness for worst case 80-100% probability of crude oil for all four seasons with capping only from Release Point A (Source: Livas 2023b).

In the unlikely event of a spill, the impacts on the marine fauna before mitigation are thus considered to be of MEDIUM significance in the case of condensate and HIGH significance in the case of crude oil. It must be emphasised that the likelihood of a blowout occurring is extremely low.

In all cases impacts are partially reversible. With the implementation of the above-mentioned best management practices, the residual impact to deep-sea benthic macrofauna, pelagic fish and larvae, seabirds, marine mammals and turtles would still be of moderate to high intensity, but the extent and duration would decrease. Overall, the residual impacts would be of MEDIUM significance.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Impacts of a major spill following a blow out on deepwater benthic macrofauna, pelagic fish and larvae, seabirds, marine mammals and turtles (condensate)	Operation	Medium	Medium	Medium
Impacts of a major spill following a blow out on deepwater benthic macrofauna, pelagic fish and larvae, seabirds, marine mammals and turtles (crude oil)	Operation	High	Medium	Medium
Mitigation Measures				

- As far as possible, avoid scheduling drilling operations during the periods when weather and metocean conditions make safe drilling operations less than optimal.
- Develop response strategy and plan (OSCP), aligned with the National OSCP that identifies the resources and response required to minimise the risk and impact of oiling (shoreline and offshore). This response strategy and associated plans must take cognisance to the local oceanographic and meteorological seasonal conditions, local environmental receptors and local spill response resources. The development of the site-specific response strategy and plans must include the following:
  - **Develop an Oiled Wildlife Contingency Plan (OWCP) in collaboration with specialist wildlife response organisations with experience in oiled wildlife response. The OWCP should be integrated into the site-specific OSCP and include detailed protocols on the collection, handling and transport of oiled marine fauna.**
  - Assessment of onshore and offshore response resources (equipment and people) and capabilities at time of drilling, location of such resources (in-country or international), and associated mobilisation / response timeframes.
  - Selection of response strategies that reduce the mobilisation / response timeframes as far as is practicable. Use the best combination of local and international resources to facilitate the fastest response.
  - Well-specific oil spill modelling for planning purposes taking into consideration site- and temporal-specific information, the planned response strategy, and associated resources.
  - Develop intervention plans for the most sensitive areas to minimise risks and impacts and integrate these into the well-specific response strategy and associated plans.
  - If modelling and intervention planning indicates that the well-specific response strategy and plans cannot reduce the response times to less than the time it would take oil to disperse, additional proactive measures must be committed to. For example: Implement measures to reduce surface

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance

response times (e.g. pre-mobilise a portion of the dispersant stock on the support vessels, contract additional response vessels and aircrafts, improve dispersant spray capability, etc.).

   - **The OSCP must include an oiled wildlife contingency plan or any wildlife response strategy developed in consultation with specialist wildlife response organisations, e.g. SANCCOB. Such plan must consider and align with international best practice, including the IPIECA Wildlife Response Preparedness Guidelines.**

- Schedule joint oil spill exercises including the operator and local departments / organisations to test the Tier 1, 2 & 3 responses.
- Ensure contract arrangements and service agreements are in place to implement the OSCP, e.g. capping stack in Saldanha Bay and other international locations, surface response equipment (e.g. booms, dispersant spraying system, skimmers, etc.), dispersants, response vessels, etc.
- Use low toxicity dispersants that rapidly dilute to concentrations below most acute toxicity thresholds. Dispersants should be used cautiously and only with the permission of DFFE.
- Ensure a standby vessel is within 30 minutes of the drilling unit, equipped for dispersant spraying and can be used for mechanical dispersion (using the propellers of the ship and/or firefighting equipment). It should have at least 5m^3 of dispersant onboard for initial response.
- As far as possible, and whenever the sea state permits, attempt to control and contain the spill at sea with suitable recovery techniques to reduce the spatial and temporal impact of the spill
- In the event of a spill, use drifter buoys and satellite-borne Synthetic Aperture Radar (SAR)-based oil pollution monitoring to track the behaviour and size of the spill and optimise available response resources.
- The Operator is to submit all forms of financial insurance and assurances to PASA to manage all damages and compensation requirements in the event of an unplanned pollution event.

9.3.1.3.5 PROJECT CONTROLS FOR UNPLANNED WELL BLOWOUT

The following project control measures have been identified during the EIA process and will be required for implementation during the exploration activities in order to prevent or respond to an unplanned well blowout event:

- Compliance with COLREGS (the Convention dealing with safety at sea, particularly to reduce the risk of collisions at sea) and SOLAS (the Convention ensuring that vessels comply with minimum safety standards).
- A 500 m safety zones will be enforced around the drilling unit within which fishing and other vessels would be excluded.
- Regulation 37 of MARPOL Annex I will be applied, which requires that all ships of 400 gross tonnage and above carry an approved SOPEP. The purpose of a SOPEP is to assist personnel in dealing with unexpected discharge of oil, to set in motion the necessary actions to stop or minimise the discharge, and to mitigate its effects on the marine environment.
- As standard practice, an ERP and an OSCP will be prepared and available at all times during the drilling operation.
- Project vessels will be equipped with appropriate spill containment and clean-up equipment, e.g. booms, dispersants and absorbent materials. All relevant vessel crews will be trained in spill clean-up equipment use and routine spill clean-up exercises.
- The primary safeguard against a blow-out is the column of drilling fluid in the well, which exerts hydrostatic pressure on the wellbore. Under normal drilling conditions, this pressure should balance or

exceed the natural rock formation pressure to help prevent an influx of gas or other formation fluids. As the formation pressures increase, the density of the drilling fluid is increased to help maintain a safe margin and prevent "blow-outs". However, if the density of the fluid becomes too heavy, the formation can break down. If drilling fluid is lost in the resultant fractures, a reduction of hydrostatic pressure occurs. Maintaining the appropriate fluid density for the wellbore pressure regime is therefore critical to safety and wellbore stability. Abnormal formation pressures are detected by primary well control equipment (pit level indicators, return mud-flow indicators and return mud gas detectors) on the drill unit. The drilling fluid is also tested frequently during drilling operations and its composition can be adjusted to account for changing downhole conditions. The likelihood of a blow-out is further minimised by installation of a BOP on the wellhead at the start of the risered drilling stage. The BOP is a secondary control system, which contain a stack of independently-operated cut-off mechanisms, to ensure redundancy in case of failure. The BOP is designed to close in the well to prevent the uncontrolled flow of hydrocarbons from the reservoir. A blow-out occurs in the highly unlikely event of these pressure control systems failing.

- If the BOP does not successfully shut off the flow from the well, the drilling rig would disconnect and move away from the well site while crews mobilise a capping system. The capping system would be lowered into place from its support barge and connected to the top of the BOP to stop the flow of oil or gas.
- OSRL, the global oil spill response co-operative funded by more than 160 oil and energy companies, has a base in Saldanha Bay and another base in Aberdeen, which houses cutting-edge well capping equipment designed to shut-in an uncontrolled subsea well. The Saldanha based capping stack is available to oil and gas companies across the industry and provides for swift subsea incident response around the world. The equipment is maintained ready for immediate mobilisation and onward transportation by sea and/or air in the event of an incident. The operator of the right must be a member of OSRL, at the point of commencing the project. This would significantly reduce the spill period. All of the wells must be designed to allow for capping.
- Other project controls include the preparation and implementation of a SOPEP and a WCCP.

9.3.2 FISHERIES

This section provides a description of the Fisheries Impacts identified by in the Fisheries Assessment. For a more detailed description of the impacts, please refer to this study included in Appendix 4.

9.3.2.1 **DRILLING AND PLACEMENT OF INFRASTRUCTURE ON THE SEAFLOOR**

AOSAC proposes to drill up to five exploration wells within the AOI. Drilling is expected to take up to three to four months to complete the physical drilling and testing of each well. Well plugging and abandonment is expected to take up to 15 days, and demobilisation a further 10 days. It is anticipated that future drilling operations would be undertaken throughout the year and not be limited to a specific seasonal window period. A drilling unit is considered to be an "offshore installation" and during drilling, there would be a minimum safety zone of 500 m around drilling unit (0.79 km^2). All unauthorised vessels would be excluded from entering this safety zone.

Once drilling and logging are completed, the exploration well(s) will be sealed with cement plugs, tested for integrity and abandoned according to international best practices. The intention is to remove the wellheads from the seafloor on non-productive wells. On productive wells, it may be decided to abandon the wellheads on the seafloor after installation of over trawlable protective equipment. The risk assessment criteria will consider factors such as the water depth and use of the area by other sectors e.g. fishing. Monitoring gauges to monitor pressure and temperature through wireless communication may be installed on wells where the Operator will return in the future for appraisal / production purposes. Monitoring gauges will not be installed on exploration wells which are earmarked for abandonment. A final clearance survey check will be undertaken using an ROV, after which the drilling unit and support vessels will demobilise from the offshore licence area. In accordance with the Marine Traffic Act (Act No. 2 of 1981) seafloor infrastructure or any appliance used for the exploration or exploitation of the seabed is protected by a 500 m safety zone therefore no anchoring or trawling would be permitted within a radius of 500 m of the wellhead.

9.3.2.1.1 EXCLUSION FROM FISHING GROUND DUE TO TEMPORARY SAFETY ZONE AROUND DRILLING UNIT

All unauthorised vessels would be excluded from entering the safety zones. The safety zones will result in an exclusion area of approximately 0.79 km^2 (assuming an exclusion radius of 500 m) around the drilling unit. The implementation of the safe operational zone around the drilling unit will exclude fishing around the drilling unit for the duration of the drilling operation. The temporary exclusion of fisheries from the safety zone could result in the displacement of fishing effort into alternative areas or, if no alternative areas are available, the loss of catch (direct negative impact).

The duration of the impact is considered to be short-term (up to 3-4 months for drilling). A safety zone of 500 m would be enforced around the drilling unit, resulting in an exclusion area of 0.79 km^2 (site). Since surface longlines are buoyed and unattended, they drift in surface currents and cover a large area before they are retrieved. The potential area of exclusion to fishing operations would therefore not be limited to the 500 m safety zone around the drilling unit. Vessel operators would be obliged to take a precautionary approach in order to avoid gear entanglement with the (stationary) drilling unit by avoiding a much wider area. Based on an assumed average line length of 60 km, operators could be expected to avoid setting lines within a distance of 30 km of the drilling unit, in order to avoid potential gear entanglement. The maximum average annual catch and effort within this area amounts to 2.75% (74 tons) and 2.74% (49 lines), respectively, of the total catch and effort reported by the sector on a national scale. The intensity of the impact, based on the catch and effort within the area of impact is considered to be low.

Thus, the impact magnitude (or consequence) is considered to be very low. The proposed AOI for drilling does not overlap with the fishing grounds of the demersal trawl, midwater trawl, hake- and shark-demersal longline, small pelagic purse-seine, tuna pole-line, linefish, west coast rock lobster, south coast rock lobster, squid jig or small-scale fisheries. Thus, the presence of the drilling unit will not result in an impact on these sectors.

Based on the sensitivity of the receptors and the magnitude predicted above, the potential impact on the large pelagic longline sector is assessed to be of LOW significance. The potential for mitigation includes effective communications with fishing sectors which could allow vessel operators the opportunity to plan fishing operations in areas unaffected by the presence of the drilling unit. Thus, it may be possible for operators to relocate fishing effort into alternative areas if adequate information is provided ahead of the project. The potential impacts cannot be eliminated due to the nature of the activity and associated safe operational zone. The residual impact significance will remain LOW for the large pelagic longline sector.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Exclusion from Fishing Ground Due to Temporary Safety Zone around Vessels - Large Pelagic Longline	Operation	Low	Low	Low
Mitigation Measures				
• Compliance with COLREGS (the Convention dealing with safety at sea, particularly to reduce the risk of collisions at sea) and SOLAS (the Convention ensuring that vessels comply with minimum safety standards). • At least three weeks prior to the commencement of the drilling operations, distribute a Notice to Mariners to key stakeholders prior to the well-drilling operations. The Notice to Mariners should give notice of (1) the co-ordinates of the drilling area, (2) an indication of the proposed operational timeframes, (3) the dimensions of the safety zone around the drilling unit (500m), and (4) details on				

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance

the movements of support vessels servicing the project. This Notice to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible.

- Stakeholders include the relevant fishing industry associations: FishSA, SA Tuna Association; SA Tuna Longline Association, Fresh Tuna Exporters Association, South African Deepsea Trawling Industry Association (SADSTIA) and South African Hake Longline Association (SAHLLA). Other key stakeholders: South African Navy Hydrographer (SANHO), South African Maritime Safety Association (SAMSA), and DFFE Vessel Monitoring, Control and Surveillance (VMS) Unit in Cape Town.
- These stakeholders should again be notified at the completion of drilling when the drilling unit and support vessels are off location.
- Request, in writing, the SANHO to broadcast a navigational warning via Navigational Telex (Navtext) and Cape Town radio (Channel 16 VHF; Call sign: ZSC) for the duration of the well drilling operation.
- Manage the lighting on the drilling unit and support vessels to ensure that it is sufficiently illuminated to be visible to fishing vessels and compatible with safe operations.
- Notify any fishing vessels at a radar range of 24 nm from the drilling unit via radio regarding the safety requirements around the drilling unit.
- Implement a grievance mechanism that allows stakeholders to register specific grievances related to operations, by ensuring they are informed about the process and that resources are mobilised to manage the resolution of all grievances, in accordance with the Grievance Management procedure.

9.3.2.1.2 EXCLUSION FROM FISHING GROUND DUE TO ABANDONMENT OF WELL

The abandonment of the wellhead on the seafloor would pose an obstruction to any sector that drags a net along the seabed or anchors at the seabed. Thus, the demersal trawl fishery could be affected if the 500 m safety exclusion zone around a wellhead coincides with trawl ground as this could result in a potential loss of catch (direct negative impact). Note that the demersal long-line sector, which also sets its gear on the seafloor, would not be affected by well abandonment as this sector is permitted to set lines over an abandoned wellhead. This sector is not considered further here.

Since the abandoned wellheads would present a permanent obstruction to the demersal trawl sector, the impact would persist beyond the temporary drilling operation (permanent). Figure 100 shows the demersal trawling effort in relation to Block 3B/4B and AOI for proposed exploration drilling area. The AOI does not overlap the spatial extend of demersal trawling ground. At its closest location, the trawl footprint is situated 5 km from the AOI and a 500 m safety zone around the drilling unit would therefore not coincide with trawl ground nor present an exclusion to fishing operations or loss of access to fishing ground. There is no impact expected on the sector.

The presence of the abandoned wellhead(s) within the AOI for well-drilling does not coincide with demersal trawling ground and there is therefore NO IMPACT expected on the sector. The alternative of removing the wellhead(s) after decommissioning is not considered to be necessary (NO IMPACT). The impact significance would be the same for the well removal alternative.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Exclusion from Fishing Ground due to Abandonment of Well	Decommissioning	None	None	None
Mitigation Measures				
• Abandoned wellhead locations must be surveyed and accurately charted with the SANHO.				

9.3.2.1.3 DISCHARGE OF DRILL CUTTINGS

The project activities that will result in impacts to benthic biota as a consequence of sediment disturbance and smothering by accumulation of cement, drill cuttings and drilling fluids are listed below:

- Discharge of drilling cuttings and muds (WBM) during the initial riserless drilling phase;
- Discharge of residual cement during casing installation at the end of the riserless stage;
- Discharge of drill cuttings and NADFs below sea surface during the risered drilling phase; and
- Discharge of excess fluids and residual cement during plugging of well.

Drill cuttings, which range in size from clay to coarse gravel and reflect the types of sedimentary rocks penetrated by the drill bit, are the primary discharge during well drilling. Drill cuttings and muds would be disposed at sea in line with accepted drilling practices. These activities and their associated aspects are described further below.

- The cuttings from the initial (riserless) top-hole sections of the well (drilled with WBMs) are discharged onto the seafloor where they would accumulate in a conical cuttings pile around the wellhead, as per Table 5. In addition to the cuttings, WBM will be discharged onto the seafloor over a period of 2.5 days (60 hrs in 2 batches plus lagtime between operations), as per Table 5. Further muds are released from the drilling unit during the displacement phase, at the end of the 26″ section. The mud used during these processes is a High Viscous Gel sweeps / KCl Polymer PAD mud, of which releases would occur over a period of a few hours.

- After the surface casing string is set in a well, specially designed cement slurries are pumped into the annular space between the outside of the casing and the borehole wall. To ensure effective cementing, an excess of cement is usually used. This excess (50 m^3 in the worst case) emerges out of the top of the well onto the cuttings pile, where (depending on its mix) it either does not set and dissolves slowly into the surrounding seawater, or if it remains in a pile.

- During the risered drilling stage, the primary discharge from the drilling unit would be the drill cuttings. The chemistry and mineralogy of the rock particles reflects the types of sedimentary rocks penetrated by the bit. Cuttings from lower hole sections (drilled with NADF) are lifted up the marine riser to the drilling unit and separated from the drilling fluid by the on-board solid control systems. The solids waste stream is discharged overboard through the cutting chute, which would be located 10 m below the sea surface. Cuttings released from the drilling unit would be dispersed more widely around the drill site by prevailing currents. Cuttings and mud released during the risered stage would be discharged over a period of ~45 days (1 080 hrs in 3 batches plus lagtime between operations).

- Before demobilisation, the well(s) would be plugged, tested for integrity and abandoned, irrespective of whether hydrocarbons have been discovered in the reserve sections. Cement plugs would be set inside the well bore and across any reserve sections.

Two scenarios were modelled namely 1) using WMBs only at release point D and 2) using NADFs for the deeper well sections for release point A and D. For the current project and assuming drilling using high performance WBMs only, 278 m^3 of cuttings would be generated, of which 116 m^3 would be discharged directly at the seafloor (42% of the total volume of cuttings generated), with the remaining 162 m^3 discharged off the drill unit into the water column, after treatment to reduce oil content to <6% Oil on Cutting (OOC). In addition, approximately 374 tons of WBM (riserless: 344 m^3; displacement: 30 m^3) will be discharged onto the seafloor at the wellbore with an additional 444 tons of high-performance KCl/glycol mud discharged from the drilling unit. These discharges are pulsed throughout the drilling campaign (Base case: 60 days), reflecting the five periods corresponding to the different wellbore diameters. A single worst case scenario discharge location (Discharge point D) was modelled across four quarters; Q1: January – March; Q2: April – June; Q3: July – September and Q4: October – December.

For scenario 2 using NADFs during the risered sections at release point A, 1 876 tons of cuttings would be generated, of which 1 039 tons would be discharged directly at the seafloor (55% of the total volume of cuttings generated), with the remaining 837 tons discharged off the drill unit, after treatment to reduce oil content to <6% Oil On Cutting, into the water column. In addition, approximately 879 tons of WBM will be discharged onto the seafloor at the wellbore during riserless drilling with an additional 116 tons of NADFs discharged from the drilling unit. These discharges are pulsed throughout the drilling campaign (Base case: 60 days), reflecting the five periods corresponding to the different wellbore diameters. Four quarters were modelled for a single discharge location (Discharge point A).

The cuttings discharged at the seabed during the riserless drilling stage typically create a cone close to the wellbore, thinning outwards. The spatial extent of the cuttings pile depends on the volume of cuttings discharged and the local hydrodynamic regime: in areas with strong currents, the cuttings piles often have an elliptical footprint with the long axis of the ellipse aligned with the predominant current direction (Breuer et al. 2004).

The discharge of cuttings and WBM onto the seabed from the top-hole section of the well and the discharge of treated cuttings with NADF from the drill rig during the risered drilling stage would have both direct and indirect effects on benthic communities in the vicinity of the wellhead and within the fall-out footprint of the cuttings plume discharged from the drill rig. These impacts on marine fauna have been assessed in the marine ecology specialist assessment (Pisces 2023) and are also presented in Section 9.3.1 of this report. Ecological impacts in response to cuttings disposal are typically characterised by reduced species diversity, enrichment of opportunistic and/or pollution-tolerant fauna and a loss of more sensitive species (Ellis et al. 2012; Paine et al. 2014).

The cuttings and WBMs from the top-hole sections of the well are discharged onto the seafloor at the wellbore where they would accumulate in a conical cuttings pile around the wellbore thereby smothering or crushing invertebrate benthic communities living on the seabed or within the sediments. Cuttings and associated NADF drilling muds discharged from the drill rig would disperse and settle over a wider area around the wellhead resulting in changes in sediment structure and community composition within the fall-out footprint of the cuttings plume.

The discharge of residual cement during cementing of the first string (surface casing) and plugging of the well on demobilisation would result in accumulation of cement on the seabed and on the cuttings pile, respectively. Any benthic biota present on the seabed may potentially be smothered by the residual cement or suffer indirect toxicity and bioaccumulation effects due to leaching of potentially toxic cement additives.

The main contributors to the environmental risk for the sediment are physical, i.e. the thickness deposit of the discharge and the grain size change of the natural sediment (due to higher grain size particles released during the discharge). The sediment deposit area is not centralized around the discharge point and is orientated towards an axis from NW to SE but with significant values close to the discharge point (175 m maximum). The depositional footprints on the seabed of the drilling discharges are highly localised, and do not overlap with the spawning areas or sensitive recruitment areas of benthic and demersal species on which the hake fisheries depend. The major fish spawning areas for commercial species such as hake and kingklip, occur further inshore on the shelf to the south of the Area of Interest and beyond the footprint of environmental risk. The depositional footprint does not coincide with any areas of demersal fishing operations. The affected area would fall entirely within any demarcated safety areas around the wellhead or abandoned well location.

The biochemical impacts to marine fauna were assessed by Pulfrich (2023) as being of negligible significance on marine organisms in unconsolidated sediments and of low significance on marine organisms on hard grounds – the difference relating to the high sensitivity of the latter in comparison to the low sensitivity of the former. Behavioural responses could include avoidance of the plume, or attraction to the plume as an area of refuge from predation. The likely response in this case is unknown; however, based on the relatively low area and volume of the cuttings discharge and plume, respectively, the potential impact is considered to be of negligible significance.

The smothering effects resulting from the discharge of drilling solids at the wellbore were assessed by Pulfrich (2023) to have a residual impact of low to medium significance on benthic macrofauna in the cuttings footprint (5 wells cumulative) depending on whether the area was unconsolidated sediment or hardground. Mortality of most fauna can be expected if deposit thickness of drilling solids at the well bore is >30 mm; this would, however, be expected only within a few metres around the wellbore therefore the site would be localised (<175 m of the wellbore). Discharges from the drilling unit would have a medium intensity impact as the depositional footprint would have a considerably lower deposit thickness, but be spread over a larger area (although outside of key spawning areas). Some biota will be smothered, but many will be capable of burying up through the deposited drilling solids. Since the model predicts that physical changes to the sediment structure within the deposition footprint would persist for 5 years, recovery of benthic communities to functional similarity is expected to occur within the medium term. The impact from riserless and risered drilling is assessed to be of MEDIUM magnitude for all 5 wells regardless of season.

The sediment plume is unlikely to overlap with the fishing grounds of the midwater trawl, small pelagic purse-seine, West Coast rock lobster, South Coast rock lobster, traditional linefish, squid jig and small-scale fisheries. Thus, there is unlikely to be an impact on these sectors due to cuttings discharge. The sediment discharge is unlikely to coincide with spawning areas. With the implementation of the mitigation measures, the residual impact on commercial fishing remains of NEGLIGIBLE significance.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Discharge of Drill Cuttings	Operation	Negligible	Negligible	Negligible

Mitigation Measures

- **Ensure there is meticulous design of pre-drilling site surveys and Ecological Baseline Surveys to provide sufficient information on seabed habitats, and to map sensitive and potentially vulnerable habitats (particularly in the modelled cuttings footprints) thereby preventing potential conflict with the well site.**
- Ensure that, based on the pre-drilling site survey and expert review, drilling locations are not located within a 1 000 m radius of any sensitive and potentially vulnerable habitats (e.g. hard grounds), species (e.g. cold corals, sponges) or sensitive structural features (e.g. rocky outcrops).
- If sensitive and potentially vulnerable habitats are detected, adjust the well position accordingly or implement appropriate technologies, operational procedures and monitoring surveys to reduce the risks of, and assess the damage to, vulnerable seabed habitats and communities.
- Monitor (using ROV) cement returns and if significant discharges are observed on the seafloor terminate cement pumping.
- The operator will also ensure that the proposed drilling campaign is undertaken in a manner consistent with good international industry practice and BAT. The following controls will be implemented:
  - Based on pre-drilling survey(s), the well(s) will specifically be sited to avoid sensitive or potentially vulnerable hardground habitats as the preference will be to have a level surface area to facilitate spudding and installation of the wellhead.
  - Should WBMs not be able to provide the necessary characteristics for drilling during the risered stage, a low toxicity Group III NADF will be used. In this instance, an "offshore treatment and disposal" strategy will be implemented (i.e. cuttings will be treated offshore to reduce oil content to <6% Oil On Cutting (OOC) and discharged overboard).
  - Discharge of risered cuttings via a caisson at greater than 10 m below surface to reduce dispersion of the cuttings in surface currents.

9.3.2.2 GENERATION OF UNDERWATER NOISE

The main sources of underwater noise related to project activities are listed below.

- Mobilisation: Transit of drilling unit and support vessels to drill site

- Operation: Operation of drilling unit and support vessels at the drill site
- Operation: Transit of support vessels between the drilling unit and port
- Operation: Vertical Seismic Profiling (VSP)
- Operation: SONAR survey
- Decommissioning: Transit of drilling unit and support vessels to drill site

The estimated maximum zones of impact on fish, fish eggs and fish larvae for all operational activities (VSP, Sonar and drilling) are summarised in Table 52, based on the Sound Transmission Loss Modelling (STLM) results by the Acoustic Assessment (Appendix 4).

Table 52: Summary of the maximum zones of impact for fish, fish eggs, and fish larvae (SLR, 2023)

Animal type	Exploration Activity	Operations	Maximum threshold distances, m			
			Mortality and potential mortal injury	**Recoverable injury**	**TTS onset**	**Behavioural disturbance**
–	VSP - cumulative	250 VSP pulses	60	60	360	-
		50 VSP pulses	40	40	180	-
	Drilling		-	-	-	420
	Single MBES pulse		-	-	-	-
Note: A dash indicates the threshold is not applicable.						

The effects of sound exposure on fishes can be broadly categorised as follows:

Table 53: Effects of sound exposure on fishes

Effect	Description
Mortality and mortal injury	Immediate or delayed death
Recoverable injury	Injuries, including hair cell damage, minor internal or external hematoma etc. Injuries unlikely to result in mortality
Permanent hearing threshold shifts	Causing direct physical injury to hearing or other organs, including permanent threshold shifts (PTS) in hearing;
Temporary hearing threshold shifts	Temporary threshold shifts (TTS) in hearing include short- or long-term changes in hearing sensitivity that may or may not reduce fitness.
Behavioural Response	Causing disturbance to the receptor resulting in behavioural changes or displacement from important feeding or breeding areas or alteration of migration patterns.
Masking	Masking or interfering with other biologically important sounds (e.g. communication, echolocation, signals, and sounds produced by predators or prey); impairment of hearing sensitivity

Exposure to high sound levels can result in physiological injury to marine fauna through a number of avenues, including shifts of hearing thresholds (as either permanent (PTS) or temporary threshold shifts (TTS)), tissue damage, acoustically induced decompression sickness (particularly in beaked whales), and non-auditory physiological effects. Both PTS and TTS represent actual changes in the ability of an animal to hear, usually at a particular frequency, whereby it is less sensitive at one or more frequencies as a result of exposure to sound. In assessing injury from noise, a dual criterion is adopted based on the peak sound pressure level (SPL) and sound exposure level (SEL) (a measure of injury that incorporates the sound pressure level and duration), with the one that is exceeded first used as the operative injury criterion. PTS-onset and TTS-onset thresholds differ between impulsive and non-impulsive noise. Peak sound pressure levels for impulsive noise resulting in mortality or potential mortal injury for fish eggs and larvae, and fish range from– 207 - 213 dB re 1 µPa, with TSS in fish occurring at cumulative sound exposure levels of above 186 dB re 1 $\mu Pa^2 \cdot s$.

A review of the literature and guidance on appropriate thresholds for– assessment of underwater noise impacts are provided in the 2014 Acoustical Society of America (ASA) Technical Report Sound Exposure Guidelines for Fishes and Sea Turtles (ASA, 2014). The ASA Technical Report includes noise thresholds for mortality (or potentially mortal injury), as well as degrees of impairment such as TTS or PTS. Separate thresholds are defined for peak noise and cumulative impacts (due to continuous or repeated noise events) and for different noise sources (e.g. explosives, seismic airguns, pile driving, low- and mid-frequency sonar). In relation to fish behavioural impacts, the ASA Technical Report includes a largely qualitative discussion, focussing on long term changes in behaviour and distribution rather than startle responses or minor movements. Where insufficient data to infer thresholds exists, the relative risk of an effect is qualitatively rated at "high," "moderate," or "low" for three distances from the source. The three distances from the source are defined in relative terms:

- Near (N): this distance typically refers to fish within tens of meters from the noise source;
- Intermediate (I): distances within hundreds of meters from the noise source; and
- Far (F): fish within thousands of meters (kilometres) from the noise source.

As a general guideline, a sound pressure level of 150 dB re 1 µPa RMS may be used as a suitable indicator at which behavioural modifications of fish start to take place (Navy, 2017). Behavioural effects are generally short-term, however, with duration of the effect being less than or equal to the duration of exposure, although these vary between species and individuals, and are dependent on the properties of the received sound.

The noise generated by vessels and well-drilling operations in general, as well as VSP, falls within the hearing range of most fish and would be audible for considerable ranges before attenuating to below threshold levels. The received level of noise (and risk of physiological injury or behavioural changes) would depend on the animal's proximity to the sound source. Nonetheless, the underwater noise generated during the project could affect a demersal species residing on the seabed in the vicinity of the wellhead, to those occurring throughout the water column and in the pelagic habitat near the surface. These could have a secondary impact on the fishing industry, namely reduced catch and/or increased fishing effort (indirect negative impact). High-frequency sonar from MBES sources is not expected to cause an adverse hearing impact on fish species.

Research into the threshold levels for underwater noise impacts on fish have focused on the potential for physiological effects (injury or mortality) rather than on quantifying noise levels with behavioural effects. A review of the literature and guidance on appropriate thresholds for assessment of underwater noise impacts are provided in the 2014 Acoustical Society of America (ASA) Technical Report Sound Exposure Guidelines for Fishes and Sea Turtles (ASA, 2014).

The ASA Technical Report includes thresholds for mortality (or potentially mortal injury) as well as degrees of impairment such as temporary or permanent threshold shifts (TTS or PTS, indicators of hearing damage). Separate thresholds are defined for peak noise and cumulative impacts (due to continuous or repeated noise events) and for different noise sources (e.g. explosives, pile driving, and continuous vessel noise, drilling or dredging). In relation to fish behavioural impacts, the ASA Technical Report includes a largely qualitative discussion, focussing on long term changes in behaviour and distribution rather than startle responses or minor movements. For this exploratory drilling project, the types of noise sources are drilling noise and vessel noise. The ASA qualitative approach to this type of noise effects at three distances from the source defined in relative terms: Near (N): this distance typically refers to fish within tens of meters from the noise source; Intermediate (I): distances within hundreds of meters from the noise source; and Far (F): fish within thousands of meters (kilometres) from the noise source. The ASA does provide numeric noise thresholds for physiological effects for some fish (those where the swim bladder is involved in hearing). However, for most effects and categories of fish the risk of effect is described qualitatively as low, moderate or high risk. Most tuna do not have a swim bladder. For continuous noise of this type at distances far from the source, there is a low risk of adverse behavioural responses for any fish types. A moderate risk of masking effects is identified in the “far” range of distances for fish without a swim bladder, i.e. of the order of kilometres from the noise source. For the purpose of this impact assessment, the objective is to determine a range of distances at which noise from project activities has the potential to exceed ambient or background sound levels. Adverse masking noise and other behavioural effects are not expected in locations where noise from the project is below the background level.

Marine fauna use sound in various contexts, including social interactions and foraging, predator avoidance, navigation and habitat selection. The effects of sounds on marine fauna differ according to the intensity of the sound source, whether it is continuous or pulsed, (e.g. shipping vs pile-driving) and the sensitivity of a particular fish species to particle motion and sound pressure. The effects on fish of elevated sound may include mortality and potential mortal injury, impairment in the form of recoverable injury, temporary threshold shifts and masking. Behavioural changes may include stress, startle responses and avoidance (Popper et al., 2014). Experiments have been carried out to define those levels of sound that cause mortality, injury or hearing damage; however, it is more difficult to determine the levels of sound that cause behavioural effects, which are likely to take place over wider areas.

There is a lack of definitive evidence regarding the effects of drilling operations on marine fishes; however, there is no direct evidence of mortality or mortal injury to fish as a result of ship noise. The most likely outcome of the exposure of fish to continuous noise are behavioural responses, masking (impairment in hearing sensitivity in the presence of noise), temporary threshold shifts (a short- or long-term change in hearing sensitivity) and recoverable injury (minor internal injury unlikely to result in mortality). The U.S. NMFS does not give numerical guidelines for behavioural responses of fish to sounds generated by shipping, but lists the relative risk of behavioural effects arising as a result of shipping and continuous sounds from moderate to high in the nearfield, moderate in the intermediate field and low in the far field.

A review by Popper et al. (2014) indicates temporary threshold shifts in fish with swim bladders at a continuous sound exposure level of 158 db re 1 µPa (rms) and recoverable injury at a level of 170 db re 1 µPa (rms). These are within the range of sound levels produced by the proposed drilling operations. According to Popper et al. (2014), for non-impulsive noise sources in general, relatively high to moderate behavioural risks are expected at near to intermediate distances (tens to hundreds of meters) from the source location. Relatively low behavioural risks are expected for fish species at far field distances (thousands of meters) from the source location. Refer to Table 4.7 for a summary of threshold levels of the different types of effects on fish as a result of noise exposure.

Behavioural responses to impulsive sounds are varied and include leaving the area of the noise source (Dalen and Rakness 1985; Dalen and Knutsen 1987; Løkkeborg 1991; Skalski et al. 1992; Løkkeborg and Soldal 1993; Engås et al. 1996; Wardle et al. 2001; Engås and Løkkeborg 2002; Hassel et al. 2004), changes in depth distribution and feeding behaviour (Chapman and Hawkins 1969; Dalen 1973; Pearson et al. 1992; Slotte et al. 2004), spatial changes in schooling behaviour (Slotte et al. 2004), and startle response to short range start up or high level sounds (Pearson et al. 1992; Wardle et al. 2001).

As a general guideline, the sound ranges of 150 dB re 1 µPa RMS may be used as a suitable indicator sound pressure level at which behavioural modifications of fish start to take place. Behavioural effects are generally short-term, however, with duration of the effect being less than or equal to the duration of exposure, although these vary between species and individuals, and are dependent on the properties of the received sound.

Table 54: Noise exposure criteria and acoustic thresholds for fish (Popper et al., 2014).

Type of animal	Mortality and potential mortal injury	Impairment			Behaviour
		Recovery injury	TTS	Masking	

Fish: no swim bladder (particle motion detection)	>219 dB SEL_{24hr}, or >213 dB Pk SPL	>216 dB SEL_{24hr} or >213 dB Pk SPL	>>186 dB SEL_{24hr}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)	210 dB SEL_{24hr} or >207 dB Pk SPL	203 dB SEL_{24hr} or >207 dB Pk SPL	>>186 dB SEL_{24hr}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{24hr} or >207 dB Pk SPL	203 dB SEL_{24hr} or >207 dB Pk SPL	186 dB SEL_{24hr}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Fish eggs and fish larvae	>210 dB SEL_{24hr} or >207 dB Pk SPL	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Notes: peak sound pressure levels (Pk SPL) dB re 1 µPa; Cumulative sound exposure level (SEL_{24hr}) dB re 1 µPa^2·s. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

9.3.2.2.1 VESSEL AND DRILLING

The presence and operation of the drilling unit and support vessels during transit to the drill site, during drilling activities on site, and during demobilisation will introduce a range of underwater noises into the surrounding water column that may potentially contribute to and/or exceed ambient noise levels in the area. For non-impulsive noise, the overall noise level from combined noise emissions from the drilling unit and three support vessels (worst-case) is approximately 198.1 dB re 1 µPa @ 1m (or dB re 1 µPa^2·S @ 1m) (SLR Consulting (Canada) Ltd, 2023). For non-impulsive drilling noise, it is assumed that the source SEL levels are equivalent to their corresponding RMS SPL source levels, considering the consistency and longer durations of the typical continuous drilling noise emissions. The overall noise level from combined noise emissions from the drillship and three support vessels is approximately 201.9 dB re 1 µPa @ 1 m (or dB re 1 µPa^2·S @ 1 m). The potential for underwater noise to be generated by helicopters is limited as broadband noise levels underwater due to helicopters flying at altitudes of 150 m or more are expected to be around 109 dB re 1 µPa (Richardson et al. 2013) at the most noise-affected point. This noise level is considerably less than the underwater noise generated by support vessels or the drilling platform and can be considered negligible in terms of the overall noise levels.

Exposure to high sound levels can result in physiological injury to marine fauna through a number of avenues, including shifts of hearing thresholds (as either permanent (PTS) or temporary threshold shifts (TTS)), tissue damage, acoustically induced decompression sickness (particularly in beaked whales), and non-auditory physiological effects. Both PTS and TTS represent actual changes in the ability of an animal to hear, usually at a particular frequency, whereby it is less sensitive at one or more frequencies as a result of exposure to sound. In assessing injury from noise, a dual criterion is adopted based on the peak sound pressure level (SPL) and sound exposure level (SEL) (a measure of injury that incorporates the sound pressure level and duration), with the one that is exceeded first used as the operative injury criterion. PTS-onset and TTS-onset thresholds differ between impulsive and non-impulsive noise. Peak sound pressure levels for impulsive noise resulting in mortality or potential mortal injury for fish eggs and larvae, and fish range fro– 207 - 213 dB re 1 µPa, with TSS in fish occurring at cumulative sound exposure levels of above 186 dB re 1 µPa^2·s.

Temporary threshold shifts may occur at close range for fish species lacking swim bladders or where the swim bladders are not involved in hearing, with TTS expected in fish with swim bladders involved in hearing at cumulative rms sound pressure levels of 158 dB re 1 µPa over 12 hours at a maximum threshold distance of 170 m from the source (SLR Consulting Australia 2022). The non-impulsive drilling operation noise therefore has low physiological impacts (both mortality and recovery injury) on fish and sea turtle species. The risk of TSS close to continuous shipping sounds is generally low, although masking and behavioural changes would be likely.

The noise emissions from the drillship are predominantly generated by propeller and thruster cavitation especially when the dynamic-positioning system is operating, with a smaller fraction of sound produced by transmission through the hull, such as by engines, gearing, and other mechanical systems. For modelling predictions, all thrusters were assumed to operate at nominal speed. The vertical position of the drill rig thrusters is assumed to be 27.75 m below the sea surface at the operating draft. For offshore support vessels to maintain position in strong current conditions, they are required to have two bow thrusters plus an azimuth thruster forward. The vertical positions of the thrusters are assumed to be 5 m below the sea surface. There are three support vessels acting simultaneously as a worst-case consideration. The drillship and support vessel noise levels are estimated based on a source level predicting empirical formula suggested by Brown (1977). The formula predicts the source level of a propeller based on the propeller diameter (m) and the propeller revolution rate (rpm). For non-impulsive drilling noise, it is assumed that the source SEL levels are equivalent to their corresponding RMS SPL source levels, considering the consistency and longer durations of the typical continuous drilling noise emissions. The overall noise level from combined noise emissions from the drillship and three support vessels is approximately 201.9 dB re 1 µPa @ 1 m (or dB re 1 $µPa^2$·S @ 1 m).

For all drilling activities, the cumulative exposure level at certain locations is modelled based on the assumption that the marine animals are constantly exposed to the source at a fixed location over the entire operational period (e.g., up to 10 hours for 250 VSP pulses or up to 24 hours for continuous drilling). However, marine fauna species, such as marine mammals, fish, and sea turtles, would not (under realistic circumstances) stay in the same location for the entire period unless either the species were attached to a specific feeding/breeding area or a species that can be considered immobile (e.g., plankton and fish eggs/larvae). Therefore, the zones of impact assessed for marine mammals, fish species, and sea turtles represent the worst-case consideration.

In terms of ambient marine traffic noise, the majority of shipping traffic is located on the outer edge of the continental shelf, with traffic inshore of the continental shelf along the West Coast largely comprising fishing vessels. The block is shows a high level of shipping traffic density over the eastern area, particularly the northeastern corner of the block. As such, the shipping noise component of the ambient noise environment is expected to be significant within some sections of the block area. Given the significant local shipping traffic and relatively strong metocean conditions specific to the area, the ambient noise levels are expected to be at least 10 dB higher than the lowest level, within the higher range of the typical ambient noise levels, i.e–, 90 - 130 dB re 1 µPa for the frequency range 10-10 k Hz.

The fisheries affected by this impact could include demersal trawl, demersal longline, large pelagic longline and tuna pole. Based on the overlap of fishing grounds with the affected area (to a distance of a few kilometres around the drilling unit or vessel), the impact has been rated as being local in extent.

The impact of drilling and vessel noise is considered to be of medium intensity, based on the catch and effort within the estimated 78.5 km^2 behavioural disturbance zone (based on a conservative radius of 5 km from the drilling location) and considering that the proposed new drilling area is located in a main marine traffic route and thus is in an area already experiencing increased marine traffic and vessel noise.

For all sectors the impact is considered to be short-term (up to 3-4 months for drilling) with the duration of behavioural effects being less than or equal to the duration of exposure, although these vary between species. The magnitude of the impact of sound on catch rates during these activities is assessed to be VERY LOW for all 5 wells. The overall significance of the impact is assessed to be VERY LOW for the large pelagic longline sector.

With the implementation of the mitigation measures, which will ensure good communication and coordination with affected sectors, allowing them to focus fishing in other areas, the intensity of the impact will reduce to low. The residual impact due to vessel and drilling noise would however remain of VERY LOW for the large pelagic longline sector.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
	Mobilisation	Very Low	Very Low	Very Low

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Impact of Sound on Catch Rates during Vessel and Drilling Operations – Large Pelagic Longline	Operation	Very Low	Very Low	Very Low
	Decommissioning	Very Low	Very Low	Very Low
Mitigation Measures				
• **Mitigation will ensure good communication and coordination with the various sectors allowing them to focus fishing in other areas.** • **The drilling contractor will ensure that the proposed project is undertaken in a manner consistent with good international industry practice and BAT.**				

9.3.2.2.2 VERTICAL SEISMIC PROFILING

The source modelling results for the VSP array show the peak sound pressure level (Pk SPL) is 226 dB re 1 µPa @ 1 m, the root-mean-square sound pressure level (RMS SPL) 208.5 dB re 1 µPa @ 1 m, and the sound exposure level (SEL) 206 dB re µPa2·s @ 1 m. It is expected that 125 VSP pulses are to be generated in total over approximately 6 hours of operation duration. Therefore, for cumulative noise modelling, two scenarios are considered for this study, including the worst case of 125 VSP pulses over the entire operation duration and 50 VSP pulses over approximately 2 hours.

The cumulative sound fields based on an assumed 9-hour operation of VSP per well (of up to 125 pulses) were modelled and the zones of cumulative impact on fish were found to extend from the drilling site to distances of 450 m (TTS effects), 40 m (mortality and recoverable injuries) (refer to Table 4.6).

As most targeted fish species likely to be encountered within the licence area are highly mobile, they would be expected to flee and move away from the sound source before trauma could occur thus the above assessment is based on the assumption of the worst-case scenario that the animal does not move away from the noise source.

VSP pulses are predicted to cause immediate physiological impacts (both mortality and recovery injury) for fishes directly adjacent to the VSP source (40 m). Potential effects of behavioural disruption from VSP pulses for all fish species may occur within 2.8 km from the assessed deepest water drilling location and within 2.9 km from the assessed shallowest water drilling location. The zone of impact relevant to fish and fish eggs and larvae for potential mortal injury is within 45 m of the VSP source. The cumulative impacts from VSP pulses are predicted to cause potential recoverable injury for fish adjacent to the seismic source (within 70 m) and TTS-onset up to 450 m from the source under the worst-case VSP pulse exposure scenario (i.e., 250 pulses within 9 hours). Under the exposure scenario of 50 pulses with approximately 2 hours period, the maximum TTS impact zones are predicted to be less than 225 m from the VSP source.

Relatively low behavioural risks are expected for fish species at far field distances (thousands of meters) from the source location. The estimated zone of noise disturbance up to a distance of 2.9 km from the drilling unit could result in an affected area of up to 24.63 km2. This zone of disturbance coincides only with the area fished by the large pelagic longline sector. Placed across the area of highest fishing activity within the Area of Interest for proposed drilling, this coincides with an average annual catch of 3.2 tons from 3 lines (0.12% of the overall national catch and effort figures).

Although the effects would largely be limited to the 500 m safety exclusion zone where fishing cannot take place in any event, due to the variability in research on changes in catch rates caused by VSP, the intensity of the impact has been rated MEDIUM in accordance with a precautionary approach.

Based on the overlap of fishing grounds with the affected area, the impact has been rated as being LOCAL in extent. The fishing grounds of the large pelagic longline sector falls within the threshold of sound levels that may lead to a behavioural response from fish.

Behavioural effects are generally short-term, with duration of the effect being less than or equal to the duration of exposure (up to 9 hours per well), although these vary between species. The effects on catch rates have been shown to persist for up to 10 days after the exposure. The potential impact on catch rates could therefore be considered to be of temporary or short-term duration.

The impact of VSP operations on zooplankton was assessed in the marine faunal assessment report (Pisces, 2023), which found that the zone of impact for zooplankton to suffer physiological injury is in relatively close proximity to the operating sound source (within 245 m of sound source). As this faunal group cannot move away from the approaching sound source, it is likely to suffer mortality and/or physiological injury within the zone of impact. Potential impacts on ichthyoplankton and pelagic invertebrates would thus be of high intensity at close range, but highly localised and transient due to the localised and short-term nature of the VSP operations. The major spawning areas, as well as egg and larval drift pathways of commercially important species, such as hake, pilchards, horse mackerel and anchovy lie inshore and to the south of the Area of Interest for drilling.

The overall magnitude of the impact of sound on catch rates during these activities is assessed to be VERY LOW for the large pelagic longline sector. The overall significance of the impact is assessed to be of VERY LOW significance for the large pelagic longline sector. With the implementation of the mitigation measures, which will ensure good communication and coordination with the large pelagic longline sector allowing them to focus fishing in other areas, the intensity of the impact will reduce to low. The residual impact of sound produced during VSP operations is assessed to be of VERY LOW significance for the large pelagic longline sector. There is no impact expected on other fisheries sectors.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Vertical Seismic Profiling Noise	Operation	Low	Very Low	Very Low
Mitigation Measures				
• Mitigation will ensure good communication and coordination with the various sectors allowing them to focus fishing in other areas. Research suggests that gradual increase in signal intensity and prior exposure to airgun noise would decrease the severity of alarm responses by fish and invertebrate species. • The mitigation measure proposed in the marine ecology assessment (Pulfrich 2023) is that the initiation of airgun firing be carried out as "soft-starts" thus allowing fish to avoid potential physiological injury, but it is considered unlikely that this would mitigate effects on catch rates in the wider area.				

9.3.2.2.3 SONAR SURVEY (MBES SURVEY)

For sonar survey activities, the Applicant is proposing to utilise an MBES (70-100 kHz) with a single beam echo-sounder (38-200 kHz) and a sub-bottom profiler (2-16 kHz). The system consists of a fully integrated wide swath bathymeter and a dual frequency side scan sonar. The Kongsberg EM 712 MBES system with similar specifications to those proposed by the Applicant was used to model the planned sonar survey as worse case. The EM 712 MBES is a high-resolution seabed mapping system with a frequency range of 40-100 kHz. The source levels for the Kongsberg EM 712 MBES system show a Pk SPL of 240 dB, and RMS SPL of 237 dB, and a SEL of 210 dB.

The noise generated by the acoustic equipment utilised during geophysical surveys falls within the hearing range of most fish, and at sound levels of between 200 to 240 dB re 1 µPa at 1 m, will be audible for considerable distances (in the order of tens of km) before attenuating to below threshold levels (Findlay 2005). However, unlike the noise generated by airguns during seismic surveys, the emission of underwater noise from geophysical surveying and vessel activity is not considered to be of sufficient amplitude to cause auditory or non-auditory trauma in marine animals in the region.

High-frequency active sonar sources, such as MBES sources with a frequency range of 10 kHz or greater, are not expected to cause an adverse hearing impact on fish species due to the low-frequency hearing ranges of these marine animals (from below 100 Hz to up to a few kHz) (Popper et al., 2014). It should be noted that the period over which the cumulative sound exposure level (SEL_{cum}) is calculated must be carefully specified. For example, SEL_{cum} may be defined over a standard period (e.g., 12 hours of drilling or for the duration of an activity) or over the total period that the animal will be exposed. Whether an animal would be exposed to a full period of sound activity will depend on its behaviour, as well as the source movements. To be in line with assessment criteria for marine mammals, an exposure period of 24 hours is specified for fish. The receiving exposure levels over this period are expected to reflect the total exposure in the near field where the major adverse impacts are expected to occur for fish species. For behavioural disruption threshold levels for all fish species, the National Marine Fisheries Services (NMFS) uses the U.S. Navy Phase III criteria for all noise thresholds (Navy, 2017). As of December 2021, potential effects on endangered listed fish species may occur when impulsive or non-impulsive activities produce sounds that exceed the thresholds.

For modelling purposes, the same locations as the modelling drilling activities and an overall sonar survey of approximately 50 km^2 (approximately 7 km X 7 km) over a period of approximately 15 days was used. The proposed MBES source has extremely strong source directionalities towards cross-track directions, with a cross-track beam fan width of 140° and an along-track beam width of up to 2°. As a result, the sound field at cross-track directions is expected to be significantly higher than the along-track sound field. Considering the extremely narrow source directionalities towards the cross-track directions and the moving MBES source during the survey, it is reasonable to expect that the adjacent receiving locations along the cross-track directions from the MBES source would be exposed to what would essentially be the acoustic energy from a single sonar pulse for the duration of the survey. As such, the sonar survey modelling is proposed to be based on the sound field modelling for a single MBES pulse at the represented source location (i.e., the selected discharge location). Consequently, the overall impact zones applied for the entire sonar survey are based on the impact zones estimated for the single MBES pulse, predominantly along the cross-track directions. From the results of the Noise specialist report, high-frequency sonar from single MBES pulse is not expected to cause an adverse hearing impact on fish species, including cumulative exposure. The modelling results show that the maximum impact distance for the behavioural disturbance caused by the immediate exposure to individual MBES pulses is predicted to reach 770 m from the source for fish.

In the case of noise generated during sonar surveys, the effects on fish are considered to be of MEDIUM intensity, with a LOCAL extent for the duration of the sonar survey activities (SHORT-TERM). The impact of underwater noise generated during sonar surveys is thus considered of very low magnitude (or consequence) for a 4-week survey.

With the implementation of the mitigation measures, which will ensure good communication and coordination with the large pelagic longline sector allowing them to focus fishing in other areas, the intensity of the impact will reduce to low. The residual impact of sound produced during sonar operations is assessed to be of VERY LOW significance for the large pelagic longline sector. There is no impact expected on other fisheries sectors.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Sonar Survey Noise	Operation	Very Low	Very Low	Very Low
Mitigation Measures				
• Mitigation will ensure good communication and coordination with the various sectors allowing them to focus fishing in other areas. Research suggests that gradual increase in signal intensity and prior exposure to airgun noise would decrease the severity of alarm responses by fish and invertebrate species. • The mitigation measure proposed in the marine ecology assessment (Pulfrich 2023) is that the initiation of airgun firing be carried out as “soft-starts” thus allowing fish to avoid potential physiological injury, but it is considered unlikely that this would mitigate effects on catch rates in the wider area.				

9.3.2.3 **UNPLANNED EVENTS**

9.3.2.3.1 OIL SPILL

The project activities that could result in the accidental release of diesel / oil are listed below.

- Mobilisation: Transit of drilling unit and support vessels to drill site;
- Operation: Operation of drilling unit at the drill site and transit of support /support vessels between the drilling unit and port;
- Operation: Bunkering of fuel;
- Operation: Hydrocarbon spills (minor) (e.g. bunkering, loss of BOP hydraulic fluid);
- Operation: Loss of well control / Blow-out; and
- Demobilisation: Transit of drilling unit and support vessels from drill site;

Project activities that have the potential to affect the fishing industry through unplanned events include hydrocarbon spills which are described below:

- Instantaneous spills of marine diesel and/or hydraulic fluid can potentially occur during all project activity phases, both from the drilling unit or from support vessels. For example, the release of fuel at the sea surface during bunkering, or the discharge of hydraulic fluid from the BOP at the seabed as a result of hydraulic pipe leaks or ruptures. Such spills are usually of a low volume;
- Larger volume spills of marine diesel would occur in the event of a vessel collision or vessel accident. The movement of the support vessel between the survey area and the port town, and presence of drilling unit, may result in limited interaction with commercial, recreational and fishing boats and other marine recreational activities during their approach to the ports. Such interaction may cause vessel strikes or collisions resulting in oil tank damage; and
- A large-scale, uncontrolled release of oil / gas from the well into the marine environment resulting from a failure of standard pressure control double barrier system (as a minimum) during well-drilling.

There is a possibility that the hydrocarbon resource targeted by the proposed exploration wells is condensate rather than crude oil. However, to ensure that all potential worst-case scenarios (i.e. of the potential five well locations identified), both scenarios were considered. Condensate and crude oil have the same rock source and would have a similar composition, but would be produced in different volumes with gas taking the place of the liquid component should the resource be condensate. The release quantities for condensate are typically significantly lower and the persistence of the condensate at sea much lower than oil. The environmental impacts realised during a condensate blowout would therefore also be much lower.

Various factors determine the impacts of oil released into the marine environment. The physical properties and chemical composition of the oil, local weather and sea state conditions and currents greatly influence the transport and fate of the released product. The physical properties that affect the behaviour and persistence of an oil spilled at sea are specific gravity (API), viscosity and pour point, all of which are dependent on the oils chemical composition (e.g. the amount of asphaltenes, resins and waxes). As soon as oil is spilled, it undergoes physical and chemical changes (collectively termed 'weathering'), which in combination with its physical transport, determine the spatial extent of oil contamination and the degree to which the environment will be exposed to the toxic constituents of the released product. It is estimated that of the oil forming surface layers during a spill, ~40% is rapidly lost to weathering (McNutt et al. 2012). Although the individual weathering processes may act simultaneously, their relative importance varies with time. Whereas spreading, evaporation, dispersion, emulsification and dissolution are most important during the early stages of a spill, the ultimate fate of oil is determined by the longer term processes of oxidation, sedimentation and biodegradation.

Marine diesel, hydraulic fluid and/or oil spilled in the marine environment would have an immediate detrimental effect on water quality, with the toxic effects potentially resulting in mortality (e.g. suffocation and poisoning) of marine fauna or affecting faunal health (e.g. respiratory damage) (direct negative impact). Sub-lethal and long-term effects can include disruption of physiological and behavioural mechanisms, reduced tolerance to stress and incorporation of carcinogens into the food chain. If the spill reaches the coast, it can result in the smothering of sensitive coastal habitats.

There are several possible direct and secondary impacts of hydrocarbon spills on fisheries:

- Oil contamination of mobile finfish species, in particular of juveniles in nursery areas could result in displacement of species from normal feeding and protective areas as well as possible physical contamination and/or physiological effects such as clogging of gills, both of which would lead to fish mortality;
- Oiling of sessile or sedentary species would result in physical clogging on individuals, disturbance and or removal of habitat for these species and gill clogging for filter feeding species such as mussels, all of which is likely to result in mortality;
- Oiling of passively drifting spawn products (eggs and larvae) would result in their contamination and mortality (the extent of mortality would depend on the nature and extent of the contaminants) leading to reduced recruitment and loss of stock;
- Exclusion of fisheries from areas that may be polluted or closed to fishing due to contamination of sea water by the oil or for example the chemicals used for cleaning oil spills; and
- Gear damage due to oil contamination.
- Contamination of Product: Oil spills in marine environments can lead to the contamination of fish and seafood products. Fish exposed to oil spills may absorb toxic substances, such as polycyclic aromatic hydrocarbons (PAHs), which can accumulate in their tissues (Gracia et al. 2020). This contamination poses significant risks to human health if contaminated fish are consumed. Studies have shown that PAHs can cause various health issues, including carcinogenic effects and reproductive toxicity (Short, 2017; Sandifer et al., 2021). Furthermore, the presence of oil residues can render fish visually unappealing and unsuitable for sale, leading to financial losses for fishing operations (Pascoe and Innes, 2018).
- Avoidance of Contaminated Fishing Areas: Impacts on fisheries livelihoods from oil spills have included periodic closure of fishing grounds for clean-up and rejuvenation, long-term displacement from fishing areas to minimize pollution effects, lost jobs and unemployment, and lost seafood markets and revenues (Levy and Gopalakrishnan, 2010; Watts and Zalik, 2020). Following an oil spill, fishing vessels may avoid areas affected by contamination to prevent the capture of contaminated fish and ensure product safety (Gracia et al. 2020; Andrews, N. et al. 2021). This avoidance behaviour can disrupt fishing operations, as vessels may need to relocate to alternative fishing grounds, resulting in increased fuel costs and reduced catch efficiency (Gracia et al. 2020). Studies have documented the displacement of fishing activities away from oil-affected areas following major spills, such as the Deepwater Horizon oil spill in the Gulf of Mexico (Pascoe and Innes, 2018; Andrews, N. et al. 2021). Avoidance of contaminated areas may also lead to competition among fishing vessels for access to unaffected fishing grounds, exacerbating resource conflicts and management challenges. Additionally, fish species have been shown to avoid areas contaminated with PAHs (Schlenker et al., 2019).
- Loss of Marketable Product: In cases where fish are exposed to oil spills and subsequently captured by fishing operations, there is a risk of product rejection due to contamination. Fish contaminated with oil residues may fail to meet quality standards set by regulatory agencies and seafood markets, resulting in the rejection of entire catch batches (Challenger and Mauseth, 2011; Gracia et al. 2020). This rejection not only leads to financial losses for fishing operations but also undermines consumer confidence in seafood products sourced from affected regions. Studies have shown that seafood market demand can decline significantly in the aftermath of oil spills, particularly in regions directly impacted by contamination (Challenger and Mauseth, 2011; Gracia et al. 2020). Loss of market access can have long-term economic consequences for fishing communities reliant on seafood trade.
- Indirect Impact on Fisheries from Contamination: The introduction of oil into marine ecosystems can lead to a range of adverse effects on phytoplankton. Petrogenic carbon may contain toxic compounds

such as PAHs and heavy metals, which can inhibit photosynthesis, disrupt cellular processes, and impair growth and reproduction in phytoplankton species (Quigg et al., 2021; Gracia et al. 2020; Tang et al., 2019). Additionally, the physical presence of oil slicks can block sunlight, thereby reducing light availability for photosynthesis and further suppressing phytoplankton productivity (Quigg et al., 2021; Gracia et al. 2020; Tang et al., 2019). The reduced productivity is likely to lead to reduced productivity on higher trophic levels, such as economically important fish species.

Condensate Environmental Risk

The environmental impacts associated with the oil spill scenario modelled by Livas (2023) for a single potential well site within the AOI at 1 499 m depth and ~215 km from the closest shoreline are assessed below, based on the worst-case footprints for the probability of surface oiling from spill events during each of the four Quarters: Quarter 1 (Q1) January to March, Quarter 2 (Q2) April to June, Quarter 3 (Q3) July to September and Quarter 4 (Q4) October to December.

Note: The oil spill modelling study assumed the worst-case scenario of a continuous blowout of 238.8 m^3/d of condensate and 930 000 Sm^3/d of gas for a period of 20 days assuming the characteristics of Condensate SKARV 13 DEG -2014 as the closest equivalent of the condensate expected from an exploration well in Block 3B/4B.

The assessment below assumes the worst-case scenario of a 20-day blow-out of condensate and gas at a rate of 238.8 m^3/d and 930 000 Sm^3/d, respectively. The modelling assumed various spill response combinations, namely:

- Capping stack only on 20th day; and
- Subsea dispersant injection (SSDI) kit after 15th day and surface dispersion using aircrafts and vessels for chemical dispersion and vessels for containment and recovery.

Two scenarios were modelled, namely:

- Capping stack only; and
- Combination of surface response + SSDI + capping stack

Threshold values applied to illustrate modelling output results are 58 ppb for oil in the water column, 0.04 µm for the surface oil thickness and 10 g/m^2 for shoreline oiling (Livas 2023b for details).

The discussion of modelling results and impact assessment below is based on the worst-case scenario of assuming capping only in the event of a blowout. Should a combination of surface response, capping and SSDI be implemented in the unlikely event of a blow out, spill footprints would be much reduced.

Condensate Stochastic Modelling Results

It is important to note that the stochastic model outputs do not represent the extent of any one oil spill event (which would be substantially smaller) but rather provides a probability summary of the total individual simulations for a given scenario.

Surface Layer and Water Column Probability of Contamination

Stochastic simulation results of the oil spill modelling study indicated that the main drift direction of the spill is NNW due to the main surface currents towards NW and winds from S to SSE in the area. In the event of a blow-out the oil would reach the surface within 3 hrs. Figure 4.5 shows probabilities of surface contamination (>0.04 µm surface oil thickness) for each quarter (assuming capping only). For this surface layer, 80 - 100% probability of surface oiling is reached at a distance of 42 km from the release point during Q1 (January to March) with a distance of 29 km during Q2 and Q4 and 32 km during Q3.

No oil is predicted to reach the shore due to main currents and wind driving the spill toward the NW, away from the coasts. Nevertheless, because those currents and winds are strong, the oil travels further. The plume is predicted to spread a maximum of ~300 km towards the Namibian EEZ (<10% probability). There is a 3.3% probability of surface oiling reaching Namibian waters.

The implementation of SSDI and surface response after 15 days results in an insignificant decrease of the surface slicks and spread in the shallower layers as condensate naturally disperses well in the water column and evaporates rapidly once at the surface. Deployment of these control measures would thus be ineffectual in reducing the oil presence probability areas. The same holds true for the minimum arrival time at the surface and maximum emulsion thickness at the surface.

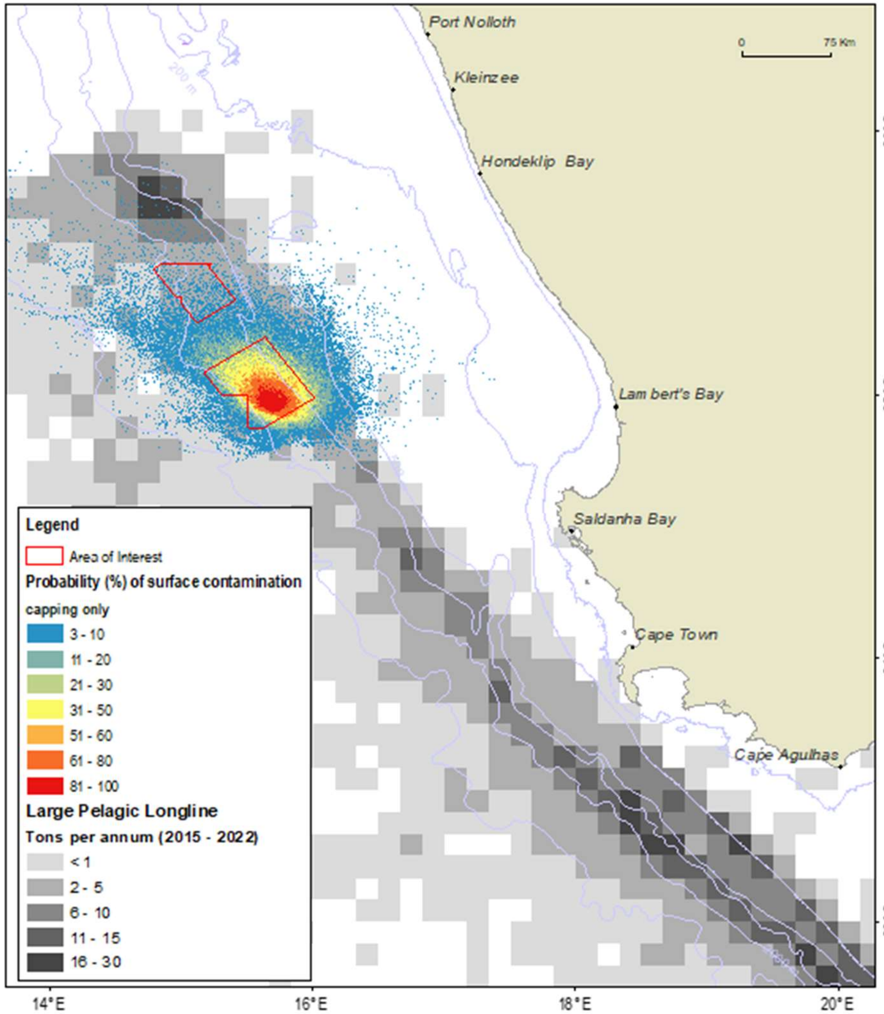


Figure 208: Fishing grounds of the large pelagic longline sector in relation to the surface probability of contamination during well blowout (Q3; with capping response)

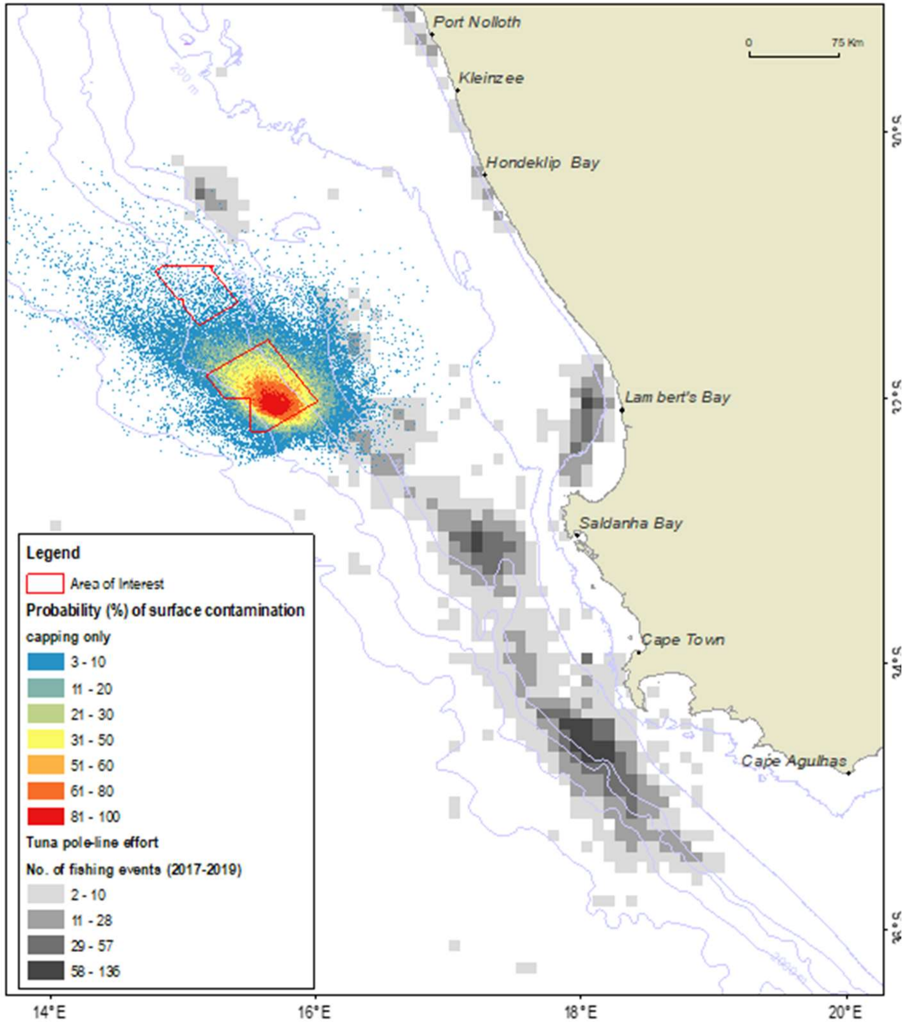


Figure 209: Fishing grounds of the tuna pole-line sector in relation to the surface probability of contamination during well blowout (Q3; with capping response).

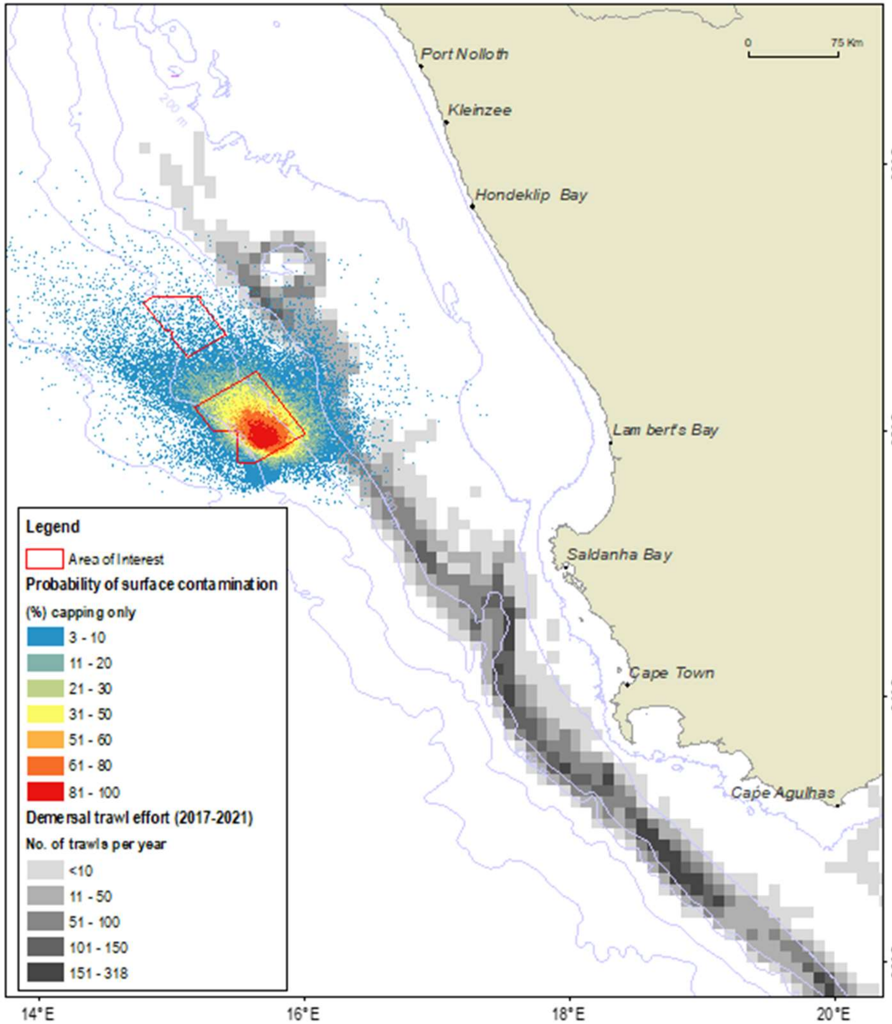


Figure 210: Fishing grounds of the demersal trawl sector in relation to the surface probability of contamination during well blowout (Q3; with capping response).

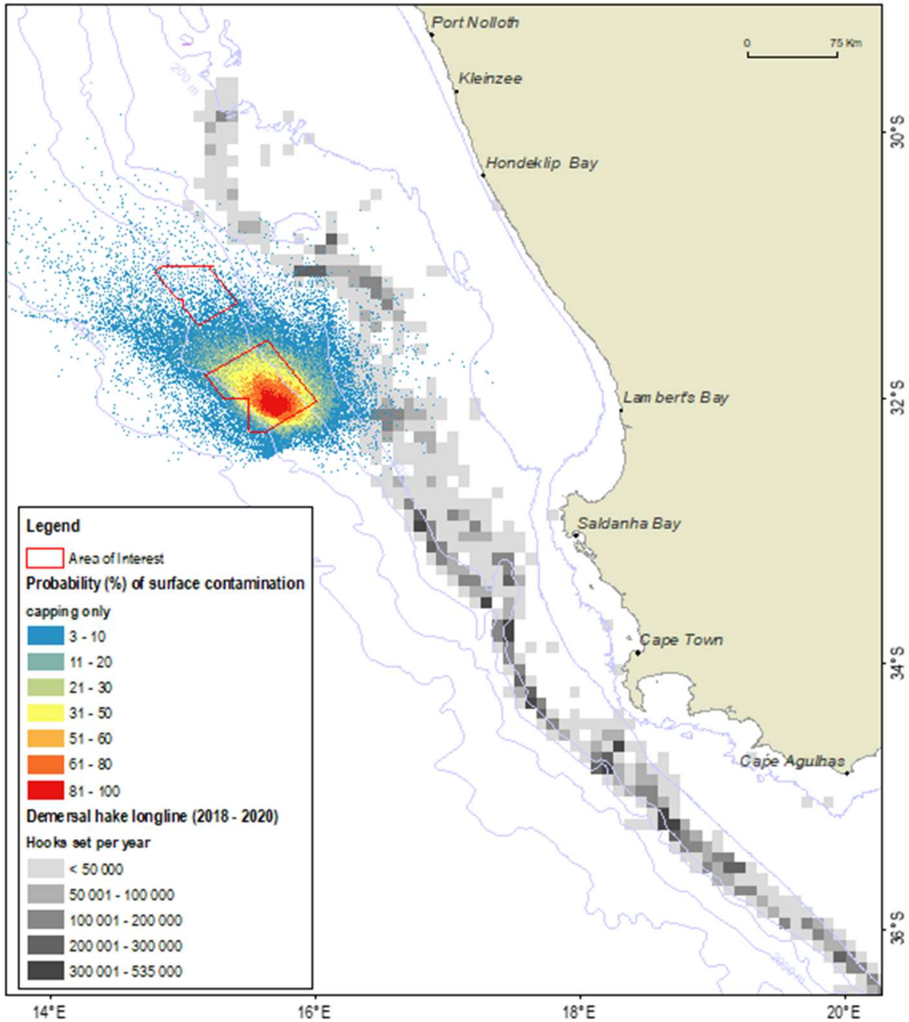


Figure 211: Fishing grounds of the demersal longline sector in relation to the surface probability of contamination during well blowout (Q3; with capping response).

Crude Oil Environmental Risk

The environmental impacts associated with the oil spill scenario modelled by Livas (2023b) for two potential well sites within the AOI were assessed based on the footprints for the probability of surface oiling from spill events during each of the four Quarters: Q1 (January to March), Q2 (April to June), Q3 (July to September) and Q4 (October to December). As the exact locations of the wells to be drilled within the area of interest are not yet known, the two locations were selected for modelling based on:

- Distance from the coast: it will directly influence the travel time and quantities that may be stranded on the shoreline.
- Proximity of marine protected areas (MPAs) and critical biodiversity areas (CBAs) that might be impacted especially by drilling discharges which are more localized than oil spill.
- Winds and Currents directions that could potentially cause the oil slick to drift ashore.

Point D (water depth 1 499 m) was selected as the release point for Condensate cases and Crude Oil cases. Point A (water depth 1626m) was selected as an additional release point for the Crude Oil cases only.

The oil spill modelling study assumed the worst-case scenario of a continuous blowout of 5 405.6 m^3/d (34 000 barrels per day) of crude oil and 1 443 243 Sm^3/d of gas for a period of 20 days assuming a crude oil analogous with OSEBERG BLEND 2006 (selected from SINTEF'S OSCAR Database). The modelling assumed the following spill response, namely the installation of a capping stack only on the 20th day following the blow-out.

Threshold values applied to illustrate modelling output results are 58 ppb for oil in the water column, 0.04 µm for the surface oil thickness and 10 g/m^2 for shoreline oiling (Livas 2023b for details). The discussion of modelling results and impact assessment below is based on the worst-case scenario of assuming capping only in the event of a blowout.

Crude Oil Stochastic Modelling Results

It is important to note that the stochastic model outputs do not represent the extent of any one oil spill event (which would be substantially smaller) but rather provides a probability summary of the total individual simulations for a given scenario.

Surface Layer and Water Column Probability of Contamination (Release Point D)

Stochastic simulation results of the oil spill modelling study indicated that the crude oil and gas mixture escaping from the well reaches the higher probability for contamination of the surface (assuming capping only) forming a plume that is transported in a WNW to NNW direction by the current. Based on the findings of the updated Oil Spill Modelling Report, one it can be observed that:

- The main drift direction of the spill simulated is towards WNW to NNW for all quarters. This is due to the main surface currents towards NW and winds from S to SSE in this area.
- In consequence, there is no oil reaching the shore for all these seasons. An oil presence with low probabilities (<10%) can be noted on the East direction from the release Point D, towards the shoreline, for Quarters 2 and 3. This may correspond to a short episode of wind coming from the west, but which does not last long enough to drift the oil to the coast.
- The maximum distance for the 80 to 100% oil surface probability is 687 km NW from the release point for Quarter 1 (January to March).

In the event of a blowout the oil would reach the surface between 900 m and 1 200 m to the S and SW of the release point within 3 hrs of the blowout. The maximum emulsion thickness reached at the surface is 619 µm, at localised spots to a maximum of 40 km W from the release point (Q2). Although the oil is evaporated, dispersed and biodegraded once at the surface, some oil remains at the surface at the end of the simulations modelled (60 days) between 700 km and 1 000 km to the NW of the release. In the case of Q2 and Q3, if the oil is not recovered from the surface, there is potential for it reaching the shoreline north of Saldanha Bay. Oil dispersed on the surface will affect the upper water layers. The high proportion of gas contained in the release results in rapid ascent to the surface. Consequently, there is no contamination of the deep layers (900 – 1 499 m), but some oil does remain in the water column as long as 20 days following release.

Capping Only Scenario - Stochastic Simulation – Release Point D

Table 55 presents the predicted area of contaminated fishing ground based on the probability of presence of oil above the threshold (0.04 µm) at sea surface. After 60 days, most of the oil is evaporated, biodegraded and dispersed. Some oil is remaining at the surface. i.e. duration of impact on fishing operations could be considered to be maximum of 60 days but shorter than this if recovery measures/surface response is implemented.

Q2 shows the highest likelihood of surface oiling extending into areas inshore of the release point as a result of westerly winds having an effect on the trajectory of the surface oil slick (i.e. in addition to the prevailing water current moving the slick in a predominantly NW direction away from the coastline). Although the findings of the modelling are that the surface oil travels the greatest distance during Q1 (due to environmental conditions), the risk to fisheries of surface oiling is highest if inshore areas are contaminated as this could affect nearshore activities and sensitive areas.

Table 55: Summary of the results of the Stochastic simulations for Capping Only / All Quarters for Point D.

Scenario STO-A Point D Q2	Results Contaminated area (Capping Stack Day 20)	Oil-surface probability contour			
		3.3%	10%	50%	90%
Fishery Sector	Main spill direction	WNW to NNW			
Demersal longline	Contaminated surface area of fishing ground (km²)	25 173	22 848	7 980	-
	Contaminated proportion of fishing ground (%)	25.51	23.15	8.09	-
	Catch (tons of hake per year; ave 2000-2017)	725	713	202	-
	Catch (%)	9.06	8.91	2.52	-
Small pelagic purse-seine	Contaminated surface area of fishing ground (km²)	13 160	6 870	-	-
	Contaminated proportion of fishing ground (%)	27.19	14.19	-	-
	Catch (tons per year; ave 2017-2022)	71 373	6 027	-	-
	Catch (%)	24.4	2.06	-	-
Large pelagic longline	Contaminated surface area of fishing ground (km²)	108 159	84 329	51 470	28 166
	Contaminated proportion of fishing ground (%)	22.51	17.55	10.71	5.86
	Catch (tons per year; ave 2015-2022)	562	491	397	241
	Catch (%)	19.85	17.34	14.02	8.51
Demersal trawl	Contaminated surface area of fishing ground (km²)				-
	Contaminated proportion of fishing ground (%)				-
	Catch (tons per year; ave)				-
	Catch (%)				-
Tuna pole-line	Contaminated surface area of fishing ground (km²)	37 560	26 867	10 694	664
	Contaminated proportion of fishing ground (%)	44.22	31.63	12.59	0.78
	Catch (tons of albacore per year; ave)	511	401	169	3
	Catch (%)	14.65	11.49	4.85	0.04

Scenario STO-A Point D Q2	Results Contaminated area (Capping Stack Day 20)	Oil-surface probability contour 3.3%	10%	50%	90%
Fishery Sector	Main spill direction		WNW to NNW		
Linefish	Contaminated surface area of fishing ground (km²)	2 103	881	-	-
	Contaminated proportion of fishing ground (%)	4.87	2.04	-	-
	Catch (tons per year: ave 2000-2021)	1 225	24	-	-
	Catch (%)	10.47	0.21	-	-
WCRL nearshore/ bakkies	Number of contaminated management sub-areas of total active management sub-areas	7 of 40	2 of 40	-	-
	Catch (tons per year: ave 2016-2020)	9	<1	-	-
	Catch (%)	4.23	0.05	-	-
WCRL offshore/ trapboats	Number of contaminated management sub-areas of total active management sub-areas	9 of 21	1 of 21	-	-
	Catch (tons per year: ave 2016-2020)	95	2	-	-
	Catch (%)	7.47	0.13	-	-

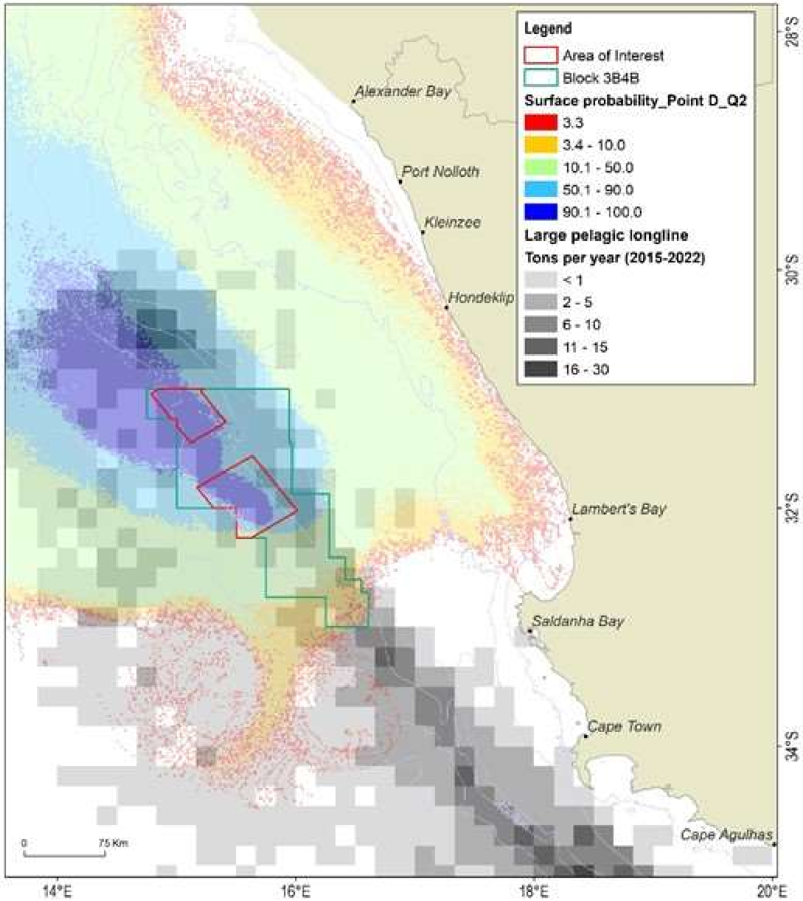


Figure 212: Fishing grounds of the large pelagic longline sector in relation to the surface probability of contamination during well blowout of crude oil (Q2; with capping response).

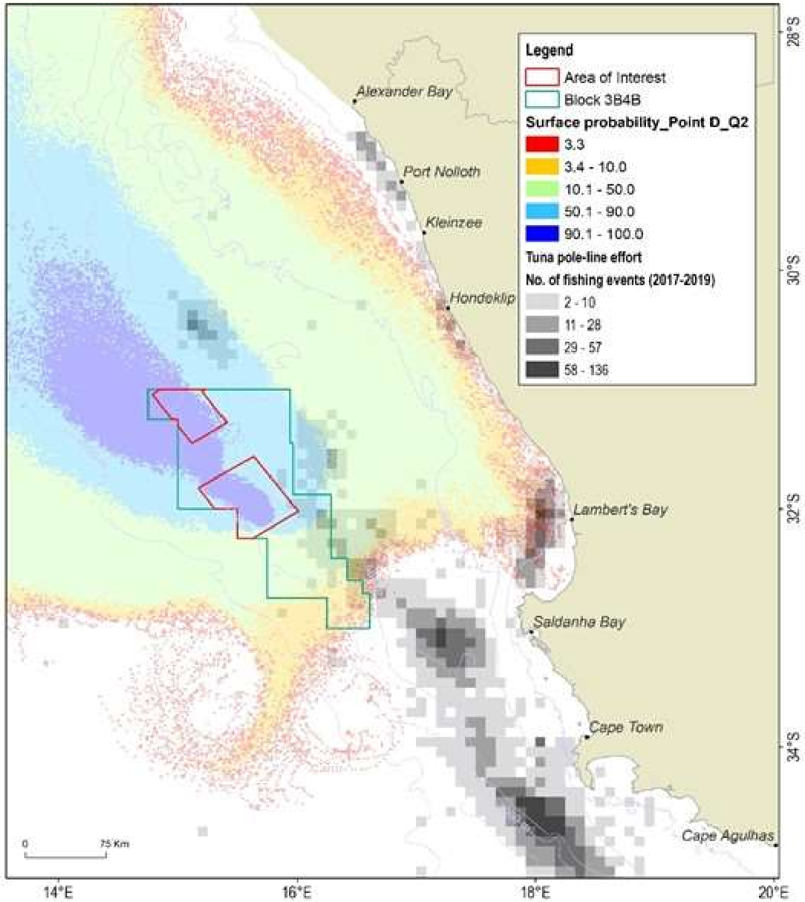


Figure 213: Fishing grounds of the tuna pole-line sector in relation to the surface probability of contamination during well blowout of crude oil (Q2; with capping response).

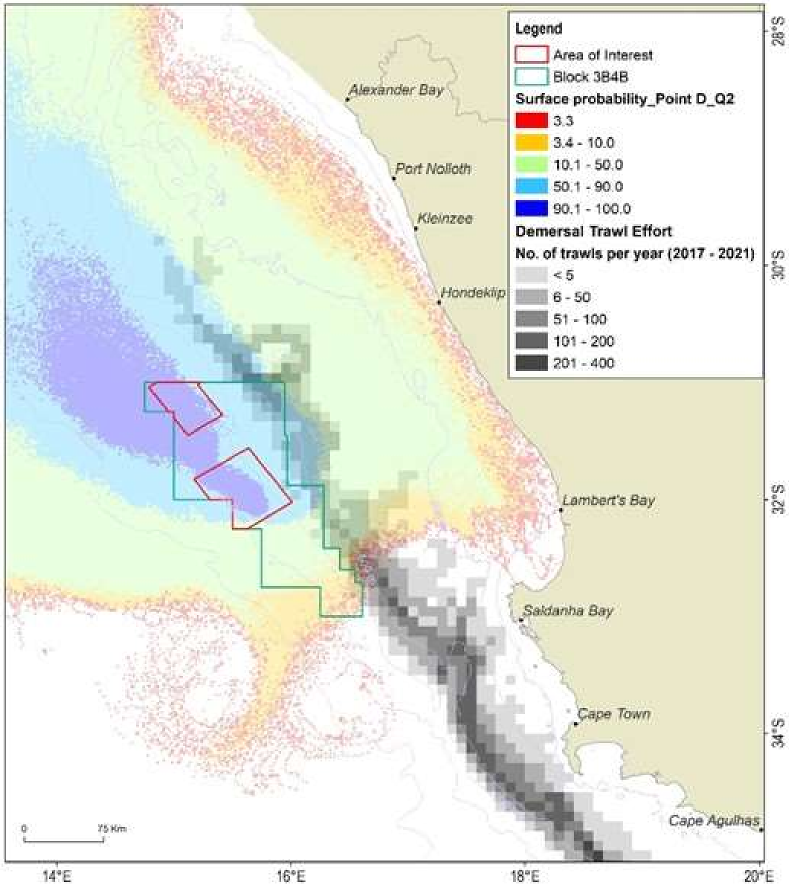


Figure 214: Fishing grounds of the demersal trawl sector in relation to the surface probability of contamination during well blowout of crude oil (Q2; with capping response).

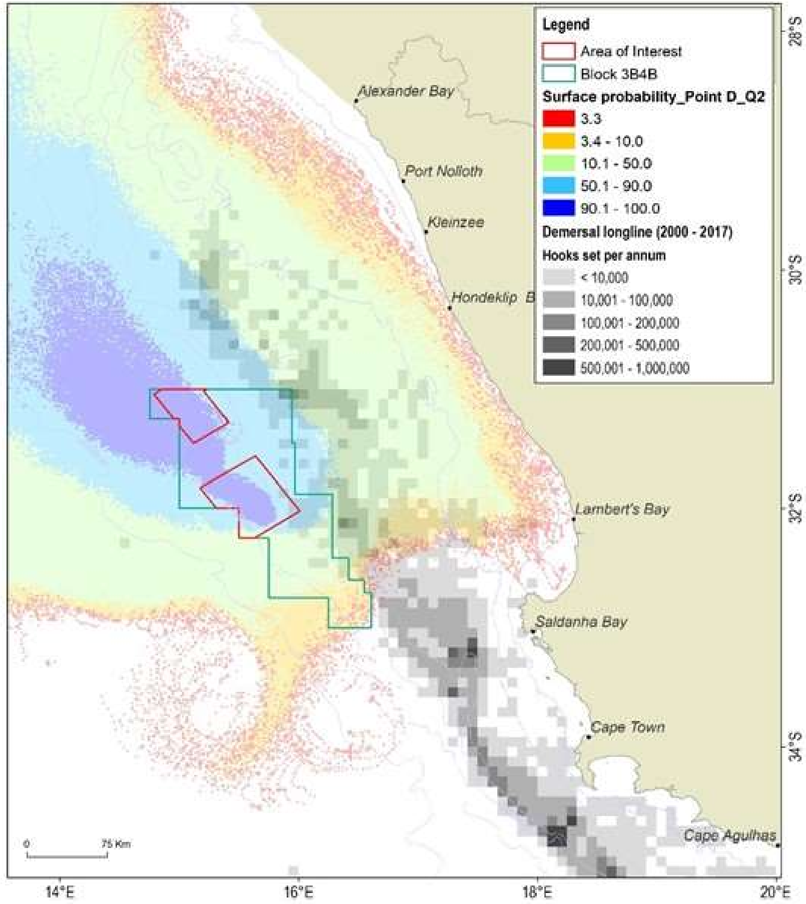


Figure 215: Fishing grounds of the demersal longline sector in relation to the surface probability of contamination during well blowout of crude oil (Q2; with capping response).

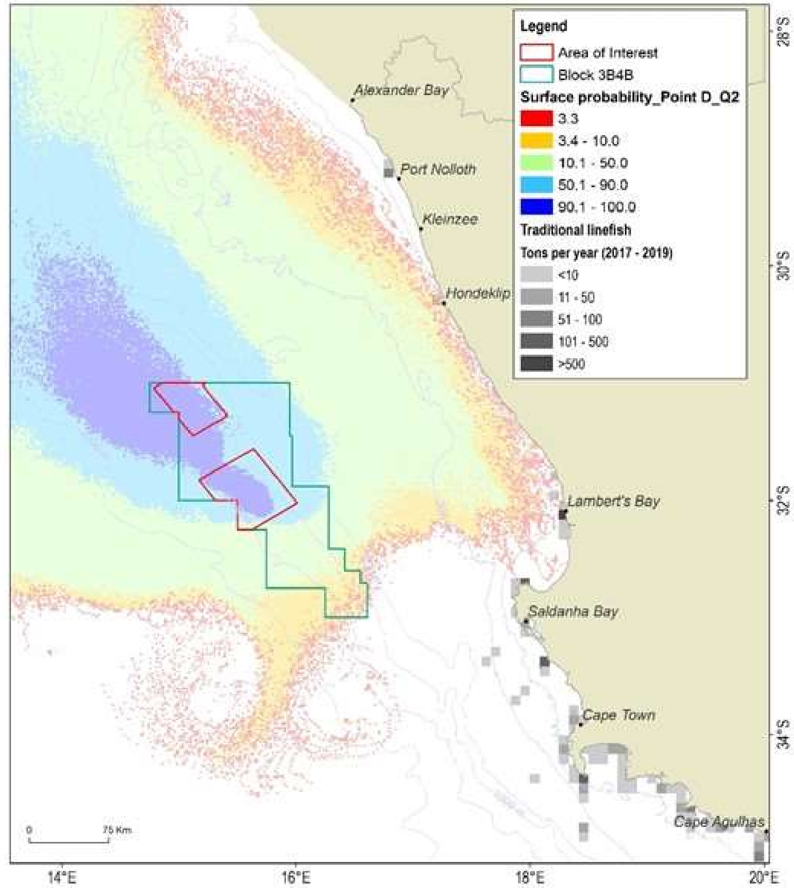


Figure 216: Fishing grounds of the traditional linefish sector in relation to the surface probability of contamination during well blowout of crude oil (Q2; with capping response).

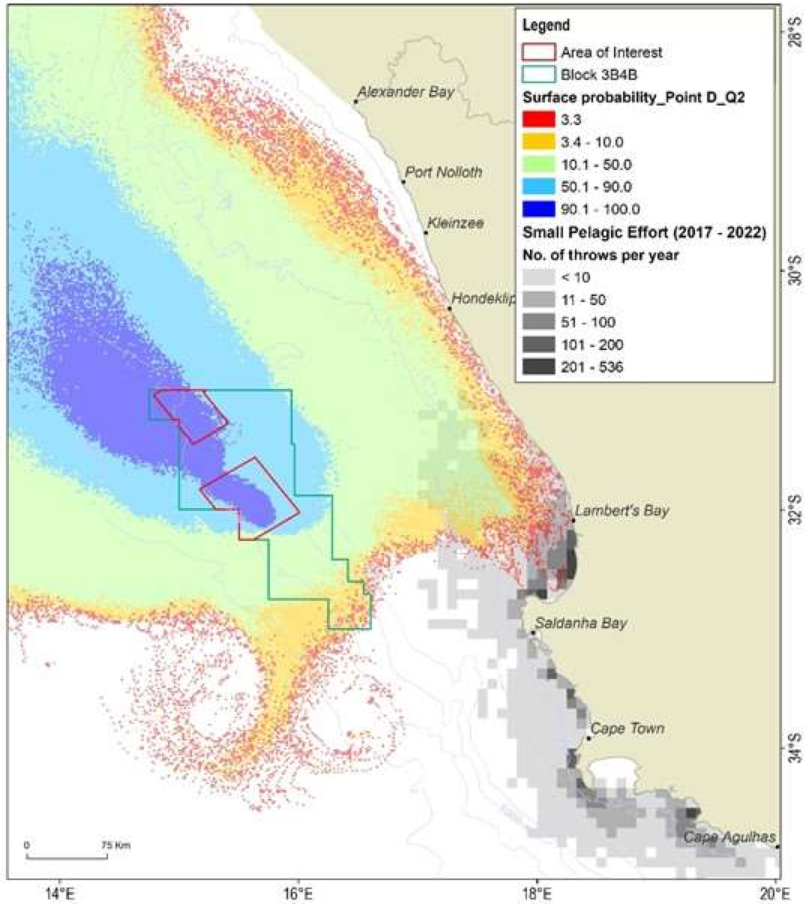


Figure 217: Fishing grounds of the small pelagic purse-seine sector in relation to the surface probability of contamination during well blowout of crude oil (Q2; with capping response).

Impact Magnitude

Condensate (Capping only scenario): The extent of the surface oiling could be provincial to national in extent. Large scale effects on fishing operations would likely include area closures and exclusion of fisheries from areas that may be polluted or closed to fishing due to contamination of surface waters. Based on the possible extent of surface oiling (across all quarters), the impact could affect the large pelagic longline, tuna pole-line, demersal trawl and demersal longline sectors. The likelihood of the impact materialising differs according to the predicted extent of the surface contaminated areas in respect to the location of fishing grounds. The likelihood of contamination is definite (100%) for large pelagic longline, 50% for tuna pole-line, 30% for demersal trawl and 20% for demersal longline. Based on the extent of predicted surface oiling, there would be no impact on the operations of any of the other sectors. For condensate the weathering processes include evaporation, dispersion, dissolution, photo-oxidation, emulsification and spreading and the duration of the impact has been classified as immediate (<1 year).

Crude oil (Capping only scenario at Release Point D during Q2): Large scale effects on fishing operations would likely include area closures and exclusion of fisheries from areas that may be polluted or closed to fishing due to contamination of surface waters. The extent of the surface contaminated areas in respect to the location of fishing grounds have been identified for four oil-spill probability contours (3.3%, 10%, 50% and 90%). The 90% probability contour overlaps ~6% of fishing grounds of the large pelagic longline sector and ~1% of that of the tuna pole-line sector. The 50% probability contour overlaps ~8% of fishing grounds of the demersal longline and demersal trawl sectors, ~11% and ~13%, respectively, of the large pelagic longline and tuna pole-line sectors. The 10% probability contour overlaps ~23% of demersal longline and demersal trawl fishing ground, ~14% small pelagic purse-seine, ~18% large pelagic longline, ~32% tuna pole-line, ~2% linefish and <1% of the west coast rock lobster grounds. The 3% probability contour extends across ~26% of demersal longline and demersal trawl fishing ground, ~27% small pelagic purse-seine, ~23% large pelagic longline, ~44% tuna pole-line, ~5% linefish and 4% and 7%, respectively, of the inshore and offshore west coast rock lobster grounds.

Small spills: For small spills of diesel or hydraulic fuel during normal operations, the dominant weathering processes are evaporation and dispersion over the immediate term. In the unlikely event of an operational spill, the intensity of the impact would depend on whether the spill occurred in offshore waters (i.e. during bunkering) or closer to the shore (e.g. vessel accident) where encounters with sensitive receptors will be higher. Due to the dominant winds and currents in the drill area, a diesel slick would be blown as a narrow plume in a north-westerly direction and away from the coast and spawning areas (regional in extent). The diesel would remain at the surface for up to 5 days (short-term) with a negligible probability of reaching sensitive coastal habitats. In offshore water, the magnitude of a small spill on all fisheries is expected to be of overall LOW.

Impact Significance

The extent of surface oiling could be international in extent. The intensity of the impact is considered to be high and the duration ranging from short-term to medium-term. Short-term impacts relating to the presence of oil above threshold levels, and medium-term relating to potential impacts on recruitment. Due to the main drift of the oil offshore and away from the majority of fishing grounds and sensitive recruitment areas (nursery grounds), the sensitivity of fisheries has been rated as medium. The overall impact significance before mitigation is rated high.

In the case of a spill *en route* to the drill area, the spill may extend into mariculture areas, in which case the intensity would be considered HIGH, but of local extent over the immediate term. In nearshore water, the magnitude of a small spill on all fisheries is expected to be of MEDIUM. Based on the high sensitivity of receptors and the very low (offshore) and medium magnitude (nearshore), the potential impact of a small accidental spill on commercial fisheries is considered to be of LOW TO MEDIUM significance for an offshore and nearshore spill, respectively.

With the implementation of the above-mentioned intrinsic mitigation measures, the residual impact would be of LOW significance for small spills and of MEDIUM significance for large spills.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Impact on fisheries of small scale hydrocarbon spill	Operation	Medium	Low	Low
Impact on fisheries of large-scale hydrocarbon spill (condensate)	Operation	Medium	Medium	Medium
Impact on fisheries of large-scale hydrocarbon spill (crude oil)	Operation	High	Medium	Medium
Mitigation Measures				
• Refer to the project controls included in Section 9.3.1.3.5 above. • As far as possible, avoid scheduling drilling operations during the periods when weather and metocean conditions make safe drilling operations less than optimal. • Develop a response strategy and plan (OSCP), aligned with the National OSCP that identifies the resources and response required to minimise the risk and impact of oiling (shoreline and offshore). This response strategy and associated plans must take cognisance to the local oceanographic and meteorological seasonal conditions, local environmental receptors and local spill response resources. The development of the site-specific response strategy and plans must include the following: ○ Assessment of onshore and offshore response resources (equipment and people) and capabilities at time of drilling, location of such resources (in-country or international), and associated mobilisation / response timeframes. ○ Selection of response strategies that reduce the mobilisation / response timeframes as far as is practicable. Use the best combination of local and international resources to facilitate the fastest response. ○ Well-specific oil spill modelling for planning purposes taking into consideration site- and temporal-specific information, the planned response strategy, and associated resources. ○ Develop intervention plans for the most sensitive areas to minimise risks and impacts and integrate these into the well-specific response strategy and associated plans. ○ If modelling and intervention planning indicates that the well-specific response strategy and plans cannot reduce the response times to less than the time it would take oil to reach the shore, additional proactive measures must be committed to. For example: Implement measures to reduce surface response times (e.g. pre-mobilise a portion of the dispersant stock on the support vessels, contract additional response vessels and aircrafts, improve dispersant spray capability, etc.). • Schedule joint oil spill exercises including AOSAC and local departments / organisations to test the Tier 1, 2 & 3 responses. • Ensure contract arrangements and service agreements are in place to implement the OSCP, e.g. capping stack in Saldanha Bay and other international locations, surface response equipment (e.g. booms, dispersant spraying system, skimmers, etc.), dispersants, response vessels, etc. • Use low toxicity dispersants that rapidly dilute to concentrations below most acute toxicity thresholds. Dispersants should be used cautiously and only with the permission of DFFE.				

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance

- Ensure a standby vessel is within 30 minutes of the drilling unit, equipped for dispersant spraying and can be used for mechanical dispersion (using the propellers of the ship and/or firefighting equipment). It should have at least 5m^3 of dispersant onboard for initial response.
- As far as possible, and whenever the sea state permits, attempt to control and contain the spill at sea with suitable recovery techniques to reduce the spatial and temporal impact of the spill
- In the event of a spill, use drifter buoys and satellite-borne Synthetic Aperture Radar (SAR)-based oil pollution monitoring to track the behaviour and size of the spill and optimise available response resources
- The Operator is to submit all forms of financial insurance and assurances to PASA to manage all damages and compensation requirements in the event of an unplanned pollution event.
- Establish a functional grievance mechanism that allows stakeholders to register specific grievances related to operations, by ensuring they are informed about the process and that resources are mobilised to manage the resolution of all grievances, in accordance with the Grievance Management procedure.

9.3.2.3.2 LOSS OF EQUIPMENT TO SEA

The potential impacts associated with lost equipment include (direct negative impact):

- Potential snagging of demersal gear with equipment that would sink to the seabed;
- Potential risk of entanglement of fishing gear with equipment drifting at the water surface or in the water column; and
- Potential risk of collision of vessels with free-floating equipment drifting at the water surface or in the water column (ship-strikes).

The loss of floating equipment could pose a collision hazard to any vessel before the object sinks under its own weight. In the unlikely event of the loss of floating equipment, the impact could be of low intensity, limited to the site over the short-term. The impact magnitude for equipment lost to the water column is, therefore, considered very low for all fisheries sectors that operate within the licence block.

The accidental loss of equipment onto the seafloor could pose a snagging hazard to demersal trawl gear if located within the demersal trawl grounds. The impact could be of low intensity, limited to the site over the short-term before being buried over time. The impact magnitude for equipment lost on the seabed is, therefore, also considered very low for the demersal trawl sector.

Based on the high sensitivity of the demersal trawl sector and the very low magnitude, the potential impact on commercial fishing is of low significance without mitigation. The implementation of the mitigation measures will reduce the intensity of the impact to very low. The residual impact will, however, remain of very low magnitude and of LOW significance.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Loss of Equipment	Operation	Low	Low	Low
Mitigation Measures				

- Contractors will ensure that the proposed exploration campaign is undertaken in a manner consistent with good international industry practice and BAT. Equipment and gear will be recovered, where possible, near the surface.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance

- Ensuring that loads are lifted using the correct lifting procedure and within the maximum lifting capacity of the crane system.
- Minimise the lifting path between vessels.
- Undertake frequent checks to ensure items and equipment are stored and secured safely on board each vessel.
- Retrieval of lost objects / equipment, where practicable, after assessing the safety and metocean conditions. Establish a hazards database listing the type of gear left on the seabed and / or in the licence area with the dates of abandonment / loss and locations and, where applicable, the dates of retrieval.
- Notify SANHO of any hazards left on the seabed or floating in the water column, and request that they send out a Notice to Mariners with this information.
- Establish a functional grievance mechanism that allows stakeholders to register specific grievances related to operations, by ensuring they are informed about the process and that resources are mobilised to manage the resolution of all grievances, in accordance with the Grievance Management procedure.

9.3.3 MARITIME HERITAGE

This section describes and assesses the specific Maritime Heritage impacts (i.e. Archaeology and Palaeontology) that will be associated with the proposed exploration in Block 3B/4B.

9.3.3.1 **DAMAGE TO OR LOSS OF PALAEONTOLOGICAL MATERIALS**

The physical extent of impacts on potential palaeontological resources is site specific and relates directly to the extents of subsurface disturbance involved in the activities. However, unlike an impact that has a defined spatial extent (e.g. loss of a portion of a habitat), the scientific findings from the analysis of deep-sea geophysical surveys and well drilling have impacts that are of international extent.

The destruction of fossils that will be a consequence of well-drilling in particular means that the duration of any impact is permanent. This is why it is important that any found fossils are preserved for posterity. The intensity of the potential impact of sampling and drilling on fossil resources is determined by the palaeontological sensitivity of the affected formations - the potential scientific value of the fossils which are included in it, together with the volume of the formation which is excavated.

Overall, the palaeontological sensitivity of marine deposits is high (Almond & Pether, 2009) due to a few, crucial fossil bone finds of high scientific importance that provided the age constraints for the formations. However, there are complications as marine formations usually contain more than one type of fossil of differing importance, e.g. common shells and rare bones as discrete objects, and formations entirely composed of fossils, as in biogenic limestones such as the foram-nannofossil formation beneath Block 3B/4B, wherein a small piece contains thousands of microfossils.

The proposed baseline environmental sampling and exploration well drilling activities have a very small footprint in the continental shelf environment and a relatively small subsurface volume of excavation of ~2 000 m^3. This may be compared with a small bulk sample for diamond exploration of 50 x 20 x 5 m = 5 000 m^3.

The approximate depth of the exploration wells of 3 750 m is equivalent to drilling through 3.5 stacked Table Mountains, into a huge volume of sediments up to 8 km thick in places. Due to the small affected volume the impact of the proposed sampling and drilling activities on the palaeontological heritage of the continental shelf deposits may be considered to be negligible or low, at most.

Within the site specific extents the potential loss of fossils in the drill operation is irreversible. Realistically, the nature of the loss at depth in the drill hole, below the upper biogenic ooze unit cored in ODP 1087, is unknown, but is insubstantial on scale considerations. An impact will occur, but as above, the minute affected volume relative to the preserved volume in the Orange Basin renders the probability of an actual impact from drilling insubstantial.

Mostly palaeontological resources are unique and their loss is irreversible. This is perfectly appreciated in the case of discrete fossils such as petrified bones, shells, wood etc. For micro-fossiliferous formations only accessible by costly drilling to acquire cores, it is the core itself with its palaeo-oceanographic record which is the irreplaceable fossil. The extent to which deep-sea cores are irreplaceable is evident in the extent of efforts to preserve them, to eke out analyses involving destruction, and increasing employ non-destructive analytical techniques. Similarly, the cuttings from non-cored hydrocarbon well drilling are archived (or should be). Thus, although not readily replaced, replacement cores can theoretically be acquired and the proposed exploration activities in Block 3B/4B will not result in an Irreplaceable loss of resources.

Based on the assessment above, a significant rating of Low Positive is found to apply to palaeontological resources in the context of the proposed exploration activities. Palaeontological concerns do not impede the proposed the Applicant's baseline sampling and hydrocarbon exploration well drilling activities in Block 3B/4B.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Damage to or Loss of Palaeontological Materials	Operation	Low	Low	Low

Mitigation Measures

- Pre-drilling Box & Piston Coring:
  - It is presumed that the box cores and piston cores will be handed over to consultant marine biologists for analysis for the baseline environmental inventory. This intended analysis for baseline purposes constitutes mitigation.
  - The modern deep-sea shell fauna is hardly sampled and poorly known. New samples from any deep-water location have the potential to discover unknown species, or at least add to the very small existing museum collections of specimens. In this respect the concerns of palaeontology and marine biology coincide.
  - It is expected that the molluscs shells and any other fossil material (fish teeth, otoliths etc.) will be sieved out at some stage. Fine sieves must be used as some deep-sea molluscs are tiny. All shells and other material of interest must have the details of context recorded and be kept for identification by an appropriate specialist, and ultimately be deposited in a curatorial institution such as the IZIKO Museum. The best outcome for piston cores is that core splits, or site duplicate cores, are the subject of a detailed study, such as for a B.Sc. Honours or M.Sc. project.
- Well Drilling
  - The sampling of drill cuttings for various standard industry analyses, most notably micro-palaeontological and palaeo-environmental, constitutes prescribed or "built-in" mitigation, the main aspects of which are very likely to be written up by the consulting experts and published in the longer term.
  - The sizes of typical drill cuttings are in the range of 0.1 mm (100 µm - very fine sand) to 3-4 mm (granules). Macrofossils are destroyed and not delivered to the "shale shaker" screen and only very small fossils will be enclosed in the coarse cuttings, such as larval mollusc shells, micro-molluscs, barnacle fragments and opercula, polychaete worm mouthparts, tiny fish teeth etc. from marine deposits and small aquatic molluscs and plant material from terrestrial deposits. Such will be in the cuttings samples and inform palaeo-environmental interpretations. There is therefore no special requirement for additional observations and a Fossil Finds Procedure at the "shale shaker" on the vessel.

9.3.3.2 DAMAGE TO OR LOSS OF MARITIME ARCHAEOLOGICAL SITES OR MATERIAL

The discussion of the maritime heritage resources in and around Block 3B/4B in Section 8.8.4 above indicates that there are no historical shipwrecks recorded within the block. The nearest recorded wreck, that of the Kalewa, appears to be well outside Block 3B/4B, but its position is very approximate and there is a possibility, albeit extremely low, that this wreck could be present within the block.

The possibility also exists that currently unknown historical wrecks or maritime debris are present on the seabed in Block 3B/4B, but this is so low that it can probably be discounted. There is thus unlikely to be any impact arising from exploration activities on maritime heritage resources within Block 3B/4B and they are considered NEGLIGIBLE.

Cuttings discharge and sediment plume arising from well drilling may indirectly impact palaeontological and/or maritime archaeological resources on the seabed by smothering or burying such sites or material. Such an impact, should it occur is unlikely to be negative, with the introduced sediment providing a protective covering to any heritage resources present.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Damage to or Loss of Maritime Archaeological Sites or Material	Operation	Negligible	Negligible	Negligible
Mitigation Measures				
• Should unrecorded wreck material be present in the project area, it may be subject to accidental impact, and it is recommended, therefore, that: ○ The interpretation of any future seabed bathymetric data / review of video footage must include the requirement to flag any shipwreck or related material. ○ Any such finds must be reported to SAHRA. ○ Any shipwreck finds must be excluded from areas subject to seabed sampling or well drilling by the implementation of a buffer of at least 50 m around the site or material.				

9.3.4 CULTURAL HERITAGE

This section describes and assesses the specific social impacts that will be associated with the proposed exploration in Block 3B/4B.

9.3.4.1 CULTURAL HERITAGE IMPACT OF DRILLING - NORMAL OPERATIONS

The normal operation of vessels may result in various discharge to sea, including galley waste, grey water, sewage, deck drainage, etc. This is, however, not unique to offshore vessel transitions, but similar to any other vessel traveling along the South African coast. Thus, while such transitions may result in the potential disturbance of ancestors who are believed to situated on the seafloor as soundwaves penetrate soil layers and reflect off the seafloor, one must also consider that there is already disturbance of the seafloor by commercial trawlers and other commercial vessels traversing the sea.

Any impact on the integrity of the coastal and marine ecosystem through disturbance, pollution, noise, etc. could impact various aspects which makes up people's intangible cultural heritage (indirect negative impact). Groups may also contest the importance of specific cultural heritages. Because of South Africa's cultural diversity there are a diversity of beliefs and religious symbolism associated with the coast. The right to culture and to cultural expression is also enshrined in the South African Constitution. Therefore, TH and ICH should be jointly and widely considered when analysing the significance of cultural heritage in a coastal context. A further consideration is that cultural heritage conservation and management occurs in a dynamic socioeconomic context, where there are competing needs, such as the need for socioeconomic growth and sustainability. These needs should be considered together.

The potential impact of normal operations on receptors noted above and prior to mitigation is considered to be of high intensity, short-term duration and regional extent. Thus, the consequence is considered to be medium. Appropriate and substantive public participation efforts in the pre-mitigation phase can reduce the intensity of impact. After mitigation, the residual impact will become medium.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Cultural heritage impact of drilling - Normal Operations	Operation	Medium	Low	Low

Mitigation Measures

- Establish a participatory forum in the area of indirect influence (i.e., between Port Nolloth and Hout Bay) in which consultation with representatives from coastal stakeholders and indigenous groupings and their leadership, can present the form of engagement and ritual events (that recognize the cultural dimension of human relations with the sea) that should be undertaken prior or during the implementation of the project. Such engagement should ensure open, direct and consistent communication with stakeholders that may be affected by operations.
- Support the implementation of the identified ritual event/s which are to take place as per the timeline appropriate to project operations, led by the aboriginal/First Nations paramount chiefs (and nominated traditional leaders) and indigenous Nguni leadership, or as deemed appropriate by affected stakeholders and determined during the consultation/s in the participatory forum.
- Support the implementation of a gender sensitive event/s that recognises gendered health and wellbeing connection with the ocean, led by nationally approved gender awareness entities in the area of indirect influence (i.e., Port Nolloth and Hout Bay), as deemed appropriate by affected stakeholders and determined during the consultation/s, that recognizes gendered coastal cultural heritage to permit all genders to articulate their cultural relation with the sea and coast.
- Establish a grievance mechanism that allows stakeholders to submit specific grievances related to operations, which includes consultation with stakeholders to ensure parameters are identified for consideration and implementation.

9.3.4.2 CULTURAL HERITAGE IMPACT OF DRILLING –UNPLANNED EVENTS

Small instantaneous spills of marine diesel at the surface of the sea can potentially occur during bunkering and such spills are usually of a low volume. Very low volumes of hydraulic fluid can be involved in the case of streamer damage. Larger volume spills of marine diesel could occur in the event of a vessel collision or vessel accident, or accident at the drilling site.

Any impact on the integrity of the coastal and marine ecosystem through an accidental spill of diesel, hydraulic fluid and/or oil could have an immediate detrimental effect on the marine environment and thus in turn could impact various aspects which make up people's intangible cultural heritage (indirect negative impact). However, unplanned events in the areas of indirect influence to the AOI are likely to only be related to small spills and would not be unique, but similar to any other vessel traveling along the South African coast.

In the case of a well blowout, the findings of the Oil Spill Modelling for Block 3B/4B, note drift distance, surface presence probabilities, water column contamination and coastal impacts of a potential oil spill. Specifically, with regard to:

- **Drift Direction:** The general direction of the surface oil drift is NW for the all the Quarters in this marine area, for the Condensate as for the Crude Oil, and for the 2 releases points A and D studied.

- **Drift Distance:** For Condensate release, the maximum distance of the 80 to 100% oil surface probability contour is 42 km NNW from Release Point during the Quarter 1 (January to March). For Crude Oil release, the maximum distance of the 80 to 100% oil surface probability contour for the release Point D is 687 km NW from future well during the Quarter 1 (January to March), and for the Point A is 580 km NW from future well during the Quarter 1 too. For the stochastic cases run where a spill is capped within 20 days, there is no oil reaching the shore for Release points A or D, for any of the 4 seasons.
- **Surface** Presence Probabilities: For Condensate release: there is almost no oil or condensate on surface due to large evaporation and dispersion processes on this condensate, but the Namibian and International Waters could be impacted by surface oil with very low probabilities (3.3%). This means that probabilistically, out of 100 spills that could occur during each quarter period, only 3 cases would have oil on the surface which would cross the Namibian border and international waters. There is no oil or condensate onshore at the end of the simulations for release points A or D, for any seasons. For Crude Oil Release: After 60 days the main part of oil is evaporated, biodegraded and dispersed. There is no oil onshore at the end of the simulations for release points A or D, for any seasons. However, for any remaining oil at surface not recovered within 60 days after the start of the spill, some remaining oil could reach the South African coastline. The highest concentrations of oil remaining at surface after 60 days for simulated releases occurs in Quarters 2 and 3 at release point D and in Quarter 2 for release point A. Given the northwestern direction of prevailing currents, simulations indicate a high probability (>80%) of surface oil from a potential release affecting Namibian and International waters.
- **Water Column Contamination:** For the Condensate release: the most contaminated layer is between 725 to 900 m depth for capping only and 775 to 875 m for full response deployed. This is probably due to the large amount of gas contained in the release, making the condensate rise quickly in the water column, and then accumulates in the mid water column before continuing to rise more slowly to the surface. For the Crude oil release: as the dispersion and dissolution during the rise of the oil is very low compared to Condensate, the impact of the crude oil release is not significant for the water column, and has to be focused on the surface, and all the processes involved after (natural dispersion, biodegradation, evaporation).
- **Coastal Impact:** there is no coastal impact for the two types of release modelled for any Quarter of the year, due to the currents in the area driving the release drift towards NW, opposite to the coastal area. However, attention should be paid to Quarters 2 and 3 for release Point D and for Quarter 2 for release Point A in that if the oil on surface is not recovered 60 days after the start of the spill, some remaining oil on surface could reach the South African coastline.

Considering the above, together with the findings of the Specialist Fisheries Baseline and Impact Assessment Report, as well as the Marine Biodiversity Specialist Assessment Report, and noting that the AOI is approximately 190 km offshore at its nearest point (which is far from coastal MPAs and sensitive coastal receptors in the unlikely event of a well blow-out), the unmitigated magnitude of an unplanned event on cultural heritage would be high, the intensity of the impact would also be high and the extent national.

However, with mitigation the duration of impacts is likely to be short-term due to the oil spill contingency plan. The rating considers and accepts the high valuation of coastal cultural heritage in South Africa and spiritual belief in the ocean as a living entity that is key to the livelihood of small-scale fishers. If mitigation measures are implemented to resolve the unplanned event, the impact on cultural heritage will be medium.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Cultural heritage impact of drilling – Unplanned Events	Operation	High	Low	Medium
Mitigation Measures				

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance

- Emergency Plans in place for very efficient and quick resolution of oil spills as per MARPOL VI.
- Avoid exploring within ecologically vulnerable areas and tangible heritage features identified.
- Ensure that there is sufficient insurance cover to financially manage the consequences of any unplanned event pollution on environmental and social aspects.
- Project controls include the preparation and implementation of a Shipboard Oil Pollution Emergency Plan (SOPEP), an Emergency Responses Plan and compliance with MARPOL requirements.

9.3.5 SOCIAL

This section describes and assesses the specific social impacts that will be associated with the proposed exploration in Block 3B/4B. It must be recognised that the exploration phase will be shortand only 1 to 5 holes will be drilled > 180km offshore. Should the exploration be successful, another EIA will be conducted to investigate the impacts of production. When the mitigation and management of social impacts are considered, one must consider that social impacts occur in communities surrounding the proposed project, and although the project proponent may be the catalyst for some impacts, there may be a number of external factors contributing to the impact. Many of these factors are outside the control of the project proponent. The proponent cannot mitigate many of the social impacts alone, and partnerships with local government and Non-Profit Organisations are often required. Social impacts must be managed in the long term. This complex process requires insight in the social environment and community dynamics. The social environment adapts to change quickly, and social impacts therefore evolve and change throughout the project cycle. Sources of social impacts are often not as clear-cut as those in the biophysical environment. Mitigation measures are context specific and the mitigation measures in this report should be viewed as guidelines.

9.3.5.1 **IMPACT ON LIVELIHOODS**

Since the on-board exploration activities undertaken as part of this project are largely automated, job creation and skills development opportunities will be minimal during the exploration phase. Fishers are concerned that there may be oil spills or unplanned events that can cause pollution. They fear that the pollution plumes may extend to their fishing areas and impact negatively on their livelihoods. They are also concerned about damage to equipment, health and safety of the fishers and noise and light pollution.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Impact on Livelihoods	Operation	Medium	Low	Low
Mitigation Measures				

- **The Applicant is to submit all forms of financial insurance and assurances to PASA to manage all damages and compensation requirements in the event of an unplanned pollution event.**
- **If there are actual losses due to the activities performed by the Applicants, the claimants should be compensated for their losses at market rates. The Applicants must have a claims procedure appropriate to their activities. Compensation should follow the international standards such as the IFC principles, which states that market related prices should be paid, and if anything is restored, it must be to the same or better standards than before.**
- **The Applicants must have an oil spill contingency plan in line with international requirements**.

9.3.5.2 IMPACT OF WELL BLOW OUT ON THE FISHING INDUSTRY (WORST CASE SCENARIO)

The Oil Spill Modelling Study (Livas, 2024) modelled oil spill scenarios during four quarters: Quarter 1 (Q1) January to March, Quarter 2 (Q2) April to June, Quarter 3 (Q3) July to September and Quarter 4 (Q4) October to December. According to the Marine Ecology Assessment (Pisces, 2024) and Fisheries Baseline and Impact Assessment (CapMarine, 2024), the worst-case scenario of an unplanned large crude oil blowout could have a high impact on the fishing industry and marine ecology. This may include an impact on international waters (Namibia) and impacts on the shoreline north of Saldanha Bay. Should a major blow out occur it will have severe short to medium term impacts on the livelihoods of people depending on the fishing industry. However, the likelihood of this impact is very low.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Impact of well blow out on the fishing industry (worst case scenario)	Operation	High	Low	Medium
Mitigation Measures				
• **In the case of a severe unplanned oil blow out causing actual losses in national and international waters and shores international conventions and procedures must be considered. South Africa and Namibia have Oil Spill Contingency Plans and are signatories of the International Convention on Civil Liability for Oil Pollution Damage, 1992 (CLC Protocol of 1992) and the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1992 (IOPC, Fund Protocol of 1992). The IOPC produced a Claims Manual (2005) that contains specific information on claiming procedures. These claims could include loss or damage to property, fishing nets, loss of livelihood etc, resulting from the discharge of oil from an offshore installation and also damage or loss caused by methods used to clean up polluted areas. Depending on the nature of the claim, the following information may be required:** ○ **Nature of loss, including evidence that the alleged loss resulted from the contamination;** ○ **Monthly breakdown of income for the period of the loss and over the previous three years;** ○ **Where possible, monthly breakdown of units (for example kilograms of fish caught and sold or number of hotel rooms let) for the period of the loss and over the previous three years;** ○ **Saved overheads or other normal variable expenses; and** ○ **Method of calculation of loss.**				

9.3.5.3 UNCERTAINTY/ CONFUSION

During the last few years several companies conducted community consultation processes on the West Coast. These processes included seismic surveys and exploration processes. Communities seem to confuse exploration drilling with production drilling. The timeframes for different activities add to the confusion. Although the environmental authorisation processes are guided by the National Environmental Management Act, some community members experience this phased process as a way to try and “soften” the communities, which in turn leads to mistrust. Some community members said that they feel as if a decision has already been made, and the Applicants are just going through the motions. It is perceived that their participation will therefore not make a difference. Although, ultimately, the Applicants are not the source of the confusion, uncertainty/confusion in the communities can impact on the Applicants’ social license to operate and the general wellbeing of the communities. Given that oil and gas development is relatively new and controversial in South Africa, it is important to ensure that communities are informed throughout the process, starting with the seismic survey process, continued during the exploration phase and operation phase, should the development be approved. There have been opposition and protests against the industry, and therefore it is important to earn the trust of the communities and involve them.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Uncertainty/ Confusion related to different processes	All Phases	Medium	Low	Medium
Mitigation Measures				
• The Applicants must develop a stakeholder engagement strategy that explains the process of exploration and associated activities. It must include explanations of the potential outcomes and explanations of the next phases such as production. • **The Applicant must establish appropriate community communication protocols and forums with local representation for the duration of the exploration activities.**				

9.3.5.4 **COMMUNITY COHESION**

The West Coast communities are not homogenous. There has been a significant influx of people into the area already. There are different groups in the communities. Some are 100% against any exploration for oil and gas. They think it will be the end of the road for small-scale fishers. Others are concerned about the impact on climate change and future generations. There are also groups that support any development that can alleviate the chronic poverty and unemployment and diversify local economies. They think that oil and gas will bring some socio-economic development and improve local conditions. This division in the communities can cause conflict and unrest in the communities.

There are also signs that issues surrounding indigenous rights are politicised and used as a way to make sure that some individuals will benefit should the exploration be successful. Many organisations claim that they represent the West Coast people, but there is no organisation that can claim to represent all stakeholders. These divisions and power struggles are impacting on community cohesion, and it is important that all stakeholders have a voice in the authorisation process.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Impact on the cohesion in the community	All Phases	Medium	Medium	Medium
Mitigation Measures				
• The Applicants must conduct a stakeholder analysis as part of their Stakeholder Engagement Strategy. They must ensure that all stakeholder groupings identified in the stakeholder analysis are included in the strategy. The strategy must be inclusive and transparent.				

9.3.6 ECONOMIC

This section describes and assesses the specific economic impacts (qualitative) that will be associated with the proposed exploration in Block 3B/4B. The quantitative impact of the proposed exploration activities is included in Section 11.1.6 and Appendix 4.

9.3.6.1 **PLANNED EVENTS**

9.3.6.1.1 SURVEY VESSEL AT DRILL SITES EXCLUDES SEA-BASED INDUSTRIES OPERATING IN THE EXPLORATION AREA'S AREA OF INTEREST FROM PERFORMING NORMAL OPERATIONS

The impact recognises that a survey vessel will undertake pre-surveys of chosen drill locations to establish and delineate any seabed and sub-seabed geo-hazards that may impact the proposed exploration drilling operations. Pre-drilling surveys may include a myriad of surveying techniques and could include sonar surveys, sediment sampling, water sampling and ROV activities. The pre-drilling survey activity offers an economic benefit in the form of additional economic activity stimulated within the receiving economy of the exploration activity. The economic value, albeit temporary and for a short duration of time, could create additional economic value throughout the exploration value chain.

Analyses of the exploration right area and its areas of interest has revealed that the AOI targeted by exploration activities overlap with general commercial fishing operations in the large pelagic longline industry and with normal operational routes for cargo and tanker shipping (logistics). The survey vessel's confirmation of the drilling locations within the AOI, coupled with a safety exclusion zone around the survey vessel may impede the access of commercial fishing operators to fishing areas and consequently influence the capacity of fishing operators to maintain optimal levels of operational efficiency and economic value extraction. Likewise, maritime logistics in the form of cargo and tanker vessels may need to make use of alternative/adjusted routing options to the Port of Cape Town or Port of Saldanha Bay. The adjusted routing removes the economic efficiency of the logistics operation and by consequence diminishes the economic value of the logistics operations. It should, however, be borne in mind that the pre-drilling survey period is temporary and would not impose long-term economic changes and/or alterations.

The reduced capacity of commercial fishing operators to catch targeted fish species and maritime logistics operators that may be required to make use of alternative routes may lead to reduced productivity throughout the value chain of the domestic large pelagic longline fishing and logistics industry. Given that survey operations are temporary and of a short duration, the cumulative impacts are expected to be negligible. Likewise, shipping operators could also experience a similar impact for the duration of the survey activity. The impact is unlikely to result in irreplaceable loss of resources.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Stimulation of economic activity (additional business sales) throughout the exploration industry's value chain for the duration of the survey operations	Pre-Drilling	Low	Low	Low
Impact on commercial fishing operators targeting large pelagic longline fish species because of reduced fishing grounds and potential lowered catch potential	Pre-Drilling	Low	Low	Low
Impact on maritime logistics operations because of disrupted	Pre-Drilling	Low	Low	Low

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
shipping routes to major ports along the South African coast. Alternate routes could impact on the economic efficiency of maritime logistics				

Mitigation Measures

- **To ensure the safety and efficiency of the survey and minimize any potential disruptions to pelagic long-line vessels, it is important to notify the operators of such vessels about the survey timing, area, and safety clearance requirements in advance. The notification can be sent through the South Africa Tuna Longline Association.**
- **Daily Coastal Navigational Warnings issued via the South African Navy Hydrographic Office.**
- **Maintain continuous communications between the survey vessel and any commercial fishing operators.**
- **Ensure that an efficient and effective operational plan is developed for pre-drilling surveys to ensure that the disruption to ocean-based industries is limited.**

9.3.6.1.2 ESTABLISHMENT OF AN ONSHORE LOGISTICS BASE AT THE PREFERRED OR ALTERNATIVE PORT

The impact recognises that as part of the mobilisation process an onshore logistics base will be established from which future exploration drilling activities will be managed and supplied. According to information received, the onshore logistics base will be established in the Port of Cape Town (preferred location) or alternatively at the Port of Saldanha Bay. The shore base would provide for the storage of materials and equipment that would be shipped to the drilling unit and back to storage for onward international freight forwarding. The shore base would also be used for offices, waste management services, bunkering vessels, and stevedoring / customs clearance services.

The onshore logistics base will provide a pivot axis point between the offshore exploration activity and the sourcing of inputs that support exploration activities. The onshore logistics base will therefore establish a centralised control location within which several employment opportunities could be generated to support logistics and operations over a short-term period (See Section 11.1.6 and Appendix 4). Furthermore, the requisite inputs and services will be sourced from the exploration industry's value chain (domestically or internationally) which will result in increased economic activity (additional business sales for suppliers and other service providers) for the duration of the exploration activity. Furthermore, the drilling rig and operator will be sourced and positioned at the location of where well drilling activity will need to take place. The time-period for the mobilisation phase has not yet been established, but general information suggests that mobilisation can occur within a 45-day period.

The establishment of an operational base that will support operational requirements of the exploration activity will act as a centralised point between exploration activities and value chain inputs. The overall impact could create value throughout the backward linking industries required to support operations and therefore could generate additional economic benefits to the receiving, provincial and national economy. It is, however, important to note that the impact will not necessarily result in a spatial and temporal cumulative change. The impact is unlikely to result in irreplaceable loss of resources.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
The establishment of the onshore logistics base will create temporary employment opportunities for skilled labour	Mobilisation Phase	Medium Positive	Medium Positive	Medium Positive
Employment opportunities created by the logistics base will provide compensation to employees that will contribute toward household livelihoods and their access to services and amenities	Mobilisation Phase	Low Positive	Low Positive	Low Positive
The economic activity stimulated by the sourcing of inputs for exploration activities will increase the fiscus of government through fiscal benefits in the form of taxation (personal, business, production, product, imports, etc)	Mobilisation Phase	Medium Positive	Medium Positive	Medium Positive
The sourcing of materials, equipment and associated services will generate additional business sales throughout the exploration industry's value chain – businesses providing inputs to the exploration industry will benefit from an increase in sales and economic output	Mobilisation Phase	Medium Positive	Medium Positive	Medium Positive
Additional employment opportunities could be created throughout the exploration industry's value chain due to increased	Mobilisation Phase	Low Positive	Low Positive	Low Positive

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
demand generated for goods and services				
The demand for bulk services contributes to the fiscus of the local authority or providing agent	Mobilisation Phase	Medium Positive	Medium Positive	Medium Positive
The increased demand on bulk infrastructure requires additional investment to accommodate additional demand. Additional demand is accompanied by an increased maintenance burden	Mobilisation Phase	Low Negative	Low Negative	Low Negative
Mitigation Measures				
• **Labour to be employed at the onshore logistics facility should so far as possible be sourced from local markets. The sourcing of employment from the local market is dependent on the availability of skills. Should the necessary skills not be available, skilled labour should be sourced from beyond the receiving economy. The sourcing of labour should also consider the role of woman and other previously disadvantaged communities**. • **The temporary nature of the employment opportunity would provide labourers at the project to benefit from temporary income generation. Should the operator of the exploration activity be in a position to provide longer term employment opportunities, local labour should be considered**. • **The mobilisation phase should, as far as possible, focus on sourcing inputs from the receiving economy, i.e., businesses located in the immediate economy. Localised sourcing enables local businesses to benefit from economic opportunities in the receiving economy**. • **The operator of the exploration activity should confirm with provider of space for the logistics base whether sufficient bulk supply to the logistics operation is available. A clear understanding of additional supply requirements should be identified so that effective and efficient planning to support operations can be undertaken**.				

9.3.6.1.3 ECONOMIC IMPACT OF THE PROPOSED EXPLORATION ACTIVITY

The proposed exploration activity could have a sizeable impact on the receiving economy by generating additional economic output – the quantitative analysis reveals that the local operational expenditure of the exploration activity could be as much as R800 million, stimulating nearly R2 billion in additional GDP and R4 billion in additional business sales. This additional output will be the result of operational expenditures across the entire value chain of the exploration industry, including both backward and forward linkages. These expenditures could create direct, indirect, and induced effects, leading to increased economic production and the demand for related services and inputs. The exploration ac'ivity's direct effects refer to the immediate economic activities directly related to the exploration process itself. This includes the expenditure on drilling operations, exploration equipment, and personnel hiring. The indirect effects arise from the interconnections and transactions between the exploration activity and other sectors of the economy. For instance, the increased demand for goods and services from suppliers and contractors who provide equipment, transportation, and support services for the exploration project.

The induced effects occur as a result of increased spending by employees and busin446xploratisociated with the value chain of the exploration industry. Employees have increased disposable income which could lead to increased consumption expenditure. The impact generated by the exploration activity could contribute to the overall output of the broader provincial and national economy and consequently could offer an overall benefit to businesses and local communities. The overall impact could create value throughout the backward linking industries required to support operations and therefore could generate additional economic benefits to the receiving, provincial and national economy. It is however, important to note that the impact will not necessarily result in a spatial and temporal cumulative change. The impact is unlikely to result in irreplaceable loss of resources.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
The operational phase of the exploration activity will generate demand for goods and services necessary to sustain operational activities. This sustained demand over the operational period of exploration could lead to additional business sales throughout the exploration industry's value chain (increased economic output, production and gross value added)	Operation	Medium	Medium	Medium
New employment opportunities throughout the exploration industry's value chain could be stimulated as a result of the increased demand generated by the proposed exploration activity	Operation	Low	Medium	Medium
The logistics base of the exploration activity sustains skilled employment opportunities for the duration of exploration activities	Operation	Low	Medium	Medium
The employment opportunities created	Operation	Low	Medium	Medium

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
directly (i.e. through the projects logistics base) or indirectly (i.e. throughout the exploration industry's value chain) by the proposed exploration activity provides compensation to employees which in turn assists with maintaining household livelihoods (i.e. access to services and amenities)				
The exploration activity through its expenditure during its operation phase stimulates economic activity throughout its value chain and as a result increases the fiscal value (i.e. taxes) collected by government	Operation	Medium	Medium	Medium
The exploration activity further contributes toward a basic sector of the economy and therefore assists with maintaining the economic functionality of the receiving economy by providing a basis from which SMME development could occur	Operation	Low	Low	Low
The demand for bulk services contributes to the fiscus of the local authority or providing agent	Operation	Low	Low	Medium
The increased demand on bulk infrastructure requires additional investment to accommodate	Operation	Low	Low	Low

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
additional demand. Additional demand is accompanied by an increased maintenance burden				
Mitigation Measures				

- The operational phase should, as far as possible, focus on sourcing inputs from the receiving economy, i.e., businesses located in the immediate economy. Localised sourcing enables local businesses to benefit from economic opportunities in the receiving economy.
- The temporary nature of the employment opportunity offered directly by the onshore logistics base and exploration activity provides labourers the benefit of a stable income during the exploration phase. Should the operator of the exploration activity be in a position to provide longer term employment opportunities, local labour should be considered.
- **The exploration operator based on commercial exploration success, should liaise with local educational institutions to assess if there are any long-term skills transfer or training opportunities to support potential future development in the block.**
- Employment sourced for the proposed exploration activity should, as far as possible, be sourced from the receiving economy and its immediate markets. The sourcing of local labour should be cognisant of key issues such as youth unemployment, woman in the workforce and other pertinent national employment targets.
- The operator of the exploration activity should confirm with provider of space for the logistics base whether sufficient bulk supply to the logistics operation is available. A clear understanding of additional supply requirements should be identified so that effective and efficient planning to support operations can be undertaken.

9.3.6.1.4 IMPACT OF THE EXPLORATION ACTIVITY ON THE COMMERCIAL FISHING INDUSTRY

It is evident that the proposed exploration activity has the potential to impact the normal operational context of the commercial fishing industry in the receiving economy. Spatial data reveals that the areas of interest for the exploration right coincide with the large pelagic longline fishing industry's operations. Consequently, the fishing industry may face limitations on its usual operations and may not be able to operate at normal levels within the areas of interest.

The consequence of this reduced fishing grounds is expected to have an economic impact on the receiving economy’s commercial fishing industry. With limited access to fishing areas, the industry’s operational efficiency could be adversely affected, leading to a reduction in the economic output produced by the fishing industry’s value chain, including demand for employment. Furthermore, the fishing industry in the receiving economy is identified as a basic sector of the economy, which positions the industry as a core component of the receiving economy’s production and employment potential and offers the receiving economy a competitive advantage over other economic regions. This is especially true for several smaller sub-regional economies in the overarching economy where the fishing industry is a key producer of economic output and employment. It should be borne in mind that the location of wells has not yet been confirmed and therefore the total AOI in the exploration right is used to identify areas where fishing industry operations could be disrupted.

The overall impact could diminish value throughout the backward and forward linking industries required to support the fishing industry and therefore could limit economic benefits to the receiving, provincial and national economy. It is, however, important to note that the impact will not necessarily result in a spatial and temporal cumulative change. The impact is unlikely to result in irreplaceable loss of resources.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
The proposed exploration activity could lead to reduced fishing grounds and catch potential for the large pelagic longline fishing industry, which, in turn, may result in decreased economic productivity for the receiving economy's fishing industry. As a consequence, the demand for inputs to the fishing industry and the outputs from the industry may be impacted (limiting business sales, economic output and gross value added). The impact is viewed as a temporary impact given that exploration activities will not be a long-term sustained operation.	Operation	Low	Low	Low
Due to the temporary decrease of economic productivity in the receiving economy's large pelagic longline fishing industry, the demand for employment throughout the industry's value chain could be lowered, affecting the availability of employment opportunities	Operation	Low	Low	Low
Due to the temporary decreased economic productivity in the receiving economy's large pelagic longline fishing industry and the subsequent lowering of demand for employment in the industry, the compensation of employees and income of households dependent on the industry could be lowered, impacting on the capability of households to sustain livelihoods	Operation	Low	Low	Low
Due to the temporary decreased of economic productivity in the receiving economy's large pelagic longline fishing industry, the fiscal value that government receives (e.g. taxation of productions, production, businesses and employees) as a result of economic activity throughout the industry's value chain could be diminished	Operation	Low	Low	Low
The temporary decrease of economic productivity in the receiving economy's large pelagic	Operation	Low	Low	Low

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
longline fishing industry could temporarily diminish the demand for new business (SMME) development due to limited scope with which business sales can be stimulated				

Mitigation Measures

- **Ensure that an efficient and effective operational plan is developed for operations to ensure that the disruption to ocean-based industries is limited.**
- Coordination should be done between the exploration activity operator and relevant shipping industry associations (such as the South African Association of Ship Operators and Agents and the South African Association of Ship Operators and Agents) to coordinate exploration activities and maritime logistics operations to minimise and reduce the impact that the proposed exploration activity could have on the industry's operational efficiency and value generation**.**
- **Daily Coastal Navigational Warnings issued via the South African Navy Hydrographic Office.**

9.3.6.1.5 IMPACT OF THE EXPLORATION ACTIVITY ON THE MARITIME LOGISTICS INDUSTRY

The proposed exploration activity has the potential to impact the normal operational context of the maritime logistics industry in the receiving economy. Spatial data reveals that the exploration'right's areas of interest coincide with crucial maritime logistics routes connecting major ports along the West Coast of South Africa (e.g., Port of Cape Town and Port of Saldanha Bay) to important trading regions like North America, Africa, and Europe. Although the precise locations of the exploration wells are yet to be determined, the overall areas of interest are expected to affect the prominent shipping routes used by the maritime logistics industry.

Even though the transport and storage industry of the receiving economy is not identified as a basic sector (i.e., a sector that forms the foundation of an economy because of its potential to service local and external demand), approximately 10% of the value of imports to the country and 6% of the value of exports from South Africa travel through the Port of Cape Town, whilst the Port of Saldanha Bay exports approximately 15% of the total value of exports from South Africa. Hence, several important shipping routes travel along the West Coast of South Africa and to and from the Port of Cape Town and the Port of Saldanha Bay. Furthermore, many shipping routes travel between the Port of Cape Town and other major ports along the southern coast of South Africa. During the exploration activity, the maritime logistics industry may experience a temporary decline in operational efficiency due to restricted access to the exploration areas and charting of alternative routes to reach destinations along the West Coast of South Africa. This loss of efficiency could have broader consequences for the receiving economy's logistics industry and is likely to impact the economic output generated by the industry's value chain, including both backward and forward linkages.

The overall impact could diminish value throughout the backward and forward linking industries required to support the maritime logistics industry and therefore could limit economic benefits to the receiving, provincial and national economy. It is, however, important to note that the impact will not necessarily result in a spatial and temporal cumulative change. The impact is unlikely to result in irreplaceable loss of resources.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
The proposed exploration activities' AOI overlaps with established and	Operation	Low	Low	Low

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
commonly used shipping routes. This overlap may result in disruptions to shipping operations, as vessels may need to use alternative routes. Such deviations can diminish operational efficiency and subsequently reduce the economic output (limiting business sales, economic output and gross value added) within the receiving economy's transport and storage industry. The impact is viewed as a temporary impact given that exploration activities will not be a long-term sustained operation				
Due to the temporary decrease of economic productivity in the receiving economy's transport and storage industry, the demand for employment throughout the industry's value chain could be lowered, affecting the availability of employment opportunities	Operation	Low	Low	Low
Due to the temporary decreased of economic productivity in the receiving economy's transport and storage industry and the subsequent lowering of demand for employment in the industry, the compensation of employees and income of households dependent on the industry could be lowered, impacting on the capability of households to sustain livelihoods	Operation	Low	Low	Low
Due to the temporary decreased of economic productivity in the receiving economy's transport and storage industry, the fiscal value that government receives (e.g. taxation of productions, production, businesses and employees) as a result of economic activity throughout the industry's value chain could be diminished	Operation	Low	Low	Low
The temporary decrease of economic productivity in the receiving economy's transport and storage industry could temporarily diminish the demand for new business (SMME) development due to limited scope	Operation	Low	Low	Low

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
with which business sales can be stimulated				
Mitigation Measures				
• **Ensure that an efficient and effective operational plan is developed for operations to ensure that the disruption to ocean-based industries are limited.** • **Coordination should be done between the exploration activity operator and relevant shipping industry associations (such as the South African Association of Ship Operators and Agents and the South African Association of Ship Operators and Agents) to coordinate exploration activities and maritime logistics operations to minimise and reduce the impact that the proposed exploration activity could have on the industry's operational efficiency and value generation.** • **Daily Coastal Navigational Warnings issued via the South African Navy Hydrographic Office**.				

9.3.6.1.6 DEMOBILISATION OF EXPLORATION ACTIVITIES

The demobilisation phase of the proposed exploration activity represents the period when the bulk of all operational activities have been completed and the winddown of operational processes and activities have begun. The demobilisation phase represents the period in which the economic benefits gained from the exploration activities ceases and industries that have been adverse affected by the exploration (large pelagic fishing industry and maritime logistics industry) begin a period of recovery within which the operational capacity of the industry is restored to pre-exploration activity levels.

The loss of economic gains provided by the exploration activity could affect the value chain that supported the exploration activity and therefore could diminish gains in other economic sectors serving the exploration industry. The stabilisation of economic activity in the fishing and transport and logistics industry of the receiving economy could commence upon the complete winddown of exploration activities, systematically increasing economic activity throughout the value chain. The impact is unlikely to result in irreplaceable loss of resources.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
The exploration activity's operational phase offered temporary economic gains, such as additional business sales, increased gross domestic product, heightened employment demand, fiscal benefits, and improved household livelihoods. However, these gains were short-lived due to the exploration activity's short-term goals and objectives, resulting in an unsustained impact on the economy	Demobilisation	Medium	Medium	Medium
The need for additional bulk services will be removed and consequently the local authority may lose revenue from the provision of bulk services but will	Demobilisation	Medium	Medium	Medium

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
also gain from a decreased maintenance burden				
The impact on commercial fishing operators targeting large pelagic longline fish species because of reduced fishing grounds and potential lowered catch potential is removed and the process of ramping up operations can begin	Demobilisation	Medium	Medium	Medium
The impact on maritime logistics operations because of disrupted shipping routes to major ports along the South African coast is removed. Alternate routes are no longer required and maritime logistics operations can return to normal operational efficiency and economic output	Demobilisation	Medium	Medium	Medium
Mitigation Measures				
• None.				

9.3.6.2 **UNPLANNED EVENTS**

The section outlines the potential economic impacts that could arise during the unlikely event that a well-blow out event occurs during the operational phase of the exploration activity. Additionally, potential mitigation measures to ensure that negative impacts are minimised, and positive impacts are enhanced within the local community and economy are identified.

In order to consider the effects of such a subsea blow-out scenario, an Oil Spill Drift Modelling Condensate and Crude Oil Technical Report was drafted. The report modelled the possible fates and trajectories of an oil spill from a subsea blow-out during exploration operations in the area of interest of the of the Block 3B/4B exploration right area. The Technical Report identifies two spill scenarios. The first scenario refers to a subsea blow-out of a condensate hydrocarbon whilst the second scenario considers a subsea blow-out of crude oil.

Based on the considerations of the Technical Report, two unplanned event scenarios are considered in this Report. The first scenario is the economic impact assessment of a condensate hydrocarbon subsea blow-out event and the second scenario is an economic impact assessment of a crude oil subsea blow-out event. As such, the impacts below will be discussed for condensate, as well as crude oil scenarios.

9.3.6.2.1 ECONOMIC IMPACT OF THE OIL SPILL RESPONSE STRATEGY FOR A WELL BLOW-OUT SCENARIO (CONDENSATE)

The capping only oil spill response strategy for an unlikely well blow-out event could have a sizeable impact on the receiving economy by generating additional economic output – the quantitative analysis reveals that the operational expenditure of the oil spill response for a single well blow-out could be as much as R1.37 billion, stimulating nearly R3.7 billion in additional GDP and R7.0 billion in additional business sales. This additional output could be the result of operational expenditures across the entire value chain of the capping oil spill response strategy, including both backward and forward linkages. These expenditures could create direct, indirect, and induced effects, leading to increased economic production and the demand for related services and inputs. The capping only oil spill response strategy's direct effects refer to the immediate economic activities directly related to the oil spill response process itself. This includes the expenditure on equipment, personnel, input and output requirements, etc. The indirect effects arise from the interconnections and transactions between the oil spill response strategy activities and other sectors of the economy. For instance, the increased demand for goods and services from suppliers and contractors who provide equipment, transportation, and support services for the response activity.

The induced effects occur as a result of increased spending by employees and businesses associated with the value chain of the oil spill response industry. Employees have increased disposable income which could lead to increased consumption expenditure. The impact generated by the oil spill response activity could contribute to the overall output of the broader provincial and national economy and consequently could offer an overall benefit to businesses and local communities.

The overall impact could create value throughout the backward linking industries required to support operations and therefore could generate additional economic benefits to the receiving, provincial and national economy. It is however, important to note that the impact will not necessarily result in a spatial and temporal cumulative change. The impact is unlikely to result in irreplaceable loss of resources.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
The oil spill response activity could generate demand for goods and services necessary to sustain operational activities. This sustained demand over the response period of exploration could lead to additional business sales throughout the response industry's value chain (increased economic output, production and gross value added) (condensate)	Operation	Low	Low	Low
New employment opportunities throughout the response industry's value chain could be stimulated as a result of the increased demand generated by the response activity (condensate)	Operation	Low	Low	Low
The employment opportunities created directly or indirectly by the response activity provides compensation to employees which in turn assists with maintaining household livelihoods (i.e., access to services and amenities) (condensate)	Operation	Low	Low	Low
Mitigation Measures				
• **The operational phase should, as far as possible, focus on sourcing inputs from the receiving economy, i.e., businesses located in the benefit from economic opportunities in the receiving economy.**				

9.3.6.2.2 ECONOMIC IMPACT OF THE OIL SPILL RESPONSE STRATEGY FOR A WELL BLOW-OUT SCENARIO (CRUDE OIL)

A full response strategy for an unlikely crude oil well blow-out event could have a sizeable impact on the receiving economy by generating additional economic output – the quantitative analysis reveals that the operational expenditure of the full oil spill response for a single well blow-out could be as much as R342 million, stimulating nearly R1.0 billion in additional GDP and R1.7 billion in additional business sales). This additional output could be the result of operational expenditures across the entire value chain of the capping oil spill response strategy, including both backward and forward linkages. These expenditures could create direct, indirect, and induced effects, leading to increased economic production and the demand for related services and inputs.

The capping only oil spill response strategy's direct effects refer to the immediate economic activities directly related to the oil spill response process itself and the effect that it has on the industry within which it operates. This includes the expenditure on equipment, personnel, input and output requirements, etc.

The indirect effects arise from the interconnections and transactions between the oil spill response strategy activities and other sectors of the economy. For instance, the increased demand for goods and services from suppliers and contractors who provide equipment, transportation, and support services for the response activity.

The induced effects occur as a result of increased spending by employees and businesses associated with the value chain of the oil spill response industry. Employees have increased disposable income which could lead to increased consumption expenditure. The impact generated by the full oil spill response activity could contribute to the overall output of the broader provincial and national economy and consequently could additional economic activity for businesses and local communities.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
The oil spill response activity could generate demand for goods and services necessary to sustain operational activities. This sustained demand over the response period of exploration could lead to additional business sales throughout the response industry's value chain (increased economic output, production and gross value added) (crude oil)	Operation	Low	Low	Low
New employment opportunities throughout the response industry's value chain could be stimulated as a result of the increased demand generated by the response activity (crude oil)	Operation	Low	Low	Low
The employment opportunities created directly or indirectly by the response activity provides compensation to employees which in turn assists with maintaining	Operation	Low	Low	Low

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
household livelihoods (i.e., access to services and amenities) (crude oil)				

Mitigation Measures

- **The operational phase should, as far as possible, focus on sourcing inputs from the receiving economy, i.e., businesses located in the benefit from economic opportunities in the receiving economy.**
- **The operator should, as far as possible, focus on sourcing inputs from the receiving economy, i.e., businesses located in the immediate economy. Localised sourcing enables local businesses to benefit from economic opportunities in the receiving economy.**
- **Personnel contracted for the oil spill response of a crude oil spill should be trained to provide safe and effective oil response strategies relevant to the projects oil spill response strategy (whether capping or a combination of responses).**
- **Ensure that a detailed oil spill response strategy is developed that can provide a myriad of options that can enable fast and efficient situation specific oil spill responses. All contractual arrangements and coordination strategies should be in place with the providers of oil spill responses in South Africa to ensure efficiency and effectiveness.**

9.3.6.2.3 IMPACT OF THE EXPLORATION ACTIVITY ON THE COMMERCIAL FISHING INDUSTRY (CONDENSATE)

A well blow-out event could have the potential to impact the normal operational context of the commercial fishing industry in the receiving economy. Consequently, the fishing industry may face limitations on its usual operations and may not be able to operate at normal levels within the areas of interest and associated areas of impact. The consequence of this reduced fishing grounds could have an economic impact on the receiving economy's commercial fishing industry. With limited access to fishing areas, the industry's operational efficiency could be adversely affected, leading to a reduction in the economic output produced by the fishing industry's value chain, including demand for employment.

Furthermore, the fishing industry in the receiving economy is identified as a basic sector of the economy, which positions the industry as a core component of the receiving economy's production and employment potential and offers the receiving economy a competitive advantage over other economic regions. This is especially true for several smaller sub-regional economies in the overarching economy where the fishing industry is a key producer of economic output and employment. It should be noted that because a well blow-out event is likely to occur within the AOI of exploration activities, the potential area effects of a well blow-out event could place limitations on operational locations that can be accessed for fishing operations.

The overall impact could diminish value throughout the backward and forward linking industries required to support the fishing industry and therefore could limit economic benefits to the receiving, provincial and national economy. It is, however, important to note that the impact will not necessarily result in a spatial and temporal cumulative change. The impact is unlikely to result in irreplaceable loss of resources.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
A well blow-out event could lead to reduced fishing grounds and catch potential for the large pelagic longline fishing industry, which, in turn, may result in decreased	Operation	Low	Low	Low

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
economic productivity for the receiving economy's fishing industry. As a consequence, the demand for inputs to the fishing industry and the outputs from the industry may be impacted (limiting business sales, economic output and gross value added). The impact is viewed as a temporary impact given that the well blow-out event might not be a long-term sustained event (condensate)				
Mitigation Measures				
• **Ensure that a complete and approved oil spill response strategy is in place to assist with quick response times to limit the extent with which the industry is disrupted**. • The operator is to submit all forms of financial insurance and assurances to PASA to manage all damages and compensation requirements in the event of an unplanned pollution event. • **Coordination should be done between the exploration activity operator and relevant large pelagic longline industry associations (such as the South Africa Tuna Longline Association) to inform the industry of relevant oil spill scenarios and response plans.**				

9.3.6.2.4 IMPACT OF THE EXPLORATION ACTIVITY ON THE COMMERCIAL FISHING INDUSTRY (CRUDE OIL)

An analysis of the updated Fisheries Baseline and Impact Assessment Report (2024) indicates that a crude oil well blow-out event could have the potential to impact the normal operational context of the commercial fishing industry in the receiving economy. Consequently, the fishing industry may face limitations on its usual operations and may not be able to operate at normal levels within the areas of interest and associated areas of impact.

The commercial fishing industry could, for a temporary period, loose operational efficiency by not having access to the areas of interest affected by a crude oil well blow-out event. As a consequence, the loss of operational efficiency (reduced fishing grounds) impacts on the economic function of the receiving economy’s commercial fishing industry and could likely impact on the economic output produced by the fishing industry’s value chain (backward and forward linkages).

Furthermore, the fishing industry in the receiving economy is identified as a basic sector of the economy, which positions the industry as a core component of the receiving economy’s production and employment potential and offers the receiving economy a competitive advantage over other economic regions. This is especially true for several smaller sub-regional economies in the overarching economy where the fishing industry is a key producer of economic output and employment.

It should be noted that the likelihood that the fishing industry is impacted varies depending on the projected scope of surface contamination relative to the proximity of fishing grounds. Data from the Fisheries Baseline and Impact Assessment Report (2024) identifies that a probability exists that several commercial fishing industries could be affected by a crude oil spill event given the aspects that inform the worst-case scenario of surface oiling.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
A well blow-out event could lead to reduced fishing grounds and catch potential for the large pelagic longline fishing industry, which, in turn, may result in decreased economic productivity for the receiving economy's fishing industry. As a consequence, the demand for inputs to the fishing industry and the outputs from the industry may be impacted (limiting business sales, economic output and gross value added). The impact is viewed as a temporary impact given that the well blow-out event might not be a long-term sustained event (crude oil)	Operation	Low	Low	Low
Mitigation Measures				
Ensure that a complete and approved oil spill response strategy is in place to assist with quick response times to limit the extent with which the industry is disrupted. **The operator is to submit all forms of financial insurance and assurances to PASA to manage all damages and compensation requirements in the event of an unplanned pollution event. Develop strategies and execute responses according to the IPICEA-IOGP guideline document to assess economic impacts and provide compensation for marine oil releases.** **Coordination should be done between the exploration activity operator and relevant large pelagic longline industry associations (such as the South Africa Tuna Longline Association) to inform the industry of relevant oil spill scenarios and response plans.**				

9.3.6.2.5 IMPACT OF THE EXPLORATION ACTIVITY ON THE MARITIME LOGISTICS INDUSTRY (CONDENSATE)

A well blow-out event could have the potential to impact the normal operational context of the maritime logistics industry in the receiving economy. Even though the transport and storage industry of the receiving economy is not identified as a basic sector (i.e., a sector that forms the foundation of an economy because of its potential to service local and external demand), approximately 10% of the value of imports to the country and 6% of the value of exports from South Africa travel through the Port of Cape Town, whilst the Port of Saldanha Bay exports approximately 15% of the total value of exports from South Africa. Hence, several important shipping routes travel along the West Coast of South Africa and to and from the Port of Cape Town and the Port of Saldanha Bay. Furthermore, many shipping routes travel between the Port of Cape Town and other major ports along the southern coast of South Africa.

During a well blow-out event, the maritime logistics industry may experience a temporary decline in operational efficiency due to restricted access to the affected areas and charting of alternative routes to reach destinations along the West Coast of South Africa. This loss of efficiency could have broader consequences for the receiving economy's logistics industry and is likely to impact the economic output generated by the industry's value chain, including both backward and forward linkages.

The overall impact could diminish value throughout the backward and forward linking industries required to support the maritime logistics industry and therefore could limit economic benefits to the receiving, provincial and national economy. It is, however, important to note that the impact will not necessarily result in a spatial and temporal cumulative change. The impact is unlikely to result in irreplaceable loss of resources.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
The potential area that is affected by a well blow-out event overlaps with established and commonly used shipping routes. This overlap may result in disruptions to shipping operations, as vessels may need to use alternative routes. Such deviations can diminish operational efficiency and subsequently reduce the economic output (limiting business sales, economic output and gross value added) within the receiving economy's transport and storage industry. The impact is viewed as a temporary impact given that exploration activities will not be a long-term sustained operation.	Operation	Low	Low	Low
Mitigation Measures				
• **Ensure that a complete and approved oil spill response strategy is in place to assist with quick response times to limit the extent with which the industry is disrupted**. • **The operator is to submit all forms of financial insurance and assurances to PASA to manage all damages and compensation requirements in the event of an unplanned pollution event. Develop strategies and execute responses according to the IPICEA-IOGP guideline document to assess economic impacts and provide compensation for marine oil releases.** • **Coordination should be done between the exploration activity operator and relevant shipping industry associations (such as the South African Association of Ship Operators and Agents and the South African Association of Ship Operators and Agents) to inform the industry of relevant oil spill scenarios and response plans**.				

9.3.6.2.6 IMPACT OF THE EXPLORATION ACTIVITY ON THE MARITIME LOGISTICS INDUSTRY (CRUDE OIL)

Analysis contained this report identifies that a crude oil well blow-out event could have the potential to impact the normal operational context of the maritime logistics industry in the receiving economy. Even though the transport and storage industry of the receiving economy is not identified as a basic sector (i.e., a sector that forms the foundation of an economy because of its potential to service local and external demand), approximately 10% of the value of imports to the country and 6% of the value of exports from South Africa travel through the Port of Cape Town, whilst the Port of Saldanha Bay exports approximately 15% of the total value of exports from South Africa. Hence, several important shipping routes travel along the West Coast of South Africa and to and from the Port of Cape Town and the Port of Saldanha Bay. Furthermore, many shipping routes travel between the Port of Cape Town and other major ports along the southern coast of South Africa.

During a well blow-out event, the maritime logistics industry may experience a temporary decline in operational efficiency due to restricted access to the affected areas and charting of alternative routes to reach destinations along the West Coast of South Africa. This loss of efficiency could have broader consequences for the receiving economy's logistics industry and is likely to impact the economic output generated by the industry's value chain, including both backward and forward linkages.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
The potential area that is affected by a well blow-out event overlaps with established and commonly used shipping routes. This overlap may result in disruptions to shipping operations, as vessels may need to use alternative routes. Such deviations can diminish operational efficiency and subsequently reduce the economic output (limiting business sales, economic output and gross value added) within the receiving economy's transport and storage industry. The impact is viewed as a temporary impact given that exploration activities will not be a long-term sustained operation. (crude oil)	Operation	Low	Low	Low

Mitigation Measures

- **Ensure that a complete and approved oil spill response strategy is in place to assist with quick response times to limit the extent with which the industry is disrupted.**
- **The operator is to submit all forms of financial insurance and assurances to PASA to manage all damages and compensation requirements in the event of an unplanned pollution event. Develop strategies and execute responses according to the IPICEA-IOGP guideline document to assess economic impacts and provide compensation for marine oil releases.**
- **Coordination should be done between the exploration activity operator and relevant shipping industry associations (such as the South African Association of Ship Operators and Agents and the South African Association of Ship Operators and Agents) to inform the industry of relevant oil spill scenarios and response plans.**

9.3.6.2.7 IMPACT OF A WELL BLOW-OUT EVENT ON THE MARITIME TOURISM INDUSTRY (CRUDE OIL)

Analysis contained this report identifies that a crude oil well blow-out event could have the potential to impact the normal operational context of the maritime tourism industry, specifically the cruise tourism industry, in the receiving economy.

Cruise tourism is a popular and integral component of maritime tourism activities along the West Coast of South Africa. It encompasses ocean-based tourism activities conducted on cruise ships that traverse between destinations within a specific geographic area or across continents. Within the South African context, the cruise ship industry is primarily concentrated at the Port of Cape Town (Western Cape) and the Port of Durban (KwaZulu-Natal). Of particular interest to this study is the cruise industry based at the Port of Cape Town – a renowned destination and departure point in Africa. In 2022, approximately 70 vessels visited the Port of Cape Town, bringing nearly 78,000 tourists to the Western Cape who spent nearly R1.4 billion within the domestic economy.

During a crude oil well blow-out event, the cruise tourism industry may experience a temporary decline in operational efficiency due to restricted access to the affected areas, the possibility that alternative routes cannot be established or because alternative routes may be financially unproductive. This loss of efficiency could have broader consequences for the receiving economy's tourism industry and is likely to impact the economic output generated by the industry's value chain, including both backward and forward linkages.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
The potential area that is affected by a crude oil well blow-out event overlaps with established and commonly used cruise tourism routes. This overlap may result in disruptions to cruise line operations, as vessels may need to use alternative routes, or temporarily postpone trips along popular routes. Such deviations can diminish operational efficiency and subsequently affect economic activity (limiting business sales, economic output and gross value added) within the receiving economy's tourism and transport and storage industry. The impact is viewed as a temporary impact given that the majority of surface oil has evaporated, biodegraded and dispersed after 60 days thereby reducing the area affected by an oil spill event. (crude oil)	Operation	Low	Low	Low
Mitigation Measures				
• Ensure that a complete and approved oil spill response strategy is in place to assist with quick response times to limit the extent with which the industry is disrupted. • **The operator is to submit all forms of financial insurance and assurances to PASA to manage all damages and compensation requirements in the event of an unplanned pollution event. Develop strategies and execute responses according to the IPICEA-IOGP guideline document to assess economic impacts and provide compensation for marine oil releases.** • Coordination should be done between the exploration activity operator and relevant shipping industry associations (such as the South African Association of Ship Operators and Agents and the South African Association of Ship Operators and Agents) to inform the industry of relevant oil spill scenarios and response plans.				

9.3.7 AIR QUALITY AND CLIMATE CHANGE

9.3.7.1 **AIR QUALITY IMPACTS**

National Ambient Air Quality Standards (NAAQS) pollutant routine emissions were summarised using the European Monitoring and Evaluation Programme / European Environment Agency (EMEP/EEA) emission factors. Emissions of NO2 range between 211 and 216 tpa with fuel combustion being the dominant source. Emissions of CO range between 54 and 76 tpa, with waste gas disposal being the dominant source. Emissions of non-methane volatile organic compound (NMVOC) range between 17 and 25 tpa, with waste gas disposal being the dominant source. Emissions of PM and SO2 are low.

NAAQS pollutant upset emissions due to an oil spill are summarised in the Air Quality Impact Assessment Report in Appendix 4 for the EMEP/EEA emission factors. Combustion emissions are fairly similar to routine emissions. Emissions of NMVOC due to evaporation and fugitive gas release are elevated for NMVOC. It should be kept in mind that this is only potential emissions and may not happen. NMVOC emissions range between 3 568 and 43 308 tpa, with evaporation emissions and gas released during the blowout being the dominant source.

Meteorological scenarios that reflect worst-case atmospheric conditions were selected to perform dispersion simulations. These include calm stable night-time conditions (wind speed of 1.5 m/s) and neutral daytime conditions with a relatively low wind speed of 3 m/s. These atmospheric conditions are more likely to occur during winter winds and in order to impact on the coastline, has to be from westerly wind sector. Based on the wind field for the study area, the wind could blow from this direction approximately 7% of the year.

Screening dispersion modelling using the United States (US) Environmental Protection Agency (EPA) SCREEN3 model was used to calculate the maximum concentrations at the closest coastal area, approximately 100 km downwind from the nearest seismic survey location. This model was used with the routine and upset emission rates calculated using the EMEP/EEA emission factors.

Conservatively, all NO_x was assumed to be NO_2. The highest hourly average NO_2 concentrations expected at Saldanha Bay (closest receptor at 120 km from a location on the eastern boundary of the AOI) is 12% of the NAAQS limit value. This represents the maximum ground level concentration that would occur under conditions of weak atmospheric dispersion, i.e., low vertical turbulence and calm wind speeds that would otherwise assist with the dilution of air pollutants. Similarly, the highest hourly average SO_2 concentration is predicted to be 0.16% of the NAAQS limit value. The extrapolated highest $PM_{2.5}$ daily average concentration is 0.32% of the NAAQS. The predicted highest CO hourly average concentration is only 0.002% of the NAAQS. There are no NAAQS for NMVOCs; however, the highest predicted hourly average NMVOC concentration is still lower at the nearest receptor than the annual average NAAQS limit value for benzene. Since the calculated maximum predicted ground level concentrations (under worst-case atmospheric conditions) are considerably lower than the NAAQS limit values, it is expected that the exposure to any significant concentration levels would be infrequent and insignificant with respect to the NAAQS. Such emissions are therefore unlikely to have a direct effect on any receptor or other activity, other than the project vessels themselves.

The impact of the estimated operational emissions from the proposed project is considered to be local, and of short-term duration and low intensity. The potential impact on the air quality emissions is of low significance without further mitigation. The impact from upset emissions is higher than for routine emissions for NMVOC. The impact at the nearest AQSR is still however below the guideline value of 200 µg/m³.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Air Quality Impacts (routine)	Operational	Low	Low	Low
Air Quality Impacts (upset)	Operational	Low	Low	Low
Mitigation Measures				

- Implement a maintenance plan to ensure all ship engines and boilers receive adequate maintenance to minimise soot and unburnt fuel released to the atmosphere and maximize energy efficiency.
- Ensure no incineration (subject to obtaining an atmospheric emissions license) of waste occurs within the port limits.
- **The applicant should have an OSCP before operations begin and must operate their facilities in accordance with that OSCP. The plan holder needs to be prepared to quickly and effectively respond to a worst-case discharge from a facility to the maximum extent practicable.**
- **An OSCP is an important contingency planning document. It contains numerous details including, exercise and equipment testing procedures, spill response strategies and tactics, spill command and control procedures, and emergency contact information.**

9.3.7.2 CLIMATE CHANGE

The assessment was based on Scope 1 GHG emissions for the proposed exploration in a portion of Block 3B/4B. The calculated CO_2-e routine emissions are estimated at a total of 31.813 kt. The calculated CO_2-e potential upset emissions are estimated at a total of 450 kt. The GHG emissions were estimated using SA specific caloric values and densities for fuels (where available) and IPCC emission factors.

Based on the published 2020 National GHG annual Inventory for South Africa, the maximum total CO_2-e routine emissions from the Project, assuming a maximum survey duration of 84 days, would contribute approximately 0.008% to the 2020 South African "energy" sector total of 379 505.2 kt CO_2-e and represent a contribution of 0.007% to the 2020 National GHG inventory total of 468 811.7 kt CO_2-e (excluding FOLU).

The European Bank for Reconstruction and Development (EBRD) classifies projects contributing more than 25 kt CO_2-e per year to have significant GHG emissions (EBRD 2019). Although the GHG emissions are expected to be above this threshold, it is less than the DFFE Pollution Prevention Plan requirement threshold of 100 kt CO_2-e. Given that the negative impact is of low intensity, national extent, reversible (due to its limited period of emission and future uptake by vegetation), but of short duration, the environmental risk for the routine operations is LOW. Although the intensity is medium for the upset operations, they are for a shorter duration and are less probable, so the environmental risk for the upset operations is also low.

Since the Project is of a temporary nature and expected to be completed in the near future, changes in meteorological parameters are not expected to have a significant impact on the Project.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact	Final Significance
Climate Change Impacts (routine)	Operational	Low	Low	Low
Climate Change Impacts (upset)	Operational	Low	Low	Low
Mitigation Measures				

- The means to minimise GHG emissions from the Project would be achieved by implementing a maintenance plan to ensure all ship engines and boilers receive adequate maintenance to minimise unburnt fuel released to the atmosphere and maximize energy efficiency.
- The control measures for flaring of gas given by the World Bank Group (Appendix E of the Climate Change Assessment Report in Appendix 4 of the EIA Report) should be implemented.
- **The applicant should have an Oil Spill Contingency Plan (OSCP) before operations begin and must operate their facilities in accordance with that OSCP. The plan holder needs be prepared to quickly and effectively respond to a worst-case discharge from a facility to the maximum extent practicable.**
- **An OSCP is an important contingency planning document. It contains numerous details including, exercise and equipment testing procedures, spill response strategies and tactics, spill command and control procedures, and emergency contact information.**

9.4 CUMULATIVE IMPACTS

Cumulative effects are the combined potential impacts from different actions that result in a significant change larger than the sum of all the impacts. Consideration of 'cumulative impact' should include "past, present and reasonably foreseeable future developments or impacts". This requires a holistic view, interpretation and analysis of the biophysical, social and economic systems (DEAT 2004).

Cumulative impact assessment is limited and constrained by the method used for identifying and analysing cumulative effects. As it is not practical to analyse the cumulative effects of an action on every environmental receptor, the list of environmental effects being considered to inform decision makes and stakeholders should focus on those that can be meaningfully interpreted (DEAT 2004).

9.4.1 MARINE ECOLOGY

The most reliable gauge of cumulative pressures on the marine environment by other users is provided by Sink et al. (2019) and Harris et al. (2022). The map was generated as part of the NBA 2018 by doing a cumulative pressure assessment in which the impact of both current and historical ocean-based activities on marine biodiversity was determined by spatially evaluating the intensity of each activity and the functional impact to, and recovery time of, the underlying ecosystem types (Figure 218, left). Based on the severity of modification across the marine realm, a map of ecological condition was generated (Figure 218, right). From this it can be determined that Block 3B/4B is located in an area experiencing very low cumulative impacts from other users and that the ecological condition is therefore mostly still natural or near-natural.

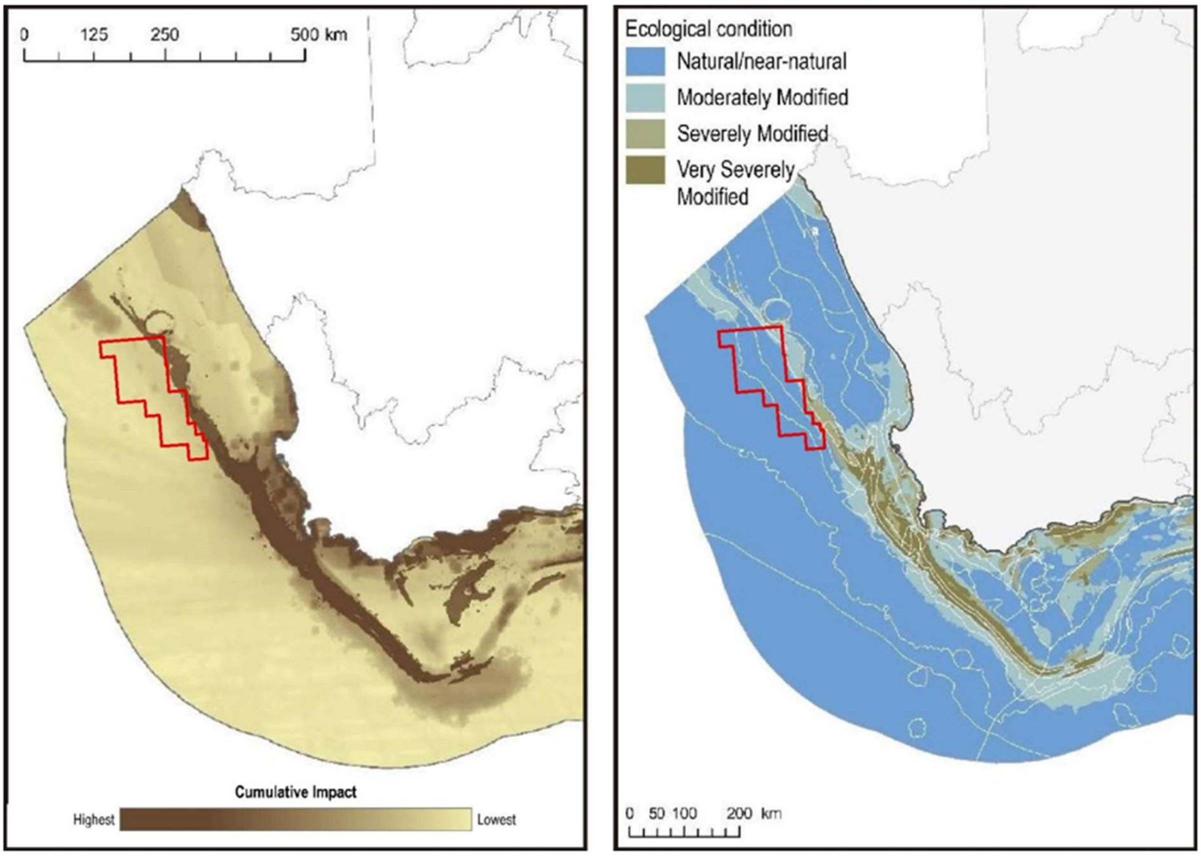


Figure 218: Block 3B/4B (red polygon) in relation to the cumulative impacts on marine biodiversity, based the intensity of all cumulative pressures and the sensitivity of the underlying ecosystem types to each of those pressures (left) and the ecological condition of the marine realm based on the severity of modification as a result of the cumulative impacts (adapted from Sink *et al.* 2019 and Harris *et al.* 2022).

The individual and population level consequences of other exploration activities or multiple smaller and more localised stressors (see for example Booth *et al*. 2020; Derous *et al*. 2020) are difficult to assess. A significant adverse residual environmental effect is considered one that affects marine biota by causing a decline in abundance or change in distribution of a population(s) over more than one generation within an area. Natural recruitment may not re-establish the population(s) to its original level within several generations or avoidance of the area becomes permanent. For example, despite the density of seismic survey coverage and exploration activities off the southern African West Coast over the past 17 years, the southern right whale population is reported to be increasing by 6.5% per year (Brandaõ *et al*. 2017), and the humpback whale by at least 5% per annum (IWC 2012) over a time when hydrocarbon exploration frequency has increased, suggesting that, for these population at least, there is no evidence of long-term negative change to population size as a direct result of exploration activities.

Reactions to sound or other anthropogenic disturbances by marine fauna depend on a multitude of factors including species, state of maturity, experience, current activity, reproductive state, and time of day (Wartzok *et al*. 2004; Southall *et al*. 2007). If a marine animal does react briefly to a disturbance by changing its behaviour or moving a small distance, the impacts of the change are unlikely to be significant to the individual, l*et al*one the population as a whole (NRC 2005). However, if a disturbance displaces a species from an important feeding or breeding area for a prolonged period, impacts at the population level could be significant. The increasing numbers of southern right and humpback whales around the Southern African coast, and their lingering on West Coast feeding grounds long into the summer, suggest that acoustic surveys and exploration activities conducted over the past 17 years have not negatively influenced the distribution patterns of these two migratory species at least. Information on the population trends of resident species of baleen and toothed whales is unfortunately lacking, and the potential effects of seismic noise on such populations remains unknown.

While it is foreseeable that further exploration (seismic and well-drilling) and future production activities could arise if the current application is granted, there is not currently sufficient information available to make reasonable assertions as to nature of such future activities. This is primarily due to the current lack of relevant geological and resource potential information, which the proposed exploration process aims to address. While there are many other rights holders in the offshore environment (e.g. marine diamonds and gemstones, heavy minerals, precious metals and ferrous and base metals), most of these are located well inshore of Block 3B/4B and are not undertaking any exploration activities at present or would be concurrently with the proposed AOSAC exploration drilling campaign. A possible exception is further proposed exploration well drilling in the Deep Water Orange Basin block offshore of Block 3B/4B. The Searcher 3D seismic survey (scheduled for January 2023) is anticipated to have been completed by the time this project receives a decision.

Thus, the possible range of the future prospecting, mining, exploration and production activities that could arise will vary significantly in scope, location, extent, and duration depending on whether a resource(s) is discovered, its size, properties and location, etc. As these cannot at this stage be reasonably defined, it is not possible to undertake a reliable assessment of the potential cumulative environmental impacts associated with these. It is also possible that the proposed, or future, exploration fails to identify an economic petroleum resource, in which case the potential impacts associated with the production phase would not be realised.

Furthermore, the assessment methodology used in the ESIA by its nature already considers past and current activities and impacts. In particular, when rating the sensitivity of the receptors, the status of the receiving environment (benthic ecosystem threat status, protection level, protected areas, etc.) or threat status of individual species is taken into consideration, which is based to some degree on past and current actions and impacts (e.g. the IUCN conservation rating is determined based on criteria such as population size and rate of decline, area of geographic range / distribution, and degree of population and distribution fragmentation). Thus, past and existing offshore activities (including shipping, prospecting, mining, exploration, production, commercial fishing, etc.) have been taken into account in the assessment of potential impacts related to the proposed project.

The primary impacts associated with the drilling of exploration wells (normal drilling operations) in the Southeast Atlantic Deep Ocean Biozone, relate to physical disturbance of the seabed, discharges of drilling solids to the benthic environment, the presence of infrastructure remaining on the seabed and operational discharges from associated vessels and drill unit. Other marine exploration and mining activities off the West Coast are all located well inshore of the AOI, but various existing and proposed subsea fibreoptics cables pass through the Block (see

Figure 144). Cumulative potential impacts from actions by these different user groups on benthic ecosystems in Block 3B/4B are therefore expected to be minimal.

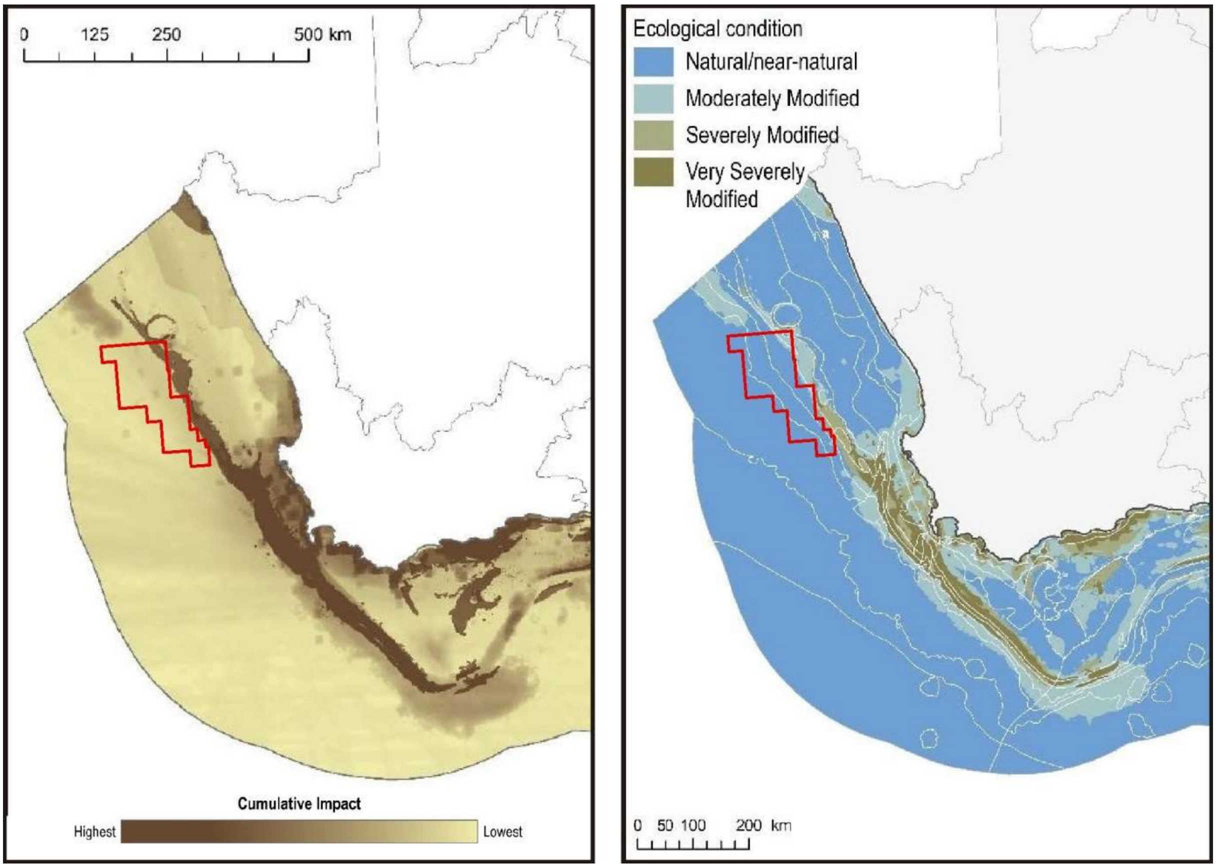


Figure 219: Block 3B/4B (red polygon) in relation to the cumulative impacts on marine biodiversity, based the intensity of all cumulative pressures and the sensitivity of the underlying ecosystem types to each of those pressures (left) and the ecological condition of the marine realm based on the severity of modification as a result of the cumulative impacts (adapted from Sink *et al.* 2019 and Harris *et al.* 2022).

9.4.1.1 CUTTINGS DISCHARGE AND SEDIMENT PLUME

With respect to physical disturbance impacts, the existing cumulative impacts to the benthic environment include the development of hydrocarbon wells. Since 1976 approximately 40 wells have been drilled in the Southern Benguela Ecoregion. The majority of these occur in the iBhubesi Gas field in Block 2A inshore of Block 3B/4B (Eco Atlantic recently completed the drilling of the Gazania-1 well in Block 2B which was spudded on 10 October 2022). Prior to 1983, technology was not available to remove wellheads from the seafloor, thus of the approximately 47 wells drilled on the West Coast, 35 wellheads remain on the seabed. Assuming a conservative estimate of 2.64 km^2 of cumulative seabed affected per well (based on the footprint calculated for a single well, TEEPSA, Pers. comm.), the total cumulative area impacted by the installation and cuttings fall-out of 5 petroleum exploration wells on the West Coast is estimated at 124 km^2.

In southern Namibia, oil and gas exploration and production activities have focused on the Kudu gas field, which lies inshore and to the north of Block 3B/4B. In the order of 32 wells have been drilled in the Namibian offshore environment to date, the majority of which have been drilled off southern Namibia, most of these in less than 300 m water depth. A further 2 wells have recently been drilled in Block 2913B, with a further two wells in PEL39, with a further two wells planned for PEL39 in the third quarter of 2023. Prior to 1983, technology was not available to remove wellheads from the seafloor, and most of the wells drilled off Namibia remain with wellhead on the seabed. Despite the number of wells drilled in the West Coast offshore environment, there is no evidence of long-term negative change (cumulative impacts) to faunal population sizes or irreparable harm as a direct result of these exploration drilling activities. In fact Atkinson (2009) reported that in South Africa, abandoned wellheads in the vicinity demersal trawling grounds provide some de facto "protection" to marine infaunal, epifaunal and fish assemblages (see also Wilkinson & Japp 2005). Assuming a conservative estimate of 2.64 km^2 of cumulative seabed affected per well, the total cumulative area impacted by the installation and cuttings fall-out of 32 petroleum exploration wells off southern Namibia is estimated at 84.5 km^2.

In reality the total cumulative impacted area at any one time is considerably less, due to the natural dispersion and recovery of benthic communities over the short to medium (shallow waters) and long term (deeper waters). Furthermore, as the AOI for drilling and the associated depositional footprints will avoid MPAs and EBSAs, impacts will affect mostly communities in unconsolidated habitats, which are less sensitive to disturbance and recover more quickly than those inhabiting hard grounds. In addition, AOSAC will actively avoid and reduce potential impacts on sensitive and potentially vulnerable habitats by ensuring that wells are >1 000 m from such habitats (using survey prior to drilling). Cumulative impacts are therefore less likely.

The development of the proposed exploration well(s) in this assessment would generate a risk plume of cuttings and drilling muds in the water column. The maximum instantaneous risk would correspond to a footprint in the water column that would impact a maximum cumulative volume of 0.045 km^3 for a maximum duration of 2 days, which can be considered an insignificant percentage of the ecoregion as a whole. There is no more risk in the water column after the end of the discharge of the 26" displacement. In other words there is no risk to the water column from discharges during the risered sections.

There is no current development or production from the South African West Coast offshore. The Ibhubesi Gas Field (Block 2A) and Kudu Gas Field (off southern Namibia) have been identified for development. Cumulative impacts from other hydrocarbon ventures in the area are thus likely to increase in future. Other activities that may have contributed to cumulative impacts to the benthic environment in the licence area include limited historical deep-water trawling along the shelf edge in the inshore portions of the licence block.

9.4.1.2 **UNDERWATER NOISE**

Noise associated with the proposed exploration programme would also have cumulative impact on marine fauna. Due to the licence area being located within the main vessel traffic routes that pass around southern Africa, ambient noise levels are naturally elevated. Sensitive receptors and faunal species (cetaceans, turtles and certain fish) are unlikely to be significantly additionally affected as faunal behaviour will not be affected beyond 28 km during drilling and beyond 1 km during VSP operations. Noise levels would return back to ambient after drilling is complete.

Data on behavioural reactions to noise and drill rig presence acquired over the short-term could, however, easily be misinterpreted as being less significant than the cumulative effects over the long-term and with multiple exposures, i.e. what is initially interpreted as an impact not having a detrimental effect and thus being of low significance, may turn out to result in a long-term decline in the population, particularly when combined with other acoustic and non-acoustic stressors (e.g. temperature, competition for food, climate change, shipping noise) (Przeslawski *et al*. 2015; Erbe *et al*. 2018, 2019; Booth *et al*. 2020; Derous *et al*. 2020). Physiological stress, for example, may not be easily detectable in marine fauna, but can affect reproduction, immune systems, growth, health, and other important life functions (Rolland *et al*. 2012; Lemos *et al*. 2021). Confounding effects are, however, difficult to separate from those due to exploration drilling.

Despite the density of seismic survey coverage over the past years off the South African West Coast, the number of Southern right and Humpback whales around the southern African coast have increased, suggesting that, for these species at least, there is no evidence of long-term negative change to population size or irreparable harm as a direct result of seismic survey activities. Although surveys have revealed a steady population increase since the protection of the species from commercial whaling, more recent results, however, indicate changes in the prevalence of southern rights on the South African breeding ground, including a marked decline of unaccompanied adults since 2010 and extreme fluctuations in the number of cow-calf pairs since 2015. Vermeulen *et al*. 2020, however, contribute the change in demographics to likely spatial and/or temporal displacement of prey due to climate variability, and not seismic surveys. To date no trophic cascades off the South African coast have been documented despite the completion of a number of seismic surveys having been completed.

9.4.1.3 VESSEL LIGHTING AND OPERATIONAL DISCHARGES

There are numerous light sources and operational discharges from vessels operating within and transiting through the area, although each is isolated in space and most are mobile. Given the extent of the ocean and the point source nature of the lighting, the prevalence of sensitive receptors and faunal species interactions with the light sources is expected to be very low. Light levels would return back to ambient once operations are completed. Each of the vessels (fishing, shipping, exploration) operating within the area will make routine discharges to the ocean, each with potential to cause a local reduction in water quality, which could impact marine fauna. However, each point source is isolated in time and widely distributed within the very large extent of the open ocean. At levels compliant with MARPOL conventions no detectable cumulative effects are anticipated.

9.4.1.4 CONCLUSION

Although possible future activities cannot be reasonably defined and it is unlikely that concurrent exploration activities will occur at the same time as the Applicant drilling campaign in Block 3B/4B, with the implementation of the proposed mitigation measures, most of the potential impacts will be of short duration, typically ceasing once drilling operations are completed. An exception is the changes in sediment grain size and thickness deposit as a consequence of the discharge of cuttings and drilling mud. Such impact footprints are highly localised and given the area of available seabed on the continental shelf are considered unlikely to contribute significantly to future cumulative impacts, and thus no more significant than assessed in the preceding sections.

The one impact that is expected to continue into the long term is the impact relating to smothering of benthic biota due to cuttings discharge, which the drilling discharge modelling study predicted can last in excess of 5 years. While there is currently further interest to undertake exploration drilling in the blocks adjacent to Block 3B/4B, the targets are suitably far away that these would not result in depositional overlap within the AOI. Cumulative impacts would thus be no more significant than assessed in the preceding sections.

Although cumulative impacts from other hydrocarbon ventures in the area may increase in future, the cumulative impacts of the proposed drilling of exploration wells in the Southeast Atlantic Deep Ocean Biozone can be considered of LOW significance. In applying the EIMS assessment methodology, the numerical approach similarly results in the cumulative impact having a LOW significance.

Impact	Phase	Pre-mitigation Impact
Impacts to marine fauna of concurrent exploration drilling by multiple operators	Mobilisation, Operation & Decommissioning	Low

9.4.2 FISHERIES

The impacts on each of the above fishing sectors (Section 9.3.2) could be increased due to the combination of impacts from other projects that may take place during the same period. Cumulative impacts include past, present and future planned activities which result in change that is larger than the sum of all the impacts. Cumulative effects can occur when impacts are 1. additive (incremental); 2. interactive; 3. sequential Or 4. synergistic and would include anthropogenic impacts (including fishing and hydrocarbon industries) as well as non-anthropogenic effects such as environmental variability and climate change.

Oil and gas exploration could be undertaken in various licence blocks off the West, South and East coasts of South Africa, although very little drilling has been undertaken in the last 10 years. In the order of 358 wells have been drilled in the South African offshore environment to date (based on information provided by PASA in 2021). Approximately 40 wells have been drilled in the Southern Benguela Ecoregion, with the majority of these occurring in the iBhubesi Gas field in Block 2A inshore of the Deep Water Orange Basin Block. Eco Atlantic recently completed the drilling of the Gazania-1 well in Block 2B which was spudded on 10 October 2022. Prior to 1983, technology was not available to remove wellheads from the seafloor, thus of the approximately 40 wells drilled on the West Coast, 35 wellheads remain on the seabed.

There is no current development or production from the South African West Coast offshore. The Ibhubesi Gas Field (Block 2A) and Kudu Gas Field (off southern Namibia) have been identified for development. On the South Coast, PetroSA operates the F-A production platform, which was brought into production in 1992. The F-A platform is located 85 km south of Mossel Bay in a water depth of 100 m. Gas and associated condensate from the associated gas fields are processed through the platform. The produced gas and condensate are exported through two separate 93 km pipelines to the PetroSA GTL plant located just outside the town of Mossel Bay. It is widely reported that the gas supplying the Mossel Bay GTL plant from Block 9 was due to cease in late 2020 (Business Insider) and it seems likely to close unless a domestic gas supply is identified or a large bail out by the South Africa taxpayer is agreed to fund processing of higher cost feedstocks.

In the Benguela region, fisheries are at risk of additional disruption due to accumulated pressure should new exploration and mining activities commence (by other applicants or existing exploration right holders) during the same period within which the drilling activities in Block 3B/4B are proposed. Table 56 lists the applications for petroleum exploration and mineral prospecting rights in the Southern Benguela region (South African West Coast and southern Namibia) since 2007, indicating which of these have been undertaken. Concurrent activities such as other planned speculative or proprietary seismic surveys in the southern Benguela region could add to the cumulative impact on fisheries.

In Namibia, wells have recently been drilled by TotalEnergies in Block 2913B (November 2021 to March 2022) and Shell in PEL39 (December 2021). Additional wells are also planned for Block 2913B and PEL39 in 2023.

In the Benguela region, it has been suggested that the seasonal movement of Longfin Tuna northwards from the West Coast of South Africa into southern Namibia may be disrupted by the noise associated with an increasing number of seismic surveys. While the potential exists to disrupt the movement of albacore tuna in the Benguela, this disruption, if it occurs, would be localised spatially and temporarily and would be compounded by environmental variability. In Australia, no direct cause and effect in changes in movement or availability of Bluefin Tuna could be attributed to seismic surveys (Evans et al., 2018), with observed changes being attributed to inter-annual variability. Due to the dearth of information on the impacts of seismic noise on truly pelagic species links between changes in migration patterns and subsequent catches thus remains speculative. There are a number of reconnaissance permit application and EIA / Basic assessments being undertaken for proposed seismic surveys off the West Coast (Searcher, Shearwater and TGS), although it is unlikely that all these will be undertaken as they are targeting similar areas in the Deep Water Orange Basin. These surveys overlap with Block 3B/4B and could potentially have any overlapping impacts such as reduced fishing area for the large pelagic long-line sector, in particular, should these seismic and drilling activities occur at the same time, which is unlikely.

Noise, operational lighting and discharges associated with the proposed exploration programme would also have cumulative impact on marine fauna, and possible indirect impact on fishing in the AOI. Due to the licence area being located within the main vessel traffic routes that pass around southern Africa, ambient noise levels are naturally elevated. Fishing receptors (namely demersal trawl, demersal longline, large pelagic longline and tuna pole-line) are unlikely to be significantly additionally affected as fish behaviour will not be affected beyond an estimated 5 km from the drilling unit during drilling and VSP operations. Noise levels would return back to ambient after drilling is complete. All vessels (fishing, shipping, exploration) operating within the area will make routine discharges to the ocean, each with potential to cause a local reduction in water quality, which could impact targeted fish species. However, each point source is isolated in time and widely distributed within the very large extent of the open ocean. At levels compliant with MARPOL conventions no detectable cumulative effects are anticipated.

Although possible future activities cannot be reasonably defined, with the implementation of the proposed mitigation measures, most of the potential impacts will be of short duration, typically ceasing once drilling is completed. Such impacts are, therefore, considered unlikely to contribute to future cumulative impacts, and thus no more significant than assessed in the preceding sections. Although cumulative impacts from other hydrocarbon ventures in the area may increase in future, the cumulative impacts of the proposed drilling of exploration wells on fishing on the Western Agulhas Shelf edge can be considered of LOW significance.

In addition to the above the following should also be considered to take account of catch variability and stock declines, which can be attributed to the following (Shomura et al 1995, Kuo-Wie Lan et al 2011, Lehodey et al 2006 and Punt et al 1996):

- Increasing fishing effort exacerbated by improved fish finding technology (vessel monitoring systems, use of sonar, sea surface temperature spatial mapping using satellite technology);
- Environmental variability such as cold and warm water events e.g. Benguela El Niño events have been shown to result in a change in the vertical distribution of tuna stocks within the water column, resulting in reduced catch rates;
- Migration and feeding patterns that change abundance levels annually and are linked to the environment; and
- Inconsistent or irregular catch reporting.

Table 56: Known applications for petroleum exploration and mineral prospecting rights in the Southern Benguela region (South African West Coast and southern Namibia) since 2007, indicating which of these have been undertaken.

YEAR	RIGHT HOLDER / OPERATOR	BLOCK	ACTIVITY	APPROVAL	CONDUCTED / COMPLETED
SOUTH AFRICAN WEST COAST PETROLEUM EXPLORATION					
2007	PASA	Orange Basin	2D Seismic	Yes	Nov-Dec 2007
2008	PASA	West Coast	2D Seismic	Yes	Sep 2008
2008	PetroSA	Block 1	3D Seismic	Yes	Jan-Apr 2009
2011	Forest Oil (Ibhubesi)	Block 2A	3D Seismic	Yes	May-Jul 2011
2011	PetroSA / Anadarko	Block 5/6 (ER224); Block 7 (ER228)	2D / 3D Seismic and CSEM	Yes	2D: Dec 2012 – Feb 2013 3D: Jan–Apr 2020
2011	PetroSA	Block 1	Exploration drilling	Yes	unknown
2012	BHP Billiton (now Ricocure Azinam & Africa Oil)	Block 3B/4B	2D and 3D Seismic	Yes	unknown
2013	Spectrum	West Coast regional	2D Seismic	Yes	2D: April 2015
2013	PetroSA	Block 1	2D and 3D Seismic	Yes	3D: Feb-May 2013 (conducted by Cairn)
2013	Anadarko	Block 2C	2D and 3D Seismic, MBES, heat flow, seabed sampling	Yes	unknown
2013	Anadarko	Block 5/6/7	MBES, heat flow, coring	Yes	Jan-Mar 2013
2014	OK/Shell	Northern Cape Ultra Deep ER274	2D and 3D Seismic, MBES, magnetics, seabed sampling	Yes	2D: Feb-Mar 2021

YEAR	RIGHT HOLDER / OPERATOR	BLOCK	ACTIVITY	APPROVAL	CONDUCTED / COMPLETED
2014	Shell	Deep Water Orange Basin	Exploration drilling	Yes	No (Shell relinquished block to TEEPSA)
2014	Cairn	ER 12/3/083	2D Seismic	Yes (obtained by PetroSA)	2D: Feb-Mar 2014
— 2014 - 2015	Thombo	Block 2B (ER105)	Exploration drilling	Yes	Drilled Gazania 1 in November 2022
2014	New Age Energy	Southwest Orange Basin	2D Seismic	unknown	unknown
2015	Cairn	Block 1	Exploration drilling	unknown	unknown
2015	Sunbird	West Coast	Production pipeline (Ibhubesi)	Yes	No (EA was renewed for an additional 5 years on 30 June 2022)
2015	Rhino	Southwest coast (inshore)	2D Seismic, MBES	Yes	unknown
2015	Rhino	Block 3617/3717	2D and 3D Seismic, MBES	Yes	unknown
2017	Impact Africa / TEEPSA	Southwest Orange Deep	2D and 3D Seismic	unknown	unknown
2018	PGS	West Coast regional	2D and 3D Seismic	Yes	No
2019	Anadarko	Block 5/6/7	2D Seismic	Yes	
2021	Searcher	West Coast regional	2D and 3D Seismic	Yes	2D: Jan 2022 (incomplete due to court interdict to stop survey)
2021	TGS	West Coast regional	2D Seismic	Yes	No
2021	Tosaco	Block 1, ER362	3D Seismic	Withdrawn	-
2022	Ion	Deep Water Orange Basin	3D Seismic	Withdrawn	No
2022	Searcher	Deep Water Orange Basin	3D Seismic	Yes (currently appealed)	No
2022	Shearwater	Deep Water Orange Basin	3D Seismic	Basic Assessment ongoing	No

YEAR	RIGHT HOLDER / OPERATOR	BLOCK	ACTIVITY	APPROVAL	CONDUCTED / COMPLETED
2022	TGS	Deep Water Orange Basin	3D Seismic	Basic Assessment ongoing	No
2022	TEEPSA	Block 5/6/7	Exploration drilling	Y–s	No - current project
SOUTHERN NAMIBIA PETROLEUM EXPLORATION					
2011	Signet	Block 2914B (now part of PEL39)	2D and 3D Seismic; development of production facility	unknown	unknown
2011	PGS	Block 2815	3D Seismic	Yes	3D: 2011 (HRT)
2013	Spectrum Namibia	Orange Basin multiclient	2D Seismic	Yes	2D: April 2014
2014	Shell Namibia	2913A; 2914B	3D Seismic	Yes	3D: 2015
2016	Spectrum	Southern Namibia regional	2D Seismic	Yes	2D: April 2019
2017	Shell Namibia	PEL39	Exploration drilling	Yes	Dec 2021
2019	Galp Namibia	PEL83	Exploration drilling	Yes	No (Applying for ECC extension)
2019	TEEPNA	Block 2913B (PEL56)	Exploration drilling	Yes	Drilling: Nov 2021 – Mar 2022
2020	TEEPNA	Block 2912, 2913B (PEL91; PEL56)	3D Seismic EIA Application (2023) for exploration drilling ongoing	Yes	Planned for Jan 2023
2020	TGS Namibia	Blocks 2711, 2712A, 2712B, 2713, 2811, 2812A, 2812B, 2913B in the Orange Basin	3D Seismic	Pending	No
2020	Tullow Namibia (Harmattan Energy Ltd)	Block 2813B (PEL90)	3D Seismic	EIA ongoing	No

9.4.3 SOCIAL

From a social perspective it is not possible to pinpoint which percentage of any given impact result from a specific activity or proponent. For example, agricultural, tourism and mining activities may cause an influx of people into an area due to the possibility of employment creation. It is not possible to say, for example, that 30% of people moving into the area looked for an agricultural job, 60% for a mining job and 10% for a tourism job. It is possible to say that all these industries contributed to the honeypot effect (project-induced in-migration where people move to the project site in search of work or economic opportunities that arise from the project) that compounded unemployment in the area. The following are identified as existing activities/phenomena leading to impacts that are experienced in the communities:

9.4.3.1 **MINING**

There are significant current and historical mining taking place on the West Coast. This includes diamond mining, sand mining and rare earths, amongst others. The mining activities caused environmental degradation, an influx of people, and unemployment when the mines close. Many community members referred to the inability of the mining industry to fulfil promises made to the communities.

Other community members claimed that men find it especially hard to find jobs. Many of them used to be employed by the mining industry, and with mines closing they have no alternative source of income. If people open businesses and it is successful, they are copied, and soon there is an oversupply of businesses, for example building contractors.

In Port Nolloth, one of the community members explained that diamond mining (legal and illegal) keeps the economy of the town alive. Flowers and fishing are seasonal activities. The community member stated that even if people make money in the diamond industry, they are not educated on how to spend the money wisely, and within a few months they are without money again.

There is also illegal mining taking place in some areas, such as Kleinzee. The existing mine attempts to control this, but with limited success. In August 2023, 13 illegal miners died at Kleinzee when the tunnel that they were working in collapsed. In September 2023, 867 persons, many foreign miners who were not legally in South Africa, were arrested at Kleinzee and their equipment and implements were confiscated (https://www.news24.com/news24/community-newspaper/noordkaapbulletin/hundreds-of-illegal-miners-arrested-on-nc-coastline-20230920). However, two days after the arrests, community members reported that miners were returning to the area. The presence of illegal miners can be attributed to the socioeconomic conditions in the country and the extreme levels of poverty and unemployment.

Current impacts of mining include:

- Damage to biodiversity in sea and on land impacts on the livelihoods of affected stakeholders.
- Lack of rehabilitation leading to impacts on livelihoods and tourism.
- Abandoned socioeconomic projects resulting in mistrust of any new developers.
- Unemployment due to boom-bust cycles.
- Influx of illegal miners and their families putting pressure on social infrastructure and creating safety issues in the communities.

It is not estimated that this specific project will contribute significantly to these impacts.

9.4.3.2 **THE FISHING INDUSTRY**

Traditionally, fishing has been part of the lives of West Coast communities. The fishing industry consists of commercial, small-scale, subsistence and recreational fishers. Illegal, unregulated, and unreported fishing and environment degradation are some of the severe challenges the fishing sector is facing. Small-scale fishers were only recognized under South African law since 2007. The fisheries were managed through individual transferable quotas. The aim of this system was supposed to open market access for previously disadvantaged people. However, most fishing rights were (and are still) allocated to the commercial sector, few artisanal fishers were granted rights, and their quotas were low (Schneider, 2023). South African waters are over-fished and some species like rock lobster are reported to be close to extinction. According to the Department of Environment Forestry and Fisheries (2020) several fish species are being overfished and some stocks have collapsed. Half or 50% of South Africa’s fish stocks are of concern with 22% considered heavily fished and 25% considered heavily depleted.

Climate change, mining, exploration, marine transport, ports, and marine protected areas also compete with the fishing industry for space. There are thus existing impacts on the fishing industry across the board, with the most significant impacts on small scale fishers who have limited livelihood alternatives.

Current impacts on the fishing industry include:

- Decrease in the availability of fish impacting on the livelihoods of small-scale fishermen.
- Shrinkage of areas where the fishers can catch fish, impacting on their livelihoods.
- Increase in other marine activities impacting on the ability to make a living from fishing.
- Environmental and climate change impacts that influence the behaviour of the fish, meaning that fishers must develop alternative livelihood strategies.
- Governance of the industry and fishing quotas making it difficult for small-scale fishers to survive.
- Cultural and societal changes making the fishing industry less attractive to the youth. The result is that young people either leave the area or end up unemployed.

It is not estimated that this specific project will contribute significantly to these impacts.

9.4.3.3 **CLIMATE CHANGE**

The National Oceanic and Atmospheric Administration (2017) have determined that the average sea surface temperature has been consistently higher during the past three decades than at any other time since reliable observations began in 1880. Many of the stakeholders that were consulted reported that they already observe changes in the marine environment. One stakeholder reported schools of orcas near Elandsbaai in October 2023, increased observations of penguins and other species of dolphins that they have never seen before.

Lutchminarayan (2020) reported that climate change research conducted by the World Wildlife Foundation (WWF) asked South African fishers to list the changes that they experienced in the last 10 years. Some observations listed in these workshops included:

- Decrease in fish availability, either due to a decrease in fish abundance or the change in fish distribution (further offshore or deeper).
- Changes in trophic relationships, either regarding fish predators or seabirds.
- In South Africa, fishers remembered seeing fewer seabirds.
- Changes in seasonality and species life cycle, inducing disturbances in fishing practices.
- Some species being found in different places at the same time of the year, pushing fishers to travel further to catch the fish. This is already happening with snoek along the South African coast.

Therefore, the impact of climate change is already experienced on the West Coast. Current impacts of climate change include:

- Due to a decrease in the availability of the fish, people struggle to make a livelihood from fishing.
- Extreme climate events such as droughts and floods have an impact on poor and vulnerable people, who are less resilient and struggle to get back on their feet after the event. It causes a downward spiral of poverty.

It is not estimated that this specific project will contribute significantly to these impacts, as discussed in the Climate Change Assessment that was done as part of the EIA process.

9.4.3.4 **GOVERNANCE**

There are existing governance issues in South Africa including corruption and mismanagement in government, political interference, lack of accountability, significant unemployment, violent crime, insufficient infrastructure, and poor government service delivery to impoverished communities (https://www.trade.gov/country-commercial-guides/south-africa-market-challenges; Mamokhere,2023).

Despite the South Africa's progressive Constitution and legislative framework, the implementation of the legislation is sometimes lacking. Many stakeholders have expressed their distrust in the ability of the government to implement the laws of the country, especially in light of legacy impacts of mining on the West Coast of South Africa. The fears of the stakeholders are reflected in media reports. In a policy brief about Trust in the Government (DPME, 2021) it is reported that South Africans have a consistently low trust in the government. The lack of trust in the government undermines their ability to intervene and deliver better policy outcomes.

South Africa is a rich country with significant mineral resources, but despite that the majority of the population lives in poverty. This proofs that revenues do not automatically transform poor economies into thriving ones, except if the revenue is efficiently managed, effectively redistributed, and properly harnessed for diversified local investments. Stakeholders expressed reservations about the potential positive economic impacts of oil and gas on the affected communities given the current challenges with governance. They fear further marginalisation due to unequal representation in political decision-making.

Current impacts of governance issues include:

- High levels of unemployment in project-affected areas.
- Lack of service delivery – in some areas such as Port Nolloth there are issues with water.
- Lack of access to social infrastructure such as schools, clinics, hospitals, police stations and government offices.
- Lack of road maintenance.
- Political interference and power imbalances – certain agendas are pushed by politicians, even if community members disagree. This damage the social fabric of the communities.

It is not estimated that this specific project will contribute significantly to these impacts.

9.4.3.5 **POVERTY, INEQUALITY, GENDER AND UNEMPLOYMENT**

South Africa has one of the highest levels of inequality in the world (Seekings, 2023). Income inequality is concerned with the degree to which income is distributed in an unequal manner amongst a population. Inequality of opportunities occurs when people, either because of circumstances or discrimination, are denied access to basic necessities such as water, sanitation, shelter, energy, healthcare or education (UNDP, 2014). Many of the towns on the West Coast reflect this inequality and have less affluent areas with permanent residents, and affluent areas with holiday homes and a few permanent residents. In some cases, the fishers moved inland (e.g. Elim) because the towns have been taken over by tourism and people from other areas that moved there because of a quiet lifestyle.

The country's unemployment rate is 32,6%, with an employment rate of 29,6% in the Northern Cape and 20,9% in the Western Cape (StatsSA, 2023). Youth aged 15-24 years and 25-34 years recorded the highest unemployment rates of 60,7% and 39,8% respectively. These unemployment rates are reflected in the project-affected communities. The fact that fishing is a seasonal activity and the declining fish stocks exacerbate the problem. The fluctuations in the mining industry also had an impact on unemployment. The communities in the project area are poor, marginalised, and desperate for work. Parents are concerned about the future of their children. It is not only a lack of income that makes people in the project area poor.

Communities in the project affected areas already suffer from unfreedoms of all sorts, and it is in this context that any potential new development must be considered. Given that the population in the Richtersveld Local Municipality more than doubled and have increased with more than 40% Nama Khoi Local Municipality (LM) and the Kamiesberg LM in the Northern Cape Province; and has increased with more than 50% in Saldanha Bay LM in the Western Cape since 2011, it can be assumed that the competition for resources have increased. This means that already limited resources and opportunities have to meet the need of an increasing number of people, which can enhance the downward spiral of poverty.

Current impacts of poverty, inequality and unemployment include:

- People are desperate to feed their families, and therefore accept any development that can potentially change their circumstances without considering the future implications.
- Many people depend on social grants to survive, placing a burden on the state and local economic development.
- Shortage of basic services due to influx of people looking for new opportunities.
- Lack of opportunities for the youth to escape the poverty cycle.

It is not estimated that this specific project will contribute significantly to these impacts.

9.4.3.6 **GENDER**

Gender is a relational term that includes both women and men. It is used to describe socially determined differences between women and men, such as roles, attitudes, behaviour, and values in a given context. Gender is not synonymous with women, gender equality is not only a women's issue, and both women and men must be involved to advance gender equality (UNDP, 2015).

More than half (51,1%) of the South African population are female and, according to the General Household Survey (GHS) 2021, more than two-fifths (42,0%) of households are headed by females. Women in SA are more likely to be unemployed than men and are less likely to participate in the labour market than their male counterparts (StatsSA, 2022). In addition, women and girls carry most of the care and domestic burden, are less likely to be employed in the formal sector (and where they are employed, earn lower wages), are less likely to be able to influence government policy, and experience high levels of violence (Unicef, 2023). In 2018, 13.1% of women aged 15-49 years reported that they had been subject to physical and/or sexual violence by a current or former intimate partner in the previous 12 months. Also, women and girls aged 10+ spend 15.6% of their time on unpaid care and domestic work, compared to 6.5% spent by men.

Women in the South African small-scale fisheries sector has made substantive yet undervalued contributions. The South African fisheries sector has been historically characterized by a sharp gendered division of labour, in which women were expected to fulfill most of the pre-and-post harvest activities, whereas men performed most of the work at sea (Harper, 2019). Women, especially from poor coastal communities of South Africa, continue to face gender-specific challenges that deny them equality of access to marine resources and the benefits therein (Cele, 2020). Some of the challenges that the women face include:

- Cultural exclusions prescribing what type of work women can do.
- Lack of control over their labour and income (all income earned are given to the man as head of the household).
- Women often receive less pay than men for the same work.
- Their work is under-valued.
- They lack resources such as capital and/or education to improve their livelihoods.
- Family responsibilities may prevent them from taking full advantage of opportunities.
- They tend to have limited decision-making power in fisheries governance institutions, communities and even their own households.

Therefore, the challenges experienced in the fishing industry (See Section 8.3.2) are even more pronounced for women. It is not estimated that this specific project will contribute significantly to the current challenges that women experience. However, the vulnerability of women to social impacts and change must always be considered, especially in the long run.

9.4.3.7 **CONCLUSION**

Although cumulative impacts from other hydrocarbon ventures in the area may increase in future, the cumulative impacts of the proposed drilling of exploration wells along the west coast of South Africa can be considered of LOW significance. In applying the assessment methodology, the numerical approach similarly results in the cumulative impact having a LOW significance.

Impact	Phase	Pre-mitigation Impact
Impacts to Social Environment in terms of Mining, Fishing, Climate Change, Governance, Poverty, Inequality and Unemployment	All Phases	Low

9.4.4 MARITIME HERITAGE

Given the nature of palaeontological and maritime archaeological heritage resources and the extent of knowledge about their occurrence and distribution, an assessment of the cumulative impact of current and future seabed activities on these resources in the area surrounding Block 3B/4B, can only be qualitative and descriptive.

9.4.4.1 PALAEONTOLOGICAL RESOURCES

The presence of palaeontological resources within the seabed of the block is proven. While current and future seabed activities in the area which will disturb the seabed and bedrock, including mineral and oil and gas exploration or production, have the potential to impact palaeontological resources, the scale of these impacts, relative to the scale of the seabed means that such impacts will be of LOW cumulative significance and will not deplete the palaeontological resources of the Orange Basin.

9.4.4.2 MARITIME ARCHAEOLOGICAL RESOURCES

With respect to potential cumulative impacts on historical shipwrecks, the discussion above indicates that this area of South Africa's West Coast has relatively few wrecks, when compared to places like Table Bay which alone contains more than 400 wrecks. The majority of West Coast wrecks are also located close to the coast, and cumulative impacts arising from offshore mining, prospecting and exploration are thus potentially more of a risk in areas close to the coast. Generally, historical wrecks and related maritime archaeological debris are avoidable (through the prior collection and analysis of geophysical data) and actively avoided (because of potential damage they can cause to plant and machinery) by seabed activities such as exploration or production.

Impacts on historical shipwrecks arising from seabed activities are likely to be accidental where they do occur, and once a site has been encountered on the seabed it is likely to be excluded from the area of activities as an operational obstruction or risk. There is thus a VERY LOW potential for cumulative impacts on maritime archaeological resources, principally historical shipwrecks, arising out of current and future seabed activities in the area surrounding Block 3B/4B.

9.4.5 CULTURAL HERITAGE

Cumulative impacts include those impacts already present in the areas researched, as well as the impacts of the project, especially in the future. Regarding existing (non-project) impacts, it is found that the West Coast and NBC have marine diamond mining impacts, commercial fishing impacts, port operations and recreational tourism impacts. These activities are already impacting the natural environment and cultural heritage expression. While the broader future impacts of drilling are difficult to determine (especially for a cultural heritage specialist), the cumulative impacts of project activities on cultural heritage may arise due to declining ocean health (i.e., noise pollution, negative impact on marine biodiversity and, directly referring to this report – negative impact on cultural heritage).

Comparing the cumulative impacts of normal operations of the project to existing, often unmitigated impacts of for example, commercial trawling, it could be argued that carefully managed drilling may have less of an impact on the seabed and therefore on cultural heritage practices involving the sea than commercial fishers are presently doing. However, the project in the AOI may still impact ritual processes, making waters being perceived as less clean for spiritual uses. Here, the reference is to spiritual cleanliness of the natural resource for ritual use.

Impact	Phase	Pre-mitigation Impact	Post-mitigation Impact
Cumulative Heritage Impacts	All Phases	Medium	Low

9.5 NO-GO ALTERNATIVE

The no go alternative would imply that no survey or exploration activities are undertaken and, as such, the negative impacts as stated above, would not materialise. However, conversely, this will negate the potential positive impacts associated with the proposed exploration activities, including:

- The opportunity to identify potential oil and gas resources within the Application Area including potential future contribution to the economy and energy security of South Africa;
- The opportunity to conduct independent research on the deep water environments of the West Coast; and
- Economic benefits to the local, regional and national economy.

Since there are no mitigation measures, the impact significance will be low pre- and post-mitigation and final significance will be the same.

Impact	Phase	Pre-mitigation ER	Post-mitigation ER	Final Significance
No-Go Alternative	Operation	Low	Low	Low
Mitigation Measures				
• N/A				

10 CLOSURE AND REHABILITATION

For a detailed description of the financial provision and costing for the proposed project, please refer to Appendix 6 for a standalone Rehabilitation and Closure Report.

It should be noted that it is anticipated that the closure and rehabilitation will have a limited impact on the receiving environment. The rehabilitation and closure actions required in terms of this project will be limited to:

- Well sealing and plugging; and
- Demobilisation.

Residual impacts post completion of the exploration activities are limited (if any) and therefore there will be no requirements further (additional) post closure activities. The overall closure objective will be to ensure that the post closure environment aligns with the pre-project environment.

10.1 WELL SEALING AND PLUGGING

The purpose of well sealing and plugging is to isolate permeable and hydrocarbon bearing formations as well as independently distinct flow (fluid or gas) zones. Well sealing and plugging aims to restore the integrity of the formation that was penetrated by the wellbore. The identification of differential flow zones and requirements for barrier placement will be determined during the initial well bore drilling and the site specific closure and plugging plan adjusted for the specific well. The principal technique applied to prevent cross flow between permeable formations is plugging of the well with cement, thus creating an impermeable barrier between two zones.

Once drilling and logging have been completed, the exploration wells will be sealed with cement plugs, tested for integrity and abandoned according to international best practices. Cement plugs will be set to isolate hydrocarbon bearing and / or permeable zones and cementing of perforated intervals (e.g. from well logging activities) will be evaluated where there is the possibility of undesirable cross flow. These cement plugs are set in stages from the bottom up. Three cement plugs would be installed: i.e. one each for isolation of the deep reservoir and the main reservoir; and a third as a second barrier for the main reservoir. Additional plugs may be required depending on the geological profile of the well bore, as determined during initial drilling and logging.

The integrity of cement plugs can be tested by a number of methods. The cement plugs will be tag tested (to validate plug position) and weight tested, and if achievable then a positive pressure test (to validate seal) and/or a negative pressure test will be performed. Additionally, a flow check may be performed to ensure sealing by the plug. Once the well is plugged, seawater will be displaced before disconnecting the riser and the BOP.

10.2 DEMOBILISATION PHASE

After any exploratory, and appraisal wells have been plugged and tested for integrity, they may be abandoned with wellhead equipment left in place on the seabed in line with industry practices worldwide. Where appropriate 'trawlable' protective equipment is applied to abandoned wellheads. The risk assessment criteria will consider factors such as the water depth and use of the area by other sectors (e.g., fishing). It is worth noting that irrespective of whether the wellhead and over trawlable protective equipment is retained the well bore itself will be plugged.

Monitoring gauges installed on wellhead equipment for exploration, appraisal, or production wells may remain on wellheads so that the Applicant has the option to access and monitor wellhead equipment during future appraisal or production activities. Monitoring gauges to monitor pressure and temperature through wireless communication may be installed on wells where the Operator will return in the future for appraisal / production purposes. Monitoring gauges will not be installed on exploration wells which are earmarked for abandonment

With the exception of the over trawlable protective equipment over abandoned wellheads and drilling discharges deposited on the seabed, no further physical remnants of the drilling operation will be left on the seafloor. A final clearance survey check will be undertaken using an ROV. The drilling unit and support vessels will demobilise from area of interest.

10.3 ADDITIONAL WORK FOR ABANDONMENT PROGRAMME

Well Abandonment program detailing design will be developed and refined as the project progresses. Site specific OSCP will be compiled and submitted for South African Maritime Safety Authority (SAMSA) approval before any commencement of operations. Further refinement of the estimated abandonment costs to a greater level of detail and accuracy considering the final well information and the applicable program for that particular well. The actual closure strategies will differ from well to well, depending on the geological profile. Following well development, a well specific decommissioning and closure plan should be developed for each well.

10.4 ADDITIONAL DECOMMISSIONING ACTIVITIES

The well abandonment cost estimates and the entire required framework will be maintained as a live document and updated with more information which comes available as the project matures. This new information will become available through changing market conditions, new studies and better understanding of the actual borehole configuration.

Once the well locations have been defined, a specific OSCP will be prepared which will be subject to SAMSA approval. It is standard practice to have this internal document prepared and aligned with local and national regulations under the South African National Oil Spill Contingency Plan (NOSCP) which includes applicable international conventions.

The applicant will conduct a final well clearance survey utilising a ROV to ensure and certify that the abandoned well has its wellhead has been removed and there are no physical remnants of the drilling operation. The drillship and support vessels will be demobilised from the well location. The onshore base will be closed post the termination of all drilling and associated operations.

11 CONCLUSIONS AND RECOMMENDATIONS

The EIA process identified potential issues and impacts associated with the proposed project. The EIA addresses those identified potential environmental impacts and benefits (direct, indirect and cumulative impacts) associated with applicable phases of the project and recommends appropriate mitigation measures for potentially significant environmental impacts. The EIA report provides sufficient information regarding the potential impacts and the acceptability of these impacts in order for the Competent Authority to make an informed decision regarding the proposed project. The release of a draft EIA Report provides stakeholders with an opportunity to verify that the issues they have raised through the process had been captured and adequately considered.

The EIA report aims to achieve the following:

- Provide an overall description of the social and biophysical environments affected by the proposed project.
- Assess potentially significant impacts (direct, indirect and cumulative, where required) associated with the proposed project.
- Identify and recommend appropriate mitigation measures for potentially significant environmental impacts; and
- Undertake a fully inclusive public involvement process to ensure that I&APs are afforded the opportunity to participate, and that their issues and concerns are recorded.

11.1 CONCLUSIONS FROM SPECIALIST STUDIES

The conclusions and recommendations of this EIA are the result of the assessment of identified impacts by specialists, and the parallel process of public participation. The public consultation process has been extensive, and every effort has been made to include representatives of all stakeholders in the study area. The main conclusions from each of the specialist studies are presented below.

11.1.1 MARINE ECOLOGY

11.1.1.1 **MITIGATION AND MANAGEMENT PLAN**

The mitigation measures are based largely on the guidelines currently accepted for exploratory well drilling in South Africa, but have been revised to include salient points from international guidelines and industry best practices discussed above.

The mitigation measures proposed are the outcome after having defined the performance objectives, indicators and targets in the various assessments. Performance objectives are influenced by international standards, legal requirements and scientific knowledge.

In their review to guide management strategies for the environmental impacts of deep-water oil and gas operations, Cordes et al. (2016) present various recommendations of which the following are applicable to, and in some cases have been implemented in, this project:

- Surface infrastructure and any discharge sites should be at least 2 km away from MPAs and declared EBSAs.
- Any high-density, high-biomass, high-relief, or specialized deep-sea habitat should be identified and mapped and avoidance rules or formal MPA designations implemented to minimize adverse impacts. The definition of these significant communities will vary from region to region and will depend on national regulations within the region of interest.
- Adopt an integrated approach to conservation, which should include spatial management in conjunction with activity management in the form of restrictions on discharge and the use of water-based drilling fluids, and temporal management in areas where the drilling activity is near breeding aggregations or seasonally spawning sessile organisms.

- Incorporate buffer zones into spatial management plans to protect vulnerable deep-sea habitats and communities.

Although at this stage the Marine Spatial Planning process implemented in South Africa lacks legislation and has only weak links to broader ocean governance, the AOI borders on ESAs to the north and CBA1: Natural and CBA2: Natural areas to the west, south and east, and should drilling targets be identified immediately adjacent to these areas, provision would need to be made to undertake the required site specific assessments and collect quantitative baseline data. This may take the form of surveys including high-resolution mapping, visual seafloor imagery and benthic samples to characterize the faunal community and ensure proper species identifications (Cordes et al. 2016).

11.1.1.2 ENVIRONMENTAL ACCEPTABILITY

The proposed exploration activities (normal operations) to be undertaken by AOSAC are expected to result in impacts on marine invertebrate fauna in the approved drilling area of Block 3B/4B, ranging from negligible to low significance without mitigation. Only in the case of potential impacts of drilling wastes on vulnerable deep-water reef communities are impacts of high significance expected. The potential impacts can be adequately mitigated with the implementation of the proposed mitigation measures (as included in the EMPr), which are in line with current industry good practice for drilling undertaken in Namibian waters. With implementation of recommended mitigation measures, the significance would reduce to medium.

In the order of 358 wells have been drilled in the South African offshore environment to date (based on information provided by PASA in 2021), the majority of which (200 wells) have been drilled off the South Coast on the Agulhas Bank, most of these in less than 250 m water depth. A further 47 (including the recent well completed in 2022) have been drilled off the West Coast. Despite the 47 wells off the West Coast, there is no evidence of long-term negative change (i.e. cumulative impacts) to faunal population sizes or irreparable harm as a direct result of these exploration drilling activities. Although there is no current development or production from the South African West Coast offshore, the Ibhubesi Gas Field (Block 2A) (off West Coast, approximately 130 km east of the AOI and Kudu Gas Field (off southern Namibia) have been identified for development. In fact Atkinson (2009) reported that abandoned wellheads in the vicinity demersal trawling grounds provide some de facto “protection” to marine infaunal, epifaunal and fish assemblages (see also Wilkinson & Japp 2005).

The Marine Ecologist concluded that the assessment was sufficiently robust and provided sufficient information for the competent authority to make an informed decision on the proposed project taking into consideration the significance of potential impacts on marine fauna and National strategic policy issues relating to energy and climate change. It is recommended that the commitments presented in this report should be conditional to the Environmental Authorisation, should DMRE approve the application.

11.1.2 FISHERIES

The proposed exploration activities could potentially affect commercial fishing activities during all phases of the project. The following impacts on fisheries arising during planned operations were identified: 1) temporary safety zone around drilling unit; 2) permanent exclusion around abandoned wellhead(s); 3) release of drill cuttings into the marine environment; 4) noise emissions during drilling; 5) noise emissions during VSP; and 6) noise emissions during sonar surveys. The potential impact of unplanned (accidental) events were identified as: 7) low volume release of diesel or hydraulic fuel from vessels or drilling unit; 8) a large-scale, uncontrolled blow-out of hydrocarbons at the well due to a failure of pressure control systems; and 9) loss of equipment to sea.

11.1.3 MARITIME HERITAGE

It is our reasoned opinion that the proposed exploration activities in Block 3B/4B are likely to have a very low impact on palaeontological resources, and no impact on maritime archaeological sites and materials. Provided the recommendations to mitigate and offset potential impacts are implemented, the proposed exploration activities can be considered to be palaeontologically and archaeologically acceptable.

11.1.4 CULTURAL HERITAGE

Considering the Cultural Heritage Impact Assessment offered, the conclusion is that the intangible cultural heritage receptors are sensitive in the area of indirect influence. While these sites are already affected by existing/cumulative impacts, mitigation plans must be implemented if the impacts of either normal operations or unplanned events are to be addressed. There are multiple use areas of different value in these locations. These valuable sites and stakeholders include potential underwater cultural heritage, and active SSF families and communities, those using the sea for leisure and business purposes, as well as those relying on the ocean for psychosocial health. These facts need to be considered, and all the recommended protocols regarding the precautionary measures to protect the highly valued natural and cultural heritages along the potentially impacted stretch of the South African coast.

Indigenous cultural valuations of the coast must be prioritized (i.e., engaged with), given the historical legacy of slavery and apartheid and the exclusion of these groups from decision-making processes regarding natural resource management.

Coastal cultural heritage is both a tangible and intangible asset for South Africa. It constitutes an important element in the restorative justice process of the country, and it is key to both psychological and physical wellbeing in a country where there is major inequality and violence. It is important that companies seeking to develop the assets of South Africa engage with local communities and seek to advance consultative, inclusive and democratic processes for socioeconomic development.

11.1.5 SOCIAL

The exploration for oil and gas are controversial. For many stakeholders it is an emotional matter, for others the potential of impacting their livelihoods is the biggest fear. There are also stakeholders that feel that the exploration for fossil fuels is not in line with sustainable development and the fight against climate change. Other stakeholders feel that it is imperative for the growth and development of the South African economy to get involved in this industry. It is a complex problem.

In South Africa the environmental authorisation process is triggered by certain activities. As a result, a project may be required to go through several impact assessment processes during the different phases of the project. This Social Impact Assessment Report is only applicable to the drilling of a limited number of exploration wells (between 1 and 5). The activities will take place > 180 km off shore. As a result, direct social impacts of the activity are limited. However, there are existing impacts from various sources that are already present in the project affected communities. These existing impacts have to be considered when looking at the social environment.

Based on the information presented in this report there are no social impacts that presents a fatal flaw, and therefore the recommendation is for the exploration process to be approved. The following plans are recommended for development and implementation throughout the life of the project.

11.1.5.1 **STAKEHOLDER ENGAGEMENT PLAN**

Social impacts already start in the planning phase of a project and as such it is imperative to start with stakeholder engagement as early in the process as possible. The stakeholder engagement conducted as part of the environmental authorisation process is a good platform to start with. A stakeholder engagement plan will assist the Applicants to outline their approach towards communicating in the most efficient way possible with stakeholders throughout the exploration phase. Stakeholders must provide input in the Stakeholder Engagement Plan.

The Applicant's Stakeholder Engagement Plan should have the following objectives:

- To identify and assess the processes and/or mechanisms that will improve the communication between local communities, the wider community, and the Applicants;
- To improve relations between the Applicant's staff and the people living in the local communities;

- To provide a guideline for the dissemination of information crucial to the local communities in a timely, respectful, and efficient manner; and
- To provide a format for the timely collection of information from the local communities in such a way that the communities are included in the decision-making process.

The Stakeholder Engagement Plan should be compiled in line with International Finance Corporation (IFC) Guidelines and should consist of the following components:

- Stakeholder Identification and Analysis – time should be invested in identifying and prioritising stakeholders and assessing their interests and concerns;
- Information Disclosure – information must be communicated to stakeholders early in the decision-making process in ways that are meaningful and accessible, and this communication should be continued throughout the life of the project;
- Stakeholder Consultation – each consultation process should be planned out, consultation should be inclusive, the process should be documented, and follow-up should be communicated;
- Negotiation and Partnerships – add value to mitigation or project benefits by forming strategic partnerships and for controversial and complex issues, enter into good faith negotiations that satisfy the interest of all parties;
- Grievance Management – accessible and responsive means for stakeholders to raise concerns and grievances about the project must be established throughout the life of the project;
- Stakeholder Involvement in Project Monitoring – directly affected stakeholders must be involved in monitoring project impacts, mitigation, and benefits. External monitors must be involved where they can enhance transparency and credibility;
- Reporting to Stakeholders – report back to stakeholders on environmental, social and economic performance, both those consulted and those with more general interests in the project and parent company; and
- Management Functions – sufficient capacity within the company must be built and maintained to manage processes of stakeholder engagement, track commitments and report on progress.

It is of critical importance that stakeholder engagement takes place during the exploration phase to keep communities involved and build relationships.

11.1.5.2 **PROPOSED GRIEVANCE MECHANISM**

In accordance with international good practice the Applicants should establish a specific mechanism for dealing with grievances during the exploration phase. A grievance is a complaint or concern raised by an individual or organisation that judges that they have been adversely affected by the project during any stage of its development. Grievances may take the form of specific complaints for actual damages or injury, general concerns about project activities, incidents and impacts, or perceived impacts. The IFC standards require Grievance Mechanisms to provide a structured way of receiving and resolving grievances. Complaints should be addressed promptly using an understandable and transparent process that is culturally appropriate and readily acceptable to all segments of affected communities and is at no cost and without retribution. The mechanism should be appropriate to the scale of impacts and risks presented by a project and beneficial for both the company and stakeholders. The mechanism must not impede access to other judicial or administrative remedies.

The grievance mechanism should be based on the following principles:

- Transparency and fairness;
- Accessibility and cultural appropriateness;
- Openness and communication regularity;
- Written records;

- Dialogue and site visits; and
- Timely resolution.

Based on the principles described above, the grievance mechanism process involves four stages:

- Receiving and recording the grievance;
- Acknowledgement and registration;
- Site inspection and investigation; and
- Response.

11.1.6 ECONOMIC

National and provincial development planning identify the need to undertake exploration activities to identify and quantify natural gas and associated petroleum resources and exploitation opportunities. The National Marine Spatial Planning Framework acknowledges the need for a regulatory framework within which exploration can occur, especially within offshore locations where a sizeable concentration of South Africa's hydrocarbon deposits are located. Furthermore, the National Development Plan identifies the potential of hydrocarbon reserves along the West Coast of South Africa as a commercial option within the South African economy and its potential as a long-term growth driver. Although the production of petroleum resources in South Africa's offshore economic zones is limited, data suggests that exploration activities have been accelerating over the past 10-years. Data shows that approximately 50% of the South African Maritime Exclusive Economic Zone (EEZ) has been allocated to either an exploration right, production right or has some form of exploration or production right pending. The West Coast of South Africa represents a prominent offshore exploration area within which new production locations are being established and which could, in future, be a key location where offshore production activities are located.

Given that exploration of hydrocarbon resources is identified at various planning levels as a key development opportunity for the national economy and given the accelerating interest in offshore exploration in South Africa, the proposed exploration activity within the Block 3B/4B Exploration Right algins with national and provincial development aspirations and trends.

Besides the exploration activity's alignment with national and provincial planning objectives and aspirations, the exploration activity could impact on the receiving environment/economy within which it is located. Analysis of the proposed exploration activity within the context of the receiving economy shows that exploration activities could directly and indirectly impact on the receiving economy. The direct impact could manifest in the form of the multiplier effect of economic output generated by the industry throughout its value chain and consequently encourage additional output, gross value added, livelihood improvements, and employment. Indirect impacts occur as a result of the exploration activity altering key inputs and dependencies of the receiving economy by disrupting the status quo of industries and in effect creating a multiplier effect throughout an industry's value chain.

Further analyses of the exploration activity within the context of the receiving economy identified various economic impacts associated with the exploration activity. These impacts fall under three core themes: direct economic impact from the exploration activity itself, the exploration activity's impact on the commercial fishing industry, and the exploration activity's impact on the maritime logistics industry. The quantitative impact assessment reveals that during the exploration project's lifespan, the commercial fishing and maritime logistics industries may experience temporary reductions in economic productivity. The reduction of economic productivity is a result of operational disruptions caused by the exploration activity in the form of reduced fishing areas and limited access to traditional shipping routes. The disruptions lead to impacts on the industries' (and their value chains) capacity to produce economic output and as a result sustain employment demand, generate new business opportunities, support household livelihoods and the generation of taxes. However, the positive gains from the exploration activity are expected to outweigh these negative impacts. The economic impact model shows that the economy could experience a net gain during the project's operation, with increased business sales, GDP, and job opportunities created as a result of the sizeable operational expenditure required to undertake the exploration activity.

Additionally, the qualitative impact assessment indicates that the proposed exploration activity could have a positive impact on the receiving economy during its operation. While negative effects on the commercial fishing and maritime logistics industries are anticipated, these impacts can be managed through coordinated mitigation strategies.

During the pre-drilling phase, the survey of drilling locations by a survey vessel may disrupt fishing and logistics operations, but coordinating survey activities with these industries can minimise the impact. The mobilization phase, focused on establishing an onshore logistics base, is expected to generate positive economic benefits such as additional business transactions throughout the exploration industry's value chain, additional employment, and increased taxes. However, it may also impose additional stresses on bulk infrastructure, leading to an increased maintenance burden. The qualitative analysis also identifies that the operational phase is expected to have overall positive impacts on the receiving, provincial, and national economy. It could stimulate demand for goods, services, and employment throughout the value chain, leading to business growth and additional tax revenue. Nevertheless, it may negatively affect the commercial fishing and logistics industries, impacting production, employment, GDP, and business growth. Coordinating exploration activities and fishing/logistics operations coupled with strategies for job retention and skills development can mitigate these negative effects.

Based on the analyses conducted in this report, outcomes suggest that the proposed exploration activity has the potential to create net benefits for the receiving economy during its operational period (Figure 220 and Table 57). The positive impacts identified in the economic impact assessments indicate that the exploration activity could generate additional economic value, stimulate various sectors, and contribute to overall economic growth. It is, however, important to note that the exploration activity offers short-term economic benefits (i.e., operational period of between 20 and 24 months) and therefore would only create additional value for a defined period of time.

Furthermore, exploration activities can also have negative effects on the receiving economy and specific industries within it. These potential negative impacts include disruptions to commercial fishing and maritime logistics operations, which can lead to temporary reductions in economic output, employment, and growth in these industries.

To mitigate these negative effects and maximise the positive outcomes, effective and coordinated planning is crucial. This entails collaborating with all interested and affected parties, including local communities, businesses, and relevant government agencies. By involving stakeholders from the outset, it is possible to assess potential challenges and identify strategies to minimise adverse impacts. Coordinated planning can ensure that exploration activities are carefully scheduled and coordinated with fishing and logistics operations to minimise disruptions. It is also important to acknowledge that because the exploration activity's operational period is defined, the disruptive effects of the exploration activity is temporary and not sustained. Apart from the potential impacts that could arise during the exploration activity, it is necessary to consider any effects that could result from unplanned events. Unplanned events in this instance refers to unlikely events or occurrences that could generate economic and associated impacts on the receiving economy and its value chains as a result of the exploration activity.

For the purposes of this study, the analysis of unplanned events focusses on the economic impacts that may arise from a subsea blow-out of an exploration well being drilled in the AOI of the exploration activity (otherwise referred to as a 'blow-out scenario'). Two oil spill scenarios have been identified from the updated Oil Spill Drift Modelling Report (2024). The first scenario refers to a subsea blow-out of a condensate hydrocarbon whilst the second scenario considers a subsea blow-out of crude oil. Because of the capacity of such scenarios to create far reaching environmental, social and economic impacts, the potential of such scenarios must be considered.

The economic impact of a well blow-out event on the economy can influence the equilibrium of an economy based on changes to economic activity within the sectors or industries affected by an oil spill event. In the context of this report, economic activity in the receiving economy is influenced by expenditure on spill response strategies whilst industries such as commercial fishing, maritime logistics and maritime tourism could experience reduced operational efficiency which could impact on the economic output produced by these industries and their value chains.

The economic impact model demonstrates the ripple effect of oil spill response expenditure (multiplier effect) within the South African economy (Table 58 and Table 59). An estimated South African expenditure of approximately R342.6 million, could generate approximately R1.7 billion in additional business sales and contribute approximately R929.0 million to the gross domestic product over the total response period. Heightened economic activity may create demand for 1 800 temporary jobs, resulting in over R383.2 million in employee compensation and potentially stimulating more than R196.1 million in additional taxes throughout the response period.

However, the potential disruptions caused by oil spill events, particularly for industries like commercial fishing, maritime logistics, and maritime tourism, could hinder operational efficiency and affect economic output. In the case of a condensate hydrocarbon spill, disruptions to affected industries totalling approximately R16.6 million could occur, while in the context of a crude oil hydrocarbon spill scenario, greater disruptions totalling approximately R231.8 million in economic output could occur across the affected industries. Based on the multiplier effect of changes to economic activity and given the context of the condensate and crude oil spill scenarios, between R78.4 million and R1.1 billion in additional business sales and between R39.2 and R559.1 million additional gross domestic product could be disrupted in affected industries (commercial fishing, maritime logistics and maritime tourism) throughout the economy per scenario tested.

The quantitative economic impact modelling of condensate and crude oil hydrocarbon spill scenarios reveals potential reductions in economic output and activity across commercial fishing, maritime logistics, and maritime tourism industries during a well blowout and response phase. Conversely, expenditures on oil spill response strategies can stimulate additional economic activity through the multiplier effect. Yet, disruptions and changes are temporary, tied directly to the response period lasting 1 to 2 months. Residual impacts, notably in the commercial fishing industry, may persist due to crude oil spills' effects on fish recruitment rates, particularly evident in crude oil hydrocarbon spill scenarios.

These shifts in economic productivity and output extend to various levels—receiving, provincial, and national economies—driven by expenditures across industry value chains affected by or benefiting from oil spill responses. This economic activity not only affects employment demand but also entails fiscal implications and encourages additional consumption expenditure. However, the implementation of a robust oil spill response strategy, coupled with effective coordination with relevant industries, holds promise in mitigating disruptive effects on fishing locations, shipping lanes, and cruise tourism activity.

Supplementing the quantitative analysis, the qualitative impact assessment of each oil spill scenario highlights the contrast between the economic effects of expenditure during an oil spill response and the disruptions to economic activity and output caused by industries affected by such an event.

The qualitative analysis reveals that expenditure during an oil spill response could trigger multiplier effects throughout the economy, particularly by increasing demand for goods and services essential for addressing oil spill incidents. This heightened demand is intertwined with impacts on the value chain supporting oil spill responses, potentially leading to temporary increases in employment and subsequent compensation within the economy.

Conversely, a well blowout event could disrupt industries such as commercial fishing, maritime logistics, and maritime tourism (including cruise tourism), resulting in decreased economic output and activity. These disruptions could ripple through the value chains supporting these sectors. In the case of a condensate hydrocarbon spill scenario, the impact is generally confined to a smaller area compared to a crude oil hydrocarbon spill event. However, the severity, duration, and reversibility of impacts are amplified in the context of a crude oil hydrocarbon spill.

Nevertheless, it's crucial to emphasize that implementing a robust oil spill response strategy, coupled with effective coordination with relevant industries, has the potential to mitigate some of the disruptive effects on fishing locations, shipping lanes, and cruise tourism activities. Additionally, mitigation measures identified within environmental, marine ecology, fishing industry, and social specializations could further aid in mitigating potential disruptive effects of oil spills on economic output and activity.

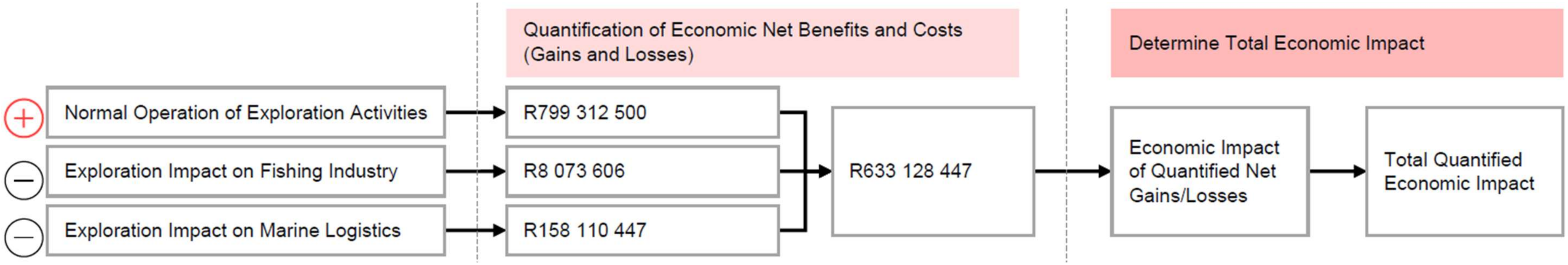


Figure 220: High-Level Overview of the Quantitative Economic Costs and Benefits in the Economic Impact Assessment

Table 57: Quantitative Impact Assessment for Planned Events

	Impact Name	Economic Impacts Created as a Result of the Normal Operation of the Exploration Activity	Normal Operations of the Exploration Activity could Temporarily Disrupt Commercial Fishing Operations that Overlap with the Project's AOI	Normal Operations of the Exploration Activity could Temporarily Disrupt Commercial Maritime Logistics Operations	Total Quantified Economic Impact
Impact Definition	Impact Effect	Positive Temporary	Negative Temporary	Negative Temporary	Negative Temporary
	Economic Value Added/Subtracted from the Economy	R799 312 500	-R8 073 606	-R158 110 447	R633 128 447
Financial Impact (Taxes)	VAT	R65 698 580	-R660 428	-R12 337 211	R52 700 941
	Custom Duties	R3 511 297	-R42 454	-R812 067	R2 656 777
	Excise Levies	R1 972 087	-R18 536	-R359 284	R1 594 266
	Fuel Levies	R16 190 338	-R242 546	-R8 321 742	R7 626 051

	Impact Name	Economic Impacts Created as a Result of the Normal Operation of the Exploration Activity	Normal Operations of the Exploration Activity could Temporarily Disrupt Commercial Fishing Operations that Overlap with the Project's AOI	Normal Operations of the Exploration Activity could Temporarily Disrupt Commercial Maritime Logistics Operations	Total Quantified Economic Impact
	Other Taxes	R14 177 123	-R143 958	-R2 733 849	R11 299 317
	Production Taxes	R61 131 150	-R379 835	-R9 387 408	R51 363 906
	Corporate Taxes	R89 500 220	-R2 160 703	-R16 621 934	R70 717 583
	Personal Taxes	R205 350 387	-R1 949 701	-R34 664 733	R168 735 953
	Total Taxes	R457 531 182	-R5 598 161	-R85 238 226	R366 694 794
Economic Impact	Gross domestic product at market prices	R2 167 557 675	-R20 519 290	-R371 494 208	R1 775 544 176
	Additional Business Sales	R4 061 029 119	-R40 170 864	-R743 737 363	R3 277 120 893
Increased Employment Demand and Specialisation	Formal skilled	1 411	-12	-213	1 186
	Formal semi-skilled	1 743	-23	-306	1 413
	Formal low-skilled	1 042	-15	-173	854
	Total Formal Employment	4 196	-51	-692	3 454
	Informal Jobs	763	-11	-151	601

	Impact Name	Economic Impacts Created as a Result of the Normal Operation of the Exploration Activity	Normal Operations of the Exploration Activity could Temporarily Disrupt Commercial Fishing Operations that Overlap with the Project's AOI	Normal Operations of the Exploration Activity could Temporarily Disrupt Commercial Maritime Logistics Operations	Total Quantified Economic Impact
Compensation of Employees	Formal skilled	R470 846 307	-R3 912 607	-R75 282 343	R391 651 357
	Formal semi-skilled	R309 256 266	-R2 868 086	-R55 842 275	R250 545 904
	Formal low-skilled	R114 117 743	-R1 340 566	-R21 645 133	R91 132 044
	Total Compensation	R894 220 316	-R8 121 259	-R152 769 752	R733 329 305
	Informal Jobs	R114 310 993	-R862 808	-R22 362 011	R91 086 174
Household Livelihoods	Household Income	R2 037 219 144	-R19 511 928	-R342 823 163	R1 674 884 053
Business Development Potential	Enterprise Opportunities	24	0	-5	19
	Small Enterprise Opportunities	18	0	-4	14
	Medium Enterprise Opportunities	8	0	-2	6
	Total SMME Opportunities	50	-1	-10	40

	Impact Name	Economic Impacts Created as a Result of the Normal Operation of the Exploration Activity	Normal Operations of the Exploration Activity could Temporarily Disrupt Commercial Fishing Operations that Overlap with the Project's AOI	Normal Operations of the Exploration Activity could Temporarily Disrupt Commercial Maritime Logistics Operations	Total Quantified Economic Impact
	Total SMME Opportunities (Black Owned)	37	0	-7	29

Table 58: Quantitative Impact Assessment of a Condensate Well Blow-Out Scenario

Economic Impact Name	Economic Impacts Created as a Result of the Capping Only Response to a Well Blow-Out Scenario	Oil Spilled during a Potential Well Blow-Out Event could Temporarily Disrupt Commercial Fishing Operations that Overlap with the Affected Oil Spill Area	Oil Spilled during a Potential Well Blow-Out Event could Temporarily Disrupt Commercial Maritime Logistics Operations	Total Quantified Economic Impact
Economic Value Added/Subtracted by Each Industry	R342 562 500	-R807 361	-R15 811 045	R325 944 095
Additional Business Sales	R1 740 441 051	-R4 017 086	-R74 373 736	R1 662 050 228
Additional Gross Domestic Product	R928 953 289	-R2 051 929	-R37 149 421	R889 751 939
Additional Taxes	R196 084 792	-R559 816	-R8 523 823	R187 001 153
Additional Formal Employment Compensation	R383 237 278	-R812 126	-R15 276 975	R367 148 177
Additional Household Income	R2 037 219 144	-R19 511 928	-R342 823 163	R1 674 884 053
Additional Formal Employment	1 798	-5	-69	1 724
Additional SMME Opportunities	22	0	-1	20
Additional SMME Opportunities (Black Owned)	16	0	-1	15

Table 59: Quantitative Impact Assessment of the Well Blow-Out Scenario

Economic Impact Name	Economic Impacts Created as a Result of a Full Response to a Well Blow-Out Scenario	Oil Spilled during a Potential Well Blow-Out Event could Temporarily Disrupt Commercial Fishing Operations that Overlap with the Affected Oil Spill Area	Oil Spilled during a Potential Well Blow-Out Event could Temporarily Disrupt Commercial Maritime Logistics Operations	Oil Spilled during a Potential Well Blow-Out Event could Temporarily Disrupt Maritime Tourism Operations	Total Quantified Economic Impact
Economic Value Added/Subtracted by Each Industry	R342 562 500	-R75 567 254	-R36 487 026	-R119 742 857	R110 765 363
Additional Business Sales	R1 740 441 051	-R375 990 840	-R171 631 699	-R563 259 661	R629 558 851
Additional Gross Domestic Product	R928 953 289	-R192 056 244	-R85 729 433	-R281 346 228	R369 821 384
Additional Taxes	R196 084 792	-R52 397 609	-R19 670 360	-R64 554 044	R59 462 779
Additional Formal Employment Compensation	R383 237 278	-R76 013 277	-R35 254 558	-R115 698 152	R156 271 291
Additional Household Income	R873 093 919	-R182 627 539	-R79 113 038	-R259 632 591	R351 720 751
Additional Formal Employment	1 798	-475	-160	-524	640
Additional SMME Opportunities	22	-5	-2	-8	7
Additional SMME Opportunities (Black Owned)	16	-3	-2	-5	5

11.1.7 AIR QUALITY AND CLIMATE CHANGE

The assessment was based on Scope 1 GHG emissions for the proposed exploration survey in a portion of Block 3B/4B. The calculated CO2-e routine emissions are estimated at a total of 31.813 kt. The calculated CO_2-e potential upset emissions are estimated at a total of 450 kt. The GHG emissions were estimated using SA specific caloric values and densities for fuels (where available) and IPCC emission factors.

Based on the published 2020 National GHG annual Inventory for South Africa, the maximum total CO2-e routine emissions from the Project, assuming a maximum survey duration of 84 days, would contribute approximately 0.008% to the 2020 South African “energy” sector total of 379 505.2 kt CO2-e and represent a contribution of 0.007% to the 2020 National GHG inventory total of 468 811.7 kt CO2-e (excluding FOLU).

The EBRD classifies projects contributing more than 25 kt CO2-e per year to have significant GHG emissions (EBRD 2019). Although the GHG emissions are expected to be above this threshold, it is less than the DFFE PPP requirement threshold of 100 kt CO2-e. Given that the negative impact is of low intensity, national extent, irreversible (due to its limited period of emission and future uptake by vegetation), but of short duration, the environmental risk for the routine operations is low. Although the intensity is medium for the upset operations, they are for a shorter duration and are less probable, so the environmental risk for the upset operations is also **low**.

Since the Project is of a temporary nature and expected to be completed in the near future, changes in meteorological parameters are not expected to have a significant impact on the Project.

11.1.8 ACOUSTICS

Dual metric criteria (i.e., per-pulse impact criteria Pk SPL and cumulative exposure impact criteria SEL_{24hr}) are applied to assess PTS and TTS impact for marine mammals and mortality and recovery injury for fish and turtles. The combined threshold distance for each impact effect is considered as the maximum threshold distance (i.e., the worst-case scenario) estimated from either metric criteria being applied.

Overall, modelling results show little variation for the different source locations less than 2 000 m in depth. The greatest variation, due to the spherical sound propagation, was noted at the deepest source location and in some scenarios of the behavioural response at multiple source locations.

For exposure to multiple VSP pulses, the cumulative level at the proposed locations is modelled based on the assumption that the animals are constantly exposed to the VSP airgun noise at a fixed location over the entire hour period. However, marine fauna species, such as marine mammals, fish species and sea turtles, would not stay in the same location for the entire period unless individuals are attached to a specific feeding or breeding area or those species that cannot move away (e.g., plankton and fish eggs/larvae).

Likewise, the continuous exposure for 24 hours to well drilling operations assumes that a receptor, i.e., marine animal, remains in proximity to (continuously moves with) the moving support vessel for a period of 24 hours and thus remains within the impact zone, which is unlikely but presents a very conservative worst-case scenario. Therefore, the zones of impact assessed for marine mammals, fish species, and sea turtles represent the worst-case consideration.

11.1.9 OIL SPILL MODELLING

Main conclusions of this study are as follows:

- DRIFT DIRECTION: The general direction of the surface oil drift is NW for the all the Quarters in this marine area, for the Condensate as for the Crude Oil, and for the 2 releases points A and D studied.
- DRIFT DISTANCE:
    - For Condensate release, the maximum distance of the 80 to 100% oil surface probability contour is 42 km NNW from Release Point during the Quarter 1 (January to March).

- For Crude Oil release, the maximum distance of the 80 to 100% oil surface probability contour for the release Point D is 687 km NW from future well during the Quarter 1 (January to March), and for the Point A is 580 km NW from future well during the Quarter 1 too.
- For the stochastic cases run where a spill is capped within 20 days, there is no oil reaching the shore for Release points A or D, for any of the 4 seasons.

- SURFACE PRESENCE PROBABILITIES:
  - For Condensate release: there is almost no oil or condensate on surface due to large evaporation and dispersion processes on this condensate, but the Namibian and International Waters could be impacted by surface oil with very low probabilities (3.3%). This means that probabilistically, out of 100 spills that could occur during each quarter period, only 3 cases would have oil on the surface which would cross the Namibian border and international waters. **There is no oil or condensate onshore at the end of the simulations for release points A or D, for any seasons**.
  - For Crude Oil Release: For Crude Oil Release: After 60 days the main part of oil is evaporated, biodegraded and dispersed. **There is no oil onshore at the end of the simulations for release points A or D, for any seasons.** However, for any remaining oil at surface not recovered within 60 days after the start of the spill, some remaining oil could reach the South African coastline. The highest concentrations of oil remaining at surface after 60 days for simulated releases occurs in Quarters 2 and 3 at release point D and in Quarter 2 for release point A. Given the northwestern direction of prevailing currents, simulations indicate a high probability (>80%) of surface oil from a potential release affecting Namibian and International waters.

- WATER COLUMN CONTAMINATION:
  - For the Condensate release: the most contaminated layer is between 725 to 900 m depth for capping only and 775 to 875 m for full response deployed. This is probably due to the large amount of gas contained in the release, making the condensate rise quickly in the water column, and then accumulates in the mid water column before continuing to rise more slowly to the surface.
  - For the Crude oil release: as the dispersion and dissolution during the rise of the oil is very low compared to Condensate, the impact of the crude oil release is not significant for the water column, and has to be focused on the surface, and all the processes involved after (natural dispersion, biodegradation, evaporation).

- COASTAL IMPACT: **there is no coastal impact for the two types of release modelled for any Quarter of the year**, due to the currents in the area driving the release drift towards NW, opposite to the coastal area. However attention should be paid to Quarters 2 and 3 for release Point D and for Quarter 2 for release Point A in that if the oil on surface is not recovered 60 days after the start of the spill, some remaining oil on surface could reach the South African coastline.

- SURFACE RESPONSE: The surface response was studied for the Quarter 3 for the Condensate release case, (initial planned Drilling period). There is a very light effect of the response deployed: the dispersed part varies very slightly, the atmospheric part is a little reduced, thanks to the very light increase in dispersion. The biodegradation is higher with the response, mainly due to the slight increased dispersion in the water column with the SSDI (these two parameters are always positively correlated).

  Because of the properties of the condensate, the SSDI deployment has a very slight effect on the dispersion. The surface response which consists of dispersing and recovering oil slicks is of no use because all the condensate disperses in the water column or evaporates upon arrival at the surface. In this kind of release, the better choice would be to deploy the capping stack as soon as possible instead of trying to increase the dispersion that is already high for this type of product.

  Concerning the Crude Oil release, only the Quarter 3 for Point D was studied (considered as the worst case), and there is significant positive effect of the response deployed for the environment: There is an increase of the dispersed part because of the SSDI deployment, allowing to disperse the oil directly from the release point in the water column, and with the surface dispersion deployed once the oil reached the surface. The biodegraded part increased too with the response deployed. With the response deployment, there is a significant decrease of the surface part (because more oil is dispersed, so less oil rises to the surface), and the evaporation part. Some oil is recovered by the surface response skimmers and boats deployed with the full response scenarios. There is no oil onshore, and the oil amount in sediment is negligible. The same interpretation can be applied to the seasons 1, 2 and 4 for this area. One of the most important conclusions of this response deployment testing is that reducing the quantity of oil on the surface by dispersion allows to minimize the risk of an oil slick reaching the coasts.

11.1.10 DRILL CUTTING MODELLING

The following conclusions were made:

Reminder: Risk>5% = significant risk = potential impact of the compartment (water column or sediment).

Remark: The calculated risk has also to be balanced because of the very conservative approach used in the model. Thus, high conservative safety factors were used (i.e. 1000) for chemicals, following the approach recommended by OSPAR/EU regulation. Recovery calculation is also quite conservative, not considering all the processes in place.

- Water Based Mud Scenarios – Point D:
    - Water Column: The environmental risk in the water column is medium, with a value of 52% to 55% and is due to the Riserless sections and the displacement discharges, given that the risk is mainly due to the release of Bentonite, and Barite to a lesser extent. The maximum risk distance reached is 260 m all around the discharge point but is quickly dispersed and diluted by the local currents, because there is no more risk after 5 days (i.e. after the 26" section displacement discharge). There is no more risk in the water column after the end of the riserless sections discharge for all the Quarters thanks to dispersion and dilution processes.
    - Sediment: Contrary to the water column, the environmental risk for the sediment is mainly due to the physical contamination by the riserless and risered sections discharge (and not the chemical contamination). The risk is significant in the sediment from day 1 to 1030 days after (less than 3 years), mainly due to the end of the riserless sections discharged. The highest risk is reached just after the end of riserless discharge, and decreases quickly 2 years and 9 months after operations, with no more risk in the sediment after 3 years.

      The main contributors to the environmental risk for the sediment are physical, i.e. the thickness deposit of the discharge and the grain size change of the natural sediment (due to higher grain size particles released during the discharge). The sediment deposit area is not centralized around the discharge point and is orientated towards an axis from NW to SE but with significant values close to the discharge point (175 m maximum). The maximum thickness deposit located on the discharge point, shows a slight decrease one year after the operations, becoming insignificant (< 6.5mm) 5 years after the operations for all the Quarters.

      The maximum percentage of grain size change is 1700 % to 1900% (depending on the Quarter) after the operations, decreasing until 1000 % to 1200 % 10 years after, located precisely on the discharge point. The grain size change is due to the discharge of the riserless and risered sections. The Grain Size change is unsignificant after 150 m around the discharge point 10 years after the operations.

      Remark: The calculated risk has also to be balanced because of the very conservative approach used in the model.

- Thus, high conservative safety factors were used (i.e. 1000) for chemicals, following the approach recommended by OSPAR/EU regulation. Recovery calculation is also quite conservative, not considering all the process in place.
- The risk of these discharge operations seems limited close to the release point, less than 300m around the release point, for both water column and sediment. The risk in the water column is quickly dispersed by the currents and is not present anymore after the operations only due to riserless discharge.
- The risk in the sediment is more physical than chemical, and is therefore more persistent especially close to the discharge point, because the high grain size particles are difficult to disperse by bottom currents, weaker than surface currents.

- Non-Aqueous Based Mud Scenarios – Point D & Point A:
    - Water Column: The environmental risk in the water column is present from the surface to the seabed for both Points D and A, meaning that both types of discharges (risered and riserless) will have an impact. The environmental risk is mainly due to the NADF released during risered sections discharges for all the seasons.

      The physical risk is due to the release of Bentonite from the riserless sections mainly, using the WBM, and the chemical risk is due to the release of EDC-99DW present in the NADF used during the risered sections drilling. The main contributor to the risk in the water column is chemical, and due to the EDC-99DW released during the risered sections drilling. The maximum EDC-99DW-A concentration (hydrotreated light petroleum distillate) in the water column is reached during the release of section 17 ½". The Bentonite discharged during the riserless sections drilling is the second most impacting component for the Water Column.

      Due to the strong currents in the area, the environmental risk in the water column is present until several kilometres. However, the strong currents present in the area allow a quick dispersion and dilution of the chemicals: the risk reached is very high close to the discharge point, but this is of short duration.

      There is no more risk in the water column after the end of the operations for all the Quarters as result of dispersion and dilution processes due to the strong currents in this area.
    - Sediment: As for the water column, the environmental risk for the sediment is mainly chemical than physical, mainly due to components of the NADF released during the drilling of the risered sections: the fatty acid present in the EZMUL NT-A, Invermul NT-B and EDC-99DW-C, responsible for 74% to 80% to the total risk.

      The physical risk, *i.e.* the grain size change of the natural sediment and the thickness deposit of the discharge, contributing together to less than 10 % of the total risk. The oxygen depletion in the sediment is responsible for values around 15% to the total risk, and is a mix of physical and chemical impact.

      The particles deposit area is not centralized around the discharge point and is orientated towards NW to SE up to 260 m of distance for the highest value, with a maximum cumulative thickness values around 60 mm located on the discharge point. The highest cuttings deposit is mainly due to the discharge of the riserless sections discharged directly on the seabed, remaining close to the discharge area, due to low-speed bottom currents. The thickness deposit 10 years after the operations is still around 30 mm, which is higher than the 6.5 mm (threshold value of thickness variation accepted by benthos, see 2.3.4 Risk assessment modelling) so the impact will be present close to the discharge point for a long period.

      The maximum percentage of grain size change is between 4300% to 6000% located precisely on the release point. The grain size change maximum values are mostly due to the discharge of the riserless sections. The Grain Size change is insignificant after a maximum distance of 160 m around the discharge point maximum, but still present 10 years after the operations.

With the use of Non Aqueous Based Mud, the risk of these discharge operations is potentially high, but limited in time for the water column, and close to the release point. The risk in the water column and in the sediment is more chemical than physical since Non-Aqueous Based Mud contains components with very low PNEC (Predicted No-Effect Concentration), which can have a higher environmental risk, even released in small quantities. Based on the simulation work, the presence of introduced chemicals is most significant in the sediment, mainly due to the chemicals present in the risered sections being discharged. The highest risk is reached just after the end of the drilling operations, peaking around day 25, and decreases quickly 66 days after operations, however low levels of residual compounds may still be present for up to 10 years near the wellbore location, where dispersion and dilution processes are not as efficient compared to within the water column (lower currents on the seabed).

- Table 60 below summarizes the maximum environmental risk distance from the future well for all the seasons:

Table 60: Maximum Environmental Risk distance form the future well for all the seasons.

Scenario	Significant Risk Distance (i.e. > 5% = potential risk for 5% of the species in the ecosystem)	
	ER in the Water Column	ER in the Sediment (including Thickness and Grain Size Change)
WBM (Point D)	260m	115m
NADF (Point D)	12 400 m	3600 m
NADF (Point A)	13 200 m	4573 m

11.2 PREFERRED ALTERNATIVES

The preferred alternatives are discussed below based on the identification of alternatives in in Section 6 above, as well as the findings of the EIA Phase.

11.2.1 LAYOUT ALTERNATIVES

As mentioned in Section 6 above, although Block 3B/4B is in close proximity to the Child's Bank and Benguela Muds MPAs, the proposed exploration drilling areas which should they be authorised can only occur within Block 3B/4B do not overlap with any proclaimed MPAs as the AOI already avoids these areas. Block 3B/4B overlaps to some extent with the Child's Bank Ecologically and Biologically Significant Area (EBSA). However, the AOI for exploration drilling avoids all EBSAs. For oil and gas exploration activities, although vessels are permitted to sail through these areas, no invasive exploration activities are permitted in any proclaimed MPA. Under the currently issued exploration permit, no invasive exploration activities such as the proposed exploration drilling will take place in any proclaimed MPAs.

The AOIs do, however, overlap with some Critical Biodiversity Areas (CBA). No other environmental sensitivities which require further avoidance have been identified in the proposed AOI. Although at this stage the Marine Spatial Planning process implemented in South Africa lacks legislation and has only weak links to broader ocean governance, the AOI borders on ESAs to the north and CBA1: Natural and CBA2: Natural areas to the west, south and east. Activities within these management zones are classified into those that are "compatible", those that are "not compatible", and those that have "restricted compatibility". Non-invasive (e.g. seismic surveys) and invasive (e.g. exploration wells) exploration activities are classified as having "restricted compatibility".

It is recommended the final placement of the wells within the AOIs be done to avoid any CBAs, as this would allow for avoidance of the overwhelming majority of the potential impacts associated with these areas. No additional layout alternatives are considered feasible. The final Sensitivity Map is provided in Figure 221 below which shows all identified sensitive areas including the CBAs.

11.2.2 TECHNOLOGY ALTERNATIVES

Various types of drilling technology can be used to drill an exploration well (e.g. barges, jack-up rigs, semi-submersible drilling units (rigs) and drill-ships) depending on, inter alia, the water depth and marine operating conditions experienced at the well site. Based on the anticipated sea conditions, the Applicants are proposing to utilise a semi-submersible drilling unit or a drillship, both with dynamic positioning system suitable for the deep-water harsh marine environment. The final rig selection will be made depending upon availability and final design specifications.

- A semi-submersible drilling unit is essentially a drilling rig located on a floating structure of pontoons. When at the well location, the pontoons are partially flooded (or ballasted), with seawater, to submerge the pontoons to a pre-determined depth below the sea level where wave motion is minimised. This gives stability to the drilling vessel thereby facilitating drilling operations.
- A drillship is a fit for purpose-built drilling vessel designed to operate in deep water conditions. The drilling "derrick" is normally located towards the centre of the ship with support operations from both sides of the ship using fixed cranes. The advantages of a drillship over the majority of semi-submersible units are that a drillship has much greater storage capacity and is independently mobile, not requiring any towing and reduced requirement of support vessels.

The activities proposed in this application require specialised technology and skills. The final technology selection will be decided upon depending on availability and final design selection. Based on the various impacts assessed as part of this application, it is not anticipated that there will be any significant differences to utilising any of the above options in terms of drilling.

Furthermore, the alternative of wellhead abandonment vs wellhead removal was considered. Due to the low sensitivity of benthic communities of unconsolidated sediments and the low (well abandonment) to very low (wellhead removal) magnitude of the impact, the presence of sub-sea structures on seabed biodiversity is deemed to be NEGLIGIBLE (wellhead removal) or of VERY LOW (well abandonment) significance. Since wellhead abandonment would result in a more permanent (although very low) impact, it is recommended that wellhead removal be implemented, unless the wells have been identified as potential future production wells.

With the exception of the over trawlable protective equipment over abandoned wellheads and drilling discharges deposited on the seabed, no further physical remnants of the drilling operation will be left on the seafloor. A final clearance survey check will be undertaken using an ROV. The drilling unit and support vessels will demobilise from area of interest.

11.2.3 SCHEDULING ALTERNATIVES

Based on the findings of the Acoustics, Marine Ecology and Fisheries recommendations, scheduling alternatives were considered in order to avoid/ minimise the impacts associated with exploration activities.

- Where possible, consider avoiding planning sonar surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (beginning of June to end of November). As no seasonal patterns of abundance are known for odontocetes occupying the area, a precautionary approach to avoiding impacts throughout the year is recommended.

11.2.4 NO-GO ALTERNATIVE

The no go alternative would imply that no survey or exploration activities are undertaken and, as such, the negative impacts as stated above, would not materialise. However, conversely, this will negate the potential positive impacts associated with the proposed exploration activities, including:

- The opportunity to identify potential oil and gas resources within the Application Area including potential future contribution to the economy of South Africa;
- The opportunity to conduct independent research on the deep water environments of the West Coast; and
- Economic benefits to the local, regional and national economy.

Since there are no mitigation measures, the impact significance will be low pre- and post-mitigation and final significance will be the same.

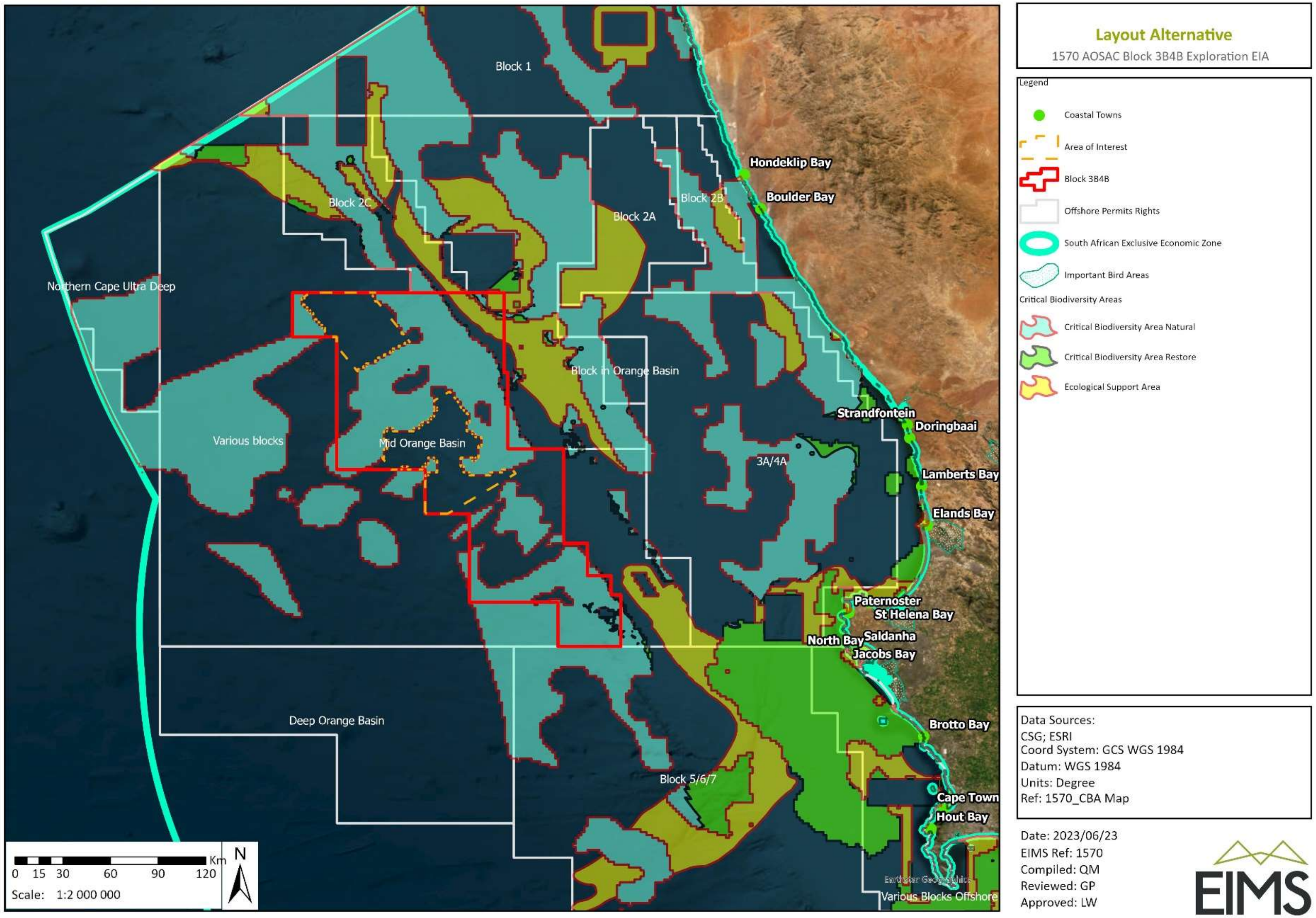


Figure 221: Final Composite Sensitivity Map

11.3 ENVIRONMENTAL IMPACT STATEMENT

The findings of the specialist studies conclude that there are no environmental fatal flaws that should prevent the proposed project from proceeding, provided that the recommended mitigation and management measures are implemented. Based on the nature and extent of the proposed project, the local level of disturbance predicted as a result of the activities, the findings of the specialist studies, and the understanding of the significance level of potential environmental impacts, it is the opinion of the EIA project team and the EAP that the significance levels of the majority of identified negative impacts can generally be reduced to an acceptable level by implementing the recommended mitigation measures and the project should be authorized. A sensitivity map is provided in Figure 221 above and a summary showing the number of impacts and the post-mitigation significance of these identified impacts is provided in Figure 222.

Figure 222: Impact Summary showing number and significance of impacts post mitigation

11.4 RECOMMENDATIONS FOR INCLUSION IN ENVIRONMENTAL AUTHORIZATION

This section contains recommendations from the various specialist studies for inclusion in the EA. It is recommended that this project and other drilling applications should be planned in such a way that the cumulative impacts would be minimised, and that the competent authority should carefully evaluate the cumulative impacts of this project combined with other proposed projects in the same general area.

11.4.1 MARINE ECOLOGY

The mitigation measures are based largely on the guidelines currently accepted for exploratory well drilling in South Africa, but have been revised to include salient points from international guidelines and industry best practices discussed above. The mitigation measures proposed are the outcome after having defined the performance objectives, indicators and targets in the various assessments. Performance objectives are influenced by international standards, legal requirements and scientific knowledge.

In their review to guide management strategies for the environmental impacts of deep-water oil and gas operations, Cordes *et al*. (2016) present various recommendations of which the following are applicable to, and in some cases have been implemented in, this project:

- Surface infrastructure and any discharge sites should be at least 2 km away from MPAs and declared EBSAs.
- Any high-density, high-biomass, high-relief, or specialized deep-sea habitat should be identified and mapped and avoidance rules or formal MPA designations implemented to minimize adverse impacts. The definition of these significant communities will vary from region to region and will depend on national regulations within the region of interest.
- Adopt an integrated approach to conservation, which should include spatial management in conjunction with activity management in the form of restrictions on discharge and the use of water-based drilling fluids, and temporal management in areas where the drilling activity is near breeding aggregations or seasonally spawning sessile organisms.
- Incorporate buffer zones into spatial management plans to protect vulnerable deep-sea habitats and communities.

Although at this stage the Marine Spatial Planning process implemented in South Africa lacks legislation and has only weak links to broader ocean governance, the AOI borders on ESAs to the north and CBA1: Natural and CBA2: Natural areas to the west, south and east, and should drilling targets be identified immediately adjacent to these areas, provision would need to be made to undertake the required site specific assessments and collect quantitative baseline data. This may take the form of surveys including high-resolution mapping, visual seafloor imagery and benthic samples to characterize the faunal community and ensure proper species identifications (Cordes *et al*. 2016).

11.4.2 FISHERIES

Based on the findings of the study, the following recommendations are made:

- At least three weeks prior to the commencement of the drilling operations, distribute a Notice to Mariners to key stakeholders prior to the well-drilling operations. The Notice to Mariners should give notice of (1) the co-ordinates of the drilling area, (2) an indication of the proposed operational timeframes, (3) the dimensions of the safety zone around the drilling unit (500 m – 2 km), and (4) details on the movements of support vessels servicing the project. This Notice to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible.
- Stakeholders include the relevant fishing industry associations: FishSA, SA Tuna Association; SA Tuna Longline Association, Fresh Tuna Exporters Association, South African Deepsea Trawling Industry Association (SADSTIA) and South African Hake Longline Association (SAHLLA).
- Other key stakeholders: SANHO, South African Maritime Safety Association (SAMSA), and DFFE Vessel Monitoring, Control and Surveillance (VMS) Unit in Cape Town.
- These stakeholders should again be notified at the completion of drilling when the drilling unit and support vessels are off location.

- Request, in writing, the SANHO to broadcast a navigational warning via Navigational Telex (Navtext) and Cape Town radio for the duration of the well drilling operation.
- Abandoned wellhead and buoy anchor locations must be surveyed and accurately charted with the South African Navy Hydrographer (SANHO).
- Undertake pre-drilling site surveys to ensure there is sufficient information on seabed habitats, including the mapping potentially vulnerable habitats within 1 000 m of a proposed well site.
- Ensure that, based on the pre-drilling site survey and expert review, drilling locations are not located within a 1 000 m radius of any sensitive or potentially vulnerable habitats (e.g. hard grounds), species (e.g. cold corals, sponges) or sensitive structural features (e.g. rocky outcrops).
- As far as possible, avoid scheduling drilling operations during the periods when weather and metocean conditions make safe drilling operations less than optimal.
- Develop a response strategy and plan (OSCP), aligned with the National OSCP that identifies the resources and response required to minimise the risk and impact of oiling (shoreline and offshore). This response strategy and associated plans must take cognisance to the local oceanographic and meteorological seasonal conditions, local environmental receptors and local spill response resources. The development of the site-specific response strategy and plans must include the following:
- Well-specific oil spill modelling for planning purposes taking into consideration site- and temporal-specific information, the planned response strategy, and associated resources.
- Schedule joint oil spill exercises including AOSAC and local departments / organisations to test the Tier 1, 2 & 3 responses.
- Use low toxicity dispersants that rapidly dilute to concentrations below most acute toxicity thresholds. Dispersants should be used cautiously and only with the permission of DFFE.
- As far as possible, and whenever the sea state permits, attempt to control and contain the spill at sea with suitable recovery techniques to reduce the spatial and temporal impact of the spill
- Ensuring that loads are lifted using the correct lifting procedure and within the maximum lifting capacity of the crane system.
- Undertake frequent checks to ensure items and equipment are stored and secured safely on board each vessel.
- Notify SANHO of any hazards left on the seabed or floating in the water column, and request that they send out a Notice to Mariners with this information.

11.4.3 CULTURAL HERITAGE

Based on the findings of the study, the following recommendations are made:

- It is also recommended that specific request be made to the cross-sectoral and traditional leadership group for rituals/event/s that might be used in mitigation of the potential negative cultural impacts of the proposed operations on cultural heritage.
- That dedicated resources be set aside for consultations and the proposed ritual/event/s, as these may not be once-off ritual processes even if AOSAC’s operations are of short-term nature.
- That such activities be implemented to publicly showcase respect for local cultural worldviews and effort to realize local rights to human dignity as emphasised both the South African Constitution, NHRA and the Indigenous Knowledge Act.

- That strict safeguards be introduced, and safety protocols be adhered to, as per provisions in MARPOL 73/78 Annexes I, V and VI, to ensure significant minimisation of pollution.
- That transiting vessels avoid, wherever possible, passing through, near or above sites of archaeological, underwater cultural heritage significance.

11.4.4 SOCIAL

Based on the findings of the study, the following recommendations are made:

- Should the project be approved, the Applicants must do a stakeholder analysis and develop a Stakeholder Engagement Plan for the exploration phase before any activities take place. The stakeholder analysis conducted in this report can be used as a starting point. There are a number of misconceptions, uncertainties and confusion that should be cleared out before the exploration commence. The plan must ensure that the different voices of stakeholders are considered and documented.
- Transparency and honesty are important considerations, and the Applicants should communicate in a clear and consistent manner;
- The Applicants must develop a Grievance Mechanism;
- The Applicants must ensure that all their insurance policies are in place in case of an unexpected event or oil spill; and
- The Applicants must develop an Oil Spill Contingency Plan that is in line with the requirements captured in the EMPr and meet international best practice principals.

11.4.5 ECONOMIC

Based on the findings of the Air Quality Assessment, the following recommendations are made:

- To ensure the safety and efficiency of the survey and minimize any potential disruptions to pelagic long-line vessels, it is important to notify the operators of such vessels about the survey timing, area, and safety clearance requirements in advance. The notification can be sent through the South Africa Tuna Longline Association.
- Daily Coastal Navigational Warnings issued via the South African Navy Hydrographic Office.
- Maintain continuous communications between the survey vessel and any commercial fishing operators.
- Ensure that an efficient and effective operational plan is developed for pre-drilling surveys to ensure that the disruption to ocean-based industries is limited.
- Labour to be employed at the onshore logistics facility should so far as possible be sourced from local markets. The sourcing of employment from the local market is dependent on the availability of skills. Should the necessary skills not be available, skilled labour should be sourced from beyond the receiving economy. The sourcing of labour should also consider the role of woman and other previously disadvantaged communities**.**
- The mobilisation phase should, as far as possible, focus on sourcing inputs from the receiving economy, i.e., businesses located in the immediate economy. Localised sourcing enables local businesses to benefit from economic opportunities in the receiving economy**.**
- The operator of the exploration activity should confirm with provider of space for the logistics base whether sufficient bulk supply to the logistics operation is available. A clear understanding of additional supply requirements should be identified so that effective and efficient planning to support operations can be undertaken.
- The exploration operator based on commercial exploration success, should liaise with local educational institutions to assess if there are any long-term skills transfer or training opportunities to support potential future development in the block.

- Coordination should be done between the exploration activity operator and relevant large pelagic longline industry associations (such as the South Africa Tuna Longline Association) to coordinate exploration activities and fishing schedules to minimise and reduce the impact that the proposed exploration activity could have on the industry's fishing grounds and their catch potential.
- Coordination should be done between the exploration activity operator and relevant shipping industry associations (such as the South African Association of Ship Operators and Agents and the South African Association of Ship Operators and Agents) to coordinate exploration activities and maritime logistics operations to minimise and reduce the impact that the proposed exploration activity could have on the industry's operational efficiency and value generation.

11.4.6 AIR QUALITY AND CLIMATE CHANGE

Based on the findings of the Air Quality Assessment, the following recommendations are made:

- Implement a maintenance plan to ensure all ship engines and boilers receive adequate maintenance to minimise soot and unburnt fuel released to the atmosphere and maximize energy efficiency;
- Ensure no incineration (subject to obtaining an atmospheric emissions license) of waste occurs within the port limits; and
- If incineration of waste material is to be undertaken, and the vessel is considered an 'installation' (as per the NEMAQA MES) and more than 10 kg waste is incinerated per day, this will require an AEL. The relevant listed activity would be Category 8.1 - Thermal Treatment of Hazardous and General Waste.

Based on the findings of the Climate Change Assessment, the following recommendations are made:

- The means to minimise air emissions from the Project would be achieved by implementing a maintenance plan to ensure all ship engines and boilers receive adequate maintenance to minimise unburnt fuel released to the atmosphere and maximize energy efficiency.
- NEMAQA also provides for the monitoring and reporting of GHG emissions. As per the National Greenhouse Gas Emission Reporting Regulations and the Methodological Guidelines for Quantifying of GHG Emissions (2022), the IPCC default emission factors are to be used together with country-specific density and calorific values for the fuel used. The Regulations require that CO_2 and CH_4 levels (calculated based on Tier 2 or 3 methodologies) be reported on annually via the SAGERS.
- Carbon tax (Carbon Tax Act (Act 15 of 2019)) needs to be estimated based on the requirements and tax allowances.
- The Declaration of Greenhouse Gases as Priority Pollutants require certain processes to submit a Pollution Prevention Plan to the Minister for approval. The production process does not involve the emissions of GHG in excess of 100 kt. Thus, although reporting is required via SAGERS, it may be concluded that the current project does not require a Pollution Prevention Plan.

12 ASSUMPTIONS AND LIMITATIONS

Certain assumptions, limitations, and uncertainties are associated with the EIA Report. This report is based on information that is currently available and, as a result, the following limitations and assumptions are applicable:

- The project scope and descriptions are based on project information provided by the Applicant;
- In determining the significance of impacts, with mitigation, it is assumed that mitigation measures proposed in the report are correctly and effectively implemented and managed throughout the life of the project;
- The information presented in this report is based on the information available at the time of compilation of the report;
- It is assumed that all data and information supplied by the Specialist, Applicant or any of their staff or consultants is complete, valid, and true; and
- The description of the baseline environment has been obtained from baseline analysis done by specialists.
- The value of the ecosystem services has not been quantified as a currency value. However, the impact associated with the loss of these ecosystem services in an unlikely unplanned event (e.g. well blowout) have been assessed in detail as part of the various specialist reports.

12.1 MARINE ECOLOGY

This study has adopted a 'desktop' approach. Consequently, the description of the natural baseline environment in the study area is based on a review and collation of existing information and data from the scientific literature, internal reports and the Marine Mammal Observer (MMO) Reports (Benthic Solutions Ltd 2019b, 2019c) and the Environmental Baseline and Habitat Assessment Report compiled for the Venus 1X project (Benthic Solutions Ltd 2019a). Information had been updated where appropriate.

The information for the identification of potential impacts of the proposed exploration activities on the benthic marine environment was drawn from various scientific publications, the Generic EMPr (CCA and CMS 2001) and Benguela Current Large Marine Ecosystem (BCLME) Thematic Report (CSIR 1999), previous specialist reports (Atkinson 2010; Atkinson & Shipton 2010) and information sourced from the Internet. The sources consulted are listed in the Reference chapter.

Information gaps include:

- abundance, distribution and diversity of the benthic macrofaunal communities and potentially vulnerable species beyond the shelf break and in continental slope and abyssal habitats;
- abundance, distribution, diversity and seasonality of demersal fish communities beyond the shelf break and in continental slope and abyssal habitats;
- information specific to the marine communities of seamounts (Child's Bank, Tripp Seamount) and submarine canyons; and
- current information on the distribution, population sizes and seasonal trends of pelagic seabird, turtle and cetacean species occurring in southern African waters and the project area in particular.

Keeping these information gaps in mind, the assessment of impacts has adopted a strongly precautionary approach and information gaps are thus not considered to have any negative implications in terms of the credibility of the results of the assessment.

12.2 FISHERIES

The study is based on a number of assumptions and is subject to certain limitations, which should be noted when considering information presented in with regards to the Fisheries Assessment Report. The validity of the findings of the study is not expected to be affected by these assumptions and limitations:

- The government record of fisheries data was used to display fishing catch and effort relative to the proposed project area. These data are derived from logbooks that are completed by skippers, and it is assumed that there will be a proportion of erroneous data due to mistakes in the capturing of these data into electronic format. The proportion of erroneous data is estimated to be up to 10% of the total dataset and would be primarily related to the accurate recording or transcription of the fishing position (latitude and longitude).

- The effects of underwater sound (specifically vertical seismic profiling) on the CPUE of fish and invertebrates have been drawn from the findings of international studies. To date there have been no studies focused directly on the species found locally of the South-West Coast. Although the results from international studies are likely also to be representative for local species, current gaps in knowledge on the topic lead to uncertainty when attempting to accurately quantify the potential loss of catch for each type of fishery. For fish species, based on the noise exposure criteria provided by Popper et al. (2014), relatively high to moderate behavioural risks are expected at near to intermediate distances (tens to hundreds of meters) from the source location. Relatively low behavioural risks are expected for fish species at far field distances (thousands of meters) from the source location. For the current report, a conservative distance of 5 km has been used to calculate the catch and effort within the zone of noise disturbance.

12.3 MARITIME HERITAGE

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

- South Africa's record of maritime and underwater cultural heritage resources is based on a mix of information derived in the main from historical documents and other secondary sources. Information from primary sources such as geophysical data and other field-based observations and site recordings is very limited and comprises only a small fraction of the available data.

- While every effort has been made to ensure the accuracy of the information presented in this report, the reliance on secondary data sources means that there are gaps and inaccuracies in this record and the locations of most of the wrecks referred to in the following sections are approximate. The potential also exists for currently unknown and/or unrecorded maritime heritage sites to be encountered Block 3B/4B in the course of exploration activities.

- In respect of palaeontology it has been assumed that the fossil potential of a formation in a study area will be typical of that found in the region and more specifically, similar to that already observed in the study area. A limitation on predictive capacity exists in that it is not possible to predict the fossil content of an area or formation other than in such general terms.

12.4 CULTURAL HERITAGE

The following assumptions and limitations were relevant:

- More time could have been given to interviews with emerging and currently accepted traditional and Khoi leaders in the Northern and Western Cape. Greater access to fisher cooperatives and commercial fisher companies would also have enriched the study further. However, and as acknowledged, it was challenging to reach SSF cooperative leaders in the Western Cape, as initial effort to communicate with researchers working on issues of SSF culture and the networks of which they are part, did not proceed. Contact was established and interviews conducted with individual fishers in the various locations indicated in the maps and interviews were also conducted with stakeholders beyond the SSF groupings/individuals – i.e., Khoi descendants and leaders, other traditional leaders, business owners, coastal dwellers, environmentalists, civil servants and healer-diviners.

- Knowledge gaps in the research are considered to be of low to negligible significance, since the fieldwork canvassed a wide variety of stakeholders and pursued deep ethnography on the cultural valuation of the ocean and coast, as well as ritual activity at the coast. There is also a reasonable set of secondary data on multiple forms and layering of cultural heritage noted in the figures provided in the CHIA report.
- The significance of the representation gap is therefore considered to be low, given the wide consultation effected during fieldwork and the secondary/desktop data provided.
- Desktop studies are undertaken to provide reasonable coverage of heritage considerations beyond ICH, such as Tangible heritages in the form of sites offshore that may be affected by the consequences of drilling, sites such as Underwater Cultural Heritage (UCH) in the form of shipwrecks (see Maitland 2017).
- The significance of the time for research is low to very low since detailed information was obtained from the highly qualitative interviews conducted. The gain was in depth, rather than breadth and for the purposes of this research endeavour, the gain was satisfactory.
- The methodology and method for the CHIA draws on several sources: Appendix 6 of EIA Regulations 2014 (as amended) promulgated in terms of Chapter 5 of NEMA and published in Government Notice (GN) No. 982 (as amended); project description and EIA Methodology (which defines the criteria for assessment, as well as descriptors for the sensitivity and magnitude of impact ratings) provided by EIMS and the national government documents on assessment of impact significance, cumulative effects and limits of acceptable change. The assessment protocol uses the 'balanced' weighting approach, which considers the cost of the impact to society, bearing in mind the values of local communities and the goals of AOSAC. The aim is to anticipate future conditions arising from normal operations and unplanned offshore events, as well the sociocultural results arising from such conditions.
- Regarding indigenous coastal cultural heritage, there is complex and holistic consideration and valuation of the sea and coast. For the Khoisan (First Nations) descendants, there is a deep connection with the coast and sea. The Khoisan ancestors were among the first strandlopers (beach walkers), and as the DSI- NRF A Rated scientist Dr Curtis Marean describes them, they were the first aquatic hunter gatherers to have established a sustainable livelihood and potential cultural relation with the sea. The issue of both tangible (archaeological cultural heritage) and intangible cultural heritage is especially significant for this block of interest.

12.5 SOCIAL

The following assumptions and limitations were relevant:

- This report is based only on the social impacts of the exploration activities. It is assumed that the exploration will be no langer than 90 days, that crews and equipment will leave from Cape Town, and that when they are not housed on the drills, the crew will stay in existing tourist accommodation;
- Not every individual in the community could be interviewed therefore only key people in the community were approached for discussion. Additional information was obtained using existing data;
- The social environment constantly changes and adapts to change, and external factors outside the scope of the project can offset social changes, for example changes in local political leadership, droughts, or economic conditions. It is therefore difficult to predict all impacts to a high level of accuracy, although care has been taken to identify and address the most likely impacts in the most appropriate way for the current local context within the limitations. In addition, it is also important to manage social impacts for the life of the project, especially in the light of the changing social environment;
- Social impacts can be felt on an actual or perceptual level, and therefore it is not always straightforward to measure the impacts in a quantitative manner;

- Social impacts commence when the project enters the public domain. Some of these impacts will occur irrespective of whether the project continues or not, and other impacts have already started. These impacts are difficult to mitigate, and some would require immediate action to minimise the risk;
- There are different groups with different interests in the community, and what one group may experience as a positive social impact, another group may experience as a negative impact.; and
- Social impacts are not site-specific but take place in the communities surrounding the proposed development.

12.6 ECONOMIC

The following assumptions and limitations were relevant:

- All rand values in the report represent 2023 current prices;
- The different measures of economic impact cannot be added together and should be interpreted separately;
- The model quantifies the economic impacts for a specific amount of time, and it is not derived gradually over time; and
- The input-output table is based on provincial supply and use tables, therefore, the multipliers and other related data measure economic impacts throughout the provincial economy (Quantec derived multipliers based on StatsSA Annual Financial Statistics, GDP at various economic levels, employment data and quarterly labour force surveys, 2023).

The underlying assumptions that define the quantitative impacts for planned events:

- Economic impacts created as a result of the normal operation of the exploration activity:
    - The impact identifies that the proposed exploration activity could drill 5 wells in the designated areas of interest of the project over a 20-month period (starting date undefined);
    - No cost data has yet been provided and therefore an estimated cost has been calculated:
        - The total cost to undertake and complete exploration drilling of each exploration well location is estimated at approximately US$35 000 000; and
        - An exchange rate of R18.27 (Average between November 2022 and November 2023) per US$ has been used to convert US$ to South African Rand.
    - The total cost per well is therefore estimated at approximately R639.5 million.
- Normal operations of the exploration activity could temporarily disrupt commercial fishing operations that overlap with the project’s AOI:
    - The impact identifies that an overlap exists between the proposed exploration activity’s AOI and the normal operational areas of the large pelagic longline fishing industry. Because of exploration activities coupled with safety exclusion zones, it is expected that normal fishing operations of the industry could be disrupted in the project’s AOI due to limited access. The disruption is expected to be temporary and to last for the duration of exploration (4-months);
    - Spatial data shows that on average approximately 127 tons of large pelagic fish species are caught in the AOI of the exploration activity per year (approximately 220 tons over the project’s operational period);
    - The value of the large pelagic longline fishing industry was determined to be approximately R38 143 per ton of fish caught (approximately 3 510 tons of fish caught at a value of R133 882 000); and
    - The total value of the disrupted fishing industry amounts to R8 073 606.

- Normal operations of the exploration activity could temporarily disrupt commercial maritime logistics operations:
  - The impact identifies that the exploration activity's AOI overlaps with common and regularly used marine logistics passageways. Because of this overlap, cargo, tankers and other related shipping would need to make use of alternate routes to access the Port of Cape Town and Port of Saldanha Bay. It is estimated that approximately 125 ships traverse the AOI per month;
  - the operational efficiency lost by the shipping industry was based on the average hourly operational cost of a typical cargo ship and the total distance lost as a result of no access to the AOI;
  - The average annual operational cost of a typical cargo ship is approximately US$9 000 000 per annum (R164 430 000), which translates to approximately R18 771 per hour;
  - The total distance that a ship could lose when not being able to traverse the AOI approximately 2 km;
  - An average cargo ship travels at approximately 46.3 km per hour;
  - In total, a cargo ship loses approximately 3.4 hours of travel time due to not being able to traverse the project's AOI;
  - The impact is expected to be temporary, lasting for the duration of the exploration activity (20-months);
  - Total hours lost because of the proposed exploration activity amounts to 8 423; and
  - The total value of the disrupted logistics industry amounts to R158 110 447.

The underlying assumptions that define the quantitative impacts for planned events:

- Economic impacts created as a result of a capping only oil spill response strategy:
  - The impact identifies that the Technical Report identifies that a capping only oil spill response strategy is the best suite response to a well blow-out event in the AOI of the proposed exploration activity;
  - Cost estimates for the response strategy was received from the applicant;
  - The total cost to undertake a capping only response to a well blow-out scenario is 75 million US$;
  - An exchange rate of R18.27 (Average between November 2022 and November 2023) per US$ has been used to convert US$ to South African Rand; and
  - The total response strategy cost for one blow-out event is therefore estimated at approximately R1.37 billion.
- Well blow-out event could temporarily disrupt commercial fishing operations that overlap with the affected area:
  - The impact identifies that a well-blowout event could disrupt commercial fishing operations because a well blow-out event is likely to occur within the project's AOI and the normal operational areas of the large pelagic longline fishing industry;
  - It is anticipated that normal fishing operations of the industry could be disrupted. The disruption is expected to be temporary and to last for 1 to 2 months;

- Fishing industry data shows that on average approximately 127 tons of large pelagic fish species are caught in the AOI of the exploration activity per year (approximately 21 tons over the well blow-out impact period);
  - The value of the large pelagic longline fishing industry was determined to be approximately R38 143 per ton of fish caught (approximately 3 510 tons of fish caught at a value of R133 882 000); and
  - The total value of the disrupted fishing industry amounts to R807 361.
- Normal operations of the exploration activity could temporarily disrupt commercial maritime logistics operations:
  - The impact identifies that a well blow-out event is likely to occur within the project's AOI which overlaps with common and regularly used marine logistics passageways. Because of this overlap, cargo, tankers and other related shipping would need to make use of alternate routes to access the Port of Cape Town and Port of Saldanha Bay. It is estimated that approximately 125 ships traverse the AOI per month;
  - the operational efficiency lost by the shipping industry was based on the average hourly operational cost of a typical cargo ship and the total distance lost as a result of no access to the AOI. The average annual operational cost of a typical cargo ship is approximately US$9 000 000 per annum (R164 430 000), which translates to approximately R18 771 per hour;
  - The total distance that a ship could lose when not being able to traverse the AOI approximately 2 km;
  - An average cargo ship travels at approximately 46.3 km per hour;
  - In total, a cargo ship loses approximately 3.4 hours of travel time due to not being able to traverse affected areas;
  - The impact is expected to be temporary, lasting for the duration of the well blow-out event duration of 1 to 2 months;
  - Total hours lost because of the well blow-out event amounts to 8 423; and
  - The total value of the disrupted logistics industry amounts to R15 811 045.

12.7 AIR QUALITY AND CLIMATE CHANGE

Several assumptions had to be made in the Air Quality Assessment. These, along with other limitations are listed below and should be noted when interpreting the outcomes of the study:

- The quantification of sources of emission was restricted to project activities provided by the Applicant including drilling, support vessels, etc;
- The fuels assumed to be consumed by these sources was provided by the Applicant;
- It was assumed that flaring may occur for 10 days during the exploration project;
- No incineration of waste was assumed to occur onboard the vessels;
- Where a range of emission factors were available, the upper range was used in the screening assessment as a worst-case estimate;
- Conservatively all NO_x was assumed to be NO_2; and
- The drill rig was assumed to be a mobile combustion source, however it will be both stationary and mobile.

Several assumptions had to be made in the Climate Change Assessment. These, along with other limitations are listed below and should be noted when interpreting the outcomes of the study:

- The quantification of sources of emission was restricted to emissions of sources as provided by the Applicant.
- The fuel assumed to be consumed by these sources was also provided by the Applicant.
- It was assumed that flaring may occur for 10 days during the exploration project. The burning of oil was assumed to range between 100 to 1000 bbl per day, and the flaring of gas was assumed to be 30 MMscfd.
- No incineration of waste was assumed to occur on board the vessels.
- Where a range of emission factors were available, the upper range was used in the screening assessment as a worst-case estimate.
- The drill rig was assumed to be a mobile combustion source, however it will be both stationary and mobile.

12.8 ACOUSTICS

The following assumptions and limitations were relevant:

- The Acoustics Assessment Report has been prepared in a manner generally accepted by professional consulting principles and practices for the same locality and under similar conditions. No other representations or warranties, expressed or implied, are made.
- Opinions and recommendations contained in this report are based on conditions that existed at the time the services were performed and are intended only for the client, purposes, locations, time frames and project parameters as outlined in the Scope of Work and agreement.
- The data reported, findings, observations and conclusions expressed are limited by the Scope of Work. The specialist is not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. The specialist does not warranty the accuracy of information provided by third party sources.

12.9 OIL SPILL AND DRILL CUTTING

The following assumptions and limitations were relevant:

- Four modelling periods were considered (i.e. Q1-Q4) for the study. The release location, release duration, discharge rate, and the selected oil type are the same for all the scenarios. The scenarios considered for this study were based on best available input data at the time of the study and are discussed in the report.
- Information provided by the Applicant for the Oil Spill Modelling Study assumed that the resource would contain condensate and crude oil and that the capping time of 20 days was chosen.

13 AFFIRMATION REGARDING CORRECTNESS OF INFORMATION

Gideon Petrus Kriel, herewith undertake that the information provided in the foregoing report is correct to the best of our knowledge, and that the comments and inputs from stakeholders and Interested and Affected Parties has been correctly recorded in the report where applicable as well as inputs and recommendations from the specialist reports completed as part of this assessment.

Signature of the EAP **Date**

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15 APPENDICES

Appendix 1: EAP CV

Appendix 3: Impact Assessment Matrix