

8. IMPACT ASSESSMENT

8.1 INTRODUCTION

This chapter describes and assesses the significance of potential impacts related to the proposed speculative seismic survey and provides a description of the identified interactions between the project activities and the receiving environment. It also presents a project-specific Aspects and Impacts Register (Section 8.2), which has been developed to ensure that all environmental and social aspects of the proposed operation and the associated impacts are identified.

This chapter provides an assessment of all the key impacts identified within the project's area of influence as described in Section 7.2. The assessment of impacts is structured as follows:

- Section 8.3 to 8.6: Normal Operations
- Section 8.7: Unplanned Events
- Section 8.8: Cumulative Impacts
- Section 8.9: No-Go Alternative
- Section 8.10: Impact Assessment and Mitigation Summary

The methodology used to determine the significance of potential impacts is presented in Appendix 7. The application of the Mitigation Hierarchy is central to the impact assessment that was used. The identification of enhancement measures was considered in parallel to the identification of mitigation measures. The impacts that remain following mitigation are assessed and presented as residual impacts. The status of all impacts should be considered negative, unless otherwise indicated.

8.2 SCREENING OF ASPECTS AND IMPACTS

8.2.1 Environmental and Social Interaction Matrix

A systematic screening of project activities was undertaken where they potentially interact with the physical, biological and socio-economic receptors. In order to identify impacts, it is important that the nature of the proposed activity is well understood so that the potential impacts associated with those activity can be identified. The environmental and social interaction matrix prepared for the proposed exploration activities and interactions in all phases of the Project (mobilisation, operation and demobilisation) is presented in Table 8-1. This process enabled a comprehensive identification of the Project's potential interactions with physical, biological and socio-economic receptors. Interactions are screened to have a "*minor negative interaction*", "*moderate / major negative interaction*" or "*positive interaction*" on the receptor. This Environmental and Social Interaction Matrix provided a reference for potential impacts requiring further investigation.

Under normal operations, most of project activities are considered to have a minor negative interaction with the environment mainly due to the offshore location of the area of interest and the short survey duration of up to five months (including downtime). The key project activities during normal operation that were subject to specialist investigation are related to the seismic operations themselves, specifically the noise impact on marine fauna and fishing.

8.2.2 Aspects and Impacts Register

The project-specific Aspects and Impacts Register developed for the proposed project is presented in Table 8-2. This register lists all project activities and associated environmental aspects and impacts. It was prepared to further elaborate the potential impacts identified through the initial screening for potential interactions. For each of the project activities, different aspects⁶ associated with the activity and their potential impacts⁷ are tabulated. This systematic approach allowed for the planning of the scope of the specialist studies.

⁶ An “aspect” is the element of an organisation’s activities, products or services that can interact with the environment.

⁷ An “impact” is any change to the environment, whether adverse or beneficial, wholly or partially resulting from the organisation’s activities, products or services.

Table 8-1: Environmental and Social Interaction Matrix

Project Phase	Resource / Receptors Project Activities		Sensitive receptors in the receiving environment																
			Physical			Biological						Socio-economic							
			Water Column (including Water Quality, Noise and Turbidity)	Atmosphere (including Air Quality, Noise and Lighting)	Seabed Sediment and Profile	Fish and Plankton Communities	Benthic Habitats and Communities	Sea and shore birds	Turtles and Marine Mammals	Seabed Features and Seamounts	Nearshore Habitats and Communities	Protected Area (Offshore and Coastal)	Fishing	Maritime Heritage	Intangible Cultural Heritage	Marine Traffic / Navigation	Public Health and Safety	Settlements, Tourism and Recreation	Employment & Income
Planned Activities (Normal Operation)																			
Seismic Surveying	Mobilisation	Transit of survey vessels to survey area, including routine discharge to sea																	
		Discharge of ballast water and equipment fouling																	
	Operation	Operation of survey vessels, including routine discharge to sea																	
		Seismic acquisition, including the deployment of seismic equipment (sources and streamers) and acquisition operations																	
	Demobilisation	Provision of services from local service providers (e.g. catering, refuelling and berthing)																	
	Demobilisation	Survey vessels leave survey area and transit to port or next destination																	
Unplanned Activities (Emergency Event)																			
All		Collision with survey vessels and equipment																	
Operation		Dropped objects / lost equipment																	
		Hydrocarbon spills																	
Colour key:																			
		No interaction		Minor negative interaction		Moderate / major negative interaction		Positive interaction											

Table 8-2: Aspects and Impacts Register

Activity Phase	Activity	Aspect	Potential Impact	
1. Seismic Surveying	Mobilisation Phase	Transit of survey vessels to survey area	Increase in underwater noise levels during transit	Disturbance to marine fauna
			Air emissions due to exhaust gases	Local reduction in air quality and contribution to global greenhouse gas emissions
			Routine discharge to sea (e.g. deck and machinery space drainage, sewage and galley wastes) and local reduction in water quality	Physiological effect on marine fauna
				Increased food source for marine fauna
			Increased predator - prey interactions	
	Discharge of ballast water and equipment fouling	Loss of biodiversity due to the introduction of invasive alien species		
	Operation Phase	Operation of survey vessels	Increase in underwater noise levels during transit	Disturbance / behavioural changes to marine fauna
			Routine discharge to sea (e.g. deck and machinery space drainage, sewage and galley wastes) and local reduction in water quality	Physiological effect on marine fauna
				Increased food source for marine fauna
				Fish aggregation and increased predator - prey interactions
			Air emissions due to exhaust gases	Local reduction in air quality and contribution to global greenhouse gas emissions
			Exclusion zone around survey vessel and seismic array	Disruption of shipping routes by ships having to make detours Reduced fishing grounds and catch
			Increase in ambient lighting	Disorientation and mortality of marine birds Increased predator - prey interactions
		Local employment and local business opportunities	Income for local service providers and suppliers	
		Seismic acquisition	Increase in underwater noise levels	Physiological effect on marine fauna
				Disturbance / behavioural changes to marine fauna
				Masking of environmental sounds and communication
				Effects on predators or prey interactions
				Fish avoidance of key feeding areas
				Reduced fish catch and increased fishing effort for local commercial fisheries
				Altered sense of place, including sites of spiritual, cultural and ritual importance
		Interaction with local economy	Local employment and business opportunities	Income for local service providers and suppliers (e.g. catering, refuelling and waste management)
				Income for Ports Authority and local service providers and suppliers (e.g. berthing during crew change)
	Reduced employment or loss income for impacted commercial fisheries			
	Operation of helicopter (only emergency situations)	Increase in noise levels	Avoidance of key breeding areas (e.g. coastal birds and cetaceans)	
			Abandonment of nests (birds) and young (birds and seals)	
	Demobilisation Phase	Survey vessels leave survey area and transit to port or next destination	Increase in underwater noise levels during transit	Disturbance to marine fauna
Air emissions due to exhaust gases			Local reduction in air quality and contribution to global greenhouse gas emissions	
			Physiological effect on marine fauna	

Activity Phase	Activity	Aspect	Potential Impact
		Routine discharge to sea (e.g. deck and machinery space drainage, sewage and galley wastes) and local reduction in water quality during transit	Increased food source for marine fauna Increased predator - prey interactions
2. Unplanned Activities	Vessel accident	Release of fuel into the sea and localised reduction in water quality	Effect on faunal health (e.g. respiratory damage) or mortality (e.g. suffocation and poisoning)
			Exclusion of fisheries and displacement of targeted species
			Altered sense of place and health of environment linked to sites of spiritual, cultural and ritual importance
	Collision with recreational fishing and pleasure vessels	Public health, safety and security impacts	
	Dropped objects / Lost equipment	Obstruction on seafloor or in water column	Physical damage to and mortality of benthic species / habitats
	Obstruction to or damage of fishing gear		
Small spills	Discharge of fuel during bunkering and reduction in water quality	Effect on faunal health (e.g. respiratory damage) or mortality (e.g. suffocation and poisoning)	
Exclusion of fisheries and displacement of targeted species			

8.3 OPERATION OF VESSELS (SURVEY AND SUPPORT)

8.3.1 Emissions to Atmosphere

8.3.1.1 Impacts on Air Quality and Greenhouse Gas Emissions

Source of Impact

The project activities likely to emit pollutants to the atmosphere and affect air quality are:

Project phase	Activity
Mobilisation	Transit of vessels to survey area
Operation	Operation of survey vessel and transit of vessels between the survey area and Port of Gqeberha
Demobilisation	Survey vessels leave survey area and transit to port or next destination

Emissions from these activities will include:

- The principal sources of emissions to air will be exhaust gas emissions from project vessels produced by the combustion of fuel. As with any combustion engine powered by fossil fuels, some emissions of unburned hydrocarbons, volatile organic compounds and particles are also likely to be generated by the propulsion system of the vessels.
- Incineration of certain wastes onboard and compressors associated with energy sources will also produce limited occasional emissions.

Potential Impact Description

The release of gaseous pollutants, principally sulphur oxides (SO_x), nitrogen oxides (NO_x), carbon dioxide (CO₂) and carbon monoxide (CO), together with lesser quantities of particulate matter (PM₁₀/PM_{2.5}) and volatile organic compounds (VOCs), from the project vessels have the potential to cause short-term reductions in local air quality close to the emissions source (**direct negative** impact).

Some of these compounds could contribute to global greenhouse gas emissions (**indirect negative** impact). Greenhouse gases are “those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth’s surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H₂O), carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄) and ozone (O₃) are the primary greenhouse gases in the Earth’s atmosphere.

Project Controls

The seismic contractor will strive to comply with the requirements set out in MARPOL Annex VI Reg. 18.3.1, by using ISO 8217 fuel. Project vessels will be supplied with marine gasoil (MGO) or heavy fuel oil (HFO) with less 0.5% sulphur (mass). Project vessels will also use well maintained, certified incinerators to optimise the combustion of waste to minimise emissions.

The seismic contractor will also comply with industry good practices with regards to waste management including:

- Waste management will follow key principles: Avoidance of Waste Generation, adopting the Waste Management Hierarchy (reduce, reuse, recycle, recover, residue disposal), and use of Best Available Technology (BAT).

- An inventory will be established of all the potential waste generated, clarifying its classification (hazardous, non-hazardous or inert) and quantity, as well as identifying the adequate treatment and disposal methods.

Sensitivity of Receptors

Emissions from activities described above would primarily take place within the survey area and along the route taken by the project vessels from the Port of Gqeberha. The main high vessel traffic route along the Southeast Coast of South Africa passes through the area of interest and the air quality in the majority of the survey area is thus already expected to experience elevated emissions from high vessel traffic. The area of interest is located more than 30 km offshore at its nearest point, and thus far removed from coastal MPAs and any sensitive coastal receptors (e.g. settlements, bird or seal colonies, etc.). The atmosphere, therefore, has the capacity to disperse relatively minor emissions without detectable alteration in local air quality and such emissions would not have a direct effect on any receptor or other activity, other than the project vessels themselves. Therefore, the sensitivity of main receptors due to changes in air quality is considered **very low**. The Project contribution to global greenhouse gas emissions is difficult to evaluate, but the effect on receptors is considered as **very low** at this scale.

Impact Magnitude (or Consequence)

The release of gaseous pollutants to the atmosphere from proposed activities may cause a short-term reduction in local **air quality**. The emission levels of the project vessels are comparable to those produced by commercial vessels sailing in South African waters. The majority of emissions will occur within the survey area, as well as along the route to and from the Port of Gqeberha. The majority of solid waste will be transported to shore for disposal, however, certain non-toxic combustible wastes (e.g. galley waste, if not discharged overboard) may be incinerated on the project vessels, creating smoke (particulate matter) emissions, mainly within the survey area.

The fuel consumption by the project vessels is estimated at 8 580 Tons for a five-month survey duration (see Table 6-7:). The associated project's **greenhouse gas** (GHG) emissions are estimated at 27 570 Tons of CO₂ equivalent (IPCC emission factors, see Table 6-8:), thus contributing to the total greenhouse gas emissions impacting the climate. The emissions will, however, be limited in space and time resulting in a relatively small increase in greenhouse gases and contribution (<0.001 %) to South Africa's total annual GHG emissions, which was 512.383 million Tons in 2015. Thus, the project emissions will make an insignificant contribution to global warming on the global scale.

Given the offshore location of the proposed survey area, air emissions are expected to disperse rapidly and there is no potential for accumulation of air pollution leading to any detectable long-term impact. The impact of the estimated operational emissions from the proposed project is considered to be **regional** and of **limited duration** (i.e. five months) and **low intensity** (removed from any sensitive receptors and changes remain undetectable). Thus, the impact **magnitude** (or consequence) for air quality and GHG contribution is, therefore, considered to be **very low**.

Impact Significance

Based on the **very low sensitivity** of receptors and the **very low magnitude**, the potential impact on air quality and greenhouse gas emissions is considered to be of **negligible significance** without mitigation (see Table 8-3).

Identification of Mitigation Measures

In addition to compliance with MARPOL 73/78 Annex VI, the following measures will be implemented to reduce emissions at the source:

No.	Mitigation measure	Classification
1	Implement a maintenance plan to ensure all diesel motors and generators receive adequate maintenance to minimise soot and unburnt diesel released to the atmosphere.	Avoid/reduce at source
2	Optimise survey line acquisition and vessel operations/logistics to minimise the survey time and number of trips required to and from the onshore supply port.	Avoid/reduce at source
3	Ensure no incineration of waste occurs within the port limits.	Avoid

Residual Impact Assessment

This potential impact cannot be eliminated as project vessels will generate emissions during operations. The proposed mitigation does not significantly reduce the emissions associated with normal operations. Thus, with the implementation of the mitigation measures, although reducing the intensity of the air quality impact to **very low**, the residual impacts remain of **very low magnitude** and of **NEGLIGIBLE significance** (see Table 8-3).

Table 8-3: Impact of atmospheric emissions on air quality and greenhouse gas emissions

Project Phase:	Mobilisation, Operation and Decommissioning	
Type of Impact	Direct and Indirect	
Nature of Impact	Negative	
Sensitivity of Receptor	VERY LOW	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	VERY LOW	VERY LOW
Intensity	LOW	VERY LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	NEGLIGIBLE	NEGLIGIBLE
Probability	HIGHLY LIKELY	HIGHLY LIKELY
Confidence	HIGH	HIGH
Reversibility	PARTIALLY REVERSIBLE	PARTIALLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	VERY LOW
Cumulative potential	POSSIBLE	POSSIBLE

8.3.2 Routine Operational Discharges to Sea

8.3.2.1 Impacts on Marine Ecology/Environment

Source of Impact

The project activities that will result in an impact on marine ecology/environment from a reduction of water quality from routine discharges to the sea from vessels are:

Project phase	Activity
Mobilisation	Transit of vessels to survey area
Operation	Operation of survey vessels and transit between the survey area and Port of Gqeberha
Demobilisation	Survey vessels leave survey area and transit to port or next destination

These activities and their associated aspects are described below:

- Galley wastes, comprising mostly of biodegradable food waste, generated on board the project vessels will be discharged overboard.
- Machinery space or bilge water drainage will be occasionally discharged after treatment. 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).
- Grey water and sewage will be discharged intermittently throughout the survey and will vary according to the number of persons on board. The treated sanitary effluents discharged into the sea are estimated at around 14 000 litres per day for the duration of the seismic survey based on 140-150 litres per 100 persons.
- Deck drainage consists of liquids from rainfall, sea spray, deck and equipment washing (using water and an approved detergent), and any spillages (chemical or fuel). Deck drainage will be variable depending on the vessel characteristics, deck activities and rainfall amounts.
- Cooling and drinking water surplus generated by the drinking water supply system are likely to contain a residual concentration of chlorine (generally less than 0.5 mg/l for freshwater supply systems).

Potential Impact Description

The routine liquid and solid discharges to sea could create local reductions in water quality, both during transit to and within the survey area. 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 negative** 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.

Project Controls

The seismic contractor will ensure that the proposed survey is undertaken in compliance with the applicable requirements in MARPOL 73/78, as summarised below.

- The discharge of biodegradable food wastes from vessels is regulated by MARPOL 73/78 Annex V, which stipulates that:
 - No disposal to occur within 3 nm (\pm 5.5 km) of the coast.
 - Disposal between 3 nm (\pm 5.5 km) and 12 nm (\pm 22 km) needs to be comminuted to particle sizes smaller than 25 mm.
 - Disposal overboard without grinding can occur greater than 12 nm from the coast when the vessel is sailing.
- 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.
 - 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.
- 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 project vessels 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 (\pm 6 km) and 12 nm (\pm 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 *en 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.

The survey contractor will also comply with industry good practices with regards to waste management, which will include the development of a Waste Management Plan for all wastes generated. This plan 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 BAT.
- Treatment of wastes at source (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.
- 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.).

Sensitivity of Receptors

The operational discharges from the activities described above would primarily take place in the survey area and along the route taken by the project vessels between the survey area and supply port. The survey area is located in the offshore marine environment, more than 30 km offshore and 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); however, discharges could still directly affect migratory pelagic species transiting through the survey area. Vessel discharges *en route* to the onshore supply base at the Port of Gqeberha could result in discharges closer to shore, thereby potentially having an environmental effect on the sensitive coastal environment, MPAs and EBSAs.

The taxa most vulnerable to routine operational discharges at sea are pelagic seabirds, turtles, large migratory pelagic fish and cetaceans, some of which, potentially occurring in the survey area, are considered regionally or globally 'Critically Endangered' (e.g. southern bluefin tuna, leatherback turtle, Leach's storm petrel and blue whale), 'Endangered' (e.g. African penguin, Cape gannet, Atlantic and Indian yellow-nosed albatross, Subantarctic skua, shortfin mako shark, whale shark, Indo-Pacific humpback dolphin, fin whale and sei whale), 'Vulnerable' (e.g. bigeye tuna, blue marlin, loggerhead turtle, thresher shark, great hammerhead shark, dusky shark, great white shark, longfin mako shark, and sperm, Bryde's and humpback whales) or 'Near threatened' (e.g. striped marlin, blue shark, longfin tuna/albacore and yellowfin tuna). Although species listed as globally Endangered or Critically Endangered may potentially occur in the survey area, their numbers are expected to be low. Based on the low numbers of listed species, the sensitivity is considered to be **medium**.

Impact Magnitude (or Consequence)

The contracted project vessels will have sewage treatment systems, oil/water separators and food waste macerators to ensure compliance with MARPOL 73/78 standards. Compliance with MARPOL 73/78 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 some opportunistic feeders. The discharge of sewage is likely to contain a low level of residual chlorine following treatment, but this is expected to have a minimal effect on seawater quality given the relatively low total discharge and taking into account dilution in the surface waters.

Furthermore, the survey area is located approximately 30 km from the coast at its closest point and is thus suitably far removed from any sensitive coastal receptors. The dominant wind and current direction will also ensure that any discharges are rapidly dispersed in a south-westerly direction away from the coast and are unlikely to have an impact on sensitive coastal receptors. The area of interest does, however, overlap with the Port Elizabeth Corals MPA, which was established to protect important seabed features. 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 wastes leading to any detectable long-term impact.

Due to the distance offshore, it is only likely to be pelagic species of 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 the survey vessels organic discharges will be large pelagic fish species, such as the highly migratory tuna and billfish, as well as sharks and odontocetes. Pelagic seabirds that feed primarily by scavenging might also be attracted.

A number of other types of wastes generated during the survey will not be discharged at sea but will be transported to shore for disposal at a licensed waste disposal facility. The disposal of all waste onshore will be fully traceable. General and hazardous waste landfill sites are located at Gqeberha.

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 routine operational discharges from the project vessels will be of **very low intensity, short-term duration** and **regional** in extent (although localised at any one time around the project vessels). Thus, the **magnitude** (or consequence) is, therefore, considered to be **very low** (see Table 8-4).

Impact Significance

Based on the **medium sensitivity** of receptors and the **very low magnitude**, the potential impact on the marine fauna is considered to be of **very low significance** without mitigation (see Table 8-4).

The majority of these discharges are not unique to the project vessels, but common to the numerous vessels that operate in or pass through South African coastal waters on a daily basis.

Identification of Mitigation Measures

In addition to compliance with MARPOL 73/78 standards, the other project controls and monitoring, the following measures will be implemented to reduce discharges to sea at the source:

No.	Mitigation measure	Classification
1	Implement leak detection and maintenance programmes for valves, flanges, fittings, seals, hydraulic systems, hoses, etc.	Avoid/reduce at source
2	Use a low-toxicity biodegradable detergent for the cleaning of the deck and in the spillage kit.	Reduce at source

Residual Impact Assessment

This potential impact cannot be eliminated because the project vessels are needed to undertake the survey and will generate routine discharges during operations. The implementation of the few minor mitigation measures

will not significantly change the discharges and thus the intensity, extent or duration of the impact. Thus, the residual impact will remain of **very low magnitude** and **VERY LOW significance** (see Table 8-4).

Table 8-4: Impacts on marine ecology/environment from operational discharges to sea

Project Phase:	Mobilisation, Operation and Decommissioning	
Type of Impact	Indirect	
Nature of Impact	Negative	
Sensitivity of Receptor	MEDIUM	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	VERY LOW	VERY LOW
Intensity	VERY LOW	VERY LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	VERY LOW	VERY LOW
Probability	LIKELY	LIKELY
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	VERY LOW
Cumulative potential	UNLIKELY	UNLIKELY

8.3.3 Discharge of Ballast Water from Vessels and Vessel / Equipment Transfer

8.3.3.1 Impact on Marine Biodiversity

Source of Impact

The project activities that will result in the discharge of ballast water and vessel / equipment transfer, and potential introduction of alien invasive species are:

Project phase	Activity
Mobilisation	Transit of vessels to survey area and discharge of ballast water
Operation	N/A
Demobilisation	N/A

De-ballasting of the survey vessel may be undertaken during transit to or once at the survey area. This could introduce non-native species into the area, especially if the vessel is arriving from another country abroad. Similarly, vessels and the subsea use of equipment from one region to another (excluding local or national translocations) also provides for the potential translocation of introduced or alien species that are attached to vessel hulls and equipment that have been at sea for any length of time.

Potential Impact Description

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 project vessels could lead to the introduction of exotic species and harmful aquatic pathogens to the marine ecosystem. Invasive marine 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**).

Project Controls

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. It stipulates that all vessels must 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, whenever possible, conduct such exchange at least 200 nm (± 370 km) from the nearest land and in water of at least 200 m depth. 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. 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 will comply with these requirements.

Sensitivity of Receptors

The discharge of ballast water from project vessels would take place *en route* to or in the vicinity of the survey area (if not possible to undertake in international waters), which is located more than 30 km offshore, far removed from any sensitive coastal receptors (e.g. sessile benthic invertebrates, endemic neritic and demersal fish species). In addition, due to the water depths in the survey area (from 150 m to beyond 4 500 m), colonisation by invasive species on the seabed is considered unlikely. Thus, the sensitivity of benthic receptors in the offshore waters of the proposed survey area of interest is considered **very low**.

Impact Magnitude (or Consequence)

Shipping has always been the primary pathway for the transfer of marine alien species from one region to another (Hewitt *et al.*, 1999; Ruiz *et al.*, 2000; Ruiz & Carlton, 2003). The principal vectors responsible for transfer of alien invasive species are ballast water and external hull fouling (Carlton, 1987, 1999; Hewitt *et al.*, 2009).

The survey vessel, and possibly the support / escort vessel, will more than likely have spent time outside of South Africa's EEZ prior to surveying. This exposure to foreign water bodies and possible loading of ballast water, although de-ballasting is not common practice for seismic vessels, increases the risk of introducing invasive or non-indigenous species into South African waters. The risk of this impact is, however, significantly reduced by the implementation of IMO ballast water management measures. The survey area is far removed from the coast, which together with the dominant wind and current direction, will ensure that any invasive species drift mainly in a south-westerly direction away from the coast. In addition, the water depths in the survey area (150 m to beyond 4 500 m) will ensure that colonisation of invasive species on the seabed is unlikely. De-ballasting in the survey area will thus not pose an additional risk to the introduction of invasive species.

In terms of hull fouling, the survey area is located along one of the main traffic routes that pass around southern Africa (see Figure 7-72). 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 and the proposed survey area of interest, on a daily basis.

Considering the location of the survey area with pre-existing international marine activity, 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** in the **short-term** (due to it having a minimal effect on receptors) and of **regional extent**. Thus, the **magnitude** (or consequence) is considered to be **low** (see Table 8-5:).

Impact Significance

Based on the **very low sensitivity** of receptors and the **low magnitude**, the potential impact on the marine biodiversity is considered to be **VERY LOW** without mitigation (see Table 8-5:).

Identification of Mitigation Measures

In addition to compliance with the requirements of the IMO 2004 Ballast Water Management Convention, the following measures will be implemented to reduce and manage the potential introduction of alien species in ballast water and hull or equipment fouling:

No.	Mitigation measure	Classification
1	Avoid the unnecessary discharge of ballast water.	Reduce at source
2	Use filtration procedures during loading in order to avoid the uptake of potentially harmful aquatic organisms, pathogens and sediment that may contain such organisms	Avoid/reduce at source
3	Ensure that routine cleaning and maintenance 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 the ship's Ballast Water Management Plan	Avoid/reduce at source
4	Ensure all infrastructure (e.g. arrays, streamers, tail buoys, etc.) that has been used in other regions is thoroughly cleaned prior to deployment	Avoid/reduce at source

Residual Impact Assessment

This potential impact cannot be eliminated because the project vessels will more than likely have spent time outside of South Africa's EEZ prior to surveying and need to de-ballast. With the implementation of the mitigation measures, the residual impact would reduce to **NEGLIGIBLE** (see Table 8-5:).

Table 8-5: Impact on marine biodiversity from ballast water discharge and equipment fouling

Project Phase:	Mobilisation	
Type of Impact	Indirect	
Nature of Impact	Negative	
Sensitivity of Receptor	VERY LOW	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	LOW	VERY LOW
Intensity	MEDIUM	LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	VERY LOW	NEGLIGIBLE
Probability	UNLIKELY	UNLIKELY
Confidence	MEDIUM	MEDIUM
Reversibility	IRREVERSIBLE	IRREVERSIBLE
Loss of Resources	LOW	LOW

Mitigation Potential	-	VERY LOW
Cumulative potential	UNLIKELY	UNLIKELY

8.3.4 Underwater Noise from Vessel Operations and Transit

8.3.4.1 Impact on Marine Fauna

Source of Impact

The project activities that will result in an increase in underwater ambient noise levels (non-seismic) are:

Project phase	Activity
Mobilisation	Transit of vessels to survey area
Operation	Operation of survey vessels and transit of vessels between the survey area and supply port
Demobilisation	Survey vessels leave survey area and transit to port or next destination

The presence and operation of the project vessels will introduce a range of underwater noises from their engines into the surrounding water column that may potentially contribute to and/or exceed ambient noise levels in the area.

Impact Description

Elevated noise levels could impact marine fauna (**direct negative** impact) by:

- Causing direct physical injury to hearing or other organs;
- Masking or interfering with other biologically important sounds (e.g. communication, echolocation, signals and sounds produced by predators or prey); and
- Causing disturbance resulting in behavioural changes or displacement from important feeding or breeding areas.

Project Controls

The seismic contractor will ensure that the proposed survey is undertaken in a manner consistent with good international industry practice and BAT.

Sensitivity of Receptors

Refer to Section 8.3.2.1 for a description of receptor sensitivity. Although species listed as globally or regionally Endangered or Critically Endangered may potentially occur in the area, the proposed survey area is located along a main marine traffic route and thus is in an area already experiencing increased marine traffic and operational noise. Thus, the overall sensitivity of receptors to vessel noise is considered to be **medium**.

Impact Magnitude (or Consequence)

The ocean is a naturally noisy place and marine animals are continually subjected to sounds from physical 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. 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 be expected to interfere directly or indirectly with such activities affecting the physiology and

behaviour of marine organisms (NRC, 2003). Of all human-generated sound sources, the most persistent in the ocean is the noise of shipping. An overview of the noise levels produced by various natural and anthropogenic sources, relative to typical background or ambient noise levels is provided in Figure 8-1.

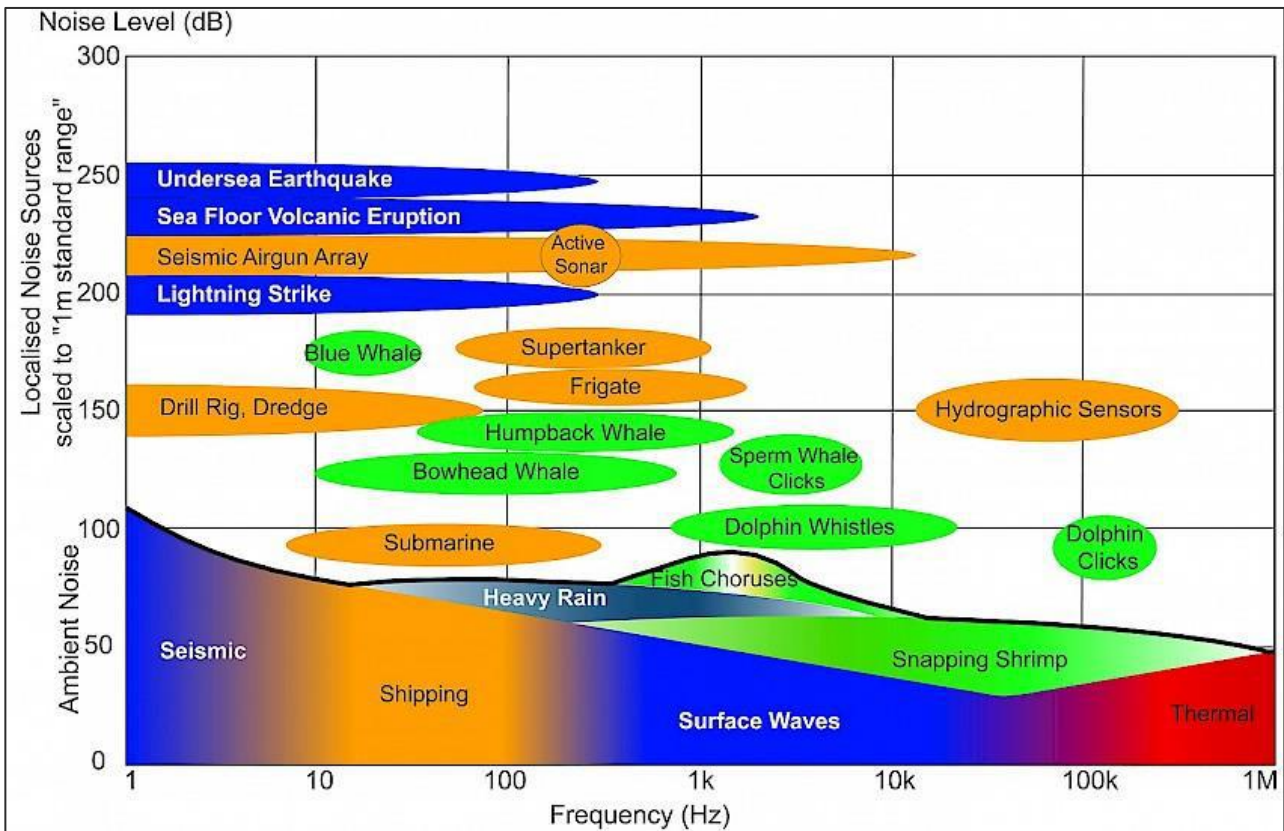


Figure 8-1: Comparison of noise sources in the ocean

Source: <https://www.ospar.org/work-areas/eiha/noise>

Depending on size and speed, the sound levels radiating from vessels range from 160 to 220 dB re 1 μ Pa at 1 m (NRC, 2003) at frequencies of 5 to 500 Hz. As the proposed survey area is located along a main traffic route passing around southern Africa (see Figure 7-72) and the high density of fishing vessel traffic, the shipping noise component of the ambient noise environment is expected to be significant within and around the survey area. Given the significant local shipping traffic and relatively strong metocean conditions in the area surrounding the survey area, the ambient noise levels are expected to be in the range of 90 - 130 dB re 1 μ Pa for the frequency range 10 Hz – 10 kHz (SLR, 2021).

The noise generated by the survey vessel, which travels at a low and regular speed of between four and five knots (i.e. 2 to 3 metres per second), and support vessel fall within the hearing range of most fish and marine mammals, and would be audible for considerable ranges before attenuating to below threshold levels. However, unlike the noise generated by airguns (see Section 8.4.1), underwater noise from vessels is not considered to be of sufficient amplitude to cause direct harm to marine life, even at close range (SLR, 2021). Due to their extensive distributions, the numbers of pelagic species (large pelagic fish, turtles and cetaceans) encountered during the proposed survey is expected to be low. Consequently, the **intensity** of potential physiological injury or behavioural disturbance as a result of vessel noise is considered to be **low**. The duration of the impact would be limited to the **short-term** (five months) and would be **regional** between the survey area and the supply base at

Gqeberha (although localised at any one time). The potential physiological injury or behavioural disturbance as a result of vessel noise would thus be of **very low magnitude** (see Table 8-6).

Impact Significance

Based on the **medium sensitivity** of receptors and the **very low magnitude**, the potential impact on the marine fauna is considered to be **very low significance** without mitigation.

Identification of Mitigation Measures

No mitigation measures are proposed or deemed necessary.

Residual Impact Assessment

The generation of noise from project vessels cannot be eliminated. Without mitigation, the intensity, extent or duration of the impact remains unchanged. Thus, the potential impact remains of **VERY LOW significance** with very minor effects on receptors.

Table 8-6: Impact on marine fauna from vessel noise

Project Phase:	Mobilisation, Operation and Decommissioning	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	MEDIUM	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	VERY LOW	VERY LOW
Intensity	LOW	LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	VERY LOW	VERY LOW
Probability	POSSIBLE	POSSIBLE
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	VERY LOW
Cumulative potential	LIKELY	LIKELY

8.3.5 Lighting from Vessels

8.3.5.1 Impact on Marine Fauna

Source of Impact

The project activities likely to result in increased ambient lighting are:

Project phase	Activity
Mobilisation	Transit of survey vessels to survey area
Operation	Operation of survey vessels and transit of vessels between the survey area and supply port
Demobilisation	Survey vessels leave survey area and transit to port or next destination

The operational lighting of project vessels during transit and operation can be a significant source of artificial light in the offshore environment increasing the ambient lighting in offshore areas.

Potential Impact Description

The strong operational lighting used to illuminate the project vessels at night will 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 on 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.

Project Controls

The seismic contractor will ensure that the proposed survey is undertaken in a manner consistent with good international industry practice and BAT.

Sensitivity of Receptors

Refer to Section 8.3.2.1 for a description of receptor sensitivity. Although species listed as globally or regionally Endangered or Critically Endangered may potentially occur in the area, the survey area is located along a main marine traffic route and thus in an area already experiencing increased marine traffic and operational lighting. Thus, the overall sensitivity of receptors to vessel lighting is considered to be **medium**.

Impact Magnitude (or Consequence)

The survey area is located in a marine environment, more than 30 km offshore, far removed from any sensitive coastal receptors (e.g. bird or seal colonies). Most of the seabird species breeding along the southeast coast feed relatively close inshore (10-30 km from the coast), with African Penguins recorded as far as 60 km offshore and Cape Gannets up to 140 km offshore. Pelagic species occurring further offshore would be unfamiliar with artificial lighting and may be attracted to the survey vessel. Fish and squid may also be attracted to the light sources potentially resulting in increased predation on these species by higher order consumers. It is expected, however, that seabirds and marine mammals in the area would become accustomed to the presence of the survey vessel within a few days. Since the survey 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.

Operational lights may also result in physiological and behavioural effects of 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. As seals are known to forage up to 120 nm (~220 km) offshore, the inshore portions of the proposed survey area therefore fall within the foraging range of seals from the southeast coast colonies. Odontocetes are also highly mobile, with various species likely to occur in the proposed survey area of interest and thus potentially attracted to the area.

Although little can be done on the survey vessel to prevent seabird collisions, reports of collisions or death of seabirds on seismic vessels are rare, possibly due to the relatively slow speed of seismic vessels when acquiring data. It is expected that seabirds and marine mammals in the area will become accustomed to the presence of the project vessels within a few days.

Due to their extensive distributions, the numbers of pelagic species (large pelagic fish, turtles and cetaceans) encountered during the proposed survey is expected to be low. Due to the anticipated low number of species

expected to be encountered and the location of the proposed survey area along a main traffic route, the **intensity** of impact is expected to be **low**. The extent of impact is **regional** (although limited to the local visual stimulus of the project vessels at any one time), while the duration will be **short-term** (five months). Thus, the **magnitude** (or consequence) is considered to be **very low** (see Table 8-7).

Impact Significance

Based on the **medium sensitivity** of receptors and the **very low magnitude**, the potential impact on the marine fauna is considered to be **very low significance** without mitigation.

Identification of Mitigation Measures

The following measures will be implemented to mitigate lighting impact:

No.	Mitigation measure	Classification
1	Reduce the lighting on the project vessels to a minimum compatible with safe operations whenever and wherever possible.	Avoid/reduce at source
2	Position light sources, if possible and consistent with safe working practices, in places where emissions to the surrounding environment can be minimised.	Avoid/reduce at source
3	Keep disorientated, but otherwise unharmed, seabirds in dark containers (e.g. cardboard box) for subsequent release during daylight hours.	Repair or restore

Residual Impact Assessment

The use of lighting on the project vessels cannot be eliminated due to safety, navigational and operational requirements. With the implementation of the few minor mitigation measures, which would reduce the intensity of the impact to very low, the residual impact remains of **VERY LOW significance**.

Table 8-7: Impact on marine fauna from vessel lighting

Project Phase:	Mobilisation, Operation and Decommissioning	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	MEDIUM	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	VERY LOW	VERY LOW
Intensity	LOW	VERY LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	VERY LOW	VERY LOW
Probability	POSSIBLE	POSSIBLE
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	VERY LOW
Cumulative potential	UNLIKELY	UNLIKELY

8.3.6 Noise from Helicopters

8.3.6.1 Impact on Marine Fauna

Source of Impact

Helicopter activities will increase the ambient airborne noise levels, as indicated below:

Project phase	Activity
Mobilisation	N/A
Operation	Operation of a helicopter between survey area and Gqeberha
Demobilisation	N/A

Although unlikely as the preferred method for crew changes is by vessel, potential crew transfers by helicopter from Gqeberha to the survey vessel will generate noise in the atmosphere. Noise source levels from the helicopter is expected to be approximately 109 dB re 1 μ Pa at the most noise-affected point (SLR, 2021).

Potential Impact Description

Elevated airborne noise levels from the helicopter may disturb faunal species resulting in behavioural changes or displacement from important feeding or breeding areas (**direct negative impact**).

Project Controls

The operation of helicopters is governed by the Civil Aviation Act, 2016 (No. 6 of 2016) and associated regulations.

All whales and dolphins are given protection under 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 approach closer than 300 m to any whale and a vessel or aircraft should move to a minimum distance of 300 m from any whales if a whale surfaces closer than 300 m. The helicopter operator will ensure that these buffer zones are maintained during flights.

Sensitivity of Receptors

Helicopter operations are unlikely as the preferred method for crew changes is by vessel. In the unlikely event that helicopter personnel transfers are required or in emergency situations, helicopter operations may take place between the survey area of interest and Gqeberha, which has a commercial airport where a lot of ambient noise already exists on a daily basis. Flight paths between the survey area and Gqeberha would potentially cross over offshore and coastal MPAs (e.g. Sardinia Bay MPA, Port Elizabeth Corals MPA), and sensitive coastal receptors (e.g. key faunal breeding/feeding areas, bird or seal colonies and nursery areas for commercial fish stocks). In addition, migratory pelagic species transiting through the survey area may also be directly affected.

The taxa most vulnerable to disturbance by helicopter noise are pelagic seabirds (except where the flight path crosses the coastal zone where coastal birds may be disturbed), turtles and large migratory cetaceans, some of which, potentially occurring in the survey area, are considered globally 'Critically Endangered' (e.g. southern bluefin tuna, leatherback turtles and blue whales), 'Endangered' (e.g. African penguin, Cape gannet, Atlantic and Indian Yellow-Nosed Albatross, Subantarctic Skua, whale shark, shortfin mako shark, Inco-Pacific humpback dolphin, fin and sei whales), 'vulnerable' (e.g. bigeye tuna, blue marlin, loggerhead turtles, thresher shark, great hammerhead shark, dusky shark, great white shark, longfin mako and sperm whale, Bryde's and humpback whales) or 'near threatened' (e.g. striped marlin, blue shark, longfin tuna/albacore and yellowfin tuna). Although

species listed as globally Endangered or Critically Endangered may potentially occur in the area of influence, their numbers are expected to be low.

Based on the low numbers of listed species and since the Southwest Indian Seamounts fall outside of any possible flight path, the sensitivity is considered to be **medium**.

Impact Magnitude (or Consequence)

Although crew transfers using the support vessel is the preferred method, if necessary, a helicopter may be used to transfer personnel to and from the survey vessel. For example, a helicopter may be used for medical evacuations from the survey vessel to shore (at day- or night-time), if required.

A helicopter flying between the survey vessel and airport may fly over sensitive receptors, such as bird and seal colonies or breeding/calving cetaceans. The noise generated by a low flying aircraft may temporarily disturb marine fauna, which may result in the abandonment of nests or young, injury to individuals or impact breeding activities. Flight paths from the Gqeberha airport to the survey area could potentially pass over coastal and offshore MPAs, but may pass over or in close proximity to certain sensitive areas (see Figure 7-46).

Sensitivity of birds to aircraft disturbance is not only species specific, but generally lessened with increasing distance or if the flight path is off to the side and downwind. Low altitude flights over bird breeding colonies could result in temporary abandonment of nests and exposure of eggs and chicks leading to increased predation risk. The nearest seabird colonies to Gqeberha airport are on the Algoa Bay islands. These colonies do not fall within the potential flight path between Gqeberha airport and the centre of the area of interest.

The frequency of aircraft engine noise also overlaps with the hearing ranges of seals and are likely to receive both acoustic and visual cues from aircraft flyovers. Seals may experience severe disturbance from aircrafts usually reacting by showing a startle response and moving rapidly into the water. Although any observed response is usually short-lived, disturbance of breeding seals can lead to pup mortalities through abandonment or injury by fleeing, frightened adults. The seal colony closest to, but outside of, the potential flight paths from the area of interest to Gqeberha airport is located at Black Rocks (Bird Island group) in Algoa Bay.

Available data indicate that the expected frequency range and dominant tones of sound produced by a helicopter overlap with the hearing capabilities of most odontocetes and mysticetes. Reactions to aircraft flyovers range from no or minimal observable behavioural response, to avoidance by diving, changes in direction or increased speed of movement away from the noise source, separation of cow-calf pairs, increased surface intervals and dramatic behavioural changes including breaching and lobtailing, and active and tight clustering behaviour at the surface. Thus, low altitude flights (especially near the coast) can have a significant disturbance impact on cetaceans during their breeding and mating season. During the northern migration, animals strike the coast at Knysna, resulting in increasing whale density on shelf waters and into deeper pelagic waters as one moves northwards, but no clear migration 'corridor'. Humpbacks could, therefore, potentially transit through the area of interest within 40 km of the coast on their northwards migration. Humpback whales are thus likely to be the most frequently encountered baleen whale in the project area, ranging from the coast out beyond the shelf, with numbers peaking in May to August and a smaller peak with the southern breeding migration around September to February. Winter concentrations of Southern Right whales have been recorded all along the Southeast Coast, with numbers in Algoa Bay peaking in August. The inshore population of Bryde's whale is resident year-round on the Agulhas Bank, with individuals undertaking occasional seasonal excursions up the East Coast in winter during the annual sardine migration. This species is likely to be encountered in the Reconnaissance Permit Area throughout the year, with peak encounter rates reported from Algoa Bay in March and May (autumn) (Melly *et*

al. 2017). Smaller cetaceans in the area include the common dolphin and Indo-Pacific humpback and bottlenose dolphin dolphins, which tend to occur further inshore on the shelf but may be encountered in the shallower portions of the proposed survey area. 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.

Although exposure could be limited up to a few return flights over the six-month survey **duration (short-term)** and be of a temporary nature while the helicopter passes overhead (although **regional in extent**), indiscriminate or direct low altitude flying over seabird and seal colonies or breeding cetaceans could impact fauna behaviour and breeding success. Although level of impact will 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 at the time, **intensity** is considered to be **low** for the populations as a whole. Thus, the **magnitude** (or consequence) is considered to be **very low** (see Table 8-8).

Impact Significance

Based on the **medium sensitivity** of receptors and the **very low magnitude**, the potential impact of helicopter noise on the marine fauna is considered to be **low significance** without mitigation.

Identification of Mitigation Measures

The following measures will be implemented for helicopter activities:

No.	Mitigation measure	Classification
1	Pre-plan flight paths to ensure that no flying occurs over coastal seal colonies and seabird nesting areas	Avoid / abate on site
2	Avoid extensive low-altitude coastal flights by ensuring that the flight path is perpendicular to the coast, as far as possible	Avoid/ abate on site
3	Brief all pilots on the ecological risks associated with flying at a low level along the coast or above marine mammals	Avoid

Residual Impact Assessment

The generation of noise from the helicopter cannot be eliminated if the helicopter is required for personnel transfer or medivac. The proposed mitigation, specifically maintaining the regulated altitude over the coastal zone and MPAs and flying perpendicular to the coast would reduce the intensity of the impact to very low, but the residual impact will remain of **very low magnitude** and of **VERY LOW significance**.

Table 8-8: Impact of helicopter noise on coastal and marine fauna

Project Phase:	Operation	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	MEDIUM	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	VERY LOW	VERY LOW
Intensity	LOW	VERY LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM

Significance	VERY LOW	VERY LOW
Probability	POSSIBLE	UNLIKELY
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	VERY LOW
Cumulative potential	UNLIKELY	UNLIKELY

8.3.7 Impact on Intangible Cultural Heritage

Source of Impact

The project activities that could impact intangible cultural heritage are listed below:

Project phase	Activity
Mobilisation	Transit of vessels to survey area
Operation	Operation of survey vessels and transit between the survey area and Port of Gqeberha
	Seismic acquisition / Firing of the airguns
Demobilisation	Survey vessels leave survey area and transit to port or next destination

The normal operation of vessels may result in various discharges to sea, including galley waste, grey water, sewage, deck drainage, etc. This is, however, not unique to seismic surveys, but similar to any other vessel traveling along the South African coast. Seismic acquisition may result in the potential disturbance of ancestors who are believed to be situated on the seafloor, as soundwaves penetrate soil layers and reflect off the seafloor.

Potential Impact Description

Any impact on the integrity of the coastal and marine ecosystem through disturbance, pollution, noise, etc. could in turn impact various aspects that make up people's intangible cultural heritage (**indirect negative** impact). The impact assessment is summarised in Table 8-32.

Project Controls

CGG will ensure that the contractors undertake the survey operations in a manner consistent with good international industry practice and BAT. In addition, contractors will ensure that the proposed survey operations are undertaken in compliance with the applicable requirements in MARPOL 73/78.

Sensitivity of Receptors

The sensitivity of the receptor for this assessment has been defined based on the following receptors:

- Ancestry / spirituality receptor:** Sea is described as 'living' waters and is believed to play a critical role in spiritual and health management in indigenous groups specifically (First Peoples and Nguni). It is considered to be a living organism that forms part of and sustains a balanced ecosystem. Human connection with the ocean is through embodied experience, as well as culture. Any impact on these 'living' waters may, therefore, impact communication with the ancestors or its use as an emetic or in other ritual practices. The sensitivity of this receptor is considered as high, due to the intensity of use of the water for ancestral/spiritual reasons in the Eastern Cape province. It could, however, be mitigated with timely and relevant healer-diviner and First Peoples' Chief interventions. Rituals are performed according to community or individual needs.

- **Archaeology / Tangible heritage receptor:** The South African coastline has been shaped by human cultural relations and beliefs. There are archaeologically and culturally significant coastal sites along the South Coast that form part of the belief and ritual complex of the First Peoples and Nguni peoples. The sensitivity of this receptor is medium (as many sites are onshore and fall outside of the project area of influence and can be mitigated via avoidance of these areas where there are vulnerable archaeological sites).
- **Sense of Place receptor:** The sea provides and enhances unique 'senses of place'. This is the unique, social, aesthetic and cultural value of the place in the sea or next to the sea which may include intangible cultural heritage practices and beliefs. There are also naturally valuable sites inshore of the area, including Tsitsikamma, Plettenberg Bay and St Francis Bay that all have a unique sense of place. The unique sense of place is determined by specific cultural groups, such as the First Peoples, the Nguni peoples and also those defined as European descendants. The sensitivity of this receptor is medium to high because the area is used for multiple purposes (i.e. leisure, tourism, small-scale fisheries, ritual purposes), all contributing to a unique sense of place.
- **Livelihoods receptor:** Certain stakeholder groups display a high regard of the sea due to their spiritual and cultural connection with the ocean and are directly reliant on the ocean and coast for their livelihood (e.g., fishing, shellfish harvesting, leisure, tourism, etc). The sensitivity of this receptor is high because many coastal communities that rely on the ocean and coast for their livelihoods.
- **Natural heritage receptor:** People have a cultural relationship with the ocean and coast and this results in high cultural valuation of nature. Coastal sporting / leisure / tourism activities have become intangible cultural heritage for these communities, since the activities contain strong cultural elements (i.e. social grouping, ritual practices, commensality, unique identity, shared histories, etc.). Any impact on the integrity of the coastal and marine ecosystem could in turn impact people's natural heritage. The sensitivity of this receptor is medium since natural and cultural heritages are interdependent. Any pollution or other form of impact on the sea, arising during normal operations may impact natural phenomena (i.e. fish, shellfish, fynbos, mangroves, penguins, beach, etc.).
- **Health receptor:** People use the sea in cultural ways to improve, sustain and restore physical and mental health. Access to a healthy ocean is critical in this regard. Any impact on the ocean may affect the health of coastal communities who regularly access the sea to sustain physical and psychological health. The sensitivity of this receptor is medium.

The overall sensitivity of receptors during normal operations is assessed to be **medium to high**.

Impact Magnitude (or Consequence)

The intensity of the impact is considered to be **high** due to the current perceived impacts of exploration activities in the marine environment and that the Eastern Cape Province is a place where the majority of Nguni and Khoisan descendants live. The intensity is also based on the facts that (1) constitutionally South Africans have the right to culture and cultural expression, (2) there is recent national attention being given to the importance of coastal cultural heritage, and (3) South Africa is globally known for its safeguarding of indigenous rights via both ratified international agreements and domestic law. These facts make cultural heritage visible and make it a sensitive issue for the public. Consistent and substantive effort to include indigenous people and their input in the processes associated with normal operations will lessen the intensity of the impact. The potential impact is of **short-term** duration (4-5 months) and of **regional** extent. Thus, the magnitude (or consequence) is considered to be **medium**.

Impact Significance

Based on the **high sensitivity** of receptors and the **medium magnitude**, the potential impact on intangible cultural heritage is considered to be of **medium significance**.

Identification of Mitigation Measures

The following mitigation measures are recommended:

No.	Mitigation measure	Classification
1	Implement a comprehensive consultation with indigenous groupings and leadership, as well as those who fall outside this category. The aim of such engagement should ensure open communication, direct communication and consistent communication with stakeholders that may be affected by operations.	Avoid / Abate offsite
2	Implement, where necessary based on the outcome of the consultation process, a ritual event(s) that permits engagement with ancestral spirits and loving communities to alleviate potential and future negative impacts of non-consultation and poor cultural/nature respect.	Avoid / Abate on site
3	Implement a gender sensitive ritual event in each region that recognizes gendered coastal cultural heritage to permit all genders to articulate their cultural relation with the sea and coast	Abate
4	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.	Abate on site

Residual Impact Assessment

With the implementation of the mitigation measures, which includes appropriate consultation with relevant stakeholders and the possible implementation of ritual events, the intensity of the impact will reduce to **low** for those community members who accept the mitigation measures, leading to a residual impact of **LOW** significance.

Additional Assessment Criteria

The mitigation potential is **medium** and **partially reversible** due to potential negative perceptions, loss of resource is **low** and the cumulative potential is **likely**.

Table 8-9: Impact on Intangible Cultural Heritage

Project Phase:	Operation	
Type of Impact	Indirect	
Nature of Impact	Negative	
	Pre-Mitigation Impact	Residual Impact
Sensitivity of Receptor	HIGH	MEDIUM
Magnitude (Consequence)	MEDIUM	LOW
Intensity	HIGH	LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	MEDIUM	LOW
Probability	POSSIBLE	LIKELY
Confidence	HIGH	MEDIUM
Reversibility	PARTIALLY REVERSIBLE	PARTIALLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	MEDIUM

Cumulative potential	LIKELY	LIKELY
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8.4 SEISMIC ACQUISITION

8.4.1 Underwater Noise from Airguns

Source of Impact

Seismic acquisition will increase the underwater ambient noise levels during operation, as presented below:

Project phase	Activity
Mobilisation	N/A
Operation	Seismic acquisition / Firing of the airguns
Demobilisation	N/A

The operation of the airguns during surveying will introduce underwater noise into the surrounding water column that will contribute to and/or exceed ambient noise levels in the area.

A Sound Transmission Loss Modelling Study (see Appendix 4) was undertaken to predict the received noise levels of various metrics (e.g. Sound Exposure Levels (SELs) from single pulses, cumulative SELs from multiple pulses over 24 hours, peak Sound Pressure Levels (SPL) and Root-Mean-Square SPL (RMS SPL)) at locations within and adjacent to the survey area. These noise levels were then used to estimate the threshold distances to potential sound effects on marine fauna species of interest.

The airgun array for the proposed seismic survey is assumed to be the 2 965 cubic inch (CUI) Sercel G-Gun Source Array. The array consists of 30 active airgun units and has a towing depth of 7 m and an operating pressure of 2 000 pounds per square inch (PSI).

The primary output of an airgun source typically has most of the energy in the frequency bandwidth between 5 and 300 Hz. The source modelling result shows that the peak sound pressure level (Pk SPL) is 256.4 dB re 1 μ Pa @ 1m, the root-mean-square sound pressure level (RMS SPL) 252.8 dB re 1 μ Pa @ 1m with a 90%-energy pulse duration of 12.5 milliseconds, and the sound exposure level (SEL) 234.2 dB re μ Pa²-s @ 1m.

One of the required characteristics of a seismic shot is that it is of short duration (the main pulse is usually between 5 and 30 milliseconds in duration with a shot interval of 18.75 m). The main pulse is followed by a negative pressure reflection from the sea surface of several lower magnitude bubble pulses (see Figure 6-7).

The assessment of potential impacts on marine fauna and commercial fishing are presented in Sections 8.4.1.1 and 8.4.1.2, respectively.

8.4.1.1 Impact on Marine Fauna

Potential Impact Description

Project activities will increase the ambient noise levels in the vicinity of the survey vessel / airguns. Elevated noise levels could impact marine fauna by:

- Causing direct physical injury to hearing or other organs (**direct negative** impact), including permanent

(PTS)⁸ or temporary threshold shifts (TTS)⁹;

- Causing disturbance to the receptor resulting in behavioural changes or displacement from important feeding or breeding / spawning areas (**direct negative** impact).
- Masking or interfering with other biologically important sounds (e.g. communication, echolocation, signals and sounds produced by predators or prey) (**indirect negative** impact).

The assessment of potential impacts on the various faunal groups due to increased underwater ambient noise levels is presented in Sections 8.4.1.1.1 to 8.4.1.1.7 below.

Project Controls

The seismic contractor will ensure that the proposed survey is undertaken in a manner consistent with good international industry practice (e.g. JNCC guidelines) and BAT.

8.4.1.1.1 Cetaceans (Whales and Dolphins)

Sensitivity of Receptors

Between 28 and 38 species or sub species/populations of cetaceans (whales and dolphins) are known or likely to occur off the Southeast Coast (refer to Section 7.4.7). The majority of migratory cetaceans in South African waters are baleen whales (mysticetes), while toothed whales (odontocetes) may be resident or migratory. Of the 38 species, the blue whale is listed as 'Critically Endangered', the fin and sei whales and humpback dolphin are 'Endangered' and the sperm and Bryde's (inshore) whales are considered 'Vulnerable' (South African Red Data list Categories). Due to its location offshore and overlap with the main migration routes, the sensitivity of migratory cetaceans is considered to be **high**. The numbers of individuals encountered during the proposed survey are, however, likely to be low because of the extensive distributions of the various species concerned.

Impact Magnitude (or Consequence)

In the wide diversity of cetaceans (whales and dolphins) occurring off the Southeast Coast, there are marked differences in the hearing capabilities of odontocete and mysticete (baleen) cetaceans. Mysticetes hearing is centred at below 1 kHz (Low Frequency (LF)), overlapping the highest peaks of the power spectrum of airgun sounds and consequently these animals may be more affected by disturbance from seismic surveys. Odontocetes hearing is centred at frequencies of between 10 and 100 kHz (High Frequency (HF) or Very High Frequency (VHF)). These species may react to seismic shots at long ranges but hearing damage from seismic shots is only likely to occur at closer range.

Review of the available literature suggests that potential impacts of seismic pulses to whales and dolphins could include physiological injury, behavioural avoidance of the survey area, masking of environmental sounds and communication and indirect impacts due to effects on prey, as presented below.

Physiological Injury, Stress and Mortality

Exposure to high sound levels can result in physiological injury to cetaceans through a number of avenues, including shifts of hearing thresholds (PTS or TTS), tissue damage, acoustically induced decompression sickness (particularly in beaked whales), and non-auditory physiological effects (including elevated blood pressures,

⁸ A permanent threshold shift is a permanent shift in the auditory threshold, which results in permanent hearing loss.

⁹ A temporary threshold shift is a temporary shift in the auditory threshold, which results in temporary hearing loss.

increased heart and respiration rates, and temporary increases in blood catecholamines and glucocorticoids), which may have secondary impacts on reproduction.

Available information suggests that the animal would need to be in close proximity to operating airguns to suffer physiological injury and, being highly mobile, it is assumed that they would avoid sound sources at distances well beyond those at which injury is likely to occur. The cumulative zones of impact presented below are conservative, and since cetaceans are highly mobile, they are likely to have moved considerable distances away from the source over the cumulative survey period. Thus, cumulative effects would only be expected where the animals do not move away from the area, e.g. from specific coastal areas used as breeding and calving sites or mid-ocean focal sites such as seamounts. As the area interest is located more than 30 km from the coast and does not overlap with any seamounts (such as the Southwestern Indian Seamounts located south of the proposed survey area of interest), cumulative effects would not be expected.

Deep-diving cetacean species (e.g. sperm whales) may, however, be more susceptible to acoustic injury, as a seafloor-focussed seismic survey where the downward focussed impulses could trap these cetaceans within the survey pulse, as escaping towards the surface would result in exposure to higher sound level pulses.

Mysticetes: The Sound Transmission Loss Modelling Study undertaken for this project predicted that the mysticetes (or LF cetaceans) expected to occur in the area of interest (e.g. Southern right, humpback, fin, sei, blue, Bryde’s and minke whales) will experience PTS due to a single seismic pulse exposure effects within approximately 55 m from the source array at all assessed water depth scenarios, with the zone of a TTS predicted within approximately 120 m from the source array. LF cetaceans have the highest zones of PTS and TTS impact from multiple pulses (cumulative impact). The cumulative zone of PTS impact are predicted to range up to 800 m from the adjacent survey lines for the typical 24-hour survey operation scenario considered, with the zones of TTS impact predicted to be around 12 000 m from the adjacent survey lines (see Table 8-10). It must be kept in mind that the cumulative zones of impact are conservative, and that being highly mobile, whales and dolphins are thus likely to have moved considerable distances over the cumulative 24-hr period. As noted above, these cumulative effects would only be expected where the animals do not move away from the area, e.g. from specific coastal areas used as calving sites or from mid-ocean focal sites, which is unlikely in the area of interest.

Table 8-10: Zones of immediate impact from single pulses and multiple pulses (cumulative) for cetaceans

Type of animal	Zones of impact – maximum horizontal distances from source to impact threshold levels			
	Injury (PTS) onset		TTS onset	
	Immediate Impact from Single Pulses	Cumulative Impact from Multiple Pulses	Immediate Impact from Single Pulses	Cumulative Impact from Multiple Pulses
LF cetaceans	55 m	800 m	120 m	12 000 m
HF cetaceans	20 m	-	30 m	< 10 m
VHF cetaceans	480 m	80 m	850 m	4 000 m
Notes:				
<ul style="list-style-type: none"> • A dash indicates the threshold is not applicable. • If the zone of impact for cumulative is smaller than that for the single pulse, then the marine species are likely to be more sensitive to pressure impact than energy impact. 				

The majority of mysticete whales migrate to the southern African subcontinent to breed during winter months. Humpback whales migrating north reach the coast in the vicinity of Knysna on their northern migrations around

April, continuing through to September/October when the southern migration begins and continues through to December. Southern Right whales arrive in coastal waters in June, building up to a maximum in September/October and departing again in December. The area of interest lies within the migration paths of Humpback and Southern Right whales, but well offshore of the inshore coastal areas frequented by Southern Right whales for mating and breeding. As the survey is proposed for the austral summer months (January to May inclusive) encounters with migrating whales should be minimal. The current distribution of the offshore population of Bryde's whales implies that it is highly likely to be encountered in the proposed survey area during the summer survey period as it is resident on the Agulhas Bank year-round, only undertaking occasional small seasonal excursions up the east coast in winter during the annual sardine migration.

Should the proposed survey be undertaken during the key migration and breeding period (beginning of June to end of November, although not proposed) when there is a high likelihood of encountering migrating Humpback and Southern Right whales, the impact of potential physiological injury to mysticete cetaceans as a result of seismic sounds would be deemed to be of **high intensity**. Furthermore, as the duration of the impact would be limited to the **short-term** (five months) and be restricted to the survey area (**regional extent**), the potential for physiological injury would be considered to be of **medium magnitude for mysticetes**.

Odontocetes: Although for HF cetaceans (e.g. Sperm, Killer and Beaked whales and the diversity of dolphins) it is predicted that the cumulative PTS criteria for the 24-hour survey operation scenario would not be reached, the zones of TTS impact were predicted to be <10 m from the adjacent survey lines for the cumulative scenario considered (see

Table 8-10). In the case of VHF cetaceans (e.g. Heaviside's Dolphins, Pygmy Sperm Whale and Dwarf Sperm Whale), the zones of PTS impact for the cumulative scenario are predicted to be 80 m from the adjacent survey lines for the typical 24-hour survey operation scenario considered, with the zones of TTS impact predicted to be 4 000 from the adjacent survey lines (see Table 8-10).

The survey is likely to frequently encounter resident odontocetes such as Common Dolphins and Pilot whales, which are present year-round, and will likely encounter Sperm whales in the deeper offshore areas.

The impact of potential physiological injury to **odontocetes** as a result of seismic sounds is deemed to be of **high intensity**. As the duration of the impact would be limited to the **short-term** (five months) and be restricted to the survey area (**regional extent**), the potential for physiological injury is considered to be of **medium magnitude for resident odontocetes**.

Behavioural Avoidance

Avoidance of seismic survey activity by cetaceans, particularly mysticete species, begins at distances where levels of approximately 150 to 180 dB re 1 μ Pa are received, while subtle behavioural responses have been noted at received levels of 120 dB. The sound transmission loss modelling undertaken for this project identified that the zones of behavioural disturbance for cetaceans caused by the immediate exposure to individual seismic pulses was within 4.4 km from the array source.

Mysticetes: Although behavioural avoidance of seismic noise in the survey area by mysticete whales is highly likely, such avoidance is generally considered of minimal impact in relation to the distances of migrations of the majority of mysticete whale species.

The timing of the survey relative to seasonal breeding cycles (such as those observed in migrating mysticete whales) may influence the degree of stress induced by noise exposure. Displacement from critical habitat is

particularly important if the sound source is located at an optimal feeding or breeding ground or areas where mating, calving or nursing occurs. The area of interest overlaps with the migration routes of Humpback and Southern Right whales to and from their breeding grounds, but is located well offshore of the coastal breeding areas for Southern Right whales. Although encounter rates peak in migration periods, humpback whales are found off South Africa year-round. For other species, the paucity of fine scale data from offshore waters on the distribution and seasonal occurrence of most cetacean species prevents prediction where such critical habitat might be with any certainty. Other mysticete whale species are also found year-round or have seasonal occurrences, which confirms year-round presence of mysticetes. However, if the survey is scheduled to occur outside of the main winter migration periods (June - November), interactions with migrating whales should be low.

Of greater concern than general avoidance of migrating whales is avoidance of critical breeding habitat or area where mating, calving or nursing occurs. Humpback whales have their winter breeding concentrations off tropical East Africa, from northern KwaZulu-Natal northwards and, therefore, over 800 km to the north-east of the survey area. Southern Right whales currently have their most significant winter concentrations on the South Coast between Gqeberha and Cape Town. As the proposed survey area is located beyond the 150 m isobath, there should be no overlap with potential coastal nursery areas for this species.

Assuming the survey is undertaken during the key migration period (early June to late November; not proposed) when there is a high likelihood of encountering migrating Humpback whales and due to the increasing numbers of Southern Right and Humpback whales year round and the resident Bryde's whales, the potential impact of behavioural avoidance of seismic survey areas by mysticete cetaceans is considered to be of **high intensity**, across the survey area (**regional**) and for the **short term** duration of the survey (five months). Thus, the **magnitude** is considered to be **medium** for resident and migrating mysticete cetaceans.

Odontocetes: Information available on behavioural responses of toothed whales and dolphins to seismic surveys is more limited than that for baleen whales. No seasonal patterns of abundance are known for odontocetes occupying the survey area, but several species are considered to be year-round residents. Furthermore, a number of toothed whale species have a more pelagic distribution thus occurring further offshore, with species diversity and encounter rates likely to be highest on the shelf slope. The impact of seismic survey noise on the behaviour of toothed whales is considered to be of **high intensity** across the survey area (**regional**) and for the **short-term** duration of the survey (five months). The overall **magnitude** will however not vary between species and is considered to be **medium**.

Masking of Environmental Sounds and Communication

Mysticetes: Mysticete whales appear to vocalise almost exclusively within the frequency range of the maximum energy of seismic survey noise. In the migratory mysticete whale species, vocalisation increases once they reach the breeding grounds and on the return journey in November/December when accompanied by calves. Although most mother-calf pairs tend to follow a coastal route southward, there is no clear migration corridor and Humpback and Southern Right whales can be spread out widely across the shelf and into deeper pelagic waters. Vocalisation of southward migrating whales may thus potentially be regionally comparatively high on commencement of operations in December, reducing thereafter. However, masking of communication signals is likely to be limited by the low duty cycle of seismic pulses.

Assuming the survey is undertaken during the key mitigation and breeding period when there is a high likelihood of encountering migrating Humpback and Southern Right whales (including possible mother-calf pairs), the

intensity of impacts on baleen whales is likely to be **high**. Furthermore, as the duration of the impact would be limited to the **short-term** (five months) and be restricted to the survey area (**regional**), the **magnitude** is considered to be **medium** for mysticetes.

Odontocetes: Toothed whales vocalise at frequencies higher than the frequency range of the maximum energy of seismic survey noise. As the by-product noise in the mid- and high frequency range (up to and exceeding 15 kHz) can travel far (at least 8 km), masking of communication sounds produced by whistling dolphins and blackfish¹⁰ is likely.

The **intensity** of impacts on **toothed whales** is likely to be **medium**. As the duration of the impact would be limited to the **short-term** (five months) and be restricted to the survey area (**regional**), the **magnitude** is considered to be **medium** for resident odontocetes.

Effects on Prey

Mysticetes: The majority of mysticete whales will undertake little feeding within breeding-ground waters along the South Coast and rely on blubber reserves during their migrations.

Any indirect effects on mysticete food source would thus be of **negligible intensity**. The duration of the impact would be limited to the **short-term** (five months) and be restricted to the survey area (**regional**). Thus, the **magnitude** is considered to be **negligible** for mysticetes.

Odontocetes: As with other vertebrates, the assessment of indirect effects of seismic surveys on resident odontocete cetaceans is limited by the complexity of trophic pathways in the marine environment. Although the fish and cephalopod prey of toothed whales and dolphins may be affected by seismic surveys, impacts will be highly localised and small in relation to the feeding ranges of cetacean species.

The broad ranges of prey species (in relation to the avoidance patterns of seismic surveys of such prey species) suggest that indirect impacts due to effects on prey would be of **low intensity**. The duration of the impact would be limited to the **short-term** (five months) and be restricted to the survey area (**regional**). Thus, the **magnitude** is considered to be **very low** for odontocetes.

Impact Significance

Based on the **high sensitivity** of receptors and the **medium magnitude** of most of the effects, the worst potential impacts of seismic surveys on mysticete and odontocete cetaceans are of **medium significance** (see Table 8-11), except effects on prey which is of negligible to very low magnitude and of **very low significance** for odontocetes and **negligible** for mysticetes (see Table 8-11).

Identification of Mitigation Measures

In order to minimise the impact of the seismic operations on cetaceans, the following mitigation measures are recommended:

¹⁰The term blackfish refers to the delphinids: melon-headed whale, killer whale, pygmy killer whale, false killer whale, long-finned pilot whale, short-finned pilot whale.

No.	Mitigation measure	Classification
1. Survey Planning		
1.1	Ensure that survey plans exclude all data acquisition in declared Marine Protected Areas.	
1.2	Plan seismic survey to avoid the periods of movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (June to November inclusive) and ensure that migration paths are not blocked by seismic operations. Thus, surveying should, therefore, be undertaken between December and May (inclusive).	Avoid
1.3	Plan survey, as far as possible, so that the commencement of airgun firing in the survey area for the first time (including gun tests) is undertaken during daylight hours.	Abate on site
1.4	Prohibit the use of airguns (including airgun tests) outside the area of operation (which includes line turns).	Avoid
2. Key Equipment		
2.1 Passive Acoustic Monitoring (PAM)		
2.1.1	Ensure seismic vessel is fitted with PAM technology, which detects animals through their vocalisations.	Abate on site
2.1.2	As the area of interest would largely be in waters deeper than 1 000 m where sperm whales and other deep-diving odontocetes are likely to be encountered, implement PAM 24-hr a day when airguns are in operation.	Abate on site
2.1.3	Ensure the PAM streamer is fitted with at least four hydrophones, of which two are HF and two LF, to allow directional detection of cetaceans.	Abate on site
2.1.4	Ensure the PAM hydrophone streamer is towed in such a way that the interference of vessel noise is minimised.	Abate on site
2.1.5	Ensure spare PAM hydrophone streamers (e.g. 4 heavy tow cables and 6 hydrophone cables) are readily available in the event that PAM breaks down, in order to ensure timeous redeployment.	Abate on site
2.2 Acoustic Source		
2.2.1	Define and enforce the use of the lowest practicable airgun volume for production.	Abate on site
2.2.2	Ensure a display screen for the acoustic source operations is provided to the marine observers. All information relating to the activation of the acoustic source and the power output levels must be readily available to support the observers in real time via the display screen and to ensure that operational capacity is not exceeded.	Abate on site
2.2.3	Ensure the ramp-up noise volumes do not exceed the production volume.	Abate on site
3. Key Personnel		
3.1	Make provision for the placing of a qualified MMO are on board the seismic vessel. As a minimum, one must be on watch during daylight hours for the pre-shoot observations and when the acoustic source is active. Refer to Section 9.4.3 for the roles and responsibilities of the MMOs.	Abate on site
3.2	Make provision for the placing of a qualified PAM operators are on the seismic vessel. As a minimum, one must be on "watch" during the pre-shoot observations and when the acoustic source is active. Refer to Section 9.4.4 for the roles and responsibilities of the PAM operators.	Abate on site
3.3	Ensure MMOs and PAM operators are briefed on the area-specific sensitivities and on the seismic survey planning (including roles and responsibilities, and lines of communication).	Abate on site
4. Airgun Testing		
4.1	Maintain a pre-shoot watch of 60-minutes before any instances of airgun testing. If only a single lowest power airgun is tested, the pre-shoot watch period can be reduced to 30 minutes	Avoid / Abate on site
4.2	Implement a "soft-start" procedure if testing multiple airguns.	Avoid / Abate on site

No.	Mitigation measure	Classification
	<ul style="list-style-type: none"> The “soft-start” should be carried out over a time period proportional to the number of guns being tested and not exceed 20 minutes; airguns should be tested in order of increasing volume. If testing all airguns at the same time, a 20 minute “soft-start” is required. If testing a single lowest power airgun a “soft-start” is not required. 	
5. Pre-Start Protocols		
5.1	Implement a dedicated MMO and PAM pre-shoot watch of at least 60 minutes (to accommodate deep-diving species in water depths greater than 200 m).	Avoid / Abate on site
5.2	Implement a “soft-start” procedure of a minimum of 20 minutes’ duration on initiation of the seismic source if: <ul style="list-style-type: none"> during daylight hours it is confirmed: <ul style="list-style-type: none"> visually by the MMO during the pre-shoot watch (60 minutes) that there are no cetaceans within 800 m¹¹ of the seismic source, and by PAM technology that there are no vocalising cetaceans detected in the 800 m mitigation zone. during times of poor visibility or darkness it is confirmed by PAM technology that no vocalising cetaceans are present in the 800 m mitigation zone during the pre-shoot watch (60 minutes). 	Avoid / Abate on site
5.3	Delay “soft-starts” if cetaceans are observed within the mitigation zone. A “soft-start” should not begin until 30 minutes after cetaceans depart the mitigation zone or 30 minutes after they are last seen or acoustically detected by PAM in the mitigation zone.	Avoid / Abate on site
5.4	As noted above for planning, when arriving at the survey area for the first time, survey activities 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, the initial acoustic source activation (including gun tests) may only be undertaken if the normal 60-minute PAM pre-watch and “soft-start” procedures have been followed.	Avoid / Abate on site
5.5	Schedule “soft-starts” so as to minimise, as far as possible, the interval between reaching full power operation and commencing a survey line. The period between the end of the soft start and commencing with a survey line must not exceed 20 minutes. If it does exceed 20 minutes, refer to breaks in firing below.	Abate on site
6. Line Turns		
6.1	If line changes are expected to take longer than 40 minutes: <ul style="list-style-type: none"> Terminate airgun firing at the end of the survey line and implement a pre-shoot search (60 minutes) and “soft-start” procedure (20 minutes) when approaching the next survey line. If line turn is shorter than 80 minutes (i.e. shorter than a 60-minute pre-shoot watch and 20-minute “soft-start” combined), the pre-shoot watch can commence before the end of the previous survey line. 	Abate on site
6.2	If line changes are expected to take less than 40 minutes, airgun firing can continue during the line change if:	Abate on site

¹¹ JNCC guidelines include a recommended 500 m mitigation zone. Based on the findings of the noise modelling study, the decision was made to follow a more conservative approach and implement a mitigation zone of 800 m. It must be noted that for VHF cetaceans to experience TTS at a distance of up to 850 m at full power would be unlikely when implementing the soft-start procedure which, provides them the opportunity to leave the area.

No.	Mitigation measure	Classification
	<ul style="list-style-type: none"> The power is reduced to 180 cubic inches (or as close as is practically feasible) at standard pressure. Airgun volumes of less than 180 cubic inches can continue to fire at their operational volume and pressure; The Shot Point Interval (SPI) is increased to provide a longer duration between shots, with the SPI not to exceed 5 minutes; The power is increased and the SPI is decreased in uniform stages during the final 10 minutes of the line change (or geophone repositioning), prior to data collection re-commencing (i.e. a form of mini soft start); and Normal MMO and PAM observations continue during this period when reduced power airgun is firing. 	
7. Shut-Downs		
7.1	Terminate seismic shooting on: <ul style="list-style-type: none"> Observation and/or detection of cetaceans within the 800 m mitigation zone. Observation of any obvious mortality or injuries to cetaceans when estimated by the MMO to be as a direct result of the survey. 	Abate on site
7.2	For cetaceans, terminate shooting until such time as there has been a 30-minute delay from the time the animal was last sighted within the mitigation zone before the commencement of the normal soft start procedure.	Abate on site
8. Breaks in Airgun Firing		
8.1	If after breaks in firing, airguns can be restarted within 5 minutes , no soft-start is required and firing can recommence at the same power level provided no marine mammals have been observed or detected in the mitigation zone during the break-down period.	Abate on site
8.2	For all breaks in airgun firing of longer than 5 minutes, but less than 20 minutes , implement a “soft-start” of similar duration, assuming there is continuous observation by the MMO and PAM operator during the break.	Abate on site
8.3	For all breaks in firing of 20 minutes or longer , implement a 60-minute pre-shoot watch and 20-minute “soft-start” procedure prior to the survey operation continuing.	Abate on site
8.4	For planned breaks, ensure that there is good communication between the seismic contractor and MMOs and PAM operators in order for all parties to be aware of these breaks and that early commencement of pre-watch periods can be implemented to limit delays.	Abate on site
9. PAM Malfunctions		
9.1	If the PAM system malfunctions or becomes damaged during night-time operations or periods of low visibility , continue operations for 30 minutes without PAM if no marine mammals were detected by PAM in the mitigation zones in the previous 2 hours, while the PAM operator diagnoses the issue. If after 30 minutes the diagnosis indicates that the PAM gear must be repaired to solve the problem, reduce power to 180 cubic inches. Firing of the reduced power gun may continue for 30 minutes while PAM is being repaired, the last 10 minutes of which is a ramp up to full power (mini “soft-start”). If the PAM diagnosis and repair will take longer than 60 minutes, stop surveying until daylight hours or such time as a functional PAM system can be redeployed and tested.	Abate on site
9.2	If the PAM system breaks down during daylight hours , continue operations for 20 minutes without PAM, while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM gear must be repaired to solve the problem, operations may continue for an additional 2 hours without PAM monitoring as long as: <ul style="list-style-type: none"> No marine mammals were detected by PAM in the mitigation zones in the previous 2 hours; MMO to maintain watch at all times during operations when PAM is not operational; and 	Abate on site

No.	Mitigation measure	Classification
	<ul style="list-style-type: none"> The time and location in which operations began and stop without an active PAM system is recorded. 	

Residual Impact Assessment

The potential impacts cannot be eliminated due to the nature of the seismic sound source required during surveying. The proposed mitigation measures, which are designed to keep animals out of the immediate area of impact and thereby reduce the risk of deliberate injury to marine mammals would reduce the intensity of most impacts from high to medium for both mysticetes and odontocetes. Thus, the residual impacts will reduce to **low magnitude** and **LOW significance** (see Table 8-11) reflecting the most conservative case), except for the effects on prey which remains of **VERY LOW significance (odontocetes)** and **NEGLIGIBLE (mysticetes)**.

Table 8-11: Impact on cetaceans from seismic noise

Project Phase:	Operation	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	HIGH	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	MEDIUM	LOW
Intensity	HIGH	MEDIUM
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	MEDIUM	LOW
Probability	HIGHLY LIKELY	POSSIBLE
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	MEDIUM
Cumulative potential	UNLIKELY	UNLIKELY

8.4.1.1.2 Seals

Sensitivity of Receptors

In the vicinity of the area of interest, Cape Fur seals (classified as Least Concern) occur at colonies at Black Rocks (Bird Island group) in Algoa Bay and at the Robberg Peninsula. These colonies all fall well inshore (90 km and 120 km) of the proposed survey area of interest. Seals are highly mobile animals covering the continental shelf up to approximately 220 km offshore and could thus be encountered in the inshore areas of the area of interest. Their sensitivity to the proposed seismic survey operations is, however, considered to be **low**.

Impact Magnitude (or Consequence)

Review of the available literature suggests that potential impacts of seismic pulses to Cape Fur seals could include physiological injury, behavioural avoidance of the seismic survey area, masking of environmental sounds and underwater communication and indirect impacts due to effects on predators or prey.

Physiological Injury and Mortality

The physiological effects of loud low frequency sounds on seals are not well documented, but include cochlear lesions following rapid rise time explosive blasts and TTS with recovery to baseline threshold levels within 24 hr of noise exposure. Due to the high level of impulsive signal emissions from seismic arrays, seals are predicted to experience a permanent auditory threshold shift (PTS) at close proximity to the sound source due to the immediate exposure to individual pulses.

The potential for physiological injury to seals from seismic noise is expected to be low as it is assumed that highly mobile creatures such as fur seals would avoid severe sound sources at levels well below those at which discomfort occurs, although Cape fur seals have been recorded to approach operational seismic survey gear. Their tendency to swim at or near the surface would expose them to reduced sound levels when in close proximity to an operating airgun array.

Based on the noise exposure criteria provided by Southall *et al.* (2019), the Sound Transmission Loss Modelling Study predicts that the maximum horizontal threshold distance for potential mortal injury (PTS) and TTS from a single pulse to other marine carnivores (seals) is within 20 m and 25 m of the airgun, respectively. Maximum threshold distance for recoverable injury from multiple pulses were not reached but for TTS the maximum threshold distance for the cumulative scenario was < 10 m. The zones of impact for PTS and TTS are presented in Table 8-12.

As seals are known to forage up to 220 km offshore, the area of interest would fall within the foraging range of seals from the Southeast Coast colonies. The **intensity** of potential physiological injury is rated as **high**. The duration of the impact would be limited to the **short-term** (five months) and be restricted to the survey area (**regional extent**). The potential physiological injury or mortality of seals is considered to be of **medium magnitude**.

Table 8-12: Zones of immediate impact from single pulses and multiple pulses (cumulative) for other marine carnivores (seals)

Type of animal	Zones of impact – maximum horizontal distances from source to impact threshold levels			
	Injury (PTS) onset		TTS onset	
	Immediate Impact from Single Pulses	Cumulative Impact from Multiple Pulses	Immediate Impact from Single Pulses	Cumulative Impact from Multiple Pulses
Other marine carnivores in water	25 m	-	35 m	< 10 m

Notes:

- A dash indicates the threshold is not applicable.
- If the zone of impact for cumulative is smaller than that for the single pulse, then the marine species are likely to be more sensitive to pressure impact than energy impact.

Behavioural Avoidance

Reports of studies conducted with Harbour and Grey seals include initial startle reaction to airgun arrays, and range from partial avoidance of the area close to the vessel (within 150 m) to fright response (dramatic reduction in heart rate), followed by a clear change in behaviour, with shorter erratic dives, rapid movement away from the noise source and a complete disruption of foraging behaviour. In most cases, however, individuals quickly reverted to normal behaviour once the seismic shooting ceased and did not appear to avoid the survey area.

Seals seem to show adaptive responses by moving away from airguns and reducing the risk of sustaining hearing damage.

Although partial avoidance (to less than 250 m) of operating airguns has been recorded for some seal species, Cape Fur seals appear to be relatively tolerant to loud noise pulses and, despite an initial startle reaction, individuals quickly reverted back to normal behaviour. The potential impact of seal foraging behaviour changing in response to seismic surveys is thus considered to be of **very low intensity**, as they are known to show a tolerance to loud noises. Furthermore, as the duration of the impact would be limited to the **short-term** (five months) and be restricted to the survey area (**regional**). The potential for behavioural avoidance of seals is considered to be of **very low magnitude**.

Masking of Environmental Sounds and Communication

The use of underwater sounds for environmental interpretation and communication by Cape Fur seals is unknown, although masking is likely to be limited by the low duty cycle of seismic pulses (18.75 m interval between consecutive shot-points). The potential impact of masking of sounds and communication in seals due to seismic noise is considered to be of **very low intensity**, as they are known to show a tolerance to loud noises. As the duration of the impact would be limited to the **short-term** (five months) and be restricted to the survey area (**regional**), the potential for masking of sounds is considered to be of **very low magnitude**.

Effects on Predators or Prey

As with other vertebrates, the assessment of indirect effects of seismic surveys on Cape Fur seals is limited by the complexity of trophic pathways in the marine environment. The impacts are difficult to determine and depends on the diet make-up of the species (and the flexibility of the diet), and the effect of seismic surveys on the diet species. Seals typically forage on small pelagic shoaling fish prey species that occur inshore of the 200 m depth contour and thus mainly inshore of the area of interest. Furthermore, the broad ranges of fish prey species (in relation to the avoidance patterns of seismic surveys of such prey species) and the extended foraging ranges of Cape Fur seals suggest that indirect impacts due to effects on predators or prey would be of **very low intensity**, would be limited to the **short-term** (five months) and be restricted to the survey area (**regional**). The potential for effects of seismic surveys on prey species is thus considered to be of **very low magnitude**.

Impact Significance

Based on the **low sensitivity** of receptors and the **medium to very low magnitude**, potential impacts on seals range from **low significance** (physiological injury and mortality) (see Table 8-13 reflecting the most conservative case) to **negligible significance** (behaviour, masking and effects on prey).

Identification of Mitigation Measures

In addition to the mitigation recommended for cetaceans (see Section 8.4.1.1.1), the following is recommended for seals during a seismic survey:

No.	Mitigation measure	Classification
1	Implement a “soft-start” procedure of a minimum of 20 minutes’ duration on initiation of the seismic source if during daylight hours it is confirmed visually by the MMO during the pre-shoot watch (60 minutes) that there are no seals within 800 m of the seismic source.	Avoid / Abate on site
2	In the case of fur seals being observed within the mitigation zone, which may occur commonly around the vessel, delay “soft-starts” for at least 10 minutes until it has been confirmed that the mitigation zone is clear of all seal activity. However, if after a period of 10 minutes seals are still	Avoid / Abate on site

No.	Mitigation measure	Classification
	observed within 800 m of the airguns, the normal “soft-start” procedure should be allowed to commence for at least a 20-minute duration. Seal activity should be carefully monitored during “soft-starts” to determine if they display any obvious negative responses to the airguns and gear or if there are any signs of injury or mortality as a direct result of the seismic activities.	
3	Terminate seismic shooting on observation of any obvious mortality or injuries to seals when estimated by the MMO to be as a direct result of the survey.	Abate on site

Residual Impact Assessment

The potential impacts cannot be eliminated due to the nature of the seismic sound sources required during surveying. With the implementation of the mitigation measures, the intensity of the impact of physiological injury and mortality reduces to medium, thereby reducing **magnitude** to **low** and overall **significance** to **VERY LOW**. All other impacts on seals remain of **NEGLIGIBLE significance** (see Table 8-13).

Table 8-13: Impact on seals from seismic noise

Project Phase:	Operation	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	LOW	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	MEDIUM	LOW
Intensity	HIGH	MEDIUM
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	LOW	VERY LOW
Probability	POSSIBLE	POSSIBLE
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	MEDIUM
Cumulative potential	UNLIKELY	UNLIKELY

8.4.1.1.3 Turtles

Sensitivity of Receptors

The leatherback and loggerhead turtles that occur in offshore and coastal waters around southern Africa, and likely to be encountered in the Reconnaissance Permit Area are considered regionally ‘Critically Endangered’ and ‘Endangered’, respectively, in the List of Marine Threatened or Protected Species (TOPS) as part of the NEMBA. Following nesting in December-January, loggerhead turtles migrate back to their foraging grounds with studies suggesting that turtles travel from iSimangaliso to Gqeberha (formerly Gqeberha) over a one month period (Harris *et al.* 2018). Hatchlings of both species emerge from their nests from mid-January to mid-March with

most dispersing south-westward within the Agulhas Current (Le Gouvello *et al.* 2020b). The Agulhas Current migration corridor will therefore be very active with migrating sea turtles between January and April (Harris *et al.* 2018). At estimated mean hatchling dispersal rates of 0.54 km/h for loggerheads and 1.08 km/h for leatherbacks (Le Gouvello *et al.* 2020b), loggerheads would take 70-80 days and leatherbacks 30-40 days to reach the Reconnaissance Permit Area. Hatchlings would therefore be expected to be passing by or through the exploration area from mid-March to late-April. Despite their extensive distributions and feeding ranges, the numbers of adult and neonate turtles encountered in the Reconnaissance Permit area are therefore likely to be seasonally high. Consequently, the sensitivity of turtles to seismic noise is considered to be **high**, particularly neonates and juveniles as they are unable to actively avoid seismic sounds and consequently are more susceptible to seismic noise.

Impact Magnitude (or Consequence)

Available data on marine turtle hearing is limited but suggest highest auditory sensitivity at frequencies of 250 - 700 Hz, and some sensitivity to frequencies at least as low as 60 Hz. More recent studies using electrophysiological and behavioural techniques have found that turtles can detect frequencies between 50 Hz and 1 600 Hz, indicating that their hearing ranges overlap with the peak amplitude, low frequency sound emitted by seismic airguns (10–500 Hz). The overlap of this hearing sensitivity with the higher frequencies produced by airguns, suggest that turtles may be significantly affected by seismic noise.

Potential impacts of seismic pulses to turtles could include physiological injury and mortality, behavioural avoidance of seismic survey areas, masking of environmental sounds and communication and indirect impacts due to effects on prey.

Physiological Injury and Mortality

Evidence suggests that turtles only detect airguns at close range (<10 m) or are not sufficiently mobile to move away from approaching airgun arrays (particularly if basking). Initiation of a sound source at full power in the immediate vicinity of a swimming or basking turtle would thus be expected to result in physiological injury. This applies particularly to hatchlings and juveniles as they would be unable to avoid seismic sounds whilst being transported in the ocean currents. The abundance of adult turtles in the proposed survey area of interest is considered to be relatively low.

If subjected to seismic sounds at close range, temporary or permanent hearing impairment may result, but it is unlikely to cause death or life-threatening injury. As with other large mobile marine vertebrates, it is assumed that sea turtles will avoid seismic noise at levels/distances where the noise is a discomfort. Juvenile turtles may, however, be unable to avoid seismic sounds in the open ocean, and consequently may be more susceptible.

Based on the noise exposure criteria provided by Popper *et al.* (2014), the Sound Transmission Loss Modelling Study predicts that the maximum horizontal threshold distance for mortality or potential mortal injury (PTS) to sea turtles for single pulse is within 240 m of the airgun. The zone of cumulative impact from multiple pulses is estimated as < 10 m for mortality and potential mortal injury. Maximum threshold distances for recoverable injury and TTS from multiple pulses are not reached. The zones of seismic impact for PTS, TTS and recovery injury are presented in Table 8-14. It must be kept in mind that the cumulative zones of impact are conservative, as any turtles likely to be encountered in the proposed survey area of interest are the highly migratory, and are likely to have moved considerable distances over the cumulative 24-hr period.

Table 8-14: Zones of immediate impact from seismic single pulses and multiple pulses (cumulative) for turtles

Type of animal	Zones of impact – maximum horizontal distances from source to impact threshold levels				
	Mortality & Mortal Injury		Recovery injury		TTS
	Immediate Impact from Single Pulses	Cumulative Impact from Multiple Pulses	Immediate Impact from Single Pulses	Cumulative Impact from Multiple Pulses	Cumulative impact From Multiple Pulses
Sea turtles	240 m	< 10 m	-	-	-
Notes:					
<ul style="list-style-type: none"> • A dash indicates the threshold is not applicable. • If the zone of impact for cumulative is smaller than that for the single pulse, then the marine species are likely to be more sensitive to pressure impact than energy impact. 					

As the breeding areas for Leatherback turtles occur over 500 km to the north of the area of interest on the northern KwaZulu Natal coast, turtles encountered during the survey(s) are likely to be migrating vagrants. Despite their extensive distributions and feeding ranges and that the number of turtles encountered in the survey area is expected to be low, the **intensity** of potential physiological injury would be rated as **high** for both adults and hatchlings/juveniles. Furthermore, the duration of the impact on the population would be limited to the **short-term** (five months) and be restricted to the survey area (**regional extent**). The potential physiological injury or mortality of turtles is considered to be of **medium magnitude**.

Behavioural Avoidance

Behavioural changes in response to anthropogenic sounds have been reported for some sea turtles. Controlled exposure experiments on captive turtles found an increase in swim speed and erratic behaviour indicative of avoidance, at received airgun sound levels of 166 – 176 dB re 1 µPa. Sounds of frequency of 250 and 500 Hz resulted in a startle response from a loggerhead turtle, and avoidance by 30 m of operating airguns where the received level would have been in the order of 175 - 176 dB re 1 µPa. Further trials carried out on caged Loggerhead and Green Turtles indicated that significant avoidance response occurred at received levels ranging between 172 and 176 dB re 1 µPa at 24 m.

Based on the noise exposure criteria provided by Popper *et al.* (2014), the Sound Transmission Loss Modelling Study predicts that the zone of behavioural disturbance for sea turtles caused by the immediate exposure to individual pulses is predicted to be within 3.1 km from the array source. Turtles can, therefore, hear seismic sounds at a considerable distance and may respond by altering their swimming/basking behaviour or alter their migration route. However, as the number of turtles encountered in the survey area is expected to be low, the impact of seismic sounds on turtle behaviour would be of **low intensity**, and would persist only for the **short-term** duration of the survey (five months), and be restricted to the survey area (**regional**). The impact of seismic noise on turtle behaviour is thus deemed to be of **very low magnitude**.

Masking of Environmental Sounds and Communication

Breeding sea turtles undertake large migrations between distant foraging areas and their nesting sites (within the summer months October to March, with peak nesting during December and January). Although it is speculated that turtles may use acoustic cues for navigation during migrations, information on turtle communication is lacking. The effect of seismic noise in masking environmental cues such as surf noise (150-500

Hz), which overlaps the frequencies of optimal hearing in turtles, is unknown and speculative. As the breeding areas for Leatherback turtles occur over 500 km north of the proposed survey area on the northern KwaZulu Natal coast, turtles encountered during the survey(s) are likely to be migrating vagrants or hatchlings/juveniles being carried by the current.

Their low abundance in the survey area would suggest that the impact, should it occur, would be of **very low intensity**. As the impact would persist only for the **short-term** duration of the survey (five months) and be restricted to the survey area (**regional**), the impact is deemed to be of **very low magnitude**.

Effects on Predators or Prey

As with other vertebrates, the assessment of indirect effects of seismic surveys on turtles is limited by the complexity of trophic pathways in the marine environment. The Leatherback Turtles eat pelagic prey, primarily jellyfish, while loggerhead, green and hawksbill turtles tend to feed on inshore reefs. The low numbers and the broad ranges of potential prey species and extensive ranges over which most turtles feed suggest that indirect impacts would be of **very low intensity**, persisting only for the **short-term** duration of the survey (five months) and restricted to the survey area (**regional**). The impact would therefore be of **very low magnitude**.

Impact Significance

Based on the **medium to high sensitivity** of receptors and the **medium to very low magnitude**, potential impacts on turtles (adults and hatchlings/juveniles) range from **medium significance** (physiological injury and mortality) (see Table 8-15 reflecting the most conservative case) to **very low significance** (masking of sounds and effects on predators or prey).

Identification of Mitigation Measures

In addition to the mitigation recommended for cetaceans (see Section 8.4.1.1.1), the following is recommended for sea turtles during a seismic survey:

No.	Mitigation measure	Classification
1	Implement a "soft-start" procedure of a minimum of 20 minutes' duration on initiation of the seismic source if during daylight hours it is confirmed visually by the MMO during the pre-shoot watch (60 minutes) that there are no turtles within 800 m of the seismic source.	Avoid / Abate on site
2	In the case of turtles being observed within the mitigation zone, delay the "soft-start" until animals are outside the 800 m mitigation zone.	Avoid / Abate on site
3	Terminate seismic shooting on: <ul style="list-style-type: none"> • observation of turtles within the 800 m mitigation zone. • observation of any obvious mortality or injuries to turtles when estimated by the MMO to be as a direct result of the survey. For turtles, terminate shooting until such time as the animals are outside of the 800 m mitigation zone (seismic "pause", no soft-start required).	Abate on site

Residual Impact Assessment

The potential impacts cannot be eliminated due to the nature of the seismic sound source required during surveying. With the implementation of the mitigation measures, the intensity of the impact of physiological Injury on adult turtles reduces to medium, thereby reducing **magnitude** to **low** and overall **significance** to **LOW**. All other impacts on turtles remain of **VERY LOW significance** (see Table 8-15). As it would

not be feasible to completely avoid the March – April period in which hatchling turtles might be encountered in the area, the residual impact on hatchling turtles would remain of **MEDIUM** significance.

Table 8-15: Impact on sea turtles from seismic noise

Project Phase:	Operation	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	MEDIUM	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	MEDIUM	LOW
Intensity	HIGH	MEDIUM
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	MEDIUM (adults & hatchlings)	LOW (adults)
		MEDIUM (hatchlings)
Probability	LIKELY	POSSIBLE
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	MEDIUM
Cumulative potential	UNLIKELY	UNLIKELY

8.4.1.1.4 Diving Seabirds

Sensitivity of Receptors

Among the marine avifauna occurring along the Southeast Coast of South Africa, it is only diving birds or birds which rest on the water surface that may be affected by the underwater noise of seismic surveys. The African Penguin occurs along the Southeastern Cape coastline and would be particularly susceptible to impacts from underwater seismic noise. Similarly, Cape Gannets dive for their pelagic prey and would be susceptible to seismic noise.

African Penguin colonies in the vicinity of the Reconnaissance Permit Area occur at Cape Recife, and on the Algoa Bay islands (St Croix Island, Jaheel Island, Bird Island, Seal Island, Stag Island and Brenton Rocks). This species forages at sea with most birds being found within 20 km of the coast (see Figure 7-34). The majority of Cape Cormorants and Algoa Bay penguins forage to the south and east of Cape Recife and thus inshore of the area of interest. During their pre- and post-moult periods (October to March) penguins forage between Cape Recife and the Robberg Peninsula, also inshore of the area of interest. Cape Cormorants and African Penguins are therefore unlikely to be encountered in the area of interest for surveying (see Figure 7-33 and Figure 7-34). Cape Gannets are known to forage within 200 km offshore and are thus likely to be encountered in the inshore portions of the area of interest (see Figure 7-33).

All three species are considered ‘endangered’ on a national and global scale. Of the pelagic seabirds likely to occur in the offshore regions characterising the area of interest, many are considered regionally ‘vulnerable’ (e.g. wandering albatross, white-chinned petrel) and ‘endangered’ (e.g. Atlantic and Indian yellow-nosed albatross, subantarctic skua, African penguin). However, due to their extensive distributions and feeding ranges, the

numbers of individuals encountered during the survey are likely to be low. Consequently, the sensitivity for both coastal and pelagic seabirds is considered to be **medium**.

Impact Magnitude (or Consequence)

Birds are well known for their acoustic communication and hearing abilities, but psychophysical or behavioural data on how birds hear or react to sound underwater is currently lacking. Potential impacts of seismic pulses to diving birds could include physiological injury, behavioural avoidance of seismic survey areas and indirect impacts due to effects on prey.

Physiological Injury and Mortality

Based on available evidence, diving seabird would be able to hear seismic sounds at considerable distances and consequently, being all highly mobile, would be able to flee from approaching seismic noise sources at distances well beyond those that could cause physiological injury. Thus, the potential for physiological injury to diving seabirds from seismic surveys in the open ocean is deemed to be low, particularly given the extensive feeding range of the potentially affected species. However, the initiation of a sound source at full power in the immediate vicinity of feeding diving seabirds could result in injury or mortality where feeding behaviour override a flight response to seismic survey sounds.

Of the plunge diving species that occur along the Southeast Coast, the Cape Gannet regularly feeds as far offshore as 100 km, the rest foraging in nearshore areas up to 40 km from the coast, although Cape Cormorants have been reported up to 80 km from their colonies. The nearest Cape Gannet nesting grounds are at Bird Island in Algoa Bay, approximately 90 km inshore of the northeastern boundary of the area of interest. This species forages at sea with most birds being found within 20 km of the coast, although individuals have been recorded as far as 70 km offshore. As the area of interest is situated 45 km from the coast at its nearest point, encounters with Cape Gannets are possible, but encounters with African penguins and Cape Cormorants are unlikely as most birds are found within 20 km of the coast. In the offshore environment, pelagic seabirds that dive for their prey may be encountered.

Should an encounter with diving pelagic seabirds occur, the potential impact on individual pelagic and coastal diving birds would be of **high intensity**, but as the likelihood of encountering large numbers of diving seabirds is low, due to their extensive distributions and feeding ranges the intensity is considered **medium**. The duration of the impact on the population would be limited to the **short-term** (five months) and be restricted to the survey area (**regional extent**). The potential for physiological injury is therefore considered to be of **low magnitude**.

Behavioural Avoidance

Diving birds would be expected to hear seismic sounds at considerable distances as they have good hearing at low frequencies (which coincide with seismic shots). Response distances are speculative as no empirical evidence is available. However, evidence from studies on the interaction of African Penguins with seismic operations within 100 km of their colonies at Bird and St Croix Islands in Algoa Bay, suggest that behavioural avoidance of preferred foraging areas by diving individuals, could extend to as far as 100 km from the survey vessel. Birds were found to revert to normal foraging behaviour after seismic operations ceased.

For penguins who spend considerable time underwater while hunting, the impact zone for behavioural disturbance may, however, be larger than for plunge diving species that undertake short dives only before returning to the sea surface.

Due to the extensive distribution and feeding ranges of pelagic seabirds, the impact is considered to be of **low intensity**. For Cape Cormorants, African penguins and Cape gannets, the impact would be of **medium intensity**, as there is a likelihood of encountering feeding birds in the inshore portions of the survey area of interest. The duration of the impact on diving seabirds would be limited to the **short-term** (five months) and be restricted to the survey area (**regional**). The potential for behavioural avoidance is therefore considered to be of **very low magnitude** for pelagic diving seabirds and **low magnitude** for coastal diving seabirds.

Effects on Prey

As with other vertebrates, the assessment of indirect effects of seismic surveys on diving seabirds is limited by the complexity of trophic pathways in the marine environment. The impacts are difficult to determine and depend on the diet make-up of the bird species concerned and the effect of seismic surveys on the diet species. With few exceptions, most plunge-diving birds forage on small shoaling fish prey species that typically occur relatively close to the shore (<200 m depth) and thus mainly inshore of the area of interest. No information is available on the feeding success of diving seabirds in association with seismic survey noise. Although, seismic surveys have been reported to affect fish catches up to 30 km from the sound source, with effects persisting for a duration of up to 10 days, for the current proposed survey relatively low behavioural risks are expected for fish species at far-field distances (thousands of metres). This could have implications for plunge-diving seabirds such as African penguins that forage in restricted areas within a given radius of their breeding sites. Similarly, pelagic seabirds that feed around oceanic fronts may also be affected.

The broad ranges of potential fish prey species (in relation to potential avoidance patterns of seismic surveys of such prey species) and extensive ranges over which most seabirds feed, however, suggest the **intensity** of the impact is **very low** within the survey area (**regional**) over the **short-term** duration of the survey period (five months). Thus, the **magnitude** is **very low**.

Impact Significance

Based on the **medium sensitivity** of receptors and the **low magnitude**, the potential physiological impact on diving seabirds and behaviour avoidance of coastal diving seabirds (African penguins and Cape gannets) is of **low significance** (see Table 8-16 reflecting the most conservative case). The remainder of the impacts, considering a **medium sensitivity** and **very low magnitude**, are of **very low significance**.

Identification of Mitigation Measures

In addition to the mitigation recommended for cetaceans (see Section 8.4.1.1.1), the following is recommended for penguins and feeding aggregations of diving seabirds during seismic survey:

No.	Mitigation measure	Classification
1	Implement a "soft-start" procedure of a minimum of 20 minutes' duration on initiation of the seismic source if during daylight hours it is confirmed visually by the MMO during the pre-shoot watch (60 minutes) that there are no penguins or feeding aggregations of diving seabirds within 800 m of the seismic source.	Avoid / Abate on site
2	In the case of penguins and diving seabirds being observed within the mitigation zone, delay the "soft-start" until animals are outside the 800 m mitigation zone.	Avoid / Abate on site
3	Terminate seismic shooting on observation of penguins or feeding aggregations of diving seabirds within the 800 m mitigation zone. For penguins and feeding aggregations of diving seabirds, terminate shooting until such time as the animals are outside of the 800 m mitigation zone (seismic "pause", no soft-start required).	Abate on site

Residual Impact Assessment

The potential impacts cannot be eliminated due to the nature of the seismic sound source required during surveying. With the implementation of the mitigation measures, the intensity of the impact of physiological injury and behavioural avoidance reduces to low, thereby reducing **magnitude to very low** and overall significance to **VERY LOW** (see Table 8-16). All other impacts on feeding aggregations of diving seabirds remain of **VERY LOW significance**.

Table 8-16: Impact on penguins and feeding aggregations of diving seabirds from seismic noise

Project Phase:	Operation	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	MEDIUM	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	LOW	VERY LOW
Intensity	MEDIUM	LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	LOW	VERY LOW
Probability	LIKELY	POSSIBLE
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	MEDIUM
Cumulative potential	UNLIKELY	UNLIKELY

8.4.1.1.5 Fish

Sensitivity of Receptors

The greatest risk of physiological injury from seismic sound sources is for species that establish home ranges on shallow- or deep-water reefs or congregate in areas to spawn or feed, and those displaying an instinctive alarm response to hide on the seabed or in the reef rather than flee. Such species would be associated with the seabed (at >200 m) or with the Kingklip Ridge and Kingklip Koppies deepwater reefs. The fish most likely to be encountered on the shelf, beyond the shelf break and in the offshore waters of the area of interest are the large migratory pelagic species. In many of the large pelagic species, the swim-bladders are either underdeveloped or absent, and the risk of physiological injury through damage of this organ is therefore lower.

Many of the large pelagic fish and shark species likely to occur in the offshore regions along the Southeast Coast are considered globally ‘vulnerable’ (e.g. bigeye tuna, blue marlin, great hammerhead shark, pelagic thresher, bigeye thresher and common thresher sharks, dusky shark, great white shark, longfin mako), ‘endangered’ (e.g. shortfin mako, whale shark) and ‘critically endangered’ (Southern bluefin tuna). However, the numbers of individuals encountered during the survey are likely to be low, even when these species are *en route* to or from recognised feeding grounds associated with the Agulhas Bank or the Southwest Indian Seamounts to the south of the area of interest where a greater concentration of pelagic fish can be expected. The sensitivity of fish to seismic noise is considered to be **high**.

Impact Magnitude (or Consequence)

The potential impact of seismic noise on fish eggs and larvae is discussed under Section 8.4.1.1.7 (plankton, including ichthyoplankton) below. Thus, this section discusses the impact on adult fish only.

Most species of fish and elasmobranchs are able to detect sounds from well below 50 Hz to upward of 500 - 1 000 Hz, and consequently can detect sounds within the frequency range of most widely occurring anthropogenic noises. Within the frequency range of 100 - 1 000 Hz at which most fish hear best, hearing thresholds vary considerably (50 and 110 dB re 1 μ Pa). They are able to discriminate between sounds, determine the direction of a sound, and detect biologically relevant sounds in the presence of noise. In addition, some clupeid fish can detect ultrasonic sounds to over 200 kHz. Fish that possess a coupling between the ear and swim-bladder have probably the best hearing of fish species, primarily based on pressure detection. As hearing thresholds differ among group of species, the impacts of seismic sounds are therefore specific.

The sound waves produced during seismic surveys are low frequency, with most energy at 20 - 150 Hz (although significant contributions may extend up to 500 Hz) and overlap with the range at which fish hear well. A review of the available literature suggests that potential impacts of seismic pulses to fish species (including sharks) could include physiological injury and mortality, behavioural avoidance of the seismic survey area, masking of environmental sounds and communication, disturbance to spawning and recruitment and indirect impacts due to effects on predators or prey.

Physiological Injury and Mortality

Studies have shown that fish can be exposed directly to the sound of seismic survey without lethal effects, outside of a very localised range of physiological effects. Physiological effects of impulsive airgun sounds on fish species include swim-bladder damage, transient stunning, short-term biochemical variations in different tissues typical of primary and secondary stress response, and temporary hearing loss due to destruction of the hair cells in the hearing maculae and haemorrhaging, eye damage and blindness.

Thus, there is a wide range of susceptibility among fish to seismic sounds, with those with a swim-bladder will be more susceptible to anthropogenic sounds than those without this organ. In many of the large pelagic species, which are most likely to be encountered in the study area, the swim-bladders are either underdeveloped or absent (e.g. many of the pelagic sharks and tunas), and the risk of physiological injury through damage of this organ is, therefore, lower. The vast majority of fish exposed to seismic sounds will in all likelihood be some distance from the source, where the sound level has attenuated considerably, only a very small number of animals in a large population can ever be directly killed or injured by sounds from seismic airgun arrays.

Based on the noise exposure criteria provided by Popper *et al.* (2014), the Sound Transmission Loss Modelling Study predicts that the maximum horizontal threshold distance for mortality or potential mortal injury (PTS) to fish species with a swim bladder is within 240 m of the airgun for a single pulse. However, fish species without swim bladders have higher injury impact thresholds, and therefore have smaller zones of potential injuries within 120 m from the array source. For recoverable injury, the zones of cumulative impact from multiple pulses are predicted to be within <10 m from the adjacent survey lines for fish without a swim bladder, and within 50 m for fish with a swim bladder. The zones of TTS effect for fish species with and without swim bladders are predicted to be within 2 000 m from the adjacent survey lines for the cumulative scenario. It must be kept in mind that the cumulative zones of impact are conservative as most fish likely to be encountered in the area of interest are the highly migratory pelagic sharks, tunas and billfish, and are likely to have moved considerable distances over the cumulative 24-hr period. The zones of impact for PTS, TTS and recovery injury are presented in Table 8-17.

Table 8-17: Zones of immediate impact from single pulses and multiple pulses (cumulative) for fish

Type of animal	Zones of impact – maximum horizontal distances from source to impact threshold levels				
	Mortality & Mortal Injury		Recovery injury		TTS
	Immediate Impact from Single Pulses	Cumulative Impact from Multiple Pulses	Immediate Impact from Single Pulses	Cumulative Impact from Multiple Pulses	Cumulative impact From Multiple Pulses
Fish: no swim bladder (particle motion detection)	120 m	< 10 m	120 m	< 10 m	2 000 m
Fish: swim bladder is not involved in hearing (particle motion detection)	120 m	10 m	240 m	50 m	2 000 m
Fish: swim bladder involved in hearing (primarily pressure detection)	240 m	20 m	240 m	50 m	2 000 m

Note: if the zone of impact for cumulative is smaller than that for the single pulse, then the marine species are likely to be more sensitive to pressure impact than energy impact.

Possible injury or mortality in pelagic species could occur on initiation of a sound source at full pressure in the immediate vicinity of fish, or where reproductive or feeding behaviour override a flight response to seismic survey sounds. The potential impact of seismic noise on the injury or mortality of fish is thus considered to be of **high intensity**.

Overall, as a conservative approach, the physiological injury and mortality impact on fish is thus considered to be of **high intensity**, limited to the survey area (**regional extent**) and for the **short-term** duration of the survey (five months). Thus, the **magnitude** of the impact would be **medium**.

Behavioural Avoidance

Behavioural responses to impulsive sounds are varied and include leaving the area of the noise source, changes in depth distribution, spatial changes in schooling behaviour and startle response to short range start up or high-level sounds. Behavioural responses, such as avoidance of seismic survey areas and changes in feeding behaviours of some fish to seismic sounds, have been documented at received levels of about 160 dB re 1 µPa, with disturbance ceasing at noise levels below this. In some cases, behavioural responses were observed at up to 5 km distance from the firing airgun array. 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.

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. In some cases, behaviour patterns returned to normal within minutes of commencement of surveying indicating habituation to the noise. The ecological significance of such effects is, therefore, expected to be low, except in cases where they influence reproductive activity or result in delayed mortality.

Seismic activities have been predicted to possibly affect the migration patterns of tuna leading to substantially reduced catches of Tuna in southern Namibia. 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 seismic surveys. Longfin Tuna and other tuna species migrations are known to be highly variable from year to year and are associated with prey availability, as well as favourable oceanographic conditions. Links between changes in migration patterns and subsequent catches remain speculative.

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 potential impact on individual fish behaviour is considered to be of **high intensity**. The behavioural impact on fish is limited to the survey area (**regional**) and for the **short-term** duration of the survey (five months). Thus, the **magnitude** of the impact would be **medium**.

Spawning and Recruitment

Although the effects of airgun noise on spawning behaviour of fish have not been quantified to date, it is predicted that if fish are exposed to powerful external forces on their migration paths (as discussed above) or spawning grounds, they may be disturbed or even cease spawning altogether. The deflection from migration paths may be sufficient to disperse spawning aggregations and displace spawning geographically and temporally, thereby affecting recruitment to fish stocks. The magnitude of effect in these cases will depend on the biology of the species and the extent of the dispersion or deflection. Depending on the physical characteristics of the area, the range of the impact may extend beyond 30 km and could thus potentially affect subsequent recruitment to fish stocks if spawning is displaced geographically or temporally. Dalen *et al.* (1996), however, recommended that in areas with concentrated spawning or spawning migration, seismic shooting be avoided at a distance of approximately 50 km from these areas, particularly when subjected to repeated, high intensity surveys. In Norway, areas supporting high densities of spawning fish are sometimes closed to seismic surveys as a measure both to avoid scaring away the spawning adults and to avoid direct mortality of early life stages (Boertmann *et al.* 2009).

The major spawning grounds for most small pelagic shoaling species (anchovy, round herring, horse mackerel, chub mackerel) are located east of Cape Point with hake spawning occurring on the western Agulhas Bank. As eggs and larvae are distributed westwards there is no overlap of these spawning areas with the survey area of interest. There is also sardine and anchovy spawning on the east coast and off KwaZulu-Natal, where sardine eggs are found during July–November before they are distributed southwestwards in the Agulhas Current. This egg and larval drift passes through the survey area of interest. Kingklip spawning associated with Kingklip Ridge and Kingklip Koppies occurs within the inshore areas of the survey area of interest (see Figure 7-15). If behavioural responses result in deflection from coastal migration routes or disturbance of spawning, further impacts may occur that may affect recruitment to fish stocks. The intensity of effect in these cases will depend on the biology of the species and the extent of the dispersion or deflection. As the survey area is not known to be a spawning area for small or large pelagic species, the intensity of the effect for pelagic fish can be considered **very low**. Considering the wide range over which the potentially affected pelagic species occur, that the main migration routes of endemic sparids lie inshore of the proposed survey area and do not constitute narrow restricted paths, and the relatively short duration of the proposed survey, the impact can be considered of **very low** magnitude. Although, the survey area overlaps with the ‘spawning box’ for kingklip and the intensity of the effect of the survey on this demersal species could be **medium**, the impact would be of **medium** magnitude.

Masking of Environmental Sounds and Communication

While some nearshore reef species are known to produce isolated sounds or to call in choruses, communication and the use of environmental sounds by fish in the offshore environment off the South African South Coast are unknown. Demersal species in abyssal and continental slope habitats or associated with Kingklip Koppies, Kingklip Ridge and the Southwest Indian Seamounts would receive the seismic noise in the far field and vocalisation, should it occur, is unlikely to be masked. Impacts arising from masking of sounds are thus expected to be of **very low intensity** due to the duty cycle of seismic surveys in relation to the more continuous biological noise. Such impacts would occur across the survey area (**regional**) and for the **short-term** duration of the survey (five months). Thus, the impact is considered to be of **very low magnitude**.

Effects on Predators or Prey

The assessment of indirect effects of seismic surveys on fish is limited by the complexity of trophic pathways in the marine environment. The impacts are difficult to determine and depend on the diet make-up of the fish species concerned and the effect of seismic surveys on the diet species.

Indirect impacts of seismic surveying could include attraction of predatory species such as sharks, tunas or diving seabirds to pelagic shoaling fish species stunned or injured by seismic noise. In such cases, where feeding behaviour overrides a flight response to seismic survey sounds, injury or mortality could result if the seismic sound source is initiated at full power in the immediate vicinity of the feeding predators. Little information is available on the feeding success of large migratory fish species in association with seismic survey noise. The pelagic shoaling species that constitute the main prey item of migratory pelagic species typically occur inshore of the 200 m depth contour and thus mainly inshore of the area of interest. Considering the extensive range over which large pelagic fish species can potentially feed in relation to the area of interest, and the likely low abundance of pelagic shoaling species in the offshore regions, the **intensity** of the impact would be **low**, restricted to the survey area (**regional**) and persisting over the **short-term** only (five months). Thus, the impact is of **very low magnitude**.

Impact Significance

Based on the **high sensitivity** of receptors and the **medium magnitude**, the impact of physiological injury, behaviour and recruitment are of **medium significance** (see Table 8-18 reflecting the most conservative case), while the remainder are of **low significance**.

Identification of Mitigation Measures

In addition to the mitigation recommended for cetaceans (see Section 8.4.1.1.1), the following is recommended for fish during seismic survey:

No.	Mitigation measure	Classification
1	Undertaking the proposed survey from January to May would avoid the key spring spawning periods.	Avoid
2	Implement a “soft-start” procedure of a minimum of 20 minutes’ duration on initiation of the seismic source if during daylight hours it is confirmed visually by the MMO during the pre-shoot watch (60 minutes) that there are no shoaling large pelagic fish within 800 m of the seismic source.	Avoid / Abate on site
3	In the case of shoaling large pelagic fish being observed within the mitigation zone, delay the “soft-start” until animals are outside the 800 m mitigation zone.	Avoid / Abate on site
4	Terminate seismic shooting on:	Abate on site

No.	Mitigation measure	Classification
	<ul style="list-style-type: none"> observation of slow swimming large pelagic fish (including whale sharks, basking sharks, manta rays and devil rays) within the 800 m mitigation zone. observation of any obvious mass mortalities of fish (specifically large shoals of tuna or surface shoaling small pelagic species such as sardine, anchovy and mackerel) when estimated by the MMO to be as a direct result of the survey. <p>For slow swimming large pelagic fish, terminate shooting until such time as the animals are outside of the 800 m mitigation zone (seismic "pause", no soft-start required).</p>	

Residual Impact Assessment

The potential impacts cannot be eliminated due to the nature of the seismic sound source required during surveying. The proposed mitigation measures, which are designed to avoid key spawning areas and keep animals out of the immediate area of impact and thereby reduce the risk of deliberate injury to fish, reduce the intensity of the impacts relating to physiological injury to medium, the residual impacts will reduce to **low magnitude** and of **LOW significance** (see Table 8-18). All other impacts on fish remain of **LOW significance**.

Table 8-18: Impact on fish from seismic noise

Project Phase:	Operation	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	HIGH	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	MEDIUM	LOW
Intensity	HIGH (injury / behaviour) MEDIUM (spawning / recruitment)	MEDIUM
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM MEDIUM TERM (spawning / recruitment)	SHORT TERM
Significance	MEDIUM	LOW
Probability	LIKELY	POSSIBLE
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	MEDIUM
Cumulative potential	UNLIKELY	UNLIKELY

8.4.1.1.6 Marine Invertebrates

Sensitivity of Receptors

The area of interest lies well offshore where the pelagic and benthic ecosystem threat status is considered of 'Least concern', with the exception of the shelf edge, which is considered 'Vulnerable' with Kingklip Ridge being rated as 'Endangered'. Most ecosystem types outside the offshore MPAs are either poorly protected or not protected at all.

Pelagic invertebrates that may occur in the area of interest are the giant squid, which is a deep dwelling species confined to the continental slopes. This species could thus potentially occur in the survey area, although the encounter likelihood is extremely low. Further species of potential concern is the commercially fished deep-water rock lobster, which occurs on rocky substrate in depths of 90 – 170 m (inshore of the area of interest), and the squid, which occurs extensively on the Agulhas Bank out to the shelf edge (500 m depth contour). Adult squid are normally distributed in waters deeper than 100 m, except along the eastern half of the South Coast where they also occur inshore, forming dense seasonal spawning aggregations at depths between 20 - 130 m (inshore of the proposed survey area of interest).

Despite the presence of potential VME species in the project area, some of which may be sensitive to physical disturbance, the sensitivity of benthic invertebrates to acoustic impacts is considered to be very low, whereas for neritic and pelagic invertebrates the sensitivity can be considered low. Following the precautionary principle, the sensitivity is considered to be **low**.

Impact Magnitude (or Consequence)

Many marine invertebrates have tactile organs or hairs (termed mechanoreceptors), which are sensitive to hydro-acoustic near-field disturbances, while some have highly sophisticated statocysts, which are thought to be sensitive to the particle acceleration component of a sound wave in the far-field. Potential impacts of seismic pulses on invertebrates would include physiological injury or mortality in the immediate vicinity of the airgun sound source and behavioural avoidance (direct impact). Masking of environmental sounds and indirect impacts due to effects on predators or prey have not been documented and are highly unlikely and are, thus, not discussed below.

Physiological Injury or Mortality

Although there is little published information on the effects of seismic surveys on invertebrate fauna, lethal and sub-lethal effects have been observed under experimental conditions where invertebrates were exposed to airguns at close range. These include reduced growth and reproduction rates in crustaceans. Other field-based studies on adult invertebrate populations (including scallops, clams or lobsters, a variety of reef-associated invertebrates, snow crabs and shrimp) have shown a range of results from no physiological damage or evidence of increased mortality in response to airgun exposure to effects on egg and embryo development and larvae size. As the survey would largely be undertaken at depths beyond 200 m, the received noise by benthic invertebrates at the seabed would be within the far-field range, and outside of distances at which physiological injury would be expected. Thus, potential physiological injury or mortality to benthic invertebrates is considered to be of very low intensity.

Exposure of various species of caged cephalopods to low frequency sounds revealed lesions in the statocysts, consistent with a massive acoustic trauma. Potential physiological injury or mortality of pelagic cephalopods is considered to be of low intensity, since the distribution of mobile neritic and pelagic squid is naturally spatially highly variable and the numbers of giant squid likely to be encountered is low. The area of interest is also located offshore of key squid spawning areas.

Overall, as a conservative approach, the impact on invertebrates is considered to be of **low intensity**, limited to the survey area (**regional extent**) and for the **short-term** duration of the survey (five months). Thus, the **magnitude** of the impact would be **very low**.

Behavioural Avoidance

Behavioural responses of invertebrates to particle motion of low frequency stimulation have been measured by numerous researchers. A wide range of responses have been reported ranging from no avoidance by free ranging invertebrates (crustaceans, echinoderms and molluscs) of reef areas to no reduction in catch rates of shrimp, prawns or rock lobsters in the near-field during or after seismic surveys. Startle responses and alarm behaviour in decapods has been observed when animals in close proximity to the sound source (<0.10 m). Other research has shown that low frequency noise being successful in deterring barnacle larvae from settling on ship hulls. Changes in predator avoidance behaviours may, however, have population-level implications if predation rates increase due to sound-induced behavioural changes in prey. The received noise at the seabed, considering a water depth of more than 150 m as in the area of interest, would be within the far-field range and outside of distances at which avoidance of benthic invertebrates would be expected. Thus, the potential behavioural avoidance by benthic invertebrates could be of very low intensity.

Cephalopods, in contrast, may be receptive to the far-field sounds of seismic airguns, with reported responses including alarm response (e.g. jetting of ink), changes in behaviour (aggression and spawning), position in the water column and swimming speeds. Behavioural changes have been observed in squid at 2 to 5 km from an approaching large seismic source, although recent research has shown that a gradual increase in signal intensity and prior exposure to airgun noise would decrease the severity of the alarm responses, suggesting that animals became accustomed to the noise at low levels. As the proposed survey area of interest lies adjacent and offshore of a major squid spawning area, the behavioural impact may be of **medium intensity** within the southern portions of the area of interest.

Overall, as a conservative approach, the impact on invertebrates is thus considered to be of **medium intensity**, limited to the survey area (**regional**) and for the **short-term** duration of the survey (five months). Thus, the **magnitude** of the impact would be **low**.

Impact Significance

Based on the **low sensitivity** of receptors and the **low magnitude**, the potential impacts on marine invertebrates (both physiological injury or mortality and behavioural avoidance) are considered to be of **very low significance** without mitigation (see Table 8-19).

Identification of Mitigation Measures

In addition to the mitigation recommended for cetaceans (see Section 8.4.1.1.1), the following is recommended for invertebrates during seismic survey:

No.	Mitigation measure	Classification
1	Terminate seismic shooting on observation of any obvious mass mortalities of squid when estimated by the MMO to be as a direct result of the survey.	Abate on site

Residual Impact Assessment

The potential impacts cannot be eliminated due to the nature of the seismic sound source required during surveying. With the implementation of the mitigation measures, which would reduce the intensity of the impact to very low, the residual impact will remain of **very low magnitude** and of **NEGLIGIBLE significance** (see Table 8-19).

Table 8-19: Impact on marine invertebrates from seismic noise

Project Phase:	Operation	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	LOW	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	VERY LOW	VERY LOW
Intensity	MEDIUM	VERY LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	VERY LOW	NEGLIGIBLE
Probability	UNLIKELY – POSSIBLE (squid)	UNLIKELY
Confidence	MEDIUM	MEDIUM
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	LOW
Cumulative potential	UNLIKELY	UNLIKELY

8.4.1.1.7 Plankton species

Sensitivity of Receptors

The area of interest lies on the shelf edge where localised shelf-edge upwelling can occur seasonally (see Figure 7-15). Phytoplankton and zooplankton abundance in the clear offshore waters of the Agulhas Current are thus expected to be low, although seasonal peaks may occur associated with the shelf edge. There is some overlap of the area of interest with kingklip spawning areas and the southward egg and larval drift of pilchards and anchovies (see Figure 7-15). The area of interest, however, lies well offshore of the squid spawning areas. Ichthyoplankton abundance in the area of interest is thus likely to be low, although seasonal peaks may occur (June to September spawning period).

Phytoplankton are not known to be affected by seismic surveys and are unlikely to show any significant effects of exposure to airgun impulses outside of a 1 m distance (Kosheleva 1992; McCauley 1994).

Zooplankton comprises meroplankton (organisms which spend a portion of their life cycle as plankton, such as fish and invertebrate larvae and eggs) and holoplankton (organisms that remain planktonic for their entire life cycle, such as siphonophores, nudibranchs and barnacles). The abundance and spatial distribution of zooplankton is highly variable and dependent on factors such as fecundity, seasonality in production, tolerances to temperature, length of time spent in the water column, hydrodynamic processes and natural mortality. Zooplankton densities are therefore generally patchily distributed.

Invertebrate members of the plankton that have a gas-filled flotation aid, may be more receptive to the sounds produced by seismic airgun arrays, and the range of effects may extend further for these species than for other plankton.

Phytoplankton, zooplankton and ichthyoplankton abundances across most of the survey area are expected to be low, and (if they occur) have a highly patchy distribution and seasonally high abundances. Although plankton

distribution is naturally temporally and spatially variable and natural mortality rates are high, the overall sensitivity is considered **medium** due to the potentially reduced reproductive success in some of the small pelagic species and in kingklip in the 'spawning box'.

Impact Magnitude (or Consequence)

Potential impacts of seismic pulses on plankton and fish eggs / larvae would include physiological injury or mortality in the immediate vicinity of the airgun sound source. The amount of exposure that plankton can withstand due to the influence of seismic sound is dependent on a wide range of variables, namely (1) the presence of gas-filled flotation aids (as plankton with gas filled cavities may be more receptive to the sounds produced by seismic airgun arrays), (2) temporal and spatial variability in occurrence (due to plankton abundance varying in time and space), and (3) proximity to the sound source.

Due to their importance in commercial fisheries, numerous studies have been undertaken experimentally exposing the eggs and larvae of various zooplankton and ichthyoplankton species to airgun sources. These studies generally identified that for a large seismic array, mortalities and physiological injuries occurred at very close range (<5 m) only. Changes have also been observed in the buoyancy of the organisms, in their ability to avoid predators and effects that affect the general condition of larvae, their growth rate and thus their ability to survive. Temporary disorientation juvenile fry was recorded for some species.

There has been conflicting research in terms of the impact on the total plankton population. McCauley (1994) initially concluded that when compared with total population sizes or natural mortality rates of planktonic organisms, the relative influence of seismic sound sources on these populations can be considered insignificant. However, more recently McCauley *et al.* (2017) demonstrated significant declines in zooplankton abundance within a maximum range of 1.2 km of the airguns' passage. However, a follow-up publication by Richardson *et al.* (2017) queried the robustness of the McCauley *et al.* (2017) study on the grounds of insufficient sample size. A more recent study by Fields *et al.* (2019) reported that there was significantly higher immediate mortality of the copepod *Calanus finmarchicus* at distances of 5 m from the airguns compared to controls, but that increased mortality did not exceed 30% at any distance from airgun blasts.

Sætre & Ona (1996) calculated that, under the "worst case" scenario, the number of larvae killed during a typical seismic survey was 0.45% of the total larvae population. Richardson *et al.* (2017) estimated that while zooplankton populations declined 22% within the survey area, biomass recovery occurred within three days following survey completion and any effects on zooplankton by seismic noise would endure in the very short term only. The authors stressed that impacts in areas of dynamic ocean circulation are likely to be even less.

Consequently, Dalen *et al.* (1996) concluded that seismic-created mortality is so low that it can be considered to have an inconsequential impact on recruitment to the populations. Furthermore, due to the rate at which airguns are discharged, and the fact that the vessel is continuously moving, in addition to the fast moving Agulhas Current, it is highly unlikely that eggs and larvae will be repeatedly exposed to harmful sound waves (Dalen & Mæsted 2008).

Based on the noise exposure criteria provided by Popper *et al.* (2014), the Sound Transmission Loss Modelling Study predicts that the maximum horizontal threshold distance for mortality or potential mortal injury (PTS) to fish eggs and larvae is 240 m for a single pulse and 10 m for multiple pulses (cumulative)¹². Maximum threshold distances for recoverable injury and TTS for fish eggs and larvae were not reached. Areas with high plankton

¹² Note: if the zone of impact for cumulative is smaller than that for the single pulse, then the marine species are likely to be more sensitive to pressure impact than energy impact.

productivity (e.g. in inshore spawning areas) are thus located well beyond the influence of seismic pulses from within the proposed survey area, and is unlikely to result in significant declines in zooplankton abundance.

As the proposed survey is scheduled for the summer survey window (start December to end May) over a five-month period, there could be some temporal overlap with the peak spawning periods of squid (September to December) and anchovies (November to December), but avoidance of the spawning periods of most other commercially important species (e.g. horse mackerel (winter months), sardines (early spring and autumn), hake (late winter to early spring), kingklip (August to September)). Although plankton distribution is naturally temporally and spatially variable and natural mortality rates are high, and most of the survey area lies east of the Agulhas Bank spawning areas and offshore of the main squid spawning area, any impacts would be of **medium intensity** for plankton species (considering there is some overlap of the area of interest with kingklip spawning areas and assuming surveying occurs during the key spawning period). Although the impact is restricted to within a few hundred metres of the airguns, it would extend over the entire survey area (**regional extent**). The impact would be of **short-term** duration (five months). The **magnitude** of the impact would therefore be **low**.

Impact Significance

Based on the **medium sensitivity** of receptors and the **low magnitude**, the potential impact on plankton species is considered to be of **low significance** without mitigation (see Table 8-20).

Identification of Mitigation Measures

Undertaking the proposed survey from January to May would avoid the key spring spawning periods. No other measures to mitigate the impacts of seismic sounds on plankton and fish egg and larval stages are feasible or deemed necessary.

Residual Impact Assessment

This potential impact cannot be eliminated due to the nature of the seismic sound source required during surveying. The residual impact would remain of **VERY LOW significance** (see Table 8-20).

Table 8-20: Impact on plankton from seismic noise

Project Phase:	Operation	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	Medium	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	Low	LOW
Intensity	Medium	LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	LOW	VERY LOW
Probability	LIKELY	LIKELY
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW

Mitigation Potential	-	NONE
Cumulative potential	UNLIKELY	UNLIKELY

8.4.1.2 Impact on Commercial Fishing

Potential Impact Description

Elevated noise levels could impact fish (**direct negative** impact) by (also refer to Section 8.4.1.1.5):

- Causing direct physical injury to hearing or other organs;
- Masking or interfering with other biologically important sounds (e.g. communication, echolocation, signals and sounds produced by predators or prey);
- Causing disturbance to the receptor resulting in behavioural changes or displacement from important feeding or breeding areas; and
- Disruption of spawning and recruitment.

These could have an impact on commercial fisheries that operate in the area through the reduction in catch rates and/or an increase in fishing effort (**indirect negative** impact).

Project Controls

The seismic contractor will ensure that the proposed survey is undertaken in a manner consistent with good international industry practice and BAT regarding fisheries management. At least one escort vessel with appropriate radar and communications will patrol the area during the seismic survey to ensure that other vessels adhere to the safe operational limits. This vessel would assist in alerting other vessels (e.g. fishing, cargo vessels, etc.) about the survey and the lack of manoeuvrability of the survey vessel.

Sensitivity of Receptors

Sensitivity herein considers the extent of fishing ground, ability of the fishing industry to operate as expected considering a project-induced change to their normal fishing operations (linked in part to fishing gear type and vessel manageability), as well as the vulnerability of the targeted fish species. An overview of each commercial fishing sector operating off the Southeast Coast region is presented in Section 7.7. Table 8-21 provides a list of fisheries sectors that operate off the Southeast Coast and the seasonality of fishing effort by sector as well as the percentage of national catch and effort in the area of interest.

The sectors that operate within the area of interest include **demersal trawl, midwater trawl, demersal longline (hake-directed), large pelagic longline and South Coast rock lobster**. All are currently active in the area to a lesser or greater degree.

The greatest risk of physiological injury from seismic sound sources is for species with swim-bladders (e.g. hake and other demersal species targeted by demersal longline and demersal trawl fisheries). In many of the large pelagic species, swim-bladders are either underdeveloped or absent and the risk of physiological injury through damage of this organ is therefore lower. However, two of the four tuna species targeted in South African fisheries, yellowfin and bigeye, do have swim bladders and so may be physically vulnerable.

Those sectors that set fishing gear for extended periods (i.e. rock lobster traps anchored at the seabed or drifting longlines) are more susceptible to exclusion than those more mobile operations (i.e. trawl nets are towed directly behind the vessel). Pelagic longline vessels set a drifting mainline, which may be up to 100 km in length, and

while setting or hauling a longline the vessel's manoeuvrability is restricted. Thus, a vessel cannot easily manoeuvre out of the way of an approaching survey vessel. Similarly, demersal longline and rock lobster vessels are severely restricted when hauling a line. Rock lobster traps may be left in place and unattended for several days before later retrieval. In the case of the large pelagic longline, the targeted fish stock may only be available in a specific area for a specific period of time. As with lobster, relocation to an alternative area may not be viable as the preferred area is predicated on the resource being available at a specific time and place. Noise levels are expected to drop to below threshold levels for behavioural disturbance before reaching areas fished by the line fish, squid, small pelagic purse-seine, netfish and small-scale sectors.

Consequently, demersal and midwater trawl, demersal longline, South Coast rock lobster and research surveys sectors are categorised as of **medium** sensitivity and the large pelagic longline sector is considered as of **high** sensitivity.

Table 8-21: Fisheries sectors that operate off the Southeast Coast, the likelihood of their presence and the % catch / effort and seasonality in the area of interest

Sector	Likelihood of presence in reconnaissance permit area	Application Area		Fishing Intensity by Month in the vicinity of the reconnaissance permit application area H = High; M = Low to Moderate; N = None											
		% of National Catch	% of National Effort												
				JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Demersal Trawl	Highly likely	6.4	6.8	H	H	H	H	M	M	M	M	M	H	H	H
Midwater Trawl	Highly likely	16.2	18.2	H	H	H	H	H	M	M	H	H	H	H	H
Hake Demersal Longline	Highly likely	6.7	6.2	M	M	M	M	M	M	M	M	H	H	H	H
Shark Demersal Longline	Unlikely	0	0	M	M	M	M	M	M	M	M	M	M	M	M
Small Pelagic Purse-Seine	Unlikely	0	0	M	H	H	H	H	H	H	H	H	H	H	M
Large Pelagic Longline	Highly likely	3.3	3.4	M	M	M	M	H	H	H	H	H	M	M	M
Traditional Linefish	Unlikely	0	0	M	M	M	M	M	M	M	M	M	M	M	M
South Coast Rock Lobster	Possible	1.9	1.7	M	M	M	M	M	M	M	M	M	M	H	H
Squid Jig	Unlikely	0	0	H	M	M	N	N	N	M	M	M	M	M	H
Small-scale	Unlikely	0	0	M	M	M	M	M	M	M	M	M	M	M	M
Demersal Research Survey (trawl)	Possible	-	-	N	N	N	M	M	M	N	N	N	N	N	N
Pelagic Research Survey (acoustic)	Possible	-	-	N	N	N	N	M	M	N	N	N	M	M	M

Impact Magnitude (or Consequence)

A review of the available literature suggests that potential impacts of seismic pulses to fish species could include physiological injury / mortality and behavioural avoidance of the seismic survey area.

Sensitivity and hearing range is highly variable amongst fish species. Data indicates that fish possessing a swim bladder are more sensitive to impulsive sounds, such as those generated by airguns, than fish without swim bladders (Popper *et al.*, 2014). Sharks and most tuna, key species targeted by the large pelagic longline sector, do not have a swim bladder.

Studies have shown that physical damage to fish caused from seismic sources occurs only in the immediate vicinity of the airguns, in distances of less than a few meters. Based on the noise exposure criteria provided by Popper *et al.* (2014), the Underwater Acoustics Modelling Study predicts that the maximum horizontal threshold distance from the 3D seismic source to impact threshold levels leading to mortality or potential mortal injury was 120 m for fish lacking swim bladders (e.g. some tunas, sharks and most mesopelagic species) and 240 m for fish with swim bladders involved in hearing. Zones of immediate impact from single pulses for recovery injury were the same. The zones of cumulative impact from multiple pulses (i.e. the maximum horizontal perpendicular distances from assessed survey lines to cumulative impact threshold levels) for potential mortal injury, was estimated as <10 m for fish without swim bladders, 10 m for fish with swim bladders involved in hearing and 20 m where swim bladders are not involved in hearing. For recoverable injury, the zones of cumulative impact from multiple pulses are predicted to be within <10 m from the adjacent survey lines for fish without a swim bladder, and within 50 m for fish with a swim bladder. The zones of impact for mortal and recovery injury and TTS are presented in Table 8-17. As most pelagic fish species likely to be encountered within the survey area are highly mobile, they will be expected to flee and move away from the sound source before trauma could occur.

Behavioural responses to impulsive sounds are varied and any changes in spawning, migration and feeding behaviour of fishes in response to seismic shooting could affect fisheries through reduced catches resulting from changes in feeding behaviour, abundance and vertical distribution. Such behavioural changes could lead to decreased commercial catch rates if fish move out of important fishing grounds.

Reports on observed declines in catch rates differ considerably between studies, however, behavioural effects are generally short-term in nature, 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. In some cases, behaviour patterns returned to normal within minutes of commencement of surveying indicating habituation to the noise.

Behavioural responses, such as avoidance of seismic survey area and changes in feeding behaviours in response to seismic sounds, have been documented to occur at received levels of about 160 dB re 1 μ Pa, with disturbance ceasing at noise levels below this level. 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. In some cases, behavioural responses have been observed at up to 5 km distance from the active source array (Santulli *et al.* 1999; Hassel *et al.* 2004; Dalen *et al.* 2007). Considering the immediate exposure from single pulse, a sound level (Root-Mean-Square Sound Pressure Level) of about 160 dB re 1 μ Pa (i.e. the level at which fish disturbance is believed to cease) would be experienced at about 4 km from the source array.

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 (short-term impact). There could, however, possibly be a medium term indirect impact on demersal trawl due to the impact on spawning and recruitment, if the survey coincides with the key kingklip spawning period between June to September.

Based on percentage overlap and key fishing period, the intensity of the impact was initially thought to be medium for demersal trawl, midwater trawl, demersal longline, large pelagic longline and South Coast rock lobster. However, after consultation with the commercial fishing sector, it became evident that, although the national percentages are low in the survey area, the demersal trawl sector does focus their efforts in the vicinity of the survey area during December and January period. Thus, if the survey occurs during this period the intensity of the impact on the demersal trawl sector could be high.

Taking the above and the areas of overlap with the different fisheries into account (refer to Section 7.7), the magnitude of the impact of sound on catch rates is assessed to be **high** for the demersal trawl sector and **low** for the midwater trawl, demersal longline, large pelagic longline and South Coast rock lobster sectors. No impact is expected on the linefish, small pelagic purse-seine, squid jig and small-scale sectors.

Impact Significance

Based on the sensitivity of the receptors and the magnitude predicted above, the potential impact on the demersal trawl sector is rated as high significance. The potential impact on the midwater trawl, demersal longline, South Coast rock lobster, large pelagic longline and research surveys is rated as of **low significance** while the impact on the squid jig, small pelagic purse-seine and small-scale sectors is rated as of **very low significance**.

Identification of Mitigation Measures

Many of the affected fisheries operate year-round, but timing the survey to acquire data in the inshore areas later in the survey window period, from April to May could reduce the intensity of the impact on the demersal trawl, demersal longline, South Coast rock lobster and squid sectors. As the potential impacts on these sectors are already assessed as relatively low, this suggestion of survey timing should be considered if practically feasible.

In addition to the mitigation listed for the impact on fish (see Section 8.4.1.1.5), the following is recommended to reduce the disruption of fishing activities related to the resource availability:

No.	Mitigation measure	Classification
1	Commence surveying January in order to avoid sensitive squid spawning and the majority of key fishing periods.	Avoid
2	Coordinate survey design and timing with marine authorities (specifically managers of the DFFE fisheries research programmes) taking into account their respective research surveys and programmes in order to minimise or avoid disruptions to all parties.	Avoid
3	At least three weeks prior to the commencement of the seismic survey, notify via email or other means the following key stakeholders of the proposed activity (including navigational co-ordinates of the vessel operational area (inclusive of the acquisition area, run-ins and vessel turning circles), timing and duration of proposed activities) and the likely implications thereof (specifically the safety clearance requirements around the vessel and towed array): <ul style="list-style-type: none"> Fishing industry / associations: SA Tuna Association; SA Tuna Longline Association, Fresh Tuna Exporters Association, South African Deepsea Trawling Industry Association (SADSTIA), South African Hake Longline Association (SAHLLA), South Coast Inshore Trawl Fishing Industry Association (SECIFA), South Coast Rock Lobster Association, South African Squid 	Avoid

No.	Mitigation measure	Classification
	<p>Management Industrial Association (SASMIA), South African Pelagic Fishing Industry Association (SAPFIA), South African Midwater Trawling Association, South African Linefish Associations (various) and SA Marine Linefish Management Association (SAMLMA).</p> <ul style="list-style-type: none"> Other key stakeholders: South African Navy Hydrograph Office (HydroSAN), SAMSA, Ports Authority and the DFFE Vessel Monitoring, Control and Surveillance Unit in Cape Town <p>These stakeholders should again be notified when the seismic survey vessel and support vessels are off location.</p>	
4	Request, in writing, the HydroSAN to broadcast a navigational warning via Navigational Telex (Navtext) and Cape Town radio for the duration of the activity.	Avoid
5	Ensure at a minimum, one Fisheries Liaison Officer (FLO) person (speaking English and Afrikaans) is on board either the survey or the escort vessel to facilitate communication in the local language with the fishing vessels that are in the area.	Abate on site
6	For the duration of the survey, circulate a 5-day and 24-hr daily survey schedule (look-ahead), via email, to key directly affected fishing associations.	Avoid
7	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 mobilized to manage the resolution of all grievances, in accordance with the Grievance Management procedure.	Abate on site

Residual Impact Assessment

With the implementation of the mitigation measures, the residual impact will reduce to **LOW** significance for the demersal trawl sector and will remain of **LOW** significance for the demersal trawl, midwater trawl, demersal longline, large pelagic longline and South Coast rock lobster sectors (see Table 8-22).

Table 8-22: Impact of Seismic Noise on Fishing Sectors off the Southeast Coast

Project Phase:	Operational	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	<p>HIGH: large pelagic longline</p> <p>MEDIUM: demersal trawl, midwater trawl, demersal longline (hake-directed) South Coast rock lobster, research surveys</p>	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	<p>HIGH: demersal trawl</p> <p>LOW: midwater trawl, demersal longline, large pelagic longline, research surveys</p>	<p>LOW: demersal trawl, midwater trawl, demersal longline, large pelagic longline, research surveys</p>
Intensity	<p>HIGH: demersal trawl</p> <p>MEDIUM: midwater trawl, demersal longline, large pelagic longline, South Coast rock lobster, research surveys</p>	<p>MEDIUM: demersal trawl, midwater trawl, demersal longline, large pelagic longline, South Coast rock lobster, research surveys</p>
Extent	REGIONAL	REGIONAL
Duration	<p>SHORT TERM</p> <p>MEDIUM TERM (demersal trawl)</p>	SHORT TERM

Significance	HIGH: demersal trawl	LOW
	LOW: midwater trawl, demersal longline, large pelagic longline, South Coast rock lobster	
Probability	LIKELY: demersal trawl, midwater trawl, demersal longline, large pelagic longline, POSSIBLE: South Coast rock lobster	LIKELY to POSSIBLE
Confidence	MEDIUM	MEDIUM
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	MEDIUM
Cumulative potential	POSSIBLE TO LIKELY	POSSIBLE TO LIKELY

8.5 TEMPORARY EXCLUSION ZONE

8.5.1 Impact on Commercial Fishing

Source of Impact

The project activities that may reduce fishing grounds are:

Project phase	Activity
Mobilisation	N/A
Operation	Operation of seismic survey vessel and seismic array
Demobilisation	N/A

Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part A, Rule 10), a seismic vessel that is engaged in surveying is defined as a “vessel restricted in its ability to manoeuvre” which requires that power-driven and sailing vessels give way to a vessel restricted in her ability to manoeuvre. In addition to a statutory 500 m safety zone, a seismic contractor will request a safe operational area (that is greater than the 500 m safety zone) that it would like other vessels to stay beyond (see Figure 6-12). The dimension of the exclusion zone to other vessels would be approximately 8 km ahead, 4 km to either side and 4 km astern. Unauthorised vessels may not enter the exclusion zone.

Potential Impact Description

The implementation of a safe operational zone around the seismic vessel and survey array will effectively temporarily exclude fishing from portions of the survey area at any one time. The temporary exclusion of fisheries from the safety zone will effectively reduce fishing grounds, which in turn could potentially result in a loss of catch and/or increased fishing effort (**direct negative** impact).

Project Controls

At least one escort vessel with appropriate radar and communications will patrol the area during the seismic survey to ensure that other vessels adhere to the safe operational limits. This vessel would assist in alerting other vessels (e.g. fishing, cargo vessels, etc.) about the survey and the lack of manoeuvrability of the survey vessel.

Sensitivity of Receptors

An overview of each commercial fishing sector operating off the Southeast Coast region is presented in Section 8.4.1.2, with the proportional percentage catch and effort within the proposed survey area summarised in Table 8-21.

Several fisheries operate within portions of the area of interest and could, therefore be affected by the temporary exclusion from fishing grounds. Of the fishing sectors that operate off the Southeast Coast, the demersal trawl, midwater trawl, hake-directed demersal long-line, large pelagic longline, South Coast rock lobster, squid jig and small-scale fisheries overlap with portions of the area of interest. **The area of interest does not overlap with the fishing grounds of the shark-directed demersal longline, traditional line fish, small pelagic purse-seine sectors, squid jig or small-scale fisheries sectors.**

The sensitivity of a particular fishing sector to the impact of an exclusion zone would differ according to the degree of disruption to fishing operations. Disruption would largely depend on the type of gear used by the particular fishery and the probability that the fishing operation can be relocated away from the affected area (the exclusion zone) into alternative fishing areas. For instance, those that set fishing gear for extended periods (i.e. longlines anchored at the seabed or drifting longlines) are more susceptible to exclusion than those more mobile operations (i.e. trawl nets towed directly behind the vessel). Pelagic longline vessels set a drifting mainline, which may be up to 100 km in length, and while setting or hauling a longline the vessel's manoeuvrability is restricted. Thus, a vessel cannot easily manoeuvre out of the way of an approaching survey vessel. Similarly, demersal longline vessels and South Coast rock lobster vessels are severely restricted when hauling a line. In the case of the large pelagic longline sector, the targeted fish stock may only be available in a specific area for a specific period of time. Relocation to an alternative area may not be viable as the preferred area is predicated on the resource being available at a specific time and place.

For this reason, the large pelagic long-line and South Coast rock lobster sectors have been categorised as having **high** sensitivity. The sensitivity of the demersal, trawl, midwater trawl and demersal longline sectors are considered to be **medium**.

Impact Magnitude (or Consequence)

Based on the location and overlap of the fishing grounds for the different sectors, the impact on the demersal longline, large pelagic longline and South Coast rock lobster sectors have been assessed as similar, with the impact on demersal trawl and mid-water trawl assessed as similar.

Demersal trawl

The demersal trawl sector operates along the shelf edge between the 200 m and 1 000 m bathymetric contours, although most effort is expended in the 300 m to 600 m depth range. The area of interest coincides with a demersal trawling ground referred to as the "Chalkline" (see Figure 7-53). Over the period 2017 to 2021, an annual average of 2 631 trawls were recorded within the proposed survey area of interest yielding 4 125 tons of hake. This is equivalent to 6.8% and 6.4%, respectively, of the total effort and catch reported by the sector on a national scale.

Midwater trawl

Fishing activity takes place across the inshore extent of the area of interest between the 200 m and 500 m (see Figure 7-55). Over the period 2017 to 2021, an average of 92 hours per year were reported within the area of

interest yielding 2 884 tons of targeted catch (horse mackerel). This is equivalent to 18.2% and 16.2% of the overall effort and catch, respectively, reported nationally by the sector.

Hake Demersal longline

The area of interest coincides with demersal hake-directed longline fishing grounds between the 200 m and 1 000 m bathymetric contours but the majority of effort takes place inshore of the 500 m depth contour (see Figure 7-57). Over the period 2000 to 2019, an average of 2.1 million hooks per year were set within the area of interest yielding 549 tons of hake. This is equivalent to 6.2% of the overall effort and 6.7% of the overall catch reported nationally by the sector.

Large Pelagic Long-Line

Fishing activity is centred along the continental shelf break and further offshore and takes place across the extent of the area of interest (see Figure 7-63). Over the period 2017 to 2019, an average of 141 lines per year were set within the proposed survey area of interest yielding 233 tons of catch. This is equivalent to 3.4% of the overall effort and 3.3% of the total catch reported by the sector.

South Coast rock lobster

Figure 7-67 shows the location of fishing activity in relation to the proposed survey area of interest. Over the period 2006 to 2020, an average of 38 000 traps were set within the area of interest yielding 6.2 tons of rock lobster which is equivalent to 1.7% and 1.9% of the overall effort and catch by the sector.

Based on percentage overlap and key fishing period, the intensity of the impact was initially assessed to be medium for the demersal trawl, midwater trawl, demersal longline, large pelagic longline and South Coast rock lobster sectors and research surveys. However, after consultation with the commercial fishing sector, it became evident that, although the national percentages are low in the survey area, the demersal trawl sector does focus their efforts in the vicinity of the survey area during December and January period. Thus, if the survey occurs during this period the intensity of the impact on the demersal trawl sector could be high. The extent of impact is regional, while the duration will be short-term (5 months). Thus, the magnitude (or consequence) for these sectors is considered to be **high** for the demersal trawl sector and **low** for the midwater trawl, demersal longline, large pelagic longline and South Coast rock lobster sectors.

Impact Significance

Based on the sensitivity of receptors and impact magnitudes, the potential impacts on the demersal trawl is assessed as of **medium** significance, while the midwater trawl, demersal longline, large pelagic longline and South Coast rock lobster sectors and research surveys is assessed as of **low** significance (see Table 8-23).

Identification of Mitigation Measures

Many of the affected fisheries operate year-round, but timing the survey to acquire data in the inshore areas later in the survey window period, from April to May could reduce the intensity of the impact on the demersal trawl, demersal longline and South Coast rock lobster. As the potential impacts on these sectors are already assessed as relatively low, this suggestion of survey timing should be considered if practically feasible.

In addition to the mitigation related to seismic noise impacts on commercial fisheries presented in Section 8.5.1, the following is recommended:

No.	Mitigation measure	Classification
1	Manage the lighting on the project vessels to ensure that it is sufficiently illuminated to be visible to fishing vessels and compatible with safe operations.	Abate on site
2	Notify any fishing vessels at a radar range of 12 nautical miles from the seismic vessel via radio regarding the safety requirements around the seismic vessel.	Abate on site
3	Ensure project vessels fly standard flags and lights to indicate that they are engaged in towing surveys and are restricted in manoeuvrability.	Avoid

Residual Impact Assessment

With the implementation of the project controls and mitigation measures, the residual impact will reduce to **LOW** significance for the demersal trawl sector and will remain of **LOW** significance for the midwater trawl, demersal longline, large pelagic longline and South Coast rock lobster sectors (see Table 8-23).

Table 8-23: Impact of temporary exclusion from fishing grounds for fishing sectors off the Southeast Coast

Project Phase:	Operational	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	HIGH: large pelagic longline, South Coast rock lobster MEDIUM: demersal trawl, midwater trawl, demersal longline, research surveys	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	MEDIUM: demersal trawl LOW: midwater trawl, demersal longline, large pelagic longline	LOW: demersal trawl, midwater trawl, demersal longline, large pelagic longline
Intensity	HIGH: demersal trawl MEDIUM: midwater trawl, demersal longline, large pelagic longline	MEDIUM: demersal trawl, midwater trawl, demersal longline, large pelagic longline
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	MEDIUM: demersal trawl	LOW: demersal trawl, midwater trawl, demersal longline, large pelagic longline, South Coast rock lobster, research surveys
	LOW: midwater trawl, demersal longline, large pelagic longline, South Coast rock lobster, research surveys	
Probability	HIGHLY LIKELY: demersal trawl, midwater trawl, demersal longline, large pelagic longline POSSIBLE: South Coast rock lobster	POSSIBLE
Confidence	MEDIUM	MEDIUM
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	VERY LOW	VERY LOW
Mitigation Potential	-	LOW
Cumulative potential	POSSIBLE	POSSIBLE

8.5.2 Disruption to Commercial Shipping Routes

Source of Impact

The project activities that may interfere with marine traffic are:

Project phase	Activity
Mobilisation	N/A
Operation	Operation of survey vessels and seismic array
Demobilisation	N/A

A survey vessel is considered to be an “offshore installation” and a “vessel restricted in its ability to manoeuvre”, and as such it (including the seismic array) is protected by, as a minimum, a 500 m safety zone. Typical safe operational limits for 3D surveys are illustrated in Figure 6-12:.. Unauthorised vessels may not enter the exclusion zone.

Potential Impact Description

The implementation of the safe operational zone around the survey vessel and seismic array will effectively exclude vessels from portions of the survey area at any one time. Thus, their presence presents a potential risk of interference with shipping routes. The exclusion of other vessels from the safety zone may require these vessels to adjust their course slightly (detour) to avoid survey vessel and line being shot (**direct negative** impact).

Project Controls

The project controls are as described in Section 8.5.1.

Sensitivity of Receptors

There are various international shipping routes along the South African coastline. Most international shipping traffic is located on the outer edge of the continental shelf. The proposed survey area of interest overlaps with the main traffic routes that pass along the Southeast Coast (see Figure 7-72). Thus, marine traffic can be expected to pass through the proposed survey area. The sensitivity of the receptor is considered to be **high**.

Impact Magnitude (or Consequence)

As noted above, the survey area is located along a main vessel traffic route and some traffic can be expect in the survey area. Since the survey vessel with its seismic array is limited in its manoeuvrability, the proposed area of exclusion is larger than the stipulated 500 m around the survey vessel and seismic array. The typical safe operational limits for 3D surveys includes an exclusion distance of approximately 8 km ahead, 4 km to either side and 6 km astern of the survey vessel (i.e. a shifting exclusion area of up to 160 km²).

If the normal laws of the sea are followed the impact associated with survey vessel is considered to be of **medium intensity, regional** (although localised at any one time) and **short-term** (five months) in duration. The **magnitude** is thus considered to be **low** (see Table 8-24).

Impact Significance

Based on the **medium sensitivity** of receptors and the **low magnitude**, the potential impact on commercial shipping is of **low significance** (see Table 8-24).

Identification of Mitigation Measures

Recommendations to mitigate the potential impact on commercial shipping routes are similar to that recommended for the fishing industry (see Section .4.1.2 and Section 8.5.1).

Residual Impact Assessment

The potential impacts cannot be eliminated due to the nature of the activity and associated safe operational zone. With the implementation of the mitigation measures, the intensity of the impact will reduce to low. The residual impacts will reduce to **very low magnitude**, but because of the expected high traffic volumes, remains of **LOW significance** (see Table 8-24).

There is the possible chance of an increase in vessel activity off the Southeast Coast should further speculative or proprietary surveys be planned for the 2023/2024 summer survey window period in parallel to CGG’s planned survey. The operation of multiple exploration activities could result in a cumulative impact on commercial shipping.

Table 8-24: Impacts on commercial shipping due to safety zone around survey vessel and seismic array

Project Phase:	Operational	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	HIGH	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	LOW	VERY LOW
Intensity	MEDIUM	LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	LOW	LOW
Probability	HIGHLY LIKELY	LIKELY
Confidence	MEDIUM	MEDIUM
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	MEDIUM
Cumulative potential	POSSIBLE	POSSIBLE

8.6 INTERACTION WITH THE LOCAL ECONOMY

8.6.1 Employment and Business Opportunities

Source of Impact

The project activities that are likely to result in economic benefits for local service providers or suppliers are:

Project phase	Activity
Mobilisation	N/A
Operation	<ul style="list-style-type: none"> • Operation of survey vessels • Provision of services (e.g. catering and refuelling) • Berthing during crew changes
Demobilisation	N/A

The seismic activities will result in limited economic benefits with respect to the use of local service providers or suppliers. The demand for such local services will largely limited to crew accommodation, meals, basic goods, and refuelling, provided at Gqeberha (**direct** Impact). In addition, the total workforce required for the exploration activities is expected to be 60 to 80 persons in total. Although the majority of these positions will be filled by international specialists employed by the seismic survey contractor(s), there will be indirect employment via the contracting of local service providers and suppliers.

Potential Impact Description

The proposed project will result in a temporary spending injection that will benefit the local economy (**direct positive** impact). All expenditures will lead to increased economic activity that will result in direct and indirect positive impacts on employment and income.

Project Controls

Requirements to maximise the use of local workforce and local supply when realistically possible will be provided by CGG to the seismic contractor.

Sensitivity of Receptors

The receptor is considered to be Gqeberha, the preferred supply base for the proposed survey operations.

Gqeberha is a major metropolitan area that supports large and diversified economic sectors that can support, and potentially benefit from the survey activities. The sensitivity of Gqeberha is therefore considered to be **very low**.

Impact Magnitude (or Consequence)

The proposed survey will require minimal support from local service providers and suppliers in terms of crew accommodation, meals, basic goods, and refuelling, provided at Gqeberha. It is likely that any benefits will not be noticeable given its well-established industrial sector and large resident population. Thus, the **intensity** of the impact is considered to be **low**. Based on the **short-term** nature of the survey (five months) and that the impact is largely restricted to Gqeberha (**local**), the impact is considered to be of **very low (positive) magnitude** (see Table 8-25).

Impact Significance

Based on the **very low sensitivity** of the receptor and the **very low (positive) magnitude**, the potential impact (or benefit) to the local economy of Gqeberha is of **negligible positive significance** (see Table 8-25).

Identification of Mitigation Measures

The following mitigation measures are recommended to maximise business benefits and manage potential over-expectation:

No.	Mitigation measure	Classification
1	Apply fair, transparent and reasonable preferential contracting of local companies to maximise benefits in Gqeberha.	Enhancement
2	Include as a condition of contracting that any non-local service providers will apply reasonable preferential sub-contracting of companies located in Gqeberha or other towns off the Southeast Coast.	Enhancement

No.	Mitigation measure	Classification
3	Ensure that all service providers/contractors actively manage community expectations related to local procurement, local content, and local employment opportunities.	Enhancement
4	Establish and maintain a functional grievance mechanism that allows stakeholders to submit specific grievances related to operations, by ensuring they are informed about the process and that resources are mobilized to manage the resolution of all grievances, in accordance with the Grievance Management procedure.	Abate on site

Residual Impact Assessment

The implementation of the enhancement and mitigation measures will not change the intensity, extent or duration of the impact. Thus, the residual impact will remain of **very low (positive) magnitude** and **NEGLIGIBLE POSITIVE significance** (see Table 8-25).

Table 8-25: Economic benefits for local service providers and suppliers due to employment and business opportunities

Project Phase:	Operational	
Type of Impact	Direct	
Nature of Impact	Positive	
Sensitivity of Receptor	LOW	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	VERY LOW	VERY LOW
Intensity	LOW	LOW
Extent	LOCAL	LOCAL
Duration	SHORT TERM	SHORT TERM
Significance	NEGLIGIBLE	NEGLIGIBLE
Probability	HIGHLY LIKELY	HIGHLY LIKELY
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	-	-
Mitigation Potential	-	LOW
Cumulative potential	POSSIBLE	POSSIBLE

8.7 UNPLANNED EVENTS

8.7.1 Collisions with Project Vessels and Equipment

Source of Impact

The movement of vessels can result in collisions and faunal strikes, as indicated below:

Project phase	Activity
Mobilisation	Ship strikes during transit of vessels to survey area
Operation	<ul style="list-style-type: none"> Ship strikes during operation Strikes and entanglement of marine fauna during seismic acquisition
Demobilisation	Ship strikes during transit to port or next destination

These activities are described further below:

- Passage of the seismic and support vessels to and from the survey area; and
- Towing of seismic equipment.

8.7.1.1 Health and Safety Impacts to Coastal/Near-shore Tourism and Recreation

Potential Impact Description

The movement of the vessels between the survey area and the supply port may result in limited interaction with coastal/nearshore tourism, fishing and other marine recreational activities during their approach to the port. Such interaction may result in vessel strikes or collisions, resulting in damage to vessels and death / injuries to humans (**direct negative** impact).

Spills from collisions are dealt with in Section 8.7.2.

Project Controls

The seismic contractor will ensure that the proposed seismic survey is undertaken in a manner consistent with good international industry practice and BAT, as well as respecting navigation rules and the relevant national and international legislation (see Table 2-2 and Table 2-3). The primary objective for avoiding the impacts of vessel collisions is to prevent any such incidents from taking place.

To be prepared for a collision event, the project will implement an emergency response system to mitigate the consequences. As standard practice, an Emergency Response Plan (ERP) / Evacuation Plan will be prepared and put in place. A Medical Evacuation Plan (Medevac Plan) will form part of the ERP.

Sensitivity of Receptors

The Port of Gqeberha supports some small-scale artisanal fisheries, recreational fisheries and recreational boating. Artisanal fishing for household subsistence is largely limited to surf and rock fishing and is very limited in scale. Recreational fishing is also associated with surf and rock fishing with Gqeberha having facilities for small boat launches.

The Port of Gqeberha also supports relatively extensive commercial vessel traffic (refer to Section 7.8.1) regarding impact on commercial shipping), and recreational and pleasure vessels should already have ample experience of operating around commercial vessels. The sensitivity of recreational and pleasure vessels is, therefore, considered to be **very low**.

Impact Magnitude (or Consequence)

As the seismic activities will be undertaken more than 45 km from the coastline, interaction between the project vessels and coastal/near-shore tourism, recreational and pleasure vessels will be negligible (only possible interaction with vessels to and from port). The support vessel would, however, call into port every 14 to 30 days during the survey for supplies (equipment, fuel, food and water) and crew changes as dictated by need. This will result in a negligible increase in the number of commercial vessels entering the port of Gqeberha. Certified recreational and pleasure craft have and continue to operate around the port and alongside existing commercial vessels.

Assuming compliance with port control and laws of the sea, the impact is deemed to be of **low intensity**. Considering the **regional** extent and **short-term duration** (five months), the **magnitude** is **very low** (see Table 8-26).

Impact Significance

Based on the **very low sensitivity** of receptors and the **very low magnitude**, the potential impact on coastal recreation and fishing vessels is considered to be of **negligible significance** without mitigation (see Table 8-26).

Identification of Mitigation Measures

The following mitigation measures are recommended:

No.	Mitigation measure	Classification
1	Request, in writing, the South African Navy (SAN) Hydrographer to broadcast a navigational warning via Navigational Telex (Navtext) for the duration of the activity.	Avoid
2	Enforce the 500 m safety/exclusion zone around the survey vessel and seismic array.	Avoid
3	Ensure at a minimum, one FLO person (speaking English and Afrikaans) is on board the escort vessel to facilitate communication in the local language with the fishing vessels that are in the area.	Abate on site
4	Escort vessel with appropriate radar and communications will be used during the seismic operation to warn vessels that are in danger of breaching the safety/exclusion zone. Any vessels at a radar range of 12 nm from the survey vessel will be notified via radio regarding the safety requirements.	Abate on site
5	Manage the lighting on the project vessels to ensure that it is sufficiently illuminated to be visible to fishing vessels and compatible with safe operations.	Abate on site
6	Ensure project vessels fly standard flags and lights to indicate that they are engaged in towing surveys and are restricted in manoeuvrability.	Abate on site
7	Establish and maintain a functional grievance mechanism that allows stakeholders to submit specific grievances related to operations, by ensuring they are informed about the process and that resources are mobilized to manage the resolution of all grievances, in accordance with the Grievance Management procedure.	Abate on site

Residual Impact Assessment

With the implementation of the mitigation measures, the intensity of the residual impact reduces from low to very low, but the **magnitude** remains **very low** and **significance NEGLIGIBLE** (see Table 8-26).

Should additional exploration activities be initiated by existing Exploration Right or Reconnaissance Permit holders off the Southeast Coast during the 2023/2024 survey window period, there is a potential for increasing the collision risk.

Table 8-26: Health and safety impacts to coastal/near-shore tourism and recreation due to a vessel collision

Project Phase:	Mobilisation, Operation and Decommissioning	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	VERY LOW	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	VERY LOW	VERY LOW

Intensity	LOW	VERY LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	NEGLIGIBLE	NEGLIGIBLE
Probability	POSSIBLE	UNLIKELY
Confidence	MEDIUM	MEDIUM
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	MEDIUM
Cumulative potential	POSSIBLE	POSSIBLE

8.7.1.2 Impacts on Marine Fauna

Potential Impact Description

The potential effects of vessel presence and towed equipment on marine fauna (and especially turtles and cetaceans) include physiological injury or mortality (**direct negative** impact).

Project Controls

The seismic contractor will ensure that the proposed survey is undertaken in a manner consistent with good international industry practice and BAT.

The Marine Living Resources Act, 1998 (No. 18 of 1998) states that no whales or dolphins may be harassed, killed or fished. No vessel may 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.

Sensitivity of Receptors

The leatherback and loggerhead turtles that occur in offshore waters around southern Africa, and likely to be encountered in the area of interest are considered regionally ‘Critically Endangered’ and ‘Endangered’, respectively. However, due to their extensive distributions and feeding ranges, the number of turtles encountered in the survey area is expected to be low. Consequently, the sensitivity of turtles is considered to be **medium**.

Between 28 and 38 species of cetaceans (whales and dolphins) are known or likely to occur off the Southeast Coast. The majority of migratory cetaceans in South African waters are baleen whales (mysticetes), while toothed whales (odontocetes) may be resident or migratory. Of these species, the Blue Whale is listed as ‘Critically Endangered’, the Fin and Sei whales are ‘Endangered’ and the sperm and Bryde’s (offshore) whales are considered ‘Vulnerable’ (South African Red Data list Categories). Although the proposed survey area is relatively far removed from the coast, the sensitivity of cetaceans to strikes is considered to be **high**.

Overall, considering the precautionary principle, the sensitivity of marine fauna to collision is considered to be **high**.

Impact Magnitude (or Consequence)

Collisions between turtles or cetaceans and vessels are not limited to seismic ships, and given the slow speed (about 4 - 6 kts) of the vessel while towing the seismic array, ship strikes and entanglement whilst surveying are unlikely, but may occur during the transit of vessels to or from the survey area.

The physical presence of the survey vessel and increased vessel traffic between the survey area and supply ports could increase the likelihood of animal-vessel collisions. Ship strikes have been documented from many regions and for numerous species of whales, with large baleen whales being particularly susceptible to collision. Any increase in vessel traffic through areas used as calving grounds or through which these species migrate will increase the risk of collision between a whale and a vessel.

The large amount of equipment towed astern of survey vessels also increases the potential for collision with or entrapment in seismic equipment and towed surface floats. Entanglement of cetaceans in gear is possible in situations where tension is lost on the towed array. Basking turtles are particularly slow to react to approaching objects and may not be able to move rapidly away from approaching airguns. Turtles are also thought to be attracted to the seismic cables to forage on barnacles and other organisms growing along these cables (https://www.ketosecology.co.uk/PDF/KE2009_Turtle_guards.pdf). Thus, ensuring all equipment that has been used in other regions is thoroughly cleaned prior to deployment will mitigate the risk of collisions to some extent. Almost all reported turtle entrapments are associated with the subsurface structures ('undercarriage') of the tail buoys attached to the end of each seismic cable. Entrapment occurs either as a result of 'startle diving' in front of towed equipment or following foraging on barnacles and other organisms growing along seismic cables and surfacing to breathe immediately in front of the tail buoy. Once stuck inside or in front of a tail buoy, the water pressure generated by the towing speed, forces the animal against/inside the buoy with little chance of escape due to the angle of its body in relation to the forward movement of the buoy.

The potential for collision between adult turtles / cetaceans and the seismic vessel, or entanglement in the towed seismic equipment and surface floats, is highly dependent on the abundance and behaviour of turtles and cetaceans in the survey area at the time of the survey and vessel speed. However, due to the extensive turtle distributions and feeding ranges, and the extended distance from their nesting sites, the numbers of individuals encountered during the proposed survey are likely to be low. Similarly, cetacean numbers encountered during the survey are likely to be low. Thus, the impacts on turtles and cetaceans are considered to be of **low intensity** for the populations as a whole. Furthermore, as the duration of the impact would be limited to the **short-term** (five months) and be restricted to the survey area (**regional**), the potential for collision and entanglement is, therefore, considered to be of **very low magnitude** (see Table 8-27).

Impact Significance

Based on the **high sensitivity** of receptors and the **very low magnitude**, the potential impact on the marine fauna is considered to be of **low significance** without mitigation (see Table 8-27).

Identification of Mitigation Measures

In addition to MMOs keeping watch for turtles and cetaceans, the following measures will be implemented:

No.	Mitigation measure	Classification
1	Ensure that 'turtle-friendly' tail buoys are used by the survey contractor or that existing tail buoys are fitted with either exclusion or deflector 'turtle guards'.	Abate on site

No.	Mitigation measure	Classification
2	Ensure vessel transit speed between the survey area and supply 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 is present in the vicinity.	Avoid / reduce at source
3	Ensure all equipment (e.g. arrays, streamers, tail buoys, etc.) that has been used in other regions is thoroughly cleaned prior to deployment.	Avoid / reduce at source
4	Retrieve or regain tension on towed gear as rapidly as possible after loss of tension.	Avoid
5	Contact the South African Whale Disentanglement Network (SAWDN) to provide specialist assistance in releasing entangled animals, should a cetacean become entangled in towed gear.	Abate

Residual Impact Assessment

With the implementation of the mitigation measures, which would reduce the intensity of the impact to very low, the residual impact will remain of **very low magnitude** and of **LOW significance** (see Table 8-27).

Table 8-27: Impacts on marine fauna from vessel strikes and entanglement

Project Phase:	Mobilisation, Operation and Decommissioning	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	HIGH	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	VERY LOW	VERY LOW
Intensity	LOW	VERY LOW
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	LOW	LOW
Probability	POSSIBLE	UNLIKELY
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	MEDIUM
Cumulative potential	UNLIKELY	UNLIKELY

8.7.2 Accidental Release of Oil at Sea

Source of Impact

The project activities likely to result in an accidental release of diesel / oil are listed below are:

Project phase	Activity
Mobilisation	Vessel accident
Operation	<ul style="list-style-type: none"> Bunkering of fuel (in port) Vessel accident and survey equipment damage
Demobilisation	Vessel accident

These activities (or events) are described further below:

- 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 will occur in the event of a vessel collision or vessel accident.

8.7.2.1 Impacts on Marine Ecology/Environment

Potential Impact Description

Diesel, hydraulic fluid and/or oil spilled in the marine environment will 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.

Project Controls

To be prepared in the event of a spill incident, the project will implement an emergency response system to mitigate the consequences of the spill.

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 onboard, to set in motion the necessary actions to stop or minimise the discharge to the sea and to mitigate its effects on the marine environment. Thus, project vessels will be equipped with appropriate spill containment and clean-up equipment, e.g. dispersants and absorbent materials. All relevant vessel crews will be trained in spill clean-up equipment use and routine spill clean-up exercises.

As standard practice, the Emergency Response Plan (ERP) will include crisis contacts and protocols.

Sensitivity of Receptors

Accidental spills and loss of marine diesel during bunkering (in port) or in the event of a vessel accident could take place in the survey area and along the route taken by the survey and support vessels between the survey area and supply port at Gqeberha. The survey area is located in the marine environment, more than 30 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); however, discharges could still directly affect migratory pelagic species transiting through the survey area. Diesel spills or accidents *en route* to the onshore supply base in Gqeberha could result in fuel loss closer to shore, thereby potentially having an environmental effect on the sensitive coastal environment.

The taxa most vulnerable to hydrocarbon spills are coastal and pelagic seabirds. Some of the species potentially occurring in the survey area, are considered regionally or globally 'Critically Endangered' (e.g. Tristan albatross, Cape gannet), 'Endangered' (e.g. Atlantic and Indian yellow-nosed albatross, African Penguin, Subantarctic skua, bank and Cape cormorant) or 'Vulnerable' (e.g. Hartlaub's gull, swift tern). The sensitivity of faunal receptors to hydrocarbon spills is considered to be **high**.

Impact Magnitude (or Consequence)

Oil or diesel spilled in the marine environment will have an immediate detrimental effect on water quality. Being highly toxic, marine diesel released during an operational spill will negatively affect any marine fauna in which it comes into contact. In the offshore environment, the taxa most vulnerable to spills are coastal and pelagic seabirds.

When considering the consequences of the effects of small (2 000 – 20 000 litres) diesel fuel spills into the marine environment, it must be noted that diesel is a light oil that, when spilled on water, spreads very quickly to a thin film and evaporates or naturally disperses within a few days or less, even in cold water. Diesel oil can be physically mixed into the water column by wave action, where it adheres to fine-grained suspended sediments, which can subsequently settle out on the seafloor. As it is not very sticky or viscous, diesel tends to penetrate porous sediments quickly, but also to be washed off quickly by waves and tidal flushing. In the case of a coastal spill, shoreline clean-up is thus usually not needed. Diesel oil is degraded by naturally occurring microbes within one to two months. Nonetheless, in terms of toxicity to marine organisms, diesel is considered to be one of the most acutely toxic oil types. Many of the compounds in petroleum products are known to smother organisms, lower fertility and cause disease. Intertidal invertebrates and seaweed that come in direct contact with a diesel spill may be killed. Fish kills, however, have never been reported for small spills in open water as the diesel dilutes rapidly. Due to differential uptake and elimination rates, filter-feeders (particularly mussels) can bioaccumulate hydrocarbon contaminants. Crabs and shellfish can be tainted from small diesel spills in shallow, nearshore areas.

In the unlikely event of a small operational spill or vessel collision, the intensity of the impact would depend on whether the spill occurred in offshore waters where encounters with pelagic seabirds, turtles and marine mammals would be low due to their extensive distribution ranges, or whether the spill occurred closer to the shore where encounters with sensitive receptors will be higher. Based on the results of an oil spill modelling exercise undertaken in a portion of Block 11B/12B to the west of the area of interest (HES 2019), a diesel slick would in the area of interest would most likely be blown in a narrow plume extending in a south-westerly direction away from the coast. The diesel would most likely remain at the surface for less than 5 days with a negligible probability of reaching sensitive coastal habitats.

In offshore environments, impacts associated with a spill would be of **low intensity, regional** (depending on the nature of the spill) over the **short-term** (less than five days). The impact **magnitude** for a marine diesel spill in the survey area (**offshore** environment) is, therefore, considered **very low**.

However, in the case of a spill *en route* to the survey area, the spill may extend into coastal MPAs and reach the shore affecting intertidal and shallow subtidal benthos and sensitive coastal bird species, in which case the **intensity** would be considered **high**, but still remaining local over the **short-term**. The **magnitude** for a **nearshore** spill is **medium**.

Impact Significance

Based on the **high sensitivity** of receptors and the **very low (offshore)** and **medium magnitude (nearshore)**, the potential impact on the marine fauna is considered to range from **low significance (offshore)** to **medium significance (nearshore)** without mitigation (see Table 8-28).

Identification of Mitigation Measures

In addition to the best industry practices and project controls, the following measures will be implemented to manage and reduce the impacts associated with small operational spills:

No.	Mitigation measure	Classification
Oil spills		
1	Ensure personnel are adequately trained in both accident prevention and immediate response, and resources are available on each vessel.	Avoid / reduce at source
2	Obtain permission from DFFE to use low toxicity dispersants. Use cautiously.	Abate on and off site
3	Ensure adequate resources are provided to collect and transport oiled birds to a cleaning station.	Restore
Bunkering at sea (not planned)		
4	Ensure offshore bunkering is not undertaken in the following circumstances: <ul style="list-style-type: none"> • 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. 	Avoid / Reduce at source
Equipment		
5	Ensure that solid streamers rather than fluid-filled streamers are used. Alternatively, low toxicity fluid-filled streamers could be used.	Avoid / Reduce at source

Residual Impact Assessment

With the implementation of the 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 (see Table 8-28).

Table 8-28: Impacts on marine ecology/environment from the accidental release of oil

Project Phase:	Mobilisation, Operation and Decommissioning	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	HIGH	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	MEDIUM	VERY LOW
Intensity	HIGH	LOW
Extent	REGIONAL	LOCAL
Duration	SHORT TERM	SHORT TERM
Significance	MEDIUM	LOW
Probability	UNLIKELY	UNLIKELY
Confidence	HIGH	HIGH
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW (offshore) TO MEDIUM (nearshore)	LOW
Mitigation Potential	-	MEDIUM
Cumulative potential	UNLIKELY	UNLIKELY

8.7.2.2 Impacts on Commercial Fishing

Potential Impact Description

An oil spill can also result in several **indirect negative** impacts on fishing. These include:

- Exclusion of fisheries from polluted areas and displacement of targeted species from normal feeding / fishing areas, both of which could potentially result in a loss of catch and / or increased fishing effort;
- Mortality of animals (including eggs and larvae) leading to reduced recruitment and loss of stock (e.g. mariculture); and
- Gear damage due to oil contamination.

Oil contamination could potentially have the greatest impact on commercial fisheries for rock lobster and sessile filter feeders (e.g. mussels) and grazers (e.g. abalone). Mortality is expected to be high on filter feeders and, to a lesser extent, grazers. These species have low mobility and no means to escape contamination and ultimately mortality. Thus, nearshore mariculture facilities in Algoa Bay could be impacted if a spill extended into the inshore areas. For a large oil spill, fishing / mariculture activities and revenues could be affected over a wide area until such time as the oil has either been dispersed or broken down naturally.

Project Controls

Project controls are as described in Section 8.7.2.1.

Sensitivity of Receptors

Due to dominant wind and currents off the Southeast Coast, a diesel slick resulting from an accidental spill would be blown in a south-westerly direction, remaining at the surface for less than 5 days (HES 2019). The sensitivity of the various fishing sectors that operate in the proposed survey area is thus considered to be **medium**.

Algoa Bay supports nearshore mariculture activities (oysters). These activities are, however, far removed from the area of interest and operational activities (e.g. bunkering) and sensitivity for mariculture is thus also considered to be **medium**.

Impact Magnitude (or Consequence)

The area of interest coincides with fishing grounds used by the demersal and mid-water trawl, hake-directed demersal longline, large pelagic longline, South Coast rock lobster, and to a lesser extent, the squid jig and small-scale sectors. Thus, any spill within the area of interest (or area of operation), could impact these sectors. The dominant wind and current direction will ensure that any spill in the survey area is dispersed in a south-westerly direction away from the coast and away from the more actively fished inshore areas of the area of interest. Thus, any spill offshore, which will disperse rapidly (days), is unlikely to have an impact on more sensitive features in the inshore areas of the proposed survey area.

The potential impact on the offshore fishing sectors is considered to be **localised** and of **low intensity** in the **short term**. Thus, the impact **magnitude** is considered to be **very low**.

The effects of an oil spill would, however, potentially have the greatest impact on sessile filter feeding (e.g. mussels and oysters) and grazing species (e.g. abalone) resulting in mortality through physical clogging and or direct absorption. Although unlikely, an accidental spill (during a vessel accident) close to the coast from vessels travelling to and from the survey location could potentially impact mariculture activities in the Algoa Bay area and small-scale shellfish harvester sectors along the coast. In such an unlikely event, the intensity would be

considered **high**, but of **local** extent and **short term** duration for both spill scales due to the dominant winds and currents moving spills offshore away from the coast. Thus, for both cases, the impact **magnitude** is expected to be **low** (see Table 8-29).

Impact Significance

Based on the **medium sensitivity** of receptors and the **very low to low magnitude**, the potential impact on commercial fishing is of **very low** significance without mitigation while the impact on nearshore mariculture and the small-scale sectors would be of **low** significance (see Table 8-29).

Identification of Mitigation Measures

Recommendations to mitigate the potential impact on commercial fishing are the same to that recommended for marine fauna (see Section 8.7.2.1).

Residual Impact Assessment

With the implementation of the mitigation measures, the residual impact will remain of **VERY LOW** and **LOW** significance (see Table 8-29).

Table 8-29: Impacts on Commercial Fishing from the accidental release of oil

Project Phase:	Mobilisation, Operation and Decommissioning	
Type of Impact	Indirect	
Nature of Impact	Negative	
Sensitivity of Receptor	MEDIUM	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	VERY LOW (offshore) LOW (nearshore)	VERY LOW
Intensity	LOW (offshore) HIGH (nearshore)	LOW
Extent	LOCAL (nearshore) REGIONAL (offshore)	LOCAL (nearshore) REGIONAL (offshore)
Duration	SHORT TERM	SHORT TERM
Significance	VERY LOW (offshore)	VERY LOW (offshore)
	LOW (nearshore)	LOW (nearshore)
Probability	UNLIKELY (mariculture) to POSSIBLE (fishing sectors)	UNLIKELY
Confidence	MEDIUM	MEDIUM
Reversibility	FULLY REVERSIBLE	FULLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	LOW
Cumulative potential	UNLIKELY	UNLIKELY

8.7.3 Loss of Equipment at Sea

Source of Impact

The project activities are provided below:

Project phase	Activity
Mobilisation	N/A
Operation	Accidental loss of equipment to the water column or seabed
Demobilisation	N/A

These activities (or event) are described further below:

- Accidental loss of paravanes, streamers, arrays, tail buoys or sound source during seismic acquisition; and
- Accidental loss of equipment during vessel transfer with crane (i.e. waste containers, equipment, consumable package, etc.).

During seismic acquisition, the survey vessel tows a substantial amount of equipment with the streamer being towed by lead-in cables. The streamer is fitted with a dilt float at the head of the streamer, numerous streamer mounts (birds and fins) to control streamer depth and lateral positioning, and a tail buoy to mark the end of the streamer. Streamers are neutrally buoyant at the required depth (5-10 m), but have buoyancy bags embedded within them that inflate at a depth of 40 m. If streamers are accidentally lost, they would float in the water column for some time before sinking. Dilt floats and tail buoys would ultimately be dragged down under the weight of the streamer.

Airguns are suspended under floats by a network of ropes, cables and chains, with each float configuration towed by an umbilical. Should both the float and umbilical fail, the airguns would sink to the seabed.

8.7.3.1 Impacts on Marine Ecology/Environment

Potential Impact Description

The potential impacts associated with lost equipment include (**direct negative** impact):

- Potential disturbance and damage to seabed habitats and crushing of epifauna and infauna within the equipment footprint; and
- 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.

Project Controls

The seismic contractor will ensure that the proposed survey is undertaken in a manner consistent with good international industry practice and BAT. Survey contractor will retrieve equipment any equipment lost overboard or from damaged seismic array, if located.

Sensitivity of Receptors

The area of interest is located more than 30 km offshore at its closest point, far removed from any sensitive coastal receptors and where the pelagic and benthic ecosystem threat status is largely considered of 'Least Concern' and the deepwater habitat types are comparatively uniform and cover large areas. The benthic fauna in deeper areas of the area of interest (beyond 450 m) are very poorly known and there are no species of commercial value occurring in the deeper offshore areas. Sensitive deep-water coral communities would be expected at topographic features such as Kingklip Ridge and Kingklip Koppies in the inshore portions of the area

of interest (where no data acquisition would take place). The sensitivity of benthic fauna in the area of interest is considered to be **low**.

Although there are pelagic species listed as ‘Critically Endangered’, ‘Endangered’ and ‘Vulnerable’ possibility occurring in the area, entanglement with a lost streamer is highly unlikely. Thus, the sensitivity of pelagic fauna to lost equipment is considered to be **medium**.

Overall, considering the precautionary principle, the sensitivity of marine fauna for crush, collision and entanglement with lost equipment is considered to be **medium**.

Impact Magnitude (or Consequence)

The accidental loss of equipment onto the seafloor would provide a localised area of hard substrate in an area of otherwise mostly unconsolidated sediments. The benthic fauna attracted to such hard substrata in otherwise unconsolidated sediments of the outer shelf and continental slope would likely be different from those of the surrounding unconsolidated sediments. In the unlikely event of equipment loss onto the seafloor associated impacts would be of **low intensity** and be highly localised and limited to the **site** over the **short-term** (any lost object, depending on its size, will likely sink into the sediments and be buried over time). The impact **magnitude** for equipment lost to the seabed is therefore considered **very low** (see Table 8-30).

The loss of streamers and floats would result in entanglement and collision hazards in the water column before the object sinks under its own weight. In the unlikely event of lost equipment floating in the water column, associated impacts would similarly be of **low intensity** and be highly localised and limited to the **site** (although would potentially float around regionally) over the **short-term**. The impact **magnitude** for equipment lost to the water column is, therefore, considered **very low** (see Table 8-30).

Impact Significance

Based on the **medium sensitivity** of receptors and the **very low magnitude**, the potential impact on the marine fauna is considered to be of **very low** significance without mitigation (see Table 8-30).

Identification of Mitigation Measures

The following measures will be implemented to manage accidental loss of equipment:

No.	Mitigation measure	Classification
1	Ensure that loads are lifted using the correct lifting procedure and within the maximum lifting capacity of the crane system.	Avoid
2	Minimise the lifting path between vessels.	Avoid
3	Undertake frequent checks to ensure items and equipment are stored and secured safely on board each vessel and maintain a good inventory of equipment onboard in order to know what is lost.	Avoid
4	Retrieve 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 the SAN Hydrographer of any hazards left on the seabed or floating in the water column, and request that a Notice to Mariners with this information be sent.	Repair / restore

Residual Impact Assessment

With the implementation of the mitigation measures, which would reduce the intensity of the impact to very low, the residual impact will remain of **very low magnitude** and of **VERY LOW significance**.

Table 8-30: Impacts on Marine Ecology/Environment from loss of equipment at sea

Project Phase:	Operation	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	MEDIUM	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	VERY LOW	VERY LOW
Intensity	LOW	VERY LOW
Extent	SITE	SITE
Duration	SHORT TERM	SHORT TERM
Significance	VERY LOW	VERY LOW
Probability	UNLIKELY	UNLIKELY
Confidence	HIGH	HIGH
Reversibility	FULLY TO PARTIALLY REVERSIBLE	FULLY TO PARTIALLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	LOW
Cumulative potential	UNLIKELY	UNLIKELY

8.7.3.2 Impacts on Commercial Fishing

Potential Impact Description

The potential impacts associated with lost equipment include (**direct negative impact**):

- Potential snagging of demersal gear with regards to equipment that sinks to the seabed; and
- Potential entanglement hazards with regards to lost equipment drifting on the surface or in the water column.

Project Controls

The seismic contractor will ensure that the proposed survey is undertaken in a manner consistent with good international industry practice and BAT. Survey contractor will retrieve equipment any equipment lost overboard or from damaged seismic array, if located.

Sensitivity of Receptors

Considering lost equipment on the seafloor, the demersal trawl sector gear may be snagged or damaged, while floating equipment (e.g. lost streamer) may become entangled with fishing gear (e.g. pelagic longlines) The sensitivity of receptors is thus considered to be **medium**.

Impact Magnitude (or Consequence)

The loss of equipment could result in entanglement and collision hazards in the water column for fishing gear in the survey area before the object sinks under its own weight, particularly for pelagic long-line gear (which can be up to 100 km long). The accidental loss of equipment onto the seafloor would provide a localised area of hard

substrate in an area of otherwise unconsolidated sediments. Since the survey area overlaps with demersal fishing grounds along the shelf break, snagging of demersal gear in inshore areas of the proposed survey area of interest due to equipment that sinks to the seabed is considered possible.

In the unlikely event of a lost streamer or other equipment, the impact could be of **low intensity**, limited to the **site** (although would potentially float around regionally) over the **short-term**. The impact **magnitude** for equipment lost to the water column and seafloor is, therefore, considered **very low** for the fishing sectors active in the proposed survey area (see Table 8-31).

Impact Significance

Based on the **medium sensitivity** of the active fishing sectors and the **very low magnitude**, the potential impact on commercial fishing is of **very low significance** without mitigation (see Table 8-31).

Identification of Mitigation Measures

Recommendations to mitigate the potential impact on commercial fishing are the same to that recommended for marine fauna (see Section 8.7.3.2). In addition, the following is recommended:

No.	Mitigation measure	Classification
1	Ensure at a minimum, one FLO person (speaking English and Afrikaans) is on board each escort vessel to facilitate communication in the local language with the fishing vessels that are in the area.	Abate on site
2	Notify PASA, the South African Maritime Safety Association (SAMSA) and the SAN Hydrographer 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.	Avoid
3	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.	Abate

Residual Impact Assessment

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 **VERY LOW significance** (see Table 8-31).

Table 8-31: Impacts on Commercial Fishing from loss of equipment at sea

Project Phase:	Operation	
Type of Impact	Direct	
Nature of Impact	Negative	
Sensitivity of Receptor	MEDIUM	
	Pre-Mitigation Impact	Residual Impact
Magnitude (Consequence)	VERY LOW	VERY LOW
Intensity	LOW	VERY LOW
Extent	SITE	SITE
Duration	SHORT TERM	SHORT TERM
Significance	VERY LOW	VERY LOW
Probability	POSSIBLE	POSSIBLE
Confidence	MEDIUM	MEDIUM

Reversibility	FULLY TO PARTIALLY REVERSIBLE	FULLY TO PARTIALLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	LOW
Cumulative potential	UNLIKELY	UNLIKELY

8.7.4 Impact on Intangible Cultural Heritage

Source of Impact

The project activities that could impact intangible cultural heritage are listed below:

Project phase	Activity
Mobilisation	Vessel accident
Operation	Bunkering of fuel in port
	Vessel accident and damage to survey equipment
Demobilisation	Vessel accident

Small accidental spills of oil or marine diesel at the sea surface from bunkering or equipment damage or larger spills of diesel from vessel collisions or accidents could occur in port, en route to the survey area or offshore in the survey area during operations.

Potential Impact Description

Any impact on the integrity of the coastal and marine ecosystem through an accidental spill of diesel, hydraulic fluid and/or oil could impact various aspects that make up people's intangible cultural heritage (**indirect negative impact**). Accidental/unplanned events are likely to only be related to small spills and would not be unique to seismic survey vessels, but similar to any other vessel traveling along the South African coast. Based on the wind and currents in the area, any spills are likely to move in a south-westerly direction away from sensitive coastal areas and would most likely remain at the sea surface for less than 5 days with negligible probability of reaching the coast. The impact assessment is summarised in Table 8-32.

Project Controls

CGG will ensure that the contractors undertake the survey operations in a manner consistent with good international industry practice and BAT. In addition, contractors will ensure that the proposed survey operations are undertaken in compliance with the applicable requirements in MARPOL 73/78.

Sensitivity of Receptors

The sensitivity of the receptor for this assessment has been defined based on the following receptors:

- Ancestry / spirituality receptor:** Should an accidental diesel/oil spill happen, the sensitivity of this receptor will rise from medium (in normal operations) to high, as ritual practice and spiritual engagement with the sea requires a healthy ocean, or at the very least, a not visibly polluted ocean. People drink seawater as an emetic in ritual purposes and swim in it for leisure and spiritual or health renewal. They may be unaware of the water quality as they are not able to see the pollution. As the proposed project, however, relates to a seismic survey and there would be no exploration drilling, only minor spills are likely and these are also unlikely to reach the shore. What needs to be considered however, is that indigenous and endogenous communities have a spiritually and symbolically important relationship with the ocean and coast and the

perceived impacts of oil/diesel spills may be high should an unplanned event occur, regardless of whether or not the spill is classified as minor.

- **Archaeology / Tangible heritage receptor:** The sensitivity of coastal tangible heritage sites are considered as high, as they are often vulnerable sites, containing vulnerable material culture (i.e. potential human artifacts in shell middens that could be destroyed by oil residues).
- **Sense of Place receptor:** The sensitivity of this receptor will increase from medium to high if an unplanned event occurs. This is because valuable heritage towns and locations depend on the sense of place to attract visitors, researchers and investors. If a place is negatively impacted by an oil spill, these patrons and researchers may not come there, thereby destroying the ‘sense’ of place. However, as noted above, there is no drilling taking place and considering the volume of fuel on the survey vessels, an accident would not result in a major oil spill.
- **Livelihoods receptor:** The sensitivity of this receptor is high because many coastal communities rely on the ocean and coast for their livelihoods, including fisheries and tourism.
- **Natural heritage receptor:** The sensitivity of this receptor is assessed to be high in an unplanned event. Since natural and cultural heritage are interdependent, any impact on the sea, as natural heritage, is going to negatively impact natural heritage items that are used in cultural heritage practices. First Peoples and Nguni descendants are likely to be most affected, given the wide range of life cycle and healing rituals that involve use of nature (i.e., medicines from the sea and fynbos) for cultural practices.
- **Health receptor:** People use the sea in cultural ways to improve, sustain and restore physical and mental health. Access to a healthy ocean is critical in this regard. Any impact on the ocean from an accidental spill may affect the health of coastal communities who regularly access the sea to sustain physical and psychological health. The sensitivity of this receptor is high.

The overall sensitivity of receptors during an unplanned event is assessed to be **high**.

Impact Magnitude (or Consequence)

The actual intensity, should a spill occur within the survey area from which it is unlikely to reach the coast, would be **low**. However, when assessing the impacts on cultural heritage, one must include *perceived* impacts. Similar to impacts from normal operations, the perceived impacts of an accidental spill in the South Coast offshore areas would be considered as of **high** intensity. The potential impact is of **short-term** duration (4-5 months) and of **regional** extent. Thus, the magnitude (or consequence) is considered to be **medium**.

Impact Significance

Based on the **high sensitivity** of receptors and the **medium magnitude**, the potential impact on intangible cultural heritage is considered to be of **medium significance**.

Identification of Mitigation Measures

The following mitigation measures are recommended:

No.	Mitigation measure	Classification
1	Implement emergency plans for efficient and quick resolution of oil/diesel spill events in line with MARPOL VI.	Avoid / Abate offsite
2	Ensure that there is sufficient insurance cover to financially manage the consequences of any unplanned event.	Abate on site

Residual Impact Assessment

With the implementation of the mitigation measures, the intensity of the impact will reduce to **medium**, leading to a residual impact of **LOW** significance.

Additional Assessment Criteria

The mitigation potential is **medium** and **partially reversible** due to potential negative perceptions, loss of resource is **low** and the cumulative potential is **unlikely**.

Table 8-32: Impact on Intangible Cultural Heritage

Project Phase:	Operation	
Type of Impact	Indirect	
Nature of Impact	Negative	
	Pre-Mitigation Impact	Residual Impact
Sensitivity of Receptor	HIGH	MEDIUM
Magnitude (Consequence)	MEDIUM	MEDIUM
Intensity	HIGH	MEDIUM
Extent	REGIONAL	REGIONAL
Duration	SHORT TERM	SHORT TERM
Significance	MEDIUM	LOW
Probability	POSSIBLE	POSSIBLE
Confidence	HIGH	MEDIUM
Reversibility	PARTIALLY REVERSIBLE	PARTIALLY REVERSIBLE
Loss of Resources	LOW	LOW
Mitigation Potential	-	MEDIUM
Cumulative potential	UNLIKELY	UNLIKELY

8.8 CUMULATIVE IMPACT

8.8.1 Bio-Physical

The assessments of impacts of seismic sounds provided in the scientific literature usually consider short-term responses at the level of individual animals only, as scientific understanding of how such short-term effects relate to adverse residual effects at the population level are limited. Data on behavioural reactions to seismic noise acquired over the short-term could, however, easily be misinterpreted as being less significant than the cumulative effects over the long-term, 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 stressors (e.g. temperature, competition for food, shipping noise). Confounding effects are, however, difficult to separate from those due to seismic surveys.

The assessment methodology used in the Basic Assessment 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). The

environment in and around the Reconnaissance Permit Area is by no means pristine, with most of the Southwest Indian Unidentified Slope habitat being considered moderately modified, and the Agulhas rocky and sandy shelf habitats in the shallower portions of the Reconnaissance Permit Area considered severely to very severely modified due primarily to commercial demersal trawling (Figure 8-2, top). Furthermore, based the intensity of all cumulative pressures and the sensitivity of the underlying ecosystem types to each of those pressures, Sink *et al.* (2019) identified that the marine biodiversity in the proposed project area has experienced high cumulative impacts (Figure 8-2, bottom). Thus, past and existing offshore activities (including shipping, prospecting, exploration, production, commercial fishing, etc.) have been taken into account in the assessment of potential cumulative impacts related to the proposed project.

Similarly, potential cumulative impacts on individuals and populations as a result of other seismic surveys or other exploration activities (e.g. other speculative or proprietary surveys that might be planned off the Southeast Coast during the same survey window period) undertaken either previously, concurrently or subsequently 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 and where natural recruitment may not re-establish the population(s) to its original level within several generations or avoidance of the area becomes permanent. Some of the historic seismic survey data acquired in the South African offshore over the past two decades is illustrated in Figure 8-3. Despite the density of seismic survey coverage over the past 17 years, the Southern right whale population is reported to be increasing by 6.5% per year (Brandaõ *et al.* 2018), and the humpback whale population by at least 5% per annum (IWC, 2012) over a time when seismic surveying frequency has increased, suggesting that, for these species at least, there is no evidence of long-term negative change to population size as a direct result of seismic survey activities.

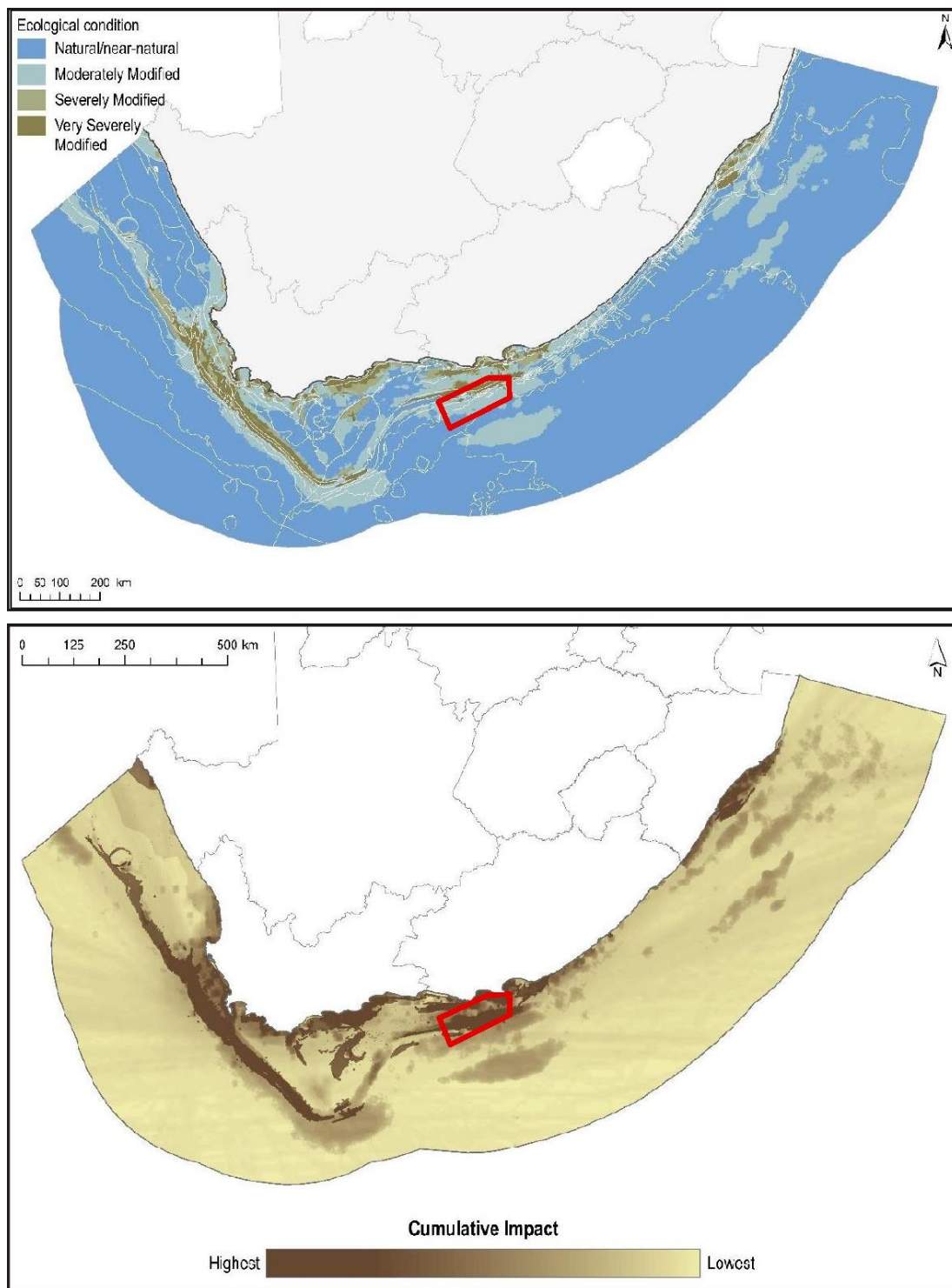


Figure 8-2: The Reconnaissance Permit Area (red polygon) in relation to the marine ecological condition (top) and cumulative impacts on marine biodiversity (bottom), based on the intensity of all cumulative pressures and the sensitivity of the underlying ecosystem types to each of those pressures (adapted from Sink *et al.* 2019).

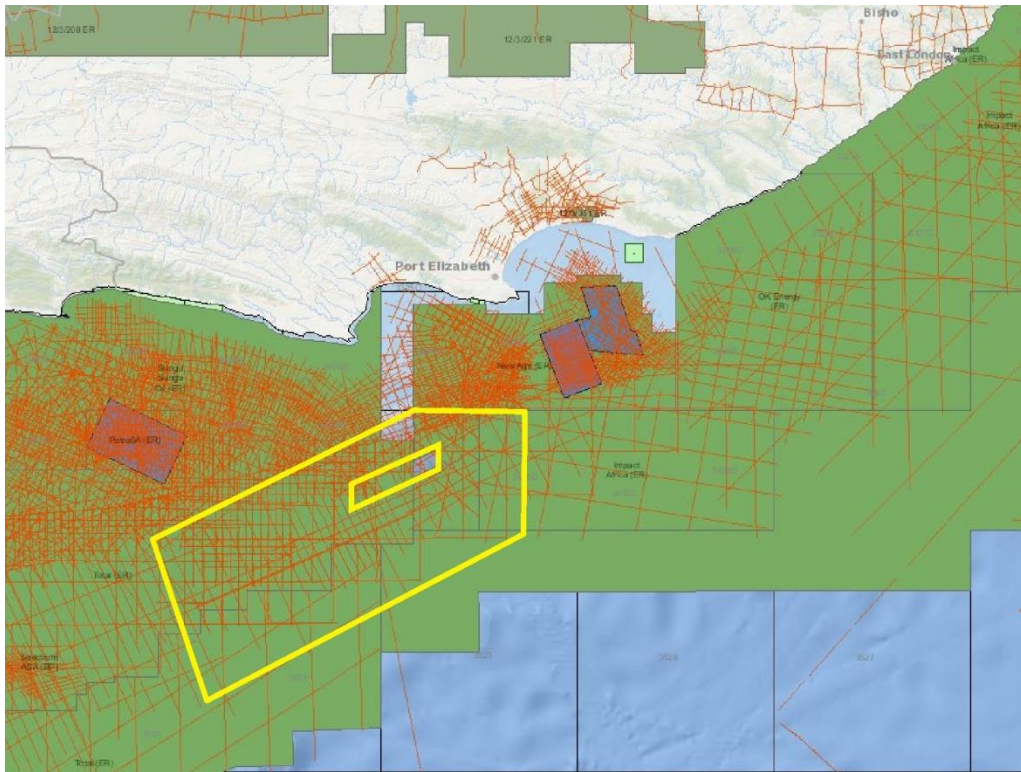


Figure 8-3: The Reconnaissance Permit area (yellow) in relation to historic 2D (orange lines) and 3D (blue and purple polygons) seismic surveys conducted off the Southeast Coast between 2001 and 2018 (Source: PASA)

Reactions to sound by marine fauna depend on a multitude of factors including species, state of maturity, experience, current activity, reproductive state, time of day. If a marine animal does react briefly to an underwater sound by changing its behaviour or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the population as a whole (NRC, 2005). However, if a sound source 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 those surveys conducted over the past decades 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 surveys on such populations remains unknown.

Consequently, suitable precautionary mitigation measures must be implemented during seismic data acquisition to ensure the least possible disturbance of marine fauna in an environment where the cumulative impact of increased background anthropogenic noise levels has been recognised as an ongoing and widespread issue of concern. Should other speculative or proprietary seismic survey campaigns be undertaken concurrently with CGG’s proposed survey off the Southeast Coast, cumulative impacts may be likely and there would need to be alignment in planning of such concurrent operations in order to avoid cumulative impacts.

8.8.2 Socio-Economic

Seismic activities have been predicted to possibly affect the migration patterns of tuna leading to substantially reduced catches of tuna along specifically the West Coast of Southern Africa. 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 Longfin Tuna and so impact on catch rates for the pelagic long-line sector, 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.

This said, there is the possible chance of an increase in disturbance and disruption to fisheries active in the area (namely demersal and mid-water trawl, demersal and large pelagic long-line, South Coast rock) should additional exploration activities related to other speculative or proprietary seismic surveys commence within the same survey window period off the Southeast Coast.

There is also the possibility of cumulative benefits being accrued to local services providers and suppliers if multiple exploration activities become active either in parallel or in close sequence to each other. The need for ongoing support from local service providers and suppliers over multiple projects may see possible cumulative benefits over a longer period of time, but may also raise strong expectations.

8.9 NO-GO ALTERNATIVE

The No-Go alternative represents the option not to proceed with the proposed speculative seismic survey, which leaves the project area of influence in its current state, except for variation by natural causes and other human activities (e.g. fishing, commercial shipping, etc.). The No-Go alternative would result in avoidance of the impacts predicted to occur from the proposed seismic survey activities (refer to Table 8-33). The result would be the prevention of a range of impacts assessed from negligible to medium significance in the short-term.

South African Government policy supports exploration for indigenous hydrocarbon resources and currently promotes the use of natural gas as part of the energy mix of the country up to 2030 (per the IRP, 2019) to serve as a transition or bridge on the path to a carbon-neutral goal (as per the Paris Agreement). The 'do nothing' or 'no-go' option would limit seismic data acquisition from the Southeast Coast.

While exploration does not automatically lead to production, it is an essential stage in the industries' development cycle, which might lead to the production of oil and gas resources. The scope and nature of the future production activities (expect possible development by TotalEnergies in Block 11B/12B) that might result off the Southeast Coast are as yet unknown, but could include a development of economic proportions significant to the South African economy. Such development would have numerous risks and benefits, which would need to be identified, appraised and managed through dedicated processes mandated by the applicable regulatory framework and investor requirements. The investment decisions and regulatory approvals to implement (or abandon) a production development would result from those processes. It is relevant that the activities and processes of exploration and production are distinct and considered separately in the South African regulatory framework. As a result, this assessment does not include consideration of the risks or benefits of any aspect of possible production that might arise as a future consequence of the exploration. Similarly, reasonable consideration of the No-Go alternative is limited to the exploration viewpoint.

In addition to promoting oil and gas exploration and use of natural gas in the energy mix, South African Government policy also supports a reduction in GHG emissions and a transition to a lower carbon economy. Not undertaking the proposed exploration activities would prevent relatively minor GHG emissions from occurring. Exploration, as contemplated, has no direct effect on whether South African consumers use more or less oil or

gas, nor on which types of fossil fuels contribute to the countries' energy mix. By extension, the undertaking of exploration has no direct influence on GHG emissions that would arise from the consumption of fossil fuels. These aspects are influenced by South Africa's energy and climate change related policy, the financial costs of the various energy sources and consumer choices in this regard. Thus, undertaking the proposed seismic surveys versus the No-Go alternative is unlikely to have any direct influence on South Africa's reliance on hydrocarbons, nor on GHG emissions from the consumption of oil or gas.

8.10 IMPACT ASSESSMENT AND MITIGATION SUMMARY

A summary of the assessment of the potential environmental and social impacts and proposed mitigation associated with the proposed seismic survey is provided in Table 8-33.

Table 8-33: Summary of the significance of the impacts associated with the proposed 3D seismic survey off the Southeast Coast

- Note: (1) Neg = Negligible; VL = Very Low; L = Low; M = Medium; H = High; VH = Very High; +ve = Positive
 (2) * indicates that no mitigation is possible and/or considered necessary, thus significance rating remains.
 (3) ** indicates that although the significance rating of the impact remains the same, the intensity of the impact decreases due to the proposed mitigation.

No.	Activities	Aspects	Impacts on Main Receptors	Pre-Mitigation Significance	Key Mitigation / Project Controls	Residual Significance
1	OPERATION OF VESSELS (SURVEY AND SUPPORT)					
1.1	Emissions to Atmosphere					
1.1.1	Emissions from the operation of the project vessels	Increase of air pollutants	Local reduction in air quality	NEG	Compliance with MARPOL 73/78 Annex VI	NEG**
1.1.2			Contribution to global greenhouse gas emissions	NEG		NEG
1.2	Routine Operational Discharges to Sea					
1.2.1	Liquid and solid discharges to sea	Local reduction in water quality	Impact marine ecology/environment	VL	Compliance with MARPOL 73/78 Annexes I, IV and V	VL
1.2.2	Discharge of ballast water and vessel / equipment transfer	Potential introduction of alien invasive species	Impact on marine biodiversity	VL	Compliance with IMO 2004 Ballast Water Management Convention	NEG
1.3	Underwater noise from project vessels transit					
1.3.1	Vessel operation	Increased underwater noise levels	Impact on marine fauna	VL	None	VL*
1.4	Lighting from vessels					
1.4.1	Vessel operation (at night)	Increased ambient lighting	Impact on marine fauna	VL	Optimise lighting	VL**
1.5	Noise from helicopters					
1.5.1	Helicopter operation (unlikely, emergencies)	Increased ambient airborne noise levels	Impact on coastal and marine fauna	VL	<ul style="list-style-type: none"> Avoid sensitive areas Maintain specified altitudes 	VL**
1.6	Impact on intangible cultural heritage					
1.6.1	Vessel operations and seismic acquisition	Seismic activities in areas considered of cultural importance	Impact on intangible cultural heritage linked to sense of place, spirituality, ancestry and livelihoods	M	<ul style="list-style-type: none"> Appropriate consultation with indigenous groups Implementation of ritual events, if requested 	L

No.	Activities	Aspects	Impacts on Main Receptors	Pre-Mitigation Significance	Key Mitigation / Project Controls	Residual Significance
2	SEISMIC ACQUISITION					
2.1	<i>Underwater Noise from Airguns</i>					
2.1.1	Seismic acquisition / firing of the airguns	Increased underwater ambient noise levels	Impact on cetaceans	M	<ul style="list-style-type: none"> Avoid key migration period Pre-shoot watch (MMO & PAM) “Soft-start” procedures MMO observation during surveying (daylight) PAM during surveying (24/7) Shut-downs 	L
2.1.2						
2.1.3			Impact on seals	L	<ul style="list-style-type: none"> Pre-shoot watch (MMO) “Soft-start” procedures MMO observation during surveying (daylight) Shut-downs 	VL
2.1.4			Impact on turtles	M	<ul style="list-style-type: none"> Pre-shoot watch (MMO) “Soft-start” procedures MMO observation during surveying (daylight) Shut-downs 	L (adults)
						M (hatchlings)
2.1.5			Impact on penguins and feeding aggregations of diving seabirds	L	<ul style="list-style-type: none"> Pre-shoot watch (MMO) “Soft-start” procedures MMO observation during surveying (daylight) Shut-downs 	VL
2.1.6			Impact on fish	M	<ul style="list-style-type: none"> Pre-shoot watch (MMO) “Soft-start” procedures MMO observation during surveying (daylight) Shut-downs 	L

No.	Activities	Aspects	Impacts on Main Receptors	Pre-Mitigation Significance	Key Mitigation / Project Controls	Residual Significance	
2.1.7	Seismic acquisition / firing of the airguns	Increased underwater ambient noise levels	Impact on invertebrates	VL	<ul style="list-style-type: none"> “Soft-start” procedures Shut-downs 	NEG**	
2.1.8			Impact on plankton	VL		Avoid key spawning period (September – December)	VL
2.1.9			Impact on demersal trawl	H		<ul style="list-style-type: none"> Stakeholder notification Navigational warning 5-day and 24-hr survey forecasts Fisheries Liaison Officer (FLO) Grievance mechanism 	L
			Impact on midwater trawl, demersal longline, large pelagic longline, South Coast rock lobster, research surveys	L			L
2.1.10			Impact on squid jig, small pelagic purse-seine, small-scale fisheries	No Impact			No Impact
2.2	Temporary Safety Zone around Survey Vessel and Array						
2.2.1	Operation of seismic vessel	Temporary safety zone around survey vessel and array	Impact on demersal trawl	M	<ul style="list-style-type: none"> Stakeholder / vessel notification 5-day and 24-hr survey forecasts Navigational warning Fisheries Liaison Officer (FLO) Vessel lighting Grievance mechanism 	L	
			Impact on midwater trawl, demersal longline, large pelagic longline, South Coast rock lobster, research surveys	L		L	
2.2.2			Impact on squid jig, small pelagic purse-seine, small-scale fisheries	No Impact		No Impact	
2.2.3			Disruption to commercial shipping	L		L**	
3	INTERACTION WITH THE LOCAL ECONOMY						
3.1	Employment and Business Opportunities						
3.1.1	Provision of services	Local employment and local business opportunities	Economic benefits for local service providers and suppliers	NEG +ve	<ul style="list-style-type: none"> Contracting of local companies Manage community expectations Grievance mechanism 	NEG +ve	
4	UNPLANNED EVENTS						
4.1	Collisions with project vessels and equipment						
4.1.1	Ship strikes and entanglement	Obstruction on sea surface, seafloor or in water column	Health and safety impacts to coastal recreation and fishing	NEG	<ul style="list-style-type: none"> Emergency Response Plan Stakeholder information Navigation warning Implement a grievance mechanism 	NEG**	

No.	Activities	Aspects	Impacts on Main Receptors	Pre-Mitigation Significance	Key Mitigation / Project Controls	Residual Significance
4.1.2			Impacts on marine fauna	L	<ul style="list-style-type: none"> 'Turtle-friendly' tail buoys Reduced transit speed Ensure all equipment used is thoroughly cleaned 	L**
4.2	<i>Accidental Release of Oil at Sea</i>					
4.2.1	Vessel or equipment damaged and bunkering of fuel	Release of fuel into the sea and localised reduction in water quality	Impacts on marine ecology/environment	M	<ul style="list-style-type: none"> Bunkering procedure Shipboard Oil Pollution Emergency Plan – MARPOL Annex I Emergency Response Plan and notification Spill training and clean-up equipment Insurance cover 	L
4.2.2			Impacts on offshore commercial fishing	VL		VL**
4.2.3			Impact on nearshore mariculture	L		L**
4.2.4			Impact on intangible cultural heritage	M		L
4.3	<i>Loss of Equipment at Sea</i>					
4.3.1	Accidental loss of equipment	Obstruction on seafloor or in water column	Impacts on marine ecology/environment	VL	<ul style="list-style-type: none"> Maintenance and lifting procedures Retrieve of lost objects / equipment, where practicable Notify PASA, SAMSA and the SAN Hydrographer 	VL**
4.3.2			Impacts on commercial fishing	VL		VL**