APPENDIX 3.3

FISHING INDUSTRY ASSESSMENT

PROPOSED EXPLORATION DRILLING IN THE ORANGE BASIN DEEP WATER LICENCE AREA OFF THE WEST COAST OF SOUTH AFRICAN

Assessment of Potential Impact on Commercial Fishing Catch and Effort

Prepared by:
CapFish SA (Pty) Ltd

Prepared for the Environmental Assessment Practitioner:
CCA Environmental (Pty) Ltd

On behalf of the Applicant:
Shell South Africa Upstream B.V.

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10 December 2013

Expertise and Declaration of Independence

This report was prepared by Dave Japp and Sarah Wilkinson of CapFish SA (Pty) Ltd. Dave Japp has a BSC in Zoology, University of Cape Town (UCT) and a MSc degree in Fisheries Science from Rhodes University. Sarah Wilkinson has a BSc (Hons) degree in Botany from UCT.

Both have considerable experience in undertaking specialist environmental impact assessments relating to fishing and fish stocks. Dave Japp has worked in the field of Fisheries Science and resource assessment since 1987. His work has included environmental economic assessments and the evaluation of the environmental impacts on fishing. Sarah Wilkinson has worked on marine resource assessments, specialising in spatial and temporal analysis (GIS), as well as the economic impacts of fisheries exploitation.

This specialist report was compiled on behalf of CCA Environmental (Pty) Ltd for their use in compiling a Basic Assessment Report and Environmental Management Programme (EMPr) Addendum for the exploration drilling operations proposed by Shell Upstream B.V. within the Orange Basin Deep Water Licence Area, off the West Coast of South Africa. We do hereby declare that we are financially and otherwise independent of the applicant and CCA Environmental.

Dave Japp

Sarah Wilkinson

EXECUTIVE SUMMARY

In February 2012 Shell South Africa Upstream B.V. (hereafter referred to as "Shell"), a subsidiary of Royal Dutch Shell plc, obtained an exploration right for the Orange Basin Deep Water Licence Area in terms of the Mineral and Petroleum Resources Development Act, 2002 (No. 28 of 2002) (MPRDA). The licence area is approximately 37 290 km^2 in extent. The eastern border of the Licence Area is located between approximately 150 km and 300 km off the West Coast of South Africa roughly between Saldanha Bay (33ºS) and Kleinzee (30ºS), in water depths ranging from 500 m to 3 500 m.

As part of the process of applying for the exploration right, an Environmental Management Programme (EMPr) was compiled and approved for the undertaking of seismic surveys and exploration drilling within the licence area. Shell subsequently undertook a 3D seismic survey in an 8 000 km^2 portion of the licence area, which was completed on 22 February 2013.

Based on analysis of the seismic data, Shell proposes to drill one or possibly two exploration wells within an area of interest in the northern portion of the licence area. The target depth of the well is between 2 700 m and 3 000 m below the seafloor and is expected to take in the order of three months to drill and complete. For operational reasons, drilling is expected to take place in a future summer window period between November to April.

Depending on the success of the first well, a second well may be drilled to establish the quantity and potential flow rate of the resource. This "appraisal" well would be drilled in a location and to a depth determined by the results of the first well. It is anticipated that the appraisal well would be drilled at least one year after completion of the first well in order to allow sufficient time for data analysis and planning.

The proposed exploration drilling programme requires authorisation in terms of both the MPRDA and the National Environmental Management Act, 1998 (No. 107 of 1998) (NEMA), as amended. The objective of this report is to provide a specialist assessment as part of the Basic Assessment and Environmental Management Programme (EMPr) Addendum processes for the proposed exploration drilling programme. This report provides information on the spatial distribution of fishing effort and catch. In addition, the potential impacts of exploration drilling (including normal drilling operations and upset conditions) on the commercial fishing operating in the area are assessed. Mitigation and management measures are proposed with a view to reducing potential negative effects between well-drilling and fishing operations.

<u>Potential impacts related to normal drilling operations</u>

Impacts could include cessation or temporary displacement of fishing activities during the proposed drilling operations. It is highly probable that the proposed well-drilling operations would negatively affect fishing operations of the large pelagic long-line fishery. The impact is assessed to be of medium intensity and of overall VERY LOW significance before and after mitigation. There is NO IMPACT expected from the proposed well-drilling activities, including the possible abandonment of wellheads on the seafloor, on the demersal trawl, demersal hake-directed long-line, demersal shark-directed long-line, tuna pole, traditional line-fish and West Coast rock lobster inshore and offshore fisheries. There is also NO IMPACT expected on the current demersal research biomass surveys conducted on a bi-annual basis by Department of Agriculture, Forestry and Fisheries.

The following mitigation measures are proposed:

- Industry bodies (specifically the pelagic long-line fishery) and other key Interested and Affected Parties (I&APs) should be notified of the proposed drilling activities and requirements with regards to the safe operational limits around the drilling unit prior to the commencement of the project. Specific industrial bodies that need to be notified include:

- > Department of Agriculture, Forestry and Fisheries (DAFF);
- > the Department of Environmental Affairs (DEA);
- > the South African Tuna Association (SATA);
- > the South African Tuna Long-Line Association (SATLA);
- > Fresh Tuna Exporters Association (FTEA);
- > the South African Deep-Sea Trawling Industry Association;
- > Transnet National Ports Authority (ports of Cape Town and Saldanha Bay); and
- > the South African Maritime Safety Association (SAMSA).

- Daily Navigational Warnings should be issued for the duration of the drilling operations through the South African Naval Hydrographic Office.
- Any fishing vessel targets at a radar range of 24 nautical miles from the drilling unit should be called via radio and informed of the safety requirements around the drilling unit.
- Notify industry bodies and other key I&APs when drilling in complete and the drilling unit is off location.

In historically trawled areas that occurred predominantly on the shelf in waters shallower than 500 m water depth, the trawling industry has objected to (and requested the removal of) abandoned wellheads and other structures associated with oil and gas development). However, in the proposed area of interest, which is located beyond the 1 500 m water depth, there are no known records of bottom trawling. Although the expansion of trawling into waters deeper than the current depths fished (approximated from 1000 m and shallower) is uncertain, it is unlikely that trawling effort would move into areas as deep as 1 500 m (noting that the technology exists to trawl to these depths and that such activity if targeting deep water species, would require approval from the national fisheries management authority). Thus it is anticipated that there would be no long-term impact on the demersal trawl sector. This said, there could still be some industry resistance to the abandonment of the wellheads on the seafloor.

<u>Potential impacts related to upset conditions (oil spills)</u>
Based on the results of the oil spill modelling a small, instantaneous oil spill (1 ton of hydraulic fluid or 10 tons of diesel) during drilling operations would have a short-term effect, local impact of low intensity and overall VERY LOW significance before and after mitigation on all fisheries sectors. The likelihood of the impact occurring is probable and the confidence in the assessment is medium.

A 5-day or 20-day large blow-out oil spill is predicted to have a short- to medium-term impact of a regional extent on all fisheries sectors. The impact on the large pelagic long-line and tuna pole sectors would be expected to be of medium intensity and of overall LOW significance before and after mitigation. The impact on the demersal trawl, demersal hake- and shark-directed long-line, traditional line-fish, west coast rock lobster and demersal research sectors would be expected to be of medium to high intensity and of overall MEDIUM significance before and after mitigation. The impact on the small pelagic purse-seine fishery would be expected to be of high intensity and of overall HIGH significance before and after mitigation. The likelihood of the large blowout oil spills occurring is improbable and the confidence in the assessment is medium.

It is recommended that an oil spill contingency plan is in place at all times to ensure that spills can be effectively handled.

Impact assessment summary

	Probability	Significance	
		(before mitigation)	(after mitigation)
Impact of related to normal exploration drilling activities			
Large Pelagic Long-line	Highly Probable	Very Low	Very Low
Demersal Trawl	No Impact		
Demersal Hake-directed Long-line	No Impact		
Demersal Shark-directed Long-line	No Impact		
Tuna Pole	No Impact		
Traditional Linefish	No Impact		
Small Pelagic Purse-Seine	No Impact		
West Coast Rock Lobster	No Impact		
Fisheries research	No Impact		
Impact of a small instantaneous oil spill			
Large Pelagic Long-line	Probable	Very Low	Very Low
Demersal Trawl	Probable	Very Low	Very Low
Demersal Hake-directed Long-line	Probable	Very Low	Very Low
Demersal Shark-directed Long-line	Probable	Very Low	Very Low
Tuna Pole	Probable	Very Low	Very Low
Traditional Linefish	Probable	Very Low	Very Low
Small Pelagic Purse-Seine	Probable	Very Low	Very Low
West Coast Rock Lobster	Probable	Very Low	Very Low
Fisheries research	Probable	Very Low	Very Low
Impact of a large blow-out of crude oil (5-day and 20-day scenarios)			
Large Pelagic Long-line	Improbable	Low	Low
Demersal Trawl	Improbable	Medium	Medium
Demersal Hake-directed Long-line	Improbable	Medium	Medium
Demersal Shark-directed Long-line	Improbable	Medium	Medium
Tuna Pole	Improbable	Low	Low
Traditional Linefish	Improbable	Medium	Medium
Small Pelagic Purse-Seine	Improbable	High	High
West Coast Rock Lobster	Improbable	Medium	Medium
Fisheries research	Improbable	Medium	Medium

Contents

LIST OF TABLES AND FIGURES

1. INTRODUCTION

1.1 PROJECT BACKGROUND

In February 2012 Shell South Africa Upstream B.V. (hereafter referred to as "Shell"), a subsidiary of Royal Dutch Shell plc, obtained an exploration right for the Orange Basin Deep Water Licence Area in terms of the Mineral and Petroleum Resources Development Act, 2002 (No. 28 or 2002) (MPRDA). The licence area is approximately 37 290 km^2 in extent. The eastern border of the Licence Area is located between approximately 150 km and 300 km off the West Coast of South Africa roughly between Saldanha Bay (33ºS) and Kleinzee (30ºS), with water depths ranging from 500 m to 3 500 m (see Figure 1).

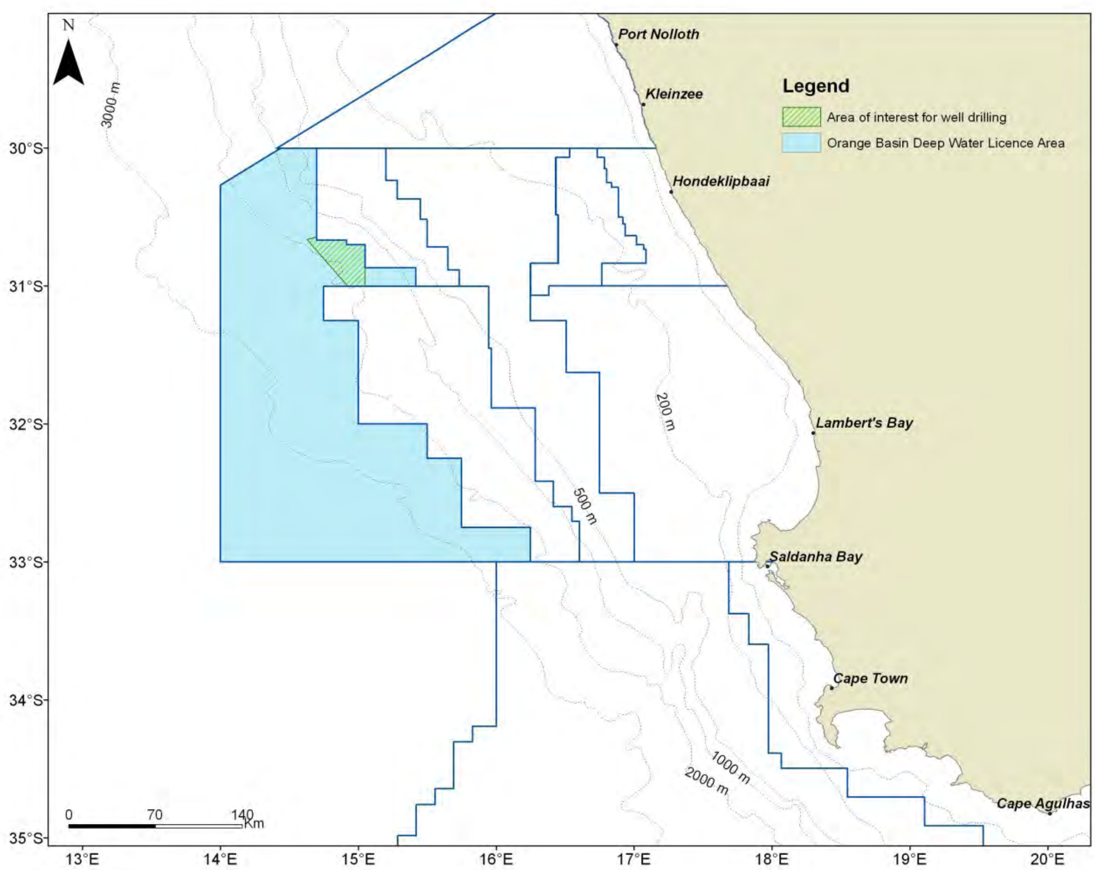


Figure 1. Locality of the Orange Basin Deep Water Licence Area off the West Coast of South Africa. The proposed area of interest for exploration drilling is also shown.

As part of the process of applying for the exploration right, an Environmental Management Programme (EMPr) was compiled and approved for the undertaking of seismic surveys and exploration drilling within the licence area. Shell subsequently undertook a 3D seismic survey in an 8 000 km^2 portion of the licence area, which was completed on 22 February 2013.

Based on analysis of the seismic data, Shell proposes to drill one or possibly two exploration wells in the northern portion of the licence area. Exploration drilling is undertaken to determine whether geological structures or "prospects", identified by studying the data from seismic surveys, contain oil or gas in potentially commercial extractable amounts.

The proposed exploration drilling programme requires authorisation in terms of both the MPRDA and the National Environmental Management Act, 1998 (No. 107 of 1998) (NEMA), as amended. CCA Environmental (Pty) Ltd (CCA), in association with NMA Effective Social Strategists (Pty) Ltd (NMA), has been appointed by Shell to compile an EMPr Addendum in terms of Section 39(6) of the MPRDA and to undertake a Basic Assessment process in terms of NEMA.

1.2 TERMS OF REFERENCE

The purpose of this report is to provide a specialist assessment on the catch and effort of commercial fishing as part of the Basic Assessment and EMPr amendment processes. The scope of this fisheries assessment is as follows:

- Provide a description of the fisheries sectors operating off the West Coast of South Africa;
- Undertake a spatial and temporal assessment of recent and historical fishing effort and catch in the proposed drilling area. Provide detailed maps delineating fishing grounds relative to the offshore Orange Basin Deep Water Block and proposed drilling site(s);
- Assess the risk of impact of the drilling activities on specific commercial fish species and the consequential implications for fish catch by the different fishing sectors;
- Assess the potential impacts of normal drilling operations (namely the proposed safety zones around the drilling unit) and upset conditions (small accidental spills and large blow-out) on the fishing activities in terms of estimated catch and effort loss; and
- Identify practicable mitigation measures to reduce any negative impacts on the fishing industry.

1.3 PROJECT DESCRIPTION

1.3.1 Well location and drilling programme

Shell is proposing to drill one or possibly two wells in the northern portion of the license area. At this stage an area of interest has been defined for the drilling locations, which is 900 km^2 in extent with water depths ranging between 1 500 m and 2 100 m. The final well location would be based on a number of factors, including further analysis of the 3D seismic data, the geological target and seafloor location obstacles. The area of the proposed drill location would be analysed for hazards on a special high definition seismic dataset, which is a subset of the acquired 3D data.

The expected final depth of the well is between 2 700 m and 3 000 m below the seafloor and is expected to take in the order of three months to complete. For operational reasons, drilling is expected to take place in a future summer window period between November and April.

Depending on the success of the first well, a second well may be drilled to establish the quantity and potential flow rate of the resource. This “appraisal” well would be drilled in a location and to a depth determined by the results of the first well. It is anticipated that the appraisal well would be drilled at least one year after completion of the first well in order to allow sufficient time for data analysis and planning.

1.3.2 Drilling unit options

Various types of drilling technology can be used depending on, *inter alia*, the water depth and marine operating conditions experienced at the well site, e.g. barges, platform rigs, jack-up rigs, semi-submersible drilling units (rigs), drill ships and tension leg platform rigs. Shell is currently considering two alternative drilling units, either a semi-submersible drilling unit (see Figure 2) or a drill-ship (see Figure 3).

Figure 2. Photograph of a semi-submersible drilling unit (Source: Shell).

Figure 3. Photograph of a drill ship (Source: Shell).

1.3.2.1 Semi-submersible drilling unit (rig)

A semi-submersible drilling unit is essentially a drilling unit with auxiliary drilling and marine support equipment located on a floating structure comprised of one or a number of pontoons. A semi-submersible unit typically requires a tow vessel or transport barge to transport the vessel to its drilling location.

When at the well location the pontoons are partially flooded (or ballasted) to submerge the pontoons to a pre-determined depth below the sea level where wave motion is minimized. This gives stability to the drilling unit thereby facilitating drilling operations. In deeper water where anchoring is not practical, the drilling unit would be held in position by dynamic positioning thrusters. On-board computers are locked onto the well location and activate bow and stern thrusters to maintain the drilling unit on location with a high degree of precision

A riser pipe on compensated hydraulic tensioners (which keep the tension of the riser pipe constant during wave motion) connects the drilling unit to the seabed during the drilling operation. The riser acts as a conduit through which drilling operations can proceed and drilling fluid can be circulated.

1.3.2.2 Drill ship

A drill-ship is essentially a self-sufficient ship with a drilling rig attached, normally located at the centre of the ship where drilling operations are conducted. The advantages of a drill ship over the majority of semi-submersible units are that the drill ship has much greater storage capacity and is independently mobile, not requiring any towing or transport vessel.

The drill-ship would similarly be held in position by dynamic positioning thrusters. However, in deeper water where anchoring is not practical, they are similarly held in position by dynamic positioning thrusters.

The drill-ship, similar to the semi-submersible drilling unit, uses a riser pipe on compensated hydraulic tensioners to connect the vessel to the seabed and to act as a conduit through which drilling operations can proceed.

1.3.2.3 Safety standards

The drilling unit would be classified for seaworthiness through an appropriate marine classification programme (e.g. American Bureau of Shipping, Det Norske Veritas, Lloyds Register, etc.). Once a drilling unit has been contracted, safety certificates and vessel specifications will be made available to PASA prior to the start of the activities.

1.3.2.4 Exclusion zone

Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part B, Section II, Rule 18), a drilling unit that is engaged in underwater operations 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. Vessels engaged in fishing are required to, so far as possible, keep out of the way of the well drilling operation.

Furthermore, under the Marine Traffic Act, 1981 (No. 2 of 1981), an "exploration platform" or "exploration vessel" used in prospecting for or mining of any substance falls under the definition of an "offshore installation" and as such it is protected by a 500 m safety zone. It is an offence for an unauthorised vessel to enter the safety zone.

The temporary 500 m safety zone around the drilling unit (approximately 0.8 km2 in extent) would be enforced around the drilling unit at all times. A support vessel equipped with appropriate radar and communications would be kept on 24-hour standby near the drilling unit and is used to patrol the area to ensure that other vessels adhere to the safety zone. The safety zone would be described in a Notice to Mariners as a navigational warning.

1.3.3 Drilling equipment and procedure

1.3.3.1 Equipment

The essential elements of a drilling unit are: hoisting, rotating, circulating, power and safety equipment. These are described below (see Figure 4).

- Hoisting System
  The hoisting system is used to raise and lower drill pipe in and out of the hole and to support the drill string to control the weight on the drill bit during drilling. The hoisting system consists of the derrick, traveling and crown blocks, the drilling line and the draw works. The drilling unit uses a derrick, which is a steel tower that is used to support the traveling and crown blocks and the drill bit and pipe (string). The crown and traveling blocks are a set of pulleys that raise and lower the drill string. The crown block is a stationary pulley located at the top of the derrick. The traveling block moves up and down and is used to raise and lower the drill string. These pulleys are connected to the drill string with a large diameter steel cable. The cable is connected to a winch or draw-works. The draw-works contain a large drum around which the drilling cable is wrapped. As the drum rotates one way or the other, the drilling cable spools on or off the drum and raises or lowers the drill string.

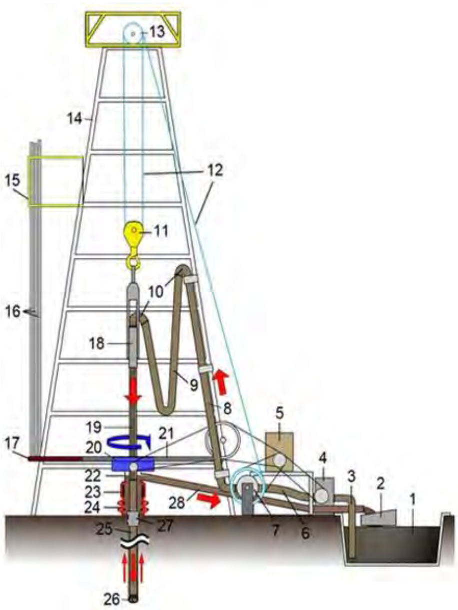
- Rotating System
  The rotating equipment turns the drilling bit. This equipment consists of the topdrive, the rotary table, the drill pipe and the drill collars (drill string) and the bit. The topdrive is attached to the bottom of the traveling block and permits the drill string to rotate. The topdrive consists of a strong engine that rotates the drill string. A hose, through which the drilling fluid enters the drill

pipe, is connected at the top of the topdrive. The drill pipe is a round pipe about 9 m long with a diameter of from 5 inch (13 cm). Drill collars are heavy thick pipes that are used at the bottom of the drill string to add weight on the bit. The drill pipe has threaded connections on each end that allow the pipe to be joined together to form longer sections as the hole gets deeper. The drilling bit is used to create the hole. Drilling bit sizes typically range from 36 inches (91 cm) to 6 inches (15 cm) in diameter.

- Circulating System
  The drilling operation uses drilling fluids to reduce friction (lubricate and cool drill bit), remove the drilled rock fragments (cuttings), and to equalise pressure in the wellbore and prevent other fluids from flowing into the wellbore. The circulation system of drilling fluid consists of the suction pits, pumps, surface piping (flowlines and standpipe), rotary hose (or kelly hose) and swivel, which is connected to the topdrive.

Figure 4 shows the flow path of the drilling fluid. The circulating system pumps the drilling fluids (or drilling muds) down the hole, out of the nozzles in the drilling bit and returns them to the surface where the cuttings are separated from the drilling fluid.

The cuttings are separated from the mud by vibrating screens called a shale shakers. The cuttings are trapped on the screens and the mud passes through the screens into the mud pits. The circulating pumps pick up this clean mud and pump it back down the hole.



1	-	Mud tank	15	-	Monkey board
2	-	Shale shakers	16	-	Stand (of drill pipe)
3	-	Suction line (mud pump)	17	-	Pipe rack (floor)
4	-	Mud pump	18	-	Swivel
5	-	Motor or power source	19	-	Kelly
6	-	Vibrating hose	20	-	Rotary table
7	-	Draw-works	21	-	Drill floor
8	-	Standpipe	22	-	Bell nipple
9	-	Kelly hose	23	-	Blow-out preventer annular
10	-	Goose-neck	24	-	Blow-out preventers
11	-	Traveling block	25	-	Drill string
12	-	Drill line	26	-	Drill bit
13	-	Crown block	27	-	Casing head
14	-	Derrick	28	-	Flow line

Figure 4 . Flow path of the drilling fluid.

- Safety System

  Although the probability of a well blow-out is extremely low, it nonetheless provides the greatest environmental concern during drilling operations. The primary safeguard against a blow-out is the drilling fluid. The density of the fluid can be controlled to balance any abnormal formation pressures. Abnormal formation pressures are detected by primary well control equipment, which generally consists of two sets of pit level indicators and return mud-flow indicators with one set manned by the drill crew and the other by the mud logger. The mud logger also has a return mud gas detector, which monitors return mud temperature and changes in shale density for abnormal pressure detection. The drilling fluid is also tested frequently during drilling operations and its composition can be adjusted to account for changing downhole conditions.

  The likelihood of a blow-out is further minimised by employing a specially designed item of safety equipment called a blow-out preventer (BOP), which is a secondary control system. The BOP is installed on the wellhead and is designed to close in the well to prevent the uncontrolled flow of hydrocarbons from the reservoir in case the pressure of the reservoir exceeds the pressure of the drilling fluid in the reservoir resulting in hydrocarbons entering the wellbore. If this cannot be controlled hydrocarbons could eventually exit the wellbore into the marine environment / atmosphere. Hence the BOP system plays a key role in preventing potential risks to people, the environment and equipment. The BOP would undergo a thorough inspection prior to installation and subsequently pressure and function tested on a regular basis.

  A typical BOP stack is shown in Figure 5. The BOP stack usually consists of the following:

  > Annular preventer: The annular-type blow-out preventer can close around the drill string, casing or a non-cylindrical object, such as a kelly. Drill pipe including the larger-diameter tool joints (threaded connectors) can be "stripped" (i.e. moved vertically while pressure is contained below) through an annular preventer by careful control of the hydraulic closing pressure. Annular BOPs are typically located at the top of a BOP stack, with one or two annular preventers positioned above a series of several ram preventers.

  > Ram type preventers: Ram type preventers are similar in operation to gate valves but use a pair of opposing steel plungers or rams. The rams extend toward the centre of the wellbore to restrict flow or retract open in order to permit flow. There are four common types of rams or ram blocks used in a BOP stack (or combination thereof):

    - Pipe rams close around a drill pipe, restricting flow in the annulus (ring-shaped space between concentric objects) between the outside of the drill pipe and the wellbore, but do not obstruct flow within the drill pipe. Variable-bore pipe rams can accommodate tubing in a wider range of outside diameters than standard pipe rams, but typically with some loss of pressure capacity and longevity;
    - Blind rams (also known as sealing rams), which have no openings for tubing, can close off the well when the well does not contain a drill string or other tubing and seal it;
    - Shear rams cut through the drill string or casing with hardened steel shears; and
    - Blind shear rams (also known as shear seal rams or sealing shear rams) are intended to seal a wellbore, even when the bore is occupied by a drill string, by cutting through the drill string as the rams close off the well.

  In deeper offshore operations, there are four primary ways in which a BOP can be controlled, including (in order of priority):

  > Electrical control signal, which is sent from the surface through a control cable;

  > Acoustical control signal, which is sent from the surface based on a modulated / encoded pulse of sound transmitted by an underwater transducer;

  > Remotely Operated Vehicle (ROV) intervention, which mechanically controls valves and provides hydraulic pressure to the stack (via “hot stab” panels); and

  > Deadman switch / auto shear, which is a fail-safe activation of selected BOPs during an emergency, and if the control, power and hydraulic lines have been severed.

In addition to the above, advanced well intervention and capping equipment is available in Saldanha Bay for deployment in the event of a subsea well control incident. The subsea well intervention system includes four capping stacks to shut-in an uncontrolled subsea well and two hardware kits to clear debris and apply subsea dispersant at a wellhead. This unique piece of equipment is only stored in four international locations, namely Norway, Brazil, Singapore and South Africa, and is maintained ready for immediate mobilisation in the event of an incident.

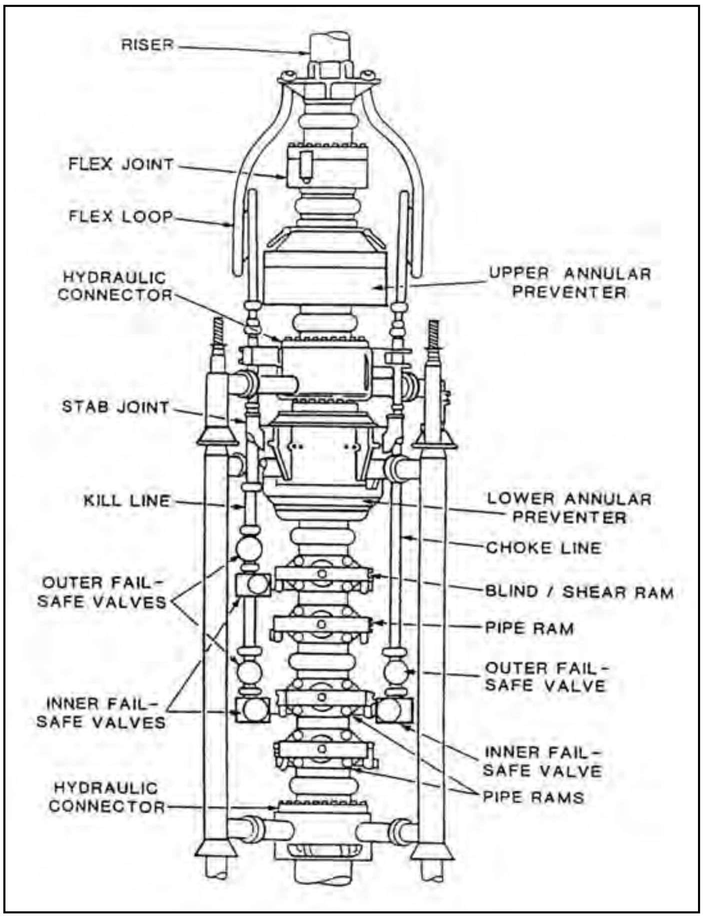


Figure 5. Schematic of a typical subsea BOP stack.

- Power System

The drill unit would need power to operate the circulating, rotating and hoisting systems. This power is generated from diesel engines that power generators which transmit electricity to the drilling unit.

- Storage Areas

  The drilling unit would have dedicated storage for a variety of fluids and chemicals including:
  - Fuel (diesel);
  - Fresh (potable) water;
  - Drilling water;
  - Bulk mud and cement;
  - Liquid mud;
  - Mud chemicals; and
  - Cementing chemicals.

1.3.3.2 Drilling method

Two drilling methods can be employed on a drilling unit, namely rotary or downhole motor drilling. The primary drilling method would be rotary drilling, where the whole drill string is rotated to penetrate the formations. However, a downhole motor may be included in the bottom hole assembly to provide additional power to the bit. The downhole motor is driven by the drilling fluid, which is pumped down the drill string.

The downhole motor drilling also allows a well to be directionally drilled to achieve any inclination from vertical to horizontal and to also change the azimuth direction in order to reach the geological target (Figure 6). The direction of the well is changed by holding the drill string stationary and pointing the downhole motor, which has a slight bend in its body, in the direction required and slide drilling ahead.

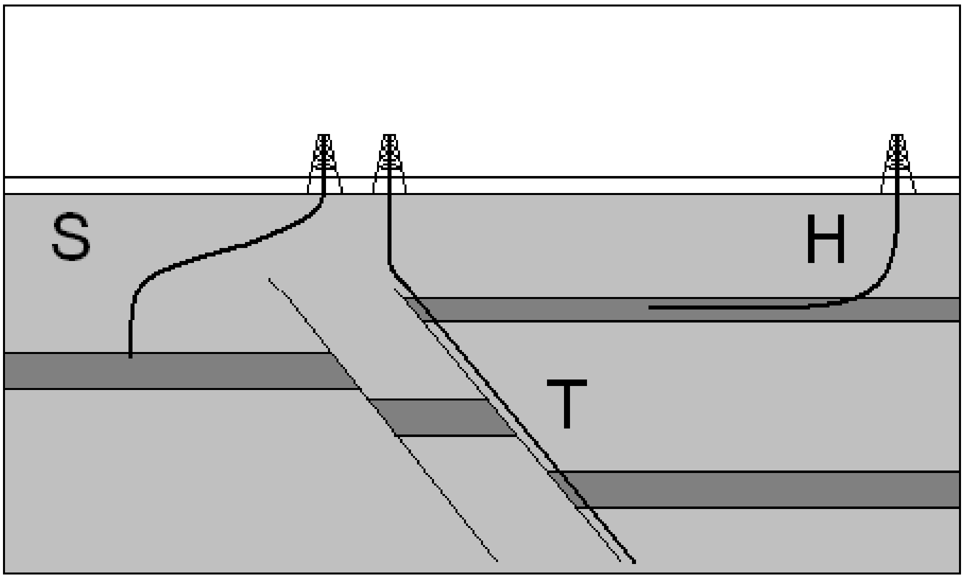


Figure 6. Tangent (T), Horizontal (H) or S shaped (S) drill trajectories.

1.3.3.3 Drilling sequence or stages

The well would be created by jetting and drilling a hole into the seafloor with a drilling unit that rotates a drill string with a bit attached. After the hole is drilled, sections of steel pipe (or casings), slightly smaller in diameter than the borehole, are placed in the hole and permanently cemented in place (cementing operations are described in Section 1.3.3.4). The hole diameter decreases with increasing depth as progressively smaller diameter casings are inserted into the hole at various stages and cemented into place.

The casing provides structural integrity to the newly drilled wellbore, in addition to isolating potentially dangerous high pressure zones from each other and from the surface. With these zones safely isolated and the formation protected by the casing, the well would be drilled deeper with a smaller bit, and also cased with a smaller size casing (see Figure 7). Shell is proposing to have four to nine sets of subsequently smaller hole sizes drilled inside one another, each cemented with casing.

Drilling is essentially undertaken in two stages, namely the riserless and risered drilling stages.

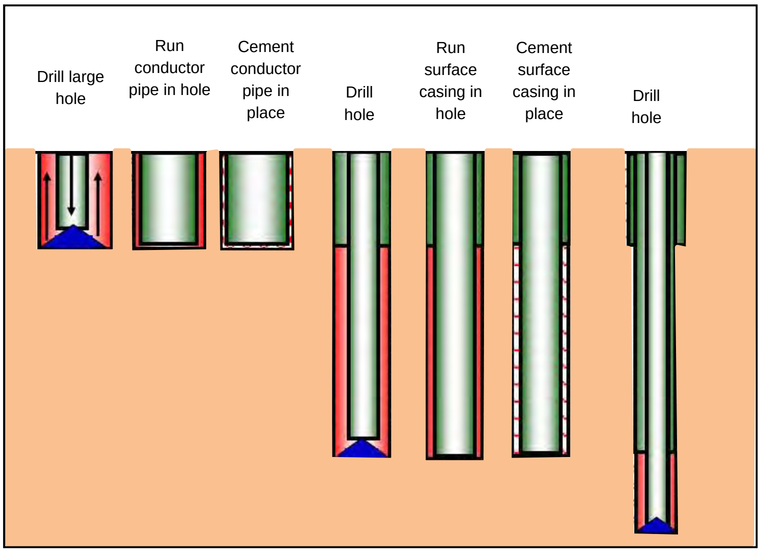


Figure 7. Simplified view of well drilling

Initial (riserless) drilling stage

Sediments just below the seafloor are often very soft and loose, and to keep the well from caving in and to carry the weight of the wellhead a 36 inch (91 cm) diameter structural conductor pipe is jetted and / or drilled and cemented into place depending on the shallow seabed properties.

The conductor pipe is assembled at the drilling unit floor and a drill bit, connected to a drill pipe, is run through the inside to the bottom of the casing. The entire assembly is lowered to the seafloor by the rig hoist. At the seafloor the driller spuds the assembly into the seafloor sediments and then turns on a pump, which uses water or drilling fluid to jet the pipe into place.

When the conductor pipe and wellhead are at the correct depth the drill bit and drill string are released in order to commence with drilling operations. The rotating drill string, causes the drill bit to crush rock into small particles, called "cuttings". While the wellbore is being drilled, drilling fluid is pumped from the surface down through the inside of the drill pipe, the drilling fluid passes through holes in the drill bit and travels back to the seafloor through the space between the drill string and the walls of the hole, thereby removing the cuttings from the hole. At the planned depth the drilling is stopped and the bit and drill string is pulled out of the hole. The conductor pipe would be approximately 75 m deep.

Below the conductor pipe, typically a 26 inch (66 cm) diameter hole would be drilled for a 20 inch (51 cm) surface casing, which would extend to approximately 1 000 m below the seabed. The surface casing would be permanently cemented into place. In the event of technical issues in the riserless section, intermediate liners could be required in order for the surface casing to be installed at a sufficient depth to accommodate the drilling riser and BOP.

These initial hole sections would be drilled using seawater (with viscous sweeps) and water-based mud (WBM) (see Section 1.3.4.1 below for a description of WBMs). All cuttings and WBM from this initial drilling stage would be discharged directly onto the seafloor adjacent to the wellbore.

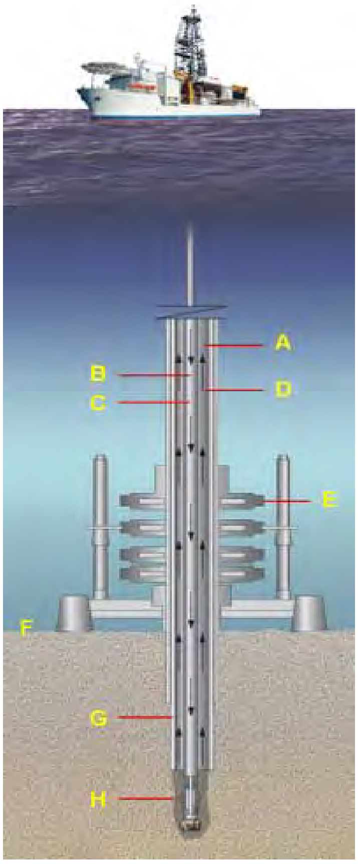
Risered drilling stage

Following the initial drilling stage described above, a BOP and marine riser (see Figure 8) is run and installed on the wellhead. The riser connects the drilling unit to the well and allows the drilling fluid and rock cuttings to be circulated back to the drilling unit, thereby isolating the drilling fluid and cuttings from the marine environment.

Drilling is continued by lowering the drill string, with a smaller bit, through the riser to the 20 inch (51 cm) diameter casing shoe and rotating the drill string. During the risered drilling stage when WBMs cannot provide the necessary characteristics, a low toxicity synthetic-based mud (SBM), which is a type of non-aqueous drilling fluid, would be used to (a) obtain critical reservoir parameters, b) provide a greater level of lubrication, and (c) provide more tolerance to high temperatures (see Section 1.3.4.2 below for a description of SBMs).

While drilling is in progress, drilling fluid is continuously recirculated to the drilling unit. The returned drilling fluid is treated to remove solids and drill cuttings from the re-circulating mud stream (see Section 1.3.3.5). The cuttings are also treated before being discharged overboard.

The hole diameter decreases in steps with depth as progressively smaller diameter casings are inserted into the hole at various stages and cemented into place. As indicated previously, the expected final depth of the well is between 2 700 m and 3 000 m below the seafloor.



A - Riser
B - Drill pipe
C - Drilling fluid is pumped down through drill pipe
D - Drilling fluid and cuttings flow up between the drill pipe and the riser
E - Blow-out preventer
F - Seafloor
G - Casing
H - Open hole

Figure 8. Typical drilling operation (Source: http://www.planetseed.com).

1.3.3.4 Cementing operation

The casings are permanently secured into place by pumping cement slurry, followed by drilling fluid, through the drill pipe and/or cement stinger at the bottom of the hole and back up into the space between the casing and the borehole wall (annulus). To separate the cement from the drilling fluid in order to minimise cement contamination a cementing plug and/or spacer fluids are used. The plug is pushed by the drilling fluid to ensure the cement is placed outside the casing filling the annular space between the casing and the hole wall.

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

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

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

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

1.3.3.5 Drilling fluid circulation system and solids control equipment

While drilling is in progress, drilling fluid is continuously pumped down the inside of the hollow drill string. The fluid emerges through ports ("nozzles") in the drill bit and then rises (carrying the rock cuttings with it) up the annular space between the sides of the hole (the casing and riser pipe) and the drill string, to the drilling unit. The returned drill mud is treated to remove the cuttings from the re-circulating mud stream (see Figure 4).

The solids control system sequentially applies different technologies to remove the cuttings from the drilling fluid and to recover drilling fluid so that it can be reused. A typical solids control system consists of the following main components:

- Shale shakers (removes large-sized cuttings);
- Degasser (removes entrained gas);
- Desanders (removes sand-sized cuttings);
- Desilters (removes silt-sized cuttings); and
- Centrifuge (recovers fine solids and weighting materials such as barite).

The components of the solids control system depends on the type of drilling fluid used, the formations being drilled, the available equipment on the drilling unit and the specific requirements of the disposal option. Solids control may involve both primary and secondary treatment steps.

1.3.3.6 Anticipated well design

The well design ultimately depends upon factors such as planned depths, expected pore pressures and anticipated hydrocarbon-bearing formations. The various components of the anticipated well design are shown in Table 1.

Table 1. Estimated well design and cutting volumes.

Drill Section	Hole diameter (in)	Pipe diameter (in)	Depth of section (m)	Drilling duration (days)	Type of drilling fluid used	Volume of drilling fluid discharged	Volume of cuttings (m^3)	Drilling fluid and cuttings discharge location
Riserless drilling stage								
1	36	30	70	1	Seawater, viscous sweeps & WBM	69 m^3	46.0	Seabed
2	26	20	1 000	2		480 m^3	342.5	Seabed
Risered drilling stage								
3	17.25	13 5/8	800	4	SBM	223 mT	120.6	Surface
4	12.25	9 7/8	450	4		10 mT	34.2	Surface
5	8.5	-	400	8		2.5 mT	14.6	Surface

1.3.4 Drilling fluids or muds

An important component in the drilling operation is the drilling fluid or drilling mud, which is used for:

- Maintaining a stable wellbore and preventing the open hole from collapsing;
- Providing sufficient hydrostatic pressure to control subsurface pressures and prevent kicks or blow-outs;
- Transport of the cuttings to the surface;
- Cooling and lubrication of the drill bit and drill string (reduce friction);
- Powering mud motors / downhole tools during the drilling process;
- Regulation of the chemical and physical characteristics of returned mud slurry on the drilling unit; and
- Displacing cements during the cementing process.

Drilling fluid is a complex mixture of fluids, solids and chemicals that are carefully tailored to provide the correct physical and chemical characteristics required to safely drill the well.

1.3.4.1 Water-based muds

Due to the variability in conditions that can be encountered drilling fluid mixtures vary to some extent. Typically, the major ingredient making up 85 to 90 % of the total volume of a WBM is fresh and / or seawater, with the remaining 10 to 15 % of the volume being barite, potato or corn starch, cellulose-based polymers, xanthan gum, bentonite clay, soda ash, caustic soda and salts (these are usually either potassium chloride [KCl] or sodium chloride[NaCl]).

Barite (barium sulphate) is an inert compound used as a weighting agent. Potato or corn starch and other cellulose-based polymers are used to control the rate of filtration of water in the mud into the formation being drilled by forming a thin filter cake on the borehole wall. Xanthan gum and minor amounts of bentonite clay are used to provide viscosity and impart rheological properties to the mud for cuttings transport, as well as to provide gel strength for cuttings suspension. Caustic soda (sodium hydroxide) is used to maintain the required pH in the drilling fluid. KCl or NaCl are used to reduce the swelling tendencies of clays being drilled and help to maintain a stable wellbore. Other minor additives may be used in special circumstances. A listing of the WBM chemicals used on a typical well, their functions and comments on their ecotoxicity are provided in Table 2.

Table 2. Main components of water-based fluid.

Material	Use	Ecotoxicity
Aluminium stearate	Defoamer	Non-toxic, insoluble
Barite	Weighting agent	Non-toxic, insoluble, non-biodegradable
Bentonite	Viscosifer	Non-toxic, insoluble, non-biodegradable
Calcium carbonate	Bridging, loss of circulation	Non-toxic, insoluble
Caustic soda	pH and alkalinity control	Soluble, corrosive
Cellulose based polymers	Fluid loss control	Insoluble, non-toxic
Citric acid	pH control	Soluble, low toxicity, irritant
Diesel oil pill (< 0.1 % mud volume)	Stuck pipe spotting fluid	Slightly soluble, 96 hr LC_{50} >0.1-1000 ppm
Gilsonite (asphalt based)	Lubricant, fluid loss reducer	Low toxicity, slightly soluble
Gluteraldehyde (0.01% mud vol)	Bactericide (biocide)	Noted for its toxic properties, irritant
Lime	Carbonate and CO_2 control	Slightly soluble, non-toxic, irritant
Organic synthetic polymer blends	Filtrate reducing agent	Non-toxic, 96 hr LC_{50} >500 ppm
Palm oil ester	Lubricant, stuck pipe pills	Slightly soluble, biodegradable
Potassium chloride	Shale / clay inhibitor	Soluble, non-toxic
Soda ash	Alkalinity, calcium reducer	Soluble, non-toxic
Sodium bicarbonate	Alkalinity, calcium reducer	Soluble, non-toxic
Xanthan gum	Viscosity, rheology	Soluble, non-toxic

1.3.4.1 Non-aqueous drilling fluids

Non-aqueous drilling fluids (NADF) are used to:

- Provide optimum wellbore stability and enable a near gauge hole to be drilled;
- Reduce torque and drag in high angle to horizontal wells;
- Minimise damage to reservoirs that contain clays that react adversely to WBM; and
- Obtain irreducible water saturation log data for gas reservoirs.

The main chemicals used in a NADF are presented in Table 3.

Table 3. Main chemicals used in a non-aqueous drilling fluid (adapted from Swan *et al.* 1994).

Material	Description
Base oil	Non-aqueous drilling fluids use base fluids with significantly reduced aromatics and extremely low polynuclear aromatic compounds. New systems using vegetable oil, polyglycols or esters have been and continue to be used.
Brine phase	$CaCl_2$, NaCl, KCl.
Gelling products	Modified clays reacted with organic amines.
Alkaline chemicals	Lime e.g. $Ca(OH)_2$.
Fluid loss control	Chemicals derived from lignites reacted with long chain or quaternary amines.
Emulsifiers	Fatty acids and derivatives, rosin acids and derivatives, dicarboxylic acids, polyamines.

The disadvantage of using a NADF is that base fluid and other chemicals would result in an increase in toxicity. Drill cuttings that derive from the reservoir section contain residual base fluids, which cannot be removed easily. The trend in the industry has been to move towards low toxicity NADF (Group III NADF) that are biodegradable and will not persist in the long-term. There are three types of NADF that are used for offshore drilling and can be defined as follows:

- **Group I NADF (high aromatic content)**
  These base fluids were used during initial days of oil and gas exploration and include diesel and conventional mineral oil based fluids. They are refined from crude oil and are a non-specific collection of hydrocarbon compounds including paraffins, olefins and aromatic and polycyclic aromatic hydrocarbons (PAHs). Group 1 NADFs are defined by having PAH levels greater than 0.35%.
- **Group II NADF (medium aromatic content)**
  These fluids are sometimes referred to as Low Toxicity Mineral Oil Based Fluids (LTMBF) and were developed to address the rising concern over the potential toxicity of diesel-based fluids. They are also developed from refining crude oil but the distillation process is controlled such that the total aromatic hydrocarbon concentration is less than Group I NADFs (0.5 – 5%) and the PAH content is less than 0.35% but greater than 0.001%.
- **Group III NADF (low to negligible aromatic content)**
  These fluids are characterised by PAH contents less than 0.001% and total aromatic contents less than 0.5%. They include SBM which are produced by chemical reactions of relatively pure compounds and can include synthetic hydrocarbons (olefins, paraffins and esters). Using special refining and/or separation processes, base fluids of Group III can also be derived from highly processed mineral oils (paraffins, enhanced mineral oil based fluid (EMBF)). PAH content is less than 0.001%. Shell is proposing to use a SBM during the risered drilling stage.

1.3.5 Well evaluation

1.3.5.1 Mud logging

Evaluation of the petro-physical properties of the formations that have been penetrated is carried out routinely during the drilling operation. Mud logging involves the examination of the drill cuttings brought to the surface by the drilling fluid.

Mud logging also monitors for hydrocarbon gases that relate to changes in formation pressure and the volume or rate of returning fluid, which is imperative to catch "kicks" early. A "kick" is when the formation pressure at the depth of the bit is more than the hydrostatic head of the mud above, which if not controlled temporarily by closing the BOP and ultimately by increasing the density of the drilling fluid would allow formation fluids and mud to come up through the drill pipe uncontrollably.

1.3.5.2 Downhole formation logging

Electrical logging and measurement while drilling logging are the two most widely used downhole formation evaluation methods. The use of wireline logging tools requires the drill string to be removed from the well so these logs are generally run at casing points. Radioactive sources may be used for certain types of data acquisition (see Section 1.3.5.3).

There are two fundamentally different uses of radioactive devices in wireline logging. In the first, the source is mounted in the wireline tool, where it generates a radioactive field that interacts with the rocks penetrated at the wellbore. The measured response is directly related to the physical properties of the rocks. The other usage is for calibrating wireline tools that measure either natural or induced radioactivity.

1.3.5.3 Radioactive sources

There are two standard types of wireline tools that use radioactive sources and measure formation porosity, namely:

1. The density log, which measures the electron density of a formation (this is a function of porosity); and
2. The neutron log, which measures the hydrogen ion concentration in a formation.

The radiation levels of the density and neutron tool activity are very low.

1.3.5.4 Radioactive calibration tools

Calibration tools generate a known level of low radioactivity, which is used to calibrate the receiver response for the neutron logging tool and for calibrating tools that measure the natural radiation of formations. The measurements are used for correlating zones between wells and for identifying lithologies, particularly volcanic ashes, organic rich shales, potassium feldspars, micas and glauconite. The radiation from the calibration tools is similar to the natural radiation from rocks.

1.3.5.5 Radiation level

The radioactive sources used in wireline logging would be stored in sealed containers. The radioactive material is encapsulated in ceramic cylinders and then sheathed in several layers of stainless steel. The size of the sealed sources is approximately 4 inches (length) x 1 inch (diameter) for the density tool and 7 inches (length) x 1.5 inches (diameter) for the neutron source.

The radiation levels are very low. The density tool activity can range from 0.1-2 curies (Ci) with a 0.5–200 milliroentgens per hour (mR/hr) maximum radiation level at the source surface. The neutron tool activity can range from 3-20 Ci with a 50-200 mR/hr maximum radiation level at the surface. The neutron tool, however, does not emit any external radiation at the tool surface when it is not energised.

The radiation from the calibration tools is similar to the natural radiation from rocks. Activities range from 0.000002–0.5 mR/hr maximum radiation levels.

Specific safety procedures would be established by the wireline logging contractor to handle the sources (see Section 1.3.5.6). In addition, the contractor has to set up incident and emergency reporting procedures for actual or suspected individual over-exposure, theft or loss, logging tools stuck downhole in wells and release or spillage into the environment. The contractor routinely tests the sources according to industry requirements to document leak levels.

1.3.5.6 Transport, storage and handling of radioactive devices

Radioactive devices are transported from the wireline contractor's base to a drilling unit in specially designed secured (locked) storage containers. The tools are inventoried upon arrival and tested for leaks. A detailed log is kept of any access to the storage container and tools.

Drilling units would have a special storage location designated for radioactive containers. The storage location would be specifically chosen to minimise the danger of fire, explosion and exposure, and are clearly identified by yellow radioactive warning signs.

Only certified wireline logging engineers would be allowed to handle the radioactive devices. Whenever the radioactive sources are used, the area between and around the storage containers and the drill floor would be secured and only key personnel would be allowed in the area. Long handling sticks would be used to transfer the density and neutron sources between the storage containers and the logging tools on the drill floor, but the calibration tools, being very low-level radioactive devices, would be hand-held.

The engineers handling the devices would follow strict approved procedures. They would also wear personal monitoring devices to measure any unusual exposure. The equipment would be handled as little as possible by the engineers and returned immediately to the storage containers upon completion of the logging run.

1.3.6 Well (flow) testing

Should the exploration well encounter hydrocarbons, an “appraisal” well may be drilled, which would be flow-tested (also called production testing) to determine the economic potential of the discovery before the well is either abandoned or suspended for later re-entry and completion.

If flow testing is required, hydrocarbons would be burned at the well site. A high-efficiency flare is used to maximise combustion of the hydrocarbons. The amount of hydrocarbons produced would depend on the quality of the reservoir but is kept to a minimum to avoid wasting potentially marketable oil and/or gas. Thus the final well test programme would be prepared when the detailed geology and fluids are defined.

No produced water is anticipated. However, if water does flow with the hydrocarbons to the surface it would be flared off. Any water remaining would be stored and brought to shore for treatment and disposal in accordance with regulatory requirements.

1.3.7 Well completion and abandonment

Based on the results of the drilling, logging and possible testing of the well, a decision would be made as to the final state of the well, before the drilling unit is moved off location. The options are described below.

a) Suspended wells: If it is verified that a well is commercially viable, it could be suspended. This would entail the following:
   - Cement plugs would be set inside the well bore and tested for integrity;
   - The blow-out preventer would be removed before the drilling unit is moved off location;
   - The wellhead (total 3 to 4 m high) would remain on the seafloor; and
   - A corrosion cap would be placed over the wellhead to facilitate re-entry.

b) Abandoned wells: If a well is unsuccessful, it would be permanently abandoned. This would entail the following:
   - Cement plugs would be set inside the well bore and tested for integrity;
   - The blow-out preventer would be removed before the drilling unit is moved off location; and
   - The wellhead (total 3 to 4 m high) would either remain on or be removed from the seafloor. The preferred alternative would be to leave the wellhead on the seafloor.

1.3.8 Sea- and land-based support

1.3.8.1 Onshore logistics base

A logistics shore base would be located in either Cape Town or Saldanha Bay. The shore base would provide for the storage of materials (including wellbore materials, diesel, water and drilling fluids) and equipment that would be transported from/to the drilling unit by sea. The shore base would also be used for bunkering vessels.

1.3.8.2 Support and supply vessels

The drilling unit will be supported by at least three vessels, namely one standby and two supply vessels. The standby vessel would provide support for firefighting, oil containment / recovery, rescue and any equipment that may be required in case of an emergency. The standby vessel would also be used to patrol the area to ensure that other vessels adhere to the 500 m safety zone around the drilling unit. The supply vessels would provide equipment and material transport between the drilling unit and the port.

It is envisioned that a supply vessel would call into port every week during the campaign.

1.3.8.3 Crew transfers

Transportation of personnel to and from the drilling unit would be provided by helicopter operations from the Kleinzee airport, which is located approximately 250 km from the proposed area of operation. Transportation to Kleinzee would be provided by fixed-wing flights from Cape Town, which is approximately 500 km to the south.

The drilling unit would accommodate in the order of 100 - 150 personnel. Crews would work in 12-hour shifts in 4-5 week cycles. Crew changes would be staggered, and in combination with ad hoc personnel requirements. Thus helicopter operations to and from the drilling unit and fixed wing operations between Kleinzee and Cape Town would occur on an almost daily basis.

A second helicopter would be kept on standby for rescue operations. This helicopter is kept in a high state of readiness, i.e. fuelled, setting on pad, pilot and crew at base in Kleinzee.

2. DATA SOURCES

Fisheries catch and effort data for the years 2000 to 2012 were sourced from the Department of Agriculture, Forestry and Fisheries (DAFF). All data were referenced to a latitude and longitude position and were redisplayed on a 10x10 minute grid.

3. SOUTH AFRICAN COMMERCIAL FISHERIES

South Africa’s commercial fisheries are regulated and monitored by DAFF (previously managed under the Department of Environmental Affairs and Tourism: Directorate: Marine and Coastal Management). Approximately 14 different commercial fisheries sectors currently operate within South African waters (see Table 1). In addition to commercial sectors, recreational fishing is active along the coastline comprising shore angling and small, open boats generally less than 10 m in length.

The primary fisheries in terms of highest economic value and greatest landed tonnage are the demersal (bottom) trawl and long-line fisheries targeting the Cape hakes (*Merluccius paradoxus* and *M. capensis*) and the pelagic-directed purse-seine fishery targeting pilchard (*Sardinops sagax)*, anchovy (*Engraulis encrasicolus*) and red-eye round herring (*Etrumeus whitheadii*). Secondary species in these fisheries includes a large assemblage of demersal fish of which monkfish (*Lophius vomerinus*), kingklip (*Genypterus capensis*) and snoek (*Thyrsites atun*) are the most commercially important.

The pelagic long-line and pole fisheries target migratory stocks of tuna including albacore (*Thunnus alalunga*), bigeye tuna (*T. obesus*) and yellowfin tuna (*T. albacares*) and swordfish (*Xiphias gladius*).

The traditional line fishery refers to a long-standing fishery based on a large assemblage of primarily 35 different species. The fishery extends both into warm-temperate and cool-temperate biogeographical regions; but operates relatively close to shore. Within the Western Cape the predominant catch species is snoek (*Thyrsites atun*), whereas towards the East Coast catch species increase in number and include both resident reef fish (Sparidae and Serranidae), pelagic migrants (Carangidae and Scombridae) and demersal migrants (Sciaenidae and Sparidae).

Crustacean fisheries comprise a trap fishery targeting West Cost rock lobster (*Jasus lalandii*), a line trap fishery targeting the South Coast rock lobster (*Palinurus gilchristi*) and a trawl fishery based solely on the East Coast targeting penaeid prawns, langoustines (*Metanephrops andamanicus* and *Nephropsis stewarti*), deep-water rock lobster (*Palinurus delagoae*) and red crab (*Chaceon macphersoni*).

Other fisheries include a mid-water trawl fishery targeting horse mackerel (*Trachurus trachurus capensis*) predominantly on the South Coast, a hand-jig fishery targeting chokka squid (*Loligo vulgaris reynaudii*) also based on the South Coast.

Table 4. South African offshore commercial fishing sectors (TAC = total allowable catch)

Sector	Areas of Operation	Number of Vessels (2012)	Rights Holders (2012)	Landed Catch (2012)
Tuna pole	West Coast, South Coast	128	170	4 400 t (2013 TAC)
Pelagic long-line	West Coast, South Coast, East Coast	31	30	1 570 t
Mid-water trawl	South Coast	6	19	18 942 t
Small pelagics	West Coast, South Coast	101	111	487 274 t
Hake long-line	West Coast, South Coast	64	146	9 257 t
Hake hand-line	West Coast, South Coast	100	86	non-operational
Traditional line fish	West Coast, South Coast, East Coast	450	-	11 855 t
Demersal shark long-line	South Coast	6	7	834 t
Hake deep sea trawl	West Coast, South Coast	45	49	166 925 t
Hake/ sole inshore trawl	South Coast	31	18	6 990 t
West coast rock lobster	West Coast	105	240	1 879 t
South coast rock lobster	South Coast	12	15	609 t
Crustacean trawl	East Coast	5	8	383 t
Squid jig	South Coast	138	121	6 110 t

4. WEST-COAST COMMERCIAL FISHING SECTORS

The fisheries active on the West Coast are addressed further in the current report, *viz*; the small pelagic purse-seine, demersal trawl, demersal long-line, pelagic long-line, tuna pole, traditional line fish and west coast rock lobster sectors.

4.1 Demersal Trawl Description and Impact Assessment

The hake-directed trawl fishery is the most valuable sector of the South African fishing industry and is split into two sub-sectors: the offshore ("deep-sea") sector which is active off both the South and West Coasts, and the much smaller inshore trawl sector which is active off the South Coast. A fleet of 45 trawlers operate within the offshore sector targeting the Cape hakes (*Merluccius capensis* and *M. paradoxus*)- Figure 9. Main by-catch species include monkfish (*Lophius vomerinus*) – Figure 10, kingklip (*Genypterus capensis*) and snoek (*Thyrsites atun*).

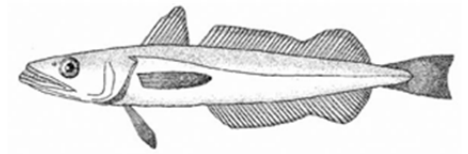


Figure 9. Cape Hake : *Merluccius capensis*

Figure 10. Anglerfish (monk): *Lophius vomerinus*

The current annual hake Total Allowable Catch (TAC) of hake across all sectors is 156 075 tons (2013), of which the majority is landed by the demersal trawl sector. In 2012, of a total hake TAC of 144 671 tons, 118 688 tons (82%) was landed by the demersal trawl sector. Of this amount, 115 465 tons was landed by the offshore demersal trawl sector and
3 223 tons by the inshore trawl sector.

Over the period 2000 to 2012, the demersal trawl fishery reported an average of 57 920 trawls per year with an associated catch of 127 743 tons of hake and 166 902 tons of all species landed per year. The last five years (2008 to 2012) have seen a decline in catch and effort with a reported 44 092 trawls per year with and associated catch of 113 607 tons of hake and 125 599 tons of all species landed per year[1].

The offshore fleet is segregated into wetfish and freezer vessels which differ in terms of the capacity for the processing of fish at sea and in terms of vessel size and capacity. While freezer vessels may work in an area for up to a month at a time, wetfish vessels may only remain in an area for about a week before returning to port. Wetfish vessels range between 24 m and 56 m in length while freezer vessels are usually larger, ranging up to 80 m in length.

The gear configurations are similar for both freezer and wet fish vessels. Trawl gear is deployed astern of the vessel and the main elements of the gear include (see Figure 11):

- Steel trawl warps up to 32 mm diameter - in pairs up to 3 km long when towed;
- A pair of trawl doors (500 kg to 3 tons each);
- Net footropes which may have heavy steel bobbins attached (up to 24" diameter; maximum 200 kg) as well as large rubber rollers ("rock-hoppers"); and
- Net mesh (diamond or square shape) is normally wide at the net opening whereas the bottom end of the net (or cod-end) has a mesh size minimum limit of 110 mm (stretched).

Figure 11. Typical gear configuration used by demersal trawlers (offshore) targeting hake.

[1] Although catch and effort data are available for the period 1983 to 2012, records prior to 2000 were reported on a 20' x 20' grid system rather than as a GPS latitude and longitude and cannot accurately be displayed in relation to the area of interest for well-drilling.

Generally, trawlers tow their gear at 3.5 knots for two to four hours per drag. When towing gear, the distance of the trawl net from the vessel is usually between two and three times the depth of the water. The horizontal net opening may be up to 50 m in width and 10 m in height and the swept area on the seabed between the doors may be up to 150 m.

A number of monk-directed trawlers are also known to operate on the West Coast. These vessels use slightly heavier trawl gear, trawl at slower speeds and for longer periods than hake-directed trawlers. Monk gear includes the use of “tickler” chains positioned ahead of the footrope to chase the monk off the substrate and into the net. These trawlers tow for up to eight hours at a time at a speed of between two and three knots and generally fish during the night.

Trawls are usually conducted along specific trawling lanes on “trawl friendly” substrate (flat, soft ground). On the West Coast, these grounds extend in a continuous band along the shelf edge between the 300 m and 1 000 m bathymetric contours[2]. Monk-directed trawlers tend to fish shallower waters than hake-directed vessels on mostly muddy substrates. Trawl nets are generally towed along depth contours (thereby maintaining a relatively constant depth) running parallel to the depth contours in a north-westerly or south-easterly direction. Trawlers also target fish aggregations around bathymetric features, in particular seamounts and canyons (i.e. Cape Columbine and Cape Canyon), where there is an increase in seafloor slope and in these cases the direction of trawls follow the depth contours. Trawlers are prohibited from operating within five nautical miles of the coastline.

Figure 12 shows the spatial distribution of trawl fishing effort (2000 – 2012) along the West Coast in relation to the area of interest between while Figure 13 presents the corresponding catch of hake over this period. Data reported by the fishery over this 13-year period indicate that fishing grounds do not coincide with the proposed area of interest for well-drilling which is situated 10 nm from trawl grounds at it’s closest point. In the vicinity of the proposed area of interest (i.e. between 30.5°S and 31°S), there is no evidence of trawlers operating beyond the 500 m bathymetric contour.

As the proposed area of is located in waters deeper than 1 000 m, the likelihood of the proposed drilling operations impacting the offshore demersal trawl sector is improbable. There is therefore NO IMPACT expected from the temporary exclusion zone around the drilling unit and the exclusion zone around suspended or abandoned wells. On abandonment of a well, it is improbable that a wellhead structure would adversely affect the demersal trawl fishery.

[2] Trawling to these depths started in the mid 1990’s for deepwater species such as Orange Roughy.

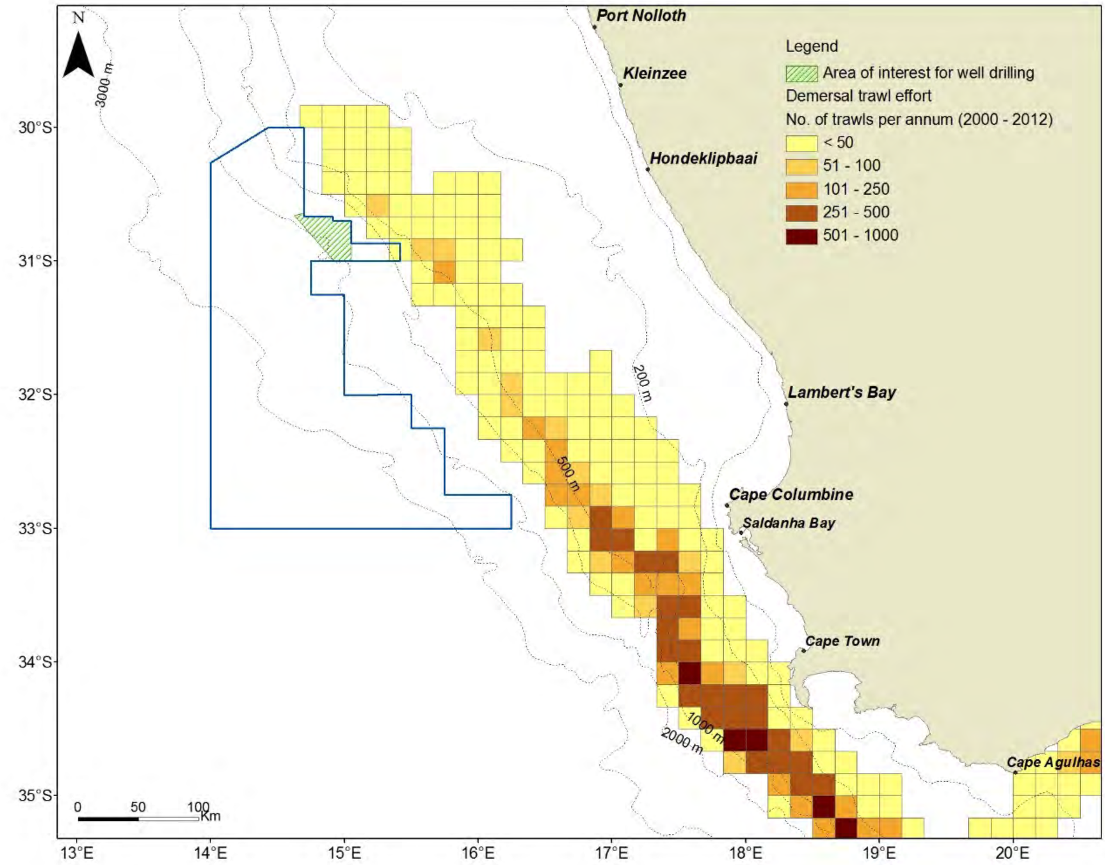


Figure 12. Spatial distribution of fishing effort expended by the demersal trawl sector targeting hake over the period 2000 to 2012 on the West Coast of South Africa in relation to the proposed area of interest for well drilling.

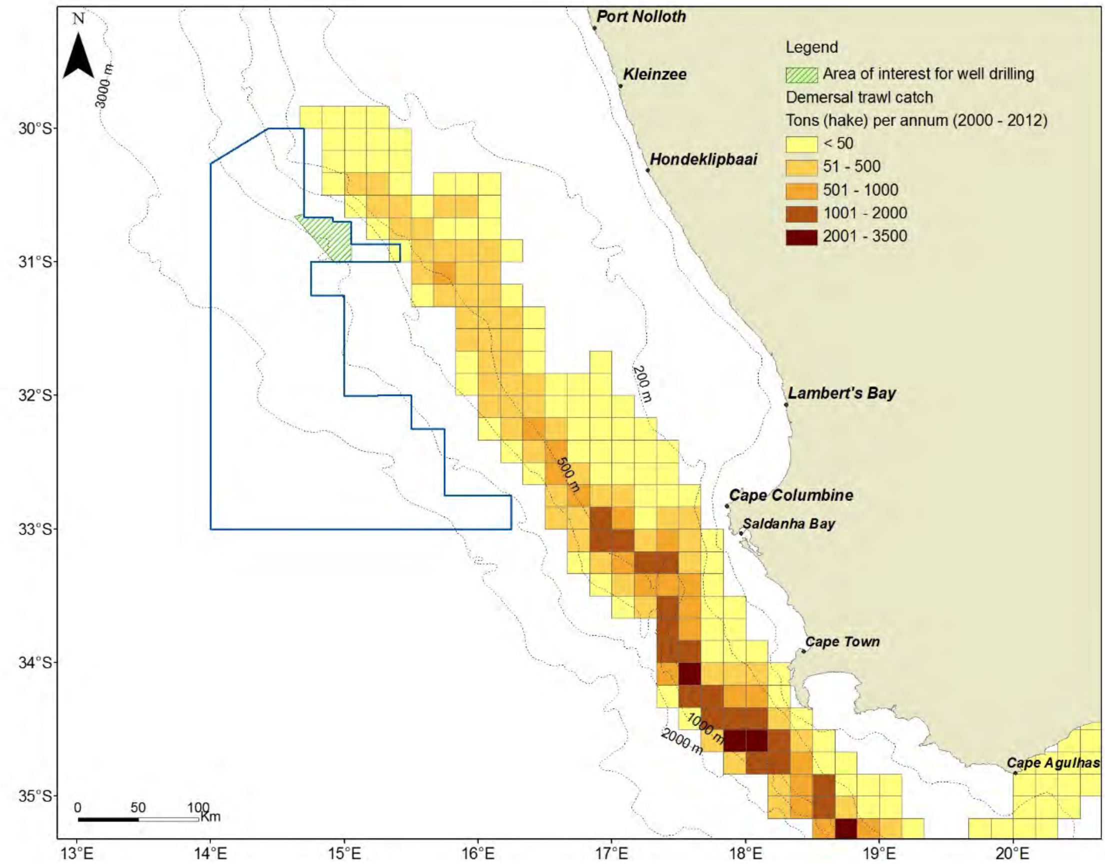


Figure 13. Spatial distribution of catch reported by the demersal trawl fishing sector over the period 2000 to 2012 in relation to the proposed area of interest for well drilling.

Impact Assessment on Fisheries: Demersal Trawl			
	Temporary exclusion zone around drilling unit	**Well abandonment: well head remains in place**	**Well abandonment: well head removed**
Extent	Local	Local	Local
Duration	Short-term	Long-term	Short-term
Intensity	Zero	Zero	Zero
Significance	NO IMPACT	NO IMPACT	NO IMPACT
Status	Negative	Negative	Negative
Probability	Improbable	Improbable	Improbable
Confidence	High	High	High

4.2 Demersal Long-Line Description and Impact Assessment

The demersal long-line fishing technique is used to target bottom-dwelling species of fish. Two fishing sectors utilize this method of capture, namely the hake long-line fishery targeting the Cape hakes (*M. capensis* and *M. paradoxus*) and the shark long-line sector targeting only demersal species of shark.

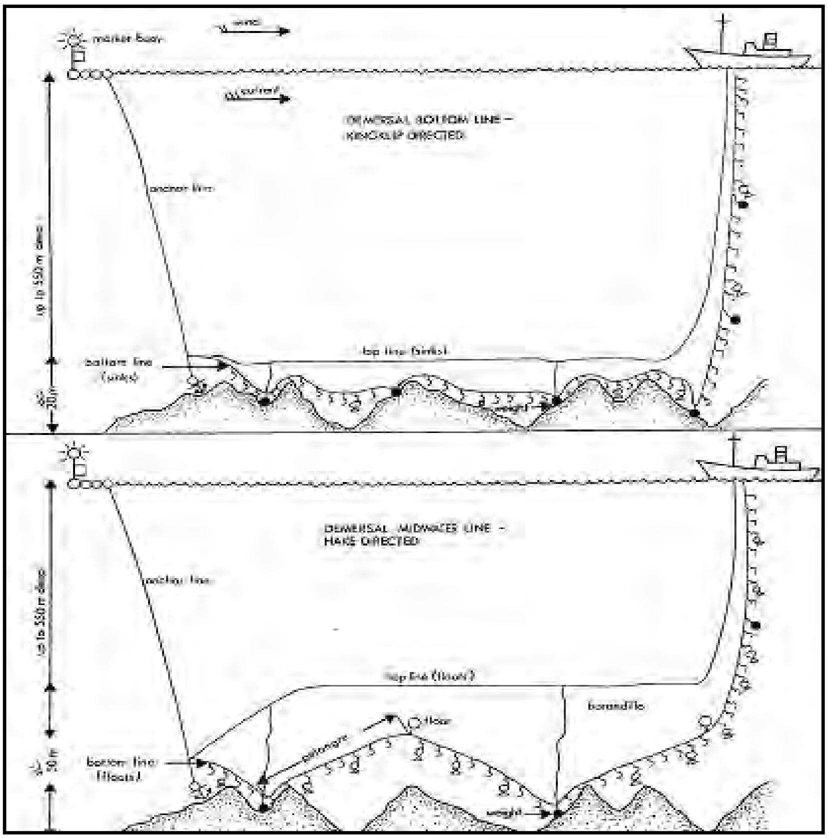


Figure 14. Typical configuration of demersal (bottom-set) hake long-line gear used in South African waters.

A demersal long-line vessel may deploy either a double or single line which is weighted along its length to keep it close to the seafloor (see Figure 14). Steel anchors, of 40 kg to 60 kg, are placed at the ends of each line to anchor it, and are marked with an array of floats. If a double line system is used, top and bottom lines are connected by means of dropper lines. Since the top-line (polyethylene, 10 – 16 mm diameter) is more buoyant than the bottom line, it is raised off the seafloor and minimizes the risk of snagging or fouling. The purpose of the top-line is to aid in gear retrieval if the bottom line breaks at any point along the length of the line. Lines are typically between 10 km and 20 km in length, carrying between 6 900 and 15 600 hooks each. Baited hooks are attached to the bottom line at regular intervals (1 to 1.5 m) by means of a snood. Gear is usually set at night at a speed of between five and nine knots. Once deployed the line is left to soak for up to eight hours before it is retrieved. A line hauler is used to retrieve gear (at a speed of approximately one knot) and can take six to ten hours to complete. Long-line vessels vary in length from 18 m to 50 m and remain at sea for four to seven days at a time. Currently 64 hake-directed and six shark-directed vessels are operational within the fishery, most of which are based at Cape Town and Hout Bay harbours.

Figure 15. Kingklip : *Genypterus capensis*

4.2.1 Hake –directed fishery

Like the demersal trawl fishery the target species of long-line fishery is the Cape hakes, with a small non-targeted commercial by-catch that includes kingklip (Figure 15). The catch is landed predominantly prime quality hake for export to Europe and is packed unfrozen on ice therefore the value is approximately 50% higher than that of trawled hake. Operations are *ad hoc* and intermittent, subject to market demand.

Of the total hake TAC of 144 671 tons set for 2012, the catch taken by the long-line fleet amounted to 8 399 tons (~6%, and 9 257 tons including all other non-hake species landed). Over the period 2000 to 2012, the fishery set an average of 30.7 million hooks and landed 8 791 tons of hake per year. This is slightly higher than the reported catch and effort over the last five years (2008 to 2012), during which time the fishery set an average of 28.9 million hooks and landed 8 368 tons of hake per year.

Demersal long-line vessels fish in similar areas to those targeted by the hake-directed trawling fleet. Lines are usually set parallel to bathymetric contours, extending along the shelf edge to the 1 000 m contour in places. Figures 16 and 17 show the spatial distribution of hake-directed long-line effort and catch on the West Coast for the years 2000 to 2012. Prior to 2008, there are incidental records of demersal long-line fishing events within 5 nm of the proposed well-drilling area. Since 2008, fishing grounds have been located 15 nm inshore of the proposed well-drilling area at closest point.

The recent fishing grounds of the hake-directed long-line fishery lie inshore of the area of interest for proposed well-drilling operations. The likelihood of the fishery being impacted is improbable and there is therefore NO IMPACT expected on the fishery. The proposed abandonment of wellheads on the seafloor would have no additional impact on this fishery. The degree of confidence in the assessment is high.

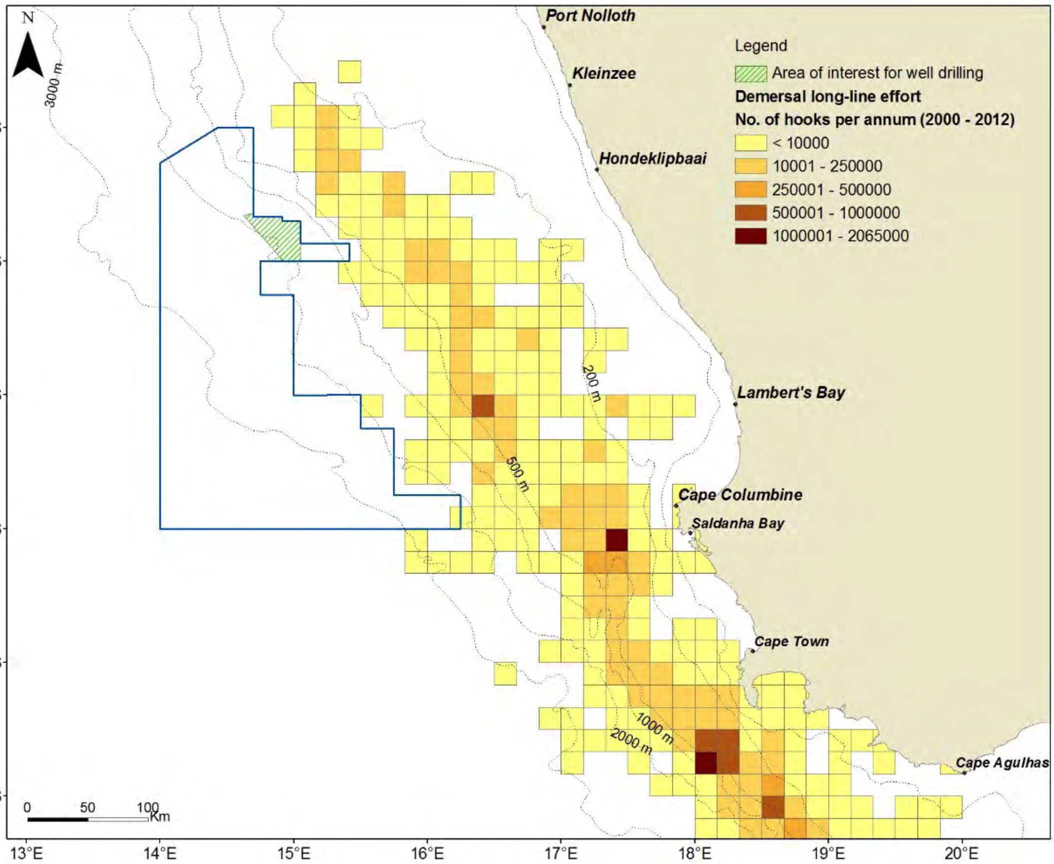


Figure 16. Spatial distribution of fishing effort expended by the hake-directed demersal long-line sector in relation to the proposed area of interest for well drilling. Effort is shown as the average annual number of hooks set for the years 2000 to 2012.

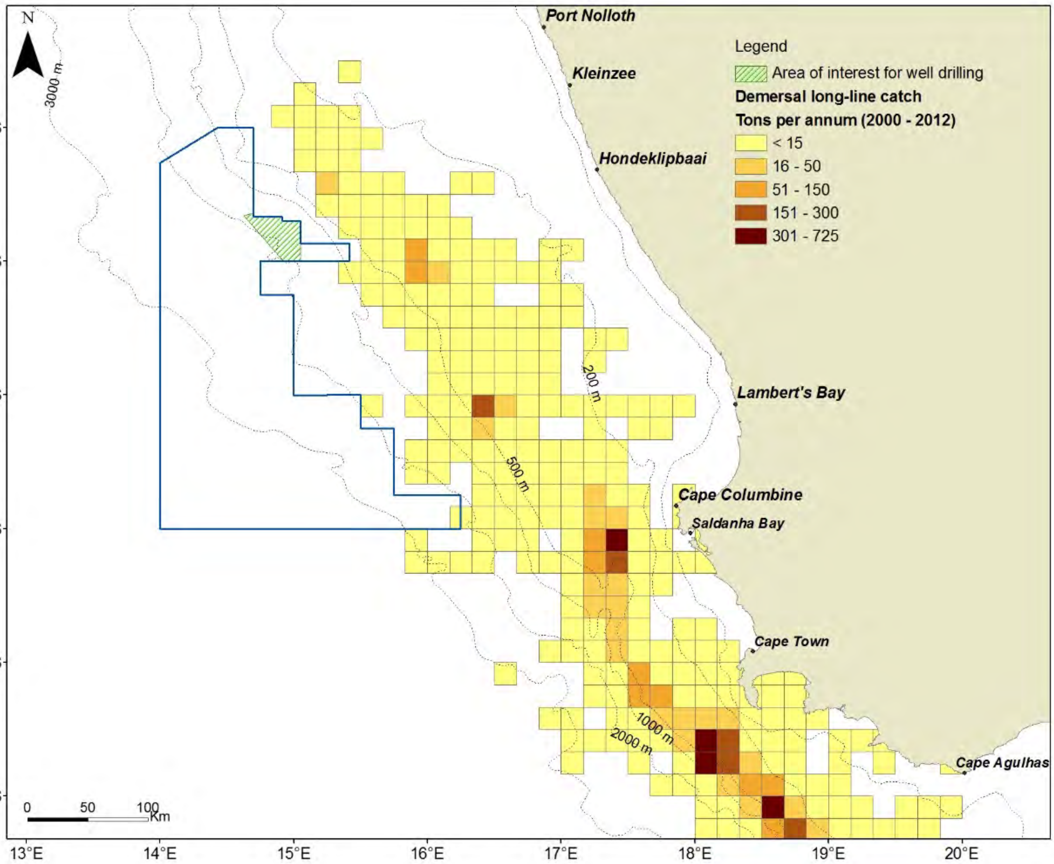


Figure 17. Spatial distribution of catch (all species; 2000 – 2012) of the hake-directed demersal long-line fishery in relation to the proposed area of interest for well drilling.

Impact Assessment on Fisheries: Demersal Long-Line (hake-directed)			
	Temporary exclusion zone around drilling unit	**Well abandonment: well head remains in place**	**Well abandonment: well head removed**
Extent	Local	Local	Local
Duration	Short-term	Long-term	Short term
Intensity	Zero	Zero	Zero
Significance	NO IMPACT	NO IMPACT	NO IMPACT
Status	Negative	Negative	Negative
Probability	Improbable	Improbable	Improbable
Confidence	High	High	High

4.2.2 Shark-directed fishery

Capture of demersal shark species occurs primarily in the demersal shark long-line fishery whilst catches of pelagic shark species occurs primarily in the large pelagic sector that targets tuna and swordfish. Prior to 2006, both demersal and pelagic shark catches were managed as a single shark fishery. The demersal shark fishery targets soupfin shark (*Galeorhinus galeus*), smooth-hound shark (*Mustelus spp*.), spiny dogfish (*Squalus* spp), St Joseph shark (*Callorhinchus capensis*), *Charcharhinus* spp., rays and skates. Other species which are not targeted but may be landed include cape gurnards (*Chelidonichthys capensis*), jacopever (*Sebastichthys capensis*) and smooth hammerhead shark (*Sphyrna zygaena*). The fishery operates within coastal waters and catches are landed at the harbours of Cape Town, Hout Bay, Mossel Bay, Plettenberg Bay, Cape St Francis, Saldanha Bay, St Helena Bay, Gansbaai and Port Elizabeth.

There are currently six permit holders that have been issued with long-term rights to operate within the fishery. The fishery was first formerly introduced with the allocation of medium-term fishing rights in 2002. With only six rights allocated and vessels limited in size, fishing effort has remained relatively low. Over the period 2007 to 2012, the fishery reported an annual average of 430 500 hooks set and 175 tons landed annually (see Figures 18 and 19). The fishery operates in coastal waters, predominantly inshore of the 150 m isobath. Spatial records of catch and effort show fishing effort located approximately 200 nm south-east of the proposed area for well-drilling. There are records of incidental fishing events in deeper waters but no evidence of fishing events within the proposed area of interest.

The fishing grounds of the demersal shark-directed long-line fishery lie inshore of the area of interest for proposed well-drilling operations. The likelihood of the fishery being impacted is improbable and there is therefore NO IMPACT expected on the fishery. The proposed abandonment of wellheads on the seafloor would have no additional impact on this fishery. The degree of confidence in the assessment is high.

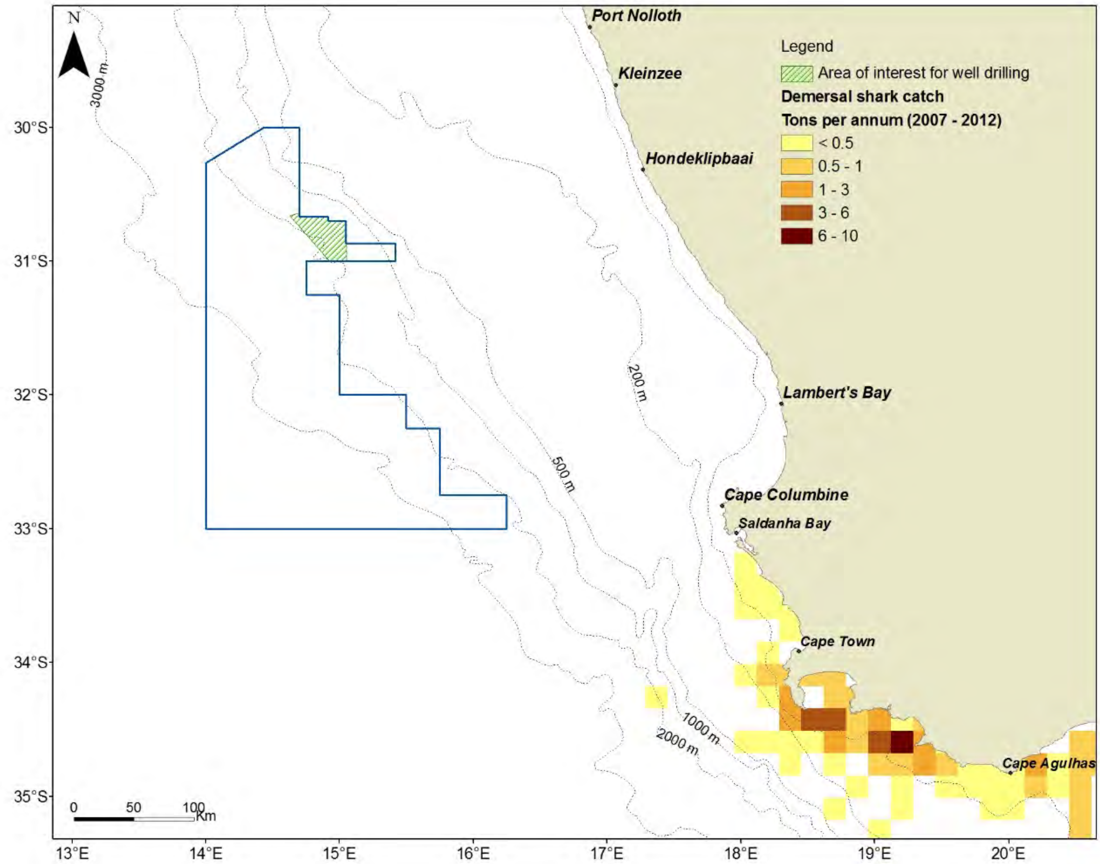


Figure 18. Spatial distribution of the catch of demersal shark species displayed on a 10' x 10' grid (2007–2012) in relation to the proposed area of interest for well drilling.

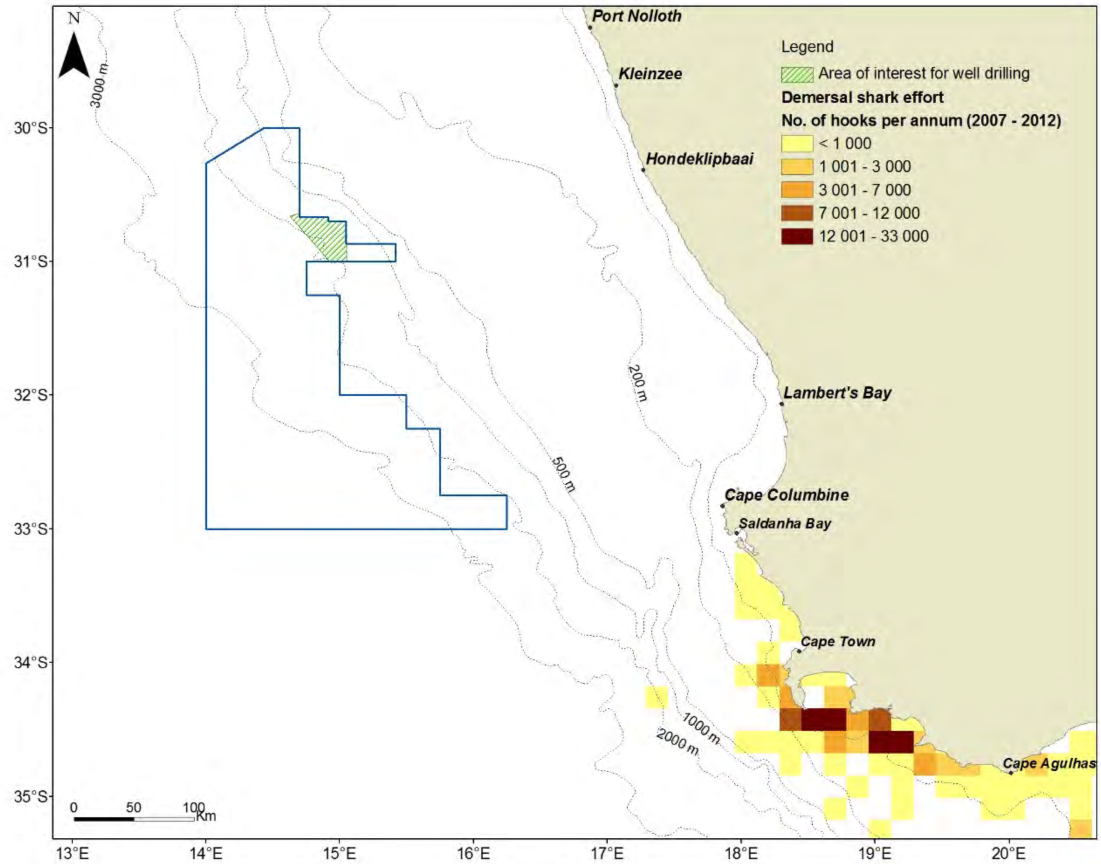


Figure 19. Spatial distribution of effort expended by the demersal long-line fishery targeting shark species displayed on a 10' x 10' grid (2007 – 2012) in relation to the proposed area of interest for well drilling.

Impact Assessment on Fisheries: Demersal Long-Line (shark-directed)			
	Temporary exclusion zone around drilling unit	**Well abandonment: well head remains in place**	**Well abandonment: well head removed**
Extent	Local	Local	Local
Duration	Short-term	Long-term	Short term
Intensity	Zero	Zero	Zero
Significance	NO IMPACT	NO IMPACT	NO IMPACT
Status	Negative	Negative	Negative
Probability	Improbable	Improbable	Improbable
Confidence	High	High	High

4.3 Large Pelagic Long-Line Description and Impact Assessment

The large pelagic long-line fishery operates extensively within the South African Exclusive Economic Zone (EEZ) targeting primarily tuna and swordfish. Tuna, tuna-like species and billfishes are migratory stocks and are therefore managed as a "shared resource" amongst various countries. There are currently 30 commercial large pelagic fishing rights issued for South African waters and 31 vessels active in the fishery. Historically, the fishery operates extensively from the continental shelf break into deeper waters, year-round. In the 1970s to mid-1990s the fishery was exclusively expedited by Asian fleets under bilateral agreements with South Africa. From the mid-1990s to present rights were issued to South Africans only. These rights holders now include a small fleet of local long-liners although the fishery is still undertaken primarily with Japanese vessels fishing in joint venture with South African companies. The main target species is Yellowfin tuna (Figure 20) with a high bycatch of blue shark (Figure 21).

Figure 20. Yellowfin tuna *Thunnus albacares* is the principle target species in the pelagic longline

Figure 21. Blue shark *Prionace glauca* is one of the most commonly caught shark species in RSA waters but is discarded due to its high urea content

Vessels range from 30 m to 54 m in length. Gear consists of monofilament mainlines of between 25 km and 100 km in length which are suspended from surface buoys and marked at each end (Figures 22 & 23). The main fishing line is normally suspended 20 m below the water surface via droppers connecting it to surface buoys at regular intervals. Baited hooks are attached to the mainline via 20 m long trace lines, thereby targeting fish at a depth of 40 m below the surface. Up to 3 500 hooks may be set per line. Lines are usually set at night, with hauling commencing the next morning. Various types of buoys are used in combinations to keep the mainline near the surface and locate it should the line be cut or break for any reason. Each end of the line is marked by a Dahn Buoy and radar reflector, which marks the line position for later retrieval. A line may be left drifting for a considerable length of time before retrieval by means of a powered hauler at a speed of approximately one knot. During hauling, vessel manoeuvrability is severely restricted and, in the event of an emergency, the line may be dropped and hauled in at a later stage.

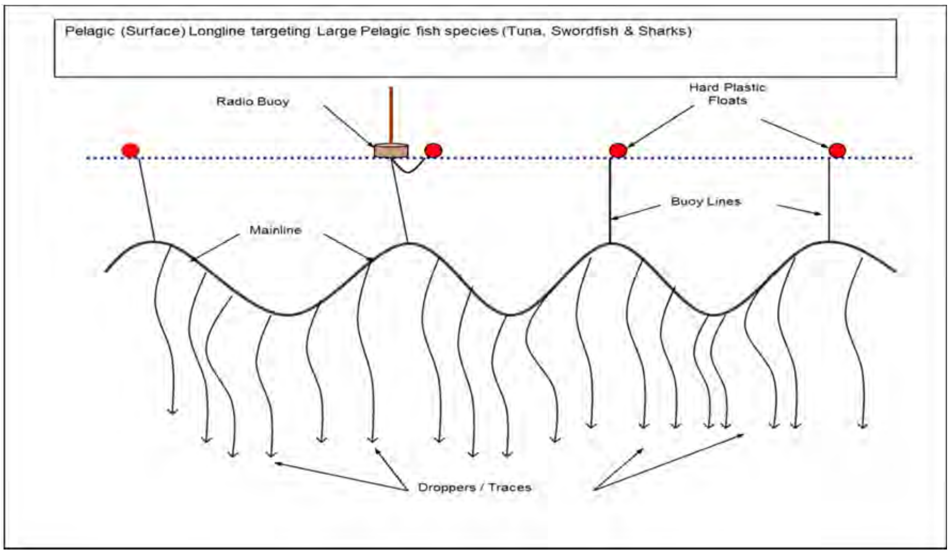


Figure 22. Typical pelagic long-line gear configuration targeting tuna, swordfish and shark species. Note: gear floats close to the surface of the sea and would present a potential obstruction to surface navigation.

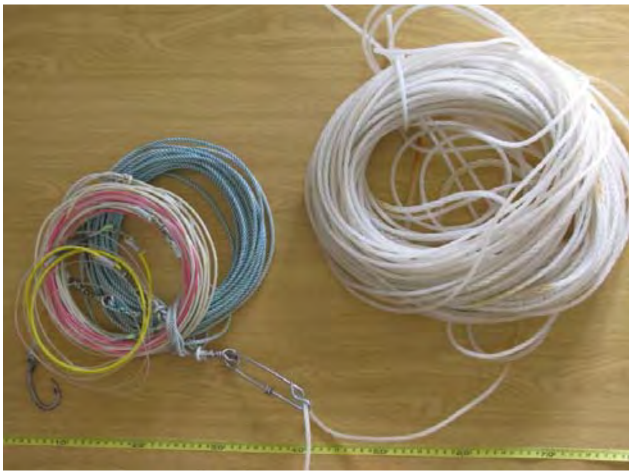


Figure 23. Photograph of a mainline (braided monofilament, on right) with a dropper line and trace typically used by the pelagic long-line fishery (on left).

Pelagic long-line vessels can be expected within the area of interest and especially concentrated where the continental slope is steepest. During the period 2000 to 2012, the national catch and effort recorded within the large pelagic fishery amounted to an average of 3 018 tons and 3.49 million hooks set per year (Figures 24 & 25). The last five years (2008 to 2012) have seen an increase in effort, whilst landings have remained relatively constant within the fishery (3 047 tons and 4.84 million hooks set per year). Approximately 2.1% of the total catch and 1.8% of the total number of hooks set were recorded in close proximity to the area of interest[3]. These figures represent the combined catch and effort of both the domestic and foreign-flagged vessels, whereas the domestic vessels conduct a comparatively higher proportion of their effort within the area than do the foreign-flagged vessels[4].

[3] A buffer of 20 nautical miles was added to the area of interest when calculating the area of impact on this fishery as pelagic long-lines are not fixed and drift with surface water currents.

[4] Note: The data used for the large pelagic is complex. Historically the fishery was expedited primarily by foreign tuna vessels comprising up to 130 boats. From the early 1990's these vessels were banned from RSA waters and South Africa went through a period of low effort as the fishing rights issues were resolved. Thereafter a domestic fishery developed and 50 fishing rights were allocated. From the early 2000's the RSA vessels went into joint venture with Asian vessels. The frequent changes in fishing effort is therefore reflected in part by the different figures for this fishery

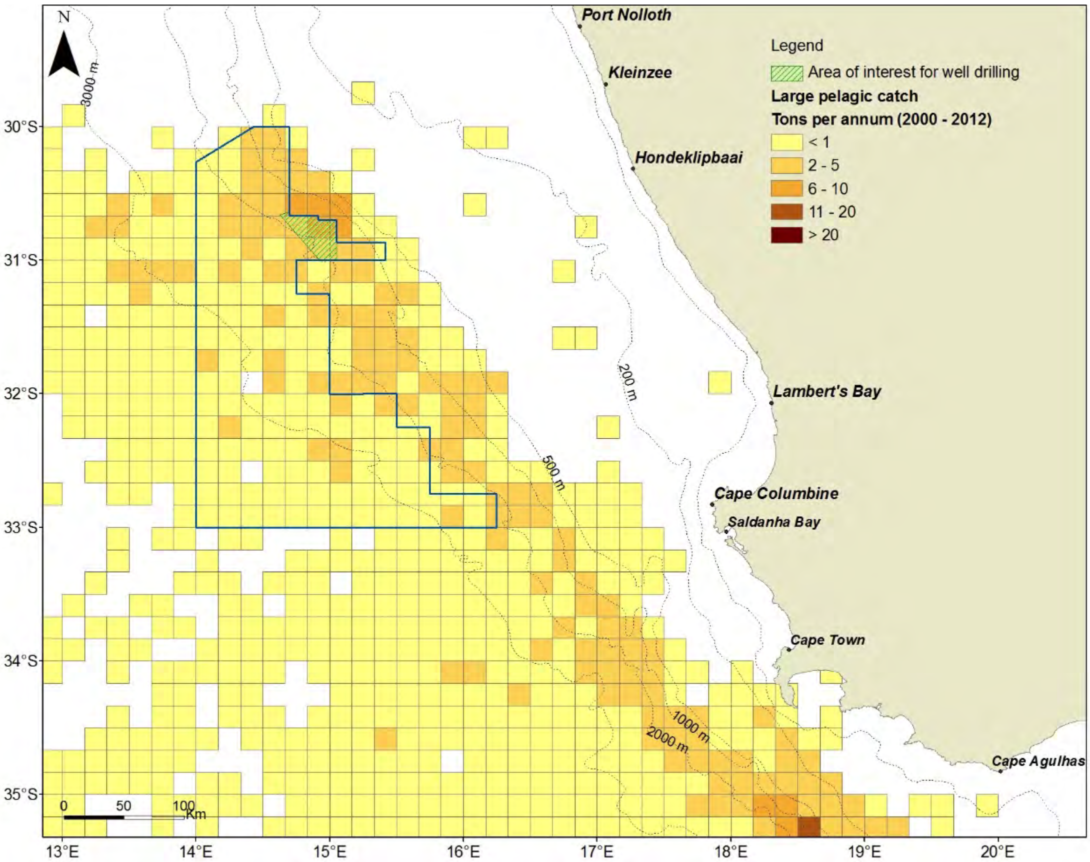


Figure 24. Spatial distribution of large pelagic species caught by the domestic and foreign pelagic long-line sector (all species) from 2000 to 2012 in relation to the proposed area of interest for well drilling.

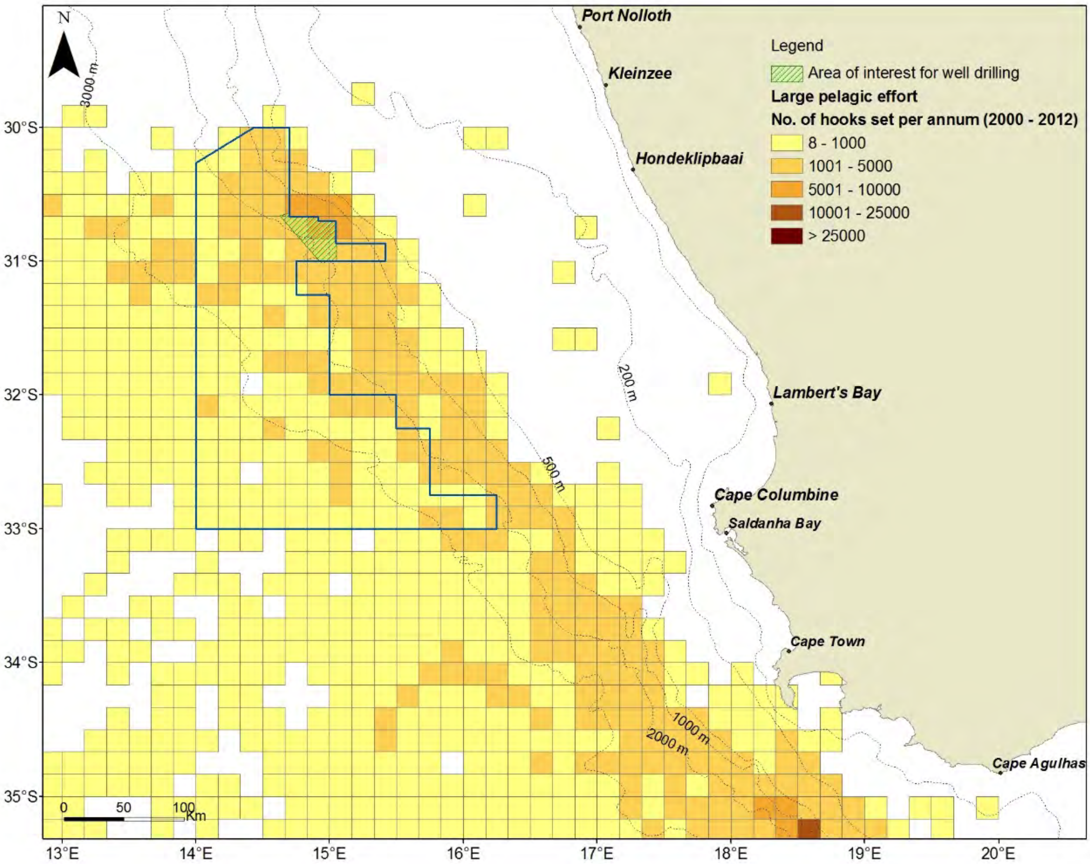


Figure 25. Spatial distribution of effort (number of hooks set per year) expended by the large pelagic long-line fishery from 2000 to 2012 in relation to the proposed area of interest for well drilling.

The impact of the proposed well-drilling operations (with a stationary drilling unit) on the large pelagic long-line fishery is considered to be of medium intensity and of overall VERY LOW significance due to the local extent and short-term duration of the impact. The degree of confidence in the assessment of this impact is high. The proposed abandonment of the wellhead on the seafloor would have no additional an impact on this fishery.

Drifting long-lines could become entangled around the drilling unit. Vigilance would be needed to identify any drifting lines and regular communications with vessels in the area would be essential.

Impact Assessment on Fisheries: Pelagic Long-Line (tuna- and swordfish-directed)			
	Temporary exclusion zone around drilling unit	**Well abandonment: well head remains in place**	**Well abandonment: well head removed**
Extent	Local	Local	Local
Duration	Short-term	Short-term	Short-term
Intensity	Medium	Zero	Zero
Significance	VERY LOW	NO IMPACT	NO IMPACT
Status	Negative	Zero	Zero
Probability	Highly probable	Improbable	Improbable
Confidence	High	High	High

4.4 Tuna Pole Description and Impact Assessment

Poling for tuna is predominantly based on the southern Atlantic longfin tuna stock (*T. alalunga*) (Figure 26) and a very small amount of skipjack tuna (*Katsumonus pelamis*), yellowfin tuna and bigeye tuna. The fishery is seasonal with vessel activity mostly between December and May and peak catches in February and March. The South African fleet consists of approximately 128 pole-and-line vessels which are based at the ports of Cape Town, Hout Bay and Saldanha Bay.

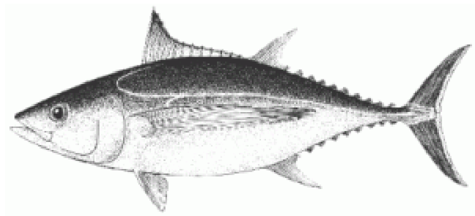


Figure 26. Longfin tuna *Thunnus alalunga*

Vessels operating within the fishery are typically small (< 25 m in length). Catch is stored on ice, chilled sea water or frozen and the storage method often determines the range of the vessel. Trip durations average between four and five days, depending on the distance of the fishing grounds from port. Vessels drift whilst attracting and catching pelagic tuna species. Whilst at sea, the majority of time is spent searching for fish with actual fishing events taking place over a relatively short period of time. Sonars and echo sounders are used to locate schools of tuna. At the start of fishing, water is sprayed outwards from high-pressure nozzles to simulate small baitfish aggregating near the water surface, thereby attracting tuna to the surface. Live bait is also flung out to entice the tuna to the surface (chumming). Tuna swimming near the surface are caught with hand-held fishing poles. The ends of these poles are fitted with a short length of fishing line leading to a hook. Hooked fish are pulled from the water and many tons can be landed in a short period of time. In order to land heavier fish, lines may be strung from the ends of the poles to overhead blocks to increase lifting power (see Figure 27).

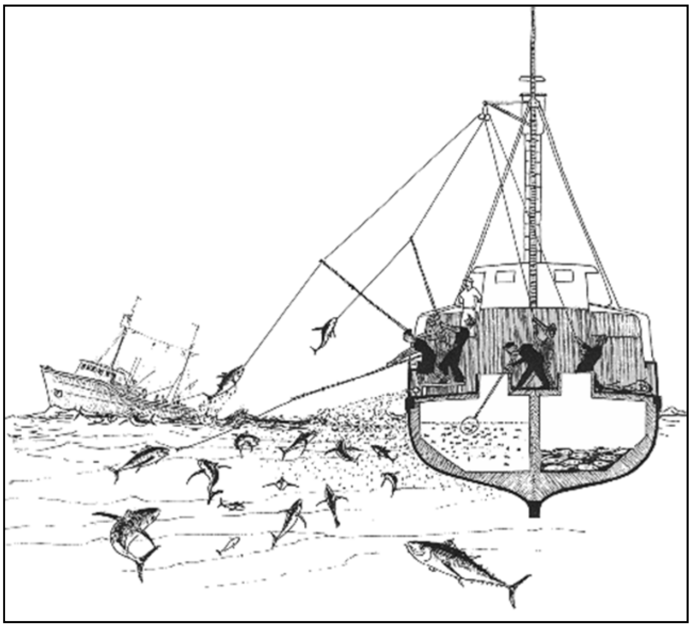


Figure 27. Schematic diagram of pole and line operation (www.fao.org/fishery).

Fishing activity occurs along the entire West Coast beyond the 200 m bathymetric contour. Activity would be expected to occur along the shelf break with favoured fishing grounds including areas north of Cape Columbine and between 60 km and 120 km offshore from Saldanha Bay. The nature of the fishery and communication between vessels often results in a large number of these vessels operating in close proximity to each other at a time. The vessels fish predominantly during daylight hours and as they do not anchor or have any fixed gear in the water, these vessels remain highly manoeuvrable and could take avoiding action at any time. However, at night in fair weather conditions the fleet of vessels may drift or deploy drogues to remain within an area and would be less responsive during these periods. Effort fluctuates according to the availability of fish in the area, but once a shoal of tuna is located a number of vessels will move into the area and target a single shoal which may remain in the area for days at a time. As such the fishery is dependent on window periods of favourable conditions relating to catch availability. Although fishing activity is highly variable during the fishing season, peak catches are usually experienced between February and March, with relatively lower levels of activity between December and January.

The 2014 TAC for the South African tuna pole fishery (albacore) will be set at 4 400 tons. The total catch landed and effort expended by the tuna pole sector over the period 2003 to 2012 was 4 110 tons (all species) and 5 723 fishing events per annum (see Figures 28 & 29). Over the period 2008 to 2012, effort within the fishery was slightly lower, whilst reported landings remained constant (4 221 tons and 4 707 fishing events per annum).

There have been no records of historical or recent fishing effort by tuna pole sector within the Orange Basin Deep Water Licence Area and the closest recorded fishing position is situated 60 nm inshore (due East) of the proposed area of interest for well-drilling. There is therefore NO IMPACT expected by the proposed well-drilling operations on the fishery. The confidence in this assessment is high. The proposed abandonment of the wellhead on the seafloor would have no additional an impact on this fishery.

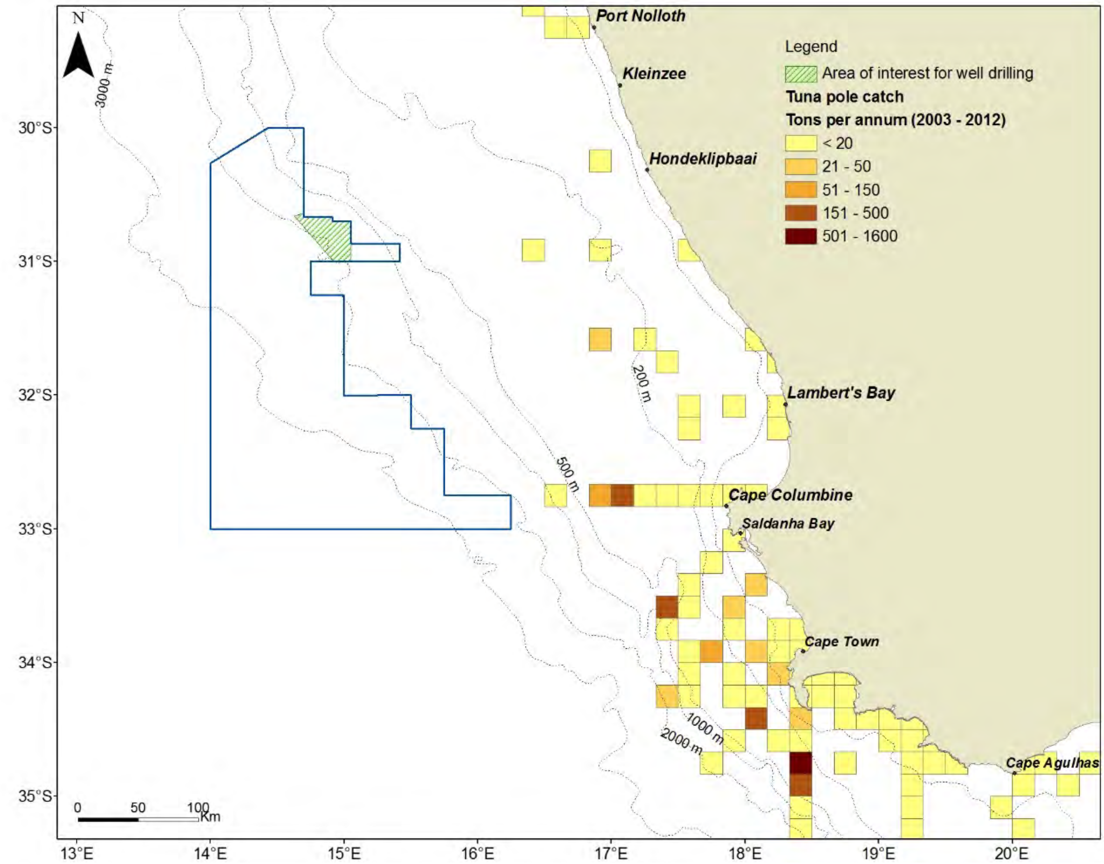


Figure 28. Spatial distribution of tuna pole catch from 2003 to 2012 in relation to the proposed area of interest for well drilling.

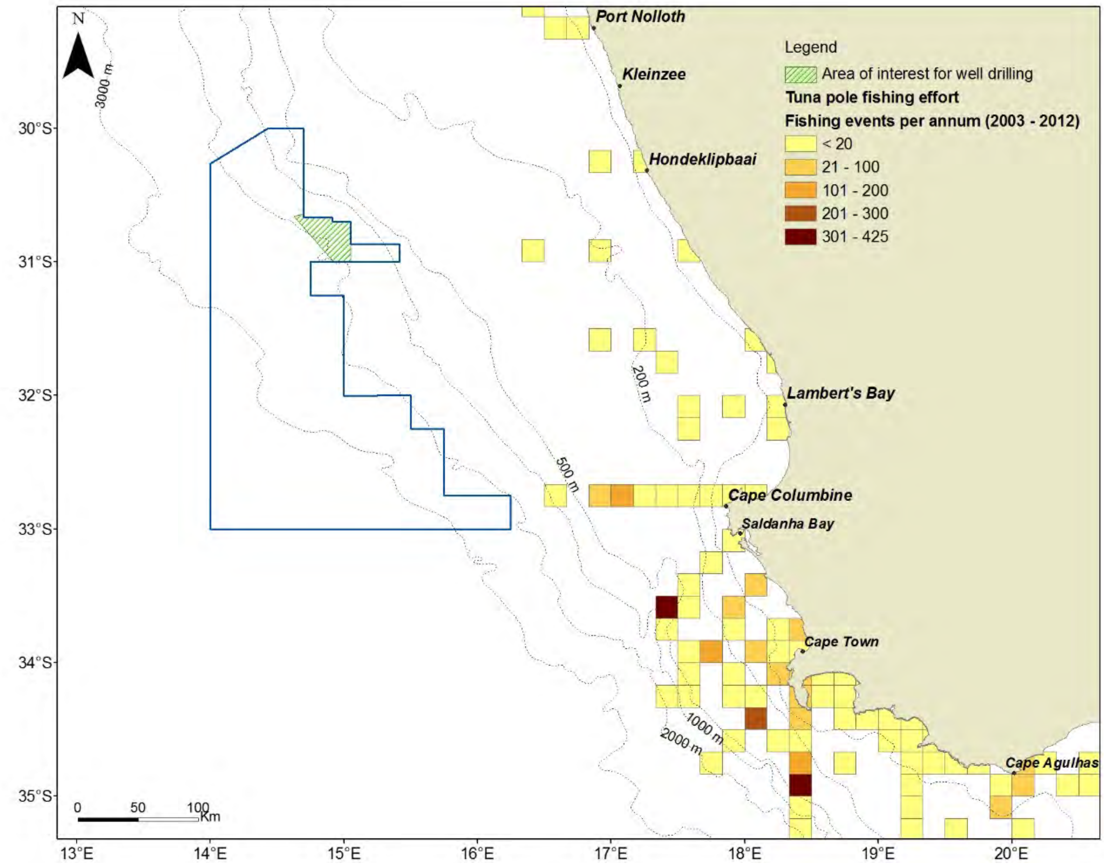


Figure 29. Spatial distribution of tuna pole effort (average annual number of fishing events) from 2003 to 2012 in relation to the proposed area of interest for well drilling.

Impact Assessment on Fisheries: Tuna Pole			
	Temporary exclusion zone around drilling unit	**Well abandonment: well head remains in place**	**Well abandonment: well head removed**
Extent	Local	Local	Local
Duration	Short-term	Short-term	Short-term
Intensity	Zero	Zero	Zero
Significance	NO IMPACT	NO IMPACT	NO IMPACT
Status	Negative	Negative	Negative
Probability	Improbable	Improbable	Improbable
Confidence	High	High	High

4.5 Traditional Line-Fish Description and Impact Assessment

The South African commercial line fishery is the country's third most important fishery in terms of total tons landed and economic value. The bulk of the fishery catch is made up of about 35 different species of reef fish as well as pelagic and demersal species which are mostly marketed locally as "fresh fish". The fishery is widespread across the country's shoreline from Port Nolloth on the West Coast to Cape Vidal on the East Coast. Effort is managed geographically with the spatial effort of the fishery divided into three zones. The majority of the catch (up to 95%) is landed by the Cape commercial fishery, which operates on the continental shelf up to a maximum depth of 200 m between from the Namibian border on the West Coast to the Kei River in the Eastern Cape. Fishing vessels generally range up to a maximum of 40 nm offshore, although fishing at the outer limit and beyond this range would be sporadic (C. Wilke, pers. comm[5]).

Over the period 2000 to 2012, the fishery reported an annual catch of 13 082 tons (see Figure 30). Recent landings have been somewhat lower since the reduction of commercial effort. Annual catches for the sector were reported as 8 551 tons over the period 2008 to 2012 compared to 15 913 tons over the period 2000 to 2007.

Line fishing techniques consist of hook and line deployments (up to 10 hooks per line), and differ from the pelagic long-line fishing technique in that the use of set long-lines is not permitted. The fishery includes commercial, subsistence and recreational sectors[6]. Up to 3 000 boats are involved in the fishery on the national level, 450 of which are involved in the commercial fishery, and range in size from 3 m beach-launched dinghy's to 20 m harbour-based vessels that may remain at sea for up to 30 days (Mann, 2000).

[5] Mr C. Wilke (christopherW@daff.gov.za) .is has been the chief technician at DAFF for 35 years and is the principle person for linefish data collection and collation. He is the main reference used regarding linefish data. There is little or no published linefish spatial data as used here – spatial mapping is undertaken directly by CapFish.

[6] Note: These fisheries are not artisanal in nature.

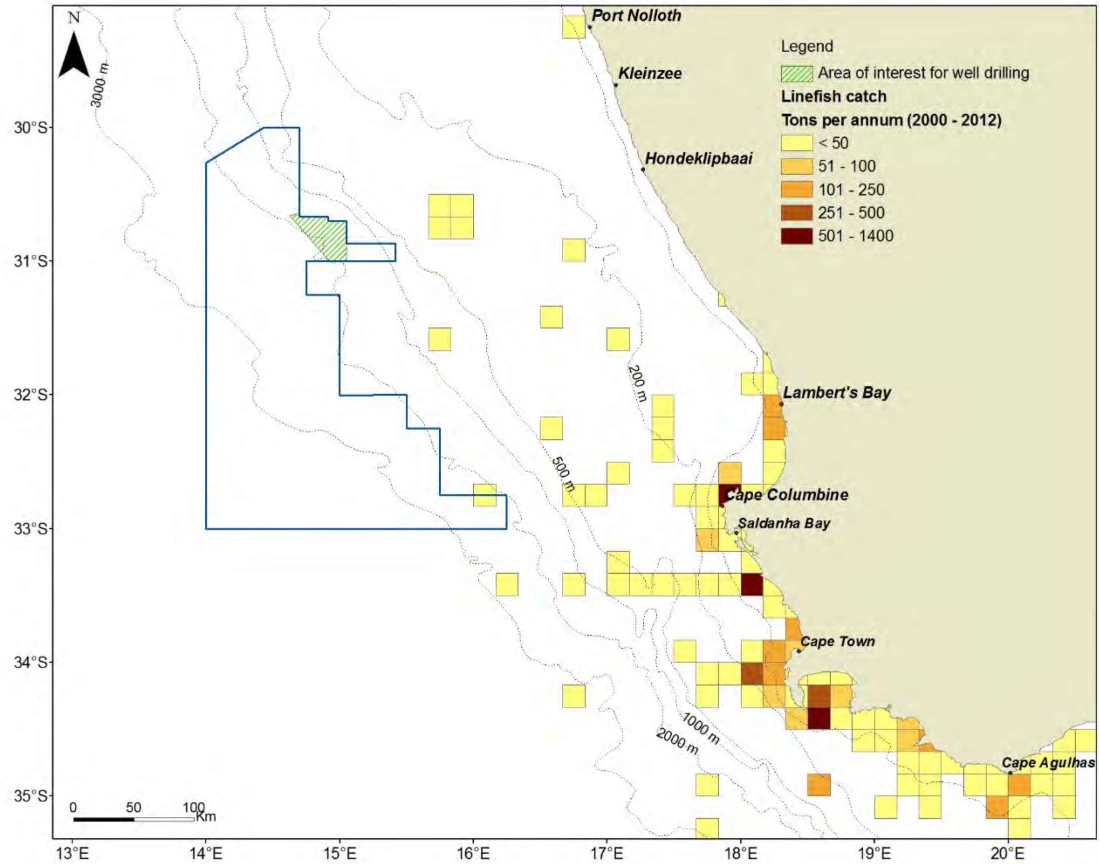


Figure 30. Spatial distribution of catch landed by the traditional linefish sector (2000 – 2012) in relation to the proposed area of interest for well drilling.

There have been no records of historical or recent fishing effort by the traditional linefish sector within the Orange Basin Deep Water Licence Area or in the area of interest for well-drilling. The closest reported fishing area is situated 40 nm from the proposed well-drilling area and therefore there is NO IMPACT expected by the proposed operations on the fishery. The confidence in this assessment is high. The proposed abandonment of the wellhead on the seafloor would have no additional an impact on this fishery.

Impact Assessment on Fisheries: Traditional Line-fish			
	Temporary exclusion zone around drilling unit	**Well abandonment: well head remains in place**	**Well abandonment: well head removed**
Extent	Local	Local	Local
Duration	Short-term	Short-term	Short-term
Intensity	Zero	Zero	Zero
Significance	NO IMPACT	NO IMPACT	NO IMPACT
Status	Negative	Negative	Negative
Probability	Improbable	Improbable	Improbable
Confidence	High	High	High

4.6 Small Pelagic Purse-Seine Description and Impact Assessment

Figure 31. Sardine, also called Pilchard is a shoaling species and is the most valuable species in the purse-seine fishery

The small pelagic fishery is the largest South African fishery by volume and the second most important in terms of value. Small pelagic species abundance and distribution fluctuates considerably in accordance with the upwelling ecosystem in which they exist. Annual landings have fluctuated between 300 000 and 600 000 tons over the last decade[7], with average landings of 468 000 tons (all species) per annum over the period 2000 to 2012 compared to 391 000 tons per annum recorded between 2008 and 2012. The two main targeted species are sardine (Figure 31) and anchovy, with associated by-catch of round herring (red-eye) and juvenile horse mackerel. Fishing grounds occur primarily along the West and South coasts of the Western Cape and the Eastern Cape coast up to a maximum distance of 100 km offshore, but usually closer inshore. The majority of the fleet of 101 vessels operate from St Helena Bay, Laaiplek, Saldanha Bay and Hout Bay (well to the south-east of the area of interest) with fewer vessels operating on the South Coast from the harbours of Gansbaai, Mossel Bay and Port Elizabeth. Ports of deployment correspond to the location of canning factories and fish reduction plants along the coast.

The fleet consists of wooden, glass-reinforced plastic and steel-hulled vessels ranging in length from 11 m to 48 m. The targeted species are surface-shoaling and once a shoal has been located the vessel will steam around it and encircle it with a large net, extending to a depth of 60 to 90 m (see Figure 32). Netting walls surround aggregated fish, preventing them from diving downwards. These are surface nets framed by lines: a float line on top and lead line at the bottom. Once the shoal has been encircled the net is pursed, hauled in and the fish pumped onboard into the hold of the vessel. It is important to note that after the net is deployed the vessel has no ability to manoeuvre until the net has been fully recovered onboard and this may take up to 1.5 hours. Vessels usually operate overnight and return to offload their catch the following day.

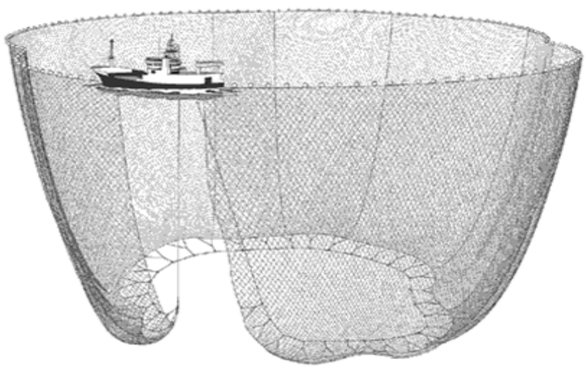


Figure 32. Schematic showing typical configuration and deployment of a small pelagic purse seine net for anchovy and pilchard in South African waters.

The small pelagic sector operates throughout the year with a short break from mid-December to mid-January[8]. The geographical distribution and intensity of the fishery is largely dependent on the seasonal fluctuation and distribution of the targeted species. The sardine-directed fleet concentrates effort in a broad area extending from Lambert's Bay, southwards past Saldanha and Cape Town towards Cape Point and then eastwards along the coast to Mossel bay and Port Elizabeth. The anchovy-directed fishery takes place predominantly on the South-West Coast from Lambert's Bay to Kleinbaai (19.5°E) and similarly the intensity of this fishery is dependent on fish availability and is most active in the period from March to September. Round herring (non-quota species) is targeted when available and specifically in the early part of the year (January to March) and is distributed from Lambert's Bay to South of Cape Point. This fishery may extend further offshore than the sardine and anchovy-directed fisheries.

[7] Acoustic surveys are conducted to assess the pre- and post-spawning biomass of small pelagic species and the TAC is set and adjusted accordingly each year.
[8] The fishery has traditionally "rested" in December and early January primarily to reduce impact on juvenile sardine.

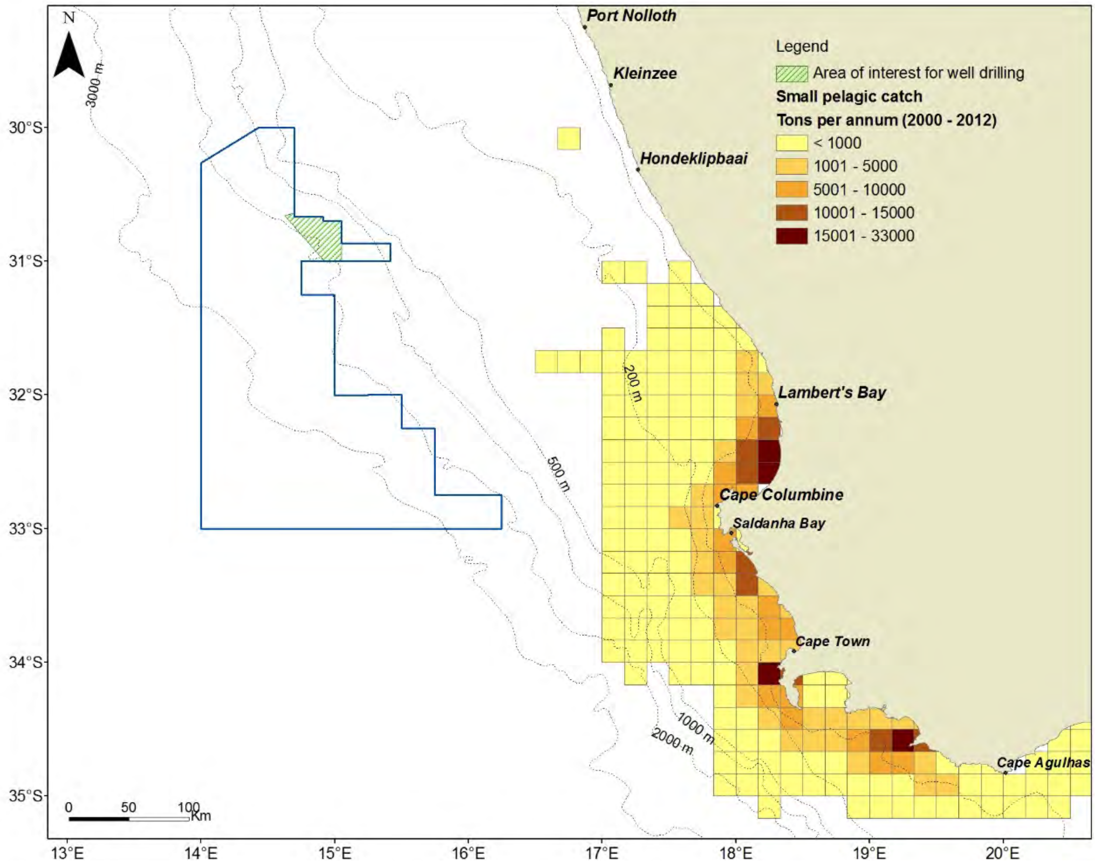


Figure 33. Spatial distribution of the catch of small pelagic species landed by the purse-seine fishery (2000 – 2012) in relation to the proposed area of interest for well drilling.

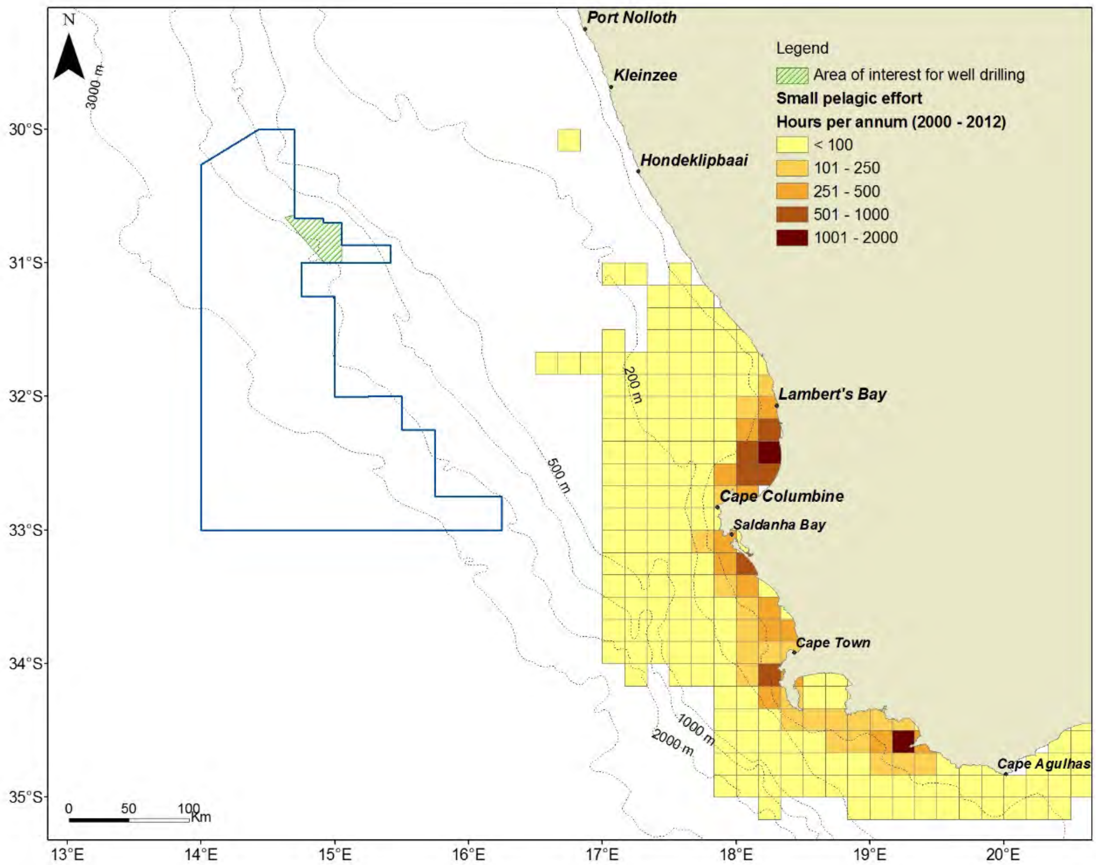


Figure 34. Spatial distribution of the fishing effort expended by the small pelagic purse-seine fishery (2000 – 2012) in relation to the proposed area of interest for well drilling.

Figures 33 and 34 show the average annual catch and effort of small pelagic species from 2000 to 2012, indicating the range of fishing grounds on the West Coast, predominantly from the 31°S line of latitude southwards and within 100 km of the shoreline. Neither recent nor historical records indicate fishing activity within the Deep Water Licence Area. Since the fishing grounds of the small pelagic fishery do not coincide with the proposed well drilling area, which is situated at least 100 nm (180 km) from the fishing grounds, there is NO IMPACT expected by the proposed drilling activities on the small pelagic purse-seine fishery. The proposed abandonment of the wellhead on the seafloor would have no additional impact on this fishery. The degree of confidence in the assessment is high.

Impact Assessment on Fisheries: Pelagic Purse-Seine			
	Temporary exclusion zone around drilling unit	**Well abandonment: well head remains in place**	**Well abandonment: well head removed**
Extent	Local	Local	Local
Duration	Short-term	Short-term	Short-term
Intensity	Zero	Zero	Zero
Significance	NO IMPACT	NO IMPACT	NO IMPACT
Status	Negative	Negative	Negative
Probability	Improbable	Improbable	Improbable
Confidence	High	High	High

4.7 West Coast Rock Lobster Description and Impact Assessment

The West Coast rock lobster (*J. lalandii*) (Figure 35) is a slow-growing, long-lived species which occurs inside the 200 m depth contour along the entire West Coast to East London on the East Coast. The fishery is divided into the offshore fishery and the near-shore fishery, both directed inshore of the 100 m bathymetric contour. Effort is seasonal with boats operating from the shore and coastal harbours. Catch is landed whole and is managed using a TAC, 80% and 20% of which is allocated to the offshore and inshore fisheries respectively. A total national landing of approximately 1 879 tons (whole weight) was recorded for 2012.

Figure 35. West Coast Rock Lobster *Jasus lalandii* (traditionally caught on the South African West Coast)

Fishing grounds are divided for management purposes into Zones (and further subdivided into Areas) stretching from the Orange River mouth to east of Cape Hangklip in the South-Eastern Cape. The offshore sector operates in a water depth range of 30 m to 100 m whilst the inshore fishery is restricted by the type of gear used to waters shallower than 30 m in depth. The offshore sector makes use of traps consisting of rectangular metal frames covered by netting, which are deployed from trap boats (otherwise known as "deck boats") whilst the inshore fishery makes use of hoop-nets deployed from small dinghy's. The West Coast rock lobster offshore fishing fleet consists of vessels that range in length from 6 m to 14 m. Traps are set at dusk and retrieved during the early morning using a powerful winch for hauling. Vessels using traps will leave up to 30 traps per vessel in the fishing grounds overnight during the week, Monday to Friday. As a requirement of permit conditions for this sector, all traps must be removed over the weekend.

See Figure 36 for the spatial distribution of catch taken by the inshore and offshore fisheries over the period 1969 to 2012[9]. At closest point, the proposed well-drilling area lies 125 nm (230 km) West of the rock lobster fishing grounds and there is no evidence of activity within the proposed area. There is

[9] Catches of rock lobster have declined systematically due to heavy fishing pressure and are currently estimated to be at only 3% of their pristine state.

therefore NO IMPACT expected by the proposed operations on the offshore fishery. The proposed abandonment of the wellhead on the seafloor would have no additional an impact on this fishery.

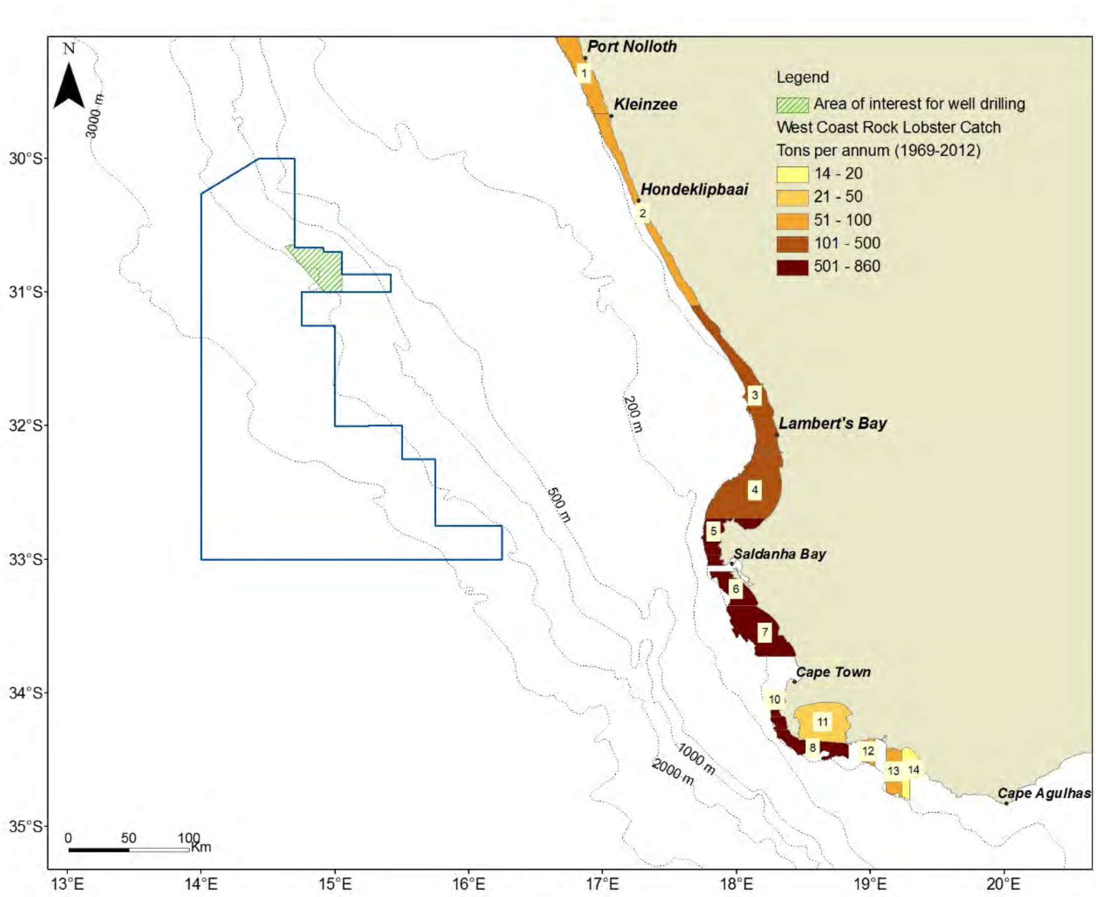


Figure 36. Spatial distribution of total catch (1969 – 2012) reported by the West Coast Rock Lobster fishery (includes inshore and offshore sectors) in relation to the proposed area of interest for well drilling. Management areas labelled (1 – 14).

Impact Assessment on Fisheries: West Coast rock lobster			
	Temporary exclusion zone around drilling unit	**Well abandonment: well head remains in place**	**Well abandonment: well head removed**
Extent	Local	Local	Local
Duration	Short-term	Long-term	Short-term
Intensity	Zero	Zero	Zero
Significance	NO IMPACT	NO IMPACT	NO IMPACT
Status	Negative	Negative	Negative
Probability	Improbable	Improbable	Improbable
Confidence	High	High	High

4. IMPACT ON FISHERIES RESEARCH

A survey of demersal fish resources is carried out twice a year by DAFF in order to set the annual TACs for demersal fisheries. Stratified, bottom trawls are conducted to assess the biomass, abundance and distribution of hake, horse mackerel, squid and other demersal trawl species on the shelf and upper slope of the South African coast. A similar gear configuration to that of commercial demersal trawlers is used, however nets are towed for a shorter duration of generally 30 minutes per tow. First started in 1985, the West Coast offshore region is surveyed from Cape Agulhas (20° E) to the Namibian maritime border. Trawl positions are randomly selected to cover specific depth strata that range from the coast to the 1 000 m bathymetric contour (see Figure 37).

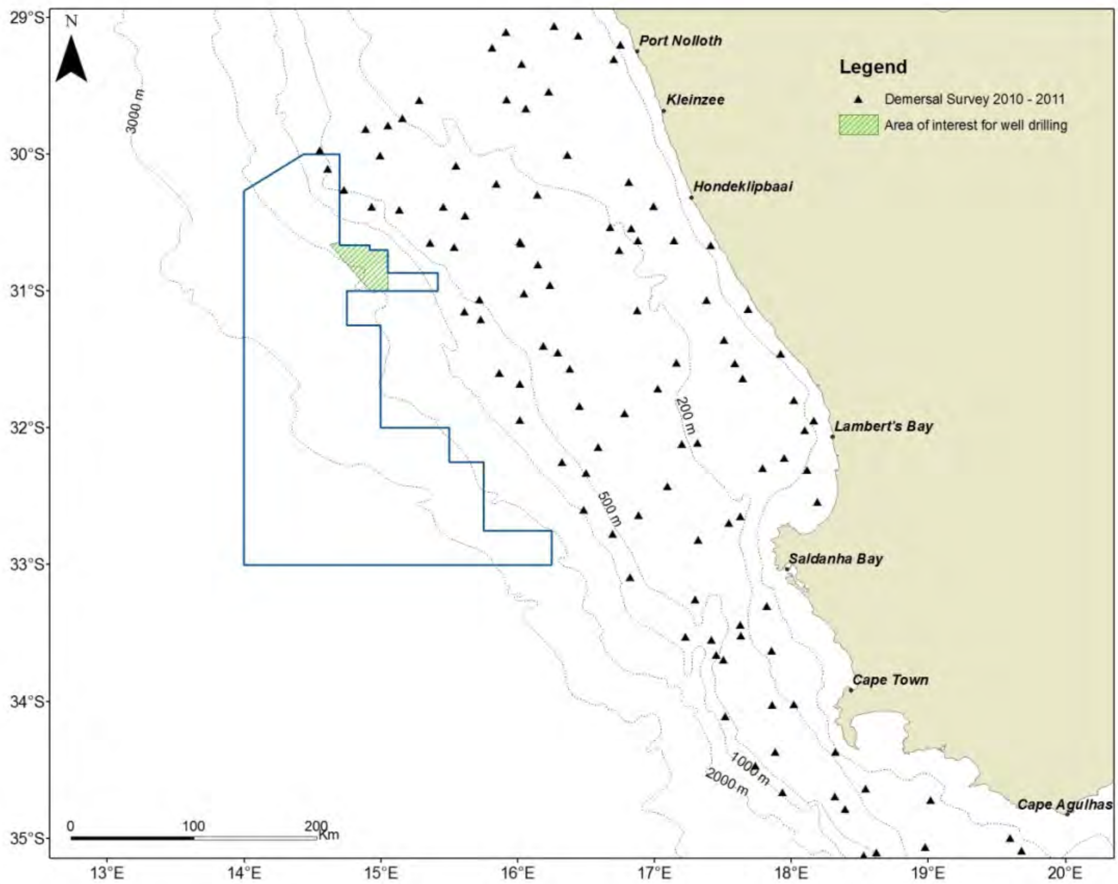


Figure 37. Spatial distribution of trawls conducted during the 2010 and 2011 demersal research survey in relation to the proposed area of interest for well drilling.

Approximately 120 trawls are conducted during each survey and the location of these trawls is pre-determined usually a week before the cruise is scheduled to take place. The survey duration is approximately one month, and takes place in January (West Coast survey) and May (South Coast survey). The proposed area of interest is situated in water depths greater than 1 500 m therefore the likelihood of the proposed well-drilling operations impacting the demersal research surveys is improbable, as demersal research trawls are carried out in water depths less than 1 000 m. There is therefore NO IMPACT expected on the West Coast and South Coast demersal research surveys. On abandonment of a well, it is improbable that a wellhead structure would adversely affect the demersal research survey strategy. It should be noted however that globally trawling technology is changing and that the fishing industry is increasingly shifting into deeper waters. Deepwater trawling research was initiated by the then *Sea Fisheries Research Institute* (now DAFF) in the mid 1990s. The reason for this was the increasing interest in deep water commercial fish stocks. Species such as orange roughy (*Hoplostethus atlanticus*) which had been found in Namibia (Figure 38) just north of the RSA Namibia border, were the primary interest. Research trawls were undertaken to 1300 m in the area of the current proposed drilling. It was also know at the time that the fishing industry was "prospecting" for commercial deepwater species in the area, using vessels and gear with skippers experienced in this type of fishing. The interest in the area and the potential for fisheries development remains at these depths. The potential interest in the area from a trawling perspective cannot therefore be discounted[10]. From a fisheries research perspective, while removal of any wellhead would be the best option, it would not impact research efforts in the future as long as the location and extent of the structure on the seafloor was appropriately documented.

Figure 38. In the mid1990s a deepwater orange roughy resource was found off Namibia in deepwater from 500-1200 m water depth. The species is found in RSA water but the large aggregations as shown above have not been found.

The biomass of small pelagic species is assessed bi-annually by an acoustic survey. The first of these surveys is timed to commence mid-May and runs until mid-June while the second starts in mid-October and runs until mid-December. The timing of the demersal and acoustic surveys is not flexible, due to restrictions with availability of the research vessel as well as scientific requirements. During these surveys the survey vessels travels pre-determined transects (perpendicular to bathymetric contours) running offshore from the coastline to approximately the 200 m bathymetric contour (thus inshore of the proposed area of interest). The survey is designed to cover an extensive area from the Orange River on the West Coast to Port Alfred on the East Coast and the DAFF survey vessel progresses systematically from the Northern border Southwards, around Cape Agulhas and on towards the East. As these surveys would be situated inshore of the proposed area of interest, NO IMPACT is anticipated.

Although there is no anticipated impacts on fisheries research it is recommended that the managers of the research survey programmes are notified of the exact well locations and timing of drilling. The relevant contacts at DAFF currently responsible for the planning of the demersal and acoustic cruises are Deon Durholtz (DeonD@daff.gov.za) and Janet Coetzee (JanetC@nda.agric.za) respectively.

Impact Assessment on Fisheries: Fisheries Research			
	Temporary exclusion zone around drilling unit	**Well abandonment: well head remains in place**	**Well abandonment: well head removed**
Extent	Local	Local	Local
Duration	Short-term	Long-term	Short term
Intensity	Zero	Zero	Zero
Significance	NO IMPACT	NO IMPACT	NO IMPACT
Status	Negative	Negative	Negative
Probability	Improbable	Improbable	Improbable
Confidence	High	High	High

[10] Note that the author (Japp dave@capfish.co.za) was responsible for the original deep water research efforts around the RSA coast. Subsequent work has been undertaken by DAFF (ref. Dr D. Durholtz DeonD@daff.gov.za and Dr Rob Leslie RobL@daff.gov.za). The deep sea trawling industry association (SADSTIA) has expressed concern regarding the accessibility of potential deep water grounds (Bross pers comm. deepsea@iafrica.com), although in this authors view, the likelihood that trawling in this area will expand to depths > 1500 m is low. There is no published literature on this subject for RSA waters although on application, confidential research survey reports could be accessed (re Dr Deon Durholtz DeonD@daff.gov.za).

5. IMPACT OF OIL SPILLS ON FISHERIES

The oils spill modelling undertaken by PRDW is divided into two main sections, namely:

1) Small instantaneous spills of hydraulic fluid (one ton) or diesel (10 tons), where the dominant weathering processes are evaporation and dispersion.
    - > A spill of one ton of hydraulic fluid is predicted to travel as a narrow plume up to 150 km north-westwards from the source. The oil would remain at the sea surface for a maximum of two days before a combination of oil dispersion and spreading reduces the oil thickness below 0.3 µm. The oil dispersed into the water column is likely to be located below the area of surface oiling and within 25 m of the water surface. There is no probability of a one ton spill reaching the shoreline.
    - > A 10 tons diesel spill is predicted to move ~110 km from the source, also as a narrow plume predominantly in a north-westerly direction. The diesel would remain on the sea surface for no more than 36 hours before a combination of oil dispersion and spreading reduces the oil thickness below 0.3 µm. The oil dispersed into the water column is likely to be located below the area of surface oiling and within 25 m of the water surface. There is no probability of a one ton spill reaching the shoreline. Although this scenario is ten times larger than the hydraulic oil spill, the area oils is smaller due to evaporation and the more rapid dispersion of diesel.
2) Large blow out of crude oil at the seabed under 5-day and 20-day blow out scenarios. For crude oil the weathering processes over the short-term (hours to weeks) include evaporation, dispersion, dissolution, photo-oxidation, emulsification and spreading, whereas biodegration and sedimentation dominate the weathering processes over the medium- to long-term (weeks to years).
    - > The large blow out oil spills under 5-day and 20-day scenarios were predicted to result in extensive areas of oiling of both sub-surface and particularly surface waters. Once the oil surfaces it generally moves in a north-westerly direction as a relatively confined plume due to the prevailing near-surface currents and winds. The probability of the oil spill reaching the coastline depends on spill duration, season and the weathering scenario. If drilling is confined to summer, as proposed, then under slow weathering conditions, the 5-day blow out was predicted to have no probability of shoreline oiling, and the 20-day blow out had <10% probability of shoreline oiling at a point between Oranjemund and Cape Town. Drilling during winter would increase the probability of shoreline oiling in the event of a spill. The oil is present on the water surface for more than 40 days after the start of the spill.

There are several probable impacts of oil spills on fisheries:

1) Oil contamination of mobile finfish species, in particular on juveniles in nursery areas may result in displacement of species from normal feeding and protective areas as well as possible physical contamination resulting in fish mortality and or physiological effects such as clogging of gills leading to fish mortality;
2) Oiling of sessile or sedentary species will result in physical clogging on individuals, disturbance and or removal of habitat for these species and, for filter feeding species such as mussels, gill clogging and mortality;
3) Oiling of passively drifting spawn products (eggs and larvae) will result in their contamination and mortality (the extent of mortality will depend on the nature and extent of the contaminants);
4) Exclusion of fisheries from areas that may be polluted or closed to fishing due to contamination of sea water by the oil or for example the chemicals used for cleaning oil spills.

For each of the above we consider two scenarios: a) localised small scale accidental spills and b) large scale spills from unplanned failure events.

We note that historically the Benguela ecosystem has been impacted by oil spills resulting from maritime incidents of different scales. In particular we refer to the sinking of the laden oil tanker MV Castillo del Bellver[11] and numerous other smaller events. The 1983 sinking of MV Castillo del Bellver occurred in the general area of the proposed drilling and would in this instance equate to both a localised and large scale oil contamination event (Figure 39).

Figure 39. The sinking of the Castillo del Bellver off the West Coast of South Africa is one of the 10 largest recorded tanker oil spills recorded

A second example which illustrates the biological and fisheries impact is the 2011 grounding of the MV Oliva on Nightingale Island in the South Atlantic Tristan Island archipelago. This particular example has relevance as the spill and subsequent pollution from the vessel's cargo (soya bean) had a major impact on the Tristan lobster fishery as well as a potential impact on recruitment to the fishery.

A second example pertinent to fisheries is the 2011 grounding of the MV Oliva on Nightingale Island in the South Atlantic Tristan Island archipelago. This particular example has relevance as the spill and subsequent pollution from the vessel's cargo (soya bean[12]) had a major impact on the Tristan lobster fishery as well as a potential impact on recruitment to the fishery.

Impact on mobile fin-fish species

a) Small scale – based on the models provided it is highly unlikely that mobile fin-fish species would be impacted. As the event would occur offshore mobile and migratory species such as tuna and tuna-like species would avoid any localised contaminated area. Small pelagic species are found inshore on the shelf and would also be highly unlikely to be impacted.

b) Large scale – such an event as demonstrated by the modelling is likely to have a much broader impact extending from source (off the shelf edge) and is likely to result in oil contamination inshore (that is on the shelf from the coastline to the shelf drop off generally accepted as starting from about 500 m and deeper) as well as, in extreme cases, extending into bay areas. The adjacent bay areas to the proposed drilling site are critical nursery areas for the following fisheries: anchovy-directed purse seine, pilchard-directed purse seine, juvenile horse mackerel-directed purse-seine, and numerous demersal species, including hakes, that are present in the bay areas in their juvenile stages.

A large-scale pollution event in the nursery areas extending from Saldanha Bay northwards to the Namibian border would have a potentially critical impact on juvenile commercial and other fin-fish species using the inshore and bay areas as nursery grounds. These species (juveniles) are unlikely to be able to move out of the area and depending on the scale of the event, fin-fish mortality is expected with a resulting impact on the fishery (undetermined economic and biological effects). The peak nursery period for juvenile fin fish occurs from December through to March. Thereafter most juvenile small pelagic species migrate southwards out of the bays. Juvenile hake migrate offshore and into deeper water i.e. move into demersal stages.

[11] http://www.oilandgasiq.com/strategy-management-and-information/articles/the-10-biggest-oil-spills-in-world-history-part-3/

[12] The initial impact of the grounding was from the bunker oil. However the oil dispersed relatively quickly. The vessel carried bulk soya bean that subsequently fouled the island and damaged the marine habitat around parts of archipelago used by *Jasus tristanii*

Impacts of oil on sessile or sedentary species

a) Small scale events offshore would not impact fisheries for sessile (such as mussels and abalone) species and other sedentary species, in particular west coast rock lobster.

b) Large scale – oil contamination would potentially have the greatest impact on commercial fisheries for rock lobster and sessile filter feeding (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. The trap fisheries for west coast lobster would be expected to be impacted economically. The nature of this impact as described above is likely to include the mortality of mussels (the principle food source of west coast rock lobster) through the oiling of the sessile species resulting in the physical clogging of individuals, disturbance and or removal of habitat for these species and gill clogging and mortality.

   The impact on rock lobster is also likely to include the oiling of passively drifting spawn products (eggs and larvae) that would result in their contamination and mortality (the extent of mortality will depend on the nature and extent of the contaminants). In addition, juvenile west coast rock lobster settlement is likely to be impacted close inshore (these are nursery areas as well for juveniles). This would result in loss of recruitment of lobster and result in a potential long-term impact on the sustainability of this resource as a result of this recruitment mortality. Larger lobster can undergo migrations and are likely to move out of contaminated areas. Hydrocarbon contamination has also been shown to impact on rock lobster quality for human consumption and can result in product rejection (this has been the case in the MV Olivia grounding off Tristan da Cunha).

   Large scale effects is also likely to include area closures and exclusion of fisheries from areas that may be polluted or closed to fishing due to contamination of sea water by the oil or for example the chemicals used for cleaning oil spills. The mussel and oyster farms (mariculture facilities) on the west coast and in Saldanha Bay would be impacted if the extent of the contamination included these areas. These facilities are mostly open water cage or rope farms dependent on juvenile settlement with sensitivity to levels of contamination in their products[13]. In the case of the *MV Oliva* grounding it resulted in closure of a section of the fishery and loss of catch as the lobster were believed to have migrated out of the area and were inaccessible to the fishery.

Direct impact on passively drifting spawn products (eggs and larvae)

The principle commercial fish species undergo a critical migration pattern in the Benguela ecosystem. This migration is central to the sustainability of the small pelagic and hake fisheries. The process is as follows (refer to Figure 40):

- Adults spawn on the central Agulhas Bank in spring (September to November);
- Spawn drifts northwards in the Benguela current across the shelf
- As eggs drift northwards, hatching takes place followed by larval development;
- Settlement of larvae occurs in the inshore areas, in particular the bays that are used as nurseries. This takes place from October through to Autumn (March onwards);
- Juveniles shoal and begin a southward migration. This is the main period the anchovy and sardine are targeted by the small pelagic purse seine fishery. The demersal species such as hake migrate offshore into deeper water.

[13] Mussel and oyster farms undergo rigorous testing of products produced for human consumption including heavy metal levels and poisonous algal blooms. When contaminants are found in the farm areas the actual area and adjacent waters are closed to prevent contamination and farm production ceases until considered safe for human consumption.

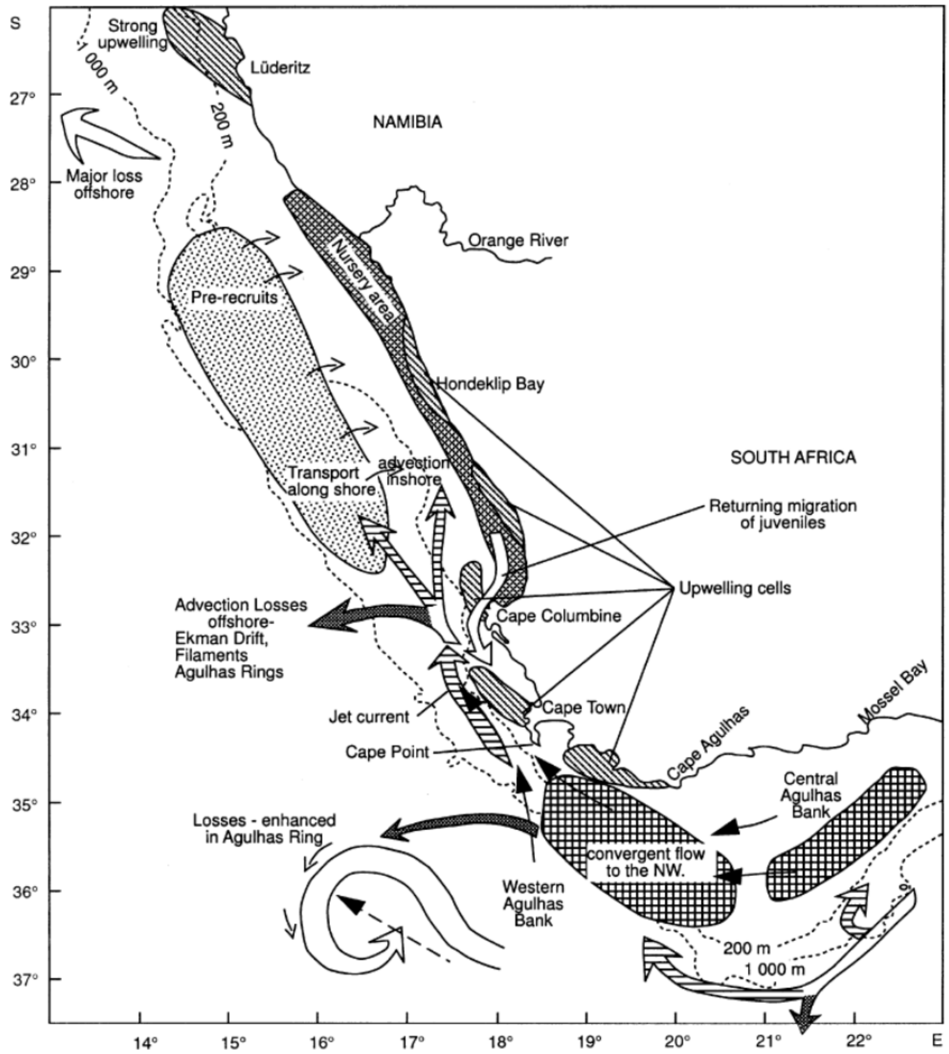


Figure 40. West Coast nursery ground and western/central Agulhas Bank spawning ground [After Hutchings et al., 2002 - light stippled area on the West Coast marks the main recruiting area for the fishery. Dark stippled area on the Agulhas Bank marks the main spawning grounds].

a) Small scale – the likely area of any small scale oil pollution events will occur well offshore and is unlikely to have a significant biological impact on the main commercial species. Eggs and larvae drifting northwards will undoubtedly be contaminated and die – however in the location of the proposed drilling the spawn products are unlikely to contribute to recruitment to the fishery.

b) Large scale – the effect of a large scale contamination event inshore and northwards of the drilling location is potentially serious for the small pelagic fisheries. This is particularly so if the event occurs at peaks of larval drift and settlement into nursery areas (most likely from November through to March). The impact on the eggs and larvae is difficult to determine – some modelling has been done on Tristan da Cunha lobster recruitment. The species likely to be impacted is different however from the continental fisheries (the oceanographic and bathymetric conditions also differ and therefore the dynamics would affect modelling outputs). Nevertheless mortality of varying scales would be expected on eggs and larvae and this would ultimately impact the biological resources upon which the commercial fisheries in the area depend. Note also that the effect can occur over a number of years depending on the life cycle of the different species. Anchovy recruit to the fishery in their first year, sardine in their second year and hake in their third year therefore the impacts on different fisheries may occur at different times.

Exclusion of fisheries from areas that may be contaminated

a) Small scale – Operators of fishing vessels would avoid surface polluted areas. For small scale events such impacts are likely to be minimal (Table 2).

b) Large Scale – Operators of fishing vessels would avoid areas of large scale contamination. Not only is it likely that fishery resources would move out of an area, but also operators avoid polluted areas that contaminate fishing gear and affect cooling water intake systems (Table 2).

Mitigation Options

- Mitigation would require the implementation of oil spill contingency plans.

Table 5. Summary table showing impact ratings of the oil spill scenarios on the West Coast fishing industry and research surveys both with and without mitigation measures in place.

	Extent	Duration	Intensity	Significance	Probability	Confidence
Large Pelagic Long-Line						
Impact of oil spill: Small instantaneous oil spill						
Without mitigation	Local	Short-term	Low	Very Low	Probable	Medium
With mitigation	Local	Short-term	Low	Very Low	Probable	Medium
Impact of oil spill: Large blow-out of crude oil at seabed (5-day and 20-day scenarios)						
Without mitigation	Regional	Short- to medium-term	Medium	Low	Improbable	Medium
With mitigation	Regional	Short- to medium-term	Medium	Low	Improbable	Medium
Demersal Trawl						
Impact of oil spill: Small instantaneous oil spill						
Without mitigation	Local	Short-term	Low	Very Low	Probable	Medium
With mitigation	Local	Short-term	Low	Very Low	Probable	Medium
Impact of oil spill: Large blow-out of crude oil at seabed (5-day and 20-day scenarios)						
Without mitigation	Regional	Short- to medium-term	Medium – High	Medium	Improbable	Medium
With mitigation	Regional	Short- to medium-term	Medium - High	Medium	Improbable	Medium
Demersal Hake-Directed Long-Line						
Impact of oil spill: Small instantaneous oil spill						
Without mitigation	Local	Short-term	Low	Very Low	Probable	Medium
With mitigation	Local	Short-term	Low	Very Low	Probable	Medium
Impact of oil spill: Large blow-out of crude oil at seabed (5-day and 20-day scenarios)						
Without mitigation	Regional	Short- to medium-term	Medium – High	Medium	Improbable	Medium
With mitigation	Regional	Short- to medium-term	Medium - High	Medium	Improbable	Medium
Demersal Shark-Directed Long-Line						
Impact of oil spill: Small instantaneous oil spill						
Without mitigation	Local	Short-term	Low	Very Low	Probable	Medium
With mitigation	Local	Short-term	Low	Very Low	Probable	Medium
Impact of oil spill: Large blow-out of crude oil at seabed (5-day and 20-day scenarios)						
Without mitigation	Regional	Short- to medium-term	Medium – High	Medium	Improbable	Medium
With mitigation	Regional	Short- to medium-term	Medium High	Medium	Improbable	Medium
Tuna Pole						
Impact of oil spill: Small instantaneous oil spill						
Without mitigation	Local	Short-term	Low	Very Low	Probable	Medium
With mitigation	Local	Short-term	Low	Very Low	Probable	Medium

	Extent	Duration	Intensity	Significance	Probability	Confidence
Impact of oil spill: Large blow-out of crude oil at seabed (5-day and 20-day scenarios)						
Without mitigation	Regional	Short- to medium-term	Medium	Low	Improbable	Medium
With mitigation	Regional	Short- to medium-term	Medium	Low	Improbable	Medium
Traditional Linefish						
Impact of oil spill: Small instantaneous oil spill						
Without mitigation	Local	Short-term	Low	Very Low	Probable	Medium
With mitigation	Local	Short-term	Low	Very Low	Probable	Medium
Impact of oil spill: Large blow-out of crude oil at seabed (5-day and 20-day scenarios)						
Without mitigation	Regional	Short- to medium-term	Medium – High	Medium	Improbable	Medium
With mitigation	Regional	Short- to medium-term	Medium - High	Medium	Improbable	Medium
Small Pelagic Purse-Seine						
Impact of oil spill: Small instantaneous oil spill						
Without mitigation	Local	Short-term	Low	Very Low	Probable	Medium
With mitigation	Local	Short-term	Low	Very Low	Probable	Medium
Impact of oil spill: Large blow-out of crude oil at seabed (5-day and 20-day scenarios)						
Without mitigation	Regional	Short- to medium-term	High	High	Improbable	Medium
With mitigation	Regional	Short- to medium-term	High	High	Improbable	Medium
West Coast Rock Lobster (Offshore and Inshore)						
Impact of oil spill: Small instantaneous oil spill						
Without mitigation	Local	Short-term	Low	Very Low	Probable	Medium
With mitigation	Local	Short-term	Low	Very Low	Probable	Medium
Impact of oil spill: Large blow-out of crude oil at seabed (5-day and 20-day scenarios)						
Without mitigation	Regional	Short- to medium-term	Medium – High	Medium	Improbable	Medium
With mitigation	Regional	Short- to medium-term	Medium - High	Medium	Improbable	Medium
Fisheries Research						
Impact of oil spill: Small instantaneous oil spill						
Without mitigation	Local	Short-term	Low	Very Low	Probable	Medium
With mitigation	Local	Short-term	Low	Very Low	Probable	Medium
Impact of oil spill: Large blow-out of crude oil at seabed (5-day and 20-day scenarios)						
Without mitigation	Regional	Short- to medium-term	Medium – High	Medium	Improbable	Medium
With mitigation	Regional	Short- to medium-term	Medium - High	Medium	Improbable	Medium

6. CONCLUSIONS AND RECOMMENDATIONS

Potential impacts related to normal drilling operations
Impacts could include cessation or temporary displacement of fishing activities during the proposed drilling operations. It is highly probable that the proposed well-drilling operations would negatively affect fishing operations of the large pelagic long-line fishery. The impact is assessed to be of medium intensity and of overall VERY LOW significance before and after mitigation. There is NO IMPACT expected from the proposed well-drilling activities, including the possible abandonment of wellheads on the seafloor, on the demersal trawl, demersal hake-directed long-line, demersal shark-directed long-line, tuna pole, traditional line-fish and West Coast rock lobster inshore and offshore fisheries. There is also NO IMPACT expected on the current demersal research biomass surveys conducted on a bi-annual basis by DAFF.

The following mitigation measures are proposed:

- Industry bodies (specifically the pelagic long-line fishery) and other key Interested and Affected Parties (I&APs) should be notified of the proposed drilling activities and requirements with regards to the safe operational limits around the drilling unit prior to the commencement of the project. Specific industrial bodies that need to be notified include:
  - Department of Agriculture, Forestry and Fisheries (DAFF);
  - the Department of Environmental Affairs (DEA);
  - the South African Tuna Association (SATA);
  - the South African Tuna Long-Line Association (SATLA);
  - Fresh Tuna Exporters Association (FTEA);
  - the South African Deep-Sea Trawling Industry Association;
  - Transnet National Ports Authority (ports of Cape Town and Saldanha Bay); and
  - the South African Maritime Safety Association (SAMSA).
- Daily Navigational Warnings should be issued for the duration of the drilling operations through the South African Naval Hydrographic Office.
- Any fishing vessel targets at a radar range of 24 nautical miles from the drilling unit should be called via radio and informed of the safety requirements around the drilling unit.
- Notify industry bodies and other key I&APs when drilling in complete and the drilling unit is off location.

In historically trawled areas that occurred predominantly on the shelf in waters shallower than 500 m water depth, the trawling industry has objected to (and requested the removal of) abandoned wellheads and other structures associated with oil and gas development). However, in the proposed area of interest, which is located beyond the 1 500 m water depth, there are no known records of bottom trawling. Although the expansion of trawling into waters deeper than the current depths fished (approximated from 1000 m and shallower) is uncertain, it is unlikely that trawling effort would move into areas as deep as 1 500 m (noting that the technology exists to trawl to these depths and that such activity if targeting deep water species, would require approval from the national fisheries management authority). Thus it is anticipated that there would be no long-term impact on the demersal trawl sector. This said, there could still be some industry resistance to the abandonment of the wellheads on the seafloor.

Potential impacts related to upset conditions (oils spills)
Based on the results of the oil spill modelling a small, instantaneous oil spill (1 ton of hydraulic fluid or 10 tons of diesel) during drilling operations would have a short-term effect, local impact of low intensity and overall VERY LOW significance before and after mitigation on all fisheries sectors. The likelihood of the impact occurring is probable and the confidence in the assessment is medium.

A 5-day or 20-day large blowout oil spill would be predicted to have a short- to medium-term impact of a regional extent on all fisheries sectors. The impact on the large pelagic long-line and tuna pole sectors would be expected to be of medium intensity and of overall LOW significance before and after mitigation. The impact on the demersal trawl, demersal hake- and shark-directed long-line, traditional line-fish, west coast rock lobster and demersal research sectors would be expected to be of medium to high intensity and of overall MEDIUM significance before and after mitigation. The impact on the small pelagic purse-seine fishery would be expected to be of high intensity and of overall HIGH significance before and after mitigation. The likelihood of the large blowout oil spills occurring is improbable and the confidence in the assessment is medium.

It is recommended that an oil spill contingency plan is in place at all times to ensure that spills can be effectively handled.

Table 6. Impact assessment summary

	Probability	Significance	
		(before mitigation)	(after mitigation)
Impact of related to normal exploration drilling activities			
Large Pelagic Long-line	Highly Probable	Very Low	Very Low
Demersal Trawl	No Impact		
Demersal Hake-directed Long-line	No Impact		
Demersal Shark-directed Long-line	No Impact		
Tuna Pole	No Impact		
Traditional Linefish	No Impact		
Small Pelagic Purse-Seine	No Impact		
West Coast Rock Lobster	No Impact		
Fisheries research	No Impact		
Impact of a small instantaneous oil spill			
Large Pelagic Long-line	Probable	Very Low	Very Low
Demersal Trawl	Probable	Very Low	Very Low
Demersal Hake-directed Long-line	Probable	Very Low	Very Low
Demersal Shark-directed Long-line	Probable	Very Low	Very Low
Tuna Pole	Probable	Very Low	Very Low
Traditional Linefish	Probable	Very Low	Very Low
Small Pelagic Purse-Seine	Probable	Very Low	Very Low
West Coast Rock Lobster	Probable	Very Low	Very Low
Fisheries research	Probable	Very Low	Very Low
Impact of a large blow-out of crude oil (5-day and 20-day scenarios)			
Large Pelagic Long-line	Improbable	Low	Low
Demersal Trawl	Improbable	Medium	Medium
Demersal Hake-directed Long-line	Improbable	Medium	Medium
Demersal Shark-directed Long-line	Improbable	Medium	Medium
Tuna Pole	Improbable	Low	Low
Traditional Linefish	Improbable	Medium	Medium
Small Pelagic Purse-Seine	Improbable	High	High
West Coast Rock Lobster	Improbable	Medium	Medium
Fisheries research	Improbable	Medium	Medium

7. REFERENCES

Atkinson, L. and K. Sink. User profiles for the South African offshore environment. South African National Biodiversity Institute. Biodiversity Series 10 (2008).

Fishing Industry Handbook 2011; South Africa, Namibia and Moçambique 39th Edition. George Warman Publications

Mann, B.Q. 2000. Southern African Marine Linefish Status Reports. Oceanographic Research Institute Special Publication, Durban.

Hutchings, L., Beckley, L.E., Griffiths, M.H., Roberts, M.J., Sundby, S and C. van der Lingen. 2002. Spawning on the edge: spawning grounds and nursery areas around the southern African coastline. *Mar. Freshwater Res.*, 2002, **53**, 307–318

Sauer, W.H.H., Hecht, T., Britz, P.J. and Mather, D. 2003. An economic and sectoral study of the South African Fishing Industry, vol. 2: fishery profiles. Report prepared for Marine and Coastal Management by Rhodes University.

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APPENDIX 1: CONVENTION FOR ASSIGNING SIGNIFICANCE RATINGS TO IMPACTS

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

1 Extent;
2 Duration;
3 Intensity;
4 Significance;
5 Status of impact;
6 Probability; and
7 Degree of confidence.

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

1. The core criteria for determining significance ratings are “extent” (Section 1), “duration” (Section 2) and “intensity” (Section 3). The preliminary significance ratings for combinations of these three criteria are given in Section 4.

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

3. Describe the impact in terms of the probability of the impact occurring (Section 5) and the degree of confidence in the impact predictions, based on the availability of information and specialist knowledge (Section 6).

4. Additional criteria to be considered, which could “increase” the significance rating if deemed justified by the specialist, with motivation, are the following:

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

5. Additional criteria to be considered, which could “decrease” the significance rating if deemed justified by the specialist, with motivation, are the following:

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

6. When assigning significance ratings to impacts *after mitigation*, the specialist needs to:

    - First, consider probable changes in intensity, extent and duration of the impact after mitigation, assuming effective implementation of mitigation measures, leading to a revised significance rating; and
    - Then moderate the significance rating after taking into account the likelihood of proposed mitigation measures being effectively implemented. Consider:

        - o Any potentially significant risks or uncertainties associated with the effectiveness of mitigation measures;
        - o The technical and financial ability of the proponent to implement the measure; and

- o The commitment of the proponent to implementing the measure, or guarantee over time that the measures would be implemented.

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

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

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

EXTENT

“Extent” defines the physical extent or spatial scale of the impact.

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

DURATION

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

Rating	Description
SHORT TERM	0 - 5 years
MEDIUM TERM	6 - 15 years
LONG TERM	Where the impact would cease after the operational life of the activity, either because of natural processes or by human intervention.
PERMANENT	Where mitigation either by natural processes or by human intervention would not occur in such a way or in such time span that the impact can be considered transient.

INTENSITY

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

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

SIGNIFICANCE

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

Rating	Description
VERY HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***long term***; OR of ***high intensity*** at a ***national level*** in the ***medium term***; OR of ***medium intensity*** at a ***national level*** in the ***long term.***
HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***high intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***medium term;*** OR of ***low intensity*** at a ***national level*** in the ***long term***; OR of ***high intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***regional level*** in the ***long term.***
MEDIUM	Impacts could be EITHER: of ***high intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***medium intensity*** at a ***regional level*** in the ***medium term***; OR of ***high intensity*** at a ***regional level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***local level*** in the ***long term***; OR of ***low intensity*** at a ***national level*** in the ***medium term;*** OR of ***low intensity*** at a ***regional level*** in the ***long term.***
LOW	Impacts could be EITHER of ***low intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***national level*** in the ***short term***; OR of ***high intensity*** at a ***local level*** and endure in the ***short term***; OR of ***medium intensity*** at a ***regional level*** in the ***short term***; OR of ***low intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***local level*** and endure in the ***medium term.***
VERY LOW	Impacts could be EITHER of ***low intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***regional level*** and endure in the ***short term***; OR of ***low to medium intensity*** at a ***local level*** and endure in the ***short term.***
INSIGNIFICANT	Impacts with:

Rating	Description
	Zero to very low intensity with any combination of extent and duration.
UNKNOWN	In certain cases it may not be possible to determine the significance of an impact.

STATUS OF IMPACT

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

PROBABILITY

"Probability" describes the likelihood of the impact occurring.

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

DEGREE OF CONFIDENCE

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

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