Borders & Southern Petroleum plc

ENVIRONMENTAL IMPACT STATEMENT ADDENDUM FOR DARWIN EAST – 1 AND STEBBING – 3 OFFSHORE FALKLAND ISLANDS EXPLORATION DRILLING

(Licence PL018)

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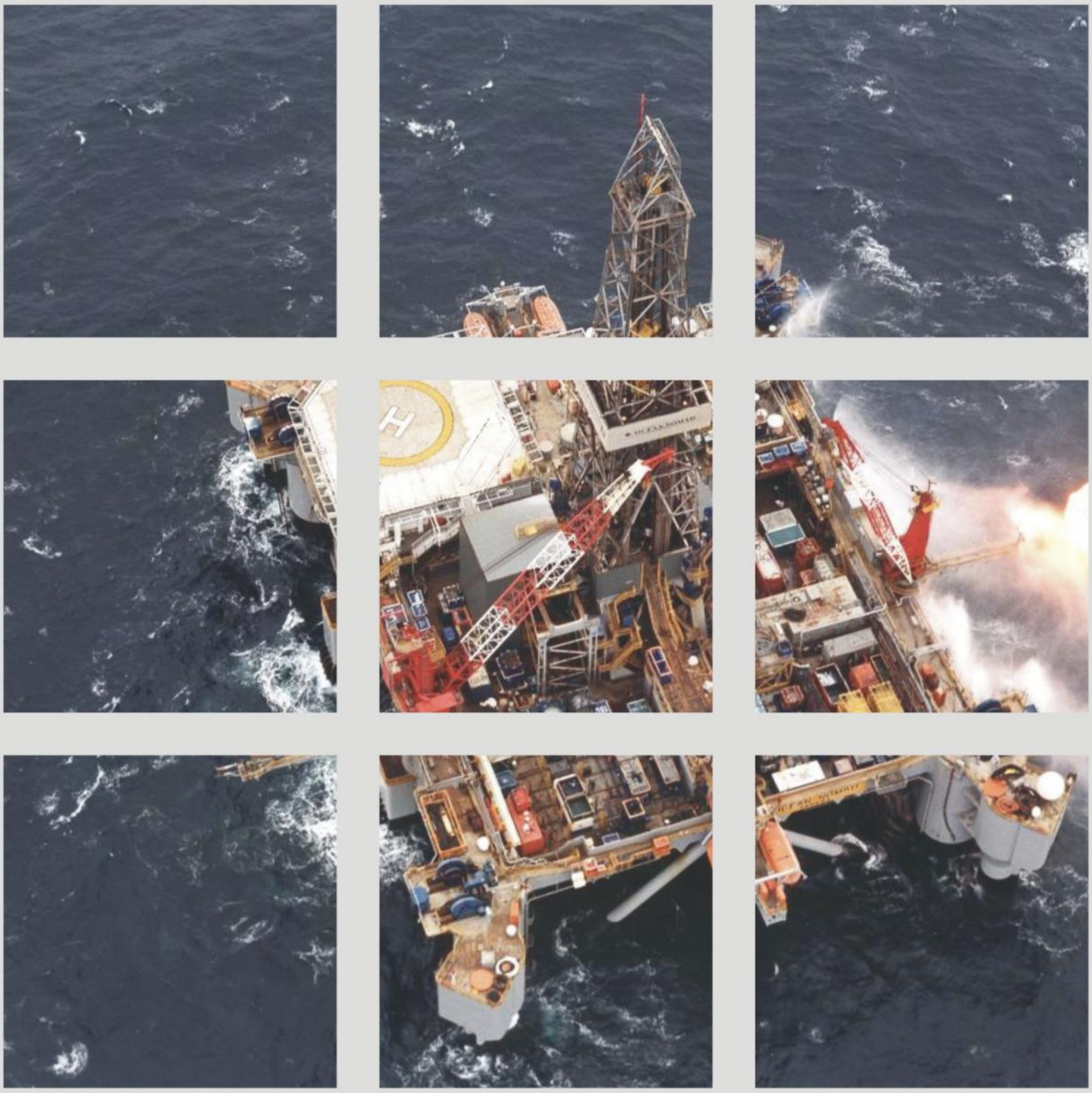

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(Licence PL018)

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September 2011

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Abbreviations

API	American Petroleum Industry
BOP	Blow out Preventor
CEFAS	Centre for Environment Fisheries and Aquaculture Science
CHARM	Chemical Hazard Assessment and Risk Management
CO_2	Carbon Dioxide
DP	Dynamically Positioned
E&P	Exploration and Production
EEM's	Environmental Emissions Monitoring System
EIS	Environmental Impact Statement
EMP	Emergency Management Plan
ERP	Emergency Response Plan
FC	Falklands Conservation
FCO	Foreign and Commonwealth Office
FICZ	Falkland Interim Conservation and Management Zone
FIG	Falkland Islands Government
FOCZ	Falkland Outer Conservation and Management Zone
HMCS	Harmonised Mandatory Control Scheme
HOCNF	Harmonised Offshore Chemical Notification Format
HQ	Hazard Quotients
HSE	Health, Safety and Environment
LAT	Lowest Astronomical Tide
LTOBM	Low Toxicity Oil Based Mud
MARPOL	International Convention for the Prevention of Pollution from Ships, 1973,
MIME	Managing Impacts on the Marine Environment
MMO	Marine Mammal Observer
MoD	Ministry of Defence
OCNS	Offshore Chemical Notification Scheme
OSPAR	Oslo / Paris Convention
OSCP	Oil Spill Contingency Plan
OSR	Oil Spill Response
PLONOR	Pose Little or No Risk to the environment
ROV	Remotely Operated Vehicle
RQ's	Risk Assessments
TD	Target Depth
TVD	Total Vertical Depth
UKOOA	United Kingdom Offshore Operators Association
WBM	Water Based Mud

Non Technical Summary

Background

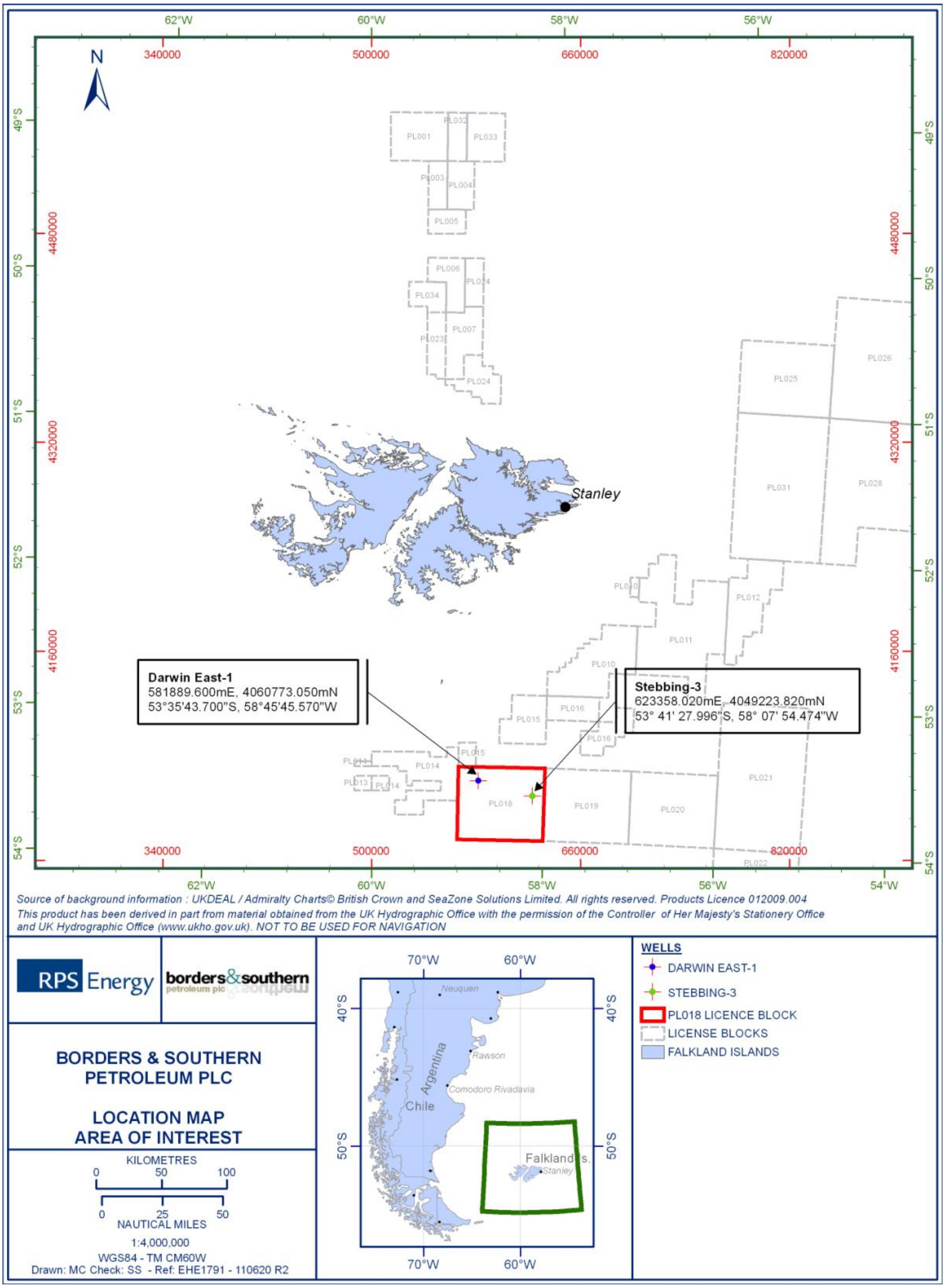
Borders and Southern Petroleum plc (Borders & Southern) is a UK based company engaged in the exploration for hydrocarbons with acreage in the Falkland Islands, a UK Overseas Territory located on the edge of the Patagonian Shelf in the South Atlantic Ocean.

Borders & Southern has been awarded Production Licences by the Falkland Islands Government for the exploration and production of oil and gas in Licences PL018, PL019, PL020, PL021 and PL022. The company holds 100% interest for five licences as a sole operator. The licence area lies approximately 150 kilometres south-east of the main Islands covering 19,598 square kilometres.

Borders & Southern has now finalised the plans for their drilling programme and contracted Ocean Rig's Leiv Eiriksson dynamically positioned fifth-generation semi-submersible drilling unit. Drilling operations are anticipated to commence in December 2011 and will last for approximately 83 days. The proposed wells are located to the south of the Falkland Islands within licence PL018. The two wells are approximately 220 kilometres south of Stanley on East Falkland (refer to Figure 1).

In 2010, Borders & Southern submitted an Environmental Impact Statement (EIS) for the offshore drilling of two exploration wells (Darwin East – 1 and Stebbing – 3) within the PL018 licence. The EIS was granted approval on the condition that an Operational Addendum be prepared (to include details of the drilling contractor, drilling unit, locations and proposed dates of operation) and submitted to the Falkland Islands Government (FIG) for comment prior to the commencement of the proposed drilling operations.

Figure 1 Borders & Sothern Licence Area and Well Locations



Existing Environment

The Patagonian Shelf, on which the Falkland Islands positioned, is of regional and global significance for marine resources. It comprises rich assemblages of seabirds, marine mammals, fish, squid and plankton populations.

The information contained in this EIA Addendum primarily covers the area known as the 'South Falklands Basin'. The South Falkland Basin is located within the Patagonian Shelf Large Marine Ecosystem and is located north of the Antarctic Convergence.

In order to obtain more detailed baseline information, Borders & Southern conducted environmental site surveys in 2008 / 2009 to acquire current data, water column profiles, sediment analysis, and to identify benthic habitats and geo hazards.

Water quality profiles revealed a consistent water mass throughout the region with a density related upper layer, caused by solar heating, in the surface 100 metres. Seabed salinity and temperatures were consistent at 34.7 practical salinity units and 2.3° Celsius. The maximum and average current speeds observed near the sea surface were 1 knot and 0.34 knots, respectively, and predominant direction of the currents was north-easterly.

The results of benthic survey indicated that seabed within the regional survey area showed considerable variability in sediment distributions relative to location on the Burdwood Bank or within the South Falkland Basin. The sediments ranged from sandy silts in the northwest to silty gravely sands and occasional bedrock exposure (*Benthic Solutions, 2009*).

The macrofaunal analysis revealed a community expected for the Magellan faunal area. Whilst similar to that of the Northern Boreal Region, the fauna is characterised by a low diversity in the echinoderms and a very high crustacean diversity. The overall faunal abundance and richness remained quite high and consistent throughout. A significant presence of epifaunal species was also recorded, and dominated by three major groups of cnidera, porifera, and bryozoa. The coral *Lophelia* was recorded in a couple of samples, however live tissue was only found in one specimen in one sample and as such does not represent a reef. No environmentally sensitive species or other habitats of conservational value were recorded during this regional survey (*Benthic Solutions, 2009*).

The main fisheries resources are the squid species, *Illex argentinus* and *Loligo gahi*. The existing finfish fishery targets predominantly hake, hoki, red cod and blue whiting. The Falkland Islands' Government annual Fisheries Statistics volume 11 (1997–2006) show that the area in the vicinity of the proposed exploration wells has no fishing interests for the key commercial target species. There are some significant fisheries interests northward of the Licence area PL018, which may be impacted by vessel movements to and from the proposed drilling operations. It should be noted that *Loligo gahi* and blue whiting fishing is most intense in the second half of the year between July and December.

Between February 1998 and January 2001 the Joint Nature Conservation Committee (JNCC) and Falklands Conservation (FC) conducted a 'Seabirds at Sea Survey' in the waters surrounding the Falkland Islands. Based on the results from this survey work (White et al., 2002), the following species of cetacean were recorded within the vicinity of the proposed drilling location: long-finned pilot whale, hourglass dolphin and Peale's dolphin. Additional marine mammal data has also been compiled based on the reports provided by Marine Mammal Observers (MMOs) during seismic acquisition (November 2007-February 2008) within the Borders & Southern Licence area. This data indicates the presence of a number of cetaceans, including long-finned pilot whale, hourglass dolphin, fin whale, sei whale, killer whale, Peale's dolphin, sperm whale, and a few species of blue whale, minke whale and baleen whale. Given the migratory nature of cetaceans and the fact that effort during the JNCC/FC 'Seabirds at Sea Survey' was lower to the south and east of the Falkland Islands, the possibility that other species are present in the exploration area cannot be discounted.

Little is known of the at-sea distribution of Falkland Islands pinnipeds, and it is possible that South American sea lions, South American fur seals and southern elephant seals may be present within the vicinity of the proposed well locations during the drilling period (November 2011 – July 2012) in low numbers. It should be noted, however, that both proposed wells are located some distance from the known seal haul-out sites.

The Falkland Islands are an area of global importance for birdlife, particularly seabird species. Of the penguin species recorded in the Falkland Islands, only Southern rockhopper penguins, king penguins and Magellanic penguins have been observed at significant distance from the Falkland Islands and may therefore be present during the proposed drilling period (November 2011 – July 2012) in the vicinity of the exploration wells. It is possible that a number of albatross species will be present in the vicinity of the proposed wells. Petrels and shearwaters known to be present in the Licence area include blue petrel , Kerguelen petrel, atlantic petrel, prion species, sooty shearwater and diving petrel; although none of these species are considered to be present in significant numbers.

The proposed exploration wells are located away from the identified areas of highest seabird vulnerability. Highest vulnerability tends to be associated with the inshore waters around the Falklands Islands, largely due to the presence of resident species with a predominantly coastal distribution such as the endemic Falklands steamer duck, imperial shag and gentoo penguin. The Patagonian Shelf waters to the north and west of the Falklands, which support high densities of black-browed albatrosses and royal albatrosses year-round are also associated with high vulnerability areas, but again these are remote from the proposed drilling locations. Seabird vulnerability in the vicinity of the proposed exploration wells is medium over between November 2011 and July 2012).

The wide range of species present in the Falklands Island and the varying seasonal and temporal distributions coupled with the difficulty of open-ocean surveying presents a challenge in understanding the full extent of the interactions between birds and exploration activity.

There are a number of protected National Nature Reserves (NNR) and internationally Important Bird Areas (IBAs) on the southern coast of Falkland Islands. The closest of these to the proposed exploration wells are Beauchêne Island, located approximately 80 kilometres to the east-north-east and Sea Lion Islands, located approximately 130 kilometres to the north-east from the Darwin East well. Both of the islands are designated NNRs and IBAs.

Impacts and Management Measures

The results of the impact assessment indicate that impacts from the drilling operation will be low and probably undetectable shortly after drilling is completed. There are environmental risks associated with drill cuttings disposal, the risk of large offshore and near-shore oil spills, waste disposal and use of resources (i.e. fuel and potable water). However, these risks can be controlled using standard drilling practices and good planning.

The potential impacts of the proposed drilling activity will be mitigated in a number of ways, including:

- Maintaining a spirit of openness and ongoing consultation with the Falkland Islands Government (FIG), the public and key stakeholders;
- Applying established UK standards to operations, particularly in offshore chemical use and emissions reporting;
- Using water based drilling muds and low toxicity chemicals approved under the UK Offshore Chemical Notification Scheme.
- Implementing a high level of environmental management offshore and applying environmental procedures for potentially impacting operations (chemical storage, bunkering, waste handling, maintenance programmes, seafloor surveys etc);
- Establishing and implementing a project specific Oil Spill Contingency Plan and carrying out training of key personnel in spill response. Borders & Southern are members of Oil Spill Response which provide outside assistance in the case of a major spill. The Oil Spill Contingency Plan will be submitted to FIG for approval prior to commencement of the drilling operations.
- Implementing a Waste Management Plan to minimise the quantity of waste going to landfill, prevent unsuitable disposal of waste, maximise the re-use of materials and establish procedures for the storage, treatment, transfer and disposal of waste materials. It is envisaged that normal waste will be disposed of on the Falkland Islands with hazardous

waste likely to be exported to the UK, Chile or Uruguay. Specific waste handling/disposal routes and procedures will be detailed in the Waste Management Plan, to be submitted to FIG for approval prior to commencement of the proposed drilling operations.

- Collecting and sharing environmental data wherever possible, for example in offshore sightings, seabed surveys and meteorological and oceanographic conditions.

Conclusions

In conclusion, despite the high sensitivity and international importance of the Falkland Islands' waters, there is clear dedication to carrying out these operations to a high environmental standard. Given the current operational commitments and proposed mitigation measures it is considered that the proposed drilling operations can be undertaken without significant risks to the Falkland Islands' environment.

1 Introduction

1.1 Document Objective

This document constitutes the Operational Addendum to the following Borders & Southern Falkland Islands Offshore Drilling Environmental Impact Statement (EIS):

- Borders & Southern Petroleum Plc Offshore Falklands Island Exploration Drilling Environmental Statement (Licence PL018), submitted February 2010.

The EIS has been approved by the Falkland Islands Government (FIG) pending the submission of an Operational Addendum to provide further details on the drilling programme, which were unknown when the EIS was produced.

Borders & Southern has now finalised their drilling programme and contracted Ocean Rig's *Leiv Eiriksson* a fifth generation, harsh environment,dynamically positioned semi submersible drilling rig. It is planned to drill up to two exploration wells within PL018, the Darwin East – 1 and the Stebbing - 3. Drilling operations are anticipated to commence in December 2011. It is estimated that the rig will be on location for 38 days at Darwin East – 1 and 46 Days at Stebbing – 3.

The location of the proposed exploration wells is shown in Figure 1.

This Operational Addendum has been produced by RPS Energy on behalf of Borders & Southern to meet the FIG condition. As such, it aims to:

- Provide details of the drilling contractor, drilling rig, location and number of wells to be drilled and the proposed dates of operation;
- Assess seasonal sensitivities within the vicinity of the licence areas at the time of the proposed drilling operations;
- Review and update the impact assessment to identify the environmental hazards, effects and mitigation measures;
- Detail the project Environmental Management Plan (EMP), with particular emphasis on waste management and resource use.

1.2 The Applicant

Borders & Southern Petroleum plc is a UK based company engaged in the exploration of hydrocarbons. Its current area of activity is in the Falkland Islands, located in the South Atlantic.

In May 2005 the Company was listed on the Alternative Investment Market (AIM) of the London Stock Exchange.

Borders & Southern currently hold five licences in the South Falklands Basin. Borders & Southern is the designated operator for the proposed drilling campaign and is therefore ultimately responsible for all operations. All operations will be undertaken by contractors under Borders and Southern's management and oversight.

1.3 Contact Address

Any questions, comments or requests for additional information regarding this EIS should be addressed to:

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2 The Proposed Drilling Programme

2.1 Overview

Borders and Southern is planning to drill two exploration wells in the South Falkland Basin to explore for hydrocarbons and appraise reservoir characteristics. The well locations are shown in Figure 2.1. Darwin East – 1 is the first of the wells to be drilled in the programme, with an anticipated spud date of 15th December 2011. The rig will then move to the Stebbing 3 location which has an anticipated spud date of 20th January 2012.

Since submission of the EIS, Borders & Southern has contracted Ocean Rig's Leiv Eiriksson dynamically positioned fifth-generation semi-submersible rig to drill the proposed Darwin East-1 and Stebbing-3 exploration wells. The rig is due to be mobilised to the Falkland Islands in October 2011 following the completion of its operations in Greenland.

Following drilling, the wells will be logged and evaluated. On completion, the wells will be plugged and abandoned in accordance with Oil & Gas UK guidelines. No equipment will be left on the seabed and there will be no evidence of drilling operations having been undertaken.

The key characteristics of each well are summarised in Table 2.1. Following drilling the wells will be logged and evaluated. No well testing or well cleanup operations are planned at either well. On completion, the wells will be plugged and abandoned in accordance with Oil and Gas UK guidelines (refer to Section 2.7 for further details). No equipment will be left on the seabed and there will be no evidence of drilling operations having been undertaken.

The remainder of this section provides a summary of the proposed drilling operations for the Darwin East-1 and Stebbing-3 exploration wells. Extensive reference has been made to Section 4 of the Borders & Southern Offshore Falkland Islands Exploration Drilling (Licence PL018) EIS.

Figure 2.1 Borders & Southern Licence Areas and Proposed Exploration Well Locations

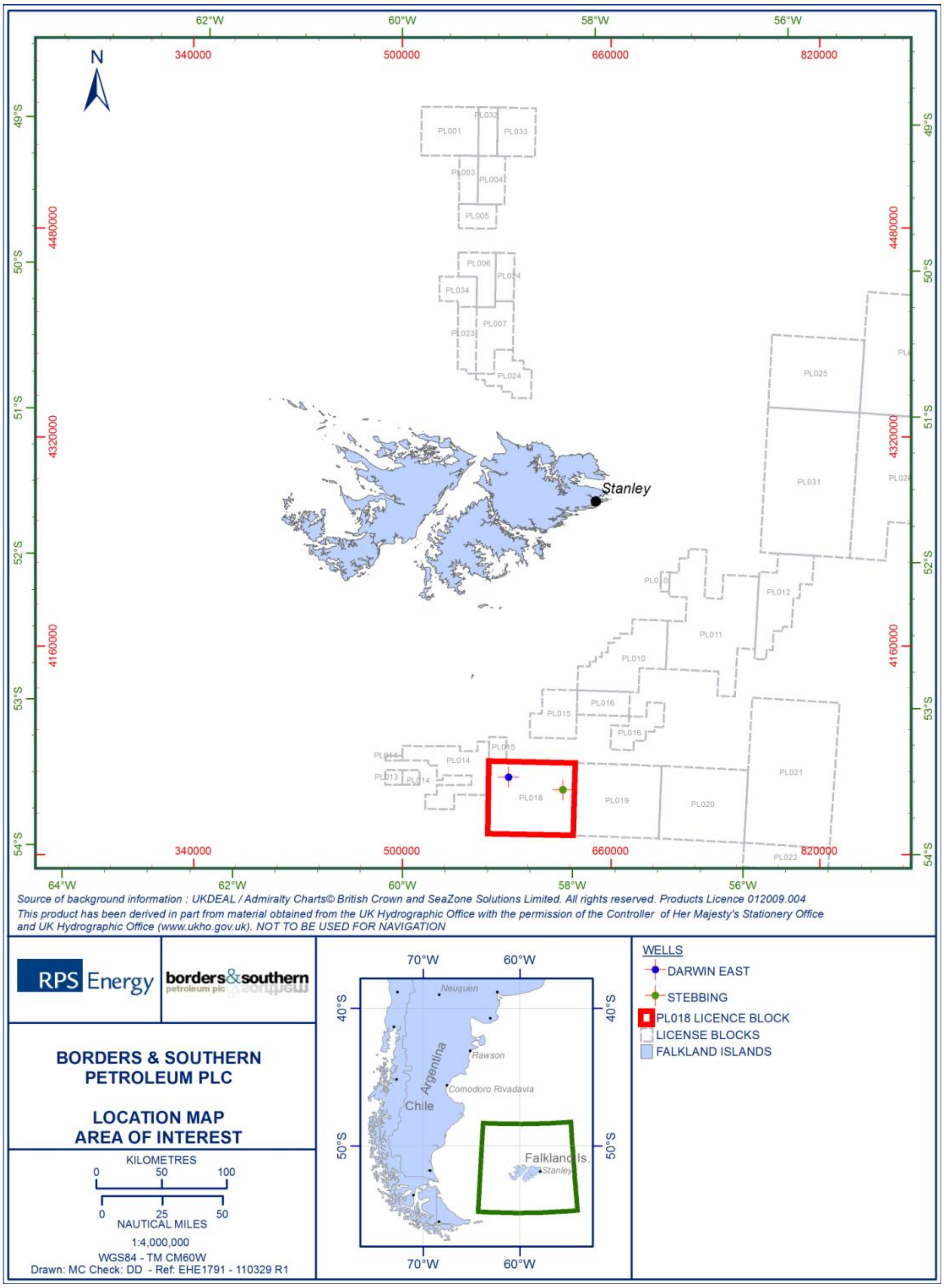


Table 2.1 Proposed Well Characteristics

Aspect	Well	
	Darwin East - 1	Stebbing - 3
License Block	PL018	PL018
Well Number	61/17 - 1	61/25-1
Well Type	Exploration	Exploration
Anticipated Drilling Location	53° 35' 43.70" S, 58 ° 45' 45.57" W	53° 41' 27.996" S 58 °.07' 54.474" W
Nearest Landfall	150 kilometres	170 kilometres
Anticipated Drill Rig	The Ocean Rig *Leiv Eiriksson* semi submersible	The Ocean Rig *Leiv Eiriksson* semi submersible
Support Location	Port of Stanley	Port of Stanley
Water Depth (metres)	2,012 (6,601 feet)	1,595 (5,232 feet)
Vertical Depth of Well	4,850 metres (15,912 feet)	3,998 metres (13,116 feet)
Measured Depth of Well	4,876 metres (15,997 feet)	4,245 metres (13,927 feet)
Anticipated Spud date	15th December 2011	20th January 2012
Estimated time to reach TD	27	34
Clean-up and Well Test	None planned	None planned
Total days on location	38	45
Hydrocarbons Anticipated	Oil and gas, Av. 32° API	Oil and gas, Av. 25° API
Anticipated Weight of Cuttings (tonnes)	1674.06	944.61

2.2 Proposed Project Schedule

It is anticipated that The Ocean Rig *Leiv Eiriksson* dynamically positioned semi-submersible rig will be on location for 38 and 45 days at the Darwin East – 1 and Stebbing – 3 wells, respectively. The earliest anticipated spud date for the Darwin East – 1 well is 15th December 2011 and for the Stebbing – 3 well is 20th January 2012.

No well testing or cleanup operations are planned at either well.

2.3 The Drilling Rig

The proposed Darwin East – 1 and Stebbing – 3 exploration wells will be drilled by The Ocean Rig *Leiv Eiriksson* dynamically positioned semi-submersible rig (Figure 2.2).

Figure 2.2 The Ocean Rig 'Leiv Eiriksson dynamically positioned semi-submersible rig' (Ocean Rig, 2010)

Further details on The Ocean Rig *Leiv Eiriksson* dynamically positioned semi-submersible rig are provided in Appendix C and are also summarised below in Table 2.2.

Table 2.2 Rig Features and Specifications for The Ocean Rig Leiv Eiriksson semi-submersible drilling rig

Feature	Specification
Rig Type	Dynamically positioned Semi-submersible
Rig Design	Trosvik Bingo 9000
Year Built	2001
Yard Built	Dalian New Shipyard, China – baredeck Oufitted Friede Goldman Offshore, USA
Class	DP Class 3 DnV +1A1 Column Stabilised Drilling Unit (N) DYNPOS AUTRO, HELDK SH, CRANE, F-AM, DRILL
Safety Case	Norwegian AoC (SUT) and UK
Water Depth	7,500 ft (2,286 metres)
Dimensions	391.68 ft by 278.88 ft

Feature	Specification
Drilling Draft	77.9 ft
Transit Speed	6 – 7 knots
Variable Deckload Operating	7,222 mt
Variable Deckload Transit	6,534 mt
Number of Columns	6
Operating Displacement	53,393 mt
Mud Capacity	1,657 m^3
Bulk Mud / Cement Capacity	350 m^3
Bulk Cement Capacity	350 m^3
Drill Water Capacity	1,960 m^3
Potable Water Capacity	1,155 m^3
Fuel Oil Capacity	4,631 m^3
Base Oil Capacity	406 m^3
Brine Capacity	680 m^3
Drawworks	Continental Emsco Electrohoist III, 3000 hp
Derrick	Hydralift 170 ft by 40 ft by 40 ft 680 mt
Top Drive	Hydralift HPS 750 2E AC Electric Drive
Pipe Handling System	Hydralift
Fwd and Aft System	Hydralift
Rotary	Varco BJ RSTT 60 ½ inch
Mud Pumps	3 x Continental Emsco FC-2200HP, 7,500 psi
Main Engines	6 x Wartsila 18V32 diesel engines (total 61,200 hp)
Generators	6 x ABB ASG 900 XUB generators (total 43,800 kW)
Propulsion	6 x Rolls Royce UUC 7001 fixed pitch variable speed thrusters
BOP	Cameron 18 ¾ inch, 15,000 psi, H_2S service Annulars: 2 each; 10,000 psi BOP Rams: 4 each; 15,000 psi
Diverter	Vetco KFDS-CSO-500
Riser Tensioner	6 x Hydralift (Total Capacity 1,089 mt)
Motion Compensators	Hydralift 800-25 Passive/Active Crown Mounted Compensator
Crane	2 x Hydralift WOMCVC 3447; 75 mt
Accommodation	120 berths and hospital
Helideck	EH 101 Helicopter (D = 22.8 metres)
Life Saving Equipment	4 x 70-person lifeboats 1 x Man Over-Board (MOB) boat Escape chute system (Selantic) with 8 life rafts (total capacity 240 men)

2.4 Well Construction

Details on well construction are provided within Section 4.4.3 of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018) (pages 4-3 to 4-8). Since submission of the EIS, the well designs for Darwin East-1 and Stebbing-3 have now been finalised resulting in some minor alterations to the section lengths and casing sizes.

Wells are drilled in sections, with the diameter of each section decreasing with increasing depth. During the drilling of the upper well sections the drill string (also called drill pipe) and drill bit are typically left open to the seawater. However, before drilling lower sections of the well, a casing is run and cemented in the well and riser is used between the rig and the seabed with the drill string passing through the riser (from seabed back to rig) and the casing (below seabed).

Once the casing has been run, the drilling fluid can be returned to the rig, in the space (or annulus) between the drill string and the casing / open hole and back up the riser to the rig. The lengths and diameters of each section of the wells have been determined prior to drilling and are dependent on the geological conditions through which the well is to be drilled.

2.4.1 Darwin East-1

The proposed Darwin East-1 will be drilled to a total depth of 2,838 metres below mud line.

42 inch Hole with 36 inch Casing

Once the rig has been installed at the proposed location, a 42 inch hole will be drilled to approximately 70 metres below mud line. This section will be drilled with seawater and viscous sweeps. A 36 inch x 30 inch casing will then be run and cemented in place to provide structural integrity for the well.

26 inch Hole with 20 inch Casing

A 26 inch hole will be drilled vertically to approximately 990 metres below mud line, using seawater and viscous sweeps. A 20 inch casing string will be run and cemented in place.

17½ inch Hole with 13⅜ inch Casing

A 17½ inch hole will be drilled vertically to approximately 2,190 metres below mud line, using Ultradrill WBM with density ranging between 9.0 – 10.0ppg. A 13⅜ inch casing string will be run and cemented in place.

12¼ inch Hole to TD

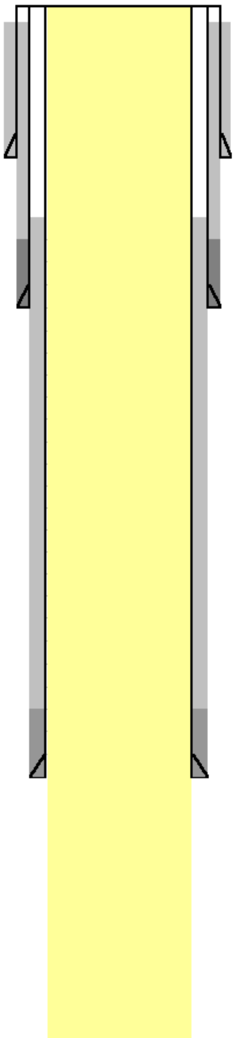
A 12¼ inch hole will be drilled vertically to approximately 2,838 metres below mud line, using partially inhibited Ultradrill WBM with density ranging between 10.0 – 11.0ppg. A full wireline formation evaluation programme will then be undertaken.

Table 2.3 Proposed Well Profiles

Darwin East – 1 Well Profile

Hole Size (Inches)	Hole size diameter (m)	Casing Size (Inches)	Section Length in metres (Measured Depth)	Proposed Mud Use
			Metres	
42	1.0668	36	71	Seawater + Bentonite Sweeps
26	0.660	20	917	Seawater + Bentonite Sweeps
17½	0.444	$13^{3}/_{8}$	1200	WBM
12¼	0.311	$9^{5}/_{8}$	650	WBM
	Total		2,838	

Figure 2.3 Proposed Darwin East -1 Well Schematic

DEPTH (m MDBRT)	DEPTH (m TVDSS)	DOWNHOLE SCHEMATIC	DESCRIPTION	Max OD (inch)	Min ID (inch)
2035	2009		Wellhead +/- 3m above seabed		
2038	2012		Seabed		
			TOC 30" - seabed		
2109	2083		36" Conductor Shoe	36.000	32.000
			TOC 20" - seabed		
			TOC 13 3/8" - 2700m		
3026	3000		20" Surface Casing Shoe	20.000	18.750
4226	4200		13 3/8" Casing Shoe	13.375	12.250
			Open Hole	12.250	
4876	4850		Total Depth		

2.4.2 Stebbing – 3

The proposed Stebbing – 3 will be drilled to a total depth of 2,624 metres below mud line.

42 inch Hole with 36 inch Casing

Once the rig has been installed at the proposed location, a 42 inch hole will be drilled to approximately 70 metres below mud line. This section will be drilled with WBM. A 36 inch x 30" inch casing will then be run and cemented in place to provide structural integrity for the well.

26 inch Hole with 20 inch Casing

A 26 inch hole will be drilled to approximately 500 metres below mud line, using WBM. A 20 inch casing string will be run and cemented in place.

17½ inch Hole with 13⅜ inch Casing

A 17½ inch hole will be drilled vertically to approximately 770 metres below mud line, using Bentonite WBM with density of around 9.0ppg. A 13⅜ inch 3/8" casing string will be run and cemented in place.

12¼ inch Hole with 9⅝ inch Casing

A 12¼ inch hole will be drilled to approximately 1,380 metres measured depth below mud line, using partially inhibited Ultradrill WBM with density ranging between 9.5 – 9.8ppg. This section will build to a tangent angle of 31 degrees on an azimuth of 181 degrees. A wireline formation evaluation programme will be undertaken across the 490 reservoir. A 9⅝ inch casing string will be run and cemented in place.

8½ inch Hole to TD

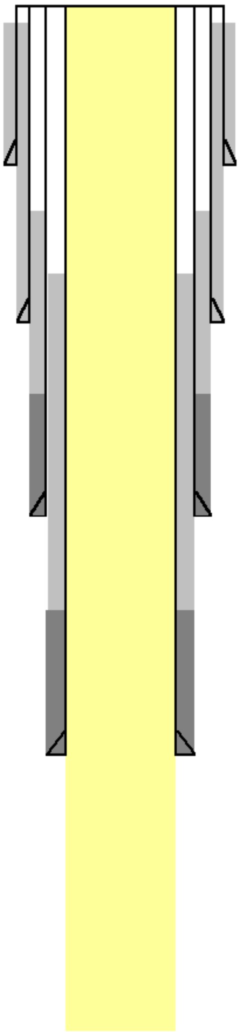
An 8½ inch hole will be drilled, maintaining tangent angle of 31 degrees to a total measured depth of 2,630 metres below mud line, using partially inhibited Ultradrill WBM with density ranging between 9.8 – 10.3ppg. A wireline formation evaluation programme will be undertaken across the 500 and 620 reservoirs.

Table 2.4 Proposed Well Profiles

Stebbing – 3 well Profile

Hole Size diameter (Inches)	Hole size diameter (m)	Casing Size (Inches)	Section Length in metres (Measured Depth) Metres	Proposed Mud Use
42	1.0668	36	47	Seawater + Bentonite Sweeps
26	0.660	20	458	Seawater + Bentonite Sweeps
17.5	0.444	13 $^{3}/_{8}$	264	WBM
12.25	0.311	9 $^{5}/_{8}$	606	WBM
8.5	0.216	-	1249	WBM
Total			2,624	

Figure 2.4 Proposed Stebbing – 3 Well Schematic

DEPTH (m MDBRT)	DEPTH (m TVDSS)	DOWNHOLE SCHEMATIC	DESCRIPTION	Max OD (inch)	Min ID (inch)
1618	1592		**Wellhead +/- 3m above seabed**		
1621	1595		**Seabed**		
			TOC 30" - seabed		
1668	1694		**36" Conductor Shoe**	36.000	32.000
			TOC 20" - seabed		
			TOC 13 3/8" - 1800m		
2126	2100		**20" Surface Casing Shoe**	20.000	18.750
			TOC 9 5/8" - 2050m TVDSS		
2390	2364		**13 3/8" Casing Shoe**	13.375	12.250
2996	2928		**9 5/8" Casing Shoe**	9.625	8.500
			Open Hole		
4245	3998		**Total Depth**	8.500	

2.5 Disposal of Drill Cuttings

The top two hole sections for the proposed wells will be drilled open to the seabed and the cuttings generated whilst doing so will be will be swept out of the hole using seawater. These will be deposited around the well bore. For subsequent sections, the wells will be cased and drilled using a riser whilst circulating drilling mud to remove cuttings, to condition the well bore and provide weight down the hole.

Whilst drilling the wells, a riser will be set between the wellhead and the rig, with a blow-out preventer (BOP) fitted on the seabed near the bottom of the riser. The mud and cuttings will be returned to the rig where they will pass through the rigs cleaning system. This reduces the amount of drilling fluid retained on the cuttings to between 5 and 10 percent. The cuttings will be cleaned to the required specification and discharged to the sea. The cuttings are variously sized particles of rock cut from the strata as the drill bit progresses down the well bore and will be comprised of sedimentary rock.

Estimated amounts of cuttings that will be generated for the proposed exploration wells are detailed in Table 2.4.

Table 2.4 Estimate of Cuttings Generated for the Proposed Wells

Darwin East – 1

Hole Size diameter (in)	Hole size diameter (m)	Length (m)	Volume (cu m)	Weight (tonnes)
42	1.0668	71	61.75	173.25
26	0.660	917	313.85	857.51
17.5	0.444	1,200	185.87	508.37
12.25	0.311	650	49.4	134.93
8.5	0.216	550	20.16	54.97
			Total cuttings	1674.06
			Discharged at Seabed	1030.76
			Discharged at Surface	**643.30**

Stebbing – 3 Well

Hole Size (in)	Hole size diameter (m)	Length (m)	Volume (cu m)	Weight (tonnes)
42	1.0668	73	63.49	178.13
26	0.660	432	139.41	403.98
17.5	0.444	264	40.90	111.84
12.25	0.311	606	46.05	125.80
8.5	0.216	1249	45.79	124.83
			Total cuttings	944.58
			Discharged at Seabed	362.47
			Discharged at Surface	**582.11**

Note: Weight of cuttings calculated assuming density of 2.6 tonnes per cubic metre, including a 5 percent excess over hole volume

2.6 Drilling Mud and Casing Cement

A background to the use of drilling muds is given in Appendix B. All wells will be drilled using water based mud (WBM). On the rig, the cleaned mud's composition will be monitored and its contents adjusted to ensure that its properties remains as specified and it will be recycled through the well.

The drilling mud is specially formulated for each section of the well to suit the conditions in the strata being drilled. The selection is made according to the technical requirements for the mud and the environmental credentials of the chemicals.

Once each section of the well has been drilled, the drill string is lifted and the casing is lowered into the hole and cemented into place. The cement is formulated specifically for each section of the well and contains small volumes of additives that are required to improve its performance. It is mixed into slurry on the rig and is then pumped down the string and forced up the space between the well bore and the casing. To ensure that sufficient cement is in place and that a good seal is achieved, a certain amount of extra cement is pumped and some of this will be discharged to the seabed in the immediate vicinity of the wellhead, only in cases where cementing back to seafloor surface (e.g. the upper most section of the well). Typically, the quantity discharged is less than 10 percent of the total volume used, however, in case of contingency, the quantity discharged could double.

Other contingency chemicals may be required if problems or emergencies are encountered during drilling or cementing operations.

2.7 Chemicals

Drilling offshore the Falkland Islands will follow the same model of chemical use as is required in the UK. Offshore chemical use in the UK is regulated through The Offshore Chemical Regulations 2002, which apply the provisions of the Decision by the Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention) for a Harmonised Mandatory Control System for the use and discharge of chemicals used in the offshore oil and gas industry. The Offshore Chemical Notification Scheme (OCNS) ranks chemical products according to Hazard Quotient (HQ), calculated using the CHARM (Chemical Hazard and Risk Management) model (refer to Appendix A for further information).

In the UK, the Centre for Environment, Fisheries & Aquaculture Science (CEFAS) maintains a list of chemicals under the OCNS that have been approved for use offshore for specific functions. Only chemicals on this list may be chosen for use when selecting the components of the drilling mud, cement, completion and general rig chemicals. Chemicals are therefore selected on their technical merits and are screened so that the collateral environmental effects are minimised as far as practical.

All of the planned chemicals, which Borders & Southern propose to use for the wells, appear on this Ranked List of Products approved under the OCNS. The vast majority of chemicals have an OCNS category of 'E' or have a Gold HQ band (i.e. are least toxic) and are naturally occurring products (e.g. barite) that are either biologically inert or readily dispersible or biodegradable.

Certain chemicals will be required for specific purposes on the drilling rig, for example, lubricant for the drill string threads and detergent to periodically wash rig equipment. These chemicals will be selected to minimise any environmental impact that they might otherwise have.

Tables 2.4 to 2.6 below show the planned chemicals which will be used during drilling operations for the proposed Darwin East – 1 exploration well. This well is considered worst case as the highest quantities of chemicals will be used and discharged. The chemicals used for the Stebbing – 3 well will be identical to the ones listed below, however, the use and discharge quantities may be lower.

Table 2.5 Planned Drilling Mud Components (presents worse case chemical use per well)

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
42 inch section primary chemicals					
Caustic Soda	Water based Drilling Fluid Additive	-	0.10	0.10	E
M-I BAR (All Grades)	Weighting Chemical	PLO	43.00	43.00	E
M-I GEL	Viscosifier	PLO	16.00	16.00	E
GUAR GUM	Viscosifier	PLO	0.30	0.30	E
Soda Ash	Water based Drilling Fluid Additive	PLO	0.10	0.10	E
42 inch section contingency chemicals					
Caustic Soda	Water based Drilling Fluid Additive	-	0.20	0.20	E
Citric Acid	Water based Drilling Fluid Additive	PLO	1.00	1.00	E
DUO-VIS	Viscosifier	-	1.00	1.00	GOLD
DUO-TEC	Viscosifier	-	1.00	1.00	GOLD
GUAR GUM	Viscosifier	PLO	0.60	0.60	E
LIME	OPF Additive	PLO	1.00	1.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	64.50	64.50	E
M-I GEL	Viscosifier	PLO	24.00	24.00	E
Mica	Lost Circulation Material	PLO	2.00	2.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	2.00	2.00	E
POLYPAC - All Grades	Viscosifier	PLO	2.00	2.00	E
SAND SEAL All grades	Lost Circulation Material	PLO	2.00	2.00	E
KWIK-SEAL (All Grades)	Lost Circulation Material	PLO	2.00	2.00	E
SAFE-SURF E	Defoamer (Drilling)	SUB	1.00	1.00	GOLD
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Soda Ash	Water based Drilling Fluid Additive	PLO	0.20	0.20	E
Sodium Bicarbonate	Cement or Cement Additive	PLO	2.00	2.00	E
17.5 inch section primary chemicals					
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	0.55	0.55	E
M-I BAR (All Grades)	Weighting Chemical	PLO	209.00	209.00	E
M-I GEL	Viscosifier	PLO	95.00	95.00	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
GUAR GUM	Viscosifier	PLO	3.73	3.73	E
POLYPAC - All Grades	Viscosifier	PLO	0.00	0.00	E
Soda Ash	Water based Drilling Fluid Additive	PLO	0.55	0.55	E
26 inch section contingency chemicals					
Caustic Soda	Water based Drilling Fluid Additive	-	1.10	1.10	E
Citric Acid	Water based Drilling Fluid Additive	PLO	1.00	1.00	E
DUO-VIS	Viscosifier	-	1.00	1.00	GOLD
DUO-TEC	Viscosifier	-	1.00	1.00	GOLD
GUAR GUM	Viscosifier	PLO	7.45	7.45	E
LIME	OPF Additive	PLO	1.00	1.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	313.50	313.50	E
M-I GEL	Viscosifier	PLO	142.50	142.50	E
Mica	Lost Circulation Material	PLO	2.00	2.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	2.00	2.00	E
POLYPAC - All Grades	Viscosifier	PLO	2.00	2.00	E
SAND SEAL All grades	Lost Circulation Material	PLO	2.00	2.00	E
KWIK-SEAL (All Grades)	Lost Circulation Material	PLO	2.00	2.00	E
SAFE-SURF E	Defoamer (Drilling)	SUB	1.00	1.00	GOLD
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	50.00	50.00	E
17.5 inch section primary chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	33.00	33.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	238.00	238.00	E
SAFE-CIDE	Biocide	-	0.65	0.65	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	0.00	0.00	E
DEFOAM NS	Defoamer (Drilling)	-	0.65	0.65	SUB
EMI 2224	Defoamer (Drilling)	-	0.65	0.65	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	32.80	32.80	SUB
ULTRACAP	Shale Inhibitor /	-	4.93	4.93	GOLD

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
	Encapsulator				
ULTRAFREE NS	Drilling Lubricant	-	28.20	28.20	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	6.55	6.55	E
POLYPAC - All Grades	Viscosifier	PLO	6.55	6.55	E
DUO-VIS	Viscosifier	-	3.28	3.28	GOLD
17.5 inch section contingency chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	66.00	66.00	E
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	145.50	145.50	E
M-I BAR (All Grades)	Weighting Chemical	PLO	476.00	476.00	E
SAFE-CIDE	Biocide	-	1.30	1.30	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	0.00	0.00	E
DEFOAM NS	Defoamer (Drilling)	-	1.30	1.30	SUB
EMI 2224	Defoamer (Drilling)	-	1.30	1.30	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	65.60	65.60	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	9.85	9.85	GOLD
ULTRAFREE NS	Drilling Lubricant	-	56.40	56.40	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	13.10	13.10	E
POLYPAC - All Grades	Viscosifier	PLO	13.10	13.10	E
DUO-VIS	Viscosifier	-	6.55	6.55	GOLD
DUO-TEC	Viscosifier	-	0.00	0.00	GOLD
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	1.00	1.00	E
Citric Acid	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Dyna Red Seepage Control Fiber	Fluid Loss Control Chemical	PLO	4.00	4.00	E
FORM-A-SQUEEZE	Fluid Loss Control Chemical	PLO	2.00	2.00	E
G-Seal	Lost Circulation Material	PLO	2.00	2.00	E
Guar Gum	Viscosifier	PLO	3.00	3.00	E
Koplus LL	Pipe Release Chemical	PLO	8.00	8.00	E
KWIKSEAL	Lost Circulation Material	PLO	5.00	5.00	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
LIME	OPF Additive	PLO	1.00	1.00	E
M-I GEL	Viscosifier	PLO	50.00	50.00	E
Mica	Lost Circulation Material	PLO	5.00	5.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	5.00	5.00	E
PBS PLUG 500	Fluid Loss Control Chemical	PLO	2.50	2.50	E
PBS Plug Activator	Crosslinking Chemical	PLO	1.25	1.25	E
PBS Plug Retarder	Crosslinking Chemical	PLO	0.50	0.50	E
SAFE-CARB (ALL GRADES)	Weighting Chemical	PLO	10.00	10.00	E
SAFE-SCAV HSB	Hydrogen Sulphide Scavenger	-	2.00	2.00	GOLD
SAFE-SURF E	Detergent / Cleaning Fluid	SUB	2.00	2.00	SUB
SAFE-SCAV NA	Oxygen Scavenger	PLO	1.00	1.00	E
SAND SEAL All grades	Lost Circulation Material	PLO	3.00	3.00	E
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Soda Ash	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Sodium Bicarbonate	Cement or Cement Additive	PLO	2.00	2.00	E
Sugar	Thinner	PLO	1.00	1.00	E
SUPER SWEEP	Lost Circulation Material	-	0.50	0.50	SUB
Ven Fyber 201	Lost Circulation Material	PLO	2.00	2.00	E
Sodium Chloride Powder (Salt PVD or Granular Salt)	Water based Drilling Fluid Additive	PLO	25.00	25.00	E
MEG	Gas Hydrate Inhibitor	PLO	2.00	2.00	E
METHANOL (all grades)	Gas Hydrate Inhibitor	PLO	1.80	1.80	E
12.25 inch section primary chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	15.00	15.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	50.00	50.00	E
SAFE-CIDE	Biocide	-	0.25	0.25	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	0.25	0.25	E
DEFOAM NS	Defoamer (Drilling)	-	0.25	0.25	SUB
EMI 2224	Defoamer (Drilling)	-	0.25	0.25	GOLD

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
ULTRAHIB	Shale Inhibitor / Encapsulator	-	10.00	10.00	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	1.50	1.50	GOLD
ULTRAFREE NS	Drilling Lubricant	-	10.00	10.00	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	1.25	1.25	E
POLYPAC - All Grades	Viscosifier	PLO	1.25	1.25	E
DUO-VIS	Viscosifier	-	0.75	0.75	GOLD
DUO-TEC	Viscosifier	-	0.75	0.75	GOLD
12.25 inch section contingency chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	30.00	30.00	E
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	105.00	105.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	100.00	100.00	E
SAFE-CIDE	Biocide	-	0.50	0.50	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	0.50	0.50	E
DEFOAM NS	Defoamer (Drilling)	-	0.50	0.50	SUB
EMI 2224	Defoamer (Drilling)	-	0.50	0.50	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	20.00	20.00	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	3.00	3.00	GOLD
ULTRAFREE NS	Drilling Lubricant	-	20.00	20.00	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	2.50	2.50	E
POLYPAC - All Grades	Viscosifier	PLO	2.50	2.50	E
DUO-VIS	Viscosifier	-	1.50	1.50	GOLD
DUO-TEC	Viscosifier	-	1.50	1.50	GOLD
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	1.00	1.00	E
Citric Acid	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Dyna Red Seepage Control Fiber	Fluid Loss Control Chemical	PLO	5.00	5.00	E
FORM-A-SQUEEZE	Fluid Loss Control Chemical	PLO	2.00	2.00	E
G-Seal	Lost Circulation Material	PLO	12.00	12.00	E
Guar Gum	Viscosifier	PLO	3.00	3.00	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
Koplus LL	Pipe Release Chemical	PLO	10.00	10.00	E
KWIKSEAL	Lost Circulation Material	PLO	10.00	10.00	E
LIME	OPF Additive	PLO	1.00	1.00	E
M-I GEL	Viscosifier	PLO	50.00	50.00	E
Mica	Lost Circulation Material	PLO	10.00	10.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	10.00	10.00	E
PBS PLUG 500	Fluid Loss Control Chemical	PLO	2.50	2.50	E
PBS Plug Activator	Crosslinking Chemical	PLO	1.25	1.25	E
PBS Plug Retarder	Crosslinking Chemical	PLO	0.50	0.50	E
SAFE-CARB (ALL GRADES)	Weighting Control	PLO	10.00	10.00	E
SAFE-SCAV HSB	Hydrogen Sulphide Scavenger	-	2.00	2.00	SILVER
SAFE-SURF E	Defoamer (Drilling)	SUB	4.00	4.00	SUB
SAFE-SCAV NA	Oxygen Scavenger	PLO	1.00	1.00	E
SAND SEAL All grades	Lost Circulation Material	PLO	3.00	3.00	E
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Soda Ash	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Sodium Bicarbonate	Cement or Cement Additive	PLO	2.00	2.00	E
Sugar	Thinner	PLO	1.00	1.00	E
SUPER SWEEP	Lost Circulation Material	-	0.50	0.50	SUB
Ven Fyber 201	Lost Circulation Material	PLO	2.00	2.00	E
Sodium Chloride Powder (Salt PVD or Granular Salt)	Water based Drilling Fluid Additive	PLO	25.00	25.00	E
MEG	Gas Hydrate Inhibitor	PLO	2.00	2.00	E
METHANOL (all grades)	Gas Hydrate Inhibitor	PLO	1.80	1.80	E
8.5 inch section primary chemicals (applies to Stebbing-3 only)					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	2.00	2.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	37.00	37.00	E
SAFE-CIDE	Biocide	-	0.10	0.10	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	0.00	0.00	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
DEFOAM NS	Defoamer (Drilling)	-	0.10	0.10	SUB
EMI 2224	Defoamer (Drilling)	-	0.10	0.10	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	2.40	2.40	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	0.35	0.35	GOLD
ULTRAFREE NS	Drilling Lubricant	-	2.00	2.00	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	0.48	0.48	E
POLYPAC - All Grades	Viscosifier	PLO	0.48	0.48	E
DUO-VIS	Viscosifier	-	0.23	0.23	GOLD
8.5 inch section contingency chemicals (applies to Stebbing-3 only)					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	4.00	4.00	E
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	50.00	50.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	74.00	74.00	E
SAFE-CIDE	Biocide	-	0.20	0.20	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	0.00	0.00	E
DEFOAM NS	Defoamer (Drilling)	-	0.20	0.20	SUB
EMI 2224	Defoamer (Drilling)	-	0.20	0.20	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	4.80	4.80	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	0.70	0.70	GOLD
ULTRAFREE NS	Drilling Lubricant	-	4.00	4.00	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	0.95	0.95	E
POLYPAC - All Grades	Viscosifier	PLO	0.95	0.95	E
DUO-VIS	Viscosifier	-	0.45	0.45	GOLD
DUO-TEC	Viscosifier	-	1.00	1.00	GOLD
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	1.00	1.00	E
Citric Acid	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Dyna Red Seepage Control Fiber	Fluid Loss Control Chemical	PLO	5.00	5.00	E
FORM-A-SQUEEZE	Fluid Loss Control Chemical	PLO	2.00	2.00	E
G-Seal	Lost Circulation Material	PLO	12.00	12.00	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
Guar Gum	Viscosifier	PLO	3.00	3.00	E
Koplus LL	Pipe Release Chemical	PLO	10.00	10.00	E
KWIKSEAL	Lost Circulation Material	PLO	10.00	10.00	E
LIME	OPF Additive	PLO	1.00	1.00	E
M-I GEL	Viscosifier	PLO	50.00	50.00	E
Mica	Lost Circulation Material	PLO	10.00	10.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	10.00	10.00	E
PBS PLUG 500	Fluid Loss Control Chemical	PLO	2.50	2.50	E
PBS Plug Activator	Crosslinking Chemical	PLO	1.25	1.25	E
PBS Plug Retarder	Crosslinking Chemical	PLO	0.50	0.50	E
SAFE-CARB (ALL GRADES)	Weighting Control	PLO	10.00	10.00	E
SAFE-SCAV HSB	Hydrogen Sulphide Scavenger	-	2.00	2.00	SILVER
SAFE-SURF E	Defoamer (Drilling)	SUB	4.00	4.00	SUB
SAFE-SCAV NA	Oxygen Scavenger	PLO	1.00	1.00	E
SAND SEAL All grades	Lost Circulation Material	PLO	3.00	3.00	E
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Soda Ash	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Sodium Bicarbonate	Cement or Cement Additive	PLO	2.00	2.00	E
Sugar	Thinner	PLO	1.00	1.00	E
SUPER SWEEP	Lost Circulation Material	-	0.50	0.50	SUB
Ven Fyber 201	Lost Circulation Material	PLO	2.00	2.00	E
Sodium Chloride Powder (Salt PVD or Granular Salt)	Water based Drilling Fluid Additive	PLO	25.00	25.00	E
MEG	Gas Hydrate Inhibitor	PLO	2.00	2.00	E
METHANOL (all grades)	Gas Hydrate Inhibitor	PLO	1.80	1.80	E
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	4.00	4.00	E
TOTALS:			**3290**	**3290**	

Table 2.5 Planned Cementing Chemicals (per well)

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (MT)	Estimated Discharged (MT)	HQ Band / OCNS group
Primary Chemicals					
Cement Class G D907	Cement or Cement Additive	PLO	1614.80	403.70	E
Special Deepwater Blend B2300	Cement or Cement Additive	PLO	923.79	238.46	E
Environmentally Friendly Dispersant B165	Dispersant	PLO	7.89	2.67	E
Viscosifier for MUDPUSH II Spacer B174	Viscosifier	PLO	3.59	0.90	E
Dye B275	Dye	-	0.88	0.23	GOLD
Liquid Antifoam B411	Cement or Cement Additive	-	8.59	2.15	GOLD
BARITE D31	Cement or Cement Additive	PLO	548.00	137.00	E
Silicate Additive D75	Cement or Cement Additive	PLO	26.87	6.72	E
Liquid Retarder D81	Cement or Cement Additive	PLO	1.53	0.38	E
D095 Cement Additive	Lost Circulation Material	PLO	0.73	0.20	E
Anti-settling Agent D153	Cement or Cement Additive	PLO	0.39	0.11	E
UNIFLAC L D168	Fluid Loss Control Chemical	-	26.14	6.53	GOLD
Low Temperature Dispersant D185	Cement or Cement Additive	SUB	28.04	9.39	GOLD
Low Temperature Cement Set Enhancer D186	Cement or Cement Additive	--	36.19	9.05	GOLD
AccuSET D197	Cement or Cement Additive	-	54.43	14.58	GOLD
Antifoaming Agent D206	Cement or Cement Additive	SUB	0.19	0.19	GOLD
GASBLOK LT D500	Cement or Cement Additive	SUB	60.85	34.00	GOLD
D600G GASBLOK*Gas-Migration Control Additive	Cement or Cement Additive	SUB	9.96	2.49	GOLD
TOTALS:			**3352.86**	**868.75**	

Table 2.6 Planned Rig Chemicals

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
Jet Lube NCS-30 ECF	Pipe Dope	-	0.0162	0.01219	E
Pelagic 50 BOP Fluid Concentrate	Hydraulic Fluid	-	8.19	8.19	E
Pelagic Stack Glycol V2	Other	PLO	43	43	E
Tristar Eco Rig Wash HD-E	Detergent / Cleaning Fluid	PLO	2.497	2.497	E
TOTALS:			**53.70**	**53.70**	

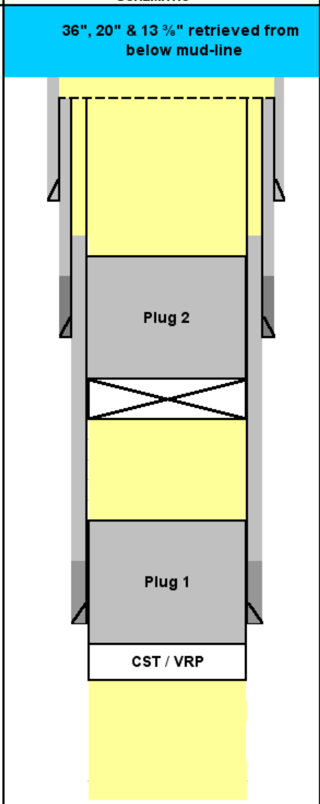
2.8 Well Clean-up & Completion

Upon completion of drilling operations electric logging tools will be run to evaluate the lithologies present and to determine the presence, type and quantities of hydrocarbons present in the target formation. Logging instruments will be attached to the bottom of a wireline and lowered to the bottom of the well. The tools are then slowly brought back up, the instruments record different physical properties of the formation and fluids present

In the event that hydrocarbons are encountered in sufficient quantities, as determined by interpretation of the wireline data, attempts to recover reservoir fluid samples will be undertaken by the use of wireline fluid sampling instruments. There are no plans to flow fluids to surface in the form of a drill stem test and therefore no flaring will be undertaken.

After evaluation, the well will be plugged and abandoned. Abandonment will be in accordance with UK Guidelines. A notional description of the abandonment procedure follows. The open hole will be cemented to seal off any hydrocarbon bearing formation. Further cement plugs will then be put inside the last casing string. Details of the exact plugging design are dependent upon the formations encountered during drilling, and the evaluation of hydrocarbon potential in these formations. Figure 2.5 and figure 2.6 provide the proposed plugging and abandonment designs for Darwin East-1 and Stebbing-3 respectively.

Figure 2.5 proposed plugging and abandonment design for Darwin East-1



DEPTH (m MDBRT)	DEPTH (m TVDSS)	DESCRIPTION	Max OD (inch)	Min ID (inch)
2038	2012	**Seabed**		
		TOC 30" Means of Verification: Visual Confirmation with ROV		
		TOC 20" Means of Verification: Dye Spacer at surface		
2109	2083	**36" Conductor Shoe**	36.000	32.000
2726	2700	TOC 13 3/8" Means of Verification: CBL		
3026	3000	**20" Surface Casing Shoe**	20.000	18.750
3926	3900	TOC 9 5/8" Means of Verification: CBL		
4226	4200	**13 3/8" Casing Shoe**	13.375	12.250
4876	4850	**TD**		

Casing Test Pressures

Casing	Pressure	MW
20"	2250psi	seawater
13.375"	3600psi	8.50ppg

Barrier Data

Number	Set From	Set To	Placement Method	Verification Method	Comments
1	4190	4040	Set Cement Support Tool or VRP	Tag and Test	500ft Permanent Barrier No. 1 to Aptian Sands and hydrocarbon bearing (assumed) 750 Reservoir
2	tbc	tbc	Set on tagged & tested Bridge Plug	Set on verified mechanical barrier	500ft Permanent Barrier - No.2 to Aptian Sands and hydrocarbon bearing (assumed) 850 reservoir. - No.1 to water bearing (assumed) sands at Base Tertiary.

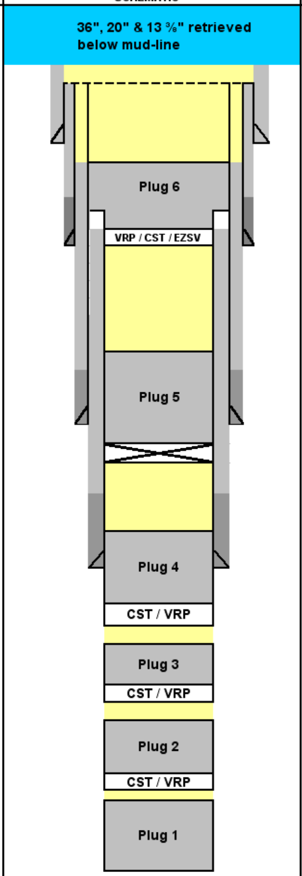
Reservoir Pressure Data

Reservoir Pressure : 8.80 - 11.3ppge

Remarks / Additional Data

The above schematic assumes a hydrocarbon bearing 750 reservoir
Plugs will be positioned such that the formation strength at the base of the plug is in excess of the potential Internal pressure.
The base for the 1st plug TBC.

Figure 2.6 proposed plugging and abandonment design for Stebbing-3



DEPTH (m MDBRT)	DEPTH (m TVDSS)	DESCRIPTION	Max OD (inch)	Min ID (inch)
1621	1595	**Seabed**		
		TOC 30" Means of verification: Visual Confirmation with ROV		
		TOC 20" Means of verfication: Dye Spacer at surface		
1668	1694	**36" Conductor Shoe**	36.000	32.000
		TOC 13 3/8" Means of Verification: CBL		
TBC	TBC	9 5/8" CUT DEPTH		
2126	2100	**20" Surface Casing Shoe**	20.000	18.750
		TOC 9 5/8" Means of Verification: CBL		
		TOC 9 5/8" - 2050m TVDSS		
2390	2364	**13 3/8" Casing Shoe**	13.375	12.250
2996	2928	**9 5/8" Casing Shoe**	9.625	8.500
4245	3998	**TD**		

Casing Test Pressures

Casing	Pressure	MW
20"	1000psi	seawater
13.375"	2000psi	9.00ppg
9.625"	4000psi	9.5ppg

Barrier Data

Number	Set From	Set To	Placement Method	Verification Method	Comments
1	tbc	tbc	TD	Weight Test	800ft Permanent Barrier No. 1 to hydrocarbon bearing (assumed) 500 - 620 Reservoir
2	tbc	tbc	Set Cement Support Tool or VRP	Weight Test	800ft Permanent Barrier No. 1 to hydrocarbon bearing (assumed) 500 - 620 Reservoir
3	tbc	tbc	Set Cement Support Tool or VRP	Weight Test	800ft Permanent Barrier No. 1 to hydrocarbon bearing (assumed) 500 - 620 Reservoir
4	tbc	tbc	Set Cement Support Tool or VRP	Tag and test	800ft Permanent Barrier No. 1 to hydrocarbon bearing (assumed) 500 - 620 Reservoir
5	tbc	tbc	Set on tagged & tested Bridge Plug	Set on verified mechanical barrier	600ft Permanent Barrier - No.2 to hydrocarbon bearing (assumed) 500 - 620 Reservoir - No. 1 to hydrocarbon bearing 490 reservoir
6	tbc	tbc	Set on tagged Bridge Plug	Tag and test	600ft Permanent Barrier - No.2 to hydrocarbon bearing (assumed) 490 reservoir.

Reservoir Pressure Data

Reservoir Pressure : 9.90 - 10.5pge (500) Reservoir
9.00 - 10.6pge (620) Reservoir
9.20 - 11.1ppge (490) Reservoir

Remarks / Additional Data

The above schematic assumes hydrocarbon bearing 490, 500 and 620 reservoirs.
Plugs will be positioned such that the formation strength at the base of the plug is in excess of the potential Internal pressure.
The base for the 2nd, 3rd, 4th and 6th plugs TBC.

2.9 Resource Use

2.9.1 Equipment and Chemicals

The remote drilling location will require sufficient materials and chemicals, equipment, spares and contingency supplies to be ordered in advance and shipped prior to rig mobilisation. These will be sourced in advance from outside of the Falkland Islands.

2.9.2 Fuel

The Ocean Rig *Leiv Eiriksson* dynamically positioned semi-submersible rig is likely to consume 30 tonnes of diesel fuel a day during drilling operations. Two support vessels will be used throughout the drilling campaign, each of which is estimated to consume 12 tonnes of diesel fuel a day. In total, therefore it is estimated that the Darwin East-1 and Stebbing-3 drilling campaign will use approximately 4,428 tonnes of diesel fuel, given that the combined campaign will be 82 days (38 days at Darwin East-1 and 45 days at Stebbing-3).The fuel will be sourced from the Falkland Islands.

Helicopter trips for crew changes will occur 24 times (round trips) during the two well drilling campaign in addition to 30 ad hoc flight requirements. The airframe being utilised is a Super Puma Mk2 that has an estimated fuel consumption of 1.91 tonnes per 1,000 kilometres (Mt Pleasant Airport to rig round trip estimate distance of 411 kilometres). Each flight is estimated to take 2.5hrs plus deck time. Total aviation fuel use is estimated at 42.39 tonnes for the two well campaign.

2.9.3 Water

The exploration wells will require 4,000,000 litres of fresh water for the top hole sections. The deeper portions of the wells will be drilled with Ultradrill water based mud that utilise seawater. It is estimated that 200 litres of potable water per person per day is required for a typical drilling operation. Assuming 100 people on board the water usage for 83 days will total 1,660,000 litres. Therefore a total potable water volume of 5,660,000 litres will be required to drill Darwin East-1 and Stebbing-3 (assuming the rig is on location for a combined total of 83 days).

Potable water will be obtained from the Falkland Islands. Availability of water has been confirmed with the Falkland Islands Government. There is a possibility of a drop in the town's water pressure while potable water is being loaded and operations should be scheduled to avoid peak periods of water use. Alternative local sources of potable water are being investigated as an insurance against a reduced water supply from Stanley.

2.9.4 Waste

Waste will be disposed of on the Falkland Island with hazardous waste likely to be exported to the UK. Specific waste handling/disposal routes and procedures will be detailed in a Waste Management Plan.

Hazardous waste generated from wells differs greatly per well, but a typical exploration well would generate between 2 and 100 tonnes of hazardous waste (average of 65 tonnes). However this estimate is based on North Sea wells, which are typically deeper than those of the Falkland so it can be expected that hazardous waste generated would be towards the lower end of the range.

2.10 Support Operations

The drilling rig will be supported by two Platform Supply Vessel's (PSV's). The vessels will rotate between the rig and the onshore supply base in Stanley. The vessel at the rig will serve as a stand-by vessel and will at all times be within proximity of the drilling rig for safety purposes. It will be in close liaison with the drilling rig and will continuously monitor other vessel movements in the area. It will warn off vessels on a course that is likely to bring them into or near the safety exclusion zone around the rig.

Given the short duration of the programme (approximately 82 days) and the seasonal nature of the PSV market (northern hemisphere) the intent is to tender for these vessels in June/July to ensure a significant number of bids.

Rig crews will be transferred to and from the rig by helicopter. A helicopter from CHC Helicopters will be dedicated to Borders & Southern throughout the drilling programme, currently anticipated to be the AS332L2 Super Puma (or equivalent). Helicopter crew changes will take place once every two weeks when approximately 60 personnel will be crew changed in one day requiring 4 helicopter flights between Stanley and the Rig carrying an average of 15 personnel per flight. On arrival at Mt. Pleasant Airport, the crews will transfer by Road to Stanley Airport. Crew change flights will then ferry outbound and inbound crew to and from the Rig. Each crew change flight consists of a round trip distance of 411 kilometres and will take approximately 2.5 hours. Four crew change round trips are anticipated to be completed in 10 hours. The inbound crew will then transfer from Stanley to MPA by road. The inbound crew will then depart MPA for the UK on a fixed wing charter flight to the UK.

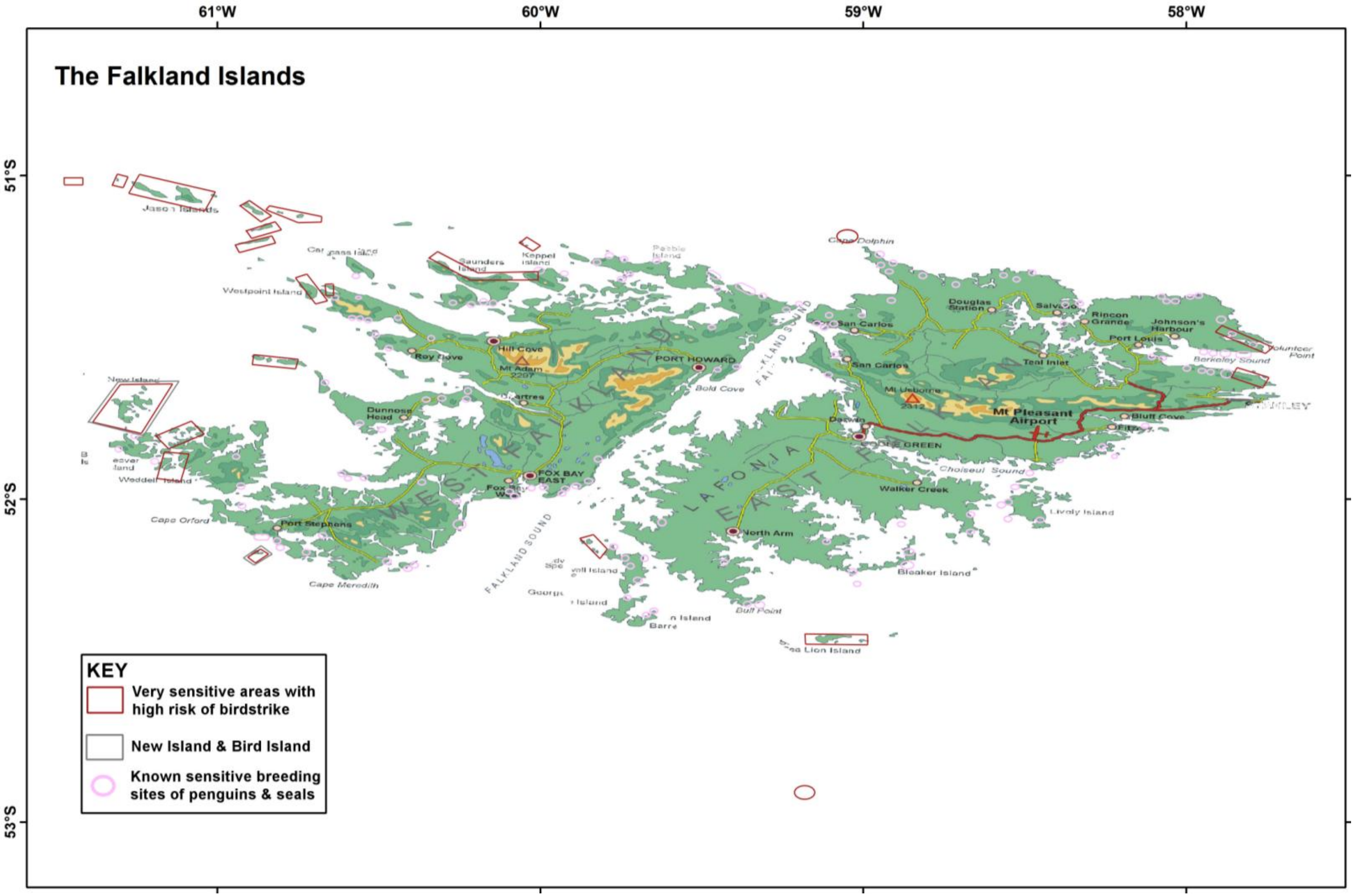
Borders and Southern intend to have a permanent arrangement, to lease 12 double rooms in the Malvina Hotel, and 6 twin bedded rooms in Millers hotel. These rooms will be used on a routine basis for operational personnel and management on an *ad hoc* basis. In addition to the permanent hotel arrangements, three houses in Stanley will be rented for rotational land based personnel. These houses will have the capacity to lodge 5 non-routine personnel for emergency accommodation requirements. During a crew change operation if either the incoming or outgoing rig crew become stranded in Stanley, accommodation facilities outside the permanent arrangement discussed above will be utilised. The table below outlines the potential emergency accommodation currently identified. The utilisation of accommodation at the F.I.D.F. is only intended for rig emergency situations. It is not intended to be used as routine accommodation during crew change delays. During normal operations it is anticipated that 40 to 60 crew members will change out during crew change operations. Table 2.7 below summarises the crew change arrangements.

Table 2.7 Accommodation arrangements for crew change procedures

Reference	Name	Rooms	Number of Beds
1	Lookout Lodge	64	64
2	Shortys Motel	6	10
3	Lafone House	5	8
4	Bennett House	3	7
5	Kay's B & B	2	3
6	Susanna Binnie's Homestay	1	2
7	Waterfront Hotel	8	9
	Sub Total: Number of Rooms and Beds	**89**	**103**
8	**F.I.D.F.**	Could accommodate up to 200	70 presently but could be easily increased

All routes used by vessels and aircraft will be pre-planned to avoid creating unnecessary disturbance to sensitive elements along their routes. Figure 2.6 illustrates the 'no-go' zones for areas identified to be ecologically sensitive from aircraft and helicopter activities. These areas will be avoided.

Figure 2.6: Identified ecologically sensitive areas to impacts from aircraft and helicopter activity *© Crown copyright material is reproduced with the permission of the Controller of HMSO. Adapted from the "Falkland Islands Range and Avoidance Areas" map provided by the Defence Geographic Centre, part of the UK Ministry of Defence.*



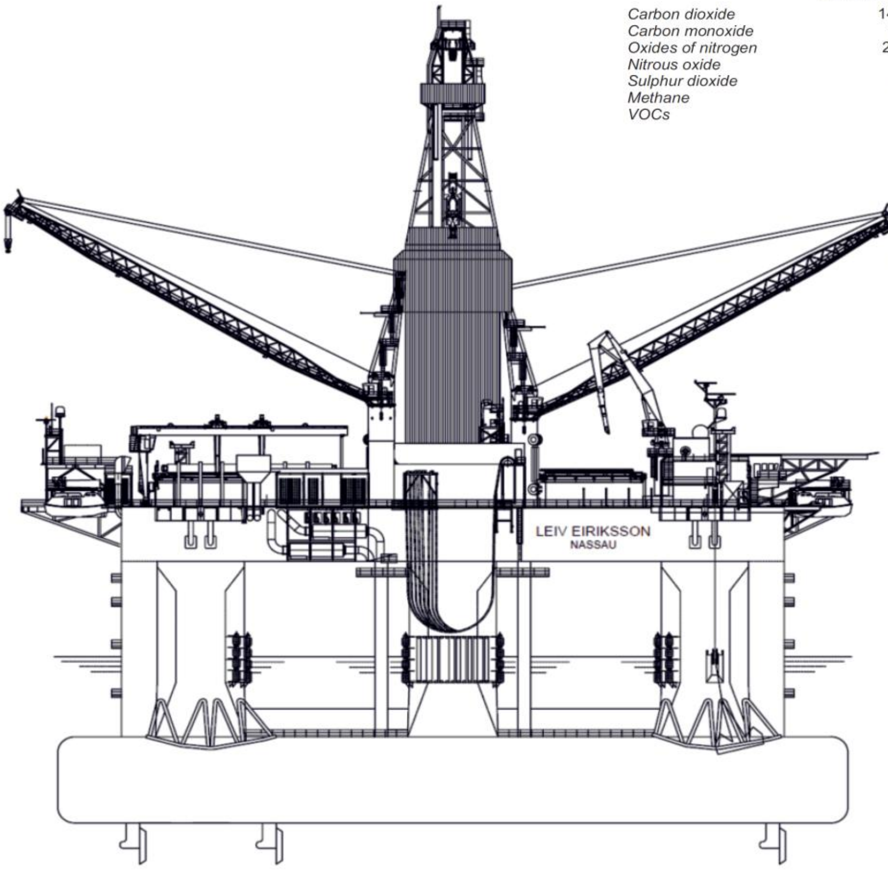
2.11 Total Emissions Summary

Figure 2.7 provides a summary of estimated totals of the main emissions and discharges directly arising from routine operations associated with the drilling of the exploration wells (total emissions from both wells).

Figure 2.7 Combined Darwin East – 1 and Stebbing 3 Emissions summary (assumes 83 days (38 days for Darwin East-1 and 45 days for Stebbing-3))

Emissions to Atmosphere (tonnes)

	Power Generation
Carbon dioxide	14478
Carbon monoxide	70.6
Oxides of nitrogen	266.8
Nitrous oxide	1
Sulphur dioxide	18.1
Methane	0.8
VOCs	9



Returned to Shore (tonnes)

Solid wastes
(e.g. garbage, scrap etc.)=
72 tonnes

Emissions to Sea (tonnes)

Drilling Fluids	6,590
Drill cuttings	2,618
Cement Chemicals	1,706
Waste water	17
Oil (deck drainage)	<1.00
Sewage	9.4

Note:

Atmospheric emissions for power generation assume rig consumes 30 tonnes fuel/day and support vessels (2 total) @ 12 tonnes fuel/day/vessel based on a estimate of 83 days on location for both wells. Atmospheric emissions for helicopter trips assumes flights for crew changes will occur 54 times (round trip) throughout the drilling programme. Fuel consumption is estimated at 1.91 tonnes per 1,000km with a return trip from Mt Pleasant Airport to the rig estimated at 411 kilometres.

Waste water discharges calculated assuming 200 l/man with 100 personnel onboard the rig.

Sewage water discharge based on 0.22m^3 of grey water and 0.1m3 of black water /man/day, assuming 100 personnel onboard the rig for a maximum of 83 days.

Solid waste production based on an estimated average of 24 tonnes/month during drilling operations.

3 Key Seasonal Sensitivities

This section describes the key physical, biological and socio-economic impact to the marine environment within and adjacent to the proposed drilling locations specific to the proposed drilling dates of the exploration wells. Drilling operations are currently scheduled to occur between December 2011 and July 2012, with the rig anticipated to be on location for a total of 83 days.

Extensive reference has been made to Section 5 (Existing Environment) and Appendix C (Benthic Survey) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

3.1 Physical Environment

Refer to Section 5.1 (pages 5-1 to 5-22) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018)

3.1.1 Geography

The Falkland Islands are an archipelago of approximately 700 islands in the South Atlantic, the largest of which are East Falkland and West Falkland. Situated some 770 kilometres (480 miles) north-east of Cape Horn and 480 kilometres (300 miles) from the nearest point on the South American mainland, the Falklands have a total land area of 12,173 square kilometres (4,700 square miles) and a permanent population of 2,913 (*FCO, 2007*).

The proposed Darwin East-1 well is situated 220 kilometres to the south of Stanley, approximately 142 kilometres from the nearest landfall on East Falkland, 130 kilometres to the south of Sea Lion Island and 85 kilometres south south-east from Beauchêne Island. The proposed Stebbing-3 well is situated 220 kilometres to the south of Stanley, approximately 170 kilometres from the nearest landfall on East Falkland, 150 kilometres to the south south-east of Sea Lion Island and 115 kilometres south-east from Beauchêne Island.

3.1.2 Bathymetry and seabed Morphology

Water depth at the Darwin East-1 location is 2,012 metres. At this location the sea floor is relatively flat with a gentle 1.18 degree dip to the NNE. There are no obvious boulders or geomorphic features. Admiralty charts indicate that there are no known wrecks in the vicinity of the well location. There are also no man-made artefacts (pipelines, wellheads, cables or munitions) in the vicinity of the well location.

Interpretation of 3D seismic at the Darwin East-1 location has revealed no evidence or recent faulting or slumping. In addition there are no indications of water-flow/gas expulsion features or biohermal build-ups. The benthic sampling revealed no indications of chemosynthetic communities.

Water depth at the Stebbing-3 location is 1,595 metres. The well is located at the crest of an uplifted and eroded subsurface anticline. The sea floor is characterised by an E-W trending ridge which delineates the strike of the underlying anticline. Erosion across the crest of the anticline has exposed indurated lithology at the seabed.

The well is located on relatively flat seafloor with a gentle dip of 1.4 degrees to the East. The well is located 330 metres to the SW of a horseshoe shaped scarp, representing a palaeo-slump scar that formed during an active phase of fold development. There is no evidence in the vicinity of the well of recent slope instability. In addition there are no indications of water-flow/gas expulsion features or biohermal build-ups. The benthic sampling revealed no indications of chemosynthetic communities.

3.1.3 Seabed Sediments

The results of the benthic survey indicated that sediments ranged from sandy silts in the north-west of the survey area to silty gravely sands and bedrock exposure in the south and east. These findings reflect the seabed terrain that reveals the fold and thrust-belt history to the evolution of the region. Samples obtained in the north-west around the Darwin East-1 location are located upon the undeformed foreland sediments. Whereas sediments to the south and south-east of Darwin East-1, around the Stebbing-3 location, are located within and upon the tectonic front that formed during the active phase of thrusting. The main phase of thrusting ceased approximately 5Ma and the relict seabed morphology is preserved in the south and south-east of the survey area.

Therefore sediments at the Darwin East-1 location and generally of a fine grained nature, sandy silts were recovered during the benthic survey. Whereas in contrast, a coarse grained sediment cover and exposed bedrock was encountered at the Stebbing-3 location.

Total Organic Matter, Organic Carbon and Carbonates

The level of total organic matter (TOM) was consistent ranging from 2.52 to 4.58% but was low when compared to other studies in a similar depth and sediment type. In addition to total organic matter, the sediments were also analysed for total organic carbon and inorganic carbon (i.e. carbonates). The total mean values exhibited proportions of 0.31 and 2.06%, respectively. TOC represented around 9.1% of all organics present, a similar level to that recorded at other sites in the East Falkland Continental margin (5.1-8.1%; *FSL, 2009a & c*), but notably lower than that recorded on the north Falkland Continental Shelf (28.1%; BSL, 2008). Overall, this level remained relatively consistent, which statistically correlated to the proportion of sediments fines.

The proportion of total carbonates was also measured here but no comparable values for the East Falklands Continental Margin was available. Values averaged at around 0.56% on the north Falklands Continental Shelf (*BSL, 2008*). Values discovered here were notably higher (up to 3.73%). This may be explained by in increased deposition in marine carbonates from zooplankton tests and mollusc and crustacean shells and echinoderm spines.

The presence of pelagic sediments from the deposition of marine snow onto the seabed was low. Sediments were indicative of sands and gravels which indicates an erosional hydrodynamic regime (*BSL, 2009*).

Hydrocarbons

Mean total hydrocarbon concentrations (THC) for the whole survey area was 12.8µg.g^{-1}. These levels are moderately high, and well above the range expected for uncontaminated similar sediments in the Northeast Atlantic (ca. 2.9µg.g^{-1}; *AFEN 2000*). Hydrocarbon data recovered from the current survey was compared to similar results acquired by BHP Billiton along the East Falkland Margin. Regional levels of THC and Total Polycyclic Aromatic Hydrocarbons (PAHs) clearly show an increased concentration in the survey area, with marginal elevations at the Toroa survey. The regional distribution pattern could either result from a plume of material emanating from west of the South Falkland Basin, being carried along the prevailing Malvinas current, or more likely represent the regional distribution of a viable source interval with associated natural hydrocarbon seeps (*BSL, 2009*).

Heavy/Trace Metals

Of the metals analysed, the crustal or matrix metals aluminium and iron indicated significantly high and slightly variable concentrations with means of 40.8 and 58.0 mg.g^{-1}, respectively. These levels reflect the naturally high level of these residual metals in the sediment of this region. Barium remains the most abundant metal found in drilling related discharges due to its use as a weighting agent within the drilling mud program in the form of barite ($BaSO_4$) and it is subsequently used as an indicator of the effects of drilling related discharges. Natural barium levels remained relatively high and variable throughout the area ranging from 265µg.g^{-1} to 2,420µg.g^{-1} (mean 782µg.g^{-1}), with no obvious pattern of distribution.

Barium levels are also affected by natural biogeochemical cycling. As $BaSO_4$ is broken down, Ba^{2+} will be produced in sediment pore waters where it can then migrate towards surface oxygenated sediments where it will re-precipitate out as $BaSO_4$. This may also contribute to the elevated levels of barium recorded in some sediments.

The levels of strontium and lead were both low (mean 281µg.g^{-1} and 9µg.g^{-1} respectively). Other metals showed correlations with different environmental parameters were copper and nickel, although these showed opposite distributions. Copper, which had a total mean of 14.6µg.g^{-1}, showed a strong correlation with finer sediments, sorting and TOM. Nickel, with a mean of 8.4µg.g^{-1}, however, correlated with the proportion of gravels, mean size and TOM. In both cases, overall concentrations were generally low and within the range recorded at neighbouring sites around the Falklands.

All of the remaining metals analysed show generally low level concentrations expected for an uncontaminated offshore environment. When comparing the key elements with those of the OSPAR background reference concentrations (BRCs) values, the seven key metals cadmium, chromium, copper, mercury, nickel, lead and zinc all gave concentrations below OSPAR BRCs with the exception of cadmium which could not be determined to a low enough resolution (*BSL, 2009*).

3.1.4 Oceanography

Water Circulation and Tidal Currents'

The predominant current flow is from west/south west to the east/north east. Current speeds are anticipated to be negligible. From 5th November 2007 to the 31st January 2008, metocean data was collected during the 3D survey carried out by Borders and Southern in their prospective licence area. The maximum and average current speeds observed near the sea surface were 1 knot and 0.34 knot, respectively and predominant current direction was to the north east. These findings concur with metocean data recorded by a Metocean buoy located at the Toroa-1 well location, 70km NNE of the proposed well location. BHP Billiton deployed two Metocean buoys to record data between 6th December 2008 and 26th April 2009. The Toroa buoy was located at a 692m water depth and recorded current speed and direction from 400m bmsl to 682m bmsl. Average current speeds measured 0.2 knot, while maximum current speeds reached 0.62 knot. The reduction in current speed with depth concurs with NOAA modelled results of rapidly decreasing currents within the first 100m and a more gradual decrease below this level.

Waves

Wave heights range from 0.5 metres to 9.5 metres however on average, wave height is around 2.4 metres. Occasional freak waves can exceed the maximum wave height under certain rare conditions. Seasonality in wave height showed a more energetic environment in the austral winter particularly between June and September. Drilling is due to take place in the austral summer between December 2011 and July 2012. However, low pressure systems and associated storms do occur on a regular basis throughout the year. This data is derived from the NOAA WAVEWATCH III model. The data in Figure 3.1 shows the wave height data recorded from the vessel during the Borders & Southern 3D survey (November 2007 to February 2008). There is close agreement between the frequency distribution of wave heights from the observed data to the 12 year hindcast data (Figure 3.2).

Waves are generated through wind-wave interaction. The amount of energy gained by the wave is determined by several factors including, wind speed, duration and direction of wind-wave interaction and the fetch of the wind-wave interaction. Different wave trains can then interfere with each other and water depth will also effect wave dynamics. At the licence area the prevailing wind direction is from the south-west through to the north-west. Wave direction is dominantly from SSW to WSW (see Figure 3.3), generally conforming to the prevailing wind direction but also reflecting the influence of the larger fetch area south of mainland South America where wind-wave interactions can take place over several thousand kilometres.

Figure 3.1 Observed wave-height frequency distribution for the PL018 licence area for the period of Nov 2007 through to Feb 2008 (obtained during the Borders & Southern 3D survey)

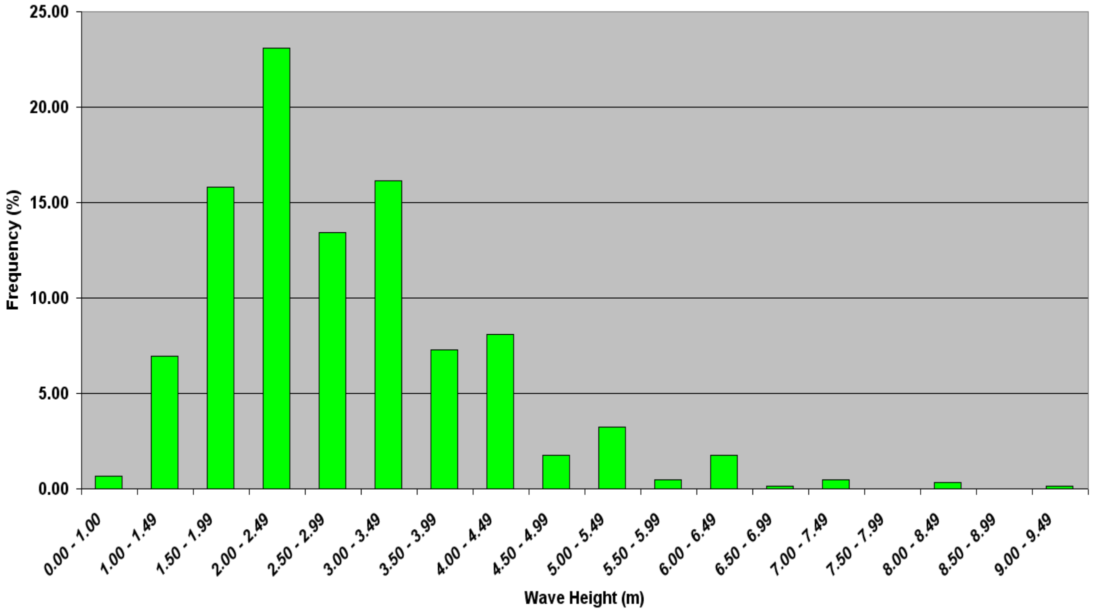


Figure 3.2: Wave height frequency distribution for the PL018 licence area for the period of Jan 1997 through to Feb 2009 (Buoyweather hindcast data from NOAA's WAVEWATCH III). Combined with observed w direction data obtained during the Borders & Southern 3D survey (Nov 2007 through to February 2008)

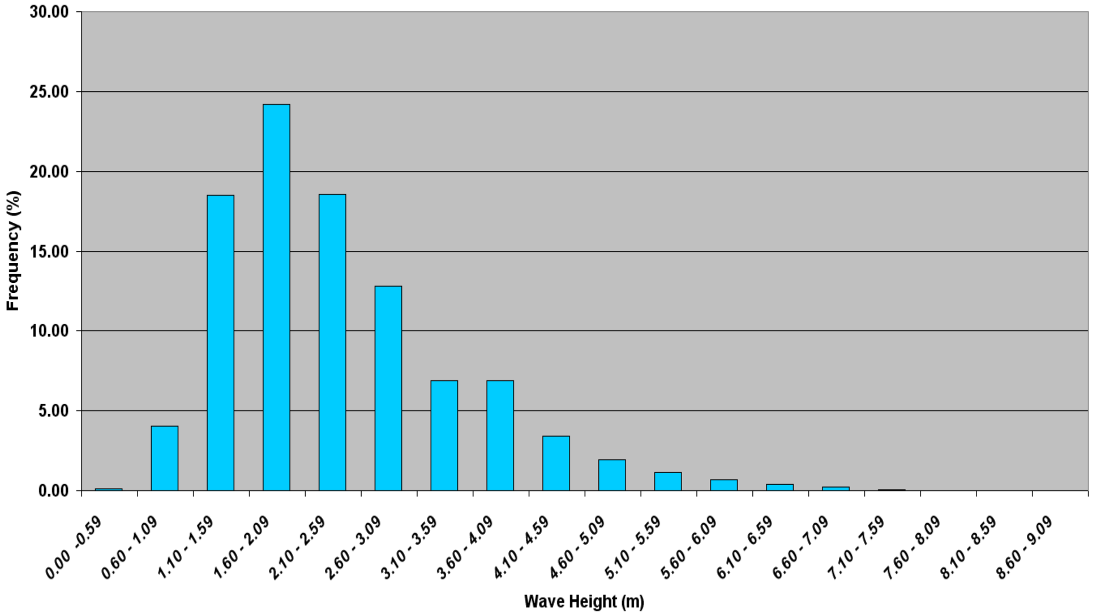
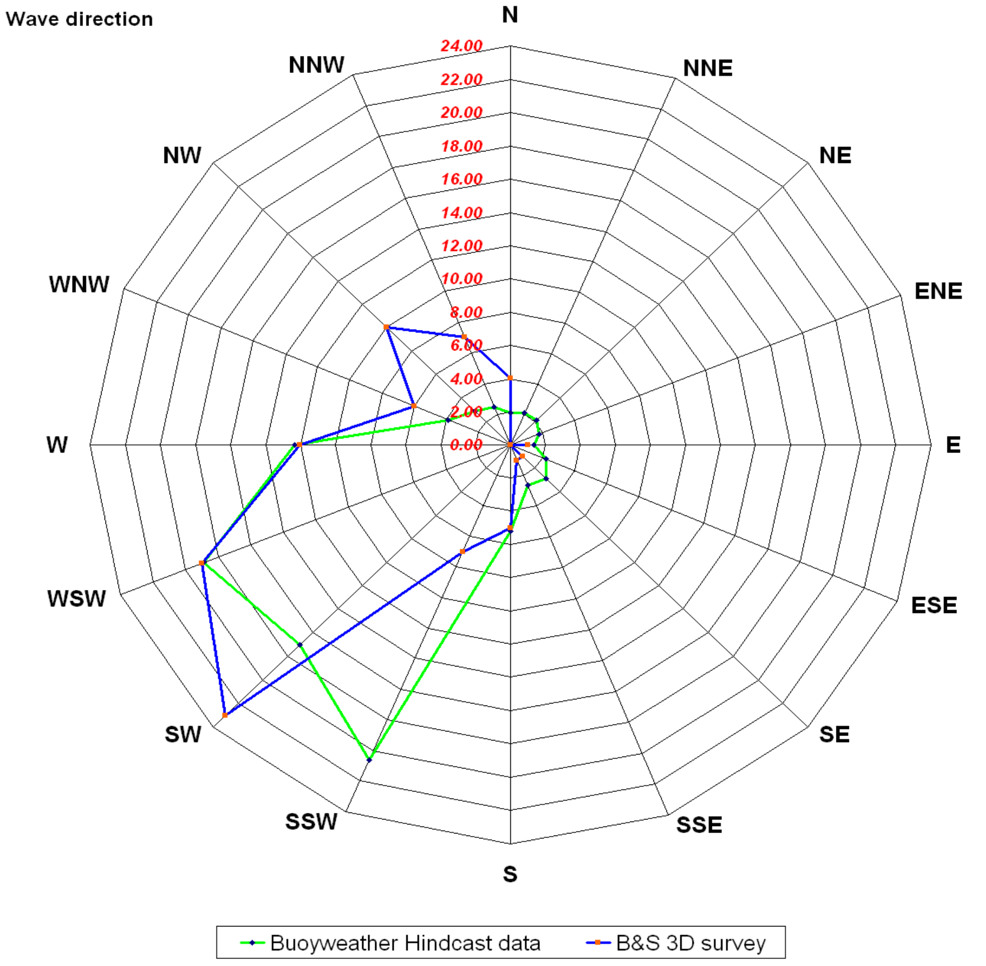


Figure 3.3 Wave direction frequency distribution for the PL018 licence area for the period of Jan 1997 through to Feb 2009 (Buoyweather hindcast data from NOAA's WAVEWATCH III). Combined with observed wind direction data obtained during the Borders & Southern 3D survey (Nov 2007 through to February 2008)



Water Column Characteristics

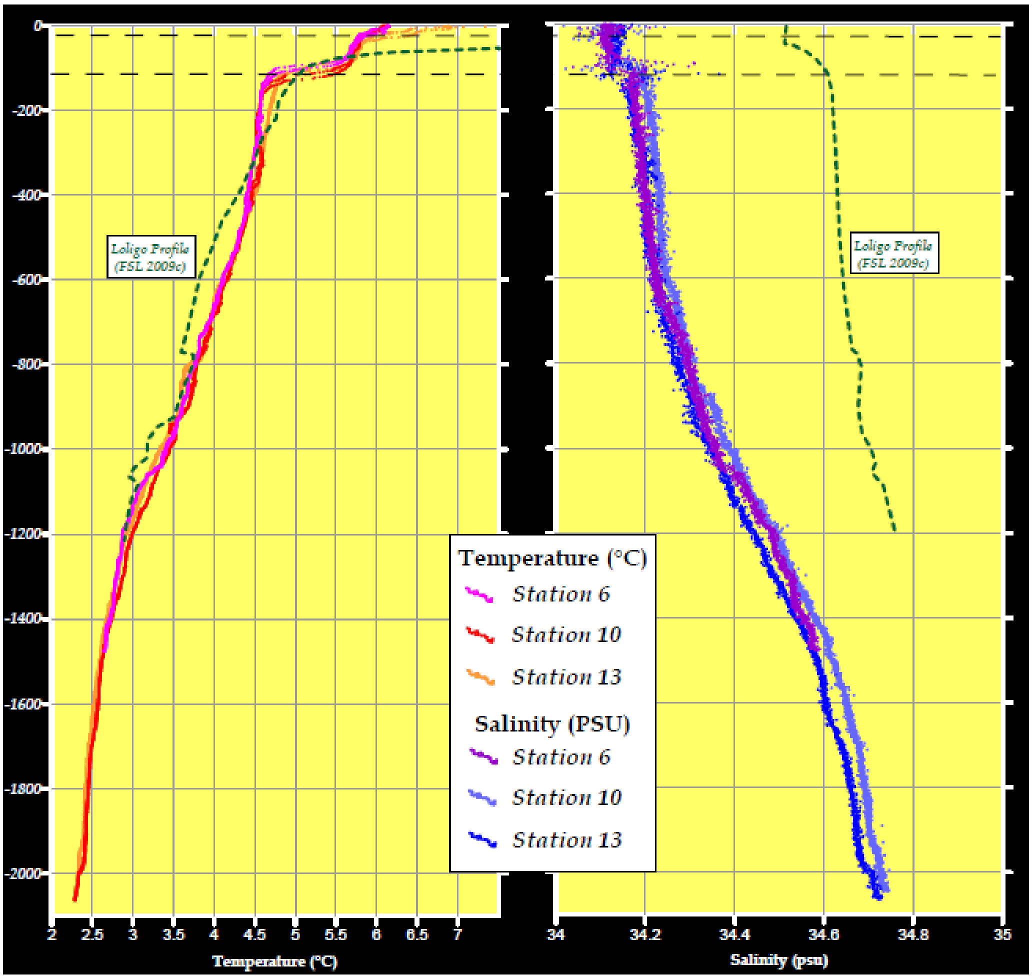
Water column profiles were obtained at three locations in the licence area. Water column profiles are shown in Figure 3.4. All three profiles showed similar patterns even taking into account the varying depths of each profile and the lateral separation of the sampling locations. Consequently, these results show that the physical characteristics of the water mass is homogeneous throughout the studied area.

The surface temperature varied between 6 and 7˚C falling to 5.5˚C by 40 metres. A thermocline, and halocline, exists at a depth of 40 to 100 metres. Above the thermocline the temperature remains above 4.8˚C, below this layer the temperature drops by approximately 1˚C. Below this layer the decreases at a relatively constant rate to around 2.3˚C at 2,100 metres.

Salinity showed minimal variation throughout the water column, ranging from a minimum of 34.1 ppt at the surface to 34.7 ppt at seabed (2100m) demonstrating a strong negative relationship with temperature.

The water column characteristics indicated a similar temperature and salinity profile to those recorded at the BHP Loligo location. The Loligo salinity profile was marginally higher throughout (0.4 ppt), although this may reflect a variation between the instruments used between the two studies.

Figure 3.4 Water Column Profiles in the proposed drilling area as compared to Loligo site east of Falkland Islands (Benthic Solutions, 2009)

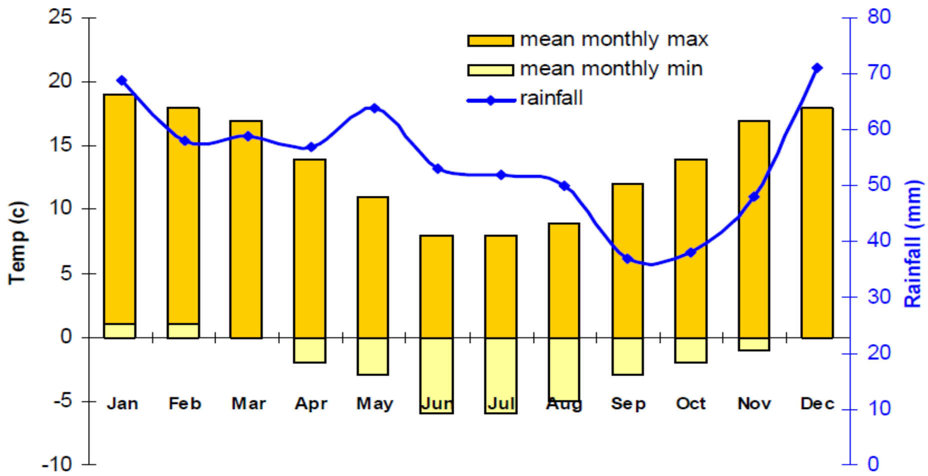


3.1.5 Meteorological Data

Temperature

The Falkland Islands have a cool temperate oceanic climate, dominated by westerly winds with a narrow terrestrial temperature range and mean annual maximum temperatures of approximately 10°C, mean annual minimum temperatures of approximately 3°C, and mean monthly ranges of between –5°C to 20°C (Figure 3.5). During the proposed drilling period, temperatures are at their highest for the year between 14 and 16°C. Temperatures over the open sea are less variable than on land.

Figure 3.5 Climate Averages for Stanley Harbour



Precipitation

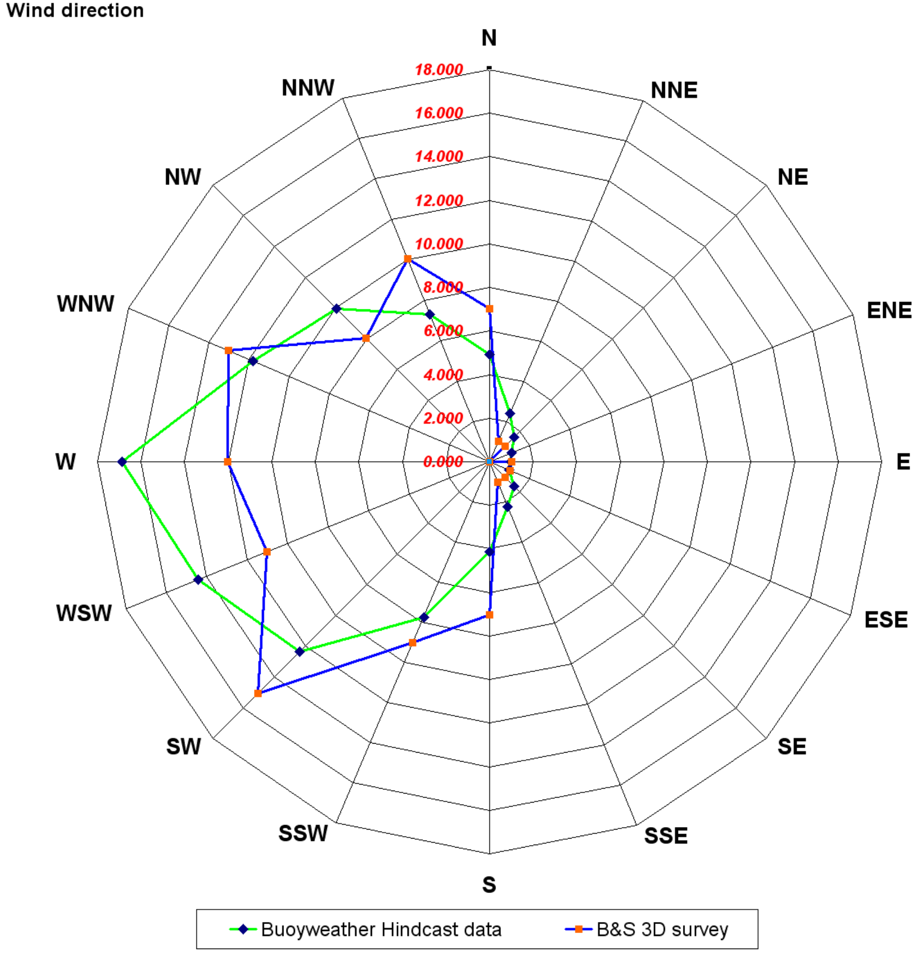
Figure 3.5 shows the average monthly rainfall for Stanley Harbour, the proposed supply base for offshore drilling operations. Average annual rainfall at Stanley is around 650 millimetres and average annual rainfall for the Falklands is low, but consistent. During the proposed drilling period rainfall is likely to be at its highest between 48 millimetres and 71 millimetres (Figure 3.5 above).

Winds

The prevailing wind direction is an annual broad arc spanning south south-west to north - north west reflecting the licence location within the southern latitude westerlies. The region is exposed to an almost unbroken series of meteorological depressions and troughs moving from west to east as they circulate clockwise around Antarctica (*Hydrographer of the Navy, 1993*). Figure 3.6 shows the wind direction data for a 12 year period (January 1997 to February 2009). The observed data recorded on the vessel during the acquisition of the Borders & Southern 3D survey (November 2007 to February 2008) is also presented on the same chart. There is a close comparison between the observed data and the modelled data.

Wind speeds predominantly range between 14 to 25 knots (Beaufort scale 4 or 6) or below. Strong gales and storms (Beaufort scale 7+) occur for less than 2% of the time over an average annual period. Strong gales in excess of Beaufort 7 are associated with strong depressions. There is a conveyer belt of progressions that form along the front between the warmer subtropical air and the colder polar air mass. Progress of the depressions from west to east is constant throughout the year. Variations in global circulation patterns/heat flux effect the intensity and frequency of the depressions which create annual variations. During the acquisition of the Borders & Southern 3D survey winds in excess of Beaufort 7 occurred for 6% of the survey duration (maximum winds of 48-55 knots (Beaufort 10) were recorded, but occurred less than 0.5% of survey duration). Because of the maritime environment depressions generally make rapid eastward progress resulting in storm events of short duration.

Figure 3.6 Wind direction frequency distribution for the PL018 licence area for the period of Jan 1997 through to Feb 2009 (Buoyweather hindcast data from NOAA's WAVEWATCH III). Combined with observed wind direction data obtained during the Borders & Southern 3D survey (Nov 2007 through to February 2008)



3.2 Biological Environment

Refer to section 5.2 (pages 5-22 to 5-70) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

The Patagonian Shelf, on which the Falkland Islands sit, is of regional and global significance for marine resources (*Croxall & Wood, 2002*). It supports rich assemblages of seabirds, marine mammals, fish, squid and plankton populations due to upwelling currents at the shelf margin which enhance regional biological productivity. Only the sensitivities that have changed or been influenced by the changes in the proposed drilling dates to between December 2011 to July 2012 have been discussed below. All other sensitivities are assumed to be the same as stated in the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

The information contained in the EIA Addendum primarily covers the area known as the South Falkland Basin. The basin is geographically located between the Burdwood Bank to the south and the Falkland Islands to the north. The basin is one of a series of basins that extend westward to the Argentinean mainland. Licence PLO18 is located within the South Falkland Basin which in turn is located within the Patagonian Shelf Large Marine Ecosystem (LME). Heileman (2009) has described the Patagonian Shelf LME as a Class I, highly productive (>300 gC/m^2-yr) ecosystem based on SeaWiFS global primary production estimates. While the southward flowing Brazil Current is warm and saline, the northward flowing Falklands/Malvinas Current carries cool, less saline, nutrient-rich sub-Antarctic water towards the equator. The two currents mix their waters at a Confluence Zone (CZ). The CZ is a wide area characterized by intense horizontal and vertical mixing. It is situated on average at the approximate latitude of 39 degrees south, but is displaced to the north in the winter. The exchange of water masses of different temperatures and salinity affects biological productivity.

The Patagonian Shelf LME is located north of the Antarctic realm. The Antarctic realm is defined as all areas, oceanic, island and continent lying in the cold Antarctic climatic zone south of the Antarctic Convergence. Antarctic surface water originates near the Antarctic continent. It flows to the north until it encounters relatively warmer subtropical surface water. Because it is denser than the warmer subtropical surface water, Antarctic surface water begins to sink and mix with underlying sub-Antarctic Intermediate water (Figure 3.7). The Antarctic Convergence not only separates two hydrological regions, but also separates areas of distinctive marine life associations. The Antarctic Convergence is a zone of approximately 32 to 48km wide, varying in latitude seasonally by up to half a degree of latitude from its mean position (Figure 3.8). The position of the Antarctic Convergence has been used to define the area of the Convention for the Conservation of Antarctic Marine Living Resources (Figure 3.9).

The cold Antarctic water mass that circulates clockwise around the Antarctic continental landmass forms the Antarctic Circumpolar Current (ACC). There is no Arctic equivalent to the ACC, due to the amount of land surrounding the northern polar region. The ACC extends from the sea surface to a depth of 2,000 - 4,000m. Although the ACC is relatively unconstrained by land masses, compared to the Arctic region, the current is strongly constrained by landforms and bathymetric features. Tierra del Fuego and the Falkland Islands lie to the north of the Antarctic Convergence. The Burdwood Bank forms a significant bathymetric barrier rising from the floor of the Scotia Sea at a depth of 2,200m to just 200m below sea level (see Figure 3.10). The barrier prevents northward migration of the Antarctic Convergence. The ACC passes west to east along the southern boundary of the Burdwood bank and eventually breaks north between the eastern end of the bank and the western side of Shag Rocks in the region of Aurora Bank.

Figure 3.7 Water mass circulation of the Southern Ocean (Grobe, 2000)

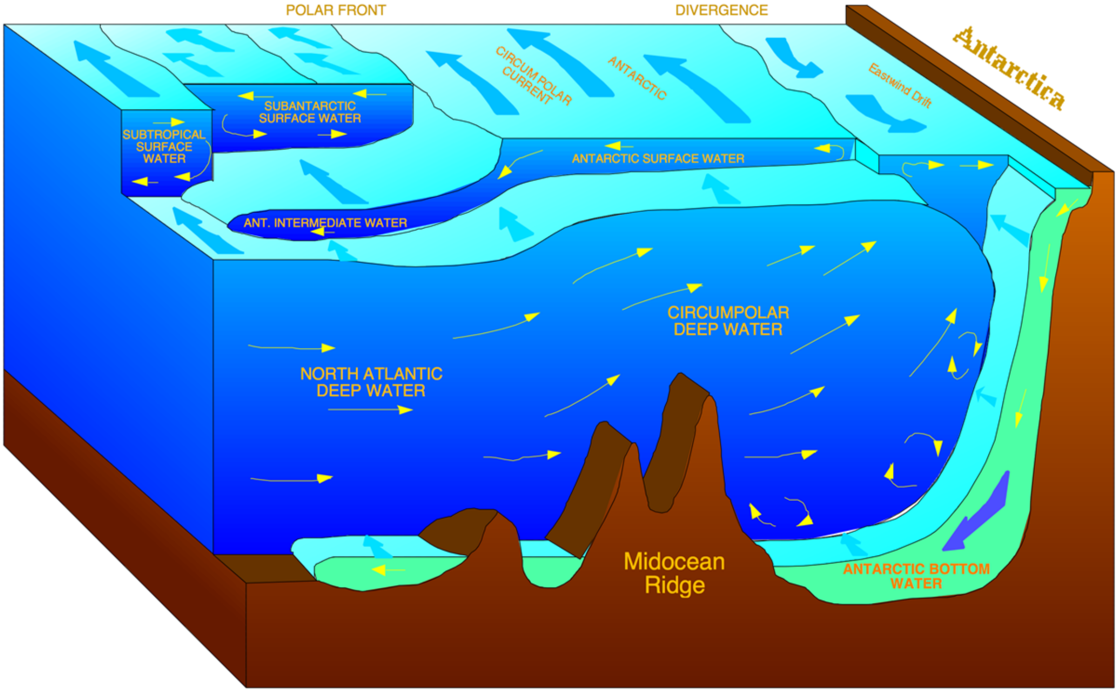


Figure 3.8 Mean location of the Antarctic Convergence (black line). Shaded grey area around black line shows standard deviation of the AC over a 3 year period. (Dong et al 2006).

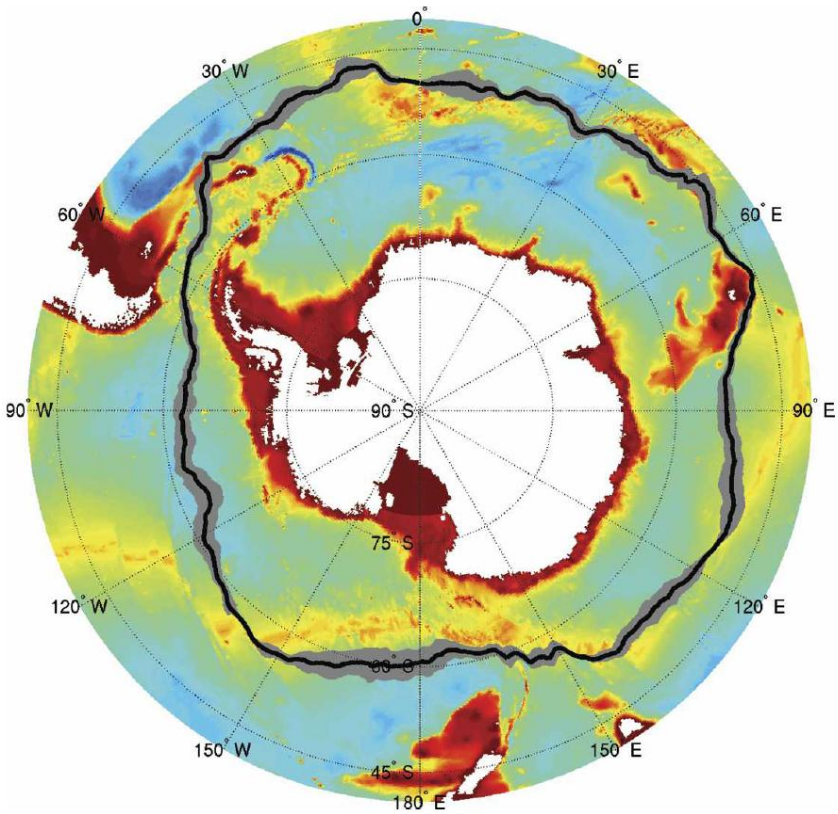


Figure 3.9 The area of the Convention of the Conservation of Antarctic Marine Living Resources (Figure from Kock et al., 2007)

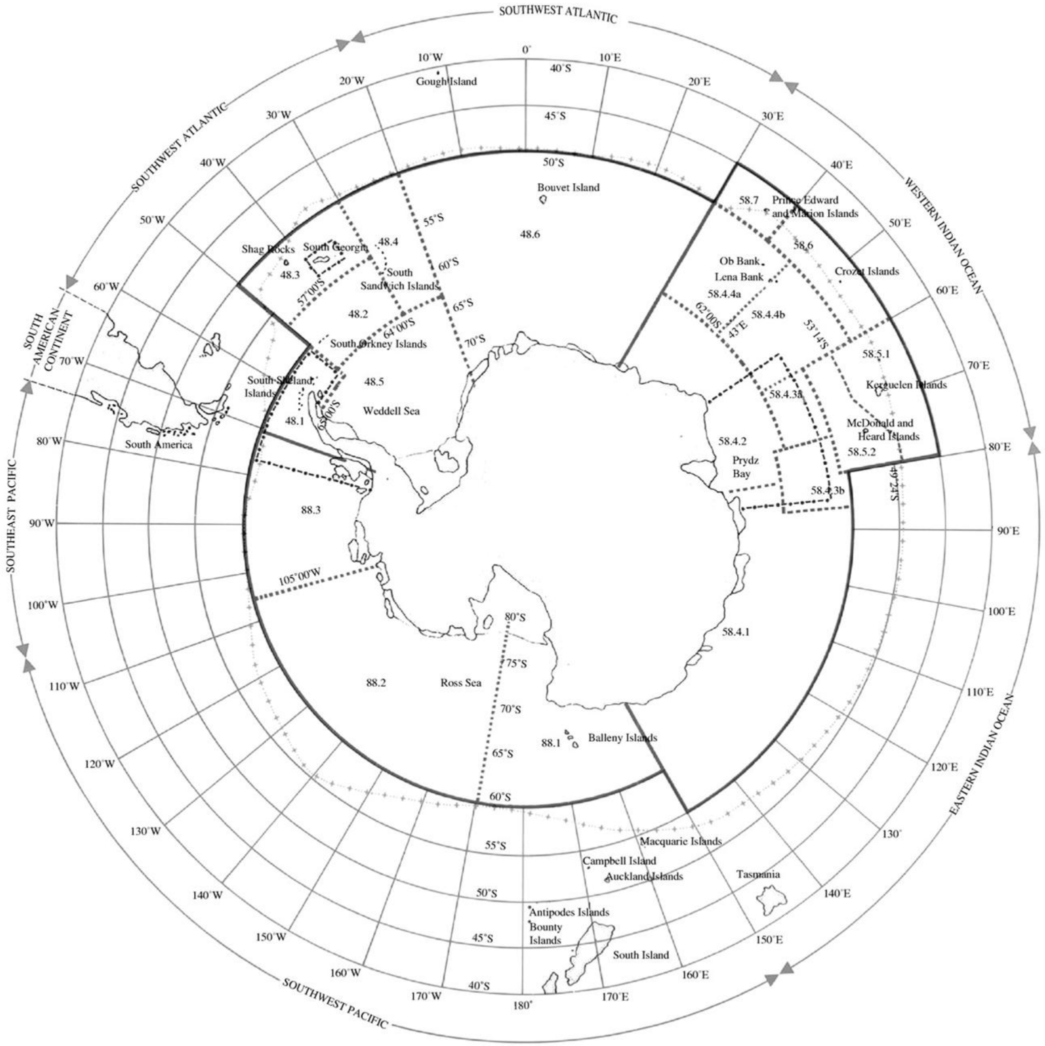
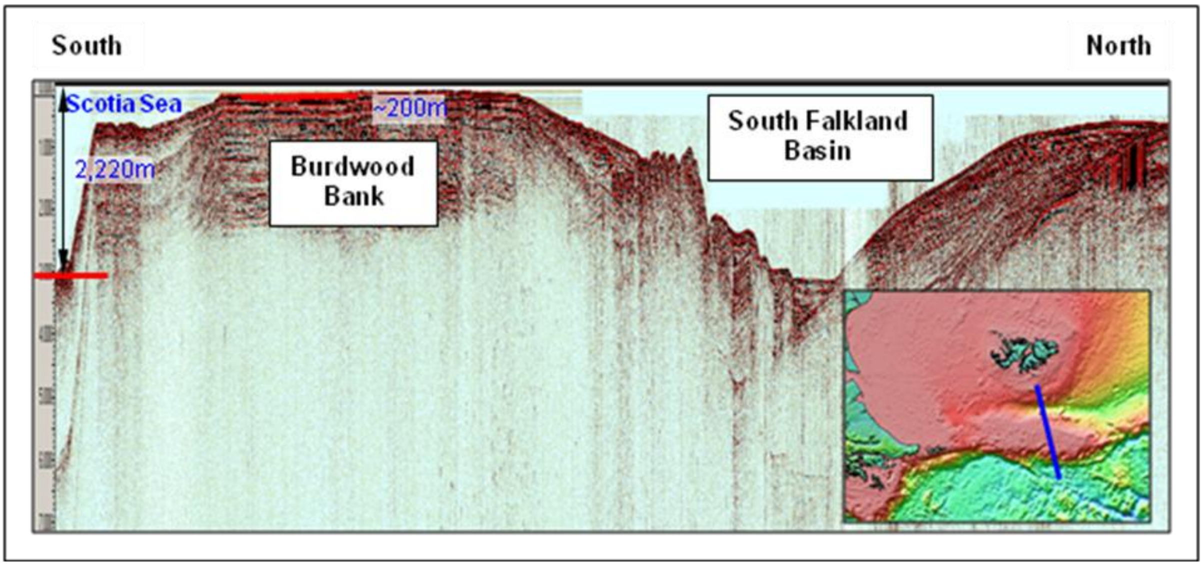


Figure 3.10 Seismic transect running south to north across the Burdwood bank and the South Falkland Basin.



3.2.1 Marine and Intertidal Vegetation

Refer to section 5.2.1 (pages 5-22) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

Seaweed is an important resource in the Falkland Islands for extraction and use in commercial products such as fertilisers. They also provide important habitat and resources for other marine organisms. Giant and tree kelp are the most common kelp species found here, however they are most likely to be found in coastal offshore zones around 4 – 30 metres water depth. Kelp beds will therefore not be directly impacted by the proposed drilling operations as only floating isolated patches are likely to be encountered in the water depths of the proposed drilling operations.

3.2.2 Plankton

Refer to section 5.2.2 (pages 5-23 and 5-24) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

Plankton are marine and freshwater organisms with limited swimming capability that drift with the prevailing currents. They represent an integral part of the marine ecosystem as they provide the basis of all food for higher levels of the marine food chain. Plankton is generally divided into broad functional groups – phytoplankton (autotrophic) and zooplankton (heterotrophic).

Phytoplankton

Phytoplankton are reliant on sunlight and nutrients in order to carry out their photosynthetic processes. This group therefore tend to exist in the upper photic zone of the water column. This group is both abundant and diverse with up to 5,000 species of phytoplankton present with cyanobacteria and dinoflagellates amongst the most prominent groups.

Remote sensing of the Patagonian shelf and areas where the Brazil and Malvinas ocean currents merge display seasonal phytoplankton blooms due to perennial wind and shelf break upwelling which both trigger upwelling of nutrient rich waters to the surface and allow phytoplankton populations to proliferate. This in turn increases the food availability at the base of the food chain and produces areas of high productivity in an otherwise region of low primary and secondary production. Phytoplankton biomass tends to be greater during the spring and summer months when light is greater and the water column is more stable.

Zooplankton

Zooplankton, the heterotrophic type of plankton represented by small floating or weakly swimming animals that drift with water currents and, with phytoplankton, make up the planktonic food supply on which almost all oceanic organisms ultimately depend. Included are many animals, from single-celled radiolarians to the eggs or larvae of herrings, crabs, and lobsters.

The local hydrography around the Falkland Islands with current convergence zones and shelf breaks produces high phytoplankton productivity and in turn generates elevated zooplankton biomass in more stable areas to the north and to a smaller extent in the south-west.

As with phytoplankton, numbers of zooplankton increase during the summer months in response to elevated availability of the phytoplankton prey. Important zooplankton species include swimming euphausiids (krill) and amphipods. Krill are a key element in the food chain and is consumed by squid, fish, seals, baleen whales and seabirds.

3.2.3 Benthic Fauna

Refer to section 5.2.3 (pages 5-24 and 5-27) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

A field environmental survey was undertaken by Benthic Solutions Limited in November 2008 from the Chilean supply vessel MV Luma, mobilised from Punta Arenas in the Magellan Straits. The field acquisition was based upon a benthic sampling campaign and water quality profiling over a regional area of the Burdwood Bank and the South Falkland Basin.

During the survey, samples were collected from 23 stations to include four prospective target areas, including Darwin East (station 13) and Stebbing (between stations 6 and 7) wells. As water depths were expected to range from between 1,200 and 2,100metres, benthic sampling was undertaken using a large 0.25m2 box corer sampler constructed of stainless steel, whilst a second large grab sampler was used in the event of limited penetration (such as compacted sands) or if insufficient surface material was recovered by the corer. Both devices were designed to completely enclose the sample on recovery and provide inspection/sub-sampling access to the samples surface without disturbing the integrity of the sediment layering. Recovered material was processed onboard over a 500µm aperture using a Wilson Auto-siever, or were sub-sampled for physico-chemical determination after the sample had been described and photographed.

For each of the 23 sample locations, three separate sub-samples were acquired, two of these were analysed for sediment macrofauna and one for physico-chemical determination. All recovered samples were assessed under strict quality control criteria prior to acceptance and subsequent processing. On recovery, with the exception of sediment biology, all samples were immediately frozen and stored (< -18^{o}C) for later transportation (frozen) to the proposed laboratory, or for storage on demobilisation. This material was to remain frozen during transportation back to the analytical laboratories. The following physico-chemical analyses were undertaken:

- Full Particle size distribution (phi scale, includes the <63µm fraction);
- Total organic matter (by loss on ignition);
- Total organic carbon and carbonates;
- Total petroleum hydrocarbons (TPH) by GC-FID;
- Saturate hydrocarbons (nC10 – nC35) by GC-FID;
- Polycyclic aromatic hydrocarbons (2-6 ring & alkyl derivatives);
- Heavy & trace metals (double analysis following both aqua regia and HF digest by ICP or AAS for Ba, Cd, Cr, As, Cu, Ni, Zn, V, Pb, Al, Fe, Sr) and Hg (by cold vapour or ICPMS);
- Duplicate or triplicate Macrofaunal determination (over 500µm.

As nothing was known of the surface geology in the region and some concerns remained over the stability of the superficial substrates, particularly if carbonate oozes were encountered, an additional 3 metre gravity corer was taken to provide additional geotechnical samples at 6 locations.

Two or three replicate water quality profiles were also undertaken down to full depth within the geographical extremes of the survey area. Water profiles were collected using a continuous reading water quality profiler or CTD depth rated to 3,000m. This was fitted with sensors to obtain and record measurements throughout the water column from sea surface down to the seabed.

Macrofauna

The fauna is characterised by a high diversity in some groups such as crustacea and low diversity in other groups, particularly the echinoderms. Statistical analysis of the site survey data revealed high species richness, diversity and evenness throughout. There appeared to be no grouping of faunal assemblages by any parameters such as water depth or sediment granulometry. This therefore suggested that communities were relatively homogenous.

The dominant macrofaunal groups included mobile surface dwelling polychaetes, the onuphid polychaete *Rhamphobranchium ehlersi*, nematodes, and crustaceans including amphipods (*Urothoe* and *Phoxocephaloidea* sp.). Other notable species include ostracods and a number of foraminifera. *R. ehlersi* was the most abundant annelid recorded during the site survey with polychaetes in general dominating the macrofaunal population.

Overall no environmentally sensitive species or habitats were recorded during the site survey (*Benthic Solutions, 2009*).

Epifauna

Sediment granulometry analysis during the site survey revealed evidence of coarser sediments ranging from granules through to large cobbles (25 cm diameter). These therefore were able to support some populations of sessile (fixed) epifaunal organisms. Statistical analysis also revealed a positive correlation between epifaunal abundance and gravel content of the sediment.

Epifaunal species present were predominantly from the phyla Cnidaria, Porifera and Bryozoa. Amongst the cnidarians, hydroids were the least prominent group. Octocorals were well represented including species of gorgonians and sea fans.

The Madreporan (stony) coral, *Lophelia* was recorded in a couple of samples however live tissue was only found in one specimen in one sample. Branched hard corals are of conservation importance as they can form extensive biogenic reefs which produce more complex habitats for a variety of species but are very fragile. Order Madrepora (Scleractina) are azooxanthellate corals which do not possess the symbiotic relationship with photosynthetic algae residing in the ghost corals epidermic tissues that many shallow tropical water corals possess. These species are therefore suspension feeders and are not restricted to the photic zone and can exist in much colder deeper waters. However, as a result of this, growth is very slow compared to shallow water corals and these species are therefore more sensitive and more vulnerable to damage as they are unable to recover as quickly. In this case, only a small example of this species and other stony corals were recorded although the small number found may indicate the possibility of larger more extensive and developed reefs to exist elsewhere within the general survey area. Existing information for *Lophelia pertusa* would suggest that its presence would not extend to the Falkland slope due to the low seabed temperatures recorded (2.9°C).

Representatives from the phylum Porifera (sponges) included Hexactinellidae (glass sponges), which were identified only as fragments as well as the numerous siliceous spicules found in sediment samples, which may indicate that their presence may be more dominant than that exhibited during the site survey. A common sponge species, *Asbestopluma* sp. was well represented during the site survey. These are branching forms and rely on a carnivorous mode of feeding which traps prey, such as small crustaceans, on hooked microscleres which extend from the surface of tentacle–like structures. Digestion and absorption is then carried out by migrating feeding cells. Other representatives of this phylum were generally limited to small encrusting patches on stones.

Representatives of the Phylum Bryozoa were frequently encountered and were encountered in various forms including encrusting, upright branches and flexible colonies. Identification was done to the genus level for functional groups within Class Cyclostomata due to changes in the classifications scheme and subsequent difficulty in identifying this class. Three species were identified to the Class Ctenostomata. Of particular interest was *Metalcyonidium* sp. which forms upside down cones on a stalk devoid of zooids. 38 taxa were identified within this group and were therefore well represented. Pterobranchia were also recorded during the survey. Overall the bryozoa were abundant and diverse and typical of that found in similar depth regimes.

The crustacean community was also dominated by frequent occurrences of Cirripedia (barnacles), including the stalked barnacle (*Scalpellum* sp.) and the acorn barnacle (*Verruca* sp.). These were unusual for the deep sea and Antarctic waters and were associated with stations with gravelly sediments to which they can attach. In addition to the free-living infaunal species, the frequent occurrence of Cirripedia, the stalked Barnacle *Scalpellum* sp. and the acorn barnacle *Verruca sp*. was recorded, both being unusual for Deep Sea and Antarctic waters. These were clearly associated with stations where coarse gravels were present. Some copepoda appeared within samples which were neither epifaunal nor benthic but accidental pelagic specimens. These were related to the *Euphausiacea* (or Krill) and were probably caught by the sampler during the descent, or have been introduced to the samples through the sea water processing phase of the operations.

3.2.4 Fish, Squid and Shellfish

Refer to section 5.2.7 (pages 5-27 and 5-31) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

At least 80 species of fish have been recorded in Falkland Islands waters ranging from the smaller rock cod to larger fish including tuna and sharks (*Strange, 1992*). The majority of data on the distribution and abundance of fish species around the Falkland Islands is based on commercial catch statistics. There are limited data on the deep sea demersal fish species which therefore may be present in the vicinity of the proposed drilling activities.

A study by Coggan *et al.*, (2006) sampled twenty deep-water stations to the east and south of the Falkland Islands by commercial bottom trawl deployed in upper, middle and lower benthopelagic zones (depth range of approximately 500-1,000 metres). Forty-one species of teleost fish were recorded, 10 species of elasmobranch and one species of agnathan. Different assemblages of fish were found to characterize each depth zone (e.g. *Moridae* in deeper waters, *Bothidae* and *Rajidae* in shallower waters), with diversity being greatest in the mid-zone and biomass greatest in the upper and lower zones. Four species, namely the grenadiers *Macrourus carinutus* and *Coelorhynchus fasciatus*, the southern blue whiting *Micromesistius australis*, and the Patagonian toothfish *Dissostichus eleginoides*, accounted for 85 percent by weight of all fish caught. Coggan *et al*, (2006) suggests that further studies may be need in the light of the developing oil and gas industry in the Falkland waters.

Fish species which are most likely to be found in the vicinity of the proposed exploration wells include hake (*Merluccius* spp.), southern blue whiting (*Micromesistius australis*) and rock cod (*Patagonothen ramsayi*). Patagonian hake (*Merluccius hubbsi*) and common hake (*Merluccius australis*) are similar species and are often counted as a single species in fishery catch statistics. The common hake tends to be found to the north of the Falkland Islands in Argentinean waters and spawns during September and October and the Patagonian hake tends to be found in more southern waters and breeds during June and August. Therefore, the proposed drilling programme is situated outside the sensitive period for both of these species. No spawning areas or juveniles of *M. hubbsi* have been recorded around the Falkland Islands or south of 46°S (*Agnew, 2002*).

Rock cod are not directly relevant to the proposed area of the operations and have not been discussed to any great extent within the addendum.

Southern blue whiting have a similar distribution to that of the Patagonian hake towards the south of the Falkland Islands. This species is most abundant in water depths of approximately 200 metres (*Inada and Nakamura, 1975*). Spawning occurs during September and October (possibly during August) in the south and south-west shelf waters of the Falkland Islands (*Agnew, 2002*) which is outside the proposed drilling period. Larvae are distributed toward the south and north-east of the Falkland Islands due to the anticlockwise flow of the Falkland Current. This species is a zooplanktivore and therefore thrives during the summer in shelf break waters where primary and secondary production is at its greatest.

Antarctic cod are one of the most common fish in Antarctic and subantarctic waters. Sixteen cod species have been recorded around the Falkland Islands. The most predominant species are rock cod (*Patagonotothen ramsayi)* and yellow belly (*Paranotothenia macrocephala*); common in nearshore waters in summer, but migrating to deeper waters during the winter (*ERT, 1997*). Spawning of most species occurs during autumn and through winter, which is outside the proposed drilling period.

Peak egg abundance has been recorded as occurring during spring (September to November). Although this is just outside the drilling period, it may coincide with the hatching of these eggs and the subsequent increase in larval abundance in the water column during the nursery period. Fish and larval stages can be particularly vulnerable to the effects of hydrocarbon pollutants, such as PAHs (*Stagg and McIntosh, 1996*). Most larvae are however pelagic and may be less likely to come into contact with untreated drilling fluids discharged to the seabed. Studies have also suggested that pollution originating from the oil exploration to the north of the islands or oil-based activities on the north shores of the Islands, would be unlikely to affect, in any major way the pelagic ecosystem around the Falkland Islands despite this area being known for its high plankton productivity (*Agnew, 2002*). Disruption to populations of fish species which spawn around the productive north and southwestern flanks of the continental shelf is believed to be most detrimental during spring (September to November; *Agnew, 2002*), which is just outside the proposed drilling period. The majority of early life stages of larvae are found in water depths of less than 400 metres around the continental slope, which is outside of the proposed drilling area. Fifty percent of all larvae collected during surveys over four years (1992-1995) were found in the 800-1,000 metre depth range, shallower than the water depth at Darwin East and Stebbing wells.

Cephalopods include species from the squid and octopus families. Squid are commercially exploited and are also an important food source for several species of marine predators (*Munro, 2004*). Octopuses are commonly found in kelp beds and rocky shores and are a prey source for sea lions. Some of the more notable cephalopod species on the Falkland Islands shelf are *Illex argentinus* (Argentine shortfin squid), *Loligo gahi* (Patagonian squid) and *Gonatus antarcticus*. Evaluation of the distribution of these species found that they tend to be concentrated around the east Falklands which is located further away from the proposed exploration area. *Illex argentinus* is one of the most abundant cephalopods in the south-west Atlantic. This species is caught in the FICZ between late February and June at depths of 80 – 800 metres, which are all outside of the proposed drilling area (Figure 3.10). *Loligo gahi* is generally found in shallower water around the coast up to water depths of 400 metres. It is therefore unlikely that this species will be impacted by the proposed drilling operations.

It is very unlikely that shellfish species will be found in the direct vicinity of the Darwin East-1, or Stebbing-3, exploration wells, due to the distance offshore and water depth.

3.2.5 Marine Mammals

Refer to section 5.2.8 (pages 5-31 and 5-46) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

Cetaceans

Refer to section 5.2.8 (pages 5-31 and 5-46) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

The following results includes data from the Distribution of Seabirds and Marine Mammals in Falkland Islands' Waters, 2002 and represent the findings of those surveys between 1998 and 2001 (*White et al., 2002*) and also the results from the Marine Mammal Observer (MMO) from the Borders and Southern 3D survey undertaken between 29th October 2007 and 10th February 2008. During the 1998 - 2001 JNCC survey, seventeen species of marine mammals were recorded over the period including 14 species of cetacean and three pinniped species. In total, 6,550 individual marine mammals were seen during the survey period.

Table 3.1 details the cetaceans that have been recorded within the offshore Falkland Islands area during the proposed drilling period (December to July) based upon the 1998 – 2001 JNCC survey (*White et al., 2002*).

Table 3.1 Cetaceans present in the vicinity of the proposed exploration wells during the proposed drilling months (December - July) (based upon White et al., 2002)

Species	Notes
Fin whale *(Balaenoptera physalus)*	Fin whale sightings peak between November and January with 53 sightings occurring during this period out of a total of 57 individuals observed. However no sightings occurred in the vicinity of the proposed exploration wells.
Sei whale *(Balaenoptera borealis)*	Most sei whale sightings were between November and April, with 45 individuals recorded on 31 occasions. Peak numbers occurred during November with a total of 15 individuals recorded. No sightings were recorded around the proposed exploration license area. Most records were from Patagonian Shelf and coastal waters, with others in relatively shallow waters. As the proposed Darwin and Stebbing wells are in deep water (>1,000 metres), this species are not anticipated to frequent the proposed drilling locations in any high numbers.
Sperm whale *(Physeter macrocephalus)*	A total of 28 sperm whales were recorded on 21 occasions, mainly in July, October and December, but also during most months. All sperm whale sightings occurred in deeper waters (>200 m), with records clustered to primarily to the north of the Falkland Islands. Although this species has been sighted in deep water around the Falkland Islands, no sightings occurred towards the south of the Islands
Minke whale *(Balaenoptera acutorostrata)*	Minke whale sightings peaked in April and December, with a total of 68 whales recorded on 60 occasions. The majority of records were from Patagonian Shelf waters around East Falklands and in the north-west of the survey area. Numbers are high during between November and January with 34 out of 68 individuals being sighted during this period. However none were observed in the proposed drilling area.
Southern bottle nose whale *(Hyperoodon planifrons)*	Southern bottlenose whales were only sighted between September and February, albeit in relatively low numbers (a total of 34 individuals recorded throughout the survey period). Only 8 of these individuals were recorded within the proposed drilling window and no sightings occurred within the vicinity of the exploration wells.
Hourglass dolphin *(Lagenorhynchus cruciger)*	Hourglass dolphins were frequently sighted around the Falkland Islands with a total of 866 sightings. Peak sightings occurred between September and February with over 250 sightings occurring during December alone which is within the proposed drilling period. No sightings were recorded within the proposed drilling area, however this species may be likely to be present during operations.
Peale's dolphin	Peale's dolphins were the most abundant cetacean species encountered. They occur in high numbers throughout the year however peak numbers occur in August. This species is predominantly coastal and was generally found in waters less than 200 metres deep, however the proposed Darwin and Stebbing drilling locations are in >2,000 metre and >1,400 metre water depths respectively.

Based upon the findings of the Distribution of Seabirds and Mammals in Falkland Island Waters (*White et al., 2002*), the predominant species which may be impacted by the proposed exploration drilling programme are hourglass dolphins and Peale's dolphin. Other cetaceans have been observed during the proposed drilling period, fin whales, sei whales, minke whales, but have not been sighted within the area of the proposed drilling operations in great numbers. This may reflect the lower survey effort which has been undertaken in these license areas compared to more coastal waters surrounding the Falkland Islands and to the west of the Falkland Islands. Therefore although these may not have been recorded within the proposed license area, they may still frequent the area (*Refer to Figure 5.18, Section 5.2.8, Page 5-32 of the Offshore Falkland Islands exploration drilling EIS*).

MMO data acquired during the Borders & Southern 3D Seismic Survey identified that the pilot whale was the most frequently observed cetacean in terms of individual numbers (228 individuals in 6 schools). Schools of the hourglass dolphin were the most commonly observed (20 schools with a total of 207 individuals) which was the second most frequent cetacean in terms of individual numbers. This was followed by Fin whale with 16 schools and 51 individuals observed. Table 3.2 and Figures 3.11 to Figure 3.14 present the cetaceans observed during this period. Based on these results which are specific to the proposed license area, pilot whales and hourglass dolphins are the most likely cetaceans to be found within licence area. Peale’s dolphin was more frequently observed closer to the shore (Figure 3.11) and sei, large rorqual (Figure 3.13), blue and sperm whales (Figure 3.14) occurring within the license area PL018, albeit in lower densities.

Table 3.2 Cetaceans observed during the Borders & Southern 3D seismic survey 29th October 2007 to 10th February 2008

Species	Schools	Individuals	Hrs / Sightings(of 686 hours)
Pilot	6	228	114.33
Killer	1	7	686
Peale’s Dolphin	5	14	137.2
Hourglass Dolphin	20	207	34.3
Unidentified Dolphin	6	81	114.33
Fin Whale	16	51	42.88
Sei Whale	3	5	228.67
Blue Whale	2	3	343
Dwarf Whale	1	1	686
Unidentified Baleen	10	23	68.6
Sperm Whale	8	20	85.75
Unidentified Whale	10	13	68.6
All Species	**88**	**653**	**-**

In conclusion, based upon all available data, the most likely cetacean species to occur within license area PL018 during the timing of proposed operations are hourglass dolphins, Peale’s dolphin and pilot and fin whales.

Figure 3.11 Hourglass and Peale's Dolphin sightings during the Borders & Southern 3D seismic survey 29th October 2007 to 10th February 2008

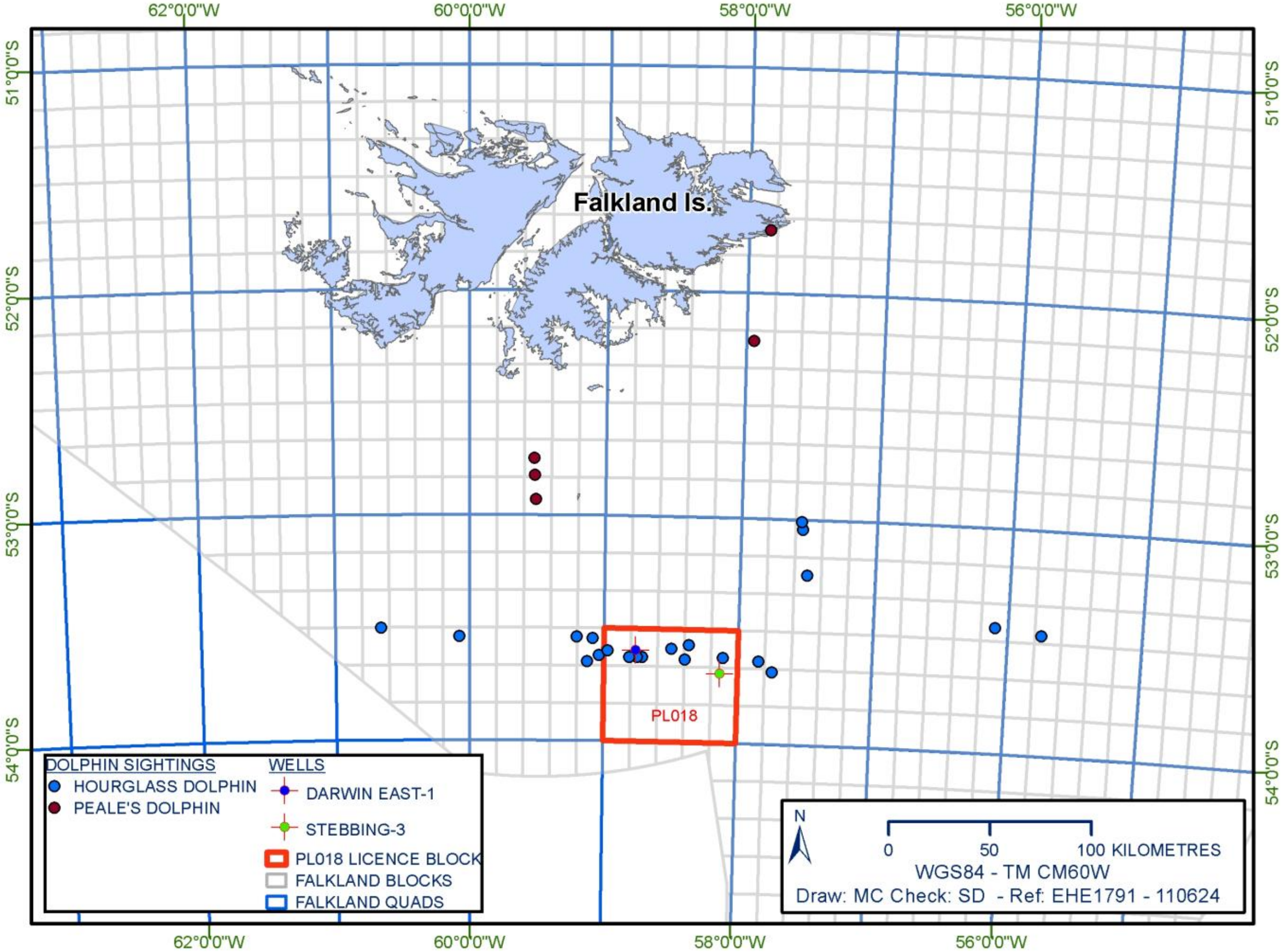


Figure 3.12 Unidentified whale species sightings during the Borders & Southern 3D seismic survey 29th October 2007 to 10th February 2008

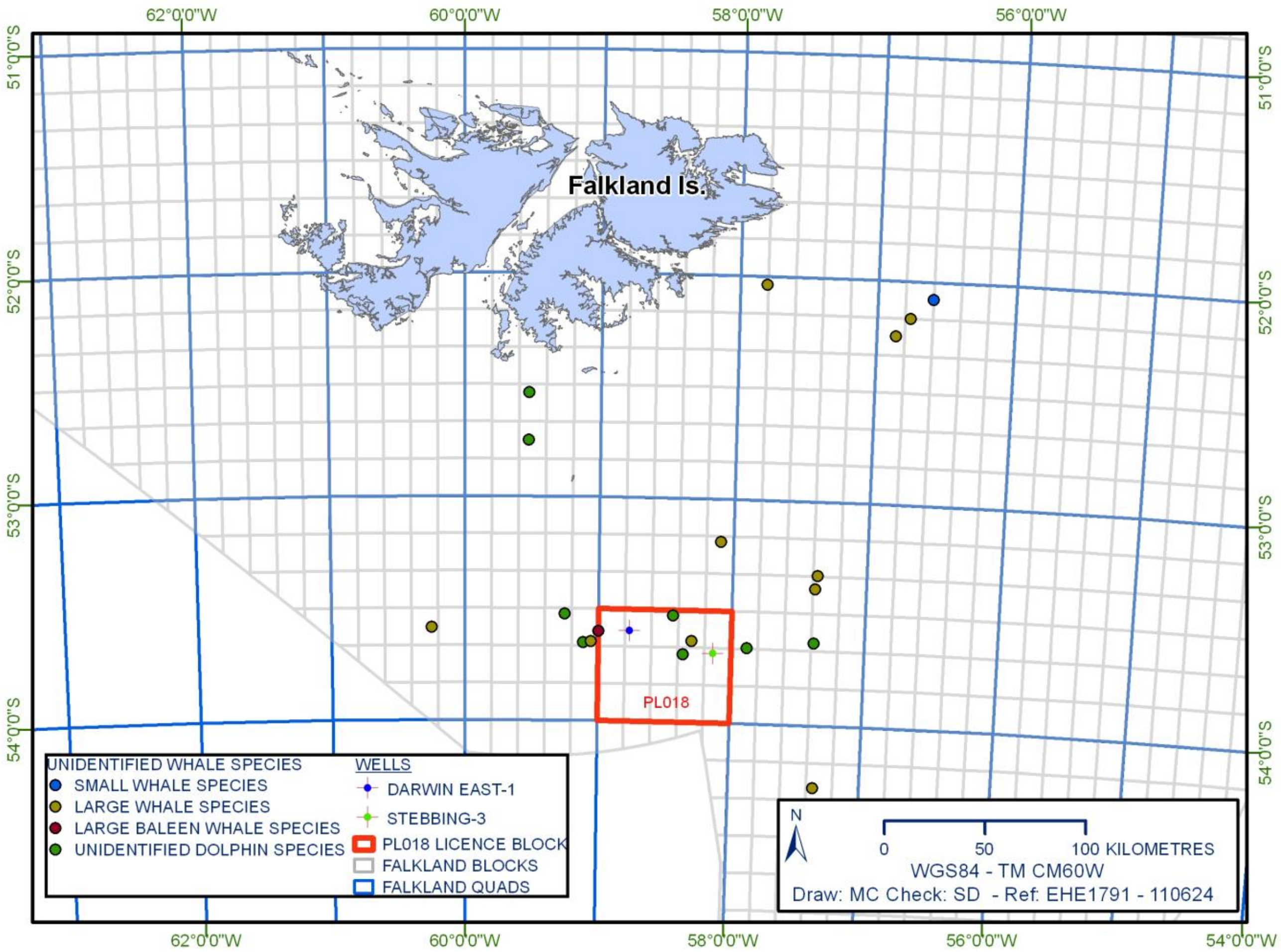


Figure 3.13 Blue whale, Dwarf whale, Killer Whale, Sei whale and Large Rorqual whale sightings during the Borders & Southern 3D seismic survey 29th October 2007 to 10th February 2008

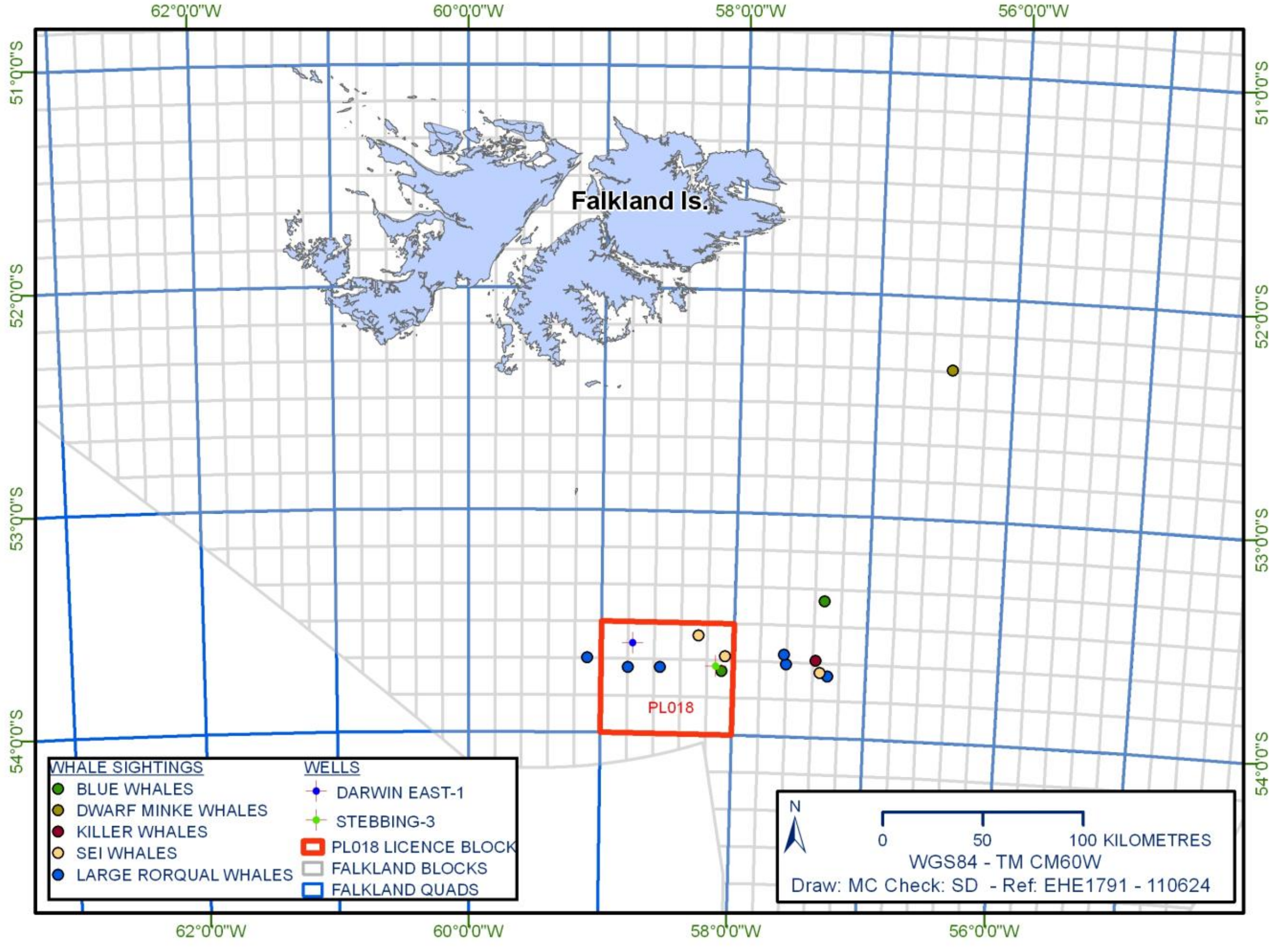
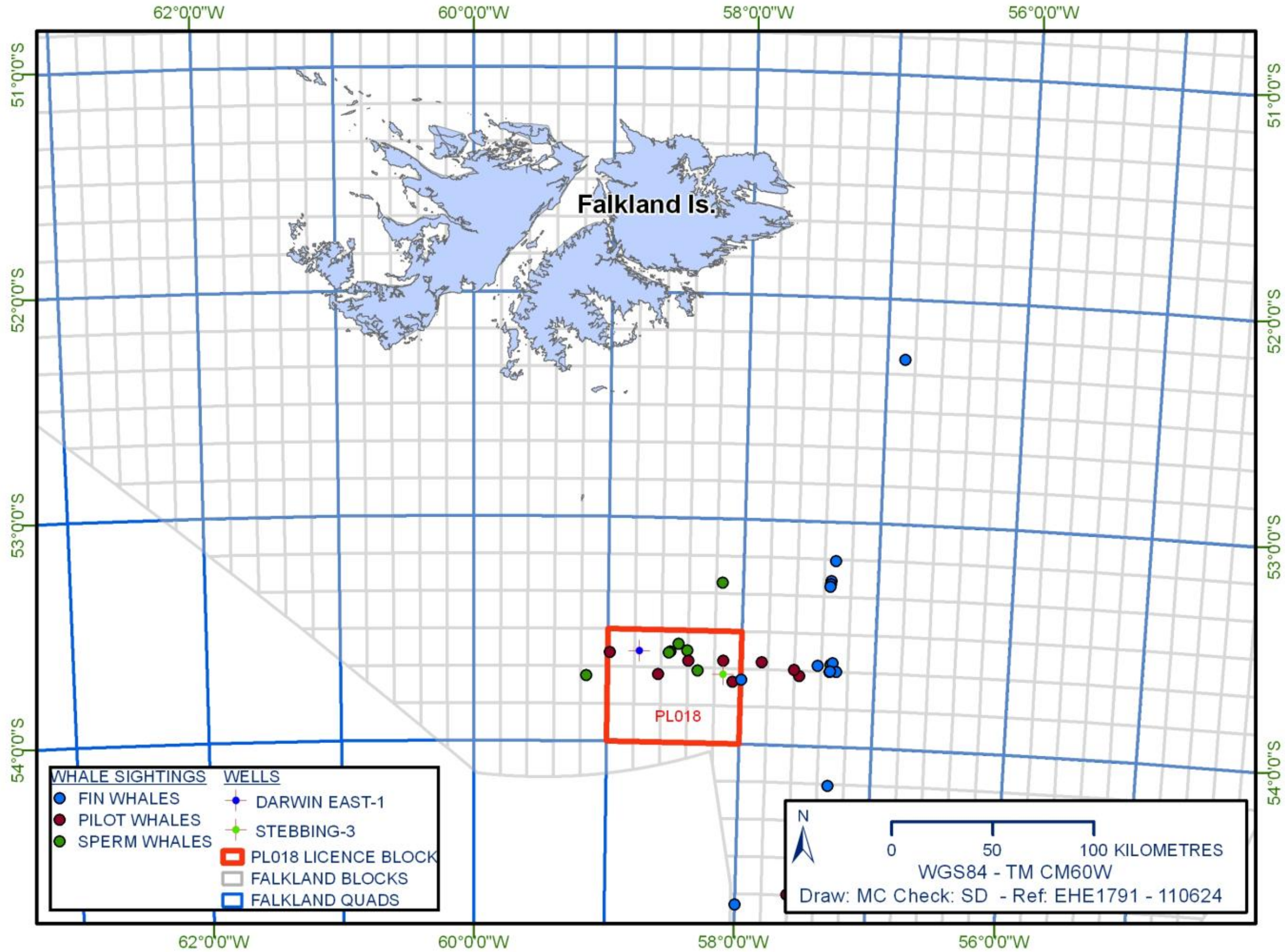


Figure 3.14 Fin whale, Pilot whale and Sperm whale sightings during the Borders & Southern 3D seismic survey 29th October 2007 to 10th February 2008



Pinnipeds

Refer to Section 5.2.8 (Pages 5-42 – 5-46) of the Offshore Falkland Islands exploration drilling EIS.

Three species of pinnipeds breed around the Falkland Islands; South American sea lion, South American fur seal and the southern elephant seal. Antarctic and subantarctic fur seals and leopard seals have also been recorded as occurring around the Falkland Islands but do not appear to be resident species.

The South American sea lion (*Otaria flavescens*, formerly *Otaria byronia*) also known as the southern or Patagonian sea lion. Both males and females are an orange-colour with upturned snouts. The manes on males are lighter than females, but female fur on the head and neck is lighter than that of males. Size varies with males having an average length of 2.6 metres and an average weight of about 300 kg. Females are slightly smaller, having an average length of 1.8 to 2 metres and usually weighing approximately half the weight of the males, around 150 kg. Breeding period commences in December when males establish territories within breeding colonies on remote sandy beaches along the coast. Females are present after pupping when they then mate and rear pups for 12 months or more (*Munro, 2004*). The UK Sea Mammals Research Unit (SMRU) conducted the most complete census of southern sea lions on the Falkland Islands in 1995 and repeated it in 2003 to monitor population trends. The two censuses update partial surveys conducted between 1934 and 1937 by Hamilton and aerial surveys conducted by Strange in 1990 (*Strange, 1992*). Population estimates have varied with the JNCC at-sea surveys estimating a Falkland Islands resident population of 3,385. Thompson (2003) estimates a current Falkland Islands population of approximately 7,047 animals, with an estimated 2,744 pups born annually. The census trends concluded that while the overall population is increasing, it is still well below the peak populations recorded in the 1930's, due to heavy exploitation during the twentieth century.

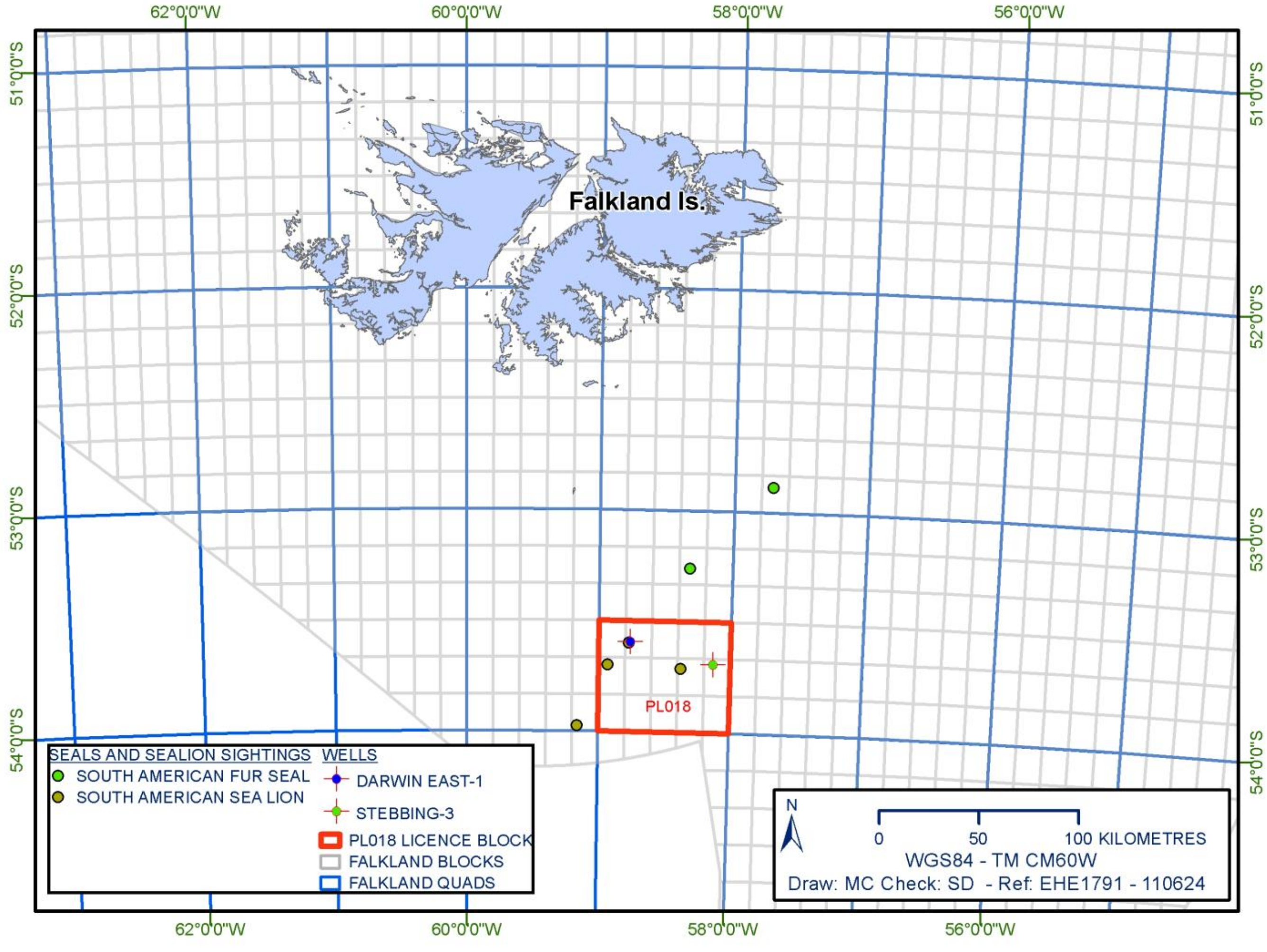
During winter, non-breeding individuals appear to remain in the Falkland Islands, hauling out at breeding sites and at other localities (*Otley, 2008*).

During the Marine Mammal Observation data from the Borders & Southern 3D Seismic Survey undertaken between 29th October 2007 and 10th February 2008 four sightings of South American sea lion were observed and two sightings of South American fur seals were observed (Table 3.3 and Figure 3.15).

Species	Schools	Individuals	Hrs / Sightings(Of 686 hours)
S. American Fur Seal	4	4	171.5
S. American Sea Lion	2	2	343
All Species	**6**	**6**	-

Given the distribution pattern and sightings recorded during the acquisition of the Borders & Southern 3D survey between 29th October 2007 to 10th February 2008, it is possible that South American sea lion might be present within the vicinity of the proposed drilling locations.

Figure 3.15 South American Fur Seal and South America Sea Lion sightings during the Borders & Southern 3D seismic survey 29th October 2007 to 10th February 2008



South American fur seals (*Arctocephalus australis)* were recorded (2 sightings) during the B&S 3D survey (October 2007 to 10th February 2008) on the 22nd November (Table 3.3 and Figure 3.15). But no sightings took place during December through to February. South American fur seals tend to inhabit more isolated rocky shores and cliffs where they are more sheltered from the sun. An estimated population of 10,000 individuals exists on the Falkland Islands (*Munro, 2004*). Mating commences in early November when bulls begin to establish their territories. Pups are born 6 – 8 weeks later during mid to late December. This period of mating and pupping coincides with the earliest proposed start of the drilling period in December, however will have finished by the end of the drilling. During this period, individuals tend to remain close to their haul out sites or within their breeding colonies. Foraging trips are generally restricted to within 10 kilometres of the breeding site during this period and they are therefore unlikely to venture offshore towards the vicinity of the drilling location during proposed operations. Outside of the drilling period, during autumn, extensive offshore foraging trips are undertaken up to 195 kilometres from the coast.

A satellite study by Thompson (2003) indicates that South American fur seal can forage as far as one hundred kilometres away from breeding sites. In this study, 16 adult female fur seals and one sub-adult male fur seal were satellite tracked for 10 to 163 days during October 1999 to June 2000. Early in the pup rearing cycle, the foraging effort was limited to short duration night time foraging trips within 10 kilometres of the breeding site and by autumn, seals were foraging for up to six days more than 195 kilometres away from the colony (*Thompson et al., 2003*). During this period of the season, greater levels of foraging effort occurred to the south-west of the Falkland Islands. The at-sea surveys of 1998 - 2000 showed the species is widespread in all regions, water depths and at various distances from land, but with the largest concentrations recorded inshore (*White et al., 2002*). During winter, non-breeding individuals appear to remain in the Falkland Islands, hauling out at breeding sites and at other localities (*Strange, 1992*).

If the spud date of the wells occurs during December it is unlikely that South American fur seals will be encountered foraging in the vicinity of the exploration wells. However should the spud date slip and which leads to the wells being completed in the summer months then the South American fur seals may be present for a short period at the well locations.

The southern elephant seal is the largest of the pinniped species. A breeding colony of this species is present on Sea Lion Island just off the south coast of the Falkland Islands. This species breeds between August and November where males establish territories at their breeding sites on Sea Lion Island. Pups are born around September, up to 10 days after females arrive at the breeding grounds. Moulting in females occurs around January where they return to land. Therefore during this period females may not be found in the vicinity of the exploration wells. Males however, moult later in the year between March and April. This species is therefore not restricted to land during the proposed drilling operations and may be found offshore.

Between 1995 and 2010, long term research on the population of southern elephant seals at Sea Lion Island has been carried out by the Elephant Seal Research Group (ESRG) (*Galimberti & Sanvito, 2011*). Sea Lion Island shelters the only notable breeding colony of the species in the Falkland Islands, with approximately 550 breeding females. Major analysis of the collected field data is currently ongoing, the bulk of which is laboratory based, and include studies on genetics, hormones, pathogens, haematology and blood chemistry, and stable isotopes analysis (*Galimberti & Sanvito, 2011*).

Of particular interest is the initial analysis of the satellite tracking data. The tracking maps from the Sea Lion Island animals show that offshore foraging distances are relatively short and are focused around some concentrated feeding areas. This contrasts markedly with data from elephant seal populations from similar studies in South Georgia and the Valdez Peninsula in Argentina. Maps of tracking data from these studies show that large areas of ocean are covered by individuals, with tracks stretching far out into the Atlantic Ocean, often covering hundreds of miles (*Falklands Conservation, 2010*). However, very few individuals did travel much further. In 2009, two of the five tracked females travelled far from Sea Lion Island, foraging over long loops with tracks very similar to those travelled by the South Georgia females. In 2010, one of the four year old tracked females roamed widely, with an additional two also roaming for long distances before stopping to forage in smaller areas (*Falklands Conservation, 2010*). This data suggests that individual elephant seals could be sighted in the vicinity of FOGL wells whilst undertaking a long foraging trip, although these are likely to be very rare occasions.

The ongoing studies by the ESRG will no doubt provide highly valuable information into the population and behaviour of the southern elephant seal population at Sea Lion Island, which will also provide useful indicators of their foraging behaviour offshore.

The leopard seal (*Hydrurga leptonyx*) has been sighted around the Falkland Islands during winter; however it is regarded as a seasonal visitor rather than a resident species and is therefore not expected to be encountered during the summer drilling period.

Although pinniped species may be present in the vicinity of the proposed drilling locations, species such as the South American fur seal and the leopard seal are unlikely to be encountered in the vicinity of the exploration wells during drilling due to life history stages such as breeding and pupping which generally restrict them to nearshore waters. The most likely species to be encountered is the South American sea lion and the elephant seal. Falkland Island populations of the southern elephant seal represent only a small proportion of the global population and results from the 1998-2001 JNCC seabirds and marine mammals at sea survey found no sightings of this species in the vicinity of the drilling locations. Southern Elephant seals are ashore between mid-September and February for breeding and subsequently, moulting. Only the South American sea lion has been reported in the vicinity of the exploration well locations during the proposed drilling period.

3.2.6 Seabirds

Refer to section 5.2.9 (pages 5-46 and 5-58) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

The Falkland Islands are an area of global importance for birdlife, particularly seabird species of international significance (Table 3.4 lists seabird species known to the Falkland Islands and their IUCN status). The North Falklands Current upwells nutrient rich water from Antarctic waters and provides an area of high plankton activity, forming the basis of the marine ecosystem and supporting seabird activity in the region.

Table 3.4 Falkland Islands seabird species

Species	IUCN Status	Percentage of World Population	Notes
Penguins			
King penguin	Least Concern	0.04%	Considered to be of local rather than global importance (*Munro, 2004*)
Gentoo penguin	Near Threatened	-	The population was estimated at 64,426 breeding pairs in 1995/1996, 113,000 in 2001/2002 and 65,857 in 2005/2006 and represents, of the 12 major breeding regions, the second largest gentoo population in the world after South Georgia (*Huin, 2007*)
Southern Rockhopper Penguin	Vulnerable	29%	Annual surveys conducted at selected sites suggest that the rockhopper population has stabilised since the early 1990's, although there are still occasional periodic annual declines from which the populations do not fully recover.
Macaroni penguin	Vulnerable	<1%	24 pairs recorded over 19 sites in the Falklands (Huin, 2007)
Magellanic penguin	Near Threatened	33%	An estimated 200,000 breeding pairs over 90 locations on the Islands are thought to comprise one third of the world's population (*Thompson, 1993*).
Chinstrap penguin	Least Concern	-	Does not breed in the Falkland Islands, however a total of 24 individuals were recorded on 10 occasions during the at sea survey period (1998–2001).
Petrels			
Northern giant petrel	Least Concern	-	-
Antarctic petrel	Least Concern	-	Winter visitors to the Falkland Islands.
Antarctic fulmar	Least Concern	-	-
Kerguelen petrel	Least Concern	-	Widespread across Falkland Islands
Atlantic petrel	Endangered	-	-
Grey petrel	Near Threatened	-	-
Great shearwater	Least Concern	<1%	Although of importance at a local level, the population is not globally significant as an estimated five million breeding pairs are found on the Tristan da Cunha and Gough Island group.
Little shearwater	Least Concern	-	the abundance of the species within the area of interest is not considered to be significant

Species	IUCN Status	Percentage of World Population	Notes
Grey backed storm-petrel	Least Concern	-	The Falkland Islands support between 1,000 and 5,000 breeding pairs of grey-backed storm-petrels (*Woods & Woods, 1997*).
Northern giant petrel	Least Concern	-	Non breeding in the Falklands
Southern giant petrel	Least Concern	-	Breeding regularly in the Falklands (population estimated at between 5,000 and 10,000 pairs (*Woods & Woods, 1997*).
Cape petrel	Least Concern	-	Distribution is primarily to the west of the Falkland Islands, although it becomes more widespread during October and November.
Blue petrel	Least Concern	-	non-breeding visitor to the Falkland Islands
Soft-plumaged petrel	Least Concern	-	non-breeding late summer visitors to the Falkland Islands
Prion spp.	Least Concern	-	Recorded as spp. through difficulties with identification due to size.
White-chinned petrel	Vulnerable	<1%	Breed on Falkland Islands.
Sooty shearwater	Near Threatened	-	breed on the Falkland Islands, with a population estimated at 10,000 to 20,000 pairs (*Woods & Woods, 1997*).
Wilson's storm-petrel	Least Concern	-	Breeds on the Falklands with an estimated population in excess of 5,000 pairs (*Woods & Woods, 1997*).
Black-bellied storm-petrel	Least Concern	-	Non breeding in the Falklands
White-bellied storm-petrel	Least Concern	-	Non breeding in the Falklands
Southern giant petrel	Least Concern	-	
Albatross			
Black-browed albatross	Endangered	70%	The population in the Falkland Islands is genetically distinct from all other populations and is the only albatross species that breeds on the Islands. Estimated 400,000 breeding pairs in the Falklands
Buller's albatross	Near Threatened	-	Grey-headed albatross visit the Falkland Islands from breeding grounds in South Georgia and Diego Ramirez.
Grey-headed albatross	Vulnerable	-	Grey-headed albatross visit the Falkland Islands from breeding grounds in South Georgia and Diego Ramirez.
Light-mantled albatross	Near Threatened	-	A non-breeding visitor from the South Georgia region where there are an estimated 5,000–7,000 breeding pairs.
Northern royal albatross	Endangered	-	visiting species, breeding in New Zealand and using South Pacific and Patagonian feeding grounds.
Southern royal albatross	Vulnerable	-	visiting species, breeding in New Zealand and using South Pacific and Patagonian feeding grounds.
Wandering albatross	Vulnerable	-	non-breeding visitor to the Falkland Islands, predominantly from breeding

Species	IUCN Status	Percentage of World Population	Notes
			colonies in the South Georgia Islands around 1,300 kilometres to the east.

Much of this section refers to data collected by JNCC. Borders & Southern recognise that the JNCC sources used for seabird and mammal distribution are outdated and only provide coarse resolution. After the award of the initial round of hydrocarbon exploration licenses in 1996, six wells were subsequently drilled. The threat to seabird and marine mammal populations was recognized, and in view of the lack of published data available, the Joint Nature Conservation Committee (JNCC) and Falklands Conservation (FC) conducted a Seabirds and Marine Mammals At Sea Survey between February 1998 and January 2001 (*White et al., 2002*). To date, the findings from these surveys are still the major body of work regarding the frequency and distribution of marine mammals and seabirds (particularly cetaceans), in the region, and for this reason were the main reference source used within the EIS.

The wide range of species present in the Falklands Island and the varying seasonal and temporal distributions coupled with the difficulty of open-ocean surveying presents a challenge in understanding the full extent of the interactions between birds and exploration activity.

A number of publications outlining survey efforts by authors including Croxall *et al.* (1984), Woods (1988; 1997), Strange (1992) have recently been supplemented by ongoing seabird monitoring and survey programmes conducted by FC/JNCC such as:

- Falkland Islands State of the Environment Report (*Otley et al., 2008*). This report documents the current knowledge of the Falkland Islands' environment.
- Origin, age, sex and breeding status of wandering albatrosses (*Diomedea exulans*), northern (*Macronectes halli*) and southern giant petrels (*Macronectes giganteus*) attending demersal longliners in Falkland Islands and Scotia Ridge waters, 2001 –2005 (*Otley et al., 2006*). The report summarises three years of survey work undertaken in Falkland Islands' waters between 2001 and 2005.
- Patterns of seabird attendance at Patagonian toothfish longliners in the oceanic waters of the Falkland Islands, 2001–2004 (*Otley, 2005*). This report summarises seabird attendance and activities at Patagonian toothfish longlining fisheries during line setting and hauling activities in deepwater to the east of the Falkland Islands between July 2001 and June 2004.
- The distribution of seabirds and marine mammals in Falkland Islands' waters (*White et al., 2002*). The report summarises three years of survey work undertaken in Falkland Islands' waters between February 1998 and January 2001.
- Vulnerable concentrations of seabirds (*White et al., 2001*). The report summarises two years of survey work in the form of a vulnerability atlas, with the aim of highlighting the locations of seabird concentrations that would be the most vulnerable to the effects of surface pollution.

These reports have been used extensively to provide a synopsis of seabird species abundance, distribution and sensitivities. The information presented in this and the proceeding sections has been based on these sources.

Between 1998 and 2001 a total of 218 species were recorded along with some unconfirmed sightings and have been included within this list. There were 21 resident landbirds, 18 waterbirds, 22 breeding seabirds, 18 annual non-breeding migrants and at least 139 occasional visitors (*Woods et al., 2004*). Between 2001 and 2005 a total of 547 sightings of 291 banded wandering albatross *Diomedea exulans* and 21 sightings of 14 banded giant petrels *Macronectes* spp. were made (*Otley, 2005*).

There are 22 designated Important Bird Areas (IBAs) on the Falkland Islands which cover a total area of 717 square kilometres (5.9 percent of the total land area of the Falkland Islands) (*Falklands Conservation, 2011*). The majority of these IBA's are located on small isolated islands where introduced predators such as rats are absent or have been eradicated, thereby allowing populations of previously threatened species to thrive.

There are five different species of breeding penguin in the Falkland Islands (Southern rockhopper penguins, Magellanic, gentoo, king and macaroni). The Falklands are the most important world site for the Southern rockhopper penguins and are also home to 80% of the world's breeding population of black-browed albatross. Several rare and threatened species of petrel nest on offshore islands.

Forster (2010) recognises that the Falkland Islands seabird population has been extensively examined both at sea by observers on fishing and research vessels, and on land in telemetry projects.

The papers collates multiple at-sea observer and satellite tracking dataset sets to examine whether sites of high species numbers or abundance were linked to seabed bathymetry, to assess whether listed threatened species were found in particular locations, and to discover if any areas showed evidence of hotspot foraging locations for multiple species.

The paper concludes that data collected by at-sea observers show no demonstrable link between seabed bathymetry and distance from land with areas containing a high number of unique species, aggregations of listed threatened species, or locations with high seabird abundance.

The collation and analysis of multiple satellite data sets found small geographic areas of high usage by the four tracked species in comparison to their total foraging range. With the application of additional data through further satellite studies, there is the potential to designate these high usage areas as marine IBAs under the criteria proposed by BirdLife International.

Penguins

Nine penguin species have been recorded in the Falkland Islands with the following six species identified during the at-sea survey period (1998–2001). Of these, only the Chinstrap penguin (p. *Antarctica*) is not considered to be a locally breeding species:

- King penguin (*Aptenodytes patagonicus*);
- Gentoo penguin (*Pygoscelis papua*);
- Southern rockhopper penguins (*Eudyptes chrysocome*);
- Macaroni penguin (*Eudyptes chrysolophus*);
- Magellanic penguin (*Speniscus magellanicus*);
- Chinstrap penguin (*P. antarctica*).

In a review by Putz (2002), king penguins from breeding islands (including the Falkland Islands) were equipped with global location sensors to compare their foraging patterns during different times of year. It was found that during the summer months, all birds travelled toward the Antarctic Polar Front (APF), where most remain north of the APF and forage in waters of the Antarctic Polar Frontal Zone. Some penguins travelled south of the APF and foraged in Antarctic waters. It is suggested by Putz that food resources in the area are sufficiently predictable to warrant travel of several hundred kilometres for foraging. During the winter months, birds originating from the Falkland Islands were seen to rely on the resources provided by the diverse and productive slope of the Patagonian Shelf. In most cases, a minimum of 10,000 kilometres distance was travelled over the year.

Putz and Cherel (2005) studied the diving behaviour of the king penguin in the Falkland Islands, where the population found there are considered to exist at the limit of their breeding range. During the investigation over 20,000 dives of greater than 3 metres were recorded from 12 birds during 15 foraging trips, with a mean duration of 5.7 days. The majority of the trips were directed up to 500 kilometres to the northeast of the breeding colony in slope waters of, and oceanic waters beyond, the Patagonian shelf.

Dive depth was seen to correlate positively with: (1) light intensity, (2) dive duration and (3) vertical velocities. However, separation of dives according to their profile—V-, U-, or W-shaped—revealed significant differences between certain dive parameters. It is suggested that foraging is more effective during W-dives than U-dives, and during twilight. These findings imply that king penguins have to make more complex decisions, individually and socially, on the performance of the subsequent dive than previously thought.

The gentoo penguin is a numerous species and is widely distributed around the Falkland Islands. This species has an affinity for inshore waters and has only been recorded offshore between the months of April and November which is just outside of the proposed drilling period. There have been no records of this species within the proposed exploration licence area.

Further investigations have looked into the foraging and breeding behaviours of other penguin species, including the Southern rockhopper penguins (*Eudyptes chrysocome*) (*Putz, 2006*). Individuals were satellite tracked in 2002 and 2003 during the onset of their winter migration. Birds were seen to travel at a mean velocity of 3.1 kilometres per hour, with the mean minimum distance travelled being 1,640 kilometres and the maximum distance to the colony was generally less than 1,000 kilometres.

The penguins dispersed over an area totalling about 1.3 million square kilometres, ranging from 50 to 62°S and from 49°W in the Atlantic to 92°W in the Pacific, and covering polar, sub-polar and temperate waters in oceanic regions as well as shelf waters. Despite the very wide dispersal, both temporally and spatially, two important wintering grounds for Southern rockhopper penguins from Staten Island could be identified, both located over shelf regions: one extended from Staten Island to the north along the coast of Tierra del Fuego up to the Magellan Strait; the other was located over the Burdwood Bank, an isolated extension of the Patagonian Shelf to the south of the Falkland Islands.

The Drake Passage also appeared to be an important area for wintering penguins, although dispersal was far more widely spread. Comparison with data obtained during winter from Southern rockhopper penguins originating from the Falkland Islands showed that the area off the coast of Tierra del Fuego was used more or less exclusively by birds from Staten Island, whereas the Burdwood Bank was shared with penguins coming from southern colonies in the Falkland Islands.

Three important colonies of Southern rockhopper penguins exist within the Falkland Islands territory. Of these, the largest colony is located on Beauchêne Island which is located 130 kilometres from the Darwin East well and 155 kilometres from the Stebbing well. Foraging movements of this species indicate that it may frequent the proposed drilling location at certain times however most movements are typically near-shore. Satellite tracking of Southern rockhopper penguins in 2002 and 2003 during their winter migration, demonstrated that they travel a mean distance of 1,640 kilometres, which indicates that this species is capable of extensive far-ranging movements. The licence area (although not the proposed exploration wells) also overlaps Burdwood Bank which is a southern extension of the Patagonian shelf. This is known as an important area for overwintering Southern rockhopper penguins originating from more southern colonies (*Putz, 2006*). This species reaches seasonal highs during the summer months, between November and January which is within the proposed drilling period (*Refer to figure 5.25, page 5-47 of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018*).

The Magellanic penguin is the most abundant penguin species around the Falkland Islands. The Falkland Islands also supports a significant proportion of the global Magellanic penguin population. Highest densities of this species were recorded between December and February which is during the proposed drilling period. Tagging studies have also demonstrated that this species may undertake longer further foraging trips offshore into the proposed exploration license areas, however the majority of sightings were around the north of the Falkland Islands and in near-shore waters. Therefore this species may frequent the proposed drilling area, but it is anticipated that this will not occur in any significant numbers.

Of the above species Southern rockhopper penguins and Magellanic penguins reach seasonal peaks during the time of the proposed drilling period. The Magellanic penguin was recorded in the highest densities throughout the JNCC survey period (1998 – 2001).

Albatrosses

Albatross species are globally declining with populations in the Falkland Islands reported to have dropped by 28% in the last 20 years (*Woods, 1988*). Eleven species of albatross have been recorded in the Falkland Islands, although only the black-browed albatross is a resident breeding species.

Ten of the 11 species of albatross recorded in the Falkland Islands are afforded conservation status according to their status on the IUCN Red List (*IUCN, 2010*), and include:

- Black-browed albatross (*Thalassarche melanophris*) – Endangered;
- Buller's albatross (*Thalassarche bulleri*) – Near Threatened;
- Grey-headed albatross (*Thalassarche chrysostoma*) – Vulnerable;
- Light-mantled albatross (*Phoebetria palpebrata*) – Near Threatened;
- Northern royal albatross (*Diomedea sanfordi*) – Endangered;
- Shy albatross (*Thalassarche cauta*) – Near Threatened;
- Sooty albatross (*Phoebetria fusca*) – Endangered;
- Southern royal albatross (*Diomedea epomophora*) – Vulnerable;
- Wandering albatross (*Diomedea exulans*) – Vulnerable;
- Atlantic yellow-nosed albatross (*Thalassarche chlororhynchos*) – Endangered.

Of the above, Black-browed albatross, Wandering albatross and Grey headed albatross can be expected to be found within the vicinity of the drilling activity during the drilling period (refer to Table 3.5). Black-browed albatross had declined by 0.7 percent per annum between 2000 and 2005 (*Huin, 2007*). The increase in mortality has been attributed to fishing activities such as long-lining and trawling throughout the range of this species.

The first two complete censuses of the Black-browed Albatross population of the Falkland Islands were conducted in November 2000 and 2005 (*Huin, 2007*). The total number of breeding pairs in the Falkland Islands changed from mean 414,268 in 2000 to mean 399,416 in 2005, which represents a decline of 0.7 percent per annum of original numbers. Although no previous complete census exists, combining historical data showed that the population consisted of around 437,855 pairs in 1995. This represents a total loss of 38,439 pairs in the last ten years, or a decrease of just below 1 percent per annum. The creation of a photographic database helped Huin (2007) in identifying areas of the colonies that have shrunk due to the reduction in breeding numbers. The Falkland Islands now holds 65 percent of the world population of this species, which should retain its status of Endangered species. This decrease is linked with increased mortality at sea due to fishing activities such as longlining and trawling, not only in Falkland Islands waters but throughout its range in the southern hemisphere. The reduction of such mortality to negligible levels (as recently achieved through improved management in Falkland Islands waters) is an essential condition for the survival of the Black-browed Albatross.

Huin (2007) studied the foraging distribution of the black-browed albatross, based on two different stages of the breeding season and two separate breeding sites. He identified that during the incubation period, birds from the north travel northwards from the Falkland Islands. During this period foraging trips were longest, both in terms of distance travelled and duration. Albatrosses foraged mainly over the Patagonian Shelf or along its edge. During the post-guard period, foraging areas were much restricted with many birds staying close to the coast. Each group had a clear foraging area, and this use of mutually exclusive foraging is thought to be part of a strategy to minimise intra-specific competition (*Huin, 2007*).

Table 3.5 Albatross species likely to be in the vicinity of the drilling locations during the proposed drilling period (December 2011 - July 2012) (JNCC, 2002)

Species	Notes
Royal albatrosses	The Royal albatrosses are a visiting species, breeding in New Zealand and using South Pacific and Patagonian feeding grounds. The Southern Royal albatross is classified as 'Vulnerable' where as the Northern is 'Endangered'. Of the 4,114 Royal albatrosses recorded (1998–2001), 3,252 were identified as Southern and 447 as Northern (with 415 not determined). Highest numbers of Southern royal albatross were seen between March and June, particularly to the north-west of the Falklands. Highest numbers of Northern Royal albatross were seen between March and July. As the majority of sightings occur to the north-west of the Falkland Islands, the presence of this species is likely to be insignificant at the drilling location during the time period of proposed operations.
Black-browed albatross	80 percent of the breeding population of black-browed albatross inhabit the Falkland Islands. Black-browed albatross were recorded throughout the year (1998–2001), with a total of 84,614 birds recorded, reaching a peak in March. Between December and June the highest densities occurred in inshore waters to the west of the Falkland Islands. Between July and October high densities shifted to the south-west of the Falklands. There are very low recorded densities in the vicinity of the drilling locations.
Grey-headed albatross	A total of 1,321 Grey-headed albatross were recorded, covering all months (1998–2001) with a peak between May and September. Distribution varied throughout the year, with species recorded over the proposed well locations throughout the year but particularly between July and September which is predominately outside the proposed drilling period.
Wandering albatross	The wandering albatross is a non-breeding visitor to the Falkland Islands originating from breeding colonies in the South Georgia Islands. This species has been recorded throughout the year and peaks during November with high densities also recorded between January and April. This species may therefore be found in the vicinity of the proposed exploration license areas.

Tagging studies of Procellariformes (albatrosses and petrels) have been undertaken in order to assess the at-sea distribution of these species in order to identify areas of significant habitat utilisation which may be designated to afford these species further protection through the designation of Important Bird Areas (IBA's) and Marine Protected Areas (MPA's) (*BirdLife International, 2004*). These studies have also been used to identify overlap areas between fisheries (particularly longliners) which are known to cause population mortality of many seabirds. The study by BirdLife International in 2004 involved satellite platform terminal transmitter (PTT) tracking and geolocator tracking (GLS) of albatrosses and petrels in order to analyse movement, abundance and distribution of these species as well as compile a database of knowledge on tagged individuals which could then be used as a tool for global conservation. Results showed movements and distribution of birds outside of the breeding period when they would otherwise be restricted to land. Breeding sites for albatrosses are known to be located on the Falkland Islands.

From the satellite tagging, it was evident that black-browed, wandering, southern, northern and grey-headed albatrosses all frequent the area around the Falkland Islands (*BirdLife International, 2004*). The distribution of these species depends on their life history stages. During the chick rearing period, the black-browed albatross foraged within the Falkland Islands Inner Conservation Zone. During the chick incubation and rearing periods foraging was exclusively to the north of the islands. Black-browed albatross located at Beauchêne Island foraged over the largest area with most trips being undertaken towards the Patagonian Shelf to the south-west of the islands. Beauchêne populations were also restricted to nearshore foraging during chick rearing around the south Falklands, Sea Lion Island and Beauchêne Island itself. Rearing and breeding colonies in the north of the Falkland Islands generally concentrated their foraging to the north of the islands.

This indicated population partitioning between colonies in the north and south which were faithful to waters around their breeding areas. After breeding, black-browed albatrosses from the Falkland Islands winter on the Patagonian shelf which is in much closer proximity to breeding grounds compared to other populations such as the South Georgia Islands populations. Males are generally restricted to the shelf break whereas females were observed to utilise the whole Patagonian Shelf.

The wandering albatross is a wide ranging species and mainly feeds on the South Georgia shelf with both males and females observed to occasionally visit the Falkland Islands and Burdwood Bank waters. The grey-headed albatross core feeding areas were situated in the Antarctic Polar Frontal Zone which is located south of the proposed drilling area.

Petrels and Shearwaters

Petrels and shearwaters form the largest group of oceanic birds, remaining at sea throughout their lives, except for a few months each year when they return to land to breed. The most common breeding species is the southern giant petrel (*Macronectes giganteus*) (*Otley et al., 2008*). As many as 26 species have previously been recorded in the Falkland Islands with nine species breeding on the Islands:

- Northern giant petrel (*Macronectes halli*)
- Southern giant petrel (*Macronectes giganteus*)
- Antarctic petrel (*Thalassoica Antarctica*)
- Cape petrel (*Daption capense*)
- Antarctic fulmar (*Fulmarus glacialoides*)
- Blue petrel (*Halobaena caerulea*)
- Kerguelen petrel (*Pterodroma brevirostris*)
- Soft-plumaged petrel (*Pterodroma mollis*)
- Atlantic petrel (*Pterodroma incerta*)
- Prion spp. (*Pachyptila* spp)
- Grey petrel (*Procellaria cinerea*)
- White-chinned petrel (*Procellaria aequinoctialis*)
- Great shearwater (*Puffins gravis*)
- Sooty shearwater (*Puffins griseus*)
- Little shearwater (*Puffins assimilis*)
- Wilson's storm-petrel (*Oceanites oceanicus*)
- Grey backed storm-petrel (*Garrodia nereis*)
- Black-bellied storm-petrel (*Fregetta tropica*)
- White-bellied storm-petrel (*Fregetta grallaria*)
- White-bellied storm-petrel (*Fregetta grallaria*)
- Northern giant petrel (*Macronectes halli*)
- Southern giant petrel (*Macronectes giganteus*)

Giant petrels are the largest birds found within the family Procellaridae. They are predominantly scavengers and rely on prey taken by penguins and pinnipeds for sustenance and supplement this with live prey such as seabirds, squid and crustacea (*BirdLife International, 2004*). Tagging studies of northern and southern giant petrels revealed that distinct sexual dimorphism exists between males and females of these species which leads to differential habitat utilisation. Males generally exhibited nearshore discrete foraging trips, whereas females undertook foraging in offshore waters around South Georgia. Female southern giant petrels tended to forage in eastern waters around South Georgia Islands, whereas female northern giant petrels exhibited a fidelity to the Patagonian shelf.

Several of the above species may be present in the vicinity of the proposed exploration wells given the timing of the exploration campaign (refer to Table 3.6).

Table 3.6 Likely distribution of Petrel and Shearwater during the proposed drilling period (December 2011 – July 2012)(JNCC, 2002)

Species	Notes
Northern giant petrels	Northern giant petrels have been recorded throughout the year. Between March and August densities were highest to the north and west of the Falklands. From September to February sightings were less concentrated and more widely scattered. Northern giant petrels were less likely to be recorded in coastal or inshore waters. The presence to the north-west of the Falklands therefore indicates that this species is not likely to frequently occur within the proposed license areas.
Southern giant petrel	The southern giant petrel has been recorded throughout during at-sea surveys. Greatest densities were observed over the Patagonian shelf, due to high biological productivity at this location, between March and June. The majority of breeding colonies are located around the south and west of the Falkland Islands. This species may therefore be sighted around the proposed drilling locations.
Antarctic petrel	A total of 56 Antarctic petrels were recorded in waters to the south-east of the Falklands. All records were in the period July to September. It is unlikely that the Antarctic petrel will be present over the proposed drilling locations, however should operations continue through to July 2012 the Antarctic petrel may be present.
Atlantic petrel	252 Atlantic petrels were recorded, predominantly between October and March. Most sightings occurred in deep water to the north-east and south-east of the Falklands. This species is likely to be found within the proposed drilling area, however it has a widespread distribution which suggests that this species is not restricted to nor relies on the license area for any reason.
Blue petrel	573 individuals of this non-breeding species were recorded between May and October. Most sightings occurred over deep waters to the east and south-east of the licence area during the months of August and September, outside of the proposed drilling period. Blue Petrel were recorded during the months of May, June and July which are within the proposed drilling period, however in significantly lower numbers compared to August and September, its presence is therefore not considered to be significant during the proposed drilling activities.
Cape petrels	Cape petrels were recorded every month, with a total of 15,199 records made over the survey. Highest numbers were recorded between May and September with very few records occurring between December and April. Should the drilling operations continue into the months of May, June and July there is the possibility that Cape Petrels will be present in the vicinity of the drilling location. However Cape petrels were only recorded in abundance to the north of the Falklands over this period, lessening off between October and November with very few records in this area throughout the rest of the year.
Diving petrels	A total of 6,078 diving petrels were recorded which encompassed the Magellan, common and other unidentified diving petrels. Most were recorded between September and February which is within the proposed drilling period. The greatest densities were around the west and south of the Falkland Islands. Therefore this group may be encountered during the proposed drilling operations, however their presence is not considered to be significant.
Grey petrels	Grey petrels were recorded mainly between December and March, with peak numbers in February. A total of 45 grey petrels were recorded, all in deep waters to the north and east of the Falklands. Although widely distributed, grey petrels are more likely to be sighted to the east and south-east of the Falkland Islands. Therefore within the drilling area there may be significant numbers of grey petrels, particularly as they have been recorded during the proposed drilling period time-frame.
Kerguelen petrels	A total of 152 Kerguelen petrels were recorded only between May and November. This species was only observed around the deep waters to the north, east and south of the Falkland Islands. Occasional sightings within the licence area may therefore be possible.
Soft-plumaged petrels	This species is a non-breeding visitor to the Falkland Islands, a total of 861 individuals were recorded between 1998 and 2001. All records were within the period November to April, with a peak in January. There was considerable inter-annual variation in the numbers of soft-plumaged petrels recorded. However, most sightings were in deep waters towards the northeast of the Falklands, therefore its presence in this area during the proposed drilling activities is not considered to be significant.

Species	Notes
White-chinned petrel	The white-chinned petrel breed on the Falkland Islands and survey work from summers of 2004/2005 and 2005/2006 indicate that this accounts for less than 1% of the global population. A total of 8,044 white-chinned petrels were recorded from the at-sea survey (1998–2001), encompassing all months but with the highest numbers between January and May, during the proposed drilling period. Most records were to the north and west of the Falklands rather than over the proposed drilling locations, therefore the species is not considered to be present in numbers.
Great shearwaters	Great shearwaters were recorded primarily between December and April during the at-sea survey, with almost none recorded between June and October. Total number of records was 6,468, mainly over shelf slope and oceanic waters to the north and east of the Falkland Islands. Although of importance at a local level, the population is not globally significant. Distribution is scattered therefore the licence area is not expected to be a significant habitat for this species.
Sooty shearwaters	Sooty shearwaters breed on the Falkland Islands mainly between September and March within which the drilling period is situated. The Falkland Island population is also not considered to be globally significant due to the large populations found elsewhere. Although sightings may occur within the vicinity of the drilling area, generally this species is restricted to shallower inshore locations.
Grey-backed storm-petrels	The Falkland Islands support between 1,000 and 5,000 breeding pairs of grey-backed storm-petrels (*Woods & Woods, 1997*). A total of 2,758 grey-backed storm-petrels were recorded, mainly between September and March. Records occurred on all sides of the Falklands, with high densities recorded to the north of the Falklands from November to March. This coincides with the proposed drilling period. However the concentration of this species towards the north suggests that their occurrence is not likely to be significant.
Antarctic fulmar	18,061 Antarctic fulmars were recorded, only in the period between April and December. In May and June, Antarctic fulmars were widespread at high densities throughout Patagonian Shelf waters to the west and north-west of the islands. At this time Antarctic fulmars were virtually absent from Patagonian Shelf waters to the south-east of East Falkland. In the period July to October, highest densities were found in inshore waters. It is therefore unlikely that the species will be present in any significant numbers at the proposed drilling locations.
Fairy prion	The fairy prion was identifiable at sea and has been recorded separately. In total 228 fairy prions were recorded, in all months except February, with peaks in April, August and October. This species was recorded primarily in continental shelf slope and oceanic waters. Distribution of the fairy prion is widely scattered and sensitivity in the vicinity of the drilling area is not considered to be significant.
Prion species	Due to the difficulty in identifying prions (small petrels) to species level at sea, most records from the survey were for ‘prion species’. A total of 119,610 records make prions the most numerous seabirds encountered during the survey, with the highest numbers recorded between September and January, which is within the proposed drilling period. Highest densities were recorded to the west, north and south of the Falklands. Occasional sightings within the vicinity of the drilling area may be possible, however due to the concentration of prion sightings outside of this area occurrence is not considered to be significant.
Black bellied storm-petrel White bellied storm-petrel	Black bellied and white bellied storm-petrels were both recorded, primarily between December and February and in the deep waters to the north-east of the Falklands, outside of the drilling area. There were 205 records of black bellied storm-petrels and 23 of white bellied storm-petrels. Numbers of both species peaked in January, which is within the proposed drilling period. Occasional sightings of black bellied storm-petrels are likely to the south of the Islands, although the number of sightings within the vicinity of the proposed drilling area is not considered significant.

Shags

There are two resident breeding species of shag recorded in Falkland Islands’ waters (*Woods, 1988*): rock shag (*Phalacrocorax magellanicus*) and imperial shag (*Phalacrocorax atriceps*). These species however are inshore coastal species and do not venture further than 27 kilometres and 37 kilometres from the land respectively therefore it is very unlikely for either of these species to be present in the vicinity of the exploration wells.

Swans, Geese and Ducks

Twenty one species of swans, geese and ducks have been recorded in the Falkland Islands. The majority of these species are migratory and are most likely to be found in coastal waters rather than in deeper offshore waters around the licence area.

One species, the Falklands steamer duck (*Tachyeres brachydactyla*) is endemic to the Falkland Island and a total of 699 individuals were recorded during the 1998-2001 JNCC seabird survey. Most of these sightings were in coastal waters and peaking during April and sightings tailed off during the austral summer months when the proposed drilling operations are planned to commence. Therefore the occurrence of this species within the licence area is not considered to be significant.

Skuas (Stercorariidae)

Five species of skua have been recorded around the Falkland Islands territory; Falklands skua (*Catharacta antarctica*), Arctic skua (*Stercorarius parasiticus*), long-tailed skua (*Stercorarius longicaudus*), south polar skua (*Catharacta maccormicki*) and the Chilean skua (*Catharacta chilensis*).

Of these, only the Falklands skua breeds on the Falkland Islands. Philips *et. al.* (2007) is the first published study of the wintering ranges and activity patterns of skuas from any colony. The study combines tracking (geolocator) and stable isotope analysis in a comparison of migration behaviour of brown skuas (*Catharacta lonnbergi*) and Falkland skuas (*C. Antarctica*) from South Georgia and the Falkland Islands, respectively. It found that Falkland skuas performed a pre-laying exodus and that they wintered mainly in subantarctic waters around the central Patagonian shelf-break (40 to 52° S). Both species of skua spent far more time on the water than foraging albatrosses.

Although the sample sizes were relatively small (4 to 6 individuals from each site), the similarity in feather isotope signatures of the tracked birds indicate that all of these birds almost certainly used the same water masses in the non-breeding period. Comprehensive at-sea surveys over several years in Falkland Islands waters concluded that the only Falkland skuas to remain in the area during the winter months were far to the north (*White et al., 2001*), in agreement with the results from Philips *et. al.* (2007).

Most sightings of skuas occurred between November and April which coincides with the proposed drilling period, however most sightings were also in inshore coastal waters or around deeper waters to the north and north-east of the Falklands. Therefore their presence around the licence area during operations is not considered to be significant.

Gulls (Laridae)

Seven species of gull have been recorded in the Falkland Islands, of which the following three species are known to breed in the Falklands (listed below) and were recorded during the at-sea surveys:

- Dolphin gull (*Larus scoresbii*);
- Kelp gull (*Larus dominicanus*);
- Brown-hooded gull (*Larus maculipennis*).

All sightings of the above species have generally been restricted to near-shore areas (within 50 kilometres from the coast) and are unlikely to be sighted over the proposed exploration drilling area given the distance from shore (the nearest well is the Darwin East-1 well located 150 kilometres from shore).

Terns

Three species of tern were recorded during the at-sea survey (listed below), although eight species have been previously recorded in Falkland Islands' waters (Otley et al., 2008) of which only one species is known to breed in the Falkland Islands:

- South American tern (Sterna hirundinacea);
- Arctic tern (Sterna paradisea);
- Unidentified sterna tern (Sterna spp).

A total of 1,894 South American terns were recorded during the at-sea survey for all months and peaking March to April. The South American tern is the only species known to breed in the Falkland Islands. Distribution was mainly in coastal waters.

Arctic terns are a summer visitor to the Falklands. A total of 21 Arctic terns was recorded during the at-sea survey, all between October and March. They were observed widely distributed throughout the at-sea survey area, mostly in offshore areas. A number of unidentified sterna terns were also recorded during the at-sea survey. Of the 160 unidentified terns recorded in offshore waters, the majority were between April and November. Distribution was widely scattered although very few sightings were made to the south-east of the Falkland Islands.

3.2.7 Seabird Vulnerability

Refer to section 5.2.10 (pages 5-58 and 5-65) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

Seabirds are affected by a number of anthropogenic factors including, competition with commercial fisheries, mortality through longline fishing and contamination from various forms of pollution. Within Falkland Islands' waters, negative impacts on seabird productivity through competition for food with commercial fisheries have not yet been identified (*White et al., 2001*). Death from entanglement and snagging with longline hooks is considered to be of low risk due to a well managed fishery and a relatively low amount of longlining. However, mortality through competition and incidental capture of migratory birds such as albatrosses and petrels in longlining and other pelagic fisheries is considered to be a serious threat (*BirdLife International, 2004*).

To date, reports of adverse effects to seabirds from surface pollution such as oil is low in the Falkland Islands. Hence, the increasing oil and gas exploration activities in the area are a potential threat to seabird populations.

The following information has been sourced from '*Vulnerable Concentrations of Seabirds in Falkland Islands Waters' (1998–2000)*, a report produced by the JNCC under contract to Falklands Conservation, with funding support from the FIG (*JNCC, 2001*).

Seabird vulnerability was assessed by the Seabirds At Sea Team (SAST) with regard to species-specific aspects of their feeding, breeding and population ecology. Maps produced in the report can be used to identify areas supporting seabird concentrations at greatest risk to the threat of surface pollution. Methods used for development of the vulnerability atlas are complex and well documented (*White et al., 2001*) and are not expanded upon further here.

A summary of the seabird vulnerability survey results from the above report in relation to the proposed exploration campaign is shown in Figure 3.16. The result of oil spill modelling for an uncontrolled flow (blowout) release over 10 days from the Stebbing-3 location (see section 4, table 4.9) has been overlaid to illustrate the potential impact of a worse case oil spill.

In general the licence area for the proposed exploration project is either unsurveyed or tends to have relatively low seabird vulnerability which increases during the summer months. Within licence area PL018 during the proposed drilling period, seabird vulnerability is 'medium' to 'high' (Figure 3.16). However during some months (December and February), license area PL018 was unsurveyed and a small proportion of the proposed license area was unsurveyed during November. As the seabird vulnerability is 'medium' to 'high' in the months surrounding December

(November and January) it could be inferred that the vulnerability would be comparable these months as previous at-sea survey do not indicate December to possess significant peaks of several bird species offshore (refer to section 3.2.7 of this Addendum; *JNCC, 2002*). Few sites in the south western Atlantic and around southern South America have been found to be important to several species of seabirds. In general discrete areas are important to individual species (*BirdLife International, 2004*). Therefore this reduced the potential for widespread disturbance to several species of seabird that may be offshore.

The months of lowest seabird vulnerability in the vicinity of the proposed exploration area are between June and October. Highest vulnerability tends to be associated with the inshore waters around the Falkland Islands. This is attributed to the number of resident species around the coasts and breeding colonies. The waters around the Patagonian Shelf also support large numbers of feeding and migrating seabirds due to the high productivity associated with the shelf break front occurring in these waters. These areas are therefore located away from the proposed drilling locations.

Seasonal seabird vulnerability maps compiled by JNCC demonstrate medium to low seabird vulnerability during the proposed drilling period (see Figure 3.16). During the planned drilling period the majority of seabirds do appear to be sighted to the north and west of the Falkland Islands.

Seabird vulnerability is consistently high in the coastal near-shore waters surrounding the Falkland Islands reflecting the higher density of seabird populations in these areas. Outside of the coastal zone the vulnerability varies regionally throughout the year.

However, the compilation of seabird concentration maps is no doubt influenced by the sampling density mostly being compiled from vessel observations. The areas of high seabird densities are commonly coincidental with the areas of fishing activity reflecting where the sampling took place.

Magellanic penguins, Wandering albatross, Southern giant petrels and Grey petrels all record peak occurrence within the planned drilling period.

Figure 3.16 Seasonal Seabird Vulnerability to Surface Pollution overlain with Stochastic model run of well blowout (27.5 tonnes per hour, for 240 hours) of 25° API crude oil released at the Stebbin-3 under typical wind conditions.

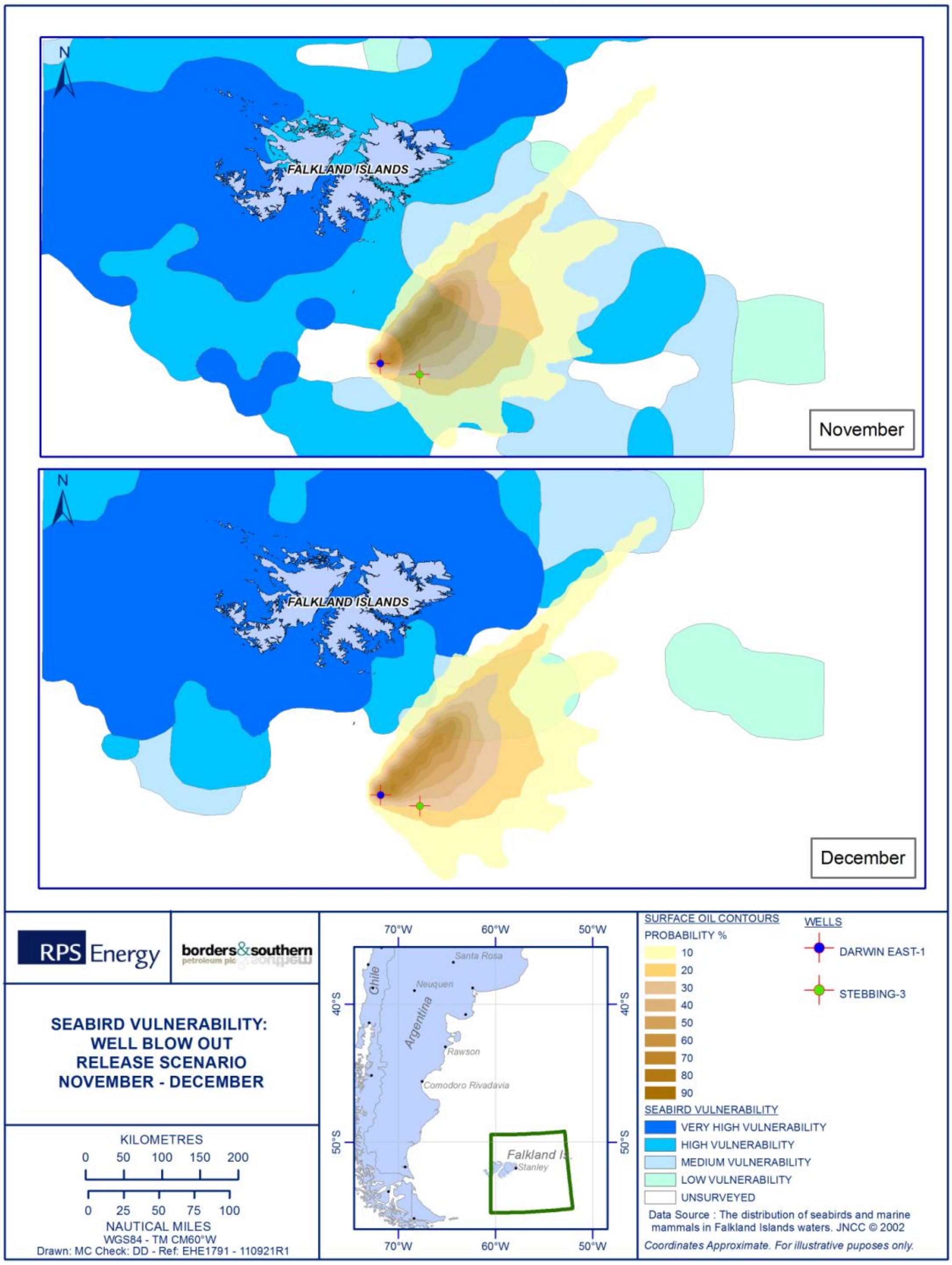


Figure 3.16 (cont.) Seasonal Seabird Vulnerability to Surface Pollution overlain with Stochastic model run of wellblowout (27.5 tonnes per hour, for 240 hours) of 25° API crude oil released at the Stebbin-3 under typical wind conditions.

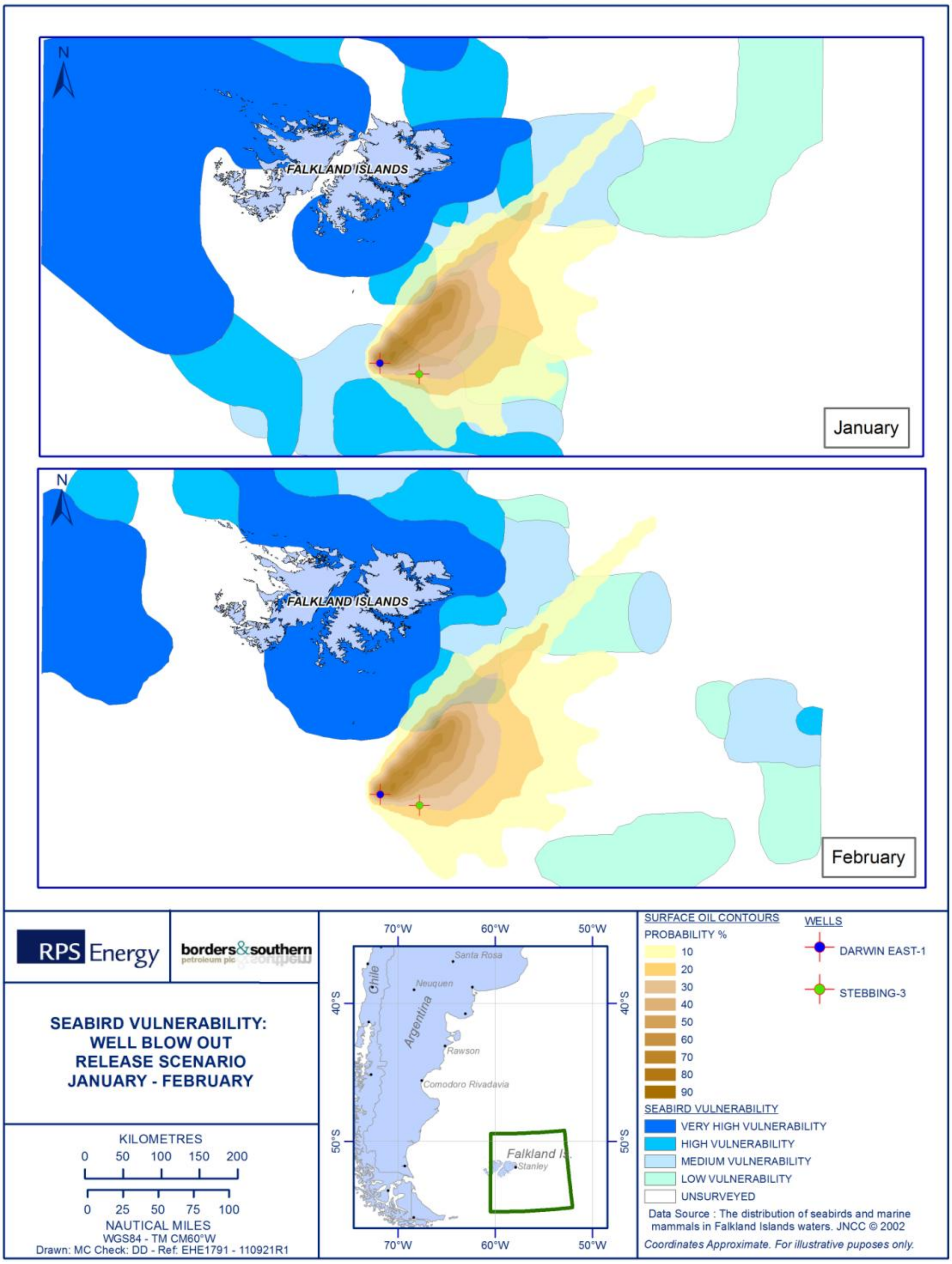


Figure 3.16 (cont.) Seasonal Seabird Vulnerability to Surface Pollution overlain with Stochastic model run of wellblowout (27.5 tonnes per hour, for 240 hours) of 25° API crude oil released at the Stebbin-3 under typical wind conditions.

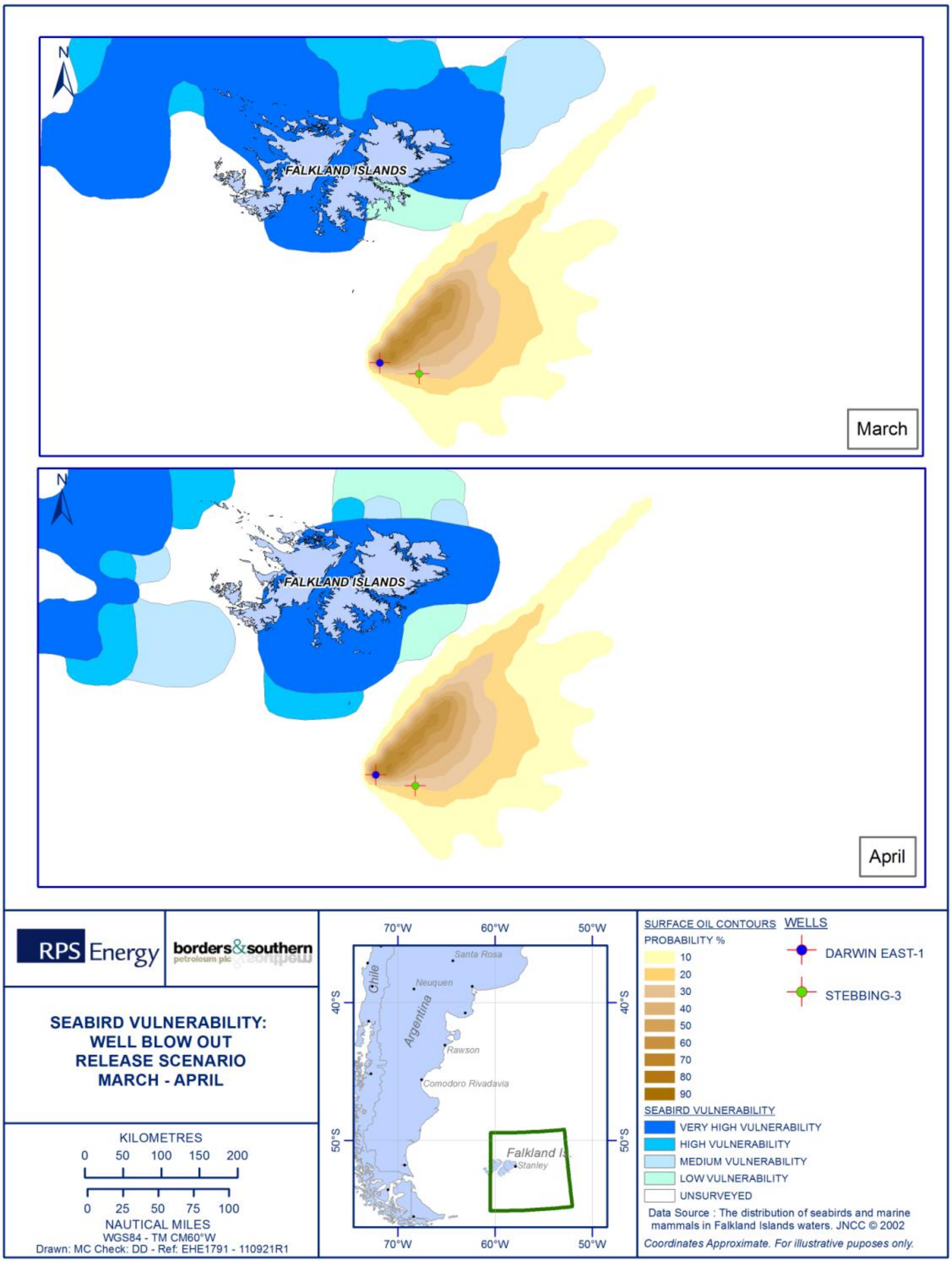


Figure 3.16 (cont.) Seasonal Seabird Vulnerability to Surface Pollution overlain with Stochastic model run of wellblowout (27.5 tonnes per hour, for 240 hours) of 25° API crude oil released at the Stebbin-3 under typical wind conditions.

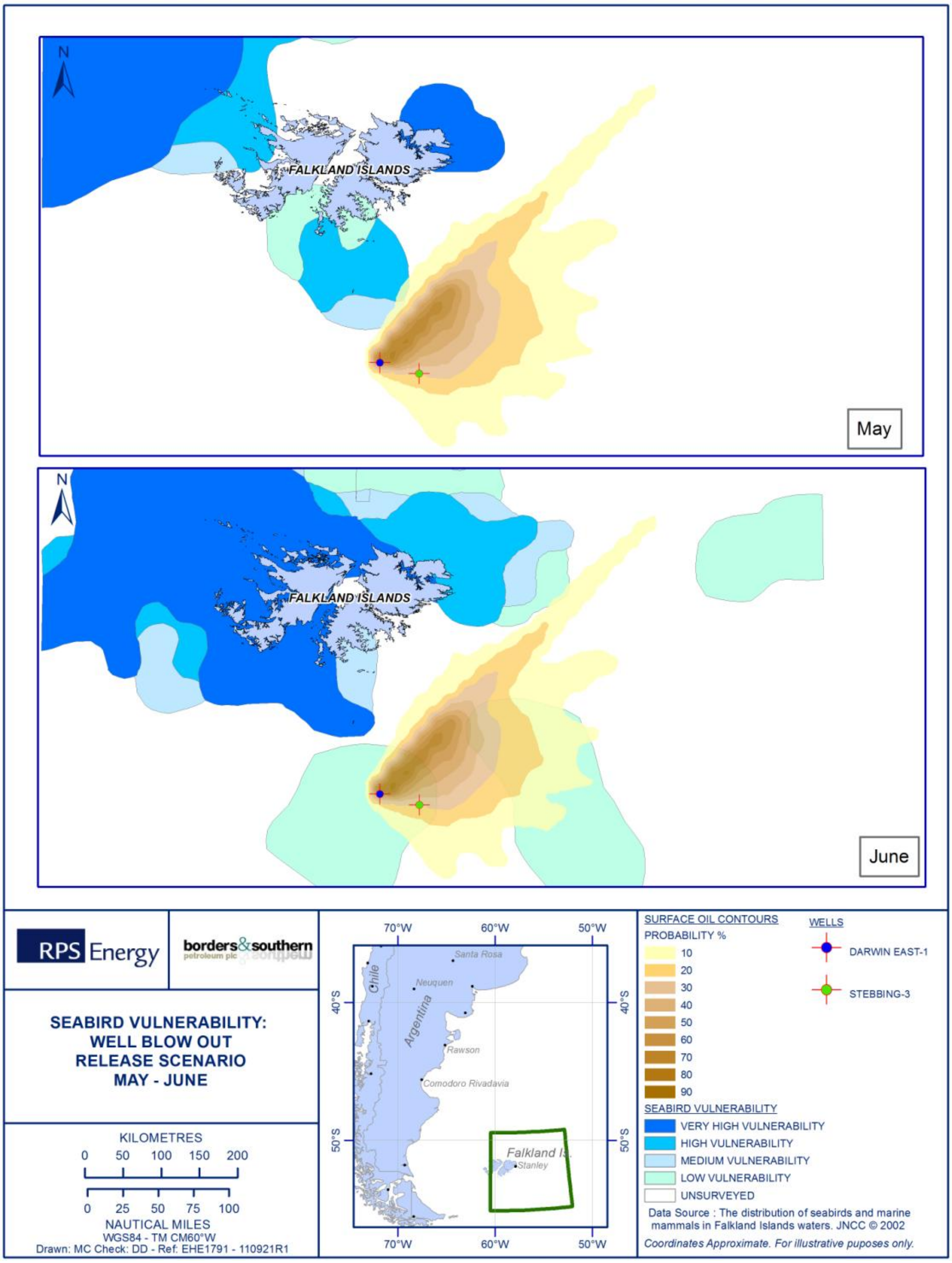


Figure 3.16 (cont.) Seasonal Seabird Vulnerability to Surface Pollution overlain with Stochastic model run of wellblowout (27.5 tonnes per hour, for 240 hours) of 25° API crude oil released at the Stebbin-3 under typical wind conditions.

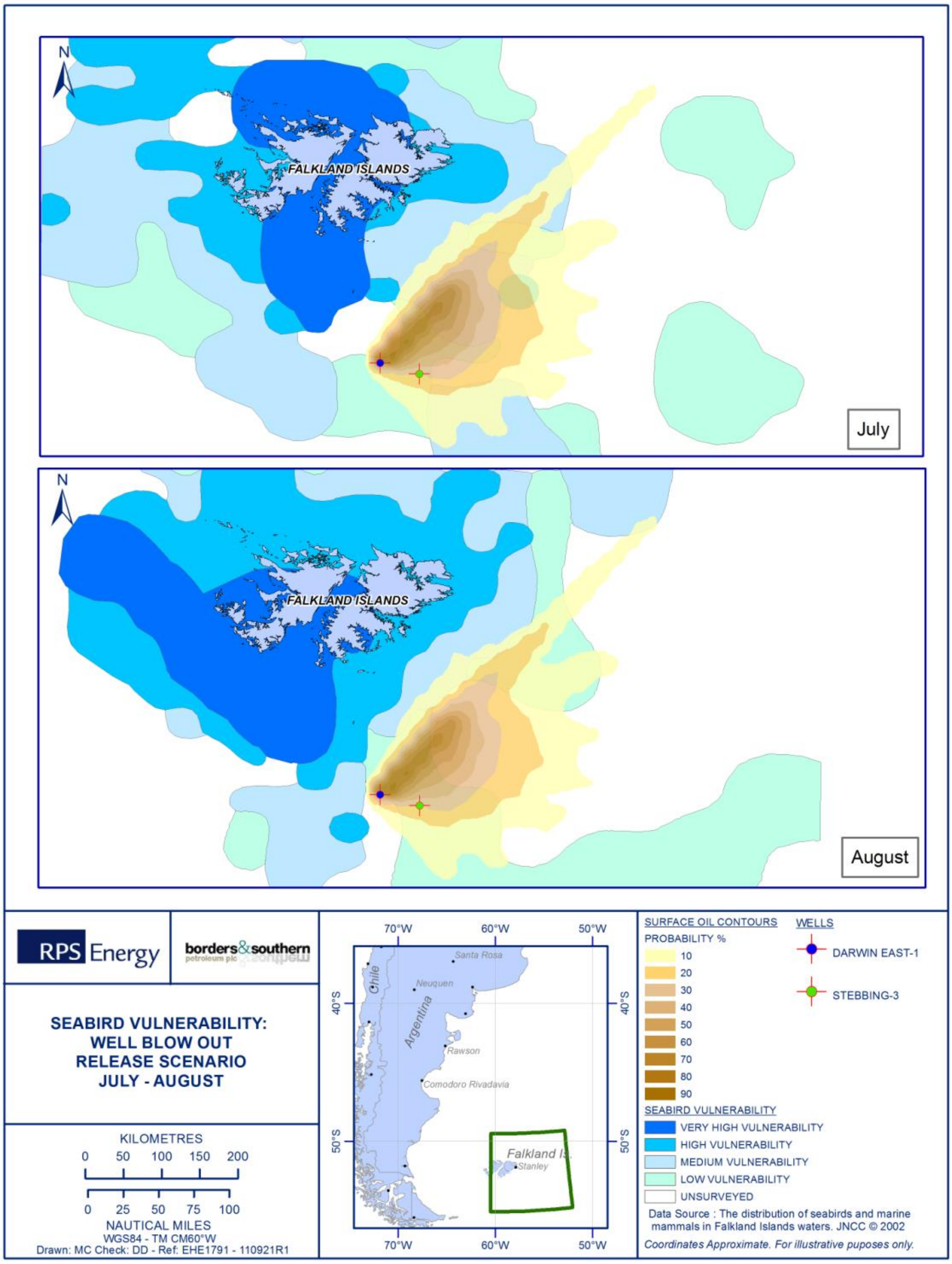
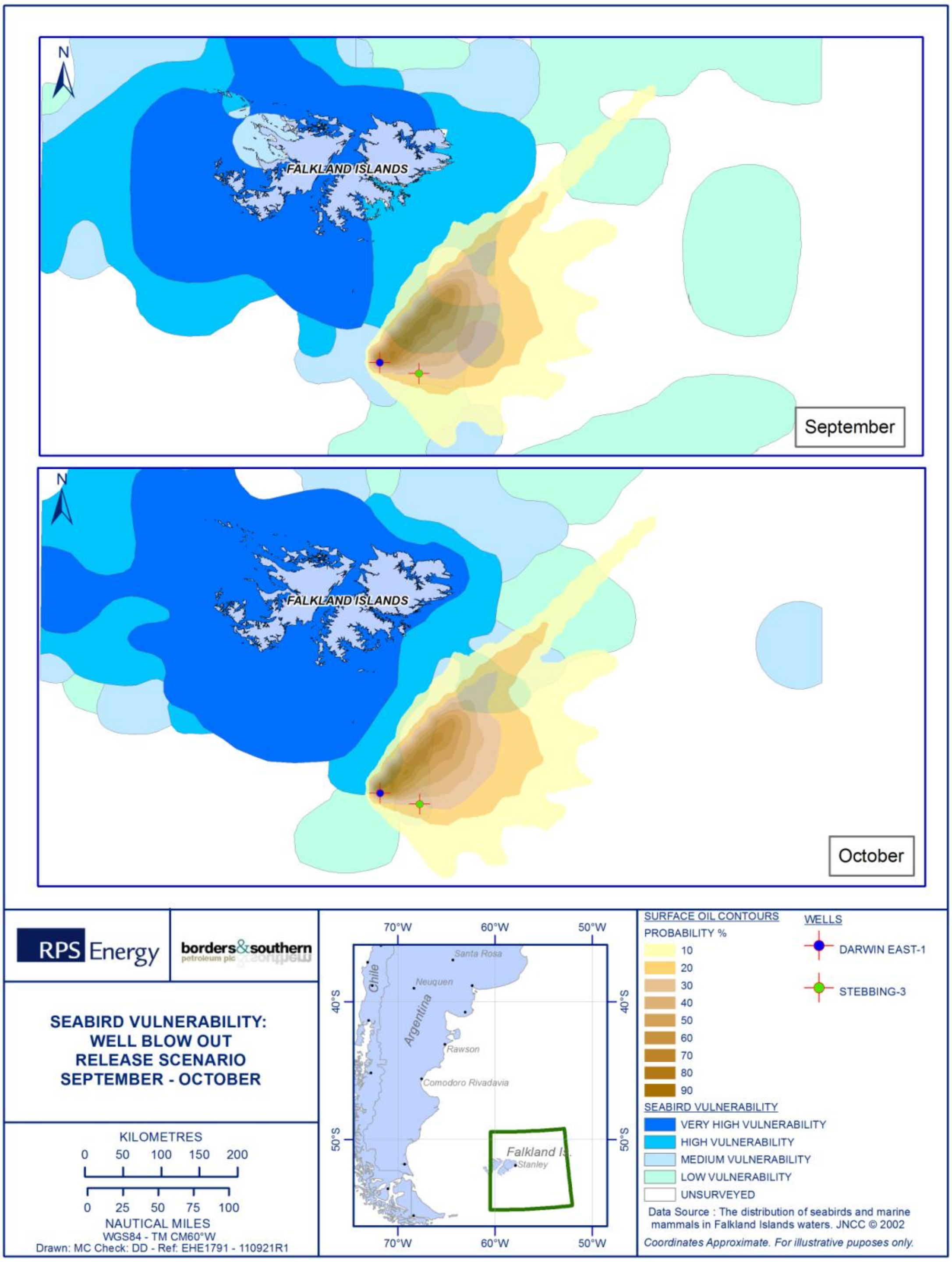


Figure 3.16 (cont.) Seasonal Seabird Vulnerability to Surface Pollution overlain with Stochastic model run of wellblowout (27.5 tonnes per hour, for 240 hours) of 25° API crude oil released at the Stebbin-3 under typical wind conditions.



Threatened Species

The IUCN Red List is a comprehensive listing of all species within the Falklands marine environment which are characterised as 'endangered', 'threatened' or 'vulnerable' to 'extinction'.

A search of the Red List found 43 species recorded as threatened, and 31 classified as 'Least Concern'. Most pinnipeds are of the latter category. There were seven species (two cetaceans and five birds) listed as endangered – the highest level of conservation status.

Overall the Red List results included:

- 17 species of cetaceans;
- 2 species of fish;
- 24 species of birds.

It should be noted that many species in the list are classified as 'data deficient'. This is not a category of threat instead it indicates that not enough data on the species is available to make an assessment of the risk of extinction. More information is required in such areas, and including them in the list acknowledges the need for additional research to show that the classification given is appropriate.

3.2.8 Protected Habitats and Areas

The following three types of formally protected areas are located in the Falkland Islands:

- National Nature Reserves (NNR) (designated under the Conservation of Wildlife & Nature Ordinance (1999));
- National Parks (designated under the National Parks Ordinance); and
- Ramsar sites.

These protected areas are illustrated in Figure 3.17. Although FIG can designate marine reserves, to-date no marine NNR has been created in the Falkland Islands.

Important Bird Areas (IBAs) have been defined and are an initiative of Birdlife International, a global partnership of conservation organisations. IBA identification is based on a standard set of criteria applied consistently worldwide, with Falklands Conservation responsible for the cataloguing and description of IBA's within the Falklands. IBAs are not part of any international agreement or convention, and were created to address the increasing global threat to birds from habitat loss and fragmentation.

Currently, 22 sites of international conservation importance for birds (IBA) have been identified in the Falkland Islands. These are illustrated on Figure 3.18.

Beauchêne Island

Forming the southernmost land in the Falklands archipelago, Beauchêne Island is located approximately 54 kilometres south of the mainland, and 78 kilometres from the proposed drilling location.

More than 30 bird species have been recorded on the Island, the majority being migratory seabirds that are present in very large numbers during the breeding season. The site is significant for the second largest populations in the world of black-browed albatrosses and Southern rockhopper penguins. Beauchêne Island is also important for Wilson's storm-petrels, grey-backed storm-petrels and common diving petrels. It is the only confirmed breeding site for fairy prions in the Falkland Islands. Southern giant petrels and Magellanic penguins are present, but populations are too small to qualify. The total congregation of seabirds far exceeds 10,000 breeding pairs, making this site classifiable under the A4iii criterion (A4iii criterion is modelled on criterion 5 of the Ramsar Convention for identifying wetlands of international importance) (BirdLife International, 2009a).

Sea Lion Island

Sea Lion Island is 8 kilometres from east to west and 2 kilometres at its widest point. The island is a slightly inclined plateau with steep cliffs of about 30 metres at the south-western point and long sandy bays to the east. Habitat inland is largely open heath and grassland. There are permanent ponds and boggy ground, which are attractive to a variety of waterbirds (*BirdLife International, 2009b*).

Between 1983 and 1993, 53 bird species were recorded on Sea Lion Island during fieldwork for the Breeding Birds Survey. Of these, 43 were breeding or probably breeding, including eight of the nine resident songbirds and five species of penguins. The macaroni penguin occasionally breeds among the Southern rockhopper penguins but not in sufficient numbers to warrant site qualification. The predator-free status Sea Lion Island makes it important for small passerines and burrowing petrels. It is noticeable that Tussacbirds and Cobb's Wrens are very numerous, particularly on the beaches of the islands. Endemic sub-species present include the White-tufted/ Rolland's Grebe, Black-crowned Night-heron, Upland Goose, Short-eared Owl, Dark-faced Ground-tyrant, Falkland Pipit, Falkland Grass Wren and the Falkland Thrush (*BirdLife International, 2009b*).

Sea Lion Island is an important wildlife tourism destination within the Falklands archipelago, with an estimated 2,000 visitors per year.

Figure 3.17 Protected areas around the coastline of the Falkland Islands (World Database on Protected Areas, 2009)

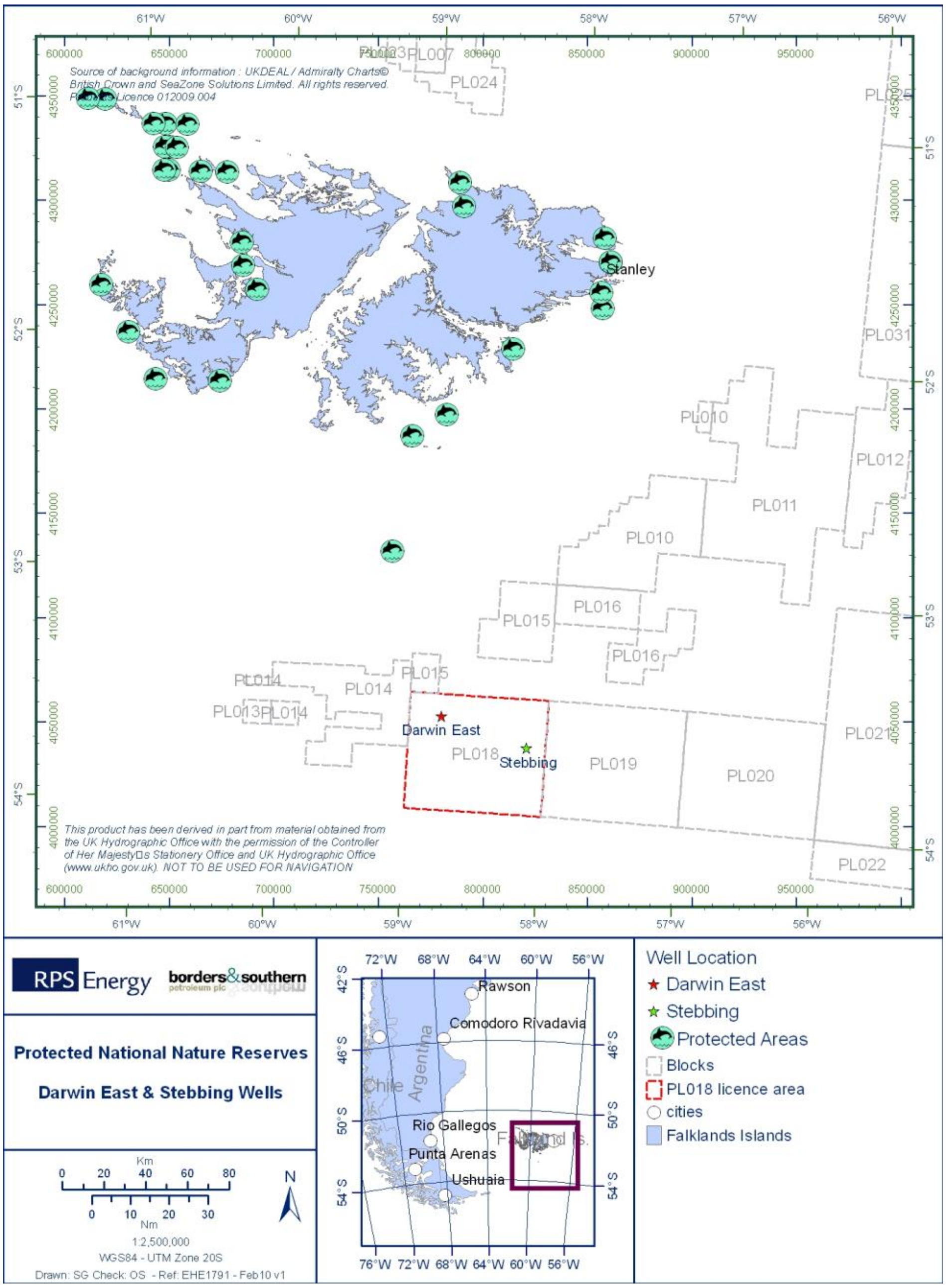
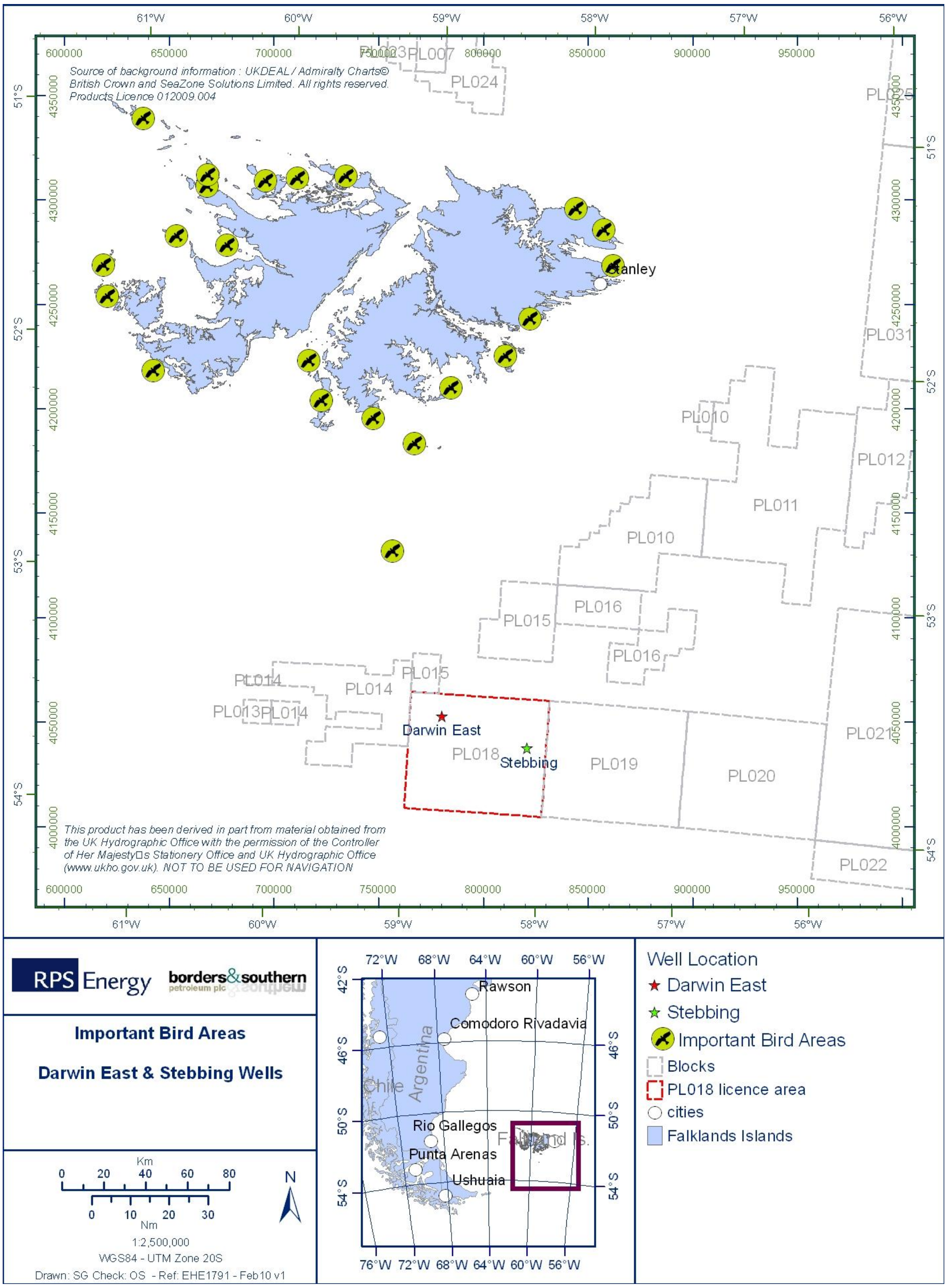


Figure 3.18: International Bird Areas (Birdlife International, 2009)



3.3 Social and Economic Environment

Refer to section 5.3 (pages 5-71 and 5-81) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

3.3.1 Fisheries and Aquaculture

Commercial fisheries are the largest source of income for the Falkland Islands. All fishing within 200 nautical miles of the Falklands is subject to licensing by the FIG. The fishing waters of the Falkland Islands are separated into the Falkland Interim Conservation and Management Zone (FICZ), which was introduced in February 1987 to reduce the rate of uncontrolled fishing, and the Falkland Islands Outer Conservation Zone (FOCZ) which is located 200 nautical miles from the coast. The fisheries generate over £21 million per annum in licence fees, roughly half the government revenue. Since 1990 Britain and Argentina have worked together to conserve fish stocks under the auspices of a UK/Argentine South Atlantic Fisheries Commission (*FCO, 2005*). Approximately £6 million of fisheries income is spent each year on catch and conservation monitoring, research and administration.

Licences are distributed according to species targeted. The total number of licenses has declined since 2005 from 205 for all target species to 175 in 2009 for all species (*FIG, 2010*). The majority of licenses distributed were for fisheries targeting *Illex argentinus* and *Loligo gahi*. Of these, the majority of licenses went to Korean, Taiwanese and Chinese fleets for *Illex* and to Falkland Island and UK fleets for *Loligo* (*FIG, 2010*).

Target species for the commercial fisheries operating in the Falkland Islands are:

- Argentine shortfin squid (*Illex argentinus*);
- Patagonian squid (*Loligo gahi*);
- Southern blue whiting (*Micromesistius australis australis*);
- Hoki (*Macruronus magellanicus*);
- Patagonian toothfish (*Dissostichus eleginoides*);
- Patagonian hake (*Merluccius australis*);
- Common hake (*Merluccius hubbsi*);
- Red cod (*Salilota australis*);
- Skates & rays (*Rajidae*).

The key catches are the squid species: *Illex argentinus* and *Loligo gahi*, followed by the rock cod (*Patagonotothen ramsayi*), hoki (*Macruronus magellanicus*) and the southern blue whiting (*Micromesistius australis australis*) (Figure 3.19). Approximately 44 MT of *Illex*, 31,475 MT of *Loligo*, and 10,395 MT of southern blue whiting were caught in 2009.

It should be noted that the proposed well locations may have some overlap with a Patagonian toothfish long line fishery and an emerging grenadier fishery.

Figure 3.19 Catch by species (tonnes) between 2005 and 2009 (FIG, 2010)

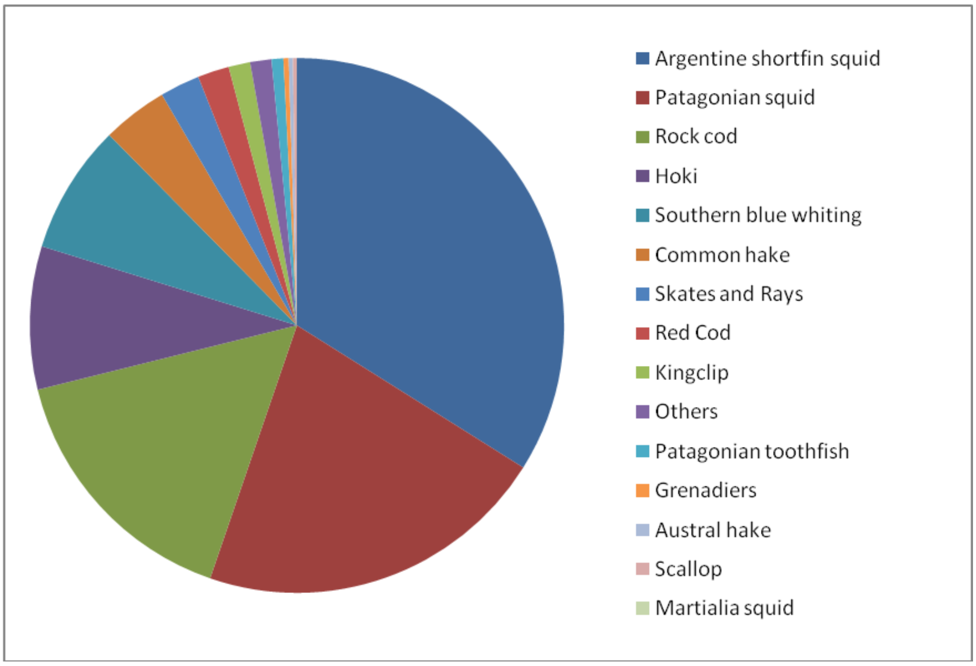
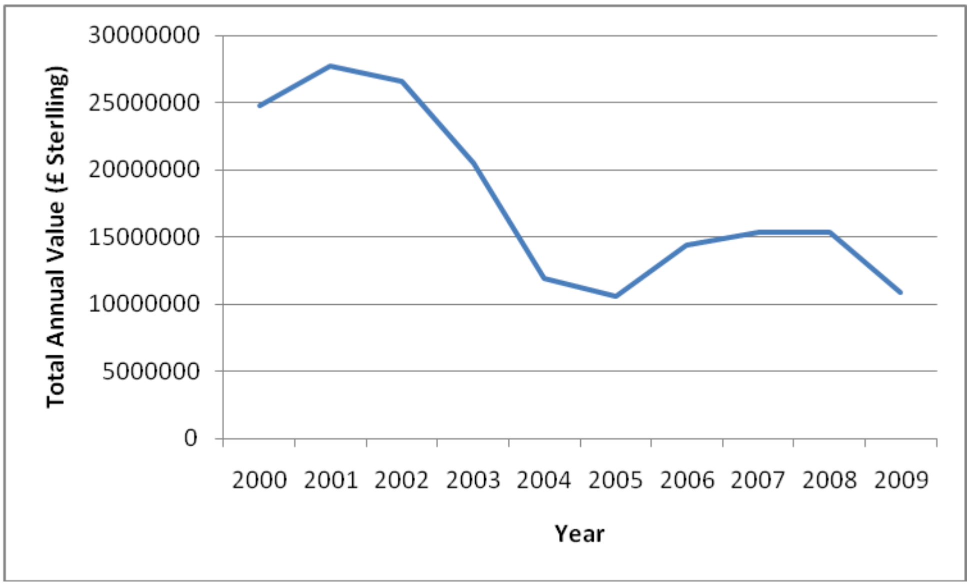


Figure 3.20 Total annual value for all fisheries between 2000 and 2009 (FIG, 2010)



Revenues from Falkland Island fisheries have been in decline and have recently been at their lowest in 2009 at a total revenue of £10,850,229 for all species compared to £27,685,053 in 2001 (Figure 3.20) and compared to peak values in 1989 of £29,001,223 (*FIG, 2010*). Revenues were split according to the license they were permitted for. The greatest revenue came from the *Illex argentinus*, *Loligo gahi* combined *Illex* and restricted finfish fisheries.

Illex had been in decline since 2002, but resurged in 2006 after oceanographic conditions returned to normal following years of warm anomalies. Seasonal jigging fishery for the *Illex* takes place between February and June and is concentrated over the Patagonian Shelf to the north and west of the Falklands. The trawl fishery for *Loligo* squid operates between February and May and between August and November off the east coast of the Falklands (Figure 3.22 below).

The FIG annual Fisheries Statistics (volume 11, 1997-2006) indicate that the offshore licence areas are not situated within any likely large fishery catch areas for the key species listed above. Figure 3.21 shows that no recorded catches of *Illex argentinus* occurred within license area PL018 between 2007 and 2010. The majority of catches did however occur towards the north east and north west of the Falkland Islands. No catches of *Loligo gahi* were recorded within the PL018 license area. Highest catches (>1000 tonnes) occurred towards the south and south east of the Falkland Islands but were located further inshore away from the proposed licence area (Figure 3.22), Figure 3.23 also shows the total finfish catches. These were greatest towards the north west of the Falkland Islands, particularly towards the Patagonian Shelf which is an area known to attract several species of feeding marine animals due to its elevated biological productivity (*NOAA, 2009*). In these areas catches were between 500 and over 1000 tonnes between 2007 and 2010 (Figure 3.24). Catches around the south of the Falklands in more inshore waters were less than 500 tonnes between 2007 and 2010. No recorded catches of these target species occurred within the licence area (Figure 3.24). The respective fisheries for *Loligo* and *Illex* also do not operate between November and February when drilling operations will commence.

Aquaculture in the Falkland Islands is relatively new and is currently restricted to trialling of salmon fish farming, farming of the native blue mussel *Mytilus edulis chilensis* and Pacific oysters, *Crassostrea gigas*. All of these aquaculture ventures are described as small scale with potential for future expansion and are therefore not currently significant. Shellfish are not considered and important part of the commercial fishery.

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Figure 3.21 Illex argentinus catches (tonnes) by grid from 2007 - 2010

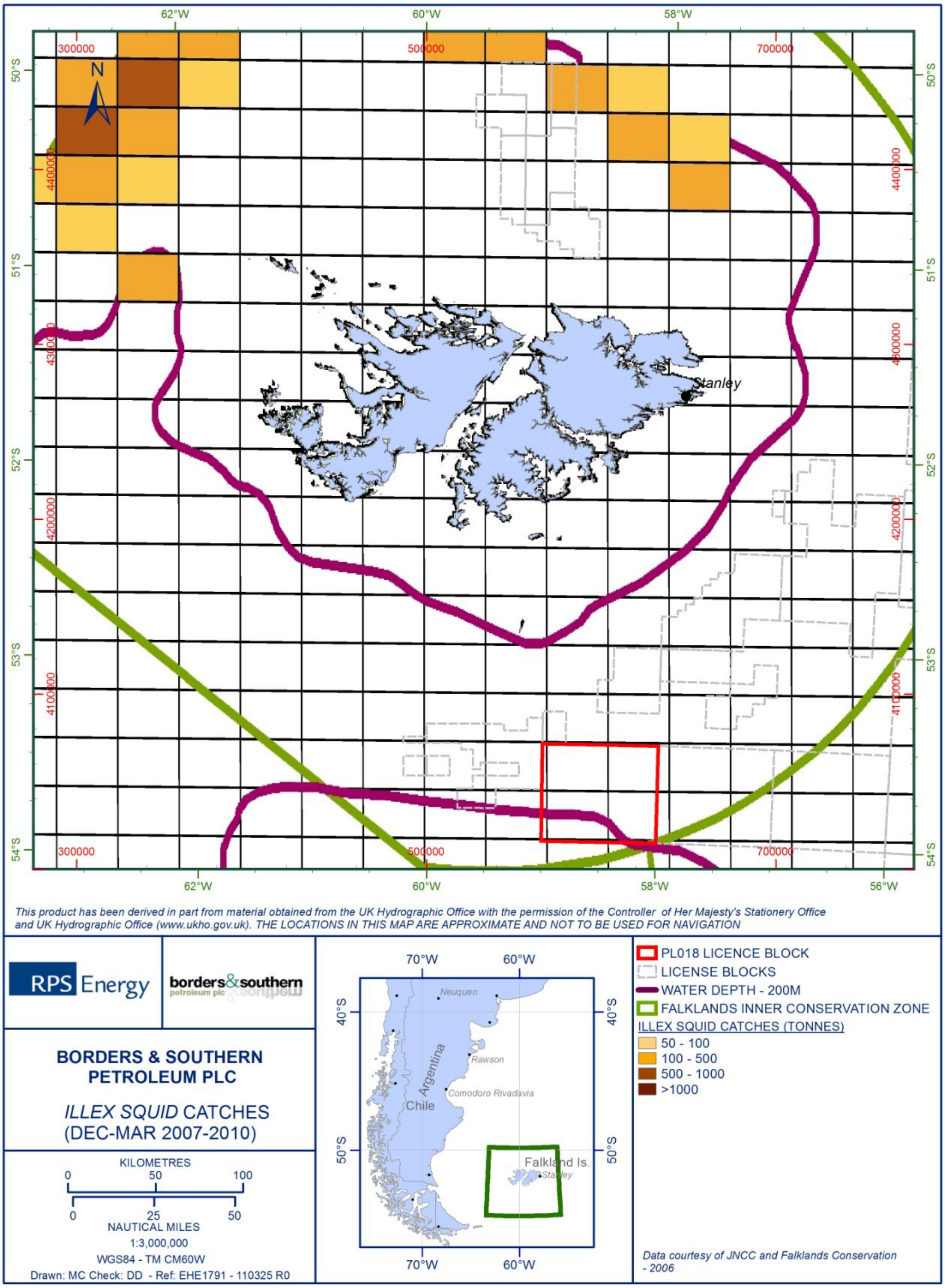


Figure 3.22 Loligo gahi catches (tonnes) by grid square from 2007 - 2010

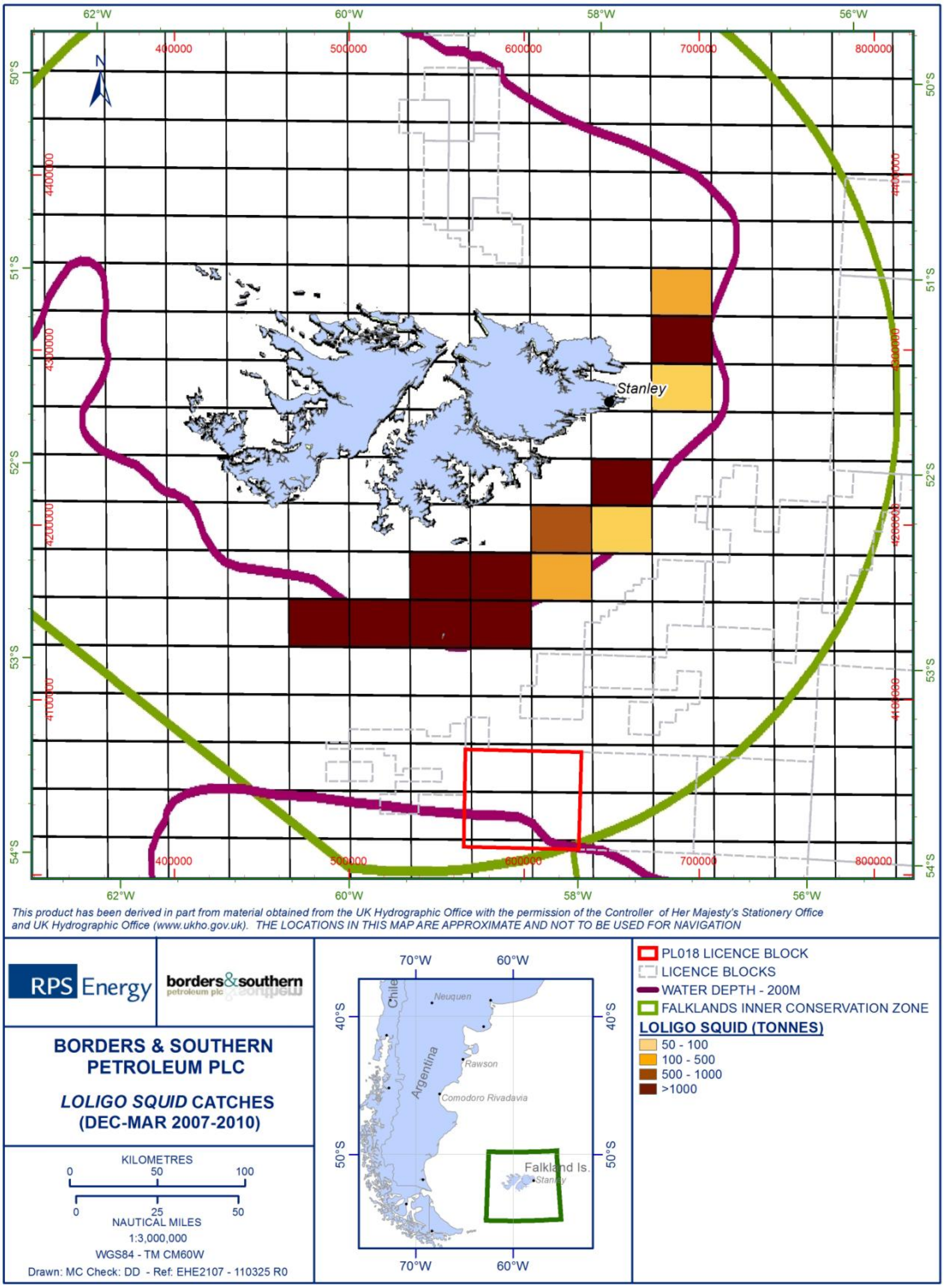


Figure 3.23 Total finfish catches (tonnes) by grid square from 2007 - 2010

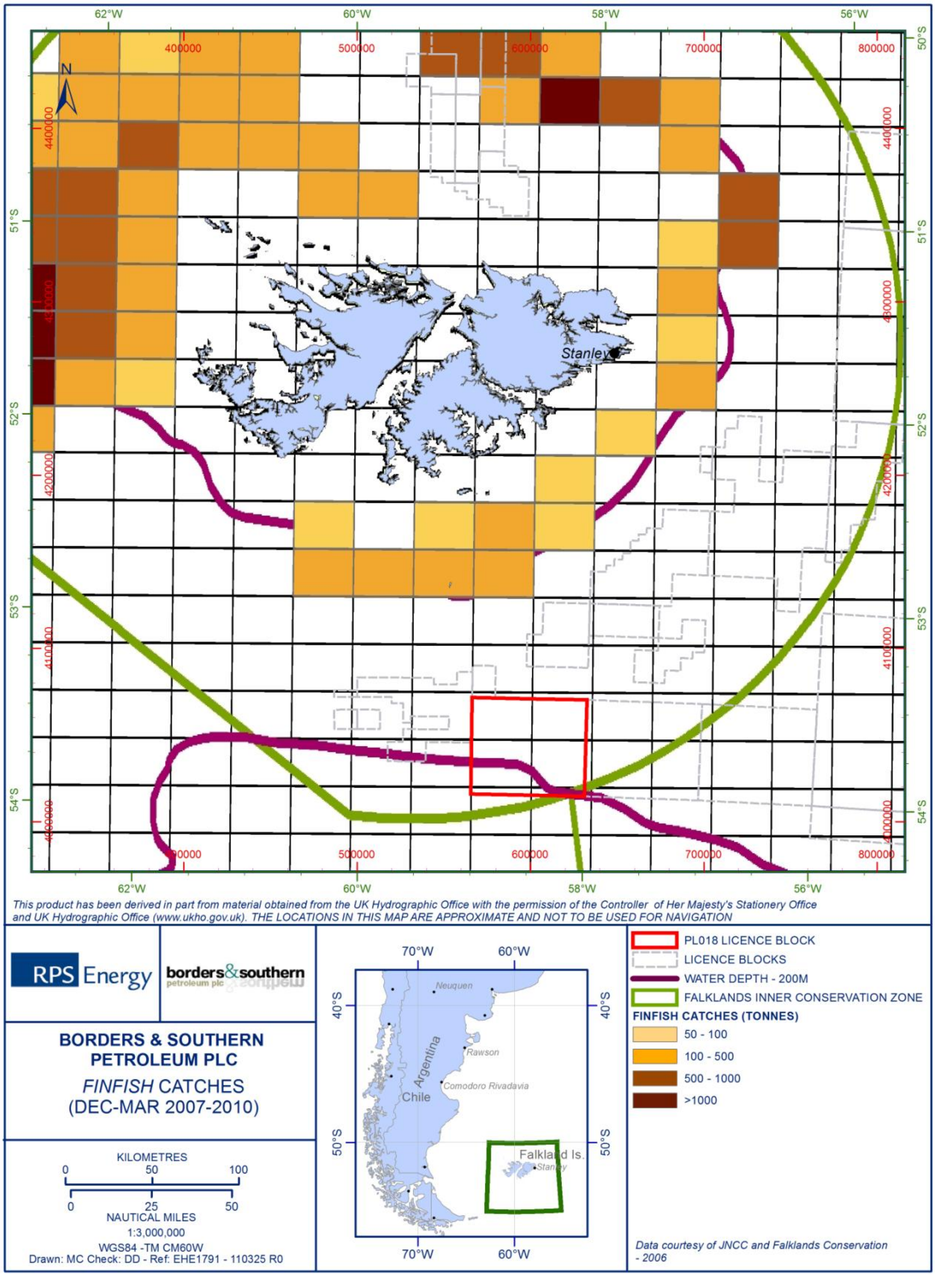
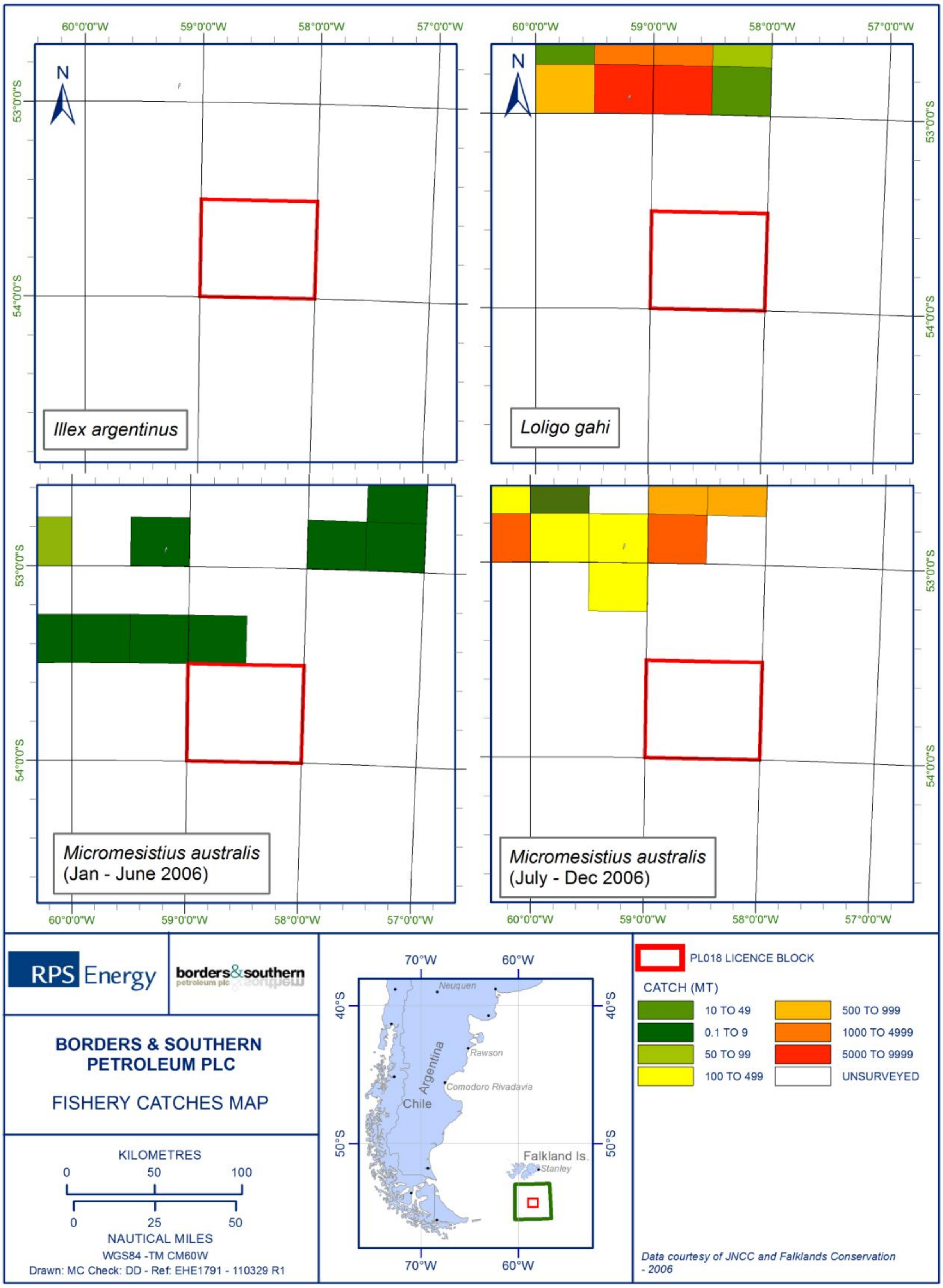


Figure 3.24 Catches of major fishery target species in and around license area PL018



3.4 Summary of Seasonal Sensitivities

Table 3.7 summarises the key environmental sensitivities in the vicinity of the PL018 licence area in relation to the proposed drilling period.

Table 3.7 Summary of Key Environmental Sensitivities in the vicinity of PL018 (the proposed drilling period is outlined in red)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Plankton	Low bloom period	Low bloom period	Low bloom period	Low bloom period	Peak bloom period	Low bloom period	Low bloom period	Low bloom period	Peak bloom period	Peak bloom period	Peak bloom period	Low bloom period

Key: *Peak bloom period* (dark blue); *Low bloom period* (light blue)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Fish												
Patagonian hake (*Merluccius hubbsi*)						Spawning	Spawning	Spawning				
Hake (*Merluccius sp.)*									Spawning	Spawning		
Southern Blue Whiting (*Micromesistius australis*)								Spawning	Spawning	Spawning		
Rock cod (*Patagonothen ramsayi*)			Spawning	Spawning	Spawning	Spawning						
Fish larvae									Spawning	Spawning	Spawning	

Key: *Peak spawning* (yellow); *Spawning* (light blue)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Seabirds												
Gentoo penguin				Known	Known	Known	Known	Known	Known	Known	Known	
Southern rockhopper penguins	Known										Known	Known
Magellanic penguin	Peak	Peak										Peak
Southern royal albatross			Known	Known	Known	Known						
Northern royal albatross			Known	Known	Known	Known	Known					
Black-browed albatross							Peak	Peak	Peak	Peak		
Grey-headed albatross							Peak	Peak	Peak			
Wandering albatross	Peak	Peak	Peak	Peak								
Diving petrels	Known	Known							Known	Known	Known	Known
Cape petrels			Known	Known	Known	Known	Known	Known	Known			
Southern giant petrel			Peak	Peak	Peak	Peak						
Grey petrel	Known	Peak	Known									Known
Kerguelen petrel											Known	
Grey-backed storm petrel	Known	Known	Known						Known	Known	Known	Known

Key: *Peak occurrence* (yellow); *Known occurrence* (light blue)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Pinnipeds												
South American Fur Seal												
South American Sea Lion												
Southern Elephant Seal												
Key (Numbers recorded per month (White et al., 2002))												
	High (<10)		*Medium (6-10)*		*Low (3-5)*		*V. low (1-2)*		*No animals*			

Species	J	F	M	A	M	J	J	A	S	O	N	D
Cetaceans												
Hourglass dolphin												
Peale's dolphin												
Pilot whale*												
Killer whale*												
Fin whale*												
Sei whale*												
Blue whale*												
Dwarf whale*												
Sperm whale*												
Key (Cetacean numbers recorded per month (White et al., 2002))												
*(data from MMO sightings during the B&s 3D survey (2007-2008) for species marked *)*												
	High (<50)		*Medium (10-49)*		*Low (4-9)*		*V. low (1-3)*		*No animals*			
Solid Red Line = Proposed April to June Drilling Period												

The table above demonstrates the range of environmental sensitivities present in the Falklands and surrounding waters for each month. Seasonal vulnerabilities likely to be present in the vicinity of the well location have been assessed throughout this section and are summarised below:

- Fish species known to spawn in the area include Patagonian hake. Hake, Southern Blue Whiting, Rock cod and Fish larvae. Only rock cod are expected to spawn during the drilling period;
- Based on the JNCC survey results (*White et al., 2002*), the following species of cetacean were recorded within the vicinity of the proposed in significant numbers, Peale's dolphin and Hourglass Dolphin.
- Little is known of the at-sea distribution of Falkland Islands pinnipeds, and it is possible that South American sea lions, south American fur seals and southern elephant seals may be present within the vicinity of the proposed location during the drilling period, but in low numbers;
- Of the penguin species recorded in the Falkland Islands, only Southern rockhopper penguins, King penguin and Magellanic penguins have been observed at significant distance from the Falkland Islands and may therefore be present during the proposed drilling period;

- It is possible that the Southern royal albatross, Northern royal albatross and the Wandering albatross will be present in the vicinity of the proposed well during the months of December to March;
- Petrels known to be present in the vicinity of the well during the drilling period include Diving petrels, Cape petrels, Southern giant petrel, Grey petrel and Grey-backed storm petrel. None of these species are considered to be present in significant numbers.

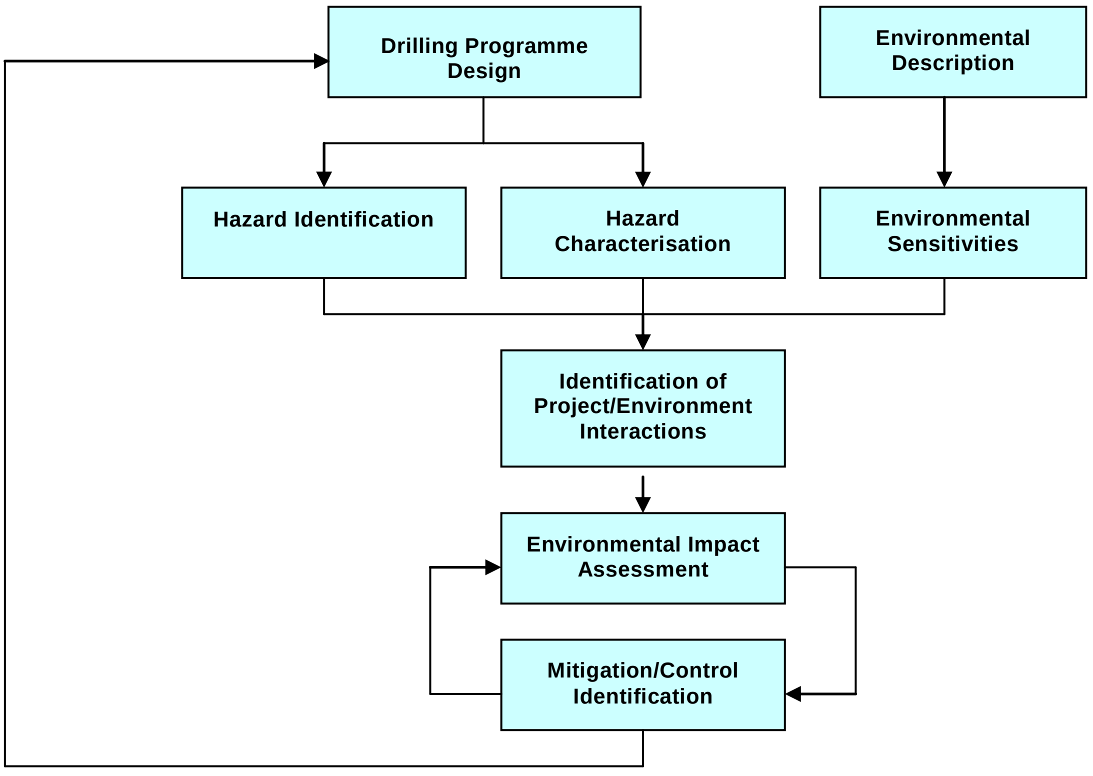
4 Environmental Hazards, Effects and Mitigation Measures

4.1 Introduction

This section aims to assess the environmental hazards and effects resulting from the Darwin East-1 and Stebbing-3 exploration wells during the proposed December 2011 to July 2012 drilling period and, where necessary, identify any mitigation measures that may be required to eliminate or lessen the severity of the impacts. Where appropriate, the impacts have been considered in context with those previously identified within Section 6 of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

The methodology used for environmental impact assessment follows the sequence summarised in Figure 4.1, with consultations incorporated into every phase.

Figure 4.1 Methodology for Environmental Impact Assessment



The main supporting information required for an assessment includes a description of both the project (refer to Section 2 of this report) and the environment (refer to Section 3 of this report) in which it will take place. In this section, the interactions between the Darwin East-1 and Stebbing-3 wells and the environment during the proposed drilling period (December to July) are identified and an environmental impact assessment is undertaken establishing a matrix of hazards against environmental sensitivities.

The results of this qualitative risk assessment exercise are presented in the form of a matrix that highlights areas where some interaction is expected and provides a measure of the expected significance based on the criteria provided in Table 4.1. This qualitative scale helps to rank issues on a relative basis and identify areas where additional control measures may be required.

Table 4.1 Assessment of Significance of Effect or Hazard (from UKOOA, 1998)

1	**Severe** Change in ecosystem leading to long term (>10 years) damage and poor potential for recovery to a normal state. Likely to effect human health. Long term loss or change to users or public finance.
2	**Major** Change in ecosystem or activity over a wide area leading to medium term (>2 years) damage but with a likelihood of recovery within 10 years. Possible effect on human health. Financial loss to users or public.
3	**Moderate** Change in ecosystem or activity in a localised area for a short time, with good recovery potential. Similar scale of effect to existing variability but may have cumulative implications. Potential effect on health but unlikely, may cause nuisance to some users.
4	**Minor** Change which is within scope of existing variability but can be monitored and/or noticed. May affect behaviour but not a nuisance to users or public.
5	**Negligible** Changes which are unlikely to be noticed or measurable against background activities. Negligible effects in terms of health or standard of living.
	None No interaction and hence no change expected.
B	**Beneficial** Likely to cause some enhancement to ecosystem or activity within existing structure. May help local population.

4.2 Identification of Interactions

Table 4.2 summarises the interactions between the proposed exploration wells and the sensitivities of the local and regional environment during the proposed drilling period (December 2011 to July 2012). A measure of the expected significance for each of the interactions has been derived based on criteria provided in Table 4.1 above. The significance level assumes that the mitigation measures, identified for each of the hazards in the following sections, have been implemented.

Table 4.2 Potential Hazards and Associated Impacts from the Proposed Drilling Operations

Hazard	Water & Air		Flora & Fauna							Socio-economic								Other		
	Water Quality	Air Quality	Plankton	Seabed Fauna	Fish Spawning	Offshore Sea Birds	Coastal Birds	Marine Mammals	Sensitive Coastal Sites	Fishing	Shipping	Military Activity	Pipelines, Wells & Cables	Drilling & Support Crews	Dredging	Archaeology	Tourism / Leisure	Land Use	Sediments	Resource Use
Physical Presence										5	5						5			4
Seabed Disturbance				4												5			4	
Noise & Vibration					4	4	5	4												
Atmospheric Emissions		4																		
Marine Discharges	5		5	4	5															
Solid Waste									5									3		
Minor Loss of Containment	4		4		5	4		5		4	5						5			
Major Loss of Containment	3		3		3	2	3	3	3	3	3						3			

Key to Significance of Effect (see Table 4.1 for definitions)

1 Severe | 2 Major | 3 Moderate | 4 Minor | 5 Negligible | None

4.3 Design Control Measures

Environmental performance has been a key consideration in option selection and through the design process. Environmental studies and controls, implemented during the design stage of the project, ensure that additional control and mitigation measures required during the operational phases of the project are limited.

The major design controls have included:

- Extensive planning prior to commencing operations to ensure that no strains are placed on current onshore capacities.
- Mud selection: use of WBM as the preferred option for the well sections with careful selection of components to reduce potential environmental effects.
- Waste: currently, any solid waste, excluding drill cuttings, that can be returned to shore for appropriate disposal will be skipped and shipped to the Falkland Islands. If the waste management capacity does not exist on the Islands, then the waste will be stored and shipped to an appropriate facility at an alternate destination by a licensed waste management contractor.
- Management procedures will be in place to ensure environmental controls are operating effectively and efficiently. These are detailed in Section 5 of this Addendum.
- Oil Spill Contingency plan (OSCP) and emergency response procedures will be in place.

The environmental impact assessment undertaken for each phase of the project uses the design basis, with its integral design controls, as the benchmark for assessing potential impacts and identifying any additional control or mitigation methods required.

4.4 Physical Presence

Refer to section 6.4 (page 6-4) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

No subsea infrastructure, such as cables or pipelines, is present in the areas of proposed wells, therefore no interference is expected.

There are no known shipping lanes within the licence area and the drilling locations are situated outside of key fishing areas. There is however, some fishing activity situated towards the landward side of the Falklands Islands towards the north of the proposed drilling sites. Subsequent vessel collision risk is minor and the following mitigation measures will be implemented:

- A safety exclusion zone that will be established during the drilling operations and the presence of project related vessels will minimise the risk of vessel collision.
- The planned activities will be promulgated in advance through Notice to Mariners, Navtex and VHF broadcast for the duration of the operations.
- The British Military will be continually informed of Borders & Southern's proposed activities.
- The Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs) will be complied with.

Resource consumption from acquisition of drilling consumables and equipment (casing, cement, mud, and chemicals) is assessed to be of low importance to the Falkland Islands as it is unlikely that these resources will be sourced in the Falklands, and are more likely to be sourced from elsewhere. The remote drilling location will require sufficient materials, equipment, spares and contingency supplies to be ordered in advance and shipped prior to rig mobilisation. Reordering and transporting replacement parts or additional materials during drilling will be financially and logistically impractical.

Fuel consumption throughout the drilling campaign is considered to be of medium importance to the Falkland Islands as it is likely that the fuel will be sourced from the Islands. The consumption of helifuel, aviation fuel for flights, diesel and marine fuel oil is an operational necessity, although fuel consumption can be minimised by a regular programme of maintenance and servicing. Advanced planning will be undertaken and should help to ensure flights and transfers are kept to a minimum, however regular crew changes are a necessity both for operational and health and safety reasons.

The use of potable water is assessed to be of medium importance due to the local scope, short duration and high probability. Water for drilling and domestic use will be sourced from Stanley. Fresh water supply at FIPASS can be delivered at a rate of 25-35 Tonnes per hour. Water can be loaded outside peak times to minimise any impacts to the local community. Alternative emergency sources of potable water have been discussed with the local authorities, and with adequate advance planning can be provided without adverse impacts in the local communities.

Although the licence area is situated outside the key fishing areas the impact of competing port use by rig support/supply vessels and other customers has to be considered.

The majority of fish (by weight) caught in the Falklands Interim Conservation and Management Zone (FICZ) are not landed. Transhipping operations take place at sea or in sheltered waters (either Port William or Berkely Sound) from the fishing vessel on to a 'reefer' (freezer) vessel which transports the catch directly to market without having to berth in the Falkland Islands. A small proportion of the total fish catch is landed onshore at FIPASS in Stanley and most is back loaded into freezer containers for shipment to Uruguay.

The only fish species where the complete catch is landed in the Falkland Islands is the small Toothfish catch from the Falkland and South Georgia fisheries. This is very tightly controlled for conservation reasons (all catches which are landed in the Falkland Islands are weighed and checked by the authorities prior to export).

Two Dynamically Positioned Platform Support Vessels (PSV's) will be used to provision and re-supply The Ocean Rig *Leiv Eiriksson* Rig. Each vessel will shuttle between the FIPASS Port Facility and the rig carrying essential drilling equipment and bulk fuel, water, mud chemicals and cement (one vessel will always remain at the rig acting in a standby role). Movement of the vessels between the rig and the FIPASS port Facility will be scheduled to ensure the essential materials and equipment required to undertake the drilling of the wells is loaded and unloaded in a timely and effective manner which will be driven by the timing of each section of the well and how it is drilled.

Given the likelihood of contiguous drilling campaigns in both the offshore north and South Falklands detailed planning and cooperation between operators and the port authorities will be required to maximise port utilisation. A plan of the proposed schedule of movements for each vessel will be provided to the FIPASS Management to allow them to plan for the timely and effective management of the port facility taking cognisance of the needs of all port users be they oilfield related or none oilfield related. Given the nature of the drilling business the FIPASS Management will be made aware of the need to allow for changes in schedules at short notice to ensure uninterrupted drilling operations can hopefully be maintained at all times, subject to all other port operational requirements being effectively managed to satisfy all other customer demands.

Given the above, it is envisaged that the increased vessel traffic around the port will not impact the majority of the fishing vessels operating around the Falklands, many of which never call at FIPASS. The effect on the remainder of vessels will be manageable.

4.5 Seabed Disturbance

4.5.1 Presence of the Rig

Refer to section 6.5.2 (pages 6-5 to 6-9) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

For the proposed drilling programme, Borders & Southern plan to use The Ocean Rig *Leiv Eiriksson* semi-submersible to drill both the Darwin East-1 and Stebbing-3 wells. This is a Dynamically Positioned (DP) rig which will be used in order to remain stable in harsh weather and accommodate drilling in water depths >7,500 feet. Therefore no anchors will be deployed and therefore there will be no impact of an anchor footprint on the seabed and associated benthic communities.

The mud mat and BOP will however be placed on the seabed but will leave a relatively minor footprint on the seabed during drilling operations. During drilling operations, other than cuttings dispersal, the physical impact of the operation on the seabed will be minimal. At the wellhead a mud mat will be in place that will occupy an area of 9.5 square metres. The only other physical presence on the seabed will be 4 hydro-acoustic positioning transponders that are deployed on to the seabed to aide with the dynamic positioning of the vessel. The transponders are suspended above cement clump weights. The clump weights are approximately 1foot by 1foot 1 foot in size. At the end of the drilling operation the transponders are released from the clump weight, leaving the clump weight on the seabed.

The impacts of deployment of the BOP and mud mat have been deemed to be minor as environmental assessment of the benthic communities has revealed a homogenous benthic environment with no habitats or species of conservation importance being noted during the site survey. The short duration of drilling and the relative small footprint of the equipment, will further reduce the potential impacts to the seabed integrity and associated faunal communities. Any impacts will also be short-lived and last only throughout the short duration of the drilling activity.

4.5.2 Deposition of Drill Cuttings

Refer to section 6.5.2 (pages 6-5 to 6-9) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

The main potential source of seabed disturbance from the proposed wells will be caused by the deposition of drill cuttings on the seabed in the vicinity of the drilling locations. The proposed drilling campaign will produce a total of approximately 1,674 tonnes of cuttings from the Darwin East-1 well and approximately 944 tonnes of cuttings for the Stebbing-3 well. Top-hole sections of both wells will be drilled with seawater and bentonite sweeps with all cuttings discharged at the seabed. The lower sections of the wells will be drilled with water based mud and cuttings will be discharged to the sea just below the sea surface.

The modelling of discharged WBM cuttings was undertaken as part of the main EIS document. The modelling for the EIS assumed a discharge of 1,337.3 tonnes from Darwin East-1 and 1331.3 tonnes for the Stebbing well. Since the submission of the original Offshore EIS, the well profiles have been finalised, resulting in some minor alterations to the section lengths and casing sizes. Subsequently the volume of cuttings discharged has changed from those initially modelled for the Darwin East-1 and Stebbing-3 wells (Table 4.3).

Table 4.3 New well profiles compared to those of the original EIS

	Darwin East-1 Well		Stebbing-3 Well	
	Previous EIS Weight (tonnes)	**Updated EIS Weight (tonnes)**	**Previous EIS Weight (tonnes)**	**Updated EIS Weight (tonnes)**
Total cuttings from well	1,337.3	1,674.06	1,331.3	944.58
Discharged at Seabed	440.9	1,030.76	780.3	582.11
Discharged at Surface	896.4	643.30	551.0	362.47

The volume of cuttings from the Stebbing-3 well has decreased due to a change in the well profile. PROTEUS modelling carried out for the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018) has therefore already presented a worst case scenario for the Stebbing-3 well. Therefore any impacts will be lessened than those previously discussed in the original Offshore Falklands Drilling EIS. The surface location of the Stebbing-3 well has been amended by just over 1 kilometre. However, due to the homogeneous seabed around the proposed Stebbing-3 location and the fact that the modelling previously carried out already covers a worst case scenario, no further cuttings deposition modelling was deemed necessary for this well.

Results from the previous modelling of cuttings deposition from the Stebbing-3 well indicate that discharged material settles in an elliptical pattern around the drilling location. The majority of cuttings are concentrated in a circular pile around the drill centre where the pile is also at its thickest. This is most likely to be caused by the drilling of the top two sections of the well (42 inch and 26 inch sections) where cuttings will be directly discharged onto the seabed. Where the thickness of the pile is 1 millimetre, the diameter of the pile extends to approximately 497 metres. Cuttings tended to disperse from the drilling centre in a north-easterly direction. The widespread and thin deposition of cuttings was attributed to the discharge of cuttings from the rig to the surface of the sea (refer to Figures 6.4 and 6.5 in the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018)).

PROTEUS modelling for the Darwin East-1 well was re-run due to the increase in the total volume of cuttings generated from 1,337.3 tonnes to 1,674.06 tonnes (an increase of 336.76 tonnes) (refer to Table 4.3).

Results from the re-run modelling of the Darwin East-1 well have demonstrated that upon discharge of a worst case total of 1,674.06 tonnes of cuttings, the maximum thickness of the cuttings pile was 2.6 millimetres in the immediate locality of the drilling centre. The majority of cuttings were deposited in concentric circles of decreasing thickness with distance from the drilling centre (Figure 4.1). A pile of cuttings 1.0 millimetres thick extends approximately 350 metres from the drilling location. The dimensions of the cuttings pile when measured to the 0.01 millimetre thickness contour are approximately 1.7 by 1.3 kilometres, at its longest and widest points, respectively. The cuttings pile measuring 1 millimetre or greater in thickness is of approximately 700 metres in diameter.

In the previous modelling carried out in the main EIS for the Darwin East-1 well, the circular-shaped pile had a diameter of approximately 175 metres when measured to the 1 millimetre thickness contour. The cuttings pile in general (measured to the 0.01 millimetre thickness contour) measured 2.4 x 1.3 kilometres at its longest and widest points, respectively. The cuttings were deposited along a north-east to south-west oriented axis, drifting away from the drilling location in a north-easterly direction. This pattern of a north easterly axis of deposition was also found when re-modelling the cuttings deposition and is the result of the influence of the residual currents in the area on the cuttings particles.

The previous cuttings modelling carried out for the Darwin East-1 well conducted in the main EIS demonstrated that the maximum thickness of the cuttings pile was 1.1 millimetres which occurred at the drilling centre location itself. This was a lower figure than the re-run modelling, where a maximum thickness of 2.6 millimetres was observed also at the drilling centre location. The reason for the increase in cuttings pile thickness is the great increase in the volume of cuttings discharged at the seabed in the new well profile (refer to Table 4.3). Previously, 441 tonnes of cuttings were discharged at the seabed. With the new well profile in the re-run modelling, 1,011 tonnes of cuttings are now discharged at the seabed, representing an increase of 570 tonnes. When cuttings are discharged directly to the seabed, they have very little time to disperse under the influence of the surrounding water current. Therefore, they settle to the seabed rapidly and result in a thicker deposit of cuttings at or near to the discharge location. The greater volume of cuttings discharged to the seabed is the cause of the greater thickness encountered in the re-run cuttings modelling.

With regard to the general pattern of cuttings dispersion, the more widespread and very thin deposition observed drifting to the north-east is likely to be the result of the mid and bottom-hole well sections being discharged overboard the rig. This is because when cuttings are discharged overboard near to the sea surface, they can remain suspended in the water column for a significant period of time under the influence of the surface and bottom currents, before settling through the water column and finally being deposited on the seabed. This often results in more widespread deposition of the cuttings and a much less thick deposition of cuttings in general. In the case of the Darwin East-1 well, the water depths in the area are significant (2,010 metres at the drilling location), meaning the time over which particles discharged near to the sea surface would settle to the seabed would likely be very great. As such, it is likely that the majority of cuttings, particularly the smaller particles that require less energy to be entrained, would have been dispersed over a very great distance, and after settling on the seabed, their thickness would be so small that it would be undetectable against the normal sediment regimes of the area.

Figure 4.1 Predicted cuttings deposition on the seabed around the proposed Darwin East-1 drilling location showing detailed view of the cuttings pile

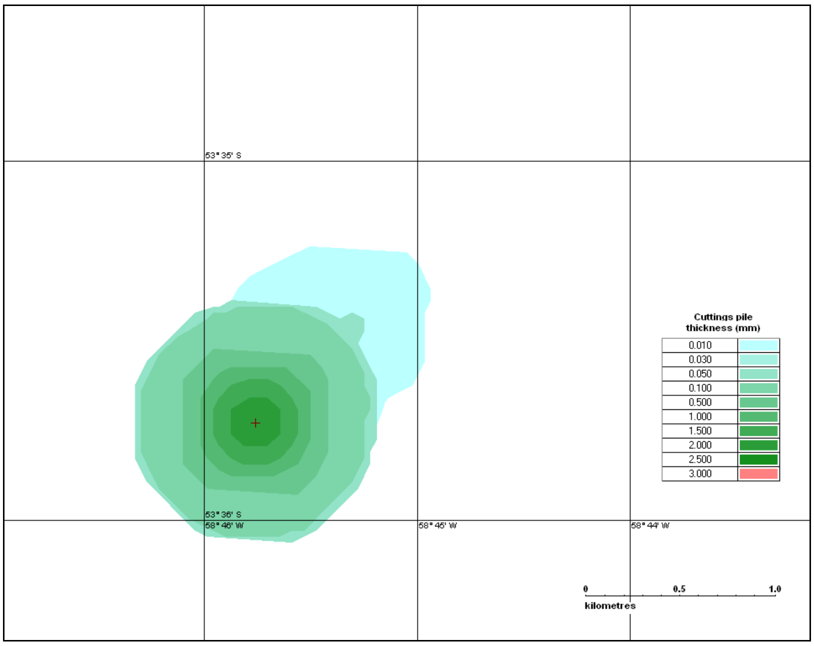
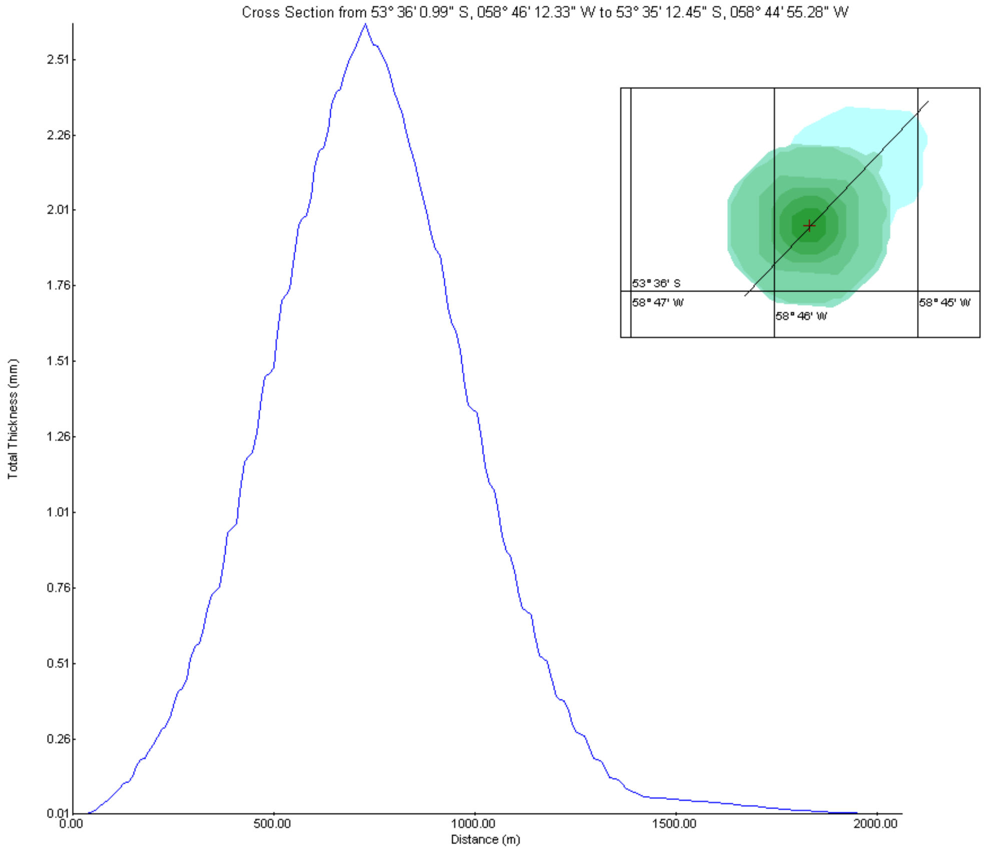


Figure 4.2 Cross section through the centre of the Darwin East-1 drilling location along the long axis of the cuttings pile



Conclusions

The deposition of cuttings and fine solids has the potential to directly affect the seabed fauna. Smothering effects and changes in the sediment grain size and chemistry combine to favour certain species over others. As a result, the population of seabed fauna within the area influenced by cuttings disposition may differ from that of the surrounding unaffected sediments. Studies have shown that impacts from smothering can occur where the depth of cuttings is one millimetre or more (*Bakke et al., 1986*).

A study of the development drilling in the Pompano field in deep water in the Gulf of Mexico (*Fechelm et al., 1998*) has assessed the dispersion of Synthetic-based Drilling Muds (SBM) cuttings from two platforms in water depths of 393 metres and 565 metres. The cuttings from these multi-well developments totalled 7,659 bbl (approximately 980 tonnes) of the SBM *Petrofree LE* (90% LAO, 10% Ester), although the mud weight discharged was not estimated. The dispersion of these cuttings was surveyed, and results indicated that no cuttings pile was observed at either location. Instead there was a thin 'veneer' of cuttings dispersed over a large area in a patchy fashion, the thickest patches were observed to be 20-25cm deep. Chemical analyses indicated that most of the fluid was observed along transects in the direction of the surface and mid-level currents rather than in the direction of bottom currents. Maximum measured SBM concentrations were recorded close to the platform (100 metres) and were in the order of 30-50,000µg/g in the top 2 centimetres of sediment. Benthic abundance was highest in sediment along the same transect that had high SBM concentrations. ROV video was used to count demersal megafauna (primarily fish). Neither benthic fauna nor demersal fish abundance appeared to have been adversely affected by the SBM cuttings discharge (*Fechelm et al., 1998*).

Other evidence of cuttings dispersion exists from the UKCS. In 1987 a benthic environmental survey was undertaken at a single well site in the Central North Sea (*AUMS, 1987*). The well had been drilled five years prior to the survey using a WBM and a total of approximately 800 tonnes of cuttings had been deposited on the seabed. The results of the survey indicated that, with the exception of a slightly elevated barium concentration, levels of sediment metals and hydrocarbons were similar to background. The analysis of the benthic fauna indicated that, even at sites closest to the wellhead, full recovery of the impacted sediments had taken place. This well site was revisited by Oil and Gas UK (formerly UKOOA) in 2005 and results now show that the area is completely consistent with background conditions (*Hartley Anderson Ltd., 2005*). In addition, field studies in the United States of America have shown that recovery of benthic communities impacted with water based drilling discharges is likely to be very rapid (i.e. within a few months) (*Neff, 1982*).

Discharged cuttings will contain trace amounts of (water based) drilling muds and any chemical additives used in the drilling process. Chemicals used in the water based mud have an OCNS category 'E' or have a Gold HQ band or are naturally occurring products (e.g. barite) that are either biologically inert or readily dispersible or biodegradable. The main impact from cuttings will be due to seafloor smothering rather than toxicity. The impact of seabed smothering can occur where the depth of cuttings is one millimetre or more. As the top hole sections of both holes have cuttings deposited directly to seabed the cuttings pile closest to the well is the thickest. Cuttings processed on the rig and discharged to the sea can remain suspended in the water column for a significant period of time under the influence of the water column currents during settling, and are therefore dispersed over a wider area.

The diameter of the Darwin East-1 cuttings pile diminishes to 1 millimetre at approximately 350 metres from the drilling centre, representing an area of approximately 0.384 square kilometres. At the Stebbing-3 well location, the cuttings pile thickness slightly exceeds 1 millimetre to a distance of approximately 497 metres from the drilling location, representing an area of approximately 0.776 km^2. However, because of the now reduced cuttings volume at Stebbing-3, this can be considered to represent an absolute worst case scenario. A reduction in existing faunal representation may be expected due to smothering effects in the immediate vicinity of the wells within these areas, however, the overall impact will be minor due to the localised scale and temporary nature of the impact. Given the generally limited thickness of the predicted cuttings deposition and the dispersal action of bottom currents, it is likely that any cuttings will soon become mixed with the natural seabed sediments and will eventually be dispersed fully.

4.6 Noise and Vibration

Refer to section 6.6 (pages 6-9 to 6-13) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

Operational activities at the proposed well sites will generate noise, both above and below the sea surface, mainly during drilling activities. Noise is thought to have the potential to disturb animals in the area, particularly cetaceans.

Naturally occurring noise levels in the ocean as a result of wind and wave action may range from around 90 dB re 1µPa under very calm, low wind conditions to 110 dB re 1µPa under windy conditions. Certain aspects of the drilling campaign could generate noise in excess of ambient conditions. Typical subsea noise levels from offshore operations are shown in Table 4.4.

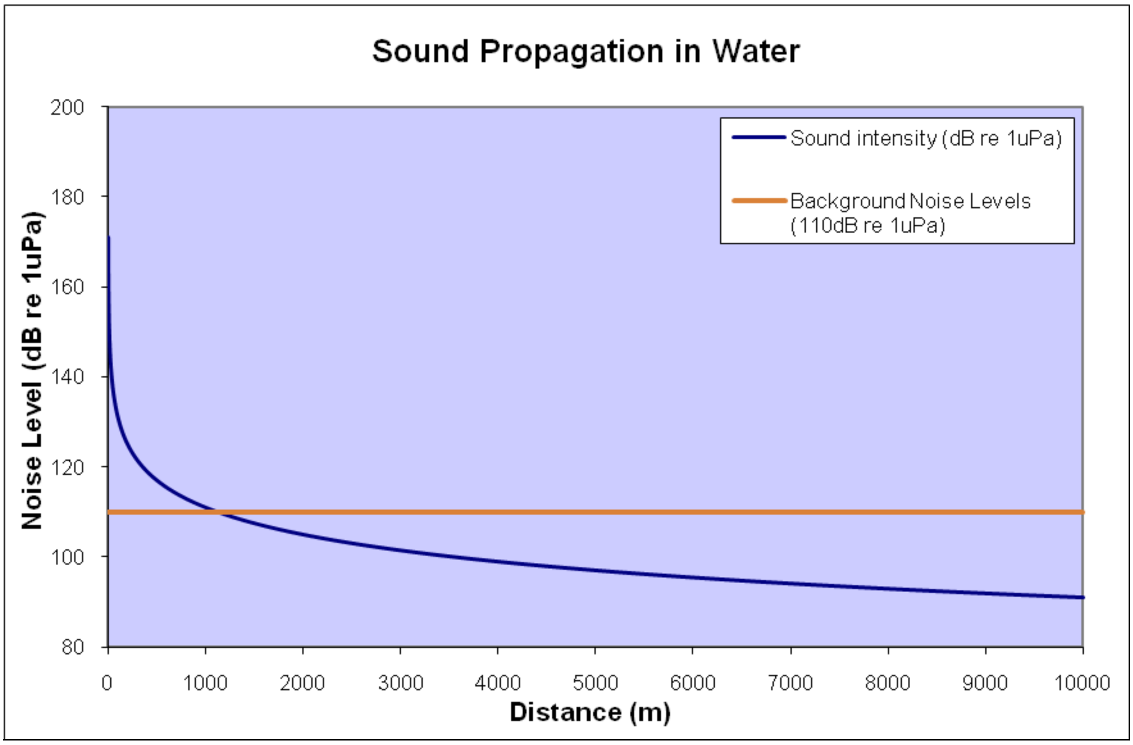
Table 4.4 Typical Noise Levels Associated with Offshore Operations

Activity	Frequency range (kHz)	Average source level (dB re 1µPa-m)	Estimated received level at different ranges (km) by spherical spreading			
			0.1 km	1 km	10 km	100 km
High resolution geophysical survey; pingers, side-scan	10 to 200	<230	190	169	144	69
Low resolution geophysical seismic survey; seismic air gun	0.008 to 0.2	248	210	144	118	102
			208	187	162	87
Vertical Seismic Profiling	0.005 to 0.1	190	150	129	104	29
Production drilling	0.25	163	123	102	77	2
Jack-up drilling rig	0.005 to 1.2	85 to 127	45 to 87	24 to 66	<41	0
Semi-submersible rig	0.016 to 0.2	167 to 171	127 to 131	106 to 110	81 to 85	6 to 10
Drill ship	0.01 to 10	179 to 191	139 to 151	118 to 130	93 to 105	18 to 30
Large merchant vessel	0.005 to 0.9	160 to 190	120 to 150	99 to 129	74 to 104	<29
Super tanker	0.02 to 0.1	187 to 232	147 to 192	126 to 171	101 to 146	26 to 71

* (dB) The magnitude of the sound manifests itself as pressure, i.e. a force acting over a given area. It is expressed in terms of 'sound levels', which use a logarithmic scale of the ratio of the measured pressure to a reference pressure (Decibels (dB)). Level of underwater noise is reported in dB re 1µPa @ one metre in water.

Taking 171dB as an example of the upper noise level limit typically generated from drilling operations using a semi-submersible drilling rig (dynamically positioned) and assuming a spherical propagation of noise from the source, it can be seen from Figure 4.3 that background noise levels will be reached within a kilometre of the source. An anchored semi-submersible will generate less noise than a dynamically positioned semi-submersible, which is more dependent on its thrusters for maintaining position.

Figure 4.3 Propagation of Sound in Water (from Richardson et al., 1995)

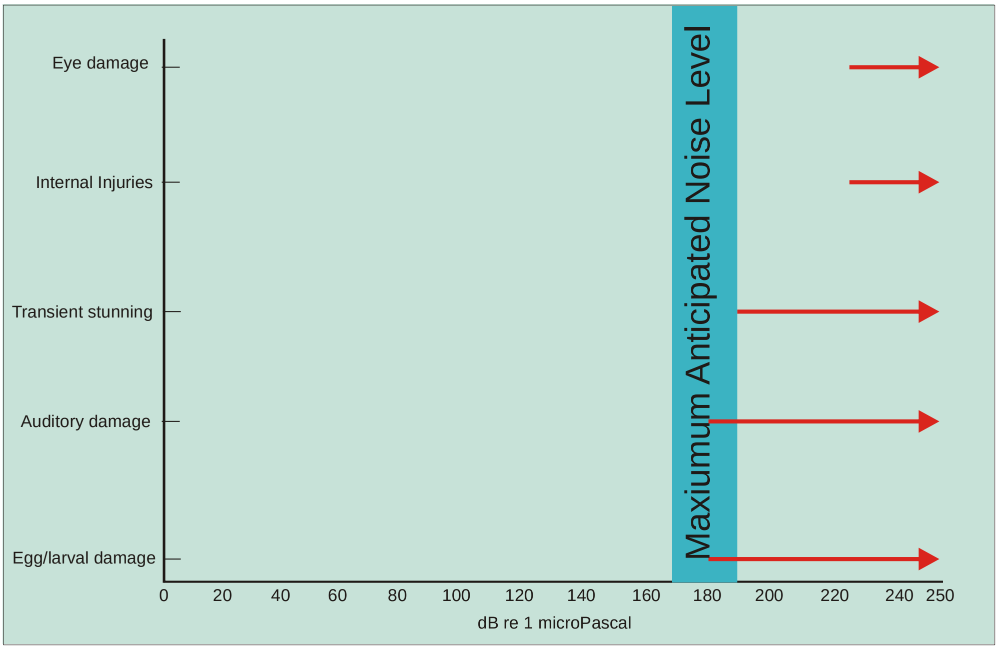


Potential Impacts on Fish

Fish are generally sensitive to noises within the frequency range of less than 1 Hertz to 3,000 Hertz, however, it has been reported that they will respond consistently to very low, or very high frequency noises (*Knudsen et al., 1992, 1994*). Sounds in the range of 50 to 2,000 Hertz, such as the peak sound levels produced by many anthropogenic activities, only produce short-term startle response at the outset of sound production with subsequent habituation to noise (*Knudsen et al. 1992, 1994; Westerberg, 1999*). Fish may be particularly sensitive to noise during spawning as noise may disrupt aggregations of the population and reduce the probability of successful fertilisation if individuals are deterred from spawning grounds. However, of the prevalent fish species likely to occur in the vicinity of the license area, none spawn within the proposed drilling period (Refer to section 3.2.4 of this Addendum).

Given the magnitude of sounds expected to be produced by the proposed drilling activities, there may be transient impacts on fish such as stunning effects and temporary auditory disturbance (Figure 4.4), particularly to species which possess swimbladders. No permanent physical damage to adult fish is expected, however damage may occur to fish eggs and larvae as they are more sensitive to noise and are not mobile and therefore cannot move away from the noise source. Peak egg abundance occurs between September and November. While this is just outside the proposed drilling period, larvae and juveniles may hatch and therefore be present during the drilling period. Most larval stages are found in water depths of <400 metres where food is more readily available throughout their larval stages (if planktotrophic) or upon hatching (if lecithotrophic). Therefore larvae are more likely to occur in water depths shallower than those of the proposed Darwin and Stebbing wells.

Figure 4.4 Sound Pressure Level Thresholds for the Onset of Fish Injuries (after Turnpenny & Nedwell, 1994)



Potential Impacts on Cetaceans

Refer to section 6.6.3 (pages 6-11 to 6-12) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

Based on JNCC survey results (*White et al., 2002*) and the results from the MMO during the Borders and Southern 3D survey (29th October 2007 – 10th February 2008), the following cetacean species may be found in the vicinity of the licence area during the proposed drilling operations between December and July: fin whale, sei whale, sperm whale, minke whale, southern bottlenose whale, hourglass dolphin and Peale's dolphin. Of these, the hourglass dolphin and Peale's dolphin and fin and pilot whales have been sighted within the licence area and are the most likely species to be impacted by the proposed drilling operations.

Evidence suggests that dolphins and other toothed whales (such as the pilot whale) show considerable tolerance of drilling rigs and support vessels (*Richardson et al., 1995*). There is however a lack of data surrounding noise tolerances and impacts of anthropogenic sound on mysticetes (baleen whales, such as the fin whale). The noise levels associated with the proposed drilling operations are well below those anticipated to cause disturbance or injury to cetaceans. However some sounds may evoke a behavioural response which may be transient and only last for the duration of the noise or for the period that the animal is in the locality of the noise source. Auditory damage may occur if an animal remains close to a noise source of around 120 dB for a prolonged period of time but it is considered unlikely that marine mammals would remain close to such a noise source for any length of time (*Richardson et al.*, 1995; *Gordon et al.*, 2004).

Studies have indicated that even when the noise generated by a drilling rig is well above the ambient (background) level, baleen whales and toothed whale exhibit no measurable change in behaviour. Habituation behaviours to prolonged noise levels from nearby vessels has also been reported (*Perry, 1998*). It has also been suggested that avoidance reactions are only likely to occur within distances of tens of metres from the rig (*Richardson et al., 1995*). In addition, anecdotal evidence indicates that cetaceans are not disturbed by the noise generated by large vessels associated with drilling operations.

Given the above, a low number of cetaceans have actually been sighted within the vicinity of the well locations, however this may also to an extent be an effect of the survey effort in the proposed area. The noise generated is likely to be of a low magnitude but above ambient background noise levels and only last for a short period. The impacts to cetaceans from the proposed drilling operations are anticipated to be minor and only last for the duration of the drilling operations.

4.6.1 Potential Impacts on Pinnipeds

Refer to section 6.6.4 (page 6-12) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

Information on the at-sea distribution of pinnipeds as well as the impact of noise on pinnipeds is scarce. Noise can interfere with the ability of pinnipeds to explore their environment and communicate with each other (*Reijnders et al., 1993*). Furthermore, heavy noise generated from seismic operations, icebreakers and drilling operations might cause serious discomfort (*Richardson et al., 1998*).

Based on JNCC survey results (*White et al., 2002),* the southern elephant seal and the South American sea lion are the most likely species of pinniped to be found in the vicinity of the exploration wells during the drilling programme. The southern elephant seal may be found offshore, as the proposed drilling period is outside of their breeding and mating seasons when this species are restricted to land. However, they are not anticipated to appear in high densities as females moult in January and are therefore restricted to land during this part of the drilling period and males moult between March and April which is the latter part of the drilling period. Coincident with this, the Falkland Island population of the southern elephant seal only represents a small proportion of the global population (White et al., 2002), therefore impacts are not anticpated to have global population-wide ramifications.

The South American sea lion has been sighted within the licence area however this species mates and breeds onshore in the Falkland Islands from December which coincides with the proposed drilling period and is therefore restricted to land, with only small inshore foraging trips being undertaken rather than extensive offshore excursions. Only four sightings of this species were made during the B&S 3D seismic survey. It is therefore possible that this species will be encountered, however given its preference for the shore habitat during this period, its presence is unlikely and not significant.

South American fur seal breeding and pupping season also coincides with the proposed drilling period. During this period, this species also exhibits and affinity for the breeding grounds nearshore and is therefore unlikely to be found offshore during the drilling period in significant numbers.

Given the low numbers of pinnipeds anticipated to venture offshore into the area of the proposed drilling operations, particularly given the timing and short duration of the drilling operations, the impact of noise generated during drilling operations is expected to be negligible.

4.7 Potential Impacts on Protected Birds

Refer to section 6.6.5 (page 6-13) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

The majority of seabird species in the Falkland Islands are observed in coastal and near-shore areas. Several bird species may frequent the offshore areas where the proposed exploration wells are located. Species which may be found in the vicinity of the exploration wells during drilling operations include; wandering albatross, black browed albatross, grey headed albatross, southern royal albatross, northern giant petrel, southern giant petrel, cape petrel, Antarctic fulmar, Atlantic petrel, white-chinned petrel, slender-billed prion, fairy prion, sooty shearwater, Wilson's storm-petrel, Southern rockhopper penguin, Magellanic penguin. Several other bird species have been observed around the Falkland Islands, however their presence is not deemed significant because they are generally more coastal species (e.g. gulls) or their occurrence is generally outside the proposed drilling period (Refer to Section 3.2.7 of this Addendum).

At the licence location seabird vulnerability ranges from low to high during the proposed drilling period (Refer to Section 3.2.8 of this Addendum). Seabird vulnerability is consistently high in the coastal near-shore waters surrounding the Falkland Islands reflecting the higher density of seabird populations in these areas. Outside of the coastal zone the vulnerability varies regionally throughout the year. During the planned drilling period the majority of seabirds do appear to be sighted to the north and west of the Falkland Islands. However, the compilation of seabird concentration maps is no doubt influenced by the sampling density mostly being compiled from vessel observations. The areas of high seabird densities are commonly coincidental with the areas of fishing activity reflecting where the sampling took place. Projections of the observed vulnerability maps indicate generally low vulnerability during the drilling period with a peak of high vulnerability during January. However, observations made during the acquisition of the 3D survey, which coincidentally took place during the same months as the proposed drilling period, have highlighted bird species that are present within the licence area during this time.

Anticipated airborne noise from drilling activities is likely to be rapidly attenuated and, as a result any impact to seabirds (i.e. displacement from the area) is likely to be very localized within the immediate vicinity of the drilling and will be temporary in nature (the rig is anticipated to be on site in the licence area for 83 days). The physical presence of the drilling rig is unlikely to have any significant effects on seabird species, although during conditions of fog and night time lighting of structures seabirds can be disorientated and could result in bird strikes.

Rockhopper and megellanic penguins reach seasonal peaks during the proposed drilling period. Given that the islands represent a significant proportion of the world populations of both species the Falkland Islands are internationally important. Recent decline of the rockhopper population has lead the IUCN classifying it as 'Threatened' (BI, 2004).

Southern rockhopper penguins have been observed at significant distance from the Falkland Islands. Between December and July the majority of recorded sightings are from near-shore areas and to the west of the Falkland Islands. Tracking records have shown that Southern rockhopper penguins may enter the licence area on foraging trips. This was confirmed by visual sightings during the 3D survey acquisition. Magellanic penguins exhibit more far reaching foraging behaviour. Tracking records for the Magellanic penguins has shown that they may travel through the licence area during foraging trips into deeper waters, again confirmed during the 3D acquisition. However, the majority of sightings were recorded to the north of the Falkland Islands and in near-shore waters. Penguins in the immediate vicinity of the drilling rig may be impacted by drilling noise; however impacts are not anticipated to be significant.

Anticipated airborne noise derived from rig activities – including incoming and outgoing helicopter flights - is likely to be rapidly attenuated and, as a result any impact to seabirds (i.e. displacement from the area) is likely to be largely very localized within the immediate vicinity of the drilling and will be temporary in nature (the rig is anticipated to be on site in the licence area for 83 days and helicopter flights will be in the order of minutes and hours). The physical presence of the drilling rig is unlikely to have any significant effects on seabird species, although during conditions of fog and night time lighting of structures seabirds can be disorientated and could result in bird strikes.

Three important colonies of penguins exist within the Falkland Islands territory. Of these, the largest colony is located on Beauchêne Island which is located 130 kilometres from the Darwin East-1 well and 155 kilometres from the Stebbing-3 well. Foraging movements of Rockhopper penguin indicate that it may frequent the proposed drilling location at certain times however most movements are typically near-shore. Penguins in the immediate vicinity of the drilling rig may be impacted by drilling noise; however impacts are not anticipated to be significant.

In a study of seabird observations during flaring operations, seabird species were present in 235 (73%) of the 320 radial point counts conducted. At least 12 different seabird species were identified and 1,085 seabirds recorded. Observed seabird densities were relatively low (*Grant Munro, 2011*).

Whilst no negative interaction was observed the data collected did suggest a level of positive association of seabirds to the drilling rig. Significantly greater numbers of seabirds were present during the morning rather than the afternoon suggesting that there may be attraction to lighting from the drilling rig over the hours of darkness.

In summary, whilst a level of seabird association to the drilling rig was observed, the short durations of well test flaring, low seabird density during winter months, and the seasonal absence of the most vulnerable species would seem to cause a low risk of negative seabird interaction, and none were observed during the testing (*Grant Munro, 2011*).

4.8 Atmospheric Emissions

The main sources of atmospheric emissions during drilling operations will result from diesel burnt for power generation for the drill rig and associated standby vessels and from aviation fuel burnt during helicopter flights. Diesel burnt for power generation will give rise to emissions of carbon dioxide (CO_2), oxides of nitrogen (NOx), nitrogen dioxide (NO_2), sulphur dioxide (SOx) and unburned hydrocarbons (refer to Tables 4.5 and 4.6).

Table 4.5 Predicted Atmospheric Emissions from Darwin East Well

Emissions[1]	Drill Rig [2] (tonnes)	Support Vessels[3] (tonnes)	Helicopter flights [4] (tonnes)	Total (tonnes)
Carbon dioxide	3648.00	2918.40	62.11	6628.5
Carbon monoxide	17.90	14.32	0.10	32.3
Oxides of nitrogen	67.72	54.17	0.24	122.1
Nitrous oxide	0.25	0.20	0.004	0.5
Sulphur dioxide	4.56	3.65	0.08	8.3
Methane	0.21	0.16	0.0017	0.4
Volatile organic chemicals	2.28	1.82	0.016	4.1

Note 1: Emission factors used from UKOOA 2002a based on methodology proposed by OGP
Note 2: Rig is estimated to consume @ 30 tonnes fuel/day for 38 days duration.
Note 3: 2 Support vessel (estimated to consume 12 tonnes fuel/ day) for 38 days duration.
Note 4: Helicopter estimated to consume 19.41 tonnes fuel for the duration of the drilling.

Table 4.6 Predicted Atmospheric Emissions from Stebbing Well

Emissions[1]	Drill Rig [2] (tonnes)	Support Vessels[3] (tonnes)	Helicopter flights [4] (tonnes)	Total (tonnes)
Carbon dioxide	4320.00	3456.00	73.54	7849.5
Carbon monoxide	21.20	16.96	0.12	38.3
Oxides of nitrogen	80.19	64.15	0.29	144.6
Nitrous oxide	0.30	0.24	0.005	0.5
Sulphur dioxide	5.40	4.32	0.09	9.8
Methane	0.24	0.19	0.0020	0.4
Volatile organic chemicals	2.70	2.16	0.018	4.9

Note 1: Emission factors used from UKOOA 2002a based on methodology proposed by OGP
Note 2: Rig is estimated to consume @ 30 tonnes fuel/day for 45 days duration.
Note 3: 2 Support vessel (estimated to consume 12 tonnes fuel/ day) for 45 days duration.
Note 4: Helicopter estimated to consume 22.98 tonnes fuel for the duration of the drilling.

Atmospheric emissions are anticipated to disperse to levels approaching background within a few tens of metres of their source. Although all such emissions will contribute to the overall pool of greenhouse and acidic gases in the atmosphere, local environmental effects will be negligible.

No well testing or well clean-up operations, which would add to the total emissions budget, are planned.

Practical steps to limit atmospheric emissions that will be adopted during the drilling programme include advanced planning to ensure efficient operations, well maintained and operated power generation equipment and regular monitoring of fuel consumption.

4.9 Invasive Species

4.9.1 In ballast water

There have been historical cases of non-native species entering marine environments via vessel ballast water and sediments which are transported by vessels. Some organisms have been known to remain alive in ballast water tanks even after journeys exceeding several weeks duration. In extreme cases, species (and possibly pathogens) entering non-native waters may thrive in the conditions of the new environment which may increase competition for resources, increase predation and mortality of native species or cause changes in the local biotope which may have cascading detrimental impacts upon the receiving environment.

Discharge of ballast water has been identified by both the International Maritime Organisation (IMO) in resolution A868(20) and also by the World Health Organisation (WHO) which is concerned about the possibility of ballast water acting as a medium of transport for epidemic diseases and pathogens (*IMO, 2001).*

Estuaries and enclosed bodies of water with longer residence times are more vulnerable to possible detrimental impacts associated with the introduction of non-native invasive species. As a result some governing bodies have placed restrictions on the discharge of ballast water in territorial waters. In Australia, ballast exchange at sea is currently mandatory but this is not the case in all international waters. The ideal option for prevention of colonisation of habitats by invasive species is by mid-ocean ballast water exchange prior to arrival. This is undertaken in the hope that species will be rapidly diluted in the large water column and by enhanced water circulation, thereby limiting proliferation of species.

The IMO has recommended that each vessel be equipped with a Ballast Water Management Plan to endeavour to comply with the local precautions taken by a receiving port or territory at the same time as ensuring the safety and stabilisation of the vessel itself (*IMO, 2001*). The IMO has also recommended that a ballast water log be kept of what water has been carried and discharged.

Recommendations have been made for managing ballast water whilst also following safe procedures (*IMO, 2001*);

- Informing shore management (via the use of ballast water logs);
- Development of a Ballast Water Management Plan for the rig which is to be kept on board for the specific journey and complies with local guidelines/legislation;
- Where practical, cleaning of the ballast tanks to remove any retained sediments should be undertaken;
- Retention of ballast on-board;
- Water treatment (by heat, chemicals or via UV treatment to eliminate pathogens or potential invasive species);
- Possible implementation of ballast water sampling methodology on behalf of the receiving port authority for analysis, research and documentation;
- Ballast water exchange at sea (it is recommended that each tank containing ballast water or sediments be flooded and pumped out 3 times).

The rig will have in place a Ballast Water Management Plan as per IMO guidelines. This will be in place to ensure that during transit and operations, industry best practise will be adhered to in order to prevent the release of non-native species into Falkland Island waters prior to operations or release of other non-native species during transit. As the rig is operating 150 kilometres offshore, and that the rig will implement a suitable Ballast Water Management Plan, it is not anticipated that invasive species introduced via ballast water tanks will pose a threat to the Falklands ecosystem.

4.9.2 Transfer of Fouling Organisms via Rig

A comparative review of the Wanless *et al*., (2009) paper and desktop study into potential risk from invasive species entering the Falkland Islands is provided below.

The paper refers to the introduction of species to an oceanic island environment which is likely to be of greater risk than the Falklands due to the remoteness of the islands and the limited exposure to species introduced naturally to the system.

The paper also suggests that if a vessel is located in one location for an extended period of time, this increases the risk of long term establishment of the fouling community and the introduction of species is also associated with the grounding of the vessel, which is an entirely different risk assessment procedure associated with towing, anchoring etc.

Furthermore, the risk assessment detailed in the paper is based on the organisms surveyed on the vessel. It is difficult to know what organisms would be present on the rig without a visual inspection due to the number of locations that the vessel has visited and the possibility of new species outcompeting existing species.

Based on these differing circumstances, a desk top review of the potential for the transfer of organisms by the *Leiv Eiriksson* semi submersible drilling rig has been conducted and concludes that there is a low risk of the successful introduction of any organism that may compete with the local faunal and floral communities.

The transoceanic movement of vessels is widely accepted as the dominant factor for the transfer of organisms in most coastal invasions. However, invasion ecology is in its relative infancy and generally lacking extensive scientific examination. Ballast water has been the most studied vector in the last 30 years and this probably reflects the dramatic invasions that have been recorded (for example, the introduction of quagga and zebra mussels *Dreissena bugensis* and *Dreissena polymorpha* - into the Laurentian Great Lakes, North America). In recent times the importance of the introduction of invasive species through transfer on the external surfaces of vessels has been increasingly recognised. The potential organisms that may be transported on a vessels hull include sessile (fouling), boring or vagile (clinging) species.

The potential for vessels to transfer aquatic species is a function of a range of physical factors of the vessel itself and the environments in which it has been stationed. The parameters influencing the likelihood of any threat include:

- The effectiveness of any antifouling systems and the potential for "niche-fouling" in sea chests, and other structures where the antifouling system is unable to perform in the same manner as coatings subjected to more typical water flow conditions;
- The period of time since dry docking, or in water treatment of the submerged surfaces;
- The duration that a vessel has been submerged in different environments and the movement between environments with different physical parameters.

The success of organisms that comprise the fouling community depends on the survivorship of individuals both on the hull and within the environment/s through which the vessel is transferred. A reduction in the viability of organisms characterising the fouling community is likely to result from changes in a range of physical parameters including:

- changes in salinity;
- dehydration through exposure to air;
- changes in temperature of the surrounding waters;
- reduced food availability;

This increased stress is likely to result in reduced capacity to satisfy the normal life functions including

- growth;
- reproduction and

- ultimately survivorship of individuals.

The combination of these factors provides an indication of the likelihood of an organism's posing a significant threat to a particular environment.

The semi submersible drilling rig proposed to be used for the purpose of a drilling campaign 220 kilometres from the coast of the Falkland Islands has been working in a range of environments with significant ranges in physical parameters.

Management and maintenance of the vessel and its recent working history along with the proposed use in waters offshore the Falklands suggest that there is a low risk of introduction of fouling organisms due to a number of factors including:

- Any periods when the columns and the tops of pontoons were exposed to air and likely to be flushed by freshwater from precipitation.

It is likely that the vast majority of fouling species on these exposed structures would not survive this extended period of exposure to air and possible fresh water flushing. There may be a higher survivorship at the waterline margins that may be influenced by the spray although these may also be stressed due to less than ideal conditions:

1. The section of the vessel that below the surface of the water was maintained in temperate water conditions. Although marine species are able to tolerate a range of temperatures, outside of their ideal conditions

2. There is a reduction in survivorship. As the rig moves into warmer waters, those organisms suited to temperate conditions may suffer reduced fitness and subsequently reduced survivorship;

3. For most benthic organisms, mechanisms used for coping with marginal conditions include the partitioning of resources to the survival of the individual, thus negating functions such as reproduction. As a consequence of this there is likely to be reduced, if any, reproductive effort made by the organisms from tropical environments fouling the hull.

Given that the proposed wells to be drilled are more than 220 kilometres from shore, the likelihood of larvae surviving in the water column from spawning to settlement phase is drastically reduced. Given that the survivorship of early life history stages is a very small proportion of those settling, this compounded impact of limited, if any, reproduction and settlement and the naturally low survivorship of larvae and recruits further reduces the risk of the successful introduction of any organisms that may compete with the local faunal and floral communities.

4.10 Marine Discharges

Refer to section 6.8 (pages 6-15 to 6-16) of the Borders & Southern Offshore Falkland Islands Exploration Drilling EIS (Licence PL018).

Sources of marine discharges for the proposed wells are:

- Water based mud (WBM) and drill cuttings;
- Cement;
- Drainage water;
- Sewage.

These discharges are discussed in the following sections.

Borders & Southern are to employ several measure to reduce impacts to the marine environment from these discharges as detailed below;

- Use of water based mud (WBM) for all well sections and the preferred selection of more environmentally benign mud and cement chemicals;
- Good housekeeping standards to be maintained on the rig to control the amount of hydrocarbons and other contaminants entering the drainage system. Appropriate drainage and sewage treatment systems will be on all rig/vessels. All discharges from the rig/supporting vessels will be treated and discharged according to the MARPOL Convention.
- All drilling chemicals to be assessed using the HOCNS methodology where appropriate, in accordance with the UK's Offshore Chemicals Regulations (OCR) 2002. Any chemicals with substitution warnings will be substituted where practicable.

Due to the low toxicity of the majority of the discharges and the anticipated dilution and dispersion, all impacts are predicted to be short-term and localised and are anticipated to be negligible.

4.10.1 Water Based Mud (WBM)

During the drilling stages of the wells WBM will be discharged as mud on cuttings and fine solids in to the sea and, upon completion of drilling each hole section, the spent WBM will be discharged to the sea. Top hole sections will be drilled with seawater and bentonite sweeps, cuttings will be discharged directly to the seabed. Lower sections of the wells will be drilled with WBM. The drilled cuttings and mud are returned to the rig through the riser for processing. The drilled cuttings are discharged to the sea at the surface (refer to Section 2.5 this document). The WBM composition is essentially a brine solution, with naturally occurring barite and bentonite clay. Small amounts of chemicals are added to this to maintain the properties of the mud which is designed to maintain wellbore stability, prevent formation fluids from entering the well, maintain efficient hole cleaning and to assist with bit performance and drilling efficiency.

The muds typically have a very low toxicity, and comprise approximately 90 percent water. The vast majority of WBM discharged for the well (approximately 96 percent) are classified under Annex 6 of the OSPAR convention (*OSPAR, 1999*) as substances which are considered to Pose Little Or No Risk to the environment (PLONOR chemicals).

Of the limited quantity of chemicals not classified as PLONOR and anticipated to be discharged along with the WBM, the majority are categorised as Category E or Gold (the lowest environmental risk category) under the UK Harmonised Offshore Chemical Notification Scheme (see Appendix B of the original Offshore Falkland Islands Exploration Drilling EIS for a description of the UK Harmonised Offshore Chemical Notification Scheme, CHARM and Hazard Quotients).

Studies of the discharge of WBM into the water column in areas where currents are weak have found dilutions of 500 to 1,000 times within one to three metres of discharge *(Ray and Meek, 1980)*. Dilution will therefore be rapid and this, together with the low toxicity, indicates that any impacts within the water column will be undetectable shortly after discharge. Discharge of the WBM will not contribute to any impacts on the local seabed communities through toxicity, bioaccumulation, low biodegradability or other physiological aspects.

In some cases drilling muds may be associated with elevated levels of heavy metals. However, a wide range of studies have shown that these are not bio-available and do not therefore result in any direct affects on marine fauna and flora (*Neff et al., 1989*).

4.10.2 Cement Chemicals

During drilling of the wells, some surface returns of cement and associated chemicals will be lost to the seabed in the immediate vicinity of the wells. Only a small volume of cement will be lost from the well. The cement is comprised mostly of PLONOR chemicals (refer to Table 2.5 in Section 2.8). All chemicals to be discharged which are non-PLONOR have a HQ band of GOLD or E (lowest environment risk category) for the purposes of CHARM assessment. Any impacts will be very close to the wells in the same area affected by cuttings deposition (refer to Section 4.5.2 above).

4.10.3 Drainage Water and Sewage

Water generated from rig wash-down and rainfall from the open deck areas may contain trace amounts of mud, lubricants and residual chemicals from small onboard leaks derived from activities such as re-fuelling of power packs or the laying down of dirty hoses or dope brushes etc. It should be stressed, however, that these would be relatively low volume discharges containing small residual quantities of contaminant. Desire will ensure that the rig is equipped with suitable containment, treatment and monitoring systems as part of the contract specification.

In addition, the Borders & Southern Drilling Representative will also ensure good housekeeping standards are maintained onboard the rig to minimise the amount of hydrocarbons and other contaminants entering the drainage systems. Liquid storage areas and areas that might otherwise be contaminated with oil are generally segregated from other deck areas to ensure that any contaminated drainage water can be treated or accidental spills contained. All the drains from the rig floor will be directed to a containment tank and the fluids processed/filtered to remove hydrocarbons (<15 parts per million hydrocarbons in water) as required under the MARPOL Convention and discharged to sea. Residual hydrocarbons will be routed to transit tanks for processing onshore.

An estimated 0.22 m^3/day of grey water and 0.10 m^3/day of black water will be generated by each person on board the drilling rig and support vessels (based on previous modelling and assumptions for offshore drilling operations (*BP, 2002*). Table 4.7 shows the estimated volume of grey and black water produced during the drilling period for both exploration wells (83 days).

Table 4.7 Estimated quantities of grey and black water discharge during drilling period (83 days)

Type of water	Volume (m^3)
Grey water produced (m^3)	1,826
Black water produced (m^3)	830

A Marine Sanitation Device will be available on the drilling rig for treatment of sewage effluent. Sanitary wastes such as black (sewerage) and grey water (showers and washing facilities) will contain detergents and cleaning agents from toilets and showers, together with human waste. All black water is routed via sewage treatment systems before being discharged to sea.

All discharges from the rig/supporting vessels will be treated and discharged according to the MARPOL Convention. In addition, all vessels, including the rig, will implement appropriate waste management plans.

4.11 Solid Wastes

Careful consideration is given to minimising the amount of waste generated and controlling its eventual disposal. It is acknowledged that waste disposal and treatment options in the Falklands are limited. Waste disposal has been discussed with Department of Public Services. Most waste will be disposed of in landfill on the Falklands Islands. However, hazardous waste will be exported to the UK for disposal as no suitable sites exist in the Falklands.

Typically, 24 tonnes of general waste are generated per month from a single well drilling programme. Bulk wastes (e.g. garbage, scrap, etc.) generated on the drilling rig will be segregated by type, stored in covered, four tonne capacity skips. Periodically these will be transported to shore (either the Falklands, if practicable, or to an alternate location) and the waste recycled or disposed of in a controlled manner through authorised waste contractors. Borders & Southern will ensure that a waste management plan is implemented to minimise the amounts generated and to ensure material such as scrap metal, waste oil and surplus chemicals are sent for re-cycle or re-use as far as practicable. Other waste will be sent to authorised landfills or incineration facilities, depending on its precise nature, to the Falklands, if practicable, or to an alternative location.

All discharges from the supporting vessels will be treated and discharged according to the MARPOL Convention (as relevant to the Atlantic Ocean). The MARPOL Convention prohibits discharge of any garbage or solid wastes into the North East Atlantic Ocean.

All vessels, including the rig, will implement appropriate waste management plans and store and dispose of all solid wastes onshore accordingly. Procedures for dealing with special waste will be implemented in accordance with regulatory guidelines.

4.12 Potential Spill Scenarios

Refer to Section 6.10 (Pages 6-17 – 6-25) of the Offshore Falkland Islands Exploration Drilling EIS.

The wells will target oil reservoirs, and therefore the main spill risks associated with drilling operations are accidental loss of hydrocarbons from the reservoir or an accidental loss from the drilling rig fuel oil inventory, the worst case being a total loss of well control (i.e. blow out), or a total loss of the fuel inventory from the rig. The likelihood of such events occurring is in the range identified as low risk.

The oil spill scenarios have been based on valid current observations and offshore wind data and are therefore relevant.

The OSIS modelling system provides a total capability to predict the movement, spreading, weathering and coastal impact of oil spilt in the marine environment. Most importantly, the model has been extensively validated during scientific sea trials (through a licence exclusively held in the UK by AEA Technology) and real incidents (e.g. the MV Braer and MVSea Empress tanker oil spills).

The system has been the primary oil spill modelling system in the UK for many years and is used by the Maritime and Coastguard Agency, Oil Spill Response Ltd., Briggs Marine Environmental Services, and most of the UK-based oil companies. It is also used internationally in areas such as SE Asia, Pacific Asia, the Gulf and the Caspian by many of the worlds largest oil companies and response organizations.

The wind rose from the 3D seismic survey recorded between November 2007 and January 2008 was used for the oil spill modelling, as it was thought to be more geographically representative of actual wind speed conditions that may be experienced in the PL018 area. The recorded data was cross referenced with 10 year hindcast data compiled from NOAA's WAVEWATCH III model to validate the results. The recorded data demonstrates the same trend as the 10 year data (see Figure 3.6). Therefore offshore wind data from the 3D seismic survey vessel observations does exhibit typical conditions and has been used for the modelling scenarios.

Diesel Spill Modelling - Scenarios

Diesel oil spill modelling was undertaken at both the Darwin East-1 location and at the Stebbing-3 well locations. The following scenarios were determined:

- The weathering of a 10 tonne operational spill of diesel with a 30 knot onshore wind;
- The weathering of a full rig inventory (3,853 tonnes) instantaneous diesel spill with a 30 knot onshore wind;
- The weathering of a full rig inventory (3,853 tonnes) diesel spill released instantaneously under typical wind conditions.

The spill modelling scenarios and results are summarised in Table 4.8 and presented in the corresponding Figures (Figure 4.5 to 4.10).

Table 4.8 OSIS Diesel Oil Spill Modelling Results for Darwin East-1 and Stebbing-3 Wells

From Location	Oil Type	Spill Size (tonnes)	Scenario	Wind Conditions	Fate of Spill	Figure
Darwin East-1	Diesel	10	Operational transfer	Trajectory: 30 knot onshore wind towards nearest landfall (Beauchêne Island)	Oil travels approx. 2.5 kilometres to the north-north-west. Disperses offshore within 1 hour.	4.5

From Location	Oil Type	Spill Size (tonnes)	Scenario	Wind Conditions	Fate of Spill	Figure
Stebbing -3	Diesel	10	Operational transfer	Trajectory: 30 knot onshore wind towards nearest landfall (Beauchêne Island)	Oil travels approx. 2.5 kilometres to the north-north-west. Disperses offshore within 1 hour.	4.6
Darwin East-1	Diesel	3,853	Rig inventory loss (trajectory)	Trajectory: 30 knot onshore wind towards nearest landfall (Beauchêne Island)	Oil travels approx. 25.5 kilometres to the north-north-west. Disperses offshore within 10 hours.	4.7
Stebbing -3	Diesel	3,853	Rig inventory loss (trajectory)	Trajectory: 30 knot onshore wind towards nearest landfall (Beauchêne Island)	Oil travels approx. 25.5 kilometres to the north-north-west. Disperses offshore within 10 hours.	4.8
Darwin East-1	Diesel	3,853	Rig inventory loss (stochastic)	Typical wind conditions (stochastic)	Oil remains offshore with a drift mainly towards the north east. 0% probability of oil beaching.	4.9
Stebbing -3	Diesel	3,853	Rig inventory loss (stochastic)	Typical wind conditions (stochastic)	Oil remains offshore with a drift mainly towards the north east. 0% probability of oil beaching.	4.10

Figure 4.5 Trajectory model run of an operational (10 tonne) spill of diesel with a 30 knot onshore wind towards Beauchêne Island at the Darwin East-1 well location

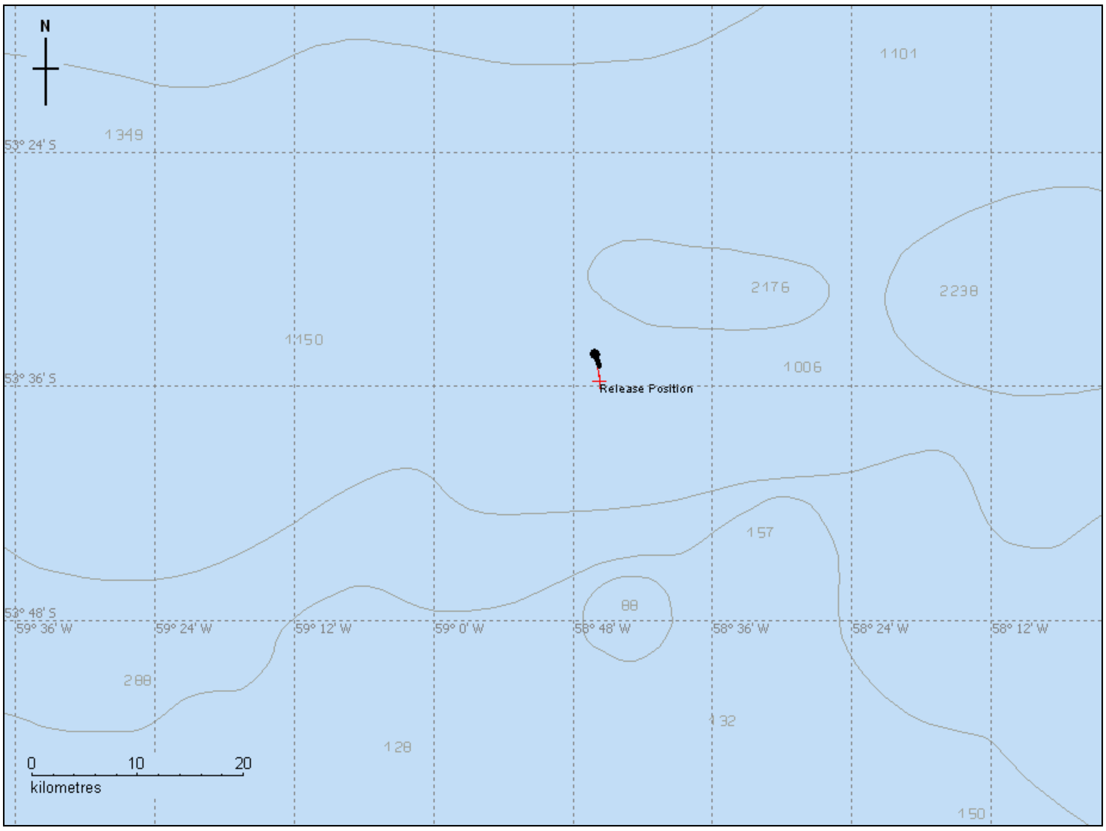


Figure 4.6 Trajectory model run of an operational (10 tonne) spill of diesel with a 30 knot onshore wind towards Beauchêne Island at the Stebbing-3 well location

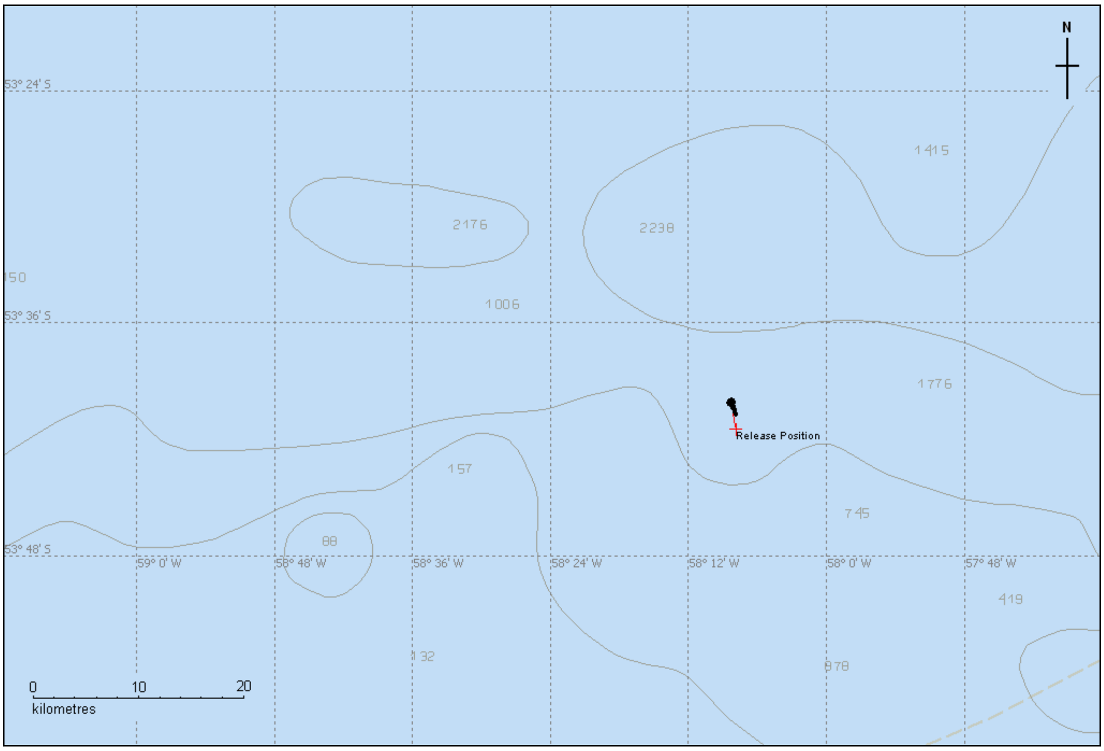


Figure 4.7 Trajectory model run of a full rig inventory (3,853 tonne) spill of diesel with a 30 knot onshore wind towards Beauchêne Island at the Darwin East-1 well location

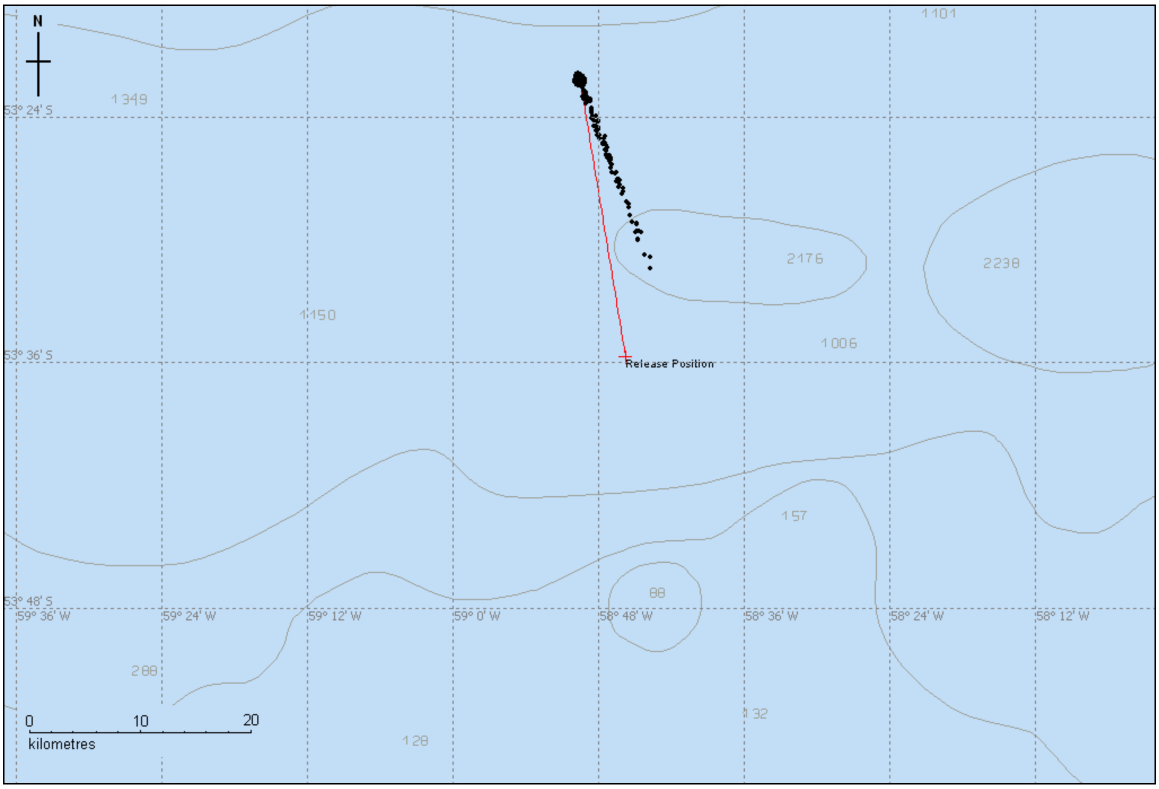


Figure 4.8 Trajectory model run of a full rig inventory (3,853 tonne) spill of diesel with a 30 knot onshore wind towards Beauchêne Island at the Stebbing-3 well location

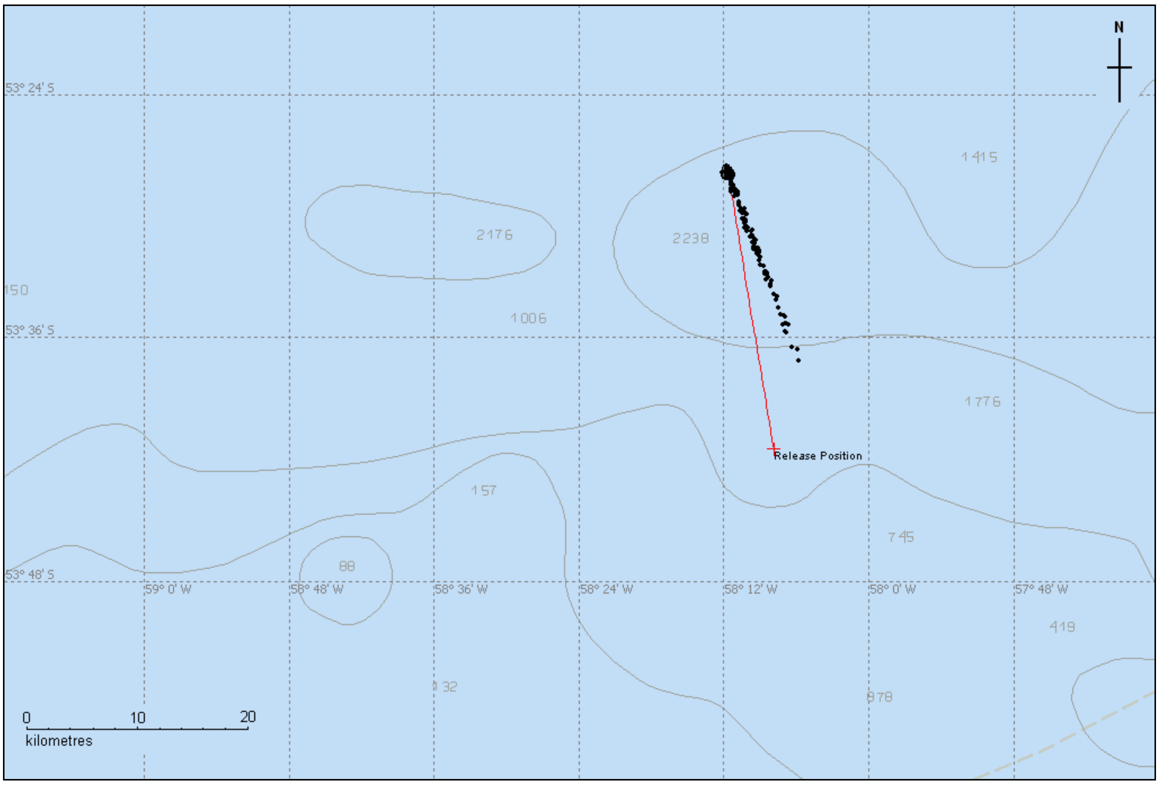


Figure 4.9 Stochastic model run (typical wind conditions) of a full rig inventory (3,853 tonnes) spill of diesel released instantaneously at the Darwin East-1 well location

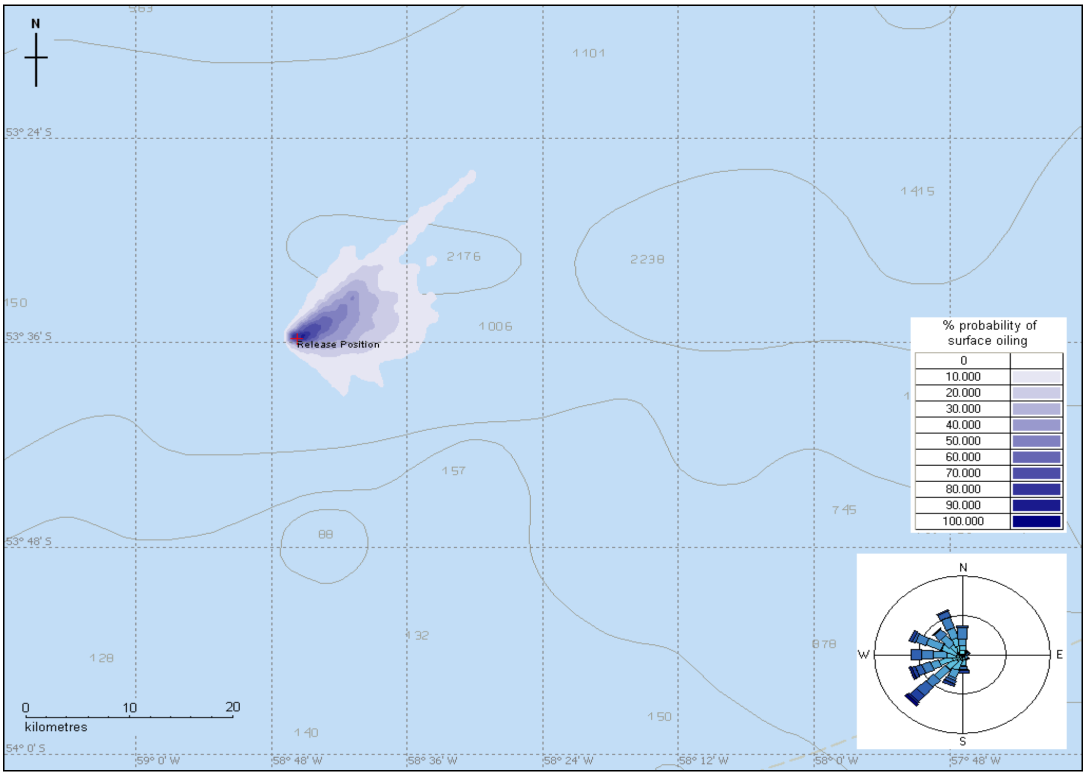
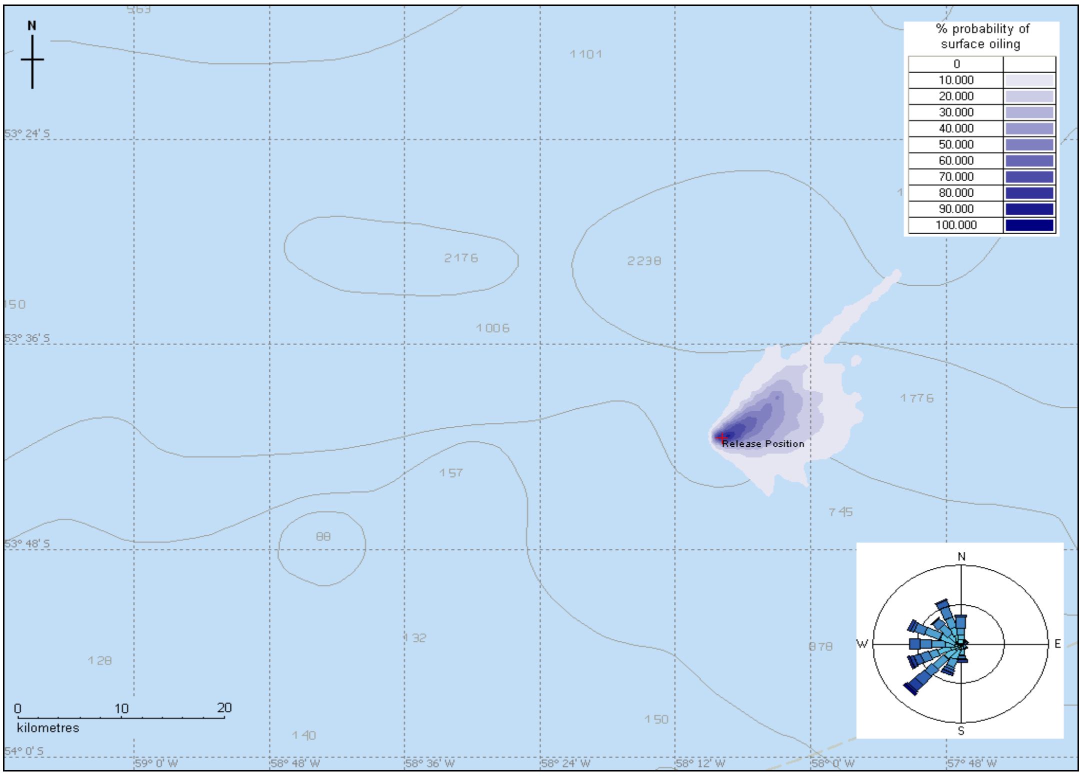


Figure 4.10 Stochastic model run (typical wind conditions) of a full rig inventory (3,853 tonnes) spill of diesel released instantaneously at the Stebbing-3 well location



Diesel Spill Modelling - Conclusions

Modelling of a 10 tonne operational spill of diesel fuel from both the Darwin East-1 and Stebbing-3 well locations with a worst case 30 knot onshore wind towards the nearest landfall (Beauchêne Island) indicated that the diesel would disperse offshore within in both cases 1 hour and would not reach the coastline (Figures 4.5 and 4.6). The model showed that the diesel travelled approximately 2.5 kilometres to the north-north-west in both cases before dispersing completely.

Similarly, modelling of the full diesel inventory of the rig (3,853 tonnes) released instantaneously (representing a total catastrophic loss of the drilling rig) from both the Darwin East-1 and Stebbing-3 well locations with a worst case 30 knot onshore wind towards the nearest landfall (Beauchêne Island) showed that the diesel dispersed offshore within 10 hours in both cases without reaching the shore (Figures 4.7 and 4.8). The model showed that the diesel travelled approximately 26 kilometres to the north-north-west in both cases before dispersing completely.

Stochastic modelling, using typical wind conditions for the area for both the Darwin East-1 and Stebbing-3 well locations indicated that the diesel would weather offshore and would drift and disperse in a north-easterly direction, in line with the prevailing wind and currents (Figures 4.9 and 4.10). The modelling indicated a zero percent chance of the diesel beaching in both scenarios. This indicates that the predominant effect of the prevailing winds is to keep any spilt diesel offshore.

Crude Oil Spill Modelling – Scenarios

A blow-out is the uncontrolled influx of reservoir fluids into the well. Due to the precautions taken to prevent their occurrence, they are very rare events. Uncontrolled flow is mostly associated with drilling into a shallow gas pocket or whilst drilling a deep gas well. In the rare event of a loss of well control from either of the exploration wells, the amount lost per unit time would depend on the unrestricted open hole flow rate. For the purposes of the oil spill modelling, the maximum theoretical open hole flow rates for the wells have been used. For the Darwin East-1 well, the anticipated hydrocarbons are 32°API crude with a theoretical maximum open hole flow rate of 46,865 bopd (approximately 6,148 tonnes per day). The anticipated hydrocarbons from the Stebbing-3 well are 25°API crude oil with a theoretical maximum open hole flow rate of 18,939 bopd (approx 2,638 tonnes per day) for the Stebbing-3 490 reservoir and 47,470 bopd (approx 6,612 tonnes per day) for the Stebbing-3 500+ reservoir. The Stebbing- 500+ reservoir open hole flow rate has been used to represent the worst case flow scenario. The methods of calculation of the theoretical maximum open hole flow rates are detailed in Appendices 1 and 2 of the Borders and Southern Project Specific OSCP Appendix.

Crude oil spill modelling was undertaken for the Darwin East-1 and Stebbing-3 wells to simulate the fate of a hydrocarbon spill due to a loss of well control in the even on a blowout. The following scenarios were determined;

- The weathering of a 10 tonne operational spill of the expected reservoir crude oil with a 30 knot onshore wind towards the nearest landfall (Beauchêne Island);
- The weathering of a 10 tonne operational spill of the expected reservoir crude oil with a 30 knot onshore wind towards the nearest landfall on the Falklands mainland;
- The weathering of a blow-out of the expected reservoir crude oil released over 48 hours with a 30 knot onshore wind towards the nearest landfall (Beauchêne Island);
- The weathering of a blow-out of the expected reservoir crude oil released over 48 hours with a 30 knot onshore wind towards the nearest landfall on the Falklands mainland;
- The weathering of a blow-out of the expected reservoir crude oil released over 48 hours with a 30 knot onshore wind under typical wind conditions;
- The weathering of a blow-out of the expected reservoir crude oil released over 10 days with a 30 knot onshore wind under typical wind conditions.

Crude Oil Spill Modelling - Results

The spill modelling scenarios and results are summarised in Table 4.9 and further details on trajectory crude oil spills and their fate can be found in the Borders and Southern Project Specific OSCP Appendix (Section A.4.5.2). The results from stochastic modelling have been included in the following sections of this Addendum.

Table 4.9. OSIS Crude Oil Spill Modelling Results for Darwin East-1 and Stebbing-3 Wells

From Location	Oil Type	Spill Size (t day^{-1})	Scenario	Wind Conditions	Fate of Spill	Figure
Darwin East -1	Crude 32° API	10t	Operational spill	Trajectory: 30 knot onshore wind towards nearest landfall (Beauchêne Island) (145°)	Oil travels approx. 50 kilometres to the north-north-west. Disperses offshore within 19 hours.	A.11 (of the OSCP Appendix)
Darwin East -1	Crude 32° API	10t	Operational spill	Trajectory: 30 knot onshore wind towards mainland Falkland Islands (170°)	Oil travels approx. 52 kilometres to the north. Disperses offshore within 19 hours.	A.12 (of the OSCP Appendix)
Stebbing-3	Crude 25° API	10t	Operational spill	Trajectory: 30 knot onshore wind towards nearest landfall (Beauchêne Island) (125°)	Oil beaches at Beauchene Island after approximately 52 hours. Total volume of oil beaching estimated at 5 tonnes.	A.13 (of the OSCP Appendix)
Stebbing-3	Crude 25° API	10t	Operational spill	Trajectory: 30 knot onshore wind towards mainland Falkland Islands (159°)	Oil travels approx. 130 kilometres to the north-north-west. Disperses offshore within 52 hours.	A.14 (of the OSCP Appendix)
Darwin East -1	Crude 32° API	6,148	Uncontrolled flow (blowout) release over 48 hours	Trajectory: 30 knot onshore wind towards nearest landfall (Beauchêne Island) (145°)	Oil beaches at Beauchene Island after approximately 38 hours and on mainland Falkland Islands after approximately 70 hours. Total volume of oil beaching estimated at 6,815 tonnes.	A.15 (of the OSCP Appendix)
Darwin East -1	Crude 32° API	6,148	Uncontrolled flow (blowout) release over 48 hours	Trajectory: 30 knot onshore wind towards mainland Falkland Islands (170°)	Oil beaches on mainland Falkland Islands after approximately 66 hours. Total volume of oil beaching estimated at 7,036 tonnes.	A.16 (of the OSCP Appendix)
Stebbing-3	Crude 25° API	6,612	Uncontrolled flow (blowout) release over 48 hours	Trajectory: 30 knot onshore wind towards nearest landfall (Beauchêne Island) (125°)	Oil beaches at Beauchêne Island after approximately 57 hours and on mainland Falkland Islands after approximately 72 hours. Total volume of oil beaching estimated at 13,505 tonnes.	A.17 (of the OSCP Appendix)
Stebbing-3	Crude 25° API	6,612	Uncontrolled flow (blowout) release over 48 hours	Trajectory: 30 knot onshore wind towards mainland Falkland Islands (159°)	Oil beaches on mainland Falkland Islands after approximately 75 hours. Total volume of oil beaching estimated at 18,111 tonnes.	A.18 (of the OSCP Appendix)
Darwin East -1	Crude 32° API	6,148	Uncontrolled flow (blowout) release over 48 hours	Typical wind conditions (stochastic)	Oil beaches at Beauchêne Island and at various locations along the south coast of the Falklands mainland. Total probability of oil beaching 8.10%.	4.11

From Location	Oil Type	Spill Size (t day^{-1})	Scenario	Wind Conditions	Fate of Spill	Figure
Darwin East -1	Crude 32° API	6,148	Uncontrolled flow (blowout) release over 10 days	Typical wind conditions (stochastic)	Oil beaches at Beauchêne Island and at various locations along the south coast of the Falklands mainland. Total probability of oil beaching 8.50%.	4.12
Stebbing-3	Crude 25° API	6,612	Uncontrolled flow (blowout) release over 48 hours	Typical wind conditions (stochastic)	Oil beaches at Beauchêne Island and at various locations along the south coast of the Falklands mainland. Total probability of oil beaching 5.20%.	4.13
Stebbing-3	Crude 25° API	6,612	Uncontrolled flow (blowout) release over 10 days	Typical wind conditions (stochastic)	Oil beaches at Beauchêne Island and at various locations along the south coast of the Falklands mainland. Total probability of oil beaching 5.20%.	4.14

Figure 4.11 Stochastic model run of uncontrolled flow (blowout) spill of 32°API crude oil over 48 hours under typical wind conditions at the Darwin East-1 well location (blue points indicate oil beaching locations)

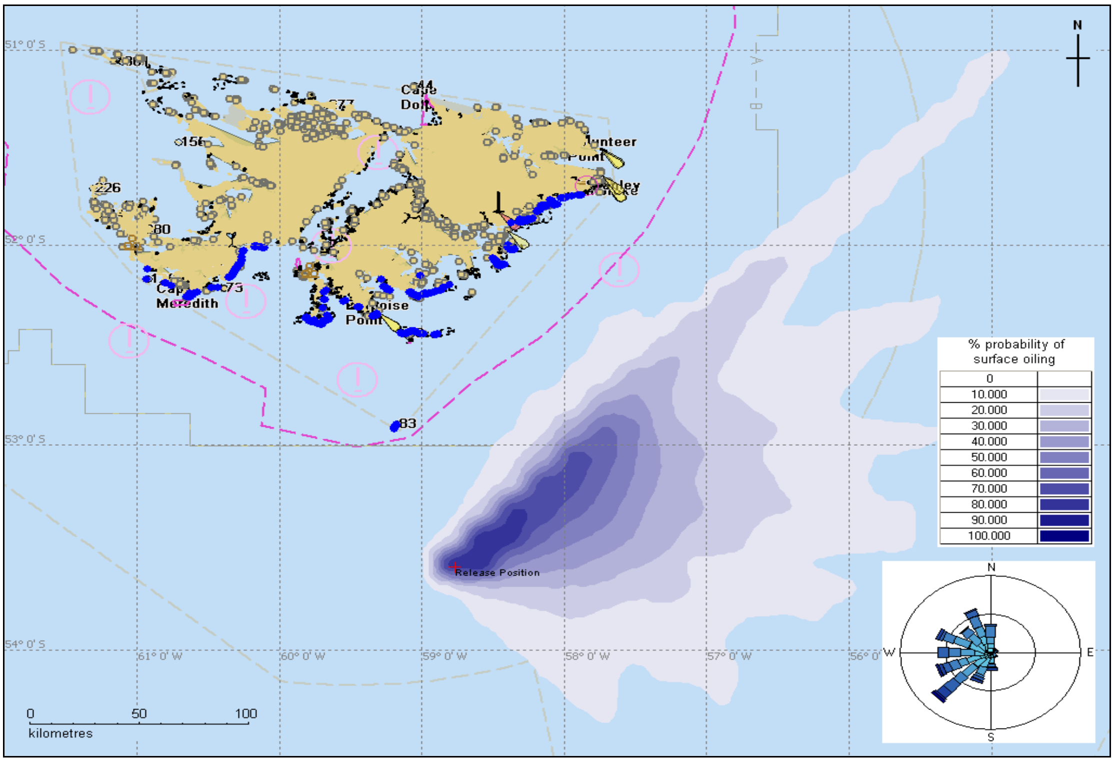


Figure 4.12 Stochastic model run of uncontrolled flow (blowout) spill of 32°API crude oil over 10 days under typical wind conditions at the Darwin East-1 well location (blue points indicate oil beaching locations)

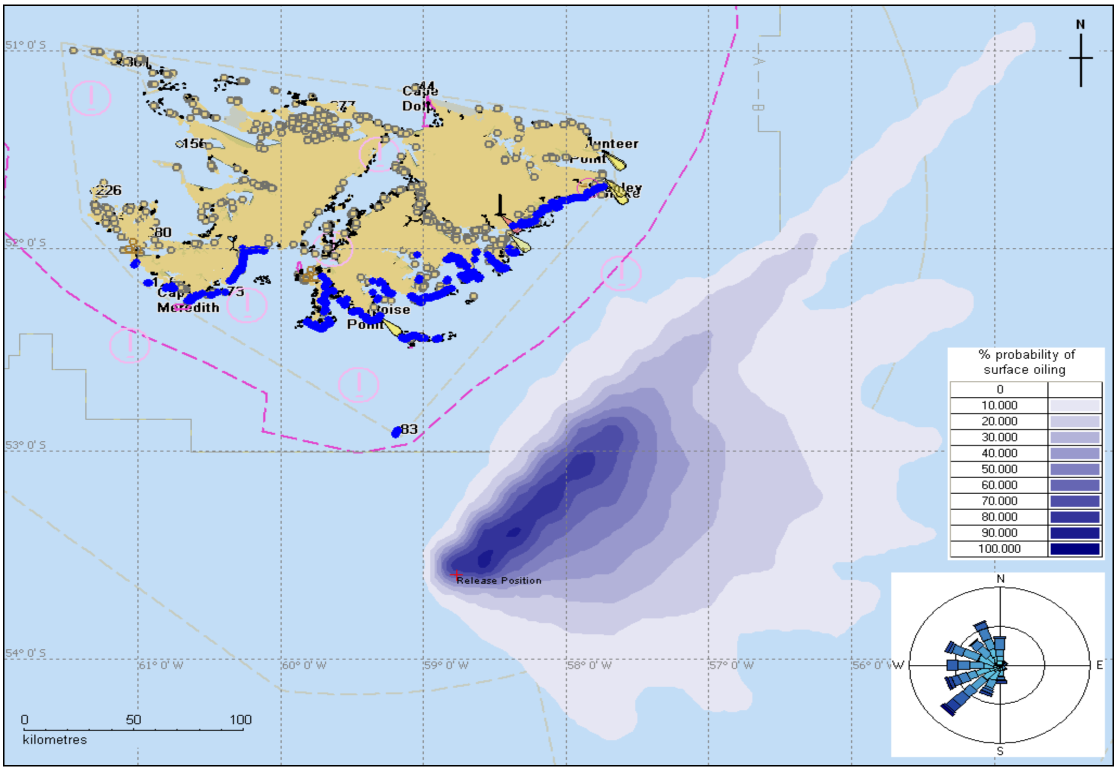


Figure 4.13 Stochastic model run of uncontrolled flow (blowout) spill of 25°API crude oil over 48 hours under typical wind conditions at the Stebbing-3 well location (blue points indicate oil beaching locations)

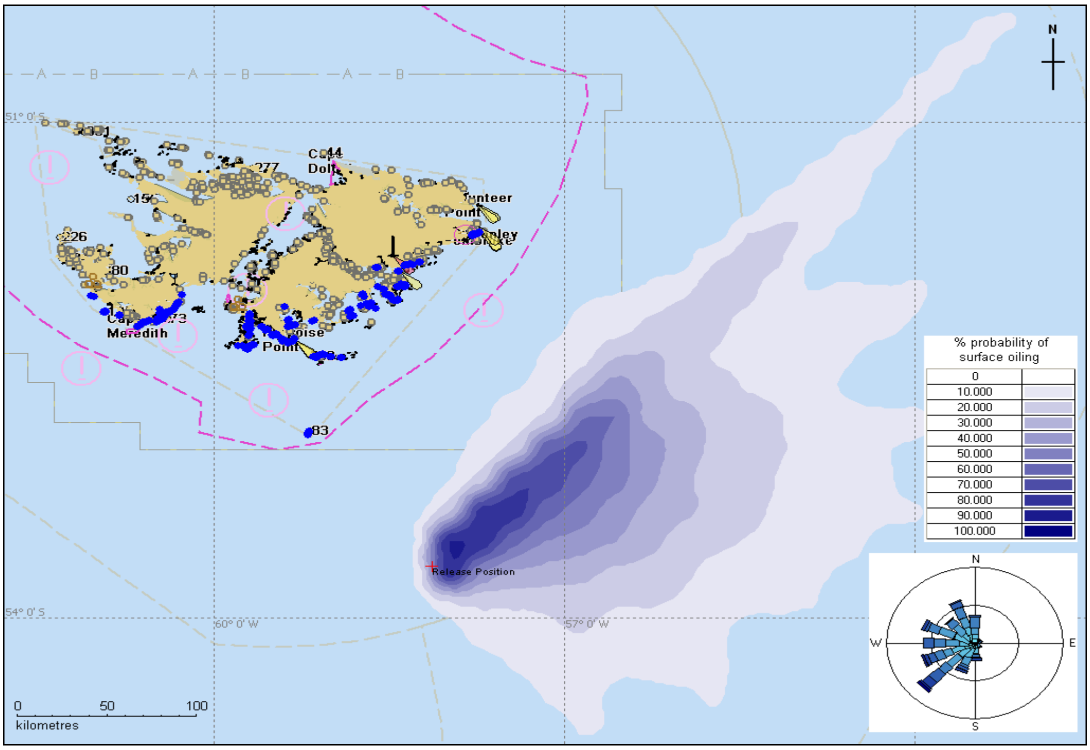
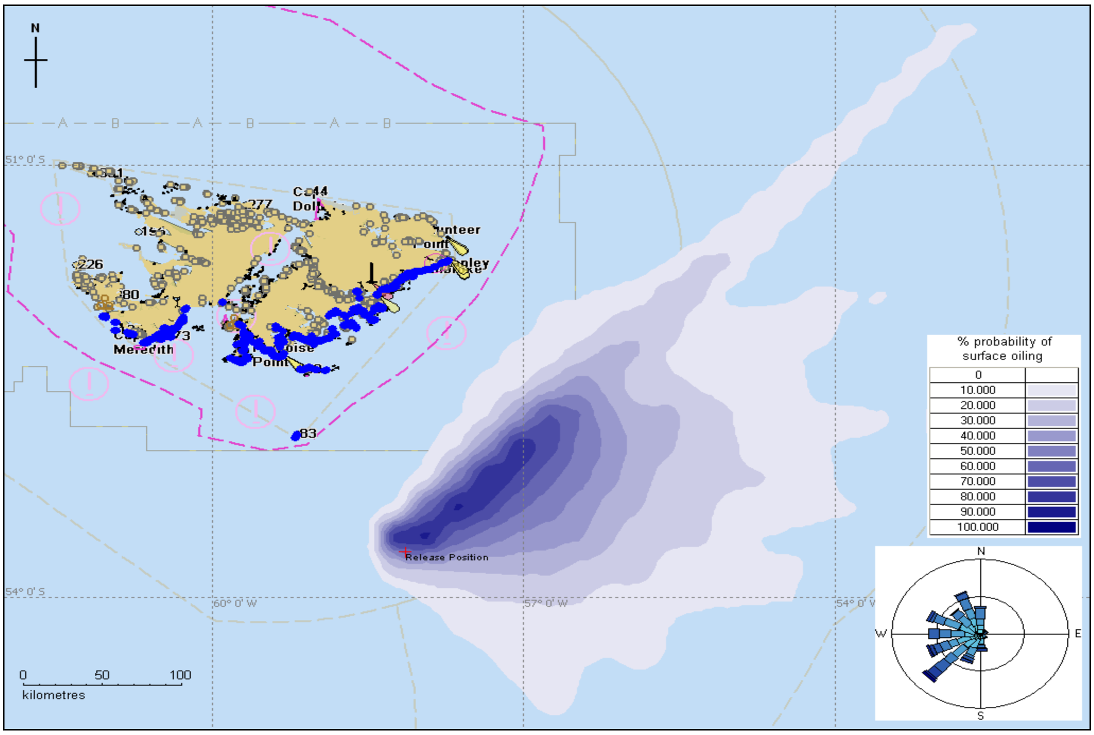


Figure 4.14 Stochastic model run of uncontrolled flow (blowout) spill of 25°API crude oil over 10 days under typical wind conditions at the Stebbing-3 well location (blue points indicate oil beaching locations)



Stochastic Crude Oil Spill Modelling

Stochastic modelling of a 6,148 tonnes per day blowout spill of crude oil (released over 48 hours) from the proposed Darwin East-1 well location using typical wind conditions (refer to Section A.4.5.1 of the Borders and Southern Project Specific OSCP Appendix) indicated that the oil would beach on Beauchêne Island and at various locations along the south coast of the Falklands mainland (Figure 4.11). The total probability of oil beaching was relatively low at 8.10%. Individual probabilities of oil beaching, which represent individual beaching sites, ranged from 0.2% to 3.7%. On consideration of Figure 4.11, it can be seen from the probability contours that the majority of oil is likely to weather offshore, under the influence of the residual current and prevailing wind conditions. Areas outside the contour plot exhibit very low probabilities of occurrence (<10%), which includes all beaching scenarios. Therefore, although the model suggests beaching to some degree, the majority of oil is predicted to remain offshore.

Stochastic modelling of a 6,612 tonnes per day blowout spill of crude oil (released over 48 hours) from the proposed Stebbing-3 well location using typical wind conditions (refer to Section A.4.5.1 of the Borders and Southern Project Specific OSCP Appendix) indicated that the oil would beach on Beauchêne Island and at various locations along the south coast of the Falklands mainland (Figure 4.13). The total probability of oil beaching was relatively low at 5.20%. Individual probabilities of oil beaching, which represent individual beaching sites, ranged from 0.2% to 3.7%. On consideration of Figure 4.13, it can be seen from the probability contours that the majority of oil would weather offshore, under the influence of the residual current and prevailing wind conditions. Areas outside the contour plot exhibit very low probabilities of occurrence (<10%), which includes all beaching scenarios. Therefore, although the model suggests beaching to some degree, the majority of oil is predicted to remain offshore. In addition, on comparison of Figures 4.11 and 4.13, it can be seen that the probability contours are of slightly different shapes, with the 10% probability contour in Figure 4.13 extending further to the north-east than in Figure 4.11. This is again due to the greater persistence of the oil from the Stebbing-3 location in relation to its higher specific gravity (25° API at Stebbing-3 as opposed to 32° API at Darwin East-1).

Stochastic modelling of a 6,148 tonnes per day blowout spill of crude oil (released over 10 days) from the proposed Darwin East-1 well location using typical wind conditions (refer to Section

A.4.5.1 of the Borders and Southern Project Specific OSCP Appendix) indicated that the oil would beach on Beauchêne Island and at various locations along the south coast of the Falklands mainland (Figure 4.12). The total probability of oil beaching was relatively low at 8.50%, which is comparable to the 48 hour blowout release above (8.10%). Individual probabilities of oil beaching, which represent individual beaching sites, ranged from 0.2% to 3.7%, the same as for the 48 hour blowout release above. On consideration of Figure 4.12, it can be seen from the probability contours that the majority of oil is likely to weather offshore, under the influence of the residual current and prevailing wind conditions. Areas outside the contour plot exhibit very low probabilities of occurrence (<10%), which includes all beaching scenarios. Therefore, although the model suggests beaching to some degree, the majority of oil is predicted to remain offshore. On comparison with the 48 hour blowout release (Figure 4.11) it can be seen that the degree of beaching is greater along the coastline. This is to be expected given the longer duration of the oil release. However, it can be seen that the beaching locations are very similar in both cases.

Stochastic modelling of a 6,612 tonnes per day blowout spill of crude oil (released over 10 days) from the proposed Stebbing-3 well location using typical wind conditions (refer to Section A.4.5.1 of the Borders and Southern Project Specific OSCP Appendix) indicated that the oil would beach on Beauchêne Island and at various locations along the south coast of the Falklands mainland (Figure 4.14). The total probability of oil beaching was relatively low at 5.20%, which is the same probability as the 48 hour blowout release above (5.20%). Individual probabilities of oil beaching, which represent individual beaching sites, ranged from 0.2% to 3.7%, again the same as for the 48 hour blowout release. On consideration of Figure 4.14, it can be seen from the probability contours that the majority of oil would weather offshore, under the influence of the residual current and prevailing wind conditions. Areas outside the contour plot exhibit very low probabilities of occurrence (<10%), which includes all beaching scenarios. Therefore, although the model suggests beaching to some degree, the majority of oil is predicted to remain offshore. On comparison with the 48 hour blowout release (Figure 4.13) it can be seen that the degree of beaching is greater along the coastline. This is to be expected given the longer duration of the oil release. However, it can be seen that the beaching locations are very similar in both cases.

Conclusions

The diesel modelling scenarios presented above have shown that fuel oil are unlikely to beach under any circumstances and will weather offshore, even under worst case scenario wind conditions.

A number of the above scenarios have shown that crude oil has the potential to beach under worst case scenario wind conditions. However, the likelihood of a 30 knot onshore wind occurring for any significant amount of time in the event of an oil spill situation remains very low.

Modelling using typical wind conditions in a blowout situation has show that the oil is likely to remain offshore under the influence of the residual current and wind conditions. The probabilities of oil beaching remain very low. Combined beaching probabilities for Darwin East-1 and Stebbing-3 were 8.10% and 5.2%, respectively. Individual probabilities of oil beaching, which represent individual beaching sites, were lower still, in the ranges of 0.2% and 3.7% for both the Darwin East-1 and Stebbing-3 wells. Therefore, the probabilities of oil beaching in a blow-out scenario remains low.

Given that the majority of the above spill modelling scenarios have shown a low chance of oil beaching, particularly for the stochastic model runs, it can be concluded that the risk of shoreline pollution remains low as the oil weathers offshore in most cases. This suggests that pollution response to an oil spill incident would primarily be offshore. The use of dispersant remains the most viable oil pollution response strategy given the distance of the wells offshore, and the associated difficulties and dangers of deploying offshore recovery equipment.

However, as the worst case scenarios above have shown oil to beach consideration must be given to this potential, regardless of the low probabilities of such events. The oil takes a significant amount of time to beach in the majority of cases. Discussions with OSR have indicated that spill response equipment and resources could be on site in the Falkland Islands within 60 hours. Although some scenarios show beaching in a shorter duration than this time (the quickest being 38 hours), it should be noted that Tier 1 offshore response resources would be mobilised immediately to combat the spill. In addition, it is also highly unlikely that the modelled worst case wind conditions will occur for any significant period of time - the stochastic wind blow-out scenarios, using prevailing wind conditions in the area, indicates that the majority of oil would weather offshore (Figures 4.11 to 4.14).

Submerged Aquatic Vegetation - Sensitivity to Oil Impacts

Submerged aquatic vegetation (SAV) includes rooted vascular plant species that grow primarily below the water surface in both fresh and salt water (e.g., water lilies, eel grass, surf grass, manatee grass, kelp). SAV is considered to be highly sensitive to oil impacts because of its high productivity, key role in nutrient cycling, and value as nursery, foraging, and sheltering habitats for many
endangered and commercially and recreationally important species. However, SAV is not as vulnerable as intertidal vegetation because it is mostly subtidal and less likely to be in direct contact with floating oil slicks. Oil effects on SAV habitats as discussed in Zieman et al. (1984) are summarized below:

- Greatest impacts occur on SAV that is on the water surface or in the intertidal zone, where the oil comes in direct contact with exposed blades.
- Oil readily adheres to exposed blades, particularly when the oil is heavy or weathered.
- Oiled SAV quickly defoliates but the plants have the capacity to grow new leaves (the leaves grow from a relatively protected meristem) in a relatively short period of time unless the sediments also are oiled. Recovery can occur with 6-12 months.
- Plant mortality has been observed during incidents when the sediments were contaminated by oil, although such incidents have been rare.
- The most sensitive component of the SAV ecosystem is the epiphytic community and juvenile organisms that utilize the grass beds as a nursery. These species and life stages can be highly sensitive to both the water-soluble and insoluble fractions of oil.
- The plants can uptake hydrocarbons from the water column and sediments, potentially lowering their tolerances to other stresses.

4.12.1 Potential Impacts

The potential hydrocarbon spills during the proposed drilling programme may impact aspects of the Falklands sensitive environment.

- Offshore seabirds and Internationally Important seabird colonies of the southern coast of Falklands main land and Beauchêne Island (*refer to Section 3.2.7 of the Offshore Falkland Island EIS Addendum*);
- Southern Falklands coast sites designated as National nature Reserves (*refer to Section 5.2.12 of the Offshore Falkland Islands Exploration Drilling EIS*);Marine mammals, particularly pinniped colonies along the coastal zone (*refer to Section 3.2.6 of the Offshore Falkland Islands Exploration Drilling EIS Addendum*);
- Fishing resources (*also refer to Section 3.3 of the Offshore Falkland Islands Exploration Drilling EIS Addendum*);
- Tourism (*refer to Section 5.3.1 of the Offshore Falkland Islands Exploration Drilling EIS*).

Plankton occupies the surface layer of the water column and are therefore vulnerable to spills which remain in surface waters. Studies into the effects of hydrocarbon spills on phytoplankton and zooplankton are few and often conflicting. Some studies have found that oil could decrease phytoplankton photosynthesis and growth or lead to mortality. Other rsearch has shown that hydrocarbon spills may stimulate phytoplankton growth (*Sloan, 1999*);

Zooplankton are an important part of the Southern Ocean and subpolar and surrounding marine ecosystems. Krill (*Euphausiacea* spp.) are an important component in the food chain and are also found in the waters surrounding the Falkland Islands. They form large austral spring/summer swarms as the larvae overwinter feeding on algae on the underside of the Antarctic ice sheet which melts in the summer and they are visible in the surface waters. This species is therefore also vulnerable to surface spills of hydrocarbons which may be synthesised into stored lipids (*Reid, 1987*) and be available to higher consumers. The likelihood of spills occurring has however been discussed and the given the large population, short generational times and distance from the Southern Ocean, the impacts of a potential spill on zooplankton populations are not anticipated to be significant;

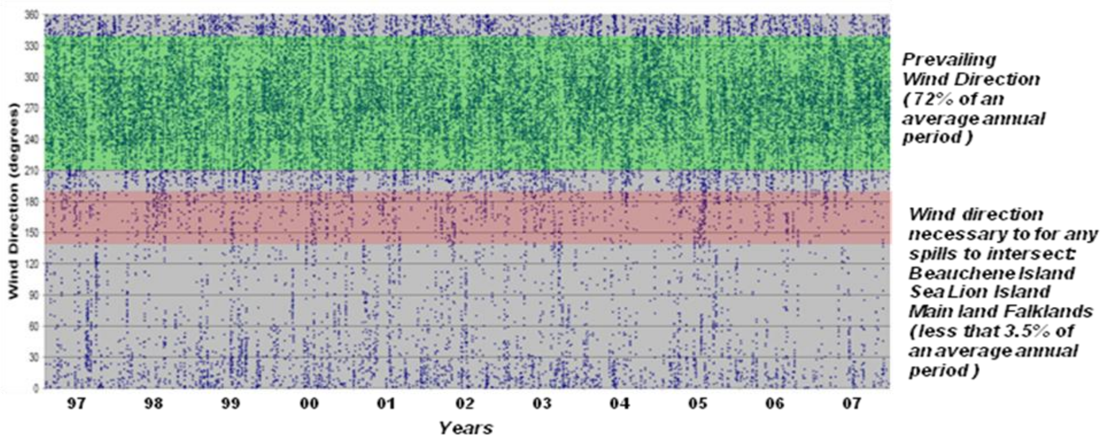
Fish species which consume zooplankton may be susceptible to oiling of their prey. Fish species with a high affinity for particular areas are most vulnerable to oiling. Most of the species which are targeted in the local fisheries however are found around the Falklands basin and are pelagic species which have the ability to move away from areas of spilt hydrocarbons. It has previously been discussed in Section 3.2.4 of this Addendum, that some larval stages of fish species which may be present in the vicinity of the proposed drilling locations may be sensitive to polyaromatic hydrocarbon (PAH) pollutants. Spawning areas in the south-west may be vulnerable to oil pollution from the Special Cooperation Area, located offshore to the south-west of the Falkland Islands. However the majority of spawning grounds and concentrations of pelagic larval stages tend to be in shelf waters and at the shelf break fronts where primary production is greatest. Long term chronic effects may be seen if polluted water flows over the shelf from the south over an extended time period. This proposed drilling activity is not anticipated to cause such an effect as the majority of drilling chemicals are PLONOR. It is also believed that the most sensitive period for commercial fish species would be in the spring (September to November) (*Agnew, 2002*), which is predominantly outside of the proposed drilling period.

The effect on bird mortality following an oil spill depends on the size of the local bird populations, their foraging behaviours, whether populations are aggregated or dispersed at the time of the spill, and on the quantity of oil spilled and its persistence. After contact oil can kill birds by removing the insulative property of their feathers and through toxilogical effects after ingestion (*Piatt et al. 1996*).

Interpretations of the biological impact of different oil spills have varied tremendously. For instance, little damage to subtidal marine organisms which could be attributed to oil were recorded following the Torrey Canyon spill (*Smith, 1968*) or the Santa Barbara spill (*Straughan, 1971*). However, substantial and long lasting damage to the subtidal marine biota was recorded following the wreck of the Tampico Maru (*North et al., 1965*) and the West Falmouth oil spill (*Blumer et al., 1970*). These differences can be attributed in part to differences in the environmental and geographic conditions at the spill sites and to differences in the nature of the oils spilled.

The prevailing wind conditions extracted from NOAAs Buoyweather hindcast data (Figure 4.15) demonstrate that winds are predominantly westerlies (Refer to Section 3.1.5 of this Addendum). Winds required for spills to intersect Beauchêne Island, Sealion Island and mainland Falklands comprise less than 3.5 per cent of the average annual period. This data combined with results of the oil spill modelling in section 6.10.3 of the Offshore Falkland Islands Exploration Drilling EIS, there is a low probability of hydrocarbons beaching under typical weather conditions, however oil slicks will have the potential to impact the wildlife offshore (Table 4.10).

Figure 4.15 Wind direction frequency distribution chart for the PL018 licence area for the period of Jan 1997 through to December 2007 (data obtained from Buoyweather hindcast data derived from NOAA's WAVEWATCH III model)



In a study of the environmental impacts from the 1989 Exxon Valdez oil spill which released approximately 41 million litres of crude oil into Prince William Sound, Alaska looked at the long term impacts on some of the key environmental indicator species in the area (*Wiens et al., 1999*). These included the pink salmon (*Oncorhychus gorbuscha*), sea otters (*Enhydra lutris*), harbour seals (*Phoca vitulina*) and several seabird species. The study reviewed 10 year post-spill data as well as baseline pre-spill data where available. Results demonstrated that species either exhibited no obvious detrimental impacts or indicated that they were impacted to an extent but followed by clear evidence of recovery. Hydrocarbon levels in spawning streams were lower than anticipated (offshore PAH concentrations were 1 ppb shortly after the spill) and subsequent returns to natal streams were at some of their greatest numbers. In the 10 years following the spill no life stages (eggs, larvae etc.) showed any signs of negative impacts due to hydrocarbon exposure.

It was expected that seals may be significantly adversely impacted by the oil spill due to their natural affinity for coastline habitats (*Wiens et al., 1999*). However it was likely that seals moved away from the affected area and were also negatively impacted by the anthropogenic clean-up operations involving aircraft, people and vessels which may have also disturbed them. Seabirds were differentially impacted by the spill. Some species that were impacted did exhibit signs of recovery by 1998 (of the 12 species, 58 percent had fully recovered by 1998).

These reduced impacts than anticipated were attributed to a combination of effective response and clean-up measures as well as natural weathering of the crude which helped to dampen some negative impacts. As a result of this, little oil remained in the affected areas after 1991 (*Wiens et al., 1999*).

Table 4.10 Summary of potential impacts from hydrocarbon spills

	Comments
Plankton	Oil is toxic to a wide range of planktonic organisms. Those living near the sea surface are particularly at risk, as water-soluble components leach from floating oil. Although oil spills may kill individuals, the effects on whole plankton communities generally appear to be short-term. Following an oil spill incident, plankton biomass may fall dramatically, due either to animal deaths or avoidance of the area. However, after only a few weeks, populations often return to previous levels, through a combination of high reproductive rates and immigration from outside the affected area.
Benthos	Effects on the benthos include acute toxicity and possible organic enrichment. Offshore impacts are likely to be minimal, and influenced by water depth and local hydrography. Shallow inshore areas and the shoreline are susceptible to heavy mortalities if coated with hydrocarbons. Recovery times are variable, dependant on many environmental factors, and may be in the region of 1 to 10+ years. The increased water depth at the proposed locations also lessens the potential impacts which may occur to seabed communities.

Fish	Lethal effects may occur in adult fish species with hydrocarbon levels of above one part per million. Larvae tend to be more susceptible and lethal effects may occur above 0.1 parts per million. Sub-lethal effects may be observed at low parts per billion concentrations; this can result in behavioural changes or narcosis (*Baker et al., 1990*). There is no definitive evidence that suggests that oil pollution has significant effects on adult fish populations in the open sea. Fish eggs and larvae are relatively immobile and under slicks there may be heavy mortalities that are exacerbated by the use of dispersants (*Swan et al, 1994*). Where oil is trapped in seabed sediments, sediment communities and demersal fish may be adversely affected. Offshore any such accumulations tend to be localised close to the spill source. Such deposits are relatively transient, disappearing as the release stops or the slick passes. As the oil weathers (typically weeks/months), these effects diminish.
Marine Mammals	It has been rare for cetaceans to be affected following a spill; they may be able to avoid affected areas and are not believed to be susceptible to the physical impacts of oil and oil emulsion lowering their resistance to the cold. Contact with oil may cause irritation of the skin and mucus membranes. Volatile hydrocarbon fractions may also cause respiratory problems. Pinnipeds are susceptible to oiling and the contamination of food sources, particularly in the coastal areas around their colonies, where their density is highest. Although South American fur seals forage offshore, the timing of life history events means that they will be restricted to inshore coastal waters (within 10 kilometres of the haul out site) during the proposed drilling period as it coincides with their mating and pupping seasons. The South American sea lion tends to forage inshore (Refer to section 3.2.6 of this Addendum) and is therefore unlikely to be impacted in the event of an accidental spill. During the Marine Mammal Observation data from the Borders & Southern 3D Siesmic Survey undertaken between 29th October 2007 to 10th February 2008 four sightings of South American sea lion were observed and two sightings of South American fur seals were observed. It is unlikely therefore that they will be present during the drilling of the exploration wells.
Birds	Species of birds that spend much of their time on the sea surface are particularly vulnerable to spills. Oiling of the plumage destroys its integrity as insulation, causing the animals to die of hypothermia or by drowning. Concentrations of birds are most vulnerable to oil pollution during the breeding season near their colonies and at other times of the year over the feeding grounds. Evidence suggests that in most cases spills are unlikely to have long term effects overall on bird populations unless a substantial portion of the population is restricted to the immediate area of the spill (*Dunnet 1982, Leppakoski 1973*). The impact on breeding colonies and bird populations depends upon the existence of a reservoir of young non-breeding adults from which they can be replenished and the reproductive rate of the impacted species. There is no evidence that oil spills have permanently damaged any seabird populations, but any small indigenous populations, or species that are clustered into a few dense colonies could potentially be at risk.
Fisheries	Fish exposed to oil may become tainted by oil-derived substances. It is of particular concern in caged fish and shellfish culture. Fin-fish rarely become tainted in the open environment, as they are able to avoid the affected area. However, major spills can result in loss of fishing days and exclusion zones and bans on certain species lasting several years may be enforced. Shellfish mortalities may occur if organisms are smothered by settling oil. Only low levels of oil in seawater may cause tainting in shellfish, which may be commercially damaging to shellfish fisheries. This is more common in filter feeding shellfish, principally bivalves, as they take up fine oil droplets from the water column. Media coverage together with public perception can also damage fisheries.
Tourism	Coastal tourism is vulnerable to the effects of major oil spills e.g. reduced amenity value. The impact would be influenced by a number of factors including media coverage and public perception.

4.12.2 Mitigation Measures

A number of measures will be implemented by Borders & Southern to reduce the risk of oil spills from the drilling rig and associated vessels and minimise the impact of any spill that may occur:

- Managing potential drilling hazards, such as shallow gas, and following established drilling safety standards to minimise the risk of control loss;
- Comprehensive operational planning and risk assessment and provision of suitable specification equipment for drilling (BOP etc.);
- Clearly defined well control procedures for the specific well and BOP arrangements particular to the B&S wells;
- Dedicated pore pressure prediction service on board the rig to assist in evaluating and communicating well pressures during drilling

- Oil Spill Contingency Plan will be implemented;
- All vessels and the drilling rig will comply with IMO/MCA codes for prevention of oil pollution and vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs);
- International Well Control Forum (IWCF) training for all key personnel involved in well planning, well operations (onshore and offshore);
- As far as possible, support vessels with an established track record of operating in the Atlantic Margin and familiar with weather and operating conditions in the area will be used;
- Approach procedures and poor weather operational restrictions for visiting vessels and transfer operations at the drilling rig;
- Audits of the drilling rig and vessels including detailed list of contract requirements in terms of spill prevention procedures that must be in place;
- Regular maintenance and inspection of equipment and high spill risk points (in particular bunkering hoses, bunds, storage tank valves etc.);
- Lube and hydraulic oil will be stored in tanks or sealed drums which pose a minimal risk of spillage. In addition, drums and storage tanks for hydrocarbons will be well secured and stored in bunded areas, all of which will be properly maintained and inspected;
- Procedures in place for bunker transfer to minimise the risk of spillage;
- Use of bulk handling methods and non return valves for diesel transfer to reduce the risk of spillage;
- Two fully independent well control monitoring systems (rig system and mud logging system);
- Availability of oil spill kits on board the rig and vessels to clean up any deck spills or leaks and suitable storage and disposal procedures for waste oil;
- Training of personnel with respects to the handling and deployment of oil spill recovery equipment;
- Collaboration with the national OSCP and availability of near-shore defences (i.e. booms), as well as trained personnel, spill surveillance services etc.;
- Availability of spill response kits on the rig and vessels for initial spill response.

Even with comprehensive prevention measures in place, the residual risk of a spill remains, and integral to any Borders & Southern operation is the formulation of detailed and fully tested contingency response plans appropriate to the local environment. An approved Oil Spill Contingency Plan (OSCP) will be in place for the proposed drilling operations, including onshore and offshore plans.

4.13 Socio-economic Impacts

Socio-economic impacts due to the requirements for accommodation and office space during mobilisation are assessed to be of low importance due to the local scope, short to medium term persistence, low intensity and high probability. The mobilisation of personnel to the Falkland Islands is likely to generate local income for individuals and businesses and provide a short term boost to the economy. The impact of land based personnel and emergency accommodation plans will lead to increased competition for available accommodation.

The socio-economic impact of routine crew change personnel is assessed to be low under routine operations as incoming and outgoing crews will change out on the same day (incoming crew landing at 6 am, outgoing crew will depart MPA at 10:30 pm). Crew change operations will have minimal impact on routine flights as an aircraft will be chartered to complete these operations. Ad hoc personnel requirements during the operation may have a limited impact on routine flights.

There is also likely to be a direct boost to jobs and the economy from the drilling campaign, although this is assessed to be of medium importance due to the limited duration.

4.14 Cumulative Impacts

The potential for cumulative impacts will arise from the drilling operation itself during which time the rig and support vessels will pose an additional shipping hazard in the area and from the legacy it will leave in terms of atmospheric greenhouse gases and the cuttings and mud discharged. However it is not anticipated that the short-term exploratory drilling campaign will significantly, or permanently, add to these existing cumulative impacts.

Cumulative solid waste generation from the drilling campaign will be minimised and managed through the implementation of a Waste Management Plan, a separate document which will define specific waste handling/disposal routes and procedures.

The cuttings were deposited along a north-east to south-west oriented axis, drifting away from the drilling location in a north-easterly direction. The diameter of the Darwin East-1 cuttings pile diminishes to 1 millimetre at approximately 350 metres from the drilling centre, representing an area of approximately 0.384 square kilometres. At the Stebbing-3 well location, the cuttings pile thickness slightly exceeds 1 millimetre to a distance of approximately 497 metres from the drilling location, representing an area of approximately 0.776 square kilometres. However, because of the now reduced cuttings volume at Stebbing-3, this can be considered to represent an absolute worst case scenario. A reduction in existing faunal representation may be expected due to smothering effects in the immediate vicinity of the wells within these areas, however, the overall impact will be minor due to the localised scale and temporary nature of the impact. Given the generally limited thickness of the predicted cuttings deposition and the dispersal action of bottom currents, it is likely that any cuttings will soon become mixed with the natural seabed sediments and will eventually be dispersed fully.

In summary, cumulative environmental effects from the planned exploration programme offshore the Falkland Islands are unlikely given the short term nature of the wells, the fact that they will be plugged and abandoned and that exploration activities are planned over a wide area. Over time, impacts from drilling will be undetectable so there is no cumulative impact. Positive socio-economic effects are possible over time as they will be concentrated in a single location (Stanley) for all drilling operations both to the north and south of the island.

5 Management Framework

5.1 Introduction

Borders and Southern Petroleum plc operates under an integrated Health Safety and Environmental Management System (HSE MS).

HSE management procedures are incorporated into relevant business functions which reinforce the Company philosophy that management of HSE issues is an integral part of the Borders & Southern business activities.

The application of the HSE MS during the drilling of the proposed exploration wells offshore the Falkland Islands will ensure that the Borders & Southern HSE Policy (Figure 5.1) is followed and that the Company's responsibilities under all relevant regulations are met.

Figure 5.1. Borders & Southern HSE Policy

borders&southern
petroleum plc

HSE Policy Statement

Borders and Southern Petroleum plc is committed to effective corporate governance. Maintaining high standards of Health, Safety and Environmental (HSE) protection throughout its operations is an integral part of this and is achieved through:

- Strong leadership and clearly defined responsibilities and accountabilities for HSE at all levels of the organisation;
- Selection of competent personnel to manage activities;
- Compliance with regulatory and other applicable requirements, or where regulations do not exist, application of industry standards;
- Identifying, assessing and managing HSE risks and preventing pollution;
- Developing specific plans to identify, assign responsibilities, schedule and track HSE activities within each project;
- Selecting competent contractors and ensuring that they are effectively managed;
- Preparing and testing response plans to ensure that any incident can be quickly and efficiently controlled, reported and investigated to prevent recurrence;
- Continual improvement of HSE performance through monitoring, regular reporting and periodic audits;
- Periodic management reviews to identify and implement improvements to our HSE systems.

This policy is implemented through our HSE Management System and is used to guide all our activities. It will not be compromised by other business priorities.

Howard Obee
Chief Executive Officer

Date: 4/2/10

5.2 The Borders and Southern Health, Safety and Environment Management System

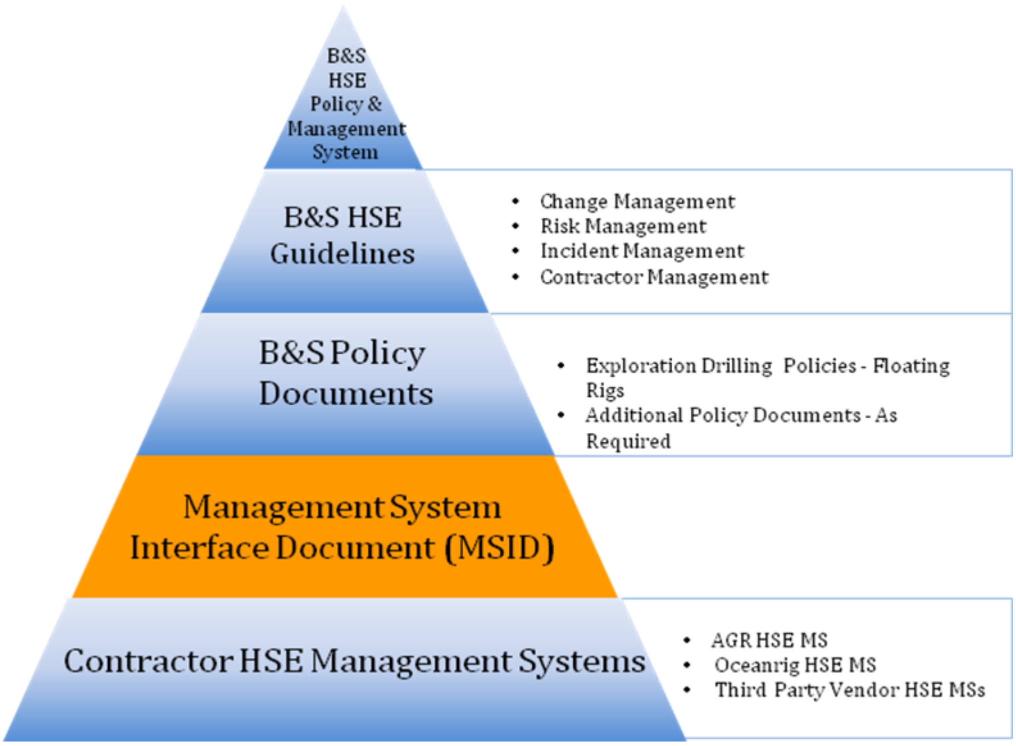
Borders & Southern's business comprises acquisition of acreage and exploration for oil and gas. Operational activities include geological and geophysical surveys, design, construction, and testing of wells and assessment of hydrocarbon reserves. In the future it is anticipated that this may lead on to field development and production operations.

The HSE MS establishes the main requirements and provides the framework for managing HSE issues within the business. It ensures:

- Clear assignment of responsibilities;
- Efficient and cost effective planning and operations;
- Effective management of HSE risks;
- Compliance with legislation; and
- Continuous improvement.

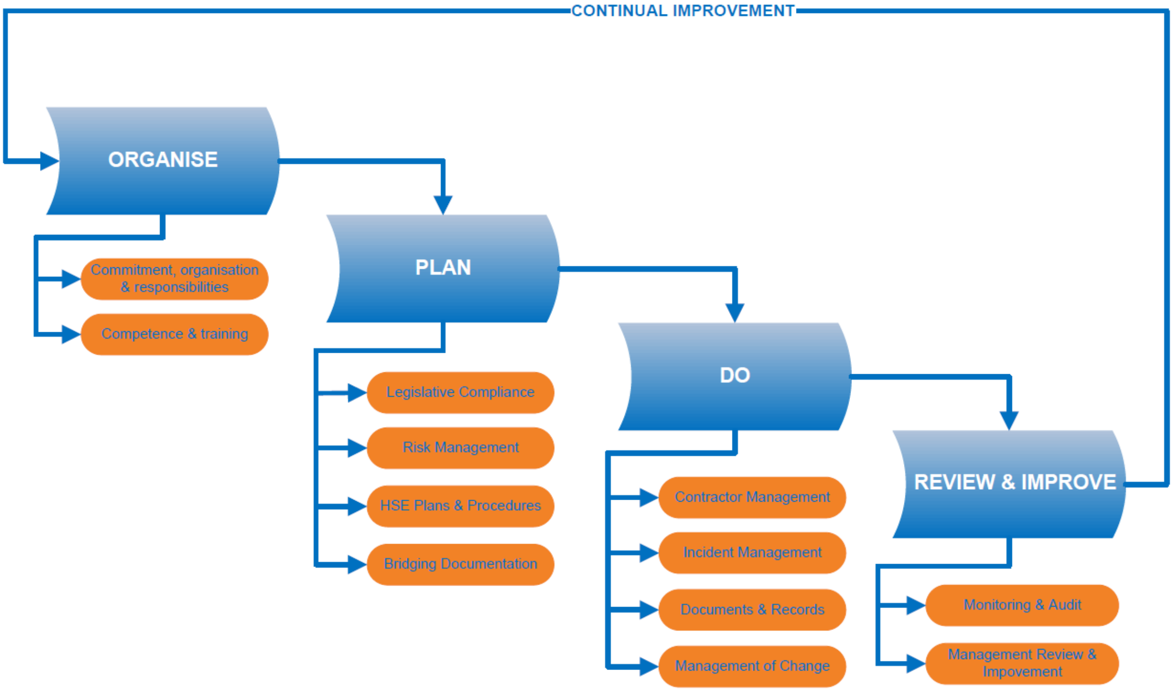
The system structure is illustrated in Figure 5.2. At the top, the HSE Policy demonstrates the commitment and intentions of the Company. The HSE MS provides guidance on the implementation of policy requirements across the Company. At the second level are the project specific HSE Procedures; these provide more guidance on key areas of HSE management. At the third lever are the Policy Documents which provide the specifics of how things are done within each project or discipline. At the base of the structure are the Bridging Documents linking Borders & Southern's system with its contractors' HSE Operating Systems/Procedures.

Figure 5.2. HSE Management System Structure



This HSE Management System is consistent with existing international models for health, safety and environmental management (e.g. ISO14001, OHSAS 18001, OGP). The system is structured around an 'organize, plan, do, review and adjust' process, with a feedback loop to assure continual improvement in performance. The system can be visualised as illustrated in Figure 5.3. It is made up of a number of elements and requirements and is relevant throughout the business lifecycle.

Figure 5.3. HSE Management System



Organise: The system is driven through commitment and organisation. Broad HSE goals are established and responsibilities clearly defined. HSE expectations are communicated through internal and external networks. Personnel are selected that have the appropriate qualifications, experience and skills to meet their responsibilities.

Plan: Regulatory requirements and potential hazards and risks associated with planned activities are identified and appropriate measures to conform/control are incorporated in a project HSE Plan and Bridging Document.

Do: Competent contractors are selected and managed to undertake specialist tasks, following agreed procedures. Effective response plans to emergencies are developed. Incidents are reported and investigated and lessons learned used to improve performance. Changes are managed via a documented change management process

Review and Improve: Routine monitoring is undertaken to assess and, where necessary, improve HSE performance. Periodic audits are conducted to ensure the effective functioning and continued suitability of the management system. Management review the system annually, identify areas for improvement and build these into the following year's work plans.

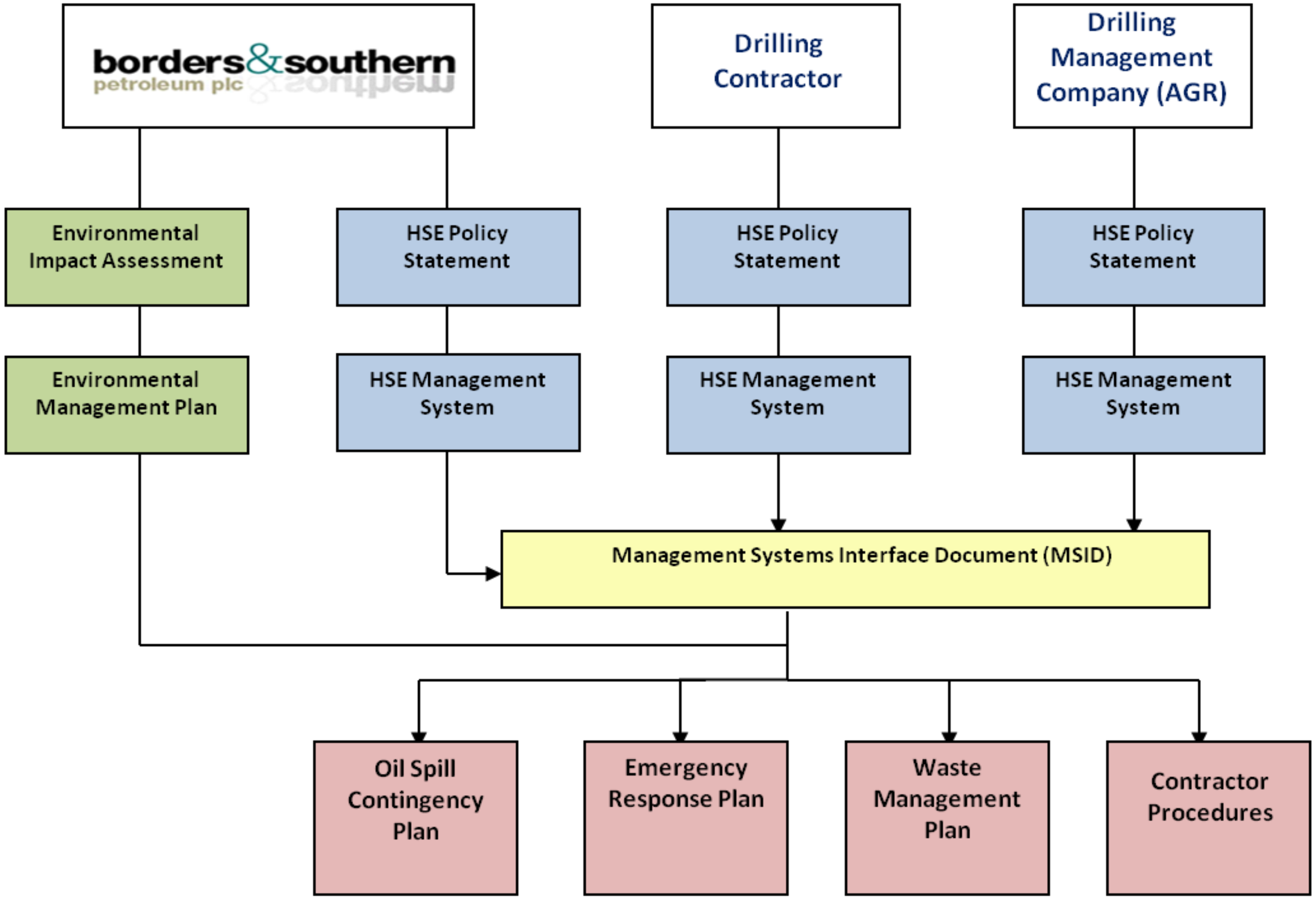
5.3 Falkland Islands Drilling Programme - HSE Management Framework

The Borders & Southern management system is not certified and, as Borders & Southern does not undertake operations itself, is based on the supervision and administration of contractors. The HSE Policy Statement and HSE Management System set out Borders & Southern's priority goals, expectations and commitments and how these will be applied within the framework outlined in Figure 5.4 below:

As outlined above, HSE management of the drilling programme will be conducted within a comprehensive framework comprising of:

- Borders and Southern’s Health, Safety and Environmental Policy Statement;
- Borders and Southern’s Health, Safety and Environmental Management System (HSE MS);
- Borders and Southern Exploration Drilling Policies – Floating Rigs;
- Drilling Contractor’s Management HSE Policy Statement;
- Well Management Contractor’s HSE Policy Statement;
- Drilling Contractor’s Safety Management System;
- Well Management Contractor’s Safety Management System;
- Management System Interface Document;
- Drilling Contractor and Well Management Contractor operational controls and specific HSE procedures Included within these document are:
  - Policies, Standards and Procedures;
  - Safety Management;
  - Emergency Response;
  - Incident Reporting and Incident Investigation;
  - Roles & Responsibilities;
  - Training and Competence;
  - Environmental Considerations;
  - Risk Management;
  - Quality Assurance;
  - Organisation;
  - Document Control.

Figure 5.4. HSE Management Control for drilling operations



5.4 Management System Interface Document

In order to ensure that operational and emergency primacy, interfaces and procedures are clearly defined, a review of Borders and Southern and contractors management systems will be undertaken resulting in a Management System Interface Document (MSID).

The MSID will be prepared in accordance with the Step Change In Safety 'Health and Safety Management System Interfacing' guidelines. The MSID document will have the following objectives:

- To define roles and responsibilities;
- To define reporting requirements;
- To identify any variations in policies and procedures between the parties and to clarify which shall take precedence;
- To identify normal operational procedures for the wells;
- To identify interfaces and procedures in the event of an incident.

The Management System Interface Document will be developed and implemented when contractors are finalised and their existing systems are known.

5.5 Oil Pollution Emergency Plan

A dedicated Oil Spill Contingency Plan (OSCP) will be developed in support of the proposed drilling campaign in the South Falkland Basin. It will be developed when the contract for the drill rig and crew has been awarded, and will be based on the results of the oil spill modeling scenarios. The OSCP will provide for a multi-tier response dependent on the scale and type of spill. At the most extreme end of the scale (Tier 3) the OSCP will rely on mobilising specialist aircraft and personnel from Oil Spill Response Limited (OSRL) in the UK to provide large scale containment equipment and aerial dispersant spraying capability. The OSCP will also correspond with the plans of the FIG and its national oil spill contingency plans.

5.6 Rig Emergency Plan

The drilling contractor will have an onboard emergency plan which will set out the roles and responsibilities, procedures, muster stations, alarms etc such that the first response to any emergency is clearly defined and understood by all on board. Regular drills will be conducted, simulating a variety of emergency scenarios, to test the effectiveness of the plan and to make improvements as required.

5.7 Emergency Response Plan

A rig-specific Emergency Response Plan will be produced in cooperation with the drilling contractor and the well management contractor. This document will set out the roles and responsibilities, lines of communication and call out procedures for support services such that any rig-based emergency can be effectively supported between the offshore and onshore teams.

5.8 Borders and Southern Crisis and Emergency Management Plan

The Borders & Southern Crisis and Emergency Plan (C&EMP) describes procedures and arrangements in place for the effective management of any incident or emergency which has the capability to become a crisis for the Company. The Crisis and Emergency Management Plan forms an integral part of Borders & Southern HSE Management System (HSE MS) and meets the criteria set out in Section 5.2. (Incident Management) of that document.

Implementation of the Crisis and Emergency Management Plan is intended to supplement the Management system Interface Document and is supported by the individual emergency management procedures associated with the rig, supply vessels and onshore emergency response units.

5.9 Falklands Waste Management Plan

The purpose of this Borders & Southern Waste Management Pan (WMP) is to provide practical guidance on the disposal of all wastes generated from Borders and Southern drilling operations offshore the Falkland Islands.

Implementation of the Waste Management Plan is intended to supplement the Borders & Southern HSE plan, Management system Interface Document and is supported by the individual waste management plans associated with the rig, supply vessels and onshore waste management contractors.

5.10 Environmental Management Plan

In order to ensure that appropriate mitigation measures, identified following the EIA process, are implemented during the planning and drilling of the proposed exploration wells, an Environmental Management Plan (EMP) has been prepared (refer to Tables 5.1 and 5.2).

The plan identifies actions required, assigns responsibilities and sets target dates for completion. The plan will act as a ‘live’ document to track progress through to cessation of drilling activities. It will provide guidance for the drilling contractor and can also be used by Borders and Southern to monitor contractor performance with regard to environmental issues. Should monitoring indicate unacceptable environmental performance, the EMP provides a mechanism to initiate remedial action

Table 5.1. Environmental Management Plan Mitigation Register – Routine Operations

ROUTINE OPERATIONS				
Hazard & Effect(s)	**Proposed Mitigation**	**Required Actions**	**Responsible**	**Completion**
Cement, Drill Cuttings & Drill Fluids Smothering & toxic effects on benthic communities in the immediate vicinity of the well.	Planned use of Water Based Mud. Selection of most environmentally benign mud & cement chemicals where possible. WBM comprised mainly of chemicals considered to pose little or no risk (PLONOR) to the environment.	Liaise with mud suppliers to ensure appropriate chemical selection.	Drilling Manager Mud Engineer & Borders & Southern Drilling Supervisor	
Physical Presence Restrictions on fishing & shipping.	Exclusion zone surrounding the drill rig (500 metres) implemented monitored & patrolled by supply vessels.	Ensure continuous 'on site' monitoring from standby vessel.	OIM / Borders & Southern Company Man	
	Drill rig to carry relevant navigational & communication aids.	Ensured during contracting process/ Pre operation inspection to ensure all vessels meet required standard.	Procurement/ Borders & Southern Company Man	
	Accommodation of needs for environmental monitoring and liaison with fishing industries.	In order to minimise disruption to the drilling and other users of the sea: Notify Fisheries Department. Notify the British Military. Notify FIG	Borders & Southern	
	Notifying other users. Ensure that other users are aware of the forthcoming drilling operation.	Issue Radio Navigation Warnings and Notices to Mariners as appropriate.	OIM	
Atmospheric Emissions Localised emissions from power generation (rig, supply / standby vessels & helicopter operations) will affect air quality.	Regular maintenance of engines, compressors and generators. Use of non ozone depleting fire fighting foam.	Audit of drilling contractor equipment and procedures prior to operations	Drilling Manager OIM	

ROUTINE OPERATIONS

Hazard & Effect(s)	Proposed Mitigation	Required Actions	Responsible	Completion
Solid Wastes Wastes will include galley wastes, scrap metal, waste oil & surplus chemicals.	Borders and Southern will ensure that the rig has an appropriate system of waste management in place and develop and implement a waste management plan.	Review of Drilling contractors waste management procedures	Drilling Superintendent/ HSE Advisor	
	Rubbish will be processed in a compactor & stored in a designated area on the rig. Other wastes will be stored in suitable containers & periodically these will be transported to shore.	Review waste management facilities onshore Falkland's and develop plan around availability of facilities and duty of care principles.	Drilling Superintendent/ HSE Advisor	
	Material such as scrap metal, waste oil & surplus chemicals will be, as far as practicable, sent for re-cycle or re-use and will be disposed of in a controlled manner through authorised waste contractors.	Pre operation inspection to ensure onshore waste disposal facilities meet required Borders and Southern standards.	Drilling Superintendent/ HSE Advisor	
	All galley wastes separated & ground to less than one inch in diameter before being discharged overboard.	'On site' monitoring to ensure appropriate procedures adhered to.	Drilling Superintendent/ HSE Advisor	
		'On site' monitoring to ensure appropriate procedures adhered to.	Drilling Superintendent/ HSE Advisor	
Drainage & Sewage Water from rig wash down may contain trace amounts of grease, fuel oil, lubricants & residual chemicals. There will be discharge of sewage & grey water.	Borders and Southern will ensure that good housekeeping measures are implemented to minimise the amount of oils and chemicals entering the rig drainage system. An oil-water separator will be used to collect any oily drainage water such that MARPOL standards for discharge are achieved. Any oily sludge from the separator will be collected and returned to shore for proper disposal.	Oil-Water separator required as part of contract. Correct function of the separator will be checked regularly.	Borders & Southern Drilling Supervisor	
	Marine Sanitation Device on rig for treatment of sewage effluent.	The Marine Sanitation Device and discharge inspected daily to ensure that no pollution or non permitted discharge occurring	OIM / Borders & Southern Drilling Supervisor	
	All discharges from the rig & supporting vessels will be treated & discharged in according to the MARPOL convention.	Pre operation Audit to ensure all vessels meet required MARPOL standards.	Drilling Superintendent	

ROUTINE OPERATIONS				
Hazard & Effect(s)	**Proposed Mitigation**	**Required Actions**	**Responsible**	**Completion**
Ballast water Spread of invasive species from the rigs ballast water.	Borders and Southern will ensure that the rig has in place an appropriate Ballast water management plan.	Ensure an IMO developed ballast water management plan is implemented for rig move.	Borders & Southern Drilling Superintendent	

Table 5.2. Environmental Management Plan - Mitigation Measures (Non-Routine Operations)

NON ROUTINE OPERATIONS				
Hazard/Effect(s)	**Proposed Mitigation**	**Required Actions**	**Responsible**	**Completion**
Spill of Hydrocarbons Potential impacts on marine fauna and flora / seabirds/ & other sea users.	*Fuel base oil or other utility fluids (e.g. diesel, lubricants)* Any re-fuelling required will preferably be undertaken during daylight, if practicable, and in good weather conditions. Non-return valves will be installed on fuel transfer hoses, and operations will be supervised at all times from both the supply boat and drill rig. Dry-Break couplings to be installed on all hydrocarbon transfer hoses. Permit-to-work required for all hydrocarbon transfers.	Hydrocarbon transfer procedure required and must include: Pre operation inspection, PTW, pre-job meeting, isolation procedure. 'On site' monitoring to ensure appropriate procedures adhered to.	OIM / Borders & Southern Drilling Supervisor OIM / Borders & Southern Drilling Supervisor	
	Loss of rig (ship collision) Rig to have 'standard' collision monitoring procedure. Standby vessel monitoring exclusion zone. Drill rig will carry all relevant navigational & communication aids. Notification of planned drilling programme with all relevant maritime authorities and representative fishing organisations.	Ensure continuous 'on site' monitoring from rig and standby vessel. Audit collision monitoring procedure during pre-contract QHSE audit.	OIM / Borders & Southern Drilling Supervisor	
	Risk of a loss of well control Minimised through details of mud programme, detailed study of the known geological conditions of the area, BOP design and configuration, and use, appropriate training and drills and good drilling practices.	Two sets of independent well monitoring equipment to detect influx from reservoir. Observation of drills and reaction times by Borders and Southern representatives. Blowout preventer risk assessment conducted to ensure it is configured for the specific well conditions and design.	Drilling Superintendent Borders & Southern Drilling Supervisor Borders & Southern Drilling Manager and Drilling Superintendent	

NON ROUTINE OPERATIONS

Hazard/Effect(s)	Proposed Mitigation	Required Actions	Responsible	Completion
		Blowout preventers tested on installation and routinely during operations. All functions including deadman, acoustic control and ROV stabs to be tested.	Senior Toolpusher Borders & Southern Drilling Supervisor	
	Spill Response (For all spills) The support vessel will be equipped with 5 m^3 of chemical dispersant and spray system, able to treat up to 100 tonnes of oil, with a contact rate of approximately 10 tonnes per hour. Oil Spill Contingency Plan in place providing guidance on actions to be taken in event of spill. Tier 1 spill equipment to be located at shore base. Managing potential drilling hazards, such as shallow gas, and following established drilling safety standards to minimize the risk of control loss. Availability of dispersants and spill response kits on the rig and vessels for initial spill response. Operational controls covering materials loading, transfer, and storage Supervision of all loading / bunkering operations. Loading / bunkering during suitable weather conditions and light levels only. All oil stored in tanks or drums on board the vessel in accordance with maritime safety requirements.	Ensured during planning process & pre-op inspection to ensure all spill kits present and meet required standard. Establishing comprehensive Oil Spill Response Planning. Training of key personnel in oil spill response. All spills reported Consultation with the Fisheries Department and ongoing communications with all concerned parties regarding spill response.	Procurement/ Borders & Southern Company Man Borders & Southern Company Man / OIM Borders & Southern Drilling Superintendent	

6 Conclusions

This EIS Operation Addendum makes a thorough assessment of the potential impacts that may arise from the planned drilling of the Darwin East – 1 and Stebbing – 3 exploration wells. It has assessed seasonal sensitivities within the vicinity of the wells during the proposed drilling period (December 2011 to July 2012) with reference to the previously submitted Borders & Southern Petroleum Plc Offshore Falklands Island Exploration Drilling Environmental Statement, submitted February 2010.

The Addendum has also re-assessed the potential impacts from the proposed drilling campaign in light of the seasonal sensitivities and the further detailed project information, which is now available. Mitigation measures have been proposed for all potential impacts with extra attention given to those deemed to be of high to medium significance, in particular waste management and the accidental loss of containment. This will allow operations to proceed without any significant long lasting impacts to the marine or coastal environment of the Falkland Islands.

In conclusion, given the current operational commitments and proposed mitigation measures as detailed in Sections 4 and 5 of this Addendum, it is considered that the proposed exploration drilling can be undertaken without significant impacts to the Falkland Islands' environment.

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Appendix A: HOCNS & HMCS

Until recently the control of offshore chemical discharges was controlled under the Offshore Chemical Notification Scheme (OCNS). Within the UK, the OCNS has been succeeded by The Offshore Chemicals Regulations 2002, which introduced a new approach to the consideration of chemical use and their discharge, the Harmonised Mandatory Control Scheme (HMCS). The Falkland Islands Government (FIG) aims to follow the example of the UK with regard to offshore chemical use. Both the OCNS and the HMCS are discussed below.

Offshore Chemical Notification Scheme (OCNS)

The Offshore Chemical Notification Scheme (OCNS) requires that all chemicals used in offshore exploration and production be tested using standard test protocols. Chemicals are then classified based on their biological properties e.g. toxicity and biodegradability. The OCNS scheme was adopted in the UK in 1979 and formed the basis of the Oslo and Paris Commissions (OSPARCOM) Harmonised Offshore Chemical Notification Format (HOCNF) which was established under cover of the Paris Commission Decision 96/3. The objectives of the OCNS and HOCNF are to regulate and manage chemical use by the oil and gas industry and consequently to prevent unacceptable damage to the marine environment through the operational or accidental discharge of chemicals.

The scheme was originally voluntary in the UK and all chemicals were given an OCNS Category ranging from 0 to 4. The system was later altered to harmonise the system with those operated by other countries bordering the North Sea. The HOCNS classifies all chemicals into five groups, A to E with Category A chemicals being the most toxic and least biodegradable and Category E chemicals considered to be the least harmful to the offshore environment.

In addition to being placed into one of the five HOCNS categories, substances known or expected to cause tainting of fish tissue or substances known or expected to cause endocrine disruption, if lost or discharged, will be identified with a special taint or endocrine disrupter (ED) warning.

Chemicals are categorised on the basis of a series of laboratory tests with particular reference to their ecotoxicological effect, the biodegradability of the chemical and the potential for bioaccumulation in marine species. The ecotoxicological data used to classify the toxicity of chemicals are the results of laboratory tests on aquatic indicator organisms. Acute toxicity is assessed and expressed as either:

- An LC_{50} – the concentration of the test substance in sea water that kills 50 percent of the test batch; and
- An EC_{50} – the concentration with a specified sub-lethal effect on 50 percent of the test batch.

The HOCNS grouping for a chemical is determined by comparing the results of toxicity tests for that chemical with the toxicity data given in Table A.1.

Table A.1. HOCNS Grouping Toxicity values (ppm) (Source: CEFAS, 2007)

HOCNS Grouping	A	B	C	D	E
Results for aquatic toxicity data (ppm)	<1	>1-10	>10-100	>100-1,000	>1,000
Results for sediment toxicity data (ppm)	<10	>10-100	>100-1,000	>1,000-10,000	>10,000

Aquatic toxicity - refers to the *Skeletonema costatum* EC_{50}, *Acartia tonsa* LC_{50}, and *Scophthalmus maximus* (juvenile turbot) LC_{50} test

Sediment toxicity - refers to the *Corophium volutator* LC_{50} test.

The categorisation also takes into account the chemicals potential to bio-accumulate and biodegrade and other aspects such as potential endocrine disruption. The bioaccumulation potential and biodegradation rate relates to the fate of a chemical within the marine environment. Bioaccumulation potential describes the net result of uptake, distribution, biodegradation and elimination of a substance within an organism, subsequent to exposure but within the environment. The partition coefficient between octanol and water (expressed as Log Pow) is used as an indication of the potential for a substance to be bioaccumulated. A high value indicates a tendency to accumulate in lipophilic ("oil liking") phases such as the fatty tissues of organisms, suspended particles or sediments. However, because of biodegradation and elimination processes, a high Log

Pow does not necessarily imply bioaccumulation will occur. The classification outlined in Table A.2 is generally used to describe bioaccumulation potential.

Table A.2. Classification of Bioaccumulation Potential

Bioaccumulation Potential	Log P_{OW}
Low	<2
Medium	2-4
High	>4

Biodegradation of a substance refers to primary breakdown of the substance by living organisms, normally bacteria. A substance is considered readily biodegradable if 60 percent or more is broken down in 28 days during a biodegradation tests. Values below this are considered not to be readily biodegradable.

Harmonised Mandatory Control Scheme (HMCS)

The OSPAR Decision introducing an HMCS for the use and discharge of chemicals offshore came into force through the Offshore Chemicals Regulations 2002. The regulatory regime requires operators to obtain a permit to use and discharge chemicals in the course of oil and gas exploration and production operations offshore.

The OSPAR Decision and its supporting Recommendations entered into force on 16 January 2001. The Decision requires offshore chemicals to be ranked according to their calculated Hazard Quotients relating to each chemical discharge under standardised platform conditions (HQ = ratio of Predicted Environmental Concentration (PEC) to Predicted No Effect Concentration (PNEC). It also obliges authorities to use the CHARM "hazard assessment" module as the primary tool for ranking. In the UK this is carried out by a multidisciplinary team at the CEFAS Burnham Laboratory. From this information, operators assess and select their chemical need, calculating PEC:PNECs for actual conditions of use (utilising the CHARM module as appropriate) and bearing in mind the objective of the HMCS to identify substances of concern for substitution and ranking of others to support moves towards the use of less harmful substances. Inorganic chemicals and organic chemicals with functions for which the CHARM model has no algorithms will continue to be ranked using the existing HOCNS hazard groups defined above.

A series of ranked lists are maintained on the CEFAS web site which use a banding system to rank organic chemicals of similar function according to PEC: PNEC “Hazard Quotients” calculated using the CHARM model. The band definitions are given in Table A.3.

Table A.3. Classification of Bioaccumulation Potential

HQ Banding	HQ Value
Gold	0>x<1
Silver	1=<x<30
White	30=<x<100
Blue	100=<x<300
Orange	300=<x<1000
Purple	1000=<x

The minimum data set of actual values and the parameters used by CEFAS to calculate them are disclosed to chemical suppliers on “templates”. The suppliers then pass these on to operators to enable the calculation of site-specific risk assessments (RQs) for any chemicals they may want to use. Some chemicals are generated and or used in-situ on offshore installations, e.g. Sodium Hypochlorite, and don't fall under the remit of any one supplier.

The properties of substances on the OSPAR List of Substances/Preparations Used and Discharged Offshore, Which Pose Little Or No Risk to the Marine Environment (PLONOR) are sufficiently well known that the UK Regulatory Authorities do not require them to be tested. This list is reviewed annually and the notification requirements for these chemicals are given in the PLONOR document.

Appendix B: Drilling Mud

During drilling operations drilling mud is pumped through the drill string down to the drilling string down to the bit but only after running a BOP and riser will mud returns will be taken to the rig.

Drilling mud is essential to the operation. It performs the following functions:

- The hydrostatic pressure generated by the mud's weight controls the downhole pressure and prevents formation fluids from entering the well bore;
- It removes the rock cuttings from the bottom of the hole and carries them to the surface and when circulation is interrupted it suspends the drill cuttings in the hole;
- It lubricates and cools the drill bit and string; and
- It deposits an impermeable cake on the wall of the well bore effectively sealing and stabilising the formations being drilled.

The mud is recycled and maintained in good condition throughout the operation. The mud and suspended cuttings are processed on the rig through screens called "shale shakers" to maximise recovery of the mud. The recovered mud is then passed for treatment provided by a centrifuge. This additional equipment removes the fine colloidal solids, the particles too small to be removed by the conventional equipment, which if allowed to build up can make the mud too viscous.

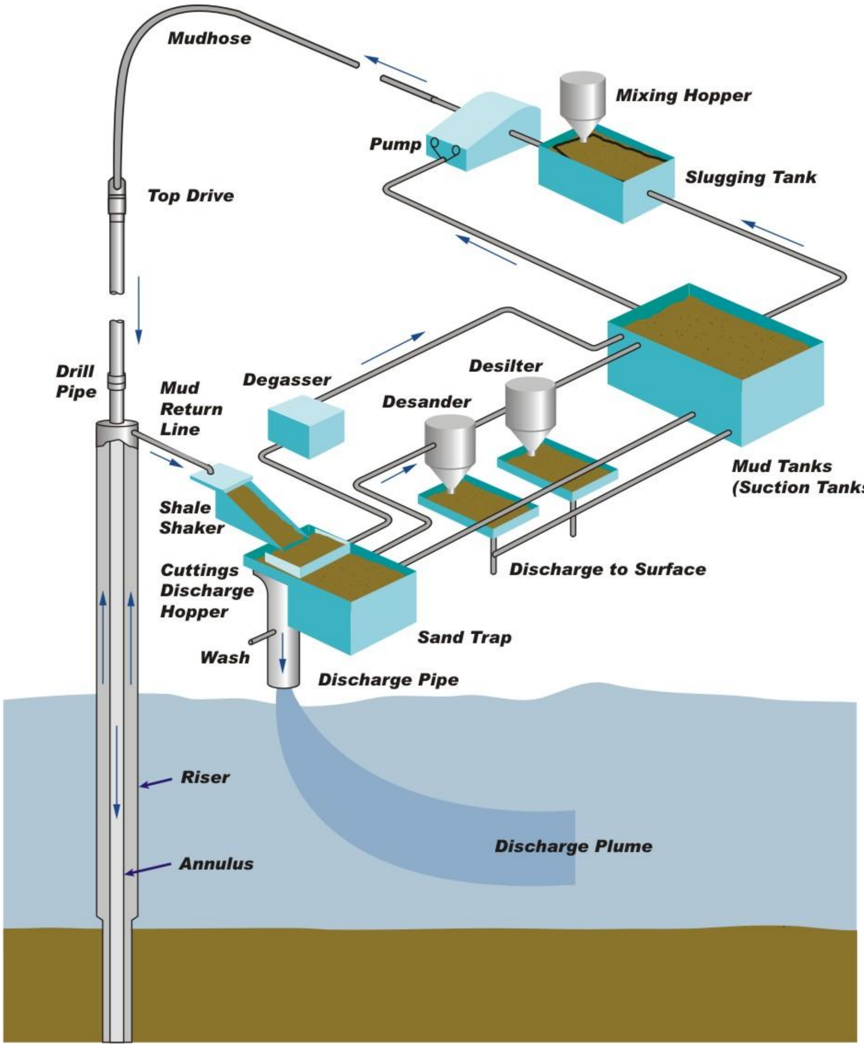
Three major types of mud are typically used in offshore drilling:

- Water based mud (WBM) – water forms the continuous phase of the mud (up to 90 percent by volume);
- Low toxicity oil based mud (LTOBM) – base oils, refined from crude oil, form the continuous phase of the mud; and
- Synthetic based mud (SBM) – the continuous phase is refined from a number of organic compounds chosen because they act like base oil but are selected to be more biodegradable.

The base muds form a viscous gel to which a variety of additives may be added for various reasons, including:

- Fluid loss control. The layer of mud on the wall of the wellbore retards the passage of liquid into the surrounding rock formation. Bentonite is the principal material for fluid loss control although additional additives such as starch and cellulose, both naturally occurring substances, are also used.
- Lost circulation. Naturally occurring fibrous, filamentous, granular or flake materials are used to stop lost circulation when the drill bit enters a porous or fractured formation. Typical materials include ground nut shells and mica.
- Lubricity. Normally the drilling mud alone is sufficient to adequately lubricate and cool the bit. However, under extreme loading, other lubricants are added to prevent the drill string from becoming stuck. No oil based chemicals will be required for Borders & Sothern's drilling programme.
- pH control. Caustic and lime are used to control the alkalinity of the mud to a pH of 9 to 10. This ensures the optimum performance of the polymers in the mud and controls bacterial activity.
- Pressure control. Barite is generally used as a weighting agent to control downhole pressure.

Figure C.B. A Typical Mud Recycling System, once Marine Riser is in Place.



Appendix C: Rig Specifications

OCEAN RIG

LEIV ERIKSSON – THE EFFECTIVE ANSWER FOR

ULTRA-DEEP WATERS

AND HARSH ENVIRONMENTS

OCEAN RIG AS P.O. BOX 409, FORUS NO-4067 STAVANGER, NORWAY TEL +47 51 96 90 00 FAX +47 51 96 90 99 oras@ocean-rig.com www.ocean-rig.com

LEIV EIRIKSSON | OCEAN RIG AS

GENERAL

Year Completed: 2001
Builder: Dalian New Shipyard, China – baredeck
Outfitted: Friede Goldman Offshore, USA
Design: Trosvik Bingo 9000,6 columns, DP Class 3
Classification: DnV + 1A1 Column Stabilised Drilling Unit, UKVS, DYNPOS AUTRO, HELDK SH, CRANE, F-AM, DRILL

Leiv Eiriksson carries a Norwegian AoC (SUT) and a UK Safety case

MAIN DIMENSIONS

Length: 119.38m (391.68ft) Overall
Width: 85.50m (278.88ft) Overall
Moon-pool: 7m x 14.5m (22.9ft x 47.50ft)
Air Gap: 13.50m (44.29ft) Operating Draft

DRAFT AND DISPLACEMENT

Operating Draft: 23.75m (77.9ft)
Transit Draft: 12m (39.4ft)
Survival Draft: 21m (68.9ft)
Operating Displacement: 53,393mt (52,552 tons)
Transit Displacement: 38,243mt (37,640 tons)

DYNAMIC POSITIONING AND VESSEL CONTROL SYSTEM

Integrated Automation System

Dynamic Positioning System: SDP 32 (SDP 12 in Backup Control Room)
Power Management System: SVC (Simrad Vessel Control)

Position Reference Systems:
1 x DPS 4D – L1/L2 Dual-frequency GPS/GLONASS GPS Receiver, aided by a high performance IMU
1 x DPS 232 - L1/L2 Dual-frequency GPS/GLONASS GPS Receiver
2 x DPS 132 - L1/L2 Dual-frequency GPS Receiver.
Dual Spotbeam, dual Inmarsat-B and UHF / HF received corrections signals.

2 High Precision Acoustic Positioning, Simrad HIPAP, systems
1 HAIN (inertial navigation system) with Honeywell HG9900 IMU.
1 RMS (Riser Management System)

Sensors: 3 Gyro Compasses Serry SR 2100 Fiber Optic.
3 Motion Reference Units, Seatex MRU-5
3 Lambrect Wind Sensors

The Kongsberg SDP 32 DP system is a triple redundancy dynamic positioning system with a full range of functionality. The system is satisfying IMO 645 Class 3 and DNV AUTRO notation.

MACHINERY

Main Engines: 6 x Wãrtsila 18V32 diesel engines, rated 7,500kW each, 10,200hp, total 61,200hp
Generators: 6 x ABB ASG 900 XUB generators, rated 7,300kW each, total 43,800 kW
Power Distribution: ABB
Propulsion: 6 x Rolls Royce UUC 7001 fixed pitch variable speed thrusters, rated 5,500kW each,
Total thrust: 600mt

OPERATING PARAMETERS

Water Depth:	2,286m (7,500ft)
Transit speed:	6 - 7 knots

DRILLING EQUIPMENT

Derrick:	Hydralift 170 x 40 x 40ft; 680mt (1,500,000 lbs)
Motion Compensators:	Hydralift 800-25 Passive / Active Crown Mounted Compensator • Rating: Static 680mt (1,500,000 lbs), Compensating 363mt (800,000 lbs) • Stroke: 25ft stroke
Drawworks:	Continental Emsco Electrohoist III, 3000hp
Rotary Table:	Varco BJ RSTT - 60 1/2"
Top Drive:	Hydralift HPS 750 2E AC Electric Drive • Rating: 680mt (1,500,000 lbs) • Torque: 90,840Nm (67,000ft lbs), continuous
Travelling Block:	Hydralift HTB 750-S
Pipe Handling:	• Hydralift, HydraRacker (pipe racker) • Hydralift, Back-up Racking System • Hydralift, Drillfloor Manipulator Arm • Hydralift, Iron Roughneck
Fwd pipe rack:	• Hydralift, Pipe Catwalk Machine • Hydralift, Knuckle-boom Pipe-handling Crane
Aft riser rack:	• Hydralift, Riser Catwalk Machine • Hydralift, Riser Gantry Crane
Riser Tensioner:	6 x Hydralift double, 91mt each (200,000 lbs); Total Capacity 1,089mt (2,400,000 lbs)
Cementing:	Dowell Schlumberger, Third Party free placement unit
Mud Pumps:	3 x Continental Emsco FC-2200, 2,200hp, 517 BAR (7,500psi)

CAPACITIES

Variable Deck Load:	• Operating: 7,222 mt • Survival: 7,222 mt • Transit: 6,534 mt
Liquid Mud:	1,657m3 (10,420 bbls)
Bulk Mud/Cement:	4 x 87.6m3 (3,094 cuft) – Total 350m3 (12,360 cuft)
Bulk Cement:	4 x 87.6m3 (3,094 cuft) – Total 350m3 (12,360 cuft)
Drill Water:	1,960m3 (12,330 bbls)
Potable Water:	1155m3 (7,265 bbls)
Fuel Oil:	4,631m3 (29,130 bbls)
Base oil:	406m3 (2,554 bbls)
Brine:	680m3 (4,277 bbls)

OCEAN RIG AS P.O. BOX 409, FORUS NO-4067 STAVANGER, NORWAY TEL +47 51 96 90 00 FAX +47 51 96 90 99 oras@ocean-rig.com www.ocean-rig.com

SUBSEA SYSTEMS

BOP: Cameron 18 ¾" 1,034 Bar (15,000psi), H2S service.
- Annulars: 2 each 690 Bar (10,000 psi)
- BOP Rams: 4 each 1,034 Bar (15,000psi)
- Choke and Kill: Cameron double master target valve 3 1/16" 15,000psi choke line

Wellhead Connector: Vetco Super HD H4
BOP Control System: Cameron MUX Control System with Multiplex modular control pods
BOP Acoustic System: Kongsberg BOP acoustic control

Cameron Hydraulic power unit with 345 Bar (5,000psi) accumulator pressure

Marine Riser:
- Vetco MR-10-GS dog riser,21" OD x 7/8" wall, rating 3,000,000 lbs;
  2 x 4 ½" ID Choke / Kill Lines; 1 x 4" ID Booster Line; 2 x 2 ½" Hydraulic Conduits Lines

Diverter:
- Vetco KFDS-CSO-500,

BOP Handling:
- Hydralift BOP and X-mas tree transporter,290mt capacity
- BOP Underhull Guiding System
- Gantry crane for BOP service 2 x 50 mt
- Rig outfitted for subsea completion and X-mas tree handling

Drillpipe: 5 ½" S-135 with HT55 tool joints
Drillcollars: 9 ½", 8 ¼" , 6 ¾"

MOORING

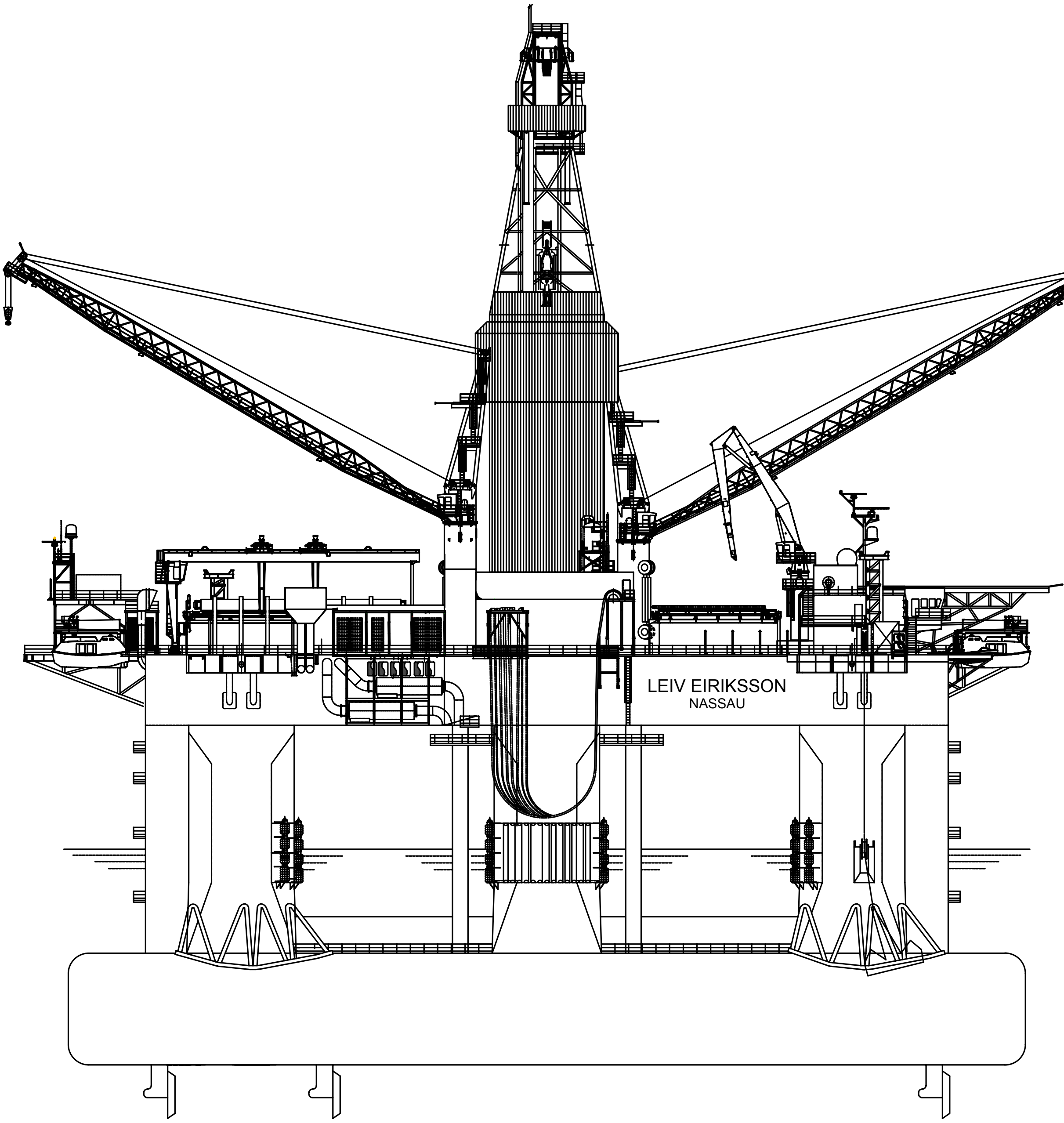
Winches: 2 x Ulstein Brattvåg single drum windlasses
Wire/Chain: 2 x 2.76" 84mm chain. 2 x 1000 meter lengths.
Anchors: 2 Bruce, 20 ton.
CRANAGE: 2 x Hydralift WOMCVC 3447, 75 mt
HELIDECK: EH 101 Helicopter, D = 22.8 meter
ACCOMMODATION: 120 berths + hospital
LIFE SAVING: 4 x 70-men lifeboats
1 x Man Over Board boat (MOB boat)
Escape Shute System (Selantic) with 8 x life rafts total capacity 240 men

ADDITIONAL DATA

Leiv Eiriksson design temperature:
- Air (deck, trusses, columns); minus 20 deg Celsius
- Sea (pontoons); zero deg Celsius
- Water max; plus 35 deg Celsius

The Leiv Eiriksson is winterized for operation in temperatures down to minus 10 deg Celsius.
Leiv Eiriksson is designed for zero discharge

LEIV EIRIKSSON | OCEAN RIG AS



MAIN DIMENSIONS

Length:	119.38m (391.68ft) Overall
Width:	85.50m (278.88ft) Overall
Moon-pool:	7m x 14.5m (22.9ft x 47.50ft)
Air Gap:	13.50m (44.29ft) Operating Draft

LEIV EIRIKSSON

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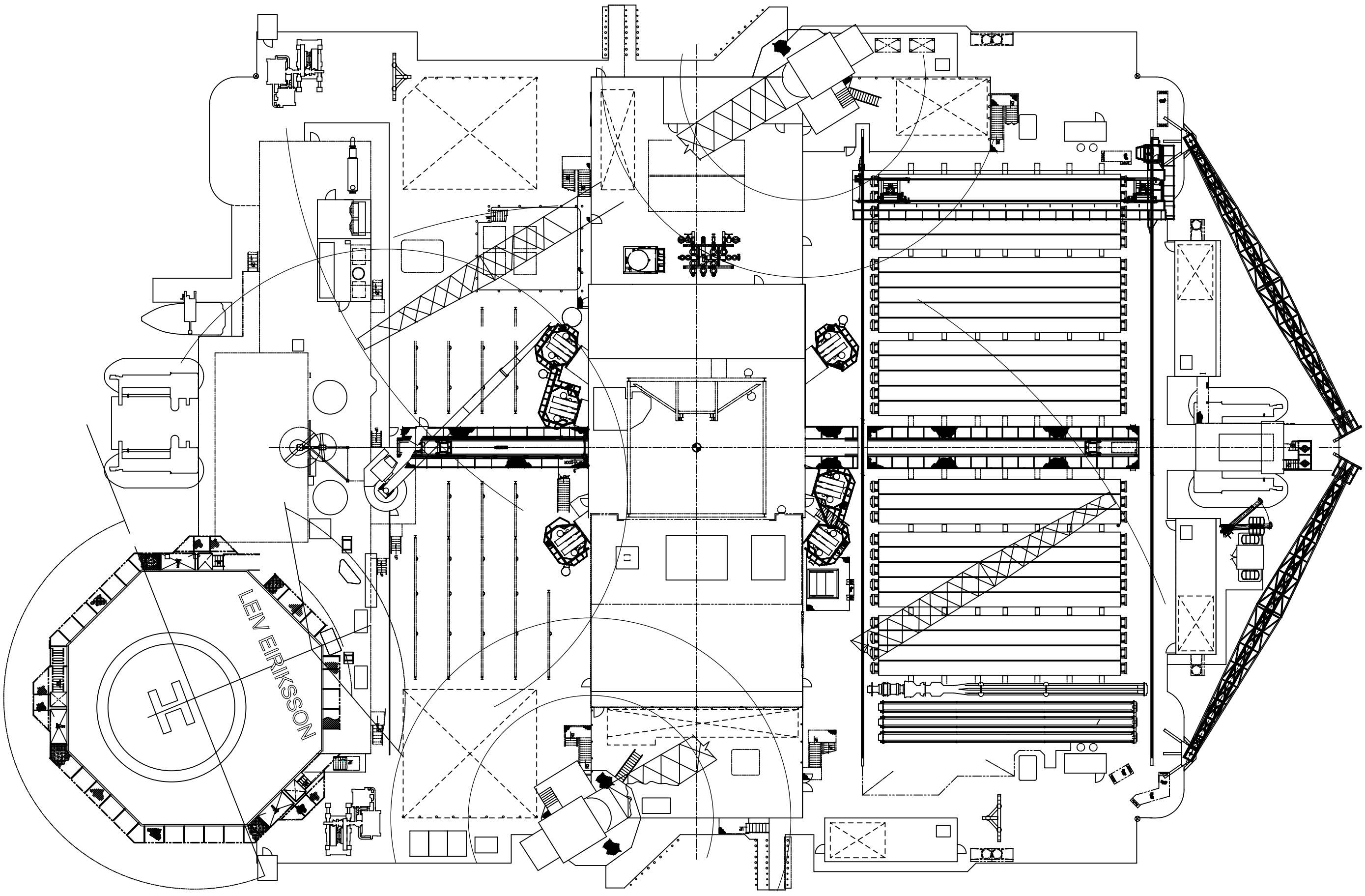

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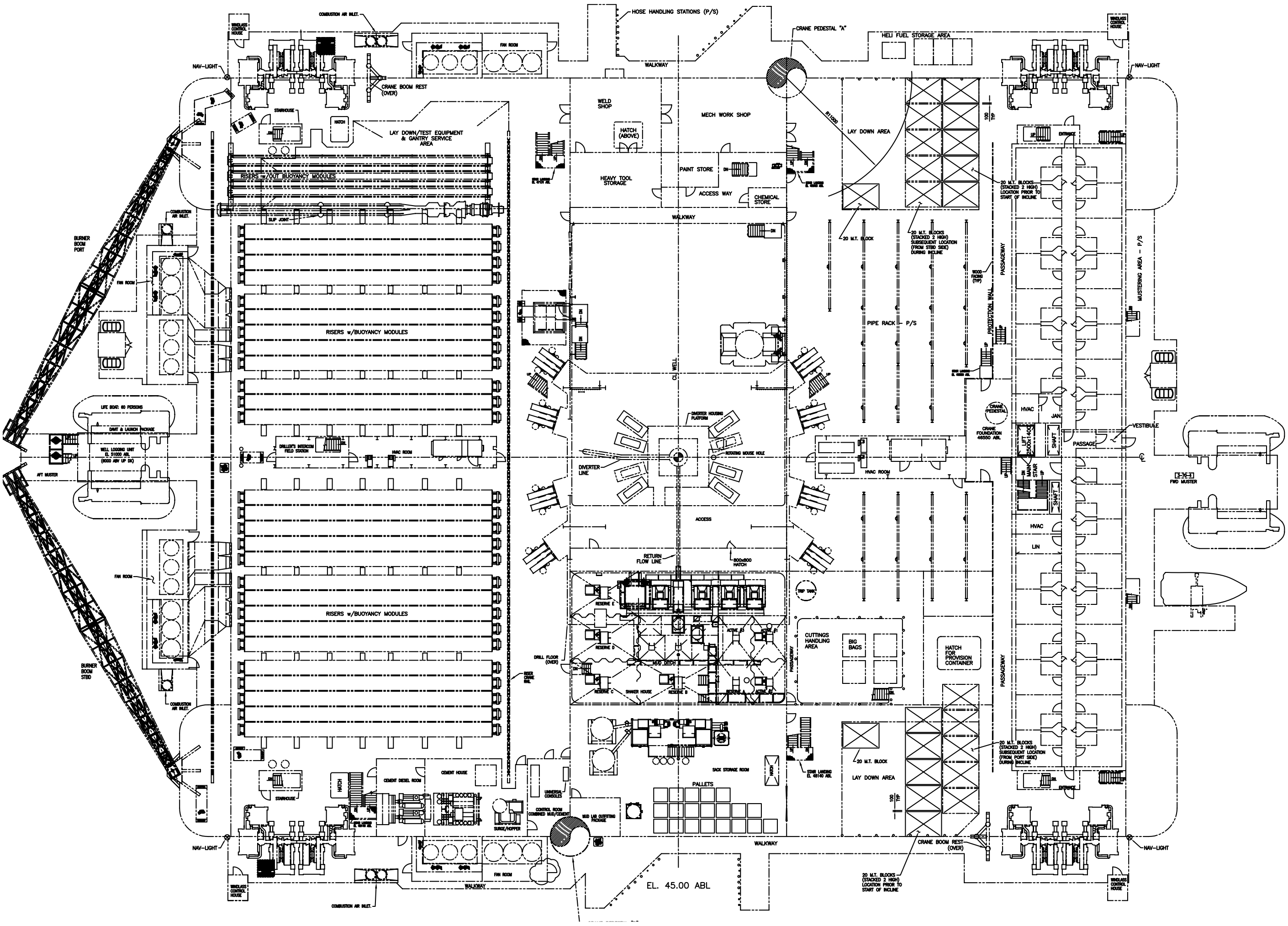

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ADDITIONAL INFORMATION

The drilling units Leiv Eiriksson and Eirik Raude are 5th generation harsh environment, dynamically positioned semi-submersibles, capable of operating in water depths up to 2286 meter and 3000 meter. The dynamic positioning capability is to Class 3.
In addition Eirik Raude is capable of being moored in water depths of 70 meters to 500 meters. Both units are designed with zero discharge capability and have low emission power generation systems.

Leiv Eiriksson area of operation:

- West Africa Angola and Congo (Deep water)
- Atlantic Sea Ireland (Deep water harsh environment)
- West Of Shetland UK (Deep water harsh environment)
- Norwegian Sea Norway (Deep water harsh environment)
- Black Sea Turkey (Deep water)

Eirik Raude area of operation:

- Nova Scotia Canada (Deep water harsh environment)
- Newfoundland Canada (Deep water harsh environment)
- Cuba (Deep water)
- West Of Shetland UK (Deep water harsh environment)
- North Sea Norway (Shallow water harsh environment)
- Barents Sea (Shallow water harsh environment)
- Norwegian Sea (Deep water harsh environment)
- Gulf of Mexico USA (Deep water)
- West Africa Ghana (Deep water)

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