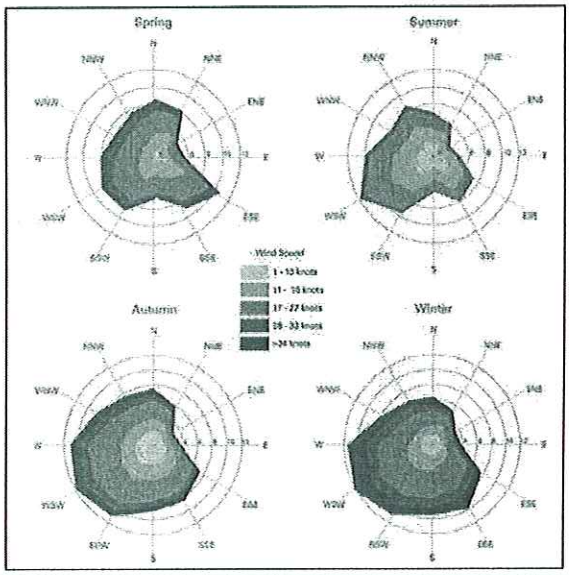
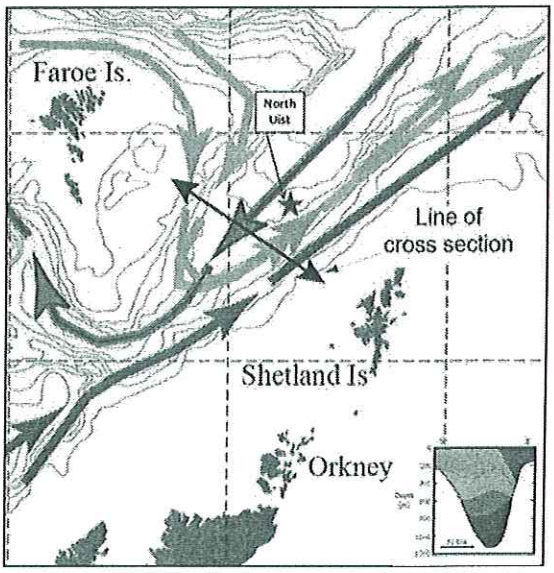
NOp 5.3.1 Metocean Data

Effects from a hydrocarbon release will largely be associated with the oil plumes. The impacts of an oil spill will be highly dependent on environmental sensitivities, prevailing sea state and weather conditions at the time. The sea and weather conditions in the Project area means any spillage of oil will break up and disperse. Surveys and observations from the West of Shetland describe the key metocean features as follows

Metocean Data





Currents	The oceanographic regime of the Faroe-Shetland Channel consist of an upper layer of warm North Atlantic water flowing towards the northeast, overlying a lower layer of cold Norwegian Sea bottom water, flowing towards the southwest (Turrell *et al.*, 1999).
Tidal Regime	The tidal flow in this area is generally aligned on a north-east to south-west axis along the slope. Mean surface water currents of 0.46 knots and mean currents at seabed of 0.32 knots. The greatest current speeds experienced in near surface waters were 1.6 knots.
Wind Regime	For much of the year (July through to March) winds from the south and west predominate. The least frequent winds are easterly winds. During winter wind speeds are generally between 6-9ms^{-1} and can reach 14ms^{-1}. During summer wind speeds are generally between 4-7ms^{-1}.
Seabed	Sediments within the North Uist are comprised of mud and muddy sands with some gravel. Generally undulating seabed with low slope gradient dominate the area.

NOp 5.3.2 Environmental and Commercial Sensitivities

This section contains a summary of the environmental sensitivities, on a seasonal basis, in the immediate vicinity of the North Uist Field. This information will be supported by actual observations from site and used by the onshore support team when determining response strategies with the relevant external agencies[9]. Further detail is available in the *North Uist Exploration Well Environmental Statement.*

Birds

The effects of oil on birds has been widely studied and includes both immediate chronic impacts which can kill birds or longer-term, sub-lethal impacts that could affect individual birds and populations over many years. The oil can become incorporated into the feathers which can cause loss of insulation and waterproofing. If birds become heavily oiled their survival rates are lowered.

To assist in determining the likely impact on birds from a release of oil, data has been collected from a number of sources to derive an oil vulnerability index (OVI) from which it is possible to indicate the sensitivities of bird families that could be impacted. The results from the study indicate that Auks and Divers are the most sensitive species to an oil spill, whilst Gulls and Skuas are least sensitive. This is based on a wide range of ecological and behavioural traits for each species, in particular the proportion of time each species is present on the sea surface. Divers tend to be a coastal species and are unlikely to be found in the vicinity of the Project site.

JNCC has stated in a memorandum to the UK Government that the greatest risks to nature conservation of oil on the offshore (deepwater) sea surface are to seabirds. Seabird species in the North Uist area are considered to be vulnerable to surface pollution during the months of February and September. For the rest of the year, vulnerability is considered medium to low. In the pre-breeding period, Fulmars, the main species in the area, undergo a pre-laying exodus to offshore waters from the breeding colonies, this may account for the high vulnerability in February. The other high vulnerability category in September is associated with the moulting period for a number of species in the area during which time they are more susceptible to surface pollutants.

The magnitude of any impact will depend on the number of birds present, the percentage of the population present, their vulnerability to oil spill and their recovery rates from oil pollution.

A seasonal sensitivity table of seabird vulnerability in the North Uist area is given below.

[9] In the event of a spill, actual sensitivities will be advised on the day through consultation with the statutory authorities.

Environmental and Commercial Sensitivities Matrix. Coastal and Marine Resource Atlas (CMRA)												
Receptor	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Seabirds	The waters surrounding North Uist are important for species such as Fulmars, Gannets, Herring Gulls, Great black-Backed Gulls, Kittiwakes, Common Guillemot Razorbill, Puffin, European Storm petrel, Leach's Storm petrel, Great Skua, Glaucous Gull, Sooty Shearwater and Arctic Tern. Vulnerability of seabirds to surface pollution ranges from high to low throughout the year.											
	Key:	1	2	3	4		1 = Very High, 4 = Low Vulnerability, Blank = No Data					
Block 213/19		3	4	3	3	3	3	3	2	3	4	4
Block 213/20		3	3	3	3	3	3	3	2	3	4	4
Block 213/24		2	4	3	3	3	3	3	2	3	4	
Block 213/25		2	3	3	3	3	3	3	2	3	4	4
Block 213/29		2		3	3	3	3	3	2	3	4	
Block 213/30		2		3	3	3	3	3	2	3	4	
Block 214/16		3	3	3	3	3	3	4	3	3	4	4
Block 214/21		2	3	3	3	3	3	3	3	3	4	4
Block 214/26		2	3	4	3	3	3	3	4	3	4	

Plankton

Oil can be toxic to a wide range of planktonic organisms. Those living near the sea surface are at risk from oil dissolving into the water column from a surface slick and from oil being entrained in the upper water layers through wind and wave action. Although oil spills may kill plankton, the effects on whole plankton communities generally appear to be short-term, through a combination of high reproductive rates and immigration from outside the affected area.

Any effects will be greater during a period of plankton blooms and during fish spawning periods. Contamination of marine prey including plankton and small fish species may then lead to aromatic hydrocarbons accumulating in the food chain.

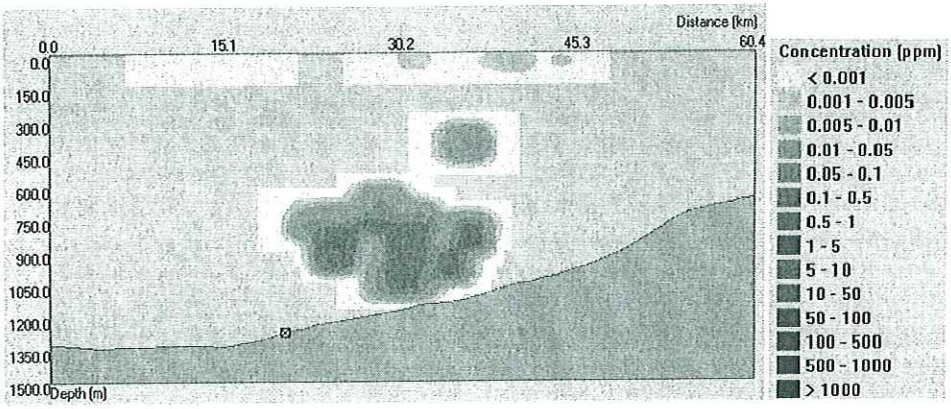
Benthic Communities

In the unlikely event of a spill at the project site, much of the oil released is predicted to remain trapped below the thermocline and move in the direction of the dominant deepwater currents thereby reaching the surrounding benthic communities. In addition coastal benthic organisms may be at risk from oil carried as fine droplets or in dissolved form in the water column, which is carried from deep water into shallow water where the plume then comes into contact with the seabed.

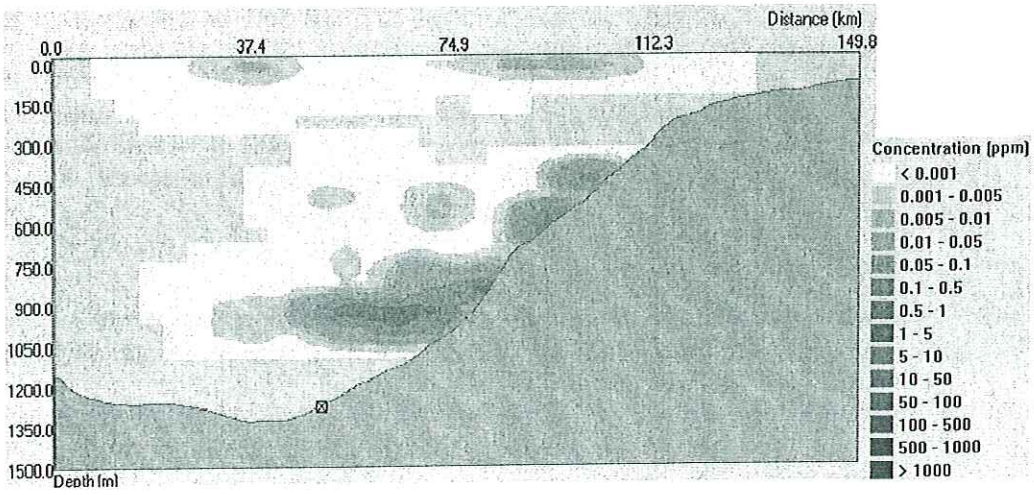
The concentrations predicted are estimated to be below a generally accepted level of discernible toxic effects. Given the assumptions and the scales of the input data used for modelling, some local degradation of benthic quality cannot be ruled out, but the results indicate a minor impact.

The OSCAR spill model predicts little if any oil deposition in the immediate area of the site in the event of a blowout. Rather oil is deposited in sediments further afield at slightly shallower depths under the influence of water currents.

The diagram below details a cross section of predicted oil concentrations through a subsea plume, 2 days after start of blowout.



The diagram below details a cross section of predicted oil concentrations, 30 days after the start of blowout (larger scale).



Characteristic benthic species present in the deeper areas of the Faroe-Shetland Channel tend to be deposit feeders that feed on the fine organic matter trapped amongst the sediments and therefore these animals would have a higher probability of being affected by oil depositing on the seabed and becoming bound to the sediments.

Colonies of coldwater coral *Lophelia pertusa* are not recorded in this area in waters deeper than 1000m, and they are generally associated with water temperatures between 4 and 12 Celsius. The seabed water temperature at the North Uist location is typically below zero Celsius. Any oil that could reach the nearest colonies would be highly dispersed and is not considered to pose a significant risk to these communities.

There are no seabed protected areas in the vicinity of the well.

The DEEPSPILL Joint Industry Project (JIP) was conducted in 2000 whereby experiments were undertaken simulating underwater blowouts in the Norwegian Sea. Several deliberate releases of oil and gas were undertaken in around 900 metres of water depth to observe the formation of the underwater plume and to understand its movement, together with sophistication detection techniques for droplet sizes, rise times and oil properties.

The experiments showed that there was an initial degassing of oil as it left the well. This resulted in the formation of a plume of oil droplets and dissolved oil which remained within the water column. Any oil reaching shallower waters will have undergone weathering, degradation and dispersion processes accelerated by the fine droplet size created by the initial release conditions and the degassing of the oil. It is therefore not predicted that any released oil would significantly affect the shallow water benthic communities that it may encounter.

Oil may also smother benthic communities. However given the distance from the project site to the shallower coastal areas, the oil reaching the sediments in these areas is expected to be very finely dispersed and this is not considered a significant impact mechanism.

Fish

There is relatively little published information on the distribution of fish populations and abundance in the project area.

In general, offshore fish populations are considered to remain relatively unaffected by oil pollution, as oil concentrations below the surface slick are generally low. There is also evidence that fish are able to detect and avoid oil-contaminated waters. This avoidance may, however, cause disruption to migration or spawning patterns. Mackerel migrate through the Faroe-Shetland Channel from spawning areas in the southwest to summer feeding areas in the Norwegian Sea. Deepwater species in the Faroe-Shetland Channel generally have slow growth rates, late onset of sexual maturity and low fecundity, leaving them vulnerable to the effects of disturbance. Rather than impacting the fish directly, heavily contaminated sediments may have an adverse effect on local populations of demersal fish species, due to the impact it has lower down the food chain. The predictions from this study are, however, that sediment contamination will be relatively slight.

Fish eggs and larvae are more vulnerable to oil pollution than adult fish and in several species the larval stages float to the surface where contact with oil as a continuous layer is more likely. As most of these fish species have extensive spawning grounds and produce large numbers of pelagic young, it is considered unlikely that there would be any long lasting effect on numbers in the adult populations

Shellfish

Shellfish that cannot or do not move away from oiled sediments may be adversely affected by oil. This can range from insignificant individual effects such as reduced feeding to the removal of a species from an area for a period of time. Low levels of certain oil components can cause tainting in shellfish, which may be commercially

damaging to shellfish fisheries. This is more common in filter feeding shellfish, particularly bivalves, as they take up fine oil droplets from the water column. In the deepwater of the Faroe-Shetland Channel, commercially important shellfish are only found in very small quantities. The inshore waters around the Shetland and Orkney Islands do, however, support commercially important shellfish fisheries. For example, in 2009 the Shetland Islands produced 3,700 tonnes of mussels and 25,000 tonnes of Pacific oysters; Source; Marine Scotland, 2009. These may be at risk in the event of a spill which reaches these areas.

Marine Mammals

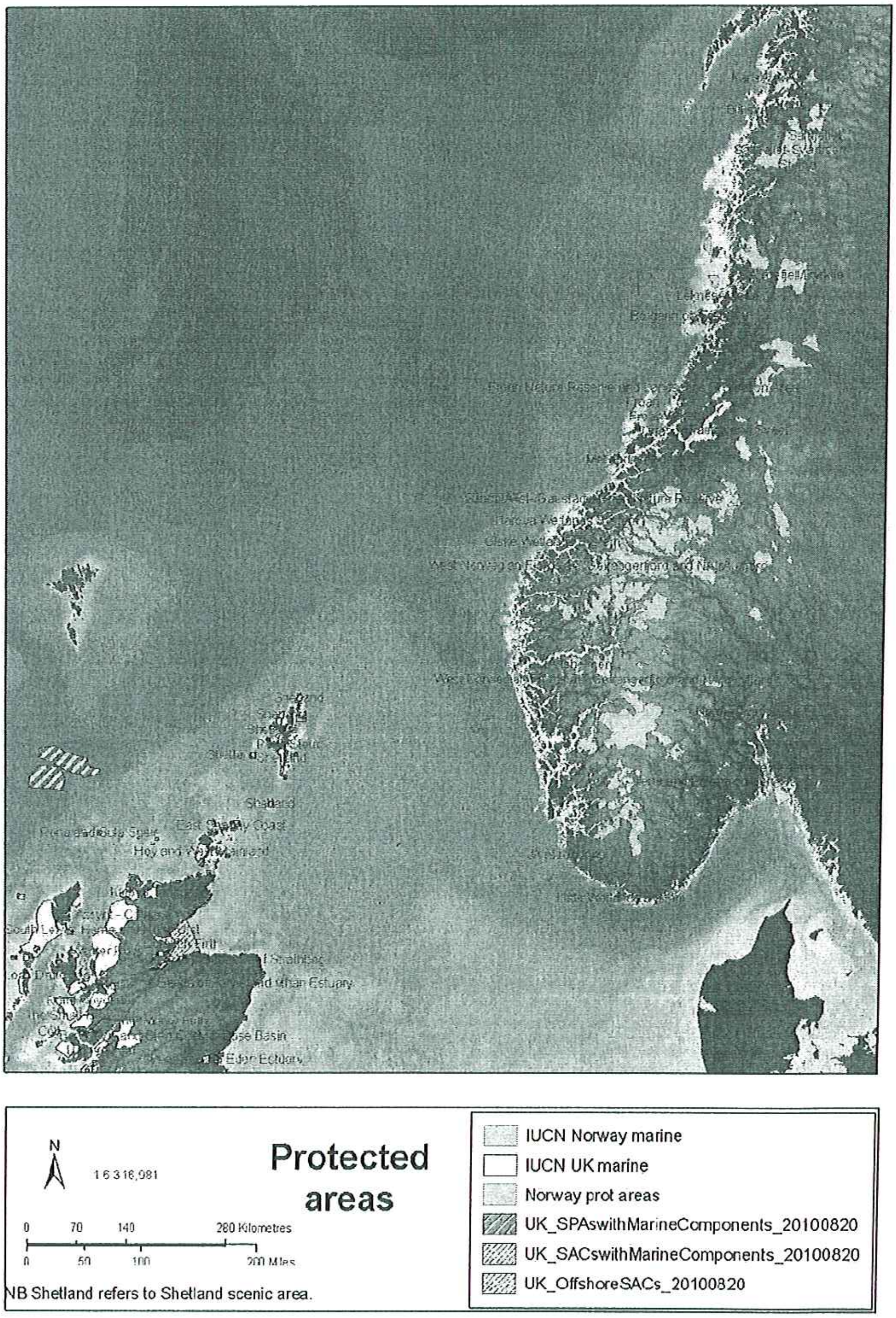
Low densities of marine mammals may be present in the area including seals, dolphins and porpoises. Marine mammals that come into contact with oil may be impacted in a number of ways. The insulation properties of otter fur are greatly reduced when covered in oil leaving the animals at risk of hypothermia if the thermal properties are reduced. Insulation is considered less of an issue for marine mammals such as seals and cetaceans as their skin forms a nearly impenetrable barrier to hydrocarbons. However, where oil is in contact with the skin there is the potential for it to cause irritation to the eyes or burns to mucous membranes. Ingestion of oil by marine mammals can damage the digestive system or affect the functioning of livers and kidneys. If inhaled, hydrocarbons can impact the respiration.

Grey seals, common seals and otters are known to inhabit and breed in the Shetland Islands, and may be at risk from surface oil reaching inshore waters.

No significant risk to marine mammal populations is anticipated such that any adverse impacts to individual cetaceans would not affect the species at a population level.

Coastlines

The figure overleaf shows UK SPAs and SACs and Norwegian protected areas. Additionally it shows sites designated by the International Union for Conservation of Nature (IUCN), which reflects a greater international significance. The site labels shown in the figure are the IUCN site names; 'Shetland' refers to the Shetland National Scenic Area.


Protected areas
N
1:6,318,981
0 70 140 280 Kilometres
0 50 100 200 Miles
NB Shetland refers to Shetland scenic area.
IUCN Norway marine
IUCN UK marine
Norway prot areas
UK_SPAswithMarineComponents_20100820
UK_SACswithMarineComponents_20100820
UK_OffshoreSACs_20100820

Shetland Coastlines

The level of impact is directly related to the volume of the oil released and the volume of emulsified oil beaching. The most likely impact of any oil spill will be one of physical smothering and coating by oil.

As previously noted, in the event of a spill the overall probability of shoreline oiling is low. However, should it occur then the impact of such an event will be low-moderate given the amount of oil predicted to beach depending on the time of year and the extent of oiling along the coast.

The Shetland Islands are the closest landmass to the proposed project and, in the unlikely event of an oil spill occurring, may be affected. Orkney and mainland Scotland are both well away from the area predicted to be affected by the stochastic modelling, which incorporates a wide variety of real weather and current conditions. The Shetland Islands incorporate many coastal habitats that are designated as sites of international, European and national importance. The following table lists those sites in the west and northwest of the Shetland Islands that are important in terms of conservation and that are at most at risk from any major oil spill from the Project area. A brief summary of the important features of each site is also provided.

The following coastal sensitivities have been identified as being particularly vulnerable to oil spills: seabird populations; waders, divers and waterfowl; otters; seals; coastal habitat types; fishing; mariculture; tourism and amenity.

The Shetland Islands have considerable lengths of cliff coastline, which support internationally and nationally important populations of breeding seabirds. In addition, shingle/rock and boulder shores on the western and northern coasts are important breeding sites for Arctic tern (*Sterna paradisaea*) and ringed plover (*Charadrius hiaticula*). The coastline also has numerous boggy areas, which support approximately half of the British breeding population of red-throated diver and other moorland bird species. Approximately 22% of the UK"s harbour seal population occurs on the Shetland Islands and nationally important otter concentrations are present in Yell Sound.

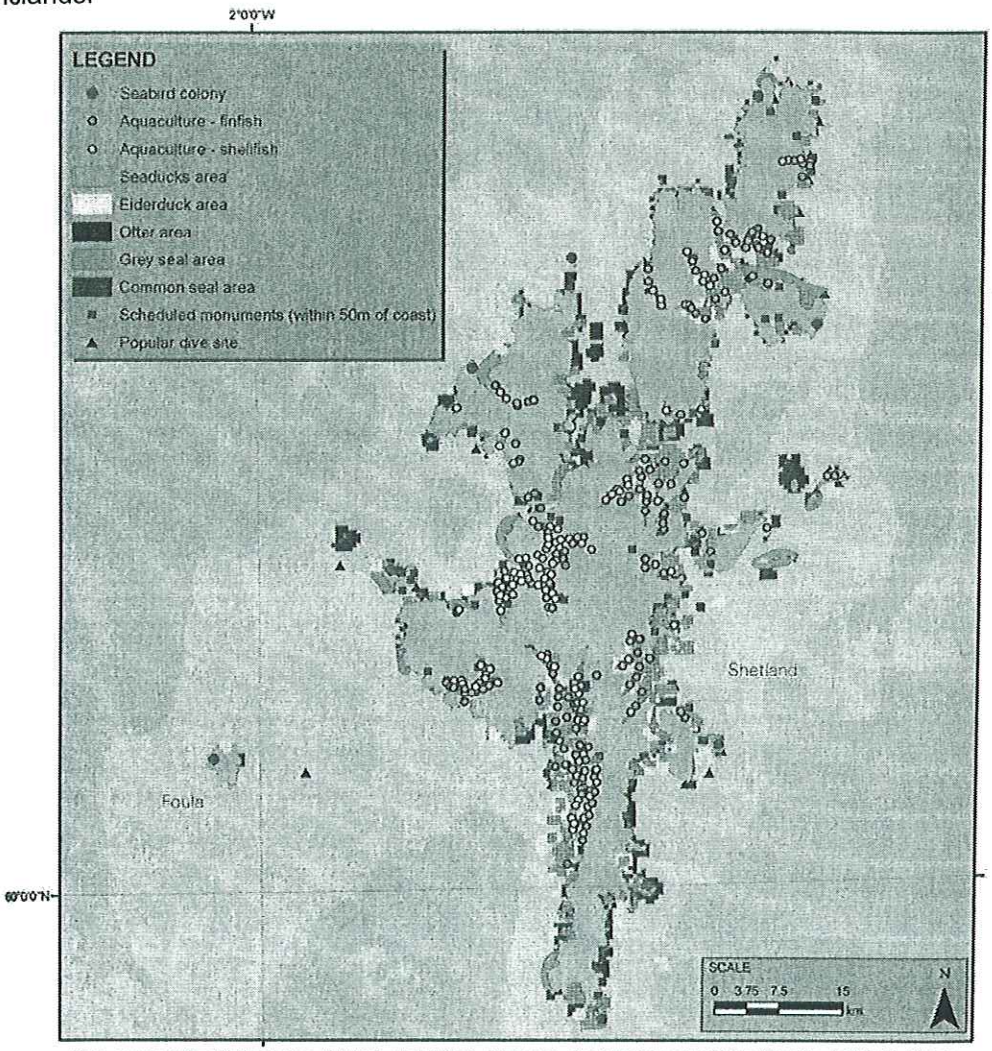
There are a number of seabird breeding colonies along the west coast of the Shetland Islands, as well as overwintering seaduck and resident seabird populations. Likely impacts arising from an oil spill will principally be from the physical smothering effects of oil and contamination and potential degradation of habitats and feeding grounds.

The main breeding seabird colonies of the Shetland Islands are listed below:

Map Ref.	Site Code	Name	Category	Qualifying Feature
Special Protection Areas				
SPA1	8512	Hermaness, Saxa Vord and Valla Field	Birds - aggregations of breeding birds	Breeding birds include: Fulmar, Gannet, Great skua, Guillemot, Puffin and Red-throated diver.
SPA2	8563	Otterswick & Graveland	Birds - aggregations of breeding birds	Breeding birds include the Red-throated diver
SPA4	8568	Ramna Stacks and Gruney	Birds - aggregations of breeding	Leach's petrel
SPA5	8564	Papa Stour	Assemblages of breeding birds	Breeding birds include: Arctic tern and Ringed plover
SPA6	8345	Papa Stour	Inshore sublittoral rock (Marine) Littoral rock (Marine)	Reefs Sea caves
SPA7	8393	The Vadills	Inshore sublittoral sediment (Marine)	Lagoons

Special Areas of Conservation				
SAC 8	8345	Papa Stour	Inshore sublittoral rock (Marine) Littoral rock (Marine)	Reefs Sea caves
SAC6	8370	Ronas Hill - North Roe	Standing open water and canals Inland rock Montane habitats Bogs (Upland) Standing open water and canals Dwarf shrub heath (Upland) Dwarf shrub heath	Acid peat-stained lakes and ponds Acidic scree Alpine and subalpine heaths Blanket bog Clear-water lakes or lochs with aquatic vegetation Dry heaths Wet heathland with cross-leaved heath
Sites of Special Scientific Interest				
SSSI 1	8108	Valla Field	Birds - aggregations of breeding birds	Breeding birds include: Red-throated diver, Great skua
SSSI 2	1545	Tonga Greff	Mineralogy	Mineralogy of Scotland
SSSI 3	776	Hermaness	Birds - aggregations of breeding birds Supralittoral rock (Coast) Mineralogy	Breeding birds include: Gannet, Great skua, Guillemot and Puffin Maritime cliff Mineralogy of Scotland
SSSI 16	1111	Lunda Wick	Mineralogy	Mineralogy of Scotland
SSSI 17	1686	Yell Sound Coast	Mammals	Otters present
SSSI 18	8110	Graveland	Birds - aggregations of breeding	Breeding birds include Red - throat divers
SSSI 19	265	Breckon	Vascular plants Standing open water and canals Supralittoral sediment (Coast) Supralittoral sediment (Coast)	Bog orchid Eutrophic loch Maritime cliff Sand dunes
SSSI 20	1217	Ness of Cullivoe	Structural and metamorphic geology	Metamorphic rocks
SSSI 25	1415	Sel Ayre	Quaternary geology and geomorphology	Quaternary of Scotland
SSSI 26	615	Eshaness Coast	Igneous petrology	Old Red Sandstone
SSSI 27	1589	Villians of Hamnavoe	Geomorphology	Coastal Geomorphology of Scotland
SSSI 28	1539	Tingon	Bogs (upland) Assemblages of breeding birds	Blanket blog Breeding birds include Red-throated diver.
RAMSAR sites				
RAM1	8453	Ronas Hill-North Roe and Tingon	Bogs (Upland)	Blanket Bog

The figure below demonstrates coastal sensitivities to oil spill in the Shetland Islands.



Data sources: Seabird colonies (Pollack et al, 2000), Dive sites, duck and mammal data (Shetland SSMEI, 2010), Aquaculture sites (SEPA, 2009), Bathymetry (GEBCO, 2009), Scheduled monuments (Historic Scotland, 2010)

Site no.	Colony name	Primary species at colonies										
		Fulmar	Gannet	Kittiwake	Arctic tern	Guillemot	Razorbill	Great skua	Puffin	Leach's Storm-petrel	Storm Petrel	Others
1	Hermaness/Saxa Vord	*	*	*		*		*	*			Shag
2	Ramna Stacks/Gruney									*		-
3	Fetlar	*						*				Arctic skua
4	Ronas Hill and North Roe							*				-
5	Papa Stour				*							-
6	Foula	*		*	*	*	*	*	*	*		Shag, Arctic skua
7	Noss	*	*	*		*		*	*			-
8	Mousa				*						*	-
9	Sumburgh Head	*		*	*	*						-
10	Fair Isle	*	*	*	*	*	*	*	*			Shag, Arctic skua

Norwegian Coastline

The coast of Norway has many protected sites that are, in the main, designated for seabirds. Additional protected features include coastal mammals and geomorphological features of importance. Coldwater corals are also of importance, and these are most abundant in the northern waters of Norway. Sponges similarly are most common in northern waters although are also found off the southern Norwegian coast.

Regarding fish sensitivities, the southern Norwegian coastline is important as a spawning ground for Norwegian spring-spawning herring, whereas the northern coast is more important for North-East Arctic cod and Barents Sea capelin. In general, it has been concluded that the northern Norwegian Sea area (Lofoten-Barents Sea region) is more vulnerable to spills as a result of lower biodiversity and lower resilience than further south in the Norwegian Sea and in the North Sea.

The spill modelling predicts potential impacts on the Norwegian coast in the event of a spill from a worst case blowout. There is a 0-30% probability of oil persisting as far as the northern Norwegian coast, and by this time the predictions are that any slick will be a very patchy and of a thickness of under 1 micron, in constant exchange with droplets in the water column, and consequently very dispersed.

Commercial Shipping

There are numerous shipping routes passing through the area. Shipping activity in the area is relatively low in the area compared with other parts of the UK. Commercial traffic in the area typically comprises of vessels en route to and from Sullom Voe Terminal and vessels in transit across the Atlantic.

Socio-economic Impacts

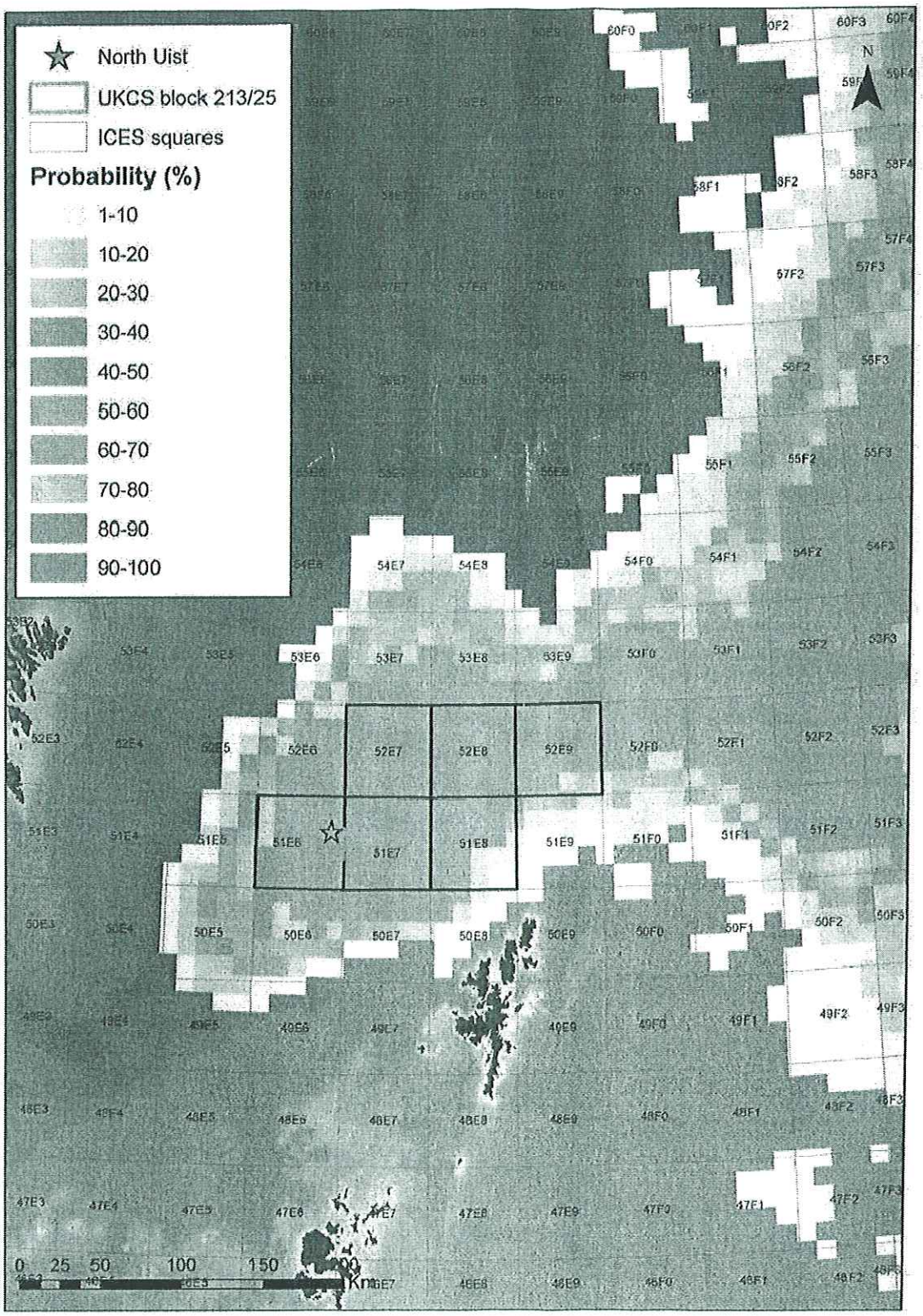
Oil spills can have a negative impact on commercial fisheries through the closure of fishing grounds, fouling of fishing gear and tainting of fish. For small spills these impacts are generally short-term and very localised and potentially much longer lasting for larger spills. Fishing and mariculture are very important industries on the Shetland Islands. Commercial fish landings in Shetland in 2009 totalled 373 million (Marine Scotland). These landings would have included landings outwith Shetland waters (Shetlands Islands Council, 2010). Mariculture operations are important along the west coast of the islands with salmon, mussels and oysters being cultivated. In 2009, 43,785 tonnes of salmon were produced and 6,300 tonnes of shellfish (Shetlands Island Council, 2010). These operations may be at risk in the event of a spill occurring and oil reaching these areas.

A major oil spill can have a localised effect on the fishing industry through the closure of areas affected by either surface oil, water column oil, or oil in sediments. Some commercially important species spawn in the vicinity of the Project or use the wider area as a nursery ground, although the immediate Project area is not a spawning or nursery ground for many commercially fished species.

Using ICES data for the value of fish landings from UK waters into UK ports, the value of fisheries that might be affected can be estimated, illustrated in the table and figure below.

Annual commercial fisheries value in ICES rectangles (£)		
ICES rectangle	Demersal	Pelagic
51E6	6,800	0
51E7	95, 800	0
51E8	2, 285,000	398,000
52E7	No data available	
52E8	115,000	0
52E9	708,000	92,000
Data Source : Scottish Government Fisheries Division (2011)		

Oil spills may also have a direct impact on the amenity value of the coastline due to the physical and visual impact of oiling. This effect is generally short lived as a large proportion of the beached oil is broken down by natural means or mechanical removal. Perception of damage may be of longer duration, particularly by potential tourists rather than the local population. The tourist industry represents a significant proportion of the Shetland Islands local economy value with walking, ornithology, sailing, fishing, archaeology and diving being the most important. There are a number of tourist attractions on the west coast of the islands, including houses, monuments and places of interest. There are also various water-based activities in this region with various leisure craft moorings and sea angling areas.


North Uist
UKCS block 213/25
ICES squares
Probability (%)
1-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
N
0 25 50 100 150 200 Km

NOp 5.3.3 Conservation

The *North Uist Exploration Well Environmental Statement* details information on the species most vulnerable to oil pollution in the North Uist area. The Environmental Statement also details information on the conservation areas in west and northwest of the Shetland Islands and the coastal sensitivities to oil spills in the Shetland Islands.

No Annex I habitats have been identified in the area of the development. The closest are the Wyville-Thomson Ridge and the Darwin Mounds, located approximately 225 and 260km respectively, southwest of the project site. It is not considered likely that the North Uist project will have any impact on these designated areas at this distance.

NOp 5.3.4 Shetland Island Coastal Sensitivity Study

A *Shetland Island Coastal Sensitivity Study* was conducted in 2010/11 to understand the environmental and socio-environmental sensitivities of the Shetland Islands.

Intentionally Left Blank

NOp 6. Modelling Outputs

NOp 6.1. Stochastic Modelling

This section identifies the worst case spill scenario in order to establish the potential impact within the marine environment and to aid decision-making on what and where response equipment is required. The oil type used in the modelling represents the most persistent hydrocarbon that may be released.

Although the probability of an oil spill occurring from the project site is considered to be extremely low, BP has chosen to model the worst case scenario in order to ensure that an appropriate and properly resourced response is available. The scenario chosen to demonstrate the worst case scenario is an uncontrolled blowout with a maximum possible flow rate of 11,923.92m³ per day (75,000bopd) with the most persistent oil type that is known from the local area (Clair oil). The models do not take into account any response strategies, for example application of dispersant or containment and recovery. Two stochastic models have been run – a subsea release, and a surface release in compliance with DECC requirements. These have been used to illustrate percentage probability of surface oiling. An explanation for the figures used and additional deterministic modelling has been detailed within the *Justification Document*.

Stochastic modelling scenarios:

- **Scenario 1a**: North Uist Well blowout, subsea release. This scenario assumes the worst case blowout rate from the North Uist well. The volume modelled was 1,669,348.8m³ (496.83m^3/h for 3,360 hours) using Clair oil type.
- **Scenario 2a**: North Uist Well Blowout, surface release. This scenario assumes the worst case blowout rate from the North Uist well. The volume modelled was 119,239.2m³ (496.83m^3/h for 240 hours) using Clair oil type.