Perenco U.K. Ltd

Welland Field Decommissioning Environmental Statement

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Perenco U.K. Ltd

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NON-TECHNICAL SUMMARY

This Environmental Statement (ES) presents the findings of the Environmental Impact Assessment (EIA) undertaken by Perenco U.K. Limited (hereafter Perenco) for the decommissioning of the Welland field in the southern North Sea. The purpose of the EIA process is to:

- Integrate environmental considerations into the project planning and design activities;
- Achieve a high standard of environmental performance for the project;
- Consult with stakeholders and address their concerns;
- Demonstrate that the project is being implemented in the correct manner.

The EIA and ES have been carried out in accordance with the requirements of the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999, which require evaluation of projects likely to have a significant effect on the offshore environment and formal comment on the resulting ES.

Project Overview

Perenco U.K. Limited (Perenco) is planning to decommission the Welland infrastructure, which is located in Blocks 53/4a, 49/28a and 49/29b, of the southern North Sea

The Welland infrastructure to be decommissioned consists of;

- The Welland installation topsides and jacket,
- Three subsea Wellhead Protection Structures (WPS),
- 17.5 kilometres of 16″ gas export pipeline (between Welland and Thames, PL674), associated 3” MEG piggyback line (PL675) and three pipeline crossing points
- Three 8″ subsea flowlines (PL676, PL677 and PL678) approximately 18 kilometres in total
- Three 4″ subsea control umbilicals (PL679, PL680 and PL681) approximately 21.6 kilometres in total
- 128 concrete mattresses (43 flexible mattresses and 85 frond mattresses)

Well intervention and abandonment in the Welland field does not form part of the scope of work for the purposes of this environmental impact assessment.

The Existing Environment

The Welland field is located in Blocks 53/4a, 49/28a and 49/29b of the southern North Sea, approximately 72 kilometres to the east of the nearest landfall on the Norfolk coastline and 26.5km from the UK/Dutch transboundary line (Figure 1.1). The Welland platform is located in Block 53/4a and three subsea tie-back wells are located in Blocks 53/4a and 49/29b. The Welland-Thames export pipeline and associated MEG piggyback line cross Blocks 53/4, 49/29 and 49/28.

Water depths within the Welland field range from 32 to 37 metres. Seabed sediments are predominately comprised of sand and slightly gravelly sand (*British Geological Survey, 1987*). A pipeline survey (*Noordhoek, 2009*) noted the seabed is generally flat and the entire area is covered with sand ripples.

Air and water quality within the area are typical of the southern North Sea. The marine fauna and flora are typical of areas of the southern North Sea with similar water depths and sediments.

Blocks 53/4a, 49/28a and 49/29b overlap potential spawning areas for mackerel, lemon sole, plaice, sprat and *Nephrops*. Additionally, these blocks overlap potential nursery areas for mackerel, lemon sole, cod and whiting.

The offshore waters of the southern North Sea are frequented by several seabird species mainly for feeding purposes. Species using the waters in the vicinity of the Welland field most notably include; kittiwake, fulmar, guillemot, black-backed gull, herring gull, common gull, Arctic skua, gannet and puffin (*UKDMap, 1998*). Seabird vulnerability to oiling in Blocks 53/04, 49/28 and 49/29 is highest during February, March and December and is moderate to low throughout the remainder of the year. Vulnerability in the surrounding blocks is also high in February, March and December.

Five species of cetacean have been recorded in the southern North Sea; minke whale, harbour porpoise, white-beaked dolphin, Atlantic white-sided dolphin and killer whale (*Smith, 1998*). Atlantic white-sided dolphins are the only other species to have been sighted – albeit in extremely low numbers – in the southern North Sea (*JNCC, 2003*). Of these species, only white-beaked dolphins and harbour porpoise have been sighted in the vicinity of the Welland field. White-beaked dolphins have been sighted in low numbers in March and April, and harbour porpoise have been sighted in low numbers in March, from May to September and in December.

The Welland facilities are approximately 8 kilometres outside the boundary of the North Norfolk Sandbanks possible Special Area of Conservation (pSAC). The North Norfolk Sandbanks are a series of ten main sandbanks and associated fragmented smaller banks formed as a result of tidal processes. The closest main sandbank to the Welland facilities is the Welland Bank, located approximately 1 kilometre to the west.

Sabellaria reefs are present offshore in the southern North Sea and are commonly found in the vicinity of shallow sandbanks. The Saturn *Sabellaria spinulosa* biogenic reef is located approximately 64 kilometres north-north-west from the Welland facilities in Block 48/20. No evidence of reefs has been found in the Welland area.

Decommissioning operations can potentially interfere with commercial fishing activities. The Welland field lies within ICES rectangles 34F2 and 35F2. The highest tonnages landed from this area by all vessels are demersal species including sole, plaice, cod, dabs and skates and rays. Other species include whelks, flounder, turbot, and brill, but these are landed in considerably lower numbers. Demersal fish are taken by trawlers and fixed gear fishermen, using fixed nets, longlines and trawls, however the majority of static gear activity in the area occurs to the west of the Welland field in ICES rectangles 34F1 and 35F1.

During the decommissioning programme, vessels involved in decommissioning operations will be a potential hazard to shipping. The volume of shipping traffic within the southern North Sea is relatively high, due to the presence of a number of international ports within the region. Major ports within this region include Hull, Grimsby and Great Yarmouth.

The key environmental sensitivities (summarised in Table 1.1 below) identified during this environmental impact assessment are:

- Fish spawning area for mackerel, lemon sole, plaice, sprat and *Nephrops*, with peak spawning periods in January and February and from May to July;
- Fish nursery area for mackerel, lemon sole, cod and whiting;
- Highest seabird vulnerability to oiling is in December;
- Cetacean numbers are low compared to areas in the north, with low densities of harbour porpoise from March to September and in December. Low numbers of white-beaked dolphin sighted from March to May;
- Welland infrastructure approximately 8 kilometres from the boundary of the North Norfolk Sandbanks dSAC;
- Shipping densities in the area of the Welland field are relatively high;

- Fishing effort within Blocks 53/4a, 49/28a and 49/29b is relatively low, mainly targeting demersal species. Peaks in activity in terms of hours fished have been recorded between January and March and between June and September.

Table 1.1. Seasonal Environmental Sensitivities in the Vicinity of the Welland Field

Activity in Blocks 53/4a, 49/28a, 49/29b, surrounding waters and adjacent coast													
Component	**Abundance/Activity**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Plankton	Phytoplankton and zooplankton												
Benthic Fauna	Benthic faunal communities												
Fish Spawning	Mackerel							**N**	**N**	**N**	**N**		
	Lemon sole						**N**	**N**	**N**	**N**	**N**	**N**	
	Plaice												
	Sprat												
	Nephrops												
	Cod			**N**	**N**	**N**	**N**						
	Whiting				**N**	**N**	**N**	**N**	**N**				
Seabirds	Blocks 53/4a, 49/29b and 49/27 vulnerability to oiling	**4**	**3**	**3**	**4**	**3**	**4**	**4**	**3**	**4**	**3**	**4**	**2**
Cetaceans	Harbour porpoise abundance												
	White-beaked dolphin abundance												
Resource Users	Commercial fishing (ICES rectangles 34F2 & 35F2)												
	Shipping and ports												
	Military Activity												
	Oil and gas activity (inc. pipelines / cables)												
	Dredging and dumping												
	Protected Sites												
	Tourism, recreation & leisure activities												

Numbers refer to the seabird vulnerability index used by JNCC (1999) ranging from highest vulnerability (1) to lowest (4).

Coastal occurrence			Activity in Block 53/4a, 49/28a and 49/29b and surrounding waters				
Peak	Low	None	Peak	Moderate	Low	None	N Nursery

Hazards, Effects and Mitigation Measures

PERENCO

The environmental assessment carried out on the Welland Decommissioning facilities, as proposed by Perenco, indicates that the key hazards, resulting environmental effects and measures proposed by Perenco to mitigate those effects are as follows:

ROUTINE HAZARDS		
Hazard & Effect(s)	**Effects and Mitigation**	**Residual Impact**
Physical Presence Disruption to other sea users	Total vessel time in the field is estimated to be approximately 303 days. The main structures (Topsides and Jacket) being decommissioned are located within the Welland exclusion zone and therefore decommissioning activities are not expected to impact on other shipping activities. However, the Subsea Wellhead Protection Structures are located in a shipping lane and although they would not normally impact shipping, during structure removal and pipeline cutting and burying there will be an impact. Any interference with fishing will be limited to temporary localized restrictions around the HLV, DSV, and PSVs, as appropriate. Prior to operations commencing, the appropriate notifications will be made & maritime notices posted. All vessel activities will be in accordance with national & international regulations. Appropriate navigation aids will be used to ensure other users of the sea are made aware of the presence of vessels.	The presence of vessels in the field is expected to have only a limited effect on third parties. Existing shipping routes in the area give due consideration to existing platform exclusion zones, however there will be a potential impact to the navigation of vessels in this area from the decommissioning of the Subsea Wellhead Protection Structures. This impact is therefore assessed as ***minor***. Leaving the infrastructure on the seabed (pipeline, MEG line, flowlines, umbilicals, pipeline crossing points and mattresses) has been assessed as having a ***minor*** impact on fishing activities in the area and this will be minimised by ensuring that all infrastructure remaining on the seabed is suitably buried. For infrastructure that will be removed from the seabed (jacket and subsea wellhead protection structures) the impact has been assessed as ***negligible/beneficial*** as there will be no obstruction to fishing activities compared with the current status.
Seabed Disturbance Disturbance will occur from the removal of jacket, subsea wellheads, pipe ends and the burial of pipe ends and mattresses.	Cutting of jacket and subsea wellhead protection structures pilings, and pipe ends will require divers and/or ROVs present near or at seabed level. This will increase sediment movement and water column turbidity, and subsequently re-deposition of fine sediment. Burial of cut pipe ends and any exposed mattresses will also involve disturbance of seabed sediments, with associated turbidity and re-deposition of fine sediments. Pipeline surveys in the Welland field have noted increasing depth of burial over time. Therefore it is expected that burial will only be necessary for newly disturbed infrastructure with the result that the area disturbed will be a small percentage of the total infrastructure footprint.	The impact on seabed fauna has been assessed as ***negligible***. Benthic communities found in the area of the proposed development are typical of those found over wide areas of the southern North Sea and the effects will be localised. No new materials will be added to the seabed (e.g. rock dump) as part of the planned decommissioning operations.
Marine Discharges Will include discharge of treated seawater, MEG, hydraulic fluid and residual hydrocarbons.	The Welland export pipeline has been left filled with approximately 1,828 m^3 of treated seawater (containing approximately; 350kg (191 mg/l) of biocide Bactron B1710, 250 kg (138mg/l) of oxygen scavenger OS-2 and 390 kg (213 mg/l) of corrosion inhibitor Cortron CP2000). During the decommissioning process there is the potential for some of the treated seawater to be released to the marine environment. The export pipeline currently also contains approximately 90 m^3 of high-viscosity pills (comprised of 2,475 kg (40:1) of GW-37	***Negligible*** for all three options. Due to the low volume of the discharges, the nature of the chemicals (taking into account any reduction in efficacy) and the anticipated rapid dilution and dispersion, all impacts are predicted to be short-term and localised.

ROUTINE HAZARDS		
Hazard & Effect(s)	**Effects and Mitigation**	**Residual Impact**
	viscosifier and 20 kg (222 mg/l) of biocide Bactron B1710). As these pills are contained behind mechanical pigs, no discharge is expected during decommissioning operations. The MEG piggyback line contains approximately 40 m^3 of 80:20 Monoethylene Glycol: water mix. The subsea control umbilicals also contain Monoethylene Glycol (approximately 11.3 m^3) There is potential for some of this to be discharged during decommissioning operations, limited only to that which may diffuse from the cut end of the pipe in the period between cutting and reburial below the seabed. The chemical risk assessment indicates that the discharge of treated seawater or Monoethylene Glycol is unlikely to have an impact on the receiving marine environment. It is also reasonable to expect the efficacy of the chemicals to have decreased after the prolonged period subsea (approximately 7years). The total volume of hydraulic fluid contained within the control umbilicals tubing has been calculated at 5.4 m^3. There is potential for some of this to be discharged to sea during decommissioning operations, limited only to that which may diffuse from the cut end of the pipe in the period between cutting and reburial below the seabed. A conservative risk calculation (using the Osborne-Adams model) indicates that this discharge is not expected to have a significant impact on the surrounding marine environment. A PON15C chemical permit will be in place to authorise all planned chemical discharges where required. The Welland export pipeline has been flushed, to an oil in water content of 77 - 155 ppm and the three 8" flowlines to 17 – 83 ppm Any release will be limited only to that which may diffuse from the cut end of the pipe in the period between cutting and reburial below the seabed and will be governed by a permit under the Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 where required. The remaining inventory of hydrocarbons (618 litres in the 16" export pipeline and 106 litres in the three 8" flowlines) will ultimately be released as the pipeline corrodes.	
Noise & Vibration Noise is thought to have the potential to disturb or confuse cetaceans	Noise will be generated from machinery vibrations and from the power generators. The vessels that will be used to support the decommissioning operations will maintain their position by using thrusters. The cutting of structures offshore has been limited but this will require use of large vessels to lift platform infrastructure. However this will reduce the	Studies indicate effects are likely to be ***negligible*** (for fish) to ***minor*** (for cetaceans)**.** In addition, densities of marine mammals in the vicinity of the development are relatively low.

ROUTINE HAZARDS		
Hazard & Effect(s)	**Effects and Mitigation**	**Residual Impact**
	time spent in the field (compared to cutting in-field). Pipelines and mattresses will remain with minimum disturbance further reducing time spend in the field.	
Atmospheric Emissions Emissions from vessels required for the decommissioning activities.	Power generation emissions during decommissioning activities will be minimised by advanced planning to ensure efficient operations; well maintained and operated equipment and generators and regular monitoring of fuel consumption. Perenco will ensure that contract specification and control processes require all equipment and generators to be well maintained and operated.	There will be a ***negligible*** local effect although emissions from gas combustion will contribute towards global greenhouse gas emissions.
Energy Use Energy used by vessels carrying out decommissioning operations, required for recycling or required to manufacture material left *in situ* from new	The total energy use figure for the selected options is approximately 543,593 Gj.	Depletion of non-renewable resources.
Solid Wastes Wastes will include scrap metal, plastics and coatings.	Perenco will ensure that, in order to minimise the impact on landfill resource, the amount of recovered material sent for recycling will be maximised as far as technically and financially viable.	***Negligible.*** Wastes will be recycled where practicable.

NON-ROUTINE HAZARDS	
Potential Spill Source	**Prevention & Mitigation Measures Planned**
Vessel grounding, collision or explosion resulting in total loss of cargo.	All vessels will comply with IMO/MCA codes for prevention of oil pollution, and will also have onboard Shipboard Oil Pollution Emergency Plans (SOPEPS). An approved Welland Field Oil Pollution Emergency Plan (OPEP) has been developed in accordance with the Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998.

Environmental Management

The identification and control of environmental impacts associated with all Perenco activities and operations form an integral part of managing the business. Potential impacts are identified during the planning stages of all operations, and the risks assessed and managed via a structured process, which is embedded in Perenco's HSE Management System (MS). The MS complies with corporate requirements and international and UK standards.

The application of the MS during the Welland decommissioning project ensures that Perenco's Health, Safety and Environmental (HSE) Policy is followed and that the Company's responsibilities under all relevant regulations are met. This Environmental Statement documents the environmental assessment as applied to the Welland decommissioning project. During the assessment, Perenco has conducted informal consultation with DECC and NFFO and will continue to liaise with the Consultees outlined in Table 1.1.

Other key facets of the MS include effective contractor management, emergency preparedness and response, measuring, monitoring and reporting, and audit and review. The Perenco MS will be interfaced with the management systems of the main contracting parties participating in the Welland decommissioning project.

Conclusions

In conclusion, although there is expected to be some environmental impact during the decommissioning of the Welland infrastructure (53/4a, 49/28a and 49/29b), long term environmental impacts from the decommissioning operations are expected to be negligible. In addition, incremental cumulative impacts and trans-boundary effects associated with the planned decommissioning operations are expected to be negligible.

Abbreviations

boepd	barrels of oil equivalent per day
CEFAS	Centre for Environment, Fisheries & Aquaculture Science
CO_2	Carbon Dioxide
dB	Decibels
DCS	Document Control System
DECC	The Department of Energy and Climate Change
DP	Dynamic Positioning
DSV	Diving Support Vessel
DTI	Department of Trade and Industry
EIA	Environmental Impact Assessment
EMS	Environmental Management System
ES	Environmental Statement
GJ	GigaJoules
HLV	Heavy Lift Vessel
HR	Habitats Regulations
Hs	Significant Wave Height
HSE	Health, Safety and Environmental
HSE MS	Health, Safety and Environmental Management System
ICES	International Council for the Exploration of the Sea
ISO	International Organisation for Standardisation
JNCC	Joint Nature Conservation Committee
Kg	Kilograms
kHz	Kilohertz
km	Kilometres
LAT	Lowest Astronomical Tide
MARPOL	International Convention for the Prevention of Pollution for Ships (Maritime Pollution Convention)
MCA	Maritime and Coastguard Agency
MEG	Monoethylene Glycol
MFA	Marine and Fisheries Agency
mmboe	million barrels of oil equivalent
MS	Management System
NFFO	National Federation of Fishermen's Organisations
Nm	Nautical Miles
NNRs	National Nature Reserves
NOx	Oxides of Nitrogen
NO_2	Nitrogen Dioxide

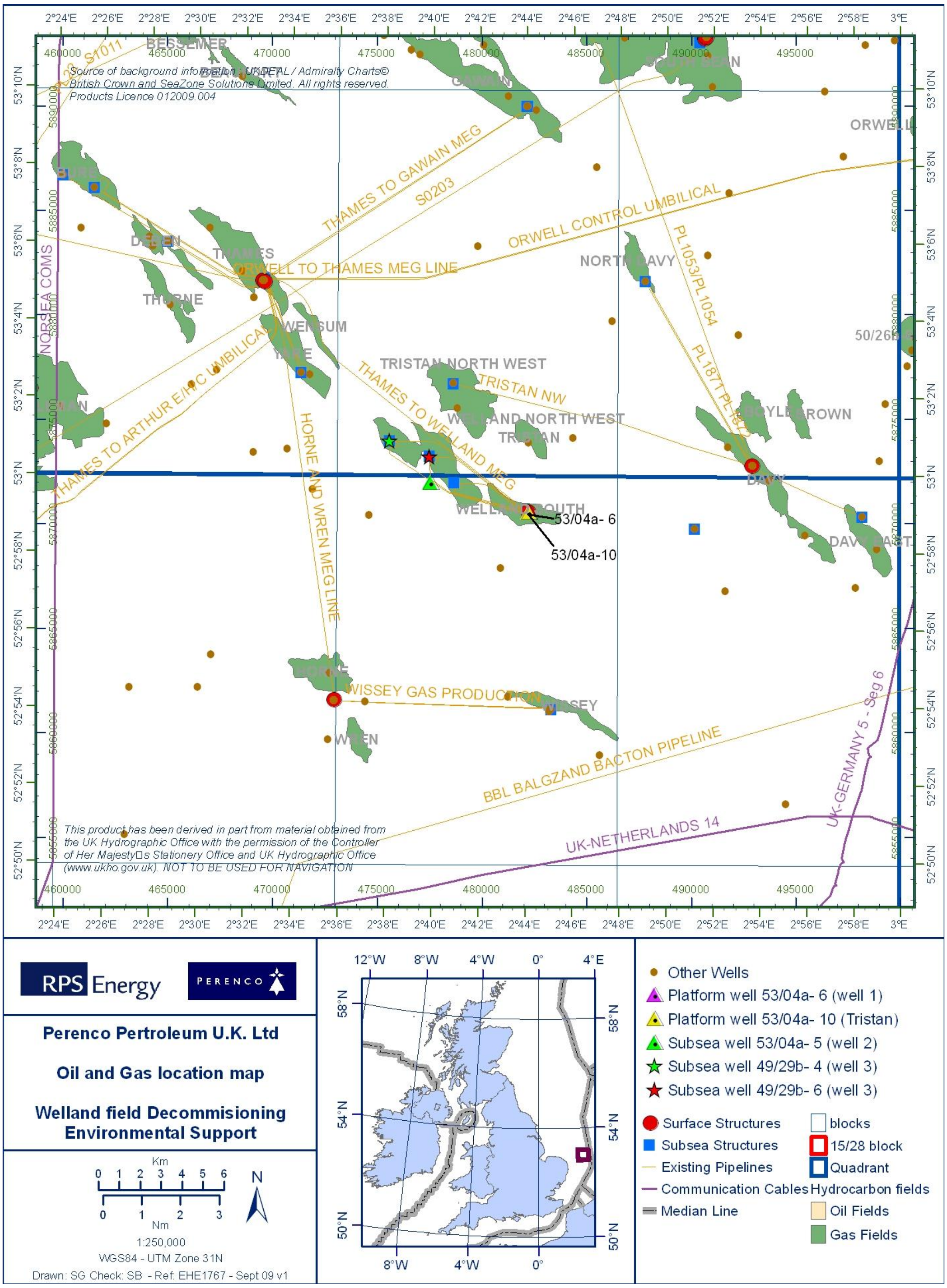
OCNS	Offshore Chemicals Notification Scheme
OMCR	The Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007
OMR	Offshore Marine Regulations
OPEP	Oil Pollution Emergency Plan
OSR	Oil Spill Response
PLONOR	Poses Little or No Risk
ppm	parts per million
PSV	Platform Support Vessel
pSAC	Possible Special Area of Conservation
QHSE	Quality, Health & Safety and Environmental
ROV	Remotely Operated Vehicle
SACs	Special Areas of Conservation
SOPEPS	Shipboard Oil Pollution Emergency Plans
SOx	Oxides of Sulphur
SPAs	Special Protection Areas
SSSI	Coastal Sites of Special Scientific Interest
UK	United Kingdom
UKCS	United Kingdom Continental Shelf

1 Introduction

1.1 The Project

The Welland field is located in the Southern Basin of the UK Continental Shelf, in Blocks 53/4a, 49/28a and 49/29b. The nearest landfall is approximately 72 kilometres west on the coast of Norfolk (Figure 1.1).

Figure 1.1 Location map



The Welland field was discovered by Arco in 1983 with Annex B approval granted in 1989. The Welland platform was installed in 1990. The Welland field is comprised of two platform wells and three subsea wells. Gas from the Welland field was fed into the Thames processing facilities. The Thames complex also provided all the processing and utilities required for the operation of Welland. A requirement to use the Welland riser on Thames to accommodate the Arthur wells has meant the Welland field has been closed in since 2002 and is currently blown down awaiting decommissioning.

1.2 The Applicant

Perenco U.K Limited (Perenco) is an independent oil and gas, exploration and production company, currently operating in Belize, Brazil, Cameroon, Colombia, Democratic Republic of the Congo, Ecuador, Egypt, Gabon, Northern Iraq, Guatemala, Peru, Tunisia, Turkey, Venezuela and the UK. Currently, Perenco-operated production is approximately 240,000 barrels of oil equivalent per day (boepd) with over 180,000 boepd net to the Perenco Group, and an estimated 608 million barrels of oil equivalent (mmboe) of reserves.

In the southern North Sea Gas Basin, Perenco operates seventeen fields which include: Indefatigable, Bell, East Leman, Davy, Thames, Trent, Tyne, Pickerill, and Waveney fields, with associated pipelines and onshore processing facilities including the Bacton Terminal.

The gross gas production for these fields is approximately 250 million cubic feet per day, or about 37,000 barrels of oil equivalent per day over a total production acreage of 1,767 square kilometres.

1.3 Environmental Impact Assessment

1.3.1 Scope

This Environmental Statement documents the results of an environmental impact assessment of the proposed decommissioning project. The environmental impact assessment carried out has assessed the potential impacts on the existing environment in the southern North Sea for all phases of the project:

- Mobilisation and preparation of infrastructure for decommissioning
- Decommissioning of Welland installation topsides and jacket
- Decommissioning of three subsea wellhead protection structures
- Decommissioning of 16″ export pipeline and associated 3″ MEG piggyback line
- Decommissioning of three 8″ subsea flowlines and three 4″ subsea control umbilicals
- Decommissioning three pipeline crossing points and 128 concrete mattresses
- Post-decommissioning seabed surveys and final fate of decommissioned material (i.e. left *in situ,* recycled, disposed of to landfill, etc.)

1.3.2 Legislative Framework

Approval of a Decommissioning Programme is required under the Petroleum Act 1998. Although there is currently no statutory requirement to undertake an Environmental Impact Assessment (EIA) at the decommissioning stage, the decommissioning programme will need to be supported by an EIA.

The Environmental Statement (ES) originally submitted for the development under the EIA regulations requires the applicant to consider the long-term impacts of the development and these include the impacts arising from decommissioning. This detailed assessment is deferred until closer to the time of actual decommissioning and is submitted as part of the decommissioning programme.

A number of associated regulations should also be taken into consideration during the development of the decommissioning programme to identify if the programme has an impact or additional permits need to be obtained or surrendered. The list below identifies the key regulations applicable to the Welland decommissioning activities described in this document.

The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001

DECC in consultation with the Joint Nature Conservation Committee (JNCC) and/or the Countryside Agencies (Natural England, Countryside Council for Wales and Scottish Natural Heritage), will decide whether the proposals are likely to have a significant effect on the habitats and species covered by the regulations, and whether there is a requirement to undertake an 'Appropriate Assessment'.

The Offshore Chemical Regulations 2002

Where it is proposed to use or discharge chemicals during the decommissioning of an offshore installation or pipeline, the Operator will need to apply to DECC for the appropriate permit. Chemicals will be permitted using a PON15C, where required.

The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005

These regulations prohibit the discharge of oil into the sea from an offshore installation or pipeline, except under authority of a permit. It will be necessary to make provision for the removal and recycling of oil recovered during the decommissioning, but it will be possible to apply for a permit for the discharge or reinjection of certain types and quantities of oil if necessary.

The Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998

Under these regulations operators of offshore oil and gas installations and pipelines are responsible for preparing and submitting an Oil Pollution Emergency Plan (OPEP) to DECC. The expectation is that the OPEP will cover all activities where there is a risk of a hydrocarbon spill, including activities relating to decommissioning. This may be achieved by the incorporation of decommissioning activities into the existing field OPEP or by producing a decommissioning specific OPEP.

This Environmental Statement has been prepared to ensure compliance with the requirements of this legislation and to meet Perenco's corporate SHE Policy. Perenco will ensure that all necessary permits and consents are obtained for the Welland Decommissioning project.

1.3.3 Methodology and Requirements

Environmental assessment is an important management tool ensuring that environmental hazards and effects are identified and evaluated and that appropriate control measures are implemented. It is a process that balances environmental considerations with business priorities.

The assessment process is comprised of four main stages:

1) Characterisation of the existing environment and identification of the environmental hazards associated with the activity;

2) Assessment of the magnitude and significance of the hazards and effects;

3) Implementation of control techniques to eliminate or lessen the severity of the effects and to manage the hazard;

4) Review and, where necessary, develop plans and procedures to manage the consequences of accidental events.

1.4 Consultation

Prior to submission of this ES to the Department of Energy and Climate Change (DECC) and the formal consultation process, informal consultations have been held with representatives of the

Department of Energy and Climate Change and the National Federation of Fishermen's Organisations (NFFO), to present an overview of the proposed decommissioning project.

1.5 Structure of the Report

The report is presented in seven main sections.

Section 1	Introduction – provides an introduction to Perenco and gives an overview of the environmental impact assessment process.
Section 2	The Proposed Project – describes the various options reviewed and preferred for the decommissioning process.
Section 3	Existing Environment – describes the background environmental characteristics and the socio-economic activities in the area.
Section 4	Environmental Hazards, Effects and Mitigation Measures – defines the potential hazards from the proposed development, assesses the potential impacts and details the control measures to be implemented to limit the potential impacts.
Section 5	EMS – describes environmental management controls in place to ensure implementation of commitments made in EIA, provides an outline of how Perenco will manage the project to ensure protection of the environment during the works.
Section 6	Conclusions - Section includes conclusions of the Environmental Statement.

In addition, the Environmental Statement includes a non-technical summary of the environmental assessment, highlights its main conclusions and provides a list of references used to obtain data and information to support the statement.

2 The Proposed Project

This section outlines the project scope and describes the preferred decommissioning options selected through the comparative assessment process. The full range of options considered and further details on the comparative assessment process are presented in the Welland Decommissioning Comparative Assessment (*RPS, 2010*).

2.1 Introduction

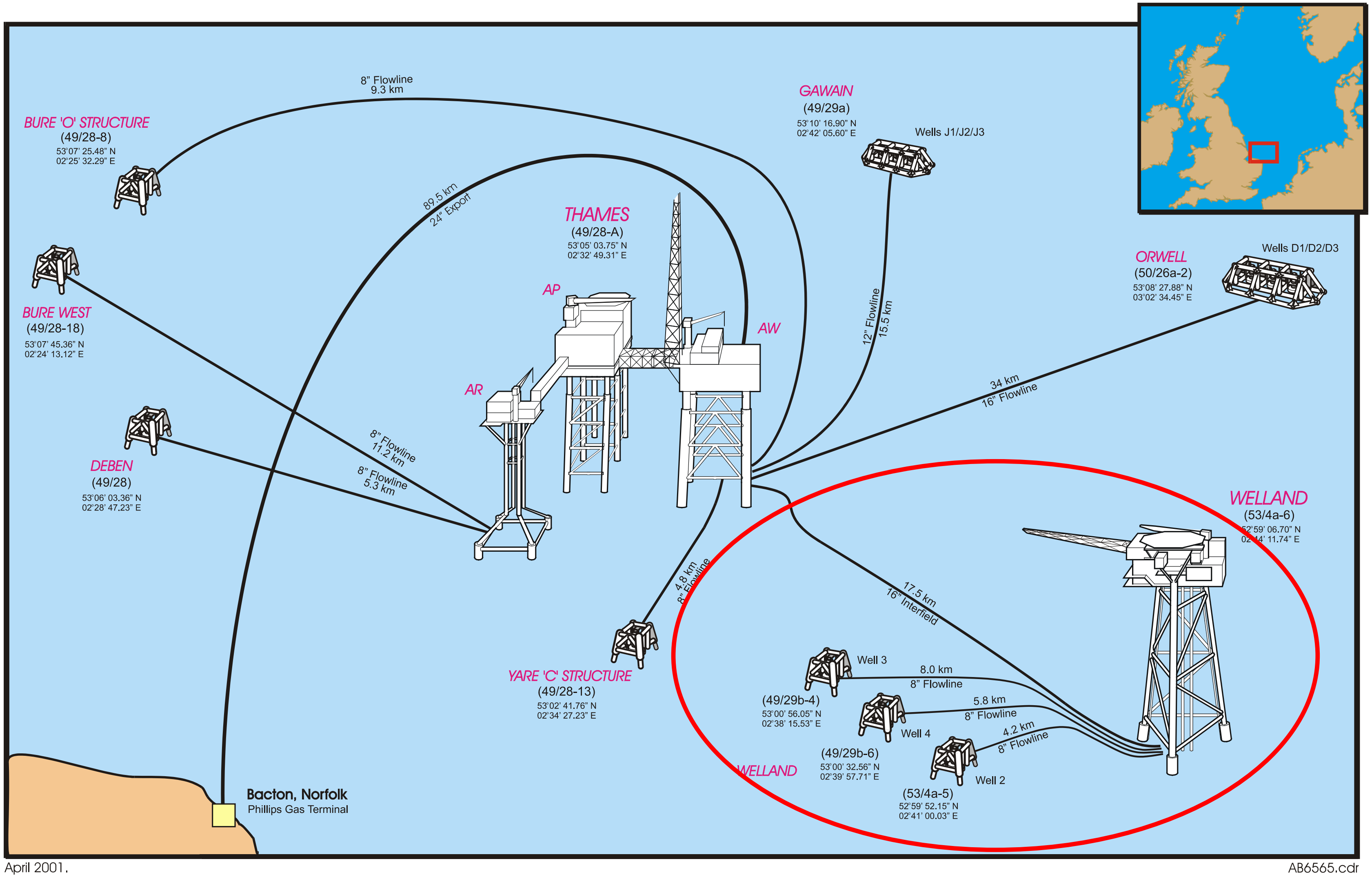
Perenco is planning to decommission the Welland infrastructure, which is located in Blocks 53/4a, 49/28a and 49/29b of the southern North Sea, approximately 72 kilometres east of the Norfolk coast (see Figure 2.1).

The Welland field was discovered by Arco in 1983 with Annex B approval granted in 1989. The Welland platform was installed in 1990. The Welland field is comprised of two platform wells and three subsea wells. Gas from the Welland field was fed into the Thames processing facilities. The Thames complex also provided all the processing and utilities required for the operation of Welland. The Welland riser on Thames was disconnected to accommodate the Arthur wells and therefore the Welland field was closed-in during 2002 and is still currently blown down awaiting decommissioning.

The proposed project covers the decommissioning of;

- The Welland platform, which comprises a three-legged steel jacket and topsides installed in 1990;
- Three subsea wellhead protection structures;
- The Welland-Thames 16″ export pipeline (PL674, approximately 17.5 km) and associated 3″ MEG piggyback line (PL675, approximately 17.5 km) including pipeline crossing points;
- Three 8″ subsea flowlines (PL676, PL677 and PL678, approximately 18 km in total) and three 4″ subsea control umbilicals (PL679, PL680 and PL681, approximately 18 km in total);
- 128 concrete mattresses (43 flexible mattresses and 85 frond mattresses).

Figure 2.1 Welland Facilities and surrounding Perenco operations (infrastructure to be decommissioned circled in red)

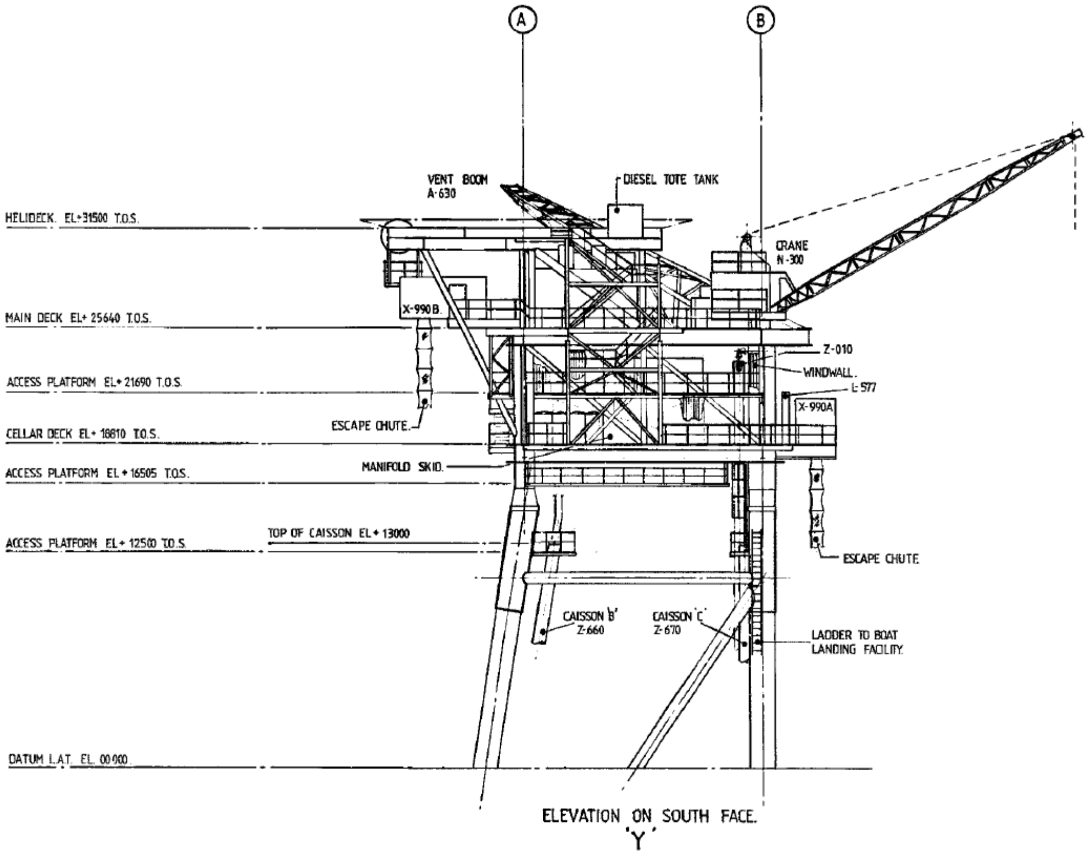


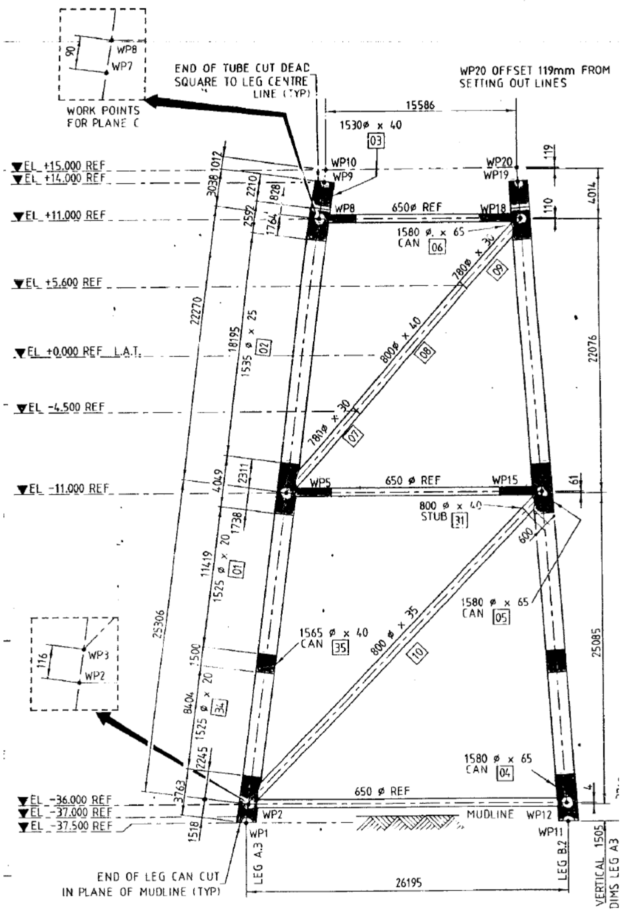
2.1.1 Welland Platform

The Welland platform is comprised of a three-legged steel jacket and topsides installed in 1990 (see Figure 2.2). Although there has been no production from the Welland field since 2003, a survey in 2008 (*Ot2k, 2008*) investigated the cathodic protection of the structure and found it to be adequately protected from external corrosion.

The jacket is anchored to the seabed by piles. If the jacket is to be removed as part of the decommissioning program, the piles will need to be cut below the natural seabed level at such a depth to ensure that any remains are unlikely to become uncovered. It may be possible to cut the piles on their internal surface via the internal access provided by the jacket leg. This would reduce disturbance to the seabed compared to making the cut on the external surface which would require exposing the piles to achieve the cut.

Figure 2.2 Welland Topsides and Jacket





2.1.2 Subsea Wellhead Protection Structures

There are three subsea wellhead protection structures that make up the Welland infrastructure that will be decommissioned. These steel structures (see Figure 2.3) are secured to the seabed by piles which will require cutting before the subsea wellhead protection structures can be removed. Unlike the piles used to anchor the platform jacket, the piles anchoring the wellhead protection structures can only be cut from an external surface, which would require removal of seabed sediments locally to provide access.

Figure 2.3 Welland Subsea Wellhead Protection Structure

2.1.3 Welland 16″ Export Pipeline, 3″ MEG Piggyback line and Pipeline Crossing Points

The 16″ Welland-Thames export pipeline is a concrete-coated steel pipeline. A 3″ MEG line is piggybacked (structurally attached) to the export pipeline. Table 2.1 provides further details on the pipelines.

Table 2.1 16" Export Pipeline & 3" MEG Piggyback Line Specification

Pipeline	Number	Diameter	Length, km	Type of construction
Welland - Thames Export line	PL674	16"	17.5	X60 Grade Steel, 65mm concrete & 6 mm coal tar
Welland - Thames MEG line	PL675	3"	17.5	X52 Grade Steel & 0.5mm Fusion Bonded Epoxy

Pipeline surveys have been carried out at the Welland field in 1991, 1994, 2006 and 2009. Comparison of these surveys indicates that the pipeline depth of burial is increasing (visibility to survey is decreasing) probably due to deposition of sand and natural burial through tide and currents (*Welland Pipeline Infrastructure Analysis – Perenco internal document*). It is also considered that the weight increase caused by flooding the main export line in 2003 has encouraged the pipeline to sink.

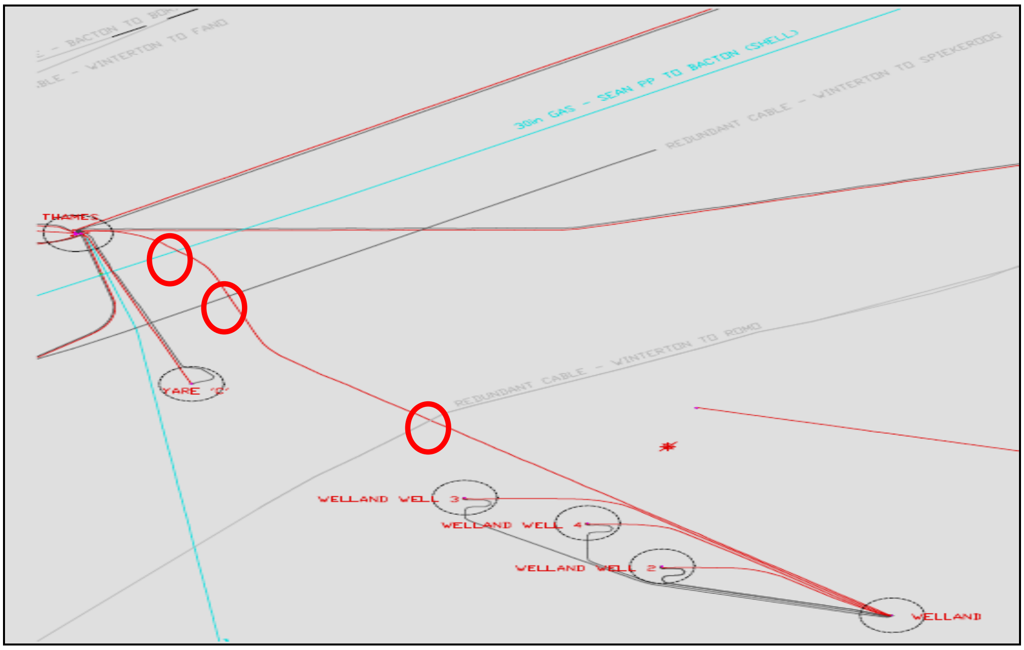
The current status of the pipelines, flowlines and umbilicals as of the 2009 survey (*Noordhoek, 2009*) is as follows:

- No evidence of original trenching,

- The pipelines, flowlines and umbilicals are buried along their whole length,
- Depth of burial varies from 0.5m to over 1.5m throughout field,
- Only one short exposed section on 16” export pipeline (PL274) of 7m length,
- There are no free spans on pipelines, flowlines or umbilicals,
- Various rock dump locations were noted on pipelines totalling 1,810m in length,

There are three crossing points along the export and MEG pipelines; two crossings over redundant subsea cables and one over the 30″ Sean-Bacton export line (gas) (see Figure 2.4).

Figure 2.4 Welland 16"Export Pipeline and MEG Piggyback Line Crossing Points (circled in red)



2.1.4 Flowlines and Control Umbilicals

Three 8″ subsea flowlines connect the three subsea wellheads to the Welland platform. A further three 4″ subsea control umbilical lines (incorporating wellhead controls and MEG lines within them) run between the subsea wellheads and the Welland platform. The flowlines and umbilicals are protected by concrete mattresses and rock dump. Details on the specifications of the flowlines and umbilicals are provided in Table 2.2.

Table 2.2 Subsea Flowlines & Umbilicals Specification

Flowlines & Umbilicals	Number	Diameter	Length, km	Type of construction
Well 2 Subsea flowline	PL678	8"	4.2	X60 Grade Steel , 42mm Concrete & 550 microns Fusion Bonded Epoxy
Well 2 Subsea control umbilical	PL681	4"	4.2	Core of shielded electrical power cables surrounded by a shielded communications cable, six thermoplastic hoses and lead fillers. Cores sheathed in polythene & further protected by armoured (steel wire) jacket and covered in an outer polythene sheath.
Well 3 Subsea flowline	PL676	8"	8.0	X60 Grade Steel , 42mm Concrete & 550 microns Fusion Bonded Epoxy
Well 3 Subsea control umbilical	PL679	4"	8.7	Core of shielded electrical power cables surrounded by a shielded communications cable, six thermoplastic hoses and lead fillers. Cores sheathed in polythene & further protected by armoured (steel wire) jacket and covered in an outer polythene sheath.
Well 4 Subsea flowline	PL677	8"	5.8	X60 Grade Steel , 42mm Concrete & 550 microns Fusion Bonded Epoxy
Well 4 Subsea control umbilical	PL680	4"	8.7	Core of shielded electrical power cables surrounded by a shielded communications cable, six thermoplastic hoses and lead fillers. Cores sheathed in polythene & further protected by armoured (steel wire) jacket and covered in an outer polythene sheath.

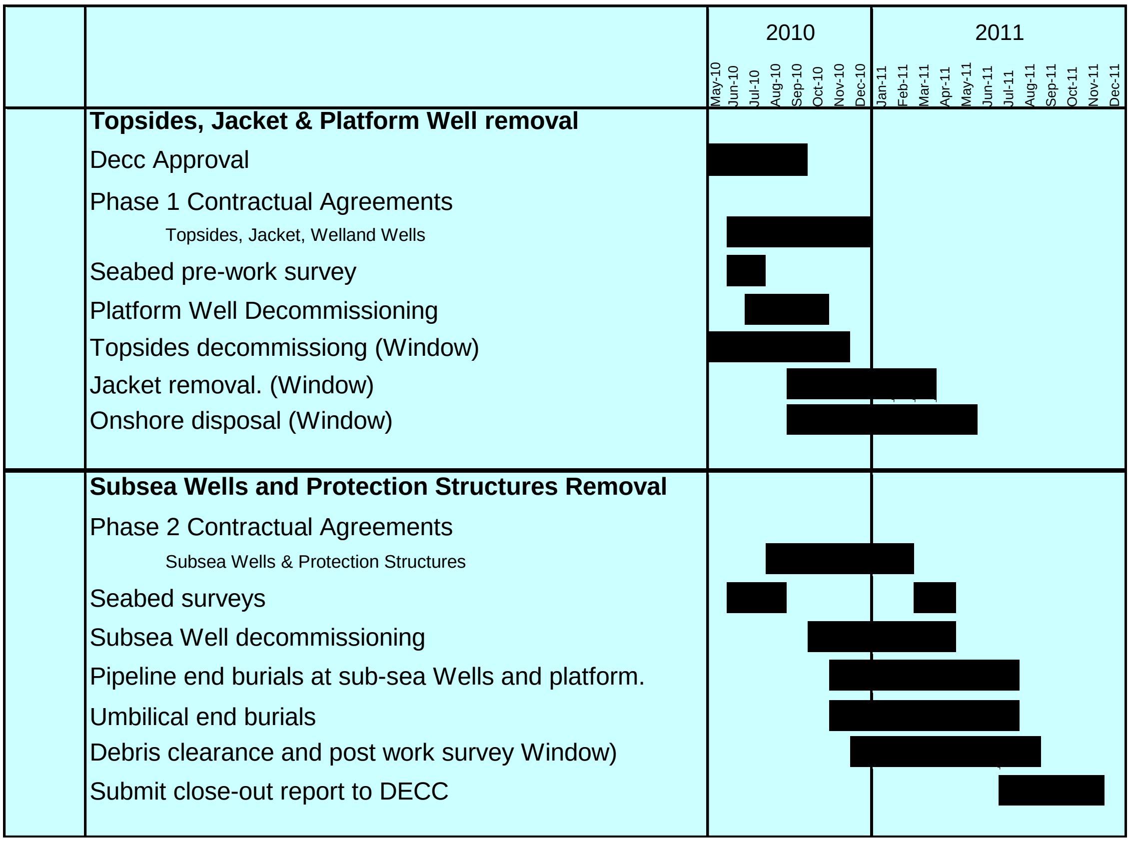
2.1.5 Mattresses

As part of the protection and stablisation of the pipelines, flowlines and umbilicals, 128 concrete mattresses have been placed over Welland infrastructure. The mattresses comprise 43 flexible mattresses and 85 frond mattresses mostly installed at pipeline approaches to other infrastructure (for example at approaches to wellheads, the Welland platform and at pipeline crossings).

2.2 Project Schedule

Perenco intend to undertake decommissioning activities in the summer months from 2010 to 2011. Topsides decommissioning may commence in 2010 dependent on a removals contract being in place. The outline schedule for the project is shown in Figure 2.2, below.

Figure 2.2 Outline Decommissioning Project Schedule



2.3 Inventory of Materials

In order to assess the fate of decommissioned infrastructure it is important to understand what materials are to be decommissioned. This data is summarised in Table 2.1.

Table 2.1 Welland Infrastructure Materials Inventory

Category	Main Source	Material	Quantity	Recyclable
Metals	Topsides	Steel (Fe)	942 tonnes	Yes
	Jacket & Piles	Steel (Fe)	843.1 tonnes	Yes
	Pipelines	Steel (Fe)	3,782 tonnes	Yes[1]
	Subsea Frames	Steel (Fe)	210 tonnes	Yes
	Umbilicals	Steel (Fe)	190 tonnes	Yes[2]
	Process and instrumentation	Stainless Steel (Fe, Ni)	9.3 tonnes	Yes
	Helideck	Aluminium (Al)	17.05 tonnes	Yes
	Jacket Anodes (2-5% Zinc)	Aluminium, Zinc, Indium (Al, Zn, In)	26.9 tonnes	No
	Pipeline Anodes (2-5% Zinc)	Aluminium, Zinc, Indium (Al, Zn, In)	69.5 tonnes	No
	Topside electrical and instrumentation	Copper (Cu)	5 tonnes	Yes
	Umbilicals	Copper (Cu)	9 tonnes	Yes[2]

Category	Main Source	Material	Quantity	Recyclable
	Umbilicals	Lead (Pb)	70 tonnes	Yes[2]
	Batteries	Lead, Nickel, Cadmium (Pb, Ni, Cd)	3 tonnes	Yes
Hydrocarbons	Pipelines	8″ flowlines & 3″ MEG piggyback line coating (FBE resin)	8.5 tonnes	No
		16″ pipeline coating (coal tar)	148.5 tonnes	No
Chemicals	Pipelines	Mono-ethylene glycol (MEG)	40 tonnes	No
	Pipelines	Treated Seawater (containing Bactron B1710, OS-2 and Cortron CP2000)	Bactron B1710 – 575 litres * OS-2 – 397 litres * Cortron CP2000 – 552 litres *	No
	Umbilicals	Mono-ethylene glycol (MEG)	11.3 tonnes	No
	Umbilicals	Hydraulic fluid (Castrol Transaqua HT)	5.4 tonnes	No
	Topsides & Jacket	Paint and coating (various material)	4.2 tonnes	No
Plastics	Topsides	Electrical and instrumentation (various)	41.5 tonnes	No[3]
	Umbilicals	Sheathing (various)	35 tonnes	No[2]
	Frond Mattresses	Polypropylene rope	42.5 tonnes	No[4]
Inert Materials	Mattresses (43)	Concrete	484.3 tonnes	No[5]
	Frond Mattresses (85)	Concrete	796.2 tonnes	No[5]
	Pipelines (coating)	Concrete	6,698 tonnes	No[1]
	Insulation cladding	Glass wool	1 tonne	No
	Pipeline cladding	Thermal blanket	0.5 tonnes	No

Note:

* Volumes of chemicals given in litres where relevant, to ensure consistency with reported data from Exxon Mobil.

[1] Pipelines that are concrete-coated require a large amount of processing to enable the steel to be recycled. If pipelines are retrieved to shore for recycling it is not guaranteed that recycling would prove the most cost-effective disposal option and the material may be disposed to landfill. Any concrete separated from the pipeline cannot be recycled due to a high residual salt content caused by saturation in seawater.

[2] Umbilicals contain potentially recyclable materials but due to the way in which the materials are integrated in construction a large amount of processing is required to separate materials for recycling. If umbilicals are retrieved to shore for recycling it is not guaranteed that recycling would prove the most cost-effective disposal option and the material may be disposed to landfill.

[3] Mixed plastics typically require a large amount of processing to separate them for recycling. If mixed plastics are retrieved to shore for recycling it is not guaranteed that recycling would prove the most cost-effective disposal option and the material may be disposed to landfill.

[4] Polypropylene ropes are expected to be too degraded for recycling. If retrieved it is expected they would be disposed of to landfill.

[5] Concrete recovered from subsea applications cannot be recycled due to a high residual salt content caused by saturation in seawater.

2.4 Preferred Decommissioning Options

The comparative assessment (*RPS, 2010*) of the available decommissioning options for the Welland field infrastructure was based on the following criteria:

- Safety,
- Environmental,
- Technical,
- Societal,
- Legal Compliance,
- Commercial.

An overview of the preferred decommissioning options is presented in Table 2.2. The environmental aspects considered during the comparative assessment process are presented in the following sections.

Table 2.2 Preferred Decommissioning Options for the Welland Field Infrastructure

Infrastructure	Selected Decommissioning Option
Jacket & Topsides	One-piece removal (Heavy Lift Vessel)
Subsea Wellhead Protection Structures	One-piece removal (Crane Vessel)
16″ Export Pipeline	Flush, Depressure & Leave *in situ*
3″ MEG Piggyback Line	Depressure & Leave *in situ*
8″ Subsea Flowlines	Flush, Depressure & Leave *in situ*
4″ Subsea Control Umbilicals	Depressure & Leave *in situ*
Pipeline Crossing Points	Leave *in situ*
Mattresses	Bury

2.4.1 Topsides & Jacket Decommissioning

In accordance with OSPAR decision 98/3, initial consideration was given to re-use of the topsides and jacket. However, internal reviews within Perenco, long term operational strategy requirements and external enquiries concluded that re-use is an unfeasible option at this time. The preferred method for the final removal of the topsides and jacket is in one piece using a Heavy Lift Vessel. This option allows re-use to be considered subsequently as the topsides and jacket will remain largely intact when taken onshore. Should re-use remain unfeasible, final decommissioning and recycling/disposal will take place onshore.

Table 2.3 Environmental Aspects Associated with Preferred Decommissioning Option for Jacket & Topsides

Jacket & Topsides	Description of Aspects
Chemical Discharge	All chemicals will be contained and shipped to shore for disposal/ reuse/ recycling. No discharge of chemicals offshore
Hydrocarbon Discharge	All hydrocarbons will be contained and shipped to shore for disposal. No discharge of hydrocarbons offshore
Seabed Disturbance	Localised seabed disturbance will occur when cutting piles. Use of Heavy Lift Vessel means no anchoring is required as HLV uses Dynamic Positioning. Additionally, it is expected that piles can be cut via the jacket internals thereby minimising seabed disturbance (compared with exposing piles by displacing seabed material to cut externally). Total duration for operations is expected to be 110 days.
Energy Usage	For comparison, energy use during the planned operations has been based on estimates of fuel consumption. Energy use has been estimated at approximately 280,000 GJ. Energy associated with recycling the steel and copper elements of the topsides & jacket is estimated at approximately 16,274.6 GJ.
Estimated Material Discarded at Sea	Decommissioning will involve removal of topsides and jacket to shore. Jacket must be separated from pilings in seabed (severed below the natural seabed level at such a depth to ensure that any remains are unlikely to become uncovered). Therefore the only material that will remain at sea will be that portion of the pilings left below the seabed. It is estimated that this represents <20% of the total quantity of material comprising the jacket and topsides.
Estimated Material Discarded to Landfill	It is estimated that less than 20% of the total quantity of material comprising the topsides and jacket brought ashore will be discarded to landfill. It is expected that the remaining material will be recycled or reused. As this selected decommissioning option involves the removal of topsides and jacket in one piece, there remains the potential for reuse should the opportunity arise before final dismantling onshore.

2.4.2 Subsea Wellhead Protection Structures

Re-use of the Subsea Wellhead Protection Structures (WPS) was considered as a disposal option. However, internal reviews within Perenco, long term operational strategy requirements and external enquiries concluded that is an unfeasible option at this time. This decision would be subject to re-assessment if a reuse opportunity was presented in the interim period before final decommissioning onshore. The preferred removal option for the WPS is using a crane vessel.

Table 2.4 Environmental Aspects Associated with Preferred Decommissioning Option for Subsea Wellhead Protection Structures

Subsea Wellhead Protection Structures	Description of Aspects
Chemical Discharge	No chemicals associated with WPS. No discharge of chemicals offshore
Hydrocarbon Discharge	No hydrocarbons associated with WPS. No discharge of hydrocarbons offshore
Seabed Disturbance	Seabed disturbance will occur when cutting piles. It is expected that piles will have to be exposed by displacing seabed material in order that they can be cut at a suitable depth below natural seabed level. Total duration for operations is expected to be 20 days.
Energy Usage	For comparison, energy use during the planned operations has been based on estimates of fuel consumption. Energy use has been estimated at approximately 66,000 GJ. Energy associated with recycling the steel element of the subsea wellhead protection structures is estimated at approximately 1,890 GJ.
Estimated Material Discarded at Sea	Decommissioning will involve removal of WPS frame to shore. Frame must be separated from pilings in seabed (severed below the natural seabed level at such a depth to ensure that any remains are unlikely to become uncovered). Therefore the only material that will remain at sea will be that portion of the pilings left below the seabed. It is estimated that this represents less than 20% of the total quantity of material comprising the jacket and topsides.
Estimated Material Discarded to Landfill	It is estimated that 0% of the material comprising the WPS will be discarded to landfill. It is expected that the steel structure is entirely recyclable. As this selected decommissioning option involves the removal of WPS in one piece, there remains the potential for reuse should the opportunity arise before final recycling onshore.

2.4.3 Pipeline & Flowlines

The selection of the preferred option for decommissioning of the Welland export pipeline and three subsea flowlines was influenced by the presence of chemicals within the pipeline and flowlines with a potential environmental impact if discharged to sea and the results of a recent pipeline survey that found all pipelines were buried over their length (*Noordhoek, 2009*). Flushing of pipeline contents to donor well(s) in the Welland field would avoid discharge of these chemicals to sea and associated potential environmental impact. Leaving pipelines and flowlines *in situ* would; avoid extensive seabed disturbance, reduce exposure hours for personnel involved in operations and reduce energy usage when compared with retrieving them. Therefore the selected option is to flush the pipeline and flowlines and leave *in situ* (ensuring the ends are buried). No de-pressurisation would be necessary, as the pipelines and flowlines are operated at sea pressure.

Table 2.5 Environmental Aspects Associated with Preferred Decommissioning Option for 16″ Export Pipeline and 8″ Flowlines

16″ Pipeline and 8″ Flowlines	Description of Aspects
Chemical Discharge	The 16" export pipeline was flushed to remove hydrocarbons by ExxonMobil in 2003 and left filled with inhibited seawater, plugged at the Thames end by a pig train. No further flushing is proposed and on cutting the pipeline at the Welland end, discharge of chemicals will be limited to a volume diffusing into the marine environment whilst the cutting and burial process takes place. Due to the de-pressurised nature of the pipeline, this is considered to be minimal. There are no residual chemical in the 8" flowlines from Welland's subsea wells.
Hydrocarbon Discharge	The 16" export pipeline was flushed in 2003, leaving a residual hydrocarbon concentration of <40 ppm. The 8" flowlines will be flushed prior to cutting with a view to achieving similar levels of residual hydrocarbons. A worst case estimation of hydrocarbon remaining adhered to the internal surfaces of the export pipeline and flowlines indicates that approximately 724 litres may remain. Any hydrocarbons remaining within pipeline or flowlines will eventually be discharged to sea once pipe integrity is compromised. However, discharge in this manner is expected to be gradual and discharges on cutting the lines will be limited to the diffusion of the low concentration of hydrocarbons from the cut ends over the period between cutting and re-burial of the pipelines.
Seabed Disturbance	Localised seabed disturbance will occur when carrying out flushing, cutting pipe ends and burying operations. This represents a much lower level disturbance when compared to removal of pipeline and flowlines. Additionally, as a Dive Support Vessel will be used (with Dynamic Positioning) no anchors are required which further limits seabed disturbance. Total duration for operations is expected to be 138 days.
Energy Usage	For comparison, energy use during the planned operations has been based on estimates of fuel consumption. Energy use has been estimated at approximately 33,000 GJ for decommissioning of pipeline and flowlines. Energy associated with the steel and concrete elements of the pipelines and flowlines that is being "lost" by leaving *in situ* is estimated at approximately

	22,972.6 GJ.
Estimated Material Discarded at Sea	As the preferred decommissioning option is to leave pipeline and flowlines *in situ*, it is expected more than 80% of the material comprising pipeline and flowlines will be discarded at sea.
Estimated Material Discarded to Landfill	It is expected that 0-20% of the material comprising the pipeline and flowline will be discarded to landfill. Any material removed when cutting pipe ends will be returned to shore. All material removed to shore is likely to be discarded to landfill due to the processing required to separate steel pipe from concrete coating which makes recycling cost prohibitive. Concrete that has been saturated with seawater cannot be recycled due to residual salt content.

2.4.4 MEG Piggyback Line & Control Umbilicals

The selection of the preferred option for decommissioning of the Welland MEG piggyback line (associated with the export pipeline) and three subsea control umbilicals was influenced by the absence of chemicals with potential for significant environmental impact (MEG is an OCNS E rated product) and the results of a recent pipeline survey that found all pipelines buried over their length caused less total disturbance than those lifted from the seabed and transported back to shore (*Noordhoek, 2009*). Leaving the MEG piggyback line and control umbilicals *in situ* would; avoid extensive seabed disturbance, reduce exposure hours for personnel involved in operations and reduce energy usage when compared with retrieving them. Therefore the selected option is to de-pressure the MEG piggyback line and the control umbilicals and leave *in situ* (ensuring the ends are buried).

Table 2.6 Environmental Aspects Associated with Preferred Decommissioning Option for MEG Piggyback Line and Control Umbilicals

MEG Piggyback Line & Control Umbilicals	Description of Aspects
Chemical Discharge	Chemicals contained within MEG line and control umbilicals will be discharged upon depressurising. Chemicals contained within the lines have low potential for causing significant environmental impact (MEG is PLONOR, Castrol Transaqua HT is OCNS C). The discharges will be limited to the small amounts that diffuse from the cut ends of the lines in the period between cutting and their re-burial beneath the seabed. Ultimate release of the chemicals in the lines will result from their eventual loss of integrity through corrosion.
Hydrocarbon Discharge	No hydrocarbons are present in the MEG line or control umbilicals. No discharge of hydrocarbons will occur.
Seabed Disturbance	Localised seabed disturbance will occur when cutting pipe ends and carrying out burial operations. This represents a much lower level disturbance when compared to removal of MEG line and control umbilicals. Additionally, as a Dive Support Vessel will be used (with Dynamic Positioning) no anchors are required which further limits seabed disturbance. Total duration for operations is expected to be 20 days.
Energy Usage	For comparison, energy use during the planned operations has been based on estimates of fuel consumption. Energy use has been estimated at

	approximately 8,100 GJ for decommissioning of MEG line and control umbilicals. Energy associated with the steel and copper elements of the piggyback line and umbilicals that is being "lost" by leaving *in situ* is estimated at approximately 5,650 GJ.
Estimated Material Discarded at Sea	As the preferred decommissioning option is to leave MEG line and control umbilicals *in situ*, it is expected >80% of the material comprising MEG line and control umbilicals will be discarded at sea.
Estimated Material Discarded to Landfill	It is expected that 0-20% of the material comprising the MEG line and control umbilicals will be discarded to landfill. Any material removed when cutting pipe ends will be returned to shore. All material removed to shore is likely to be discarded to landfill due to the processing required to separate pipes from coating/armour which makes recycling cost prohibitive.

2.4.5 Pipeline Crossing Points

The options considered for pipeline crossing points are not a decommissioning option in their own right. However, it was decided to investigate the way these specific areas were to be decommissioned in the event that Welland pipelines are decommissioned by being left beneath the seabed. There are three pipeline crossing points in the Welland field, two over submarine telecom cables and one over the Sean-Bacton pipeline. Although initially the pipelines crossings would have been features that were raised above the seabed, no evidence of these areas were seen on the pipeline survey (*Noordhoek, 2009*). Therefore, the selected decommissioning option for the pipeline crossing points is to leave *in situ*.

Table 2.7 Environmental Aspects Associated with Preferred Decommissioning Option for Pipeline Crossing Points

Pipeline Crossing Points	Description of Aspects
Chemical Discharge	No chemicals associated with pipeline crossing points. No discharge of chemicals.
Hydrocarbon Discharge	No hydrocarbons associated with pipeline crossing points. No discharge of hydrocarbons.
Seabed Disturbance	No interaction with seabed for leave *in situ* option. No seabed disturbance. Total duration for operations is expected to be less than 1 day.
Energy Usage	For comparison, energy use during the planned operations has been based on estimates of fuel consumption. Energy use has been estimated at approximately 60 GJ for leave *in situ* option (this is associated with ROV survey of crossings).
Estimated Material Discarded at Sea	Preferred decommissioning option is leave *in situ*, therefore it is expected all of the material comprising pipeline crossings will be discarded at sea.
Estimated Material Discarded to Landfill	No material will be discarded to landfill.

2.4.6 Mattresses

There are 128 mattresses in the Welland field: 43 flexible mattresses and 85 frond mattresses. Although initially the mattresses would have been features that were raised above the seabed, no evidence of these areas was seen during the pipeline survey (*Noordhoek, 2009*). However, in line with discussions with the NFFO that indicated mattresses can interfere with fishing gear when exposed, the selected option for decommissioning of mattresses associated with the Welland infrastructure is to recover them. This is largely dependent on whether it is possible to do so without incurring unacceptable safety risks. Perenco will determine the integrity of the concrete mattresses in an initial trial lift and, subject to the outcome, will recover them. If the trial demonstrates that the degradation of the mattresses renders their recovery unsafe, they will be buried *in situ*.

Table 2.8 Environmental Aspects Associated with Preferred Decommissioning Option for Mattresses

Mattresses	Description of Aspects
Chemical Discharge	No chemicals associated with mattresses. No discharge of chemicals.
Hydrocarbon Discharge	No hydrocarbons associated with mattresses. No discharge of hydrocarbons.
Seabed Disturbance	Seabed disturbance will occur when burying mattresses. If left *in situ* it is expected that mattresses will be buried by displacing seabed material to cover them. This will result in an area of up to twice the footprint of the mattresses being disturbed. Total duration for operations is expected to be 14 days.
Energy Usage	For comparison, energy use during the planned operations has been based on estimates of fuel consumption. Energy use has been estimated at approximately 31,000 GJ for burial option. Energy associated with the concrete element of the mattresses that is being “lost” by leaving *in situ* is estimated at approximately 1,280.5 GJ.
Estimated Material Discarded at Sea	Preferred decommissioning option is to bury, therefore it is expected all of the material comprising mattresses will be discarded at sea.
Estimated Material Discarded to Landfill	No material will be discarded to landfill.

2.4.7 Drill Cuttings

Modelling of the fate of discharged cuttings for Perenco’s drilling programmes undertaken in the last 5 years has demonstrated that they are distributed widely and in very thin layers no greater than 5mm. Cuttings generated when Welland’s platform and subsea wells were drilled are likely to have been deposited in similar quantities and with similar characteristics. Sea bed sampling as part of the decommissioning programme will investigate the presence and extent of residual cuttings, though it is extremely unlikely that any trace will be found.

2.5 Total Emissions and Energy Use Estimates

A summary of the anticipated emissions and energy use associated with the preferred decommissioning options is provided in Table 2.9, below. The data used to compile these figures is provided in Appendix A.

Energy use in the table below has been split into that associated with vessels, which relates directly to the fuel consumption of the vessels employed in the decommissioning activities, and the energy use associated with the materials to be either recovered or left *in situ*.

The ‘materials’ energy use figures account for recycling of material returned to shore or the energy required to manufacture the ‘lost’ materials (those left on the seabed) from raw materials.

The energy required by the cutting equipment itself offshore has not been included in the calculations as energy associated with onshore cutting and cleaning is assumed to be trivial in line with the Institute of Petroleum guidance (*IP, 2000*).

Table 2.9 Summary Energy Use, Area affected and Emissions for Welland Decommissioning

Emissions/Energy Use	Welland Field Decommissioning
Chemicals*	Gas Hydrate Inhibitor (Monoethylene Glycol) – 51.3 tonnes Biocide (Bactron B1710) – 575 litres Oxygen Scavenger (OS-2) – 397 litres Corrosion Inhibitor (Cortron CP2000) – 552 litres Hydraulic Fluid (Castrol Transaqua HT) – 5.4 tonnes
Hydrocarbons*	724 litres condensate
Atmospheric Emissions	6,334.28 tonnes CO_2
Energy Use (Vessels)	417,250 GJ
Energy Use (Materials)	126,343 GJ
Total Energy	543,593 GJ
Area affected**	1380 m^2

* Discharges of chemicals and hydrocarbons will largely be as a result of gradual loss of integrity of pipelines over time. Short-term discharges associated with decommissioning operations are expected to be a fraction of the total. However, no quantification of these operational discharges is possible as it will involve processes such as diffusion, etc.

** The area affected is estimated by reference to the total area of the seabed that will be subject to reburial operations to ensure no structures left *in situ* will be left exposed above the seabed. These include the cut ends of pipelines, flowlines and umbilicals, as well as the wellhead protection structures, the limited length of currently exposed export pipeline (7 m) and the platform piles.

2.6 Post Decommissioning Survey/ Maintenance

If all infrastructure was removed, no ongoing monitoring or maintenance would be required beyond the post-operation debris clearance and 'as left' surveys. However, for pipelines, umbilicals, pipeline crossing points and mattresses remaining *in situ*, periodic survey, at a frequency to be defined, will be necessary to monitor the status of the infrastructure to ensure risks to other users of the sea (such as snagging risks to fishing vessels) is minimised. The defined survey frequency will reflect the stability of the seabed in the area and the occurrence of any incidents that may impact the pipelines, umbilicals, pipeline crossing points and/or mattresses.

Perenco's survey frequency of live pipelines is 3-5 years. Given the evidence of progressive burial of the 16" pipeline and the fact that all the lines will be left filled with either seawater or their original liquid contents, a more frequent post decommissioning survey frequency is unlikely to be warranted. Perenco propose, therefore to maintain existing survey schedules following decommissioning of the pipelines.

3 Environmental Description

3.1 Introduction

Understanding the characteristics of the local environment is a key consideration in planning the decommissioning project. The potential for the project to interact with the environment must be identified so that appropriate controls can be adopted to mitigate negative impacts.

The physical, biological and socio-economic environment in the immediate vicinity of the Welland field together with surrounding areas of the southern North Sea has been reviewed.

Particular reference is made to those biological components of the environment that are considered to be of ecological and/or commercial importance. The key biological components described are:

- Plankton;
- Benthic communities;
- Spawning areas, geographical distribution of adult and juvenile populations for commercially important fish and shellfish species;
- Seabirds;
- Marine mammals.

Other commercial activities undertaken within the area are also described and the extent to which the proposed decommissioning project could interfere with these activities is considered.

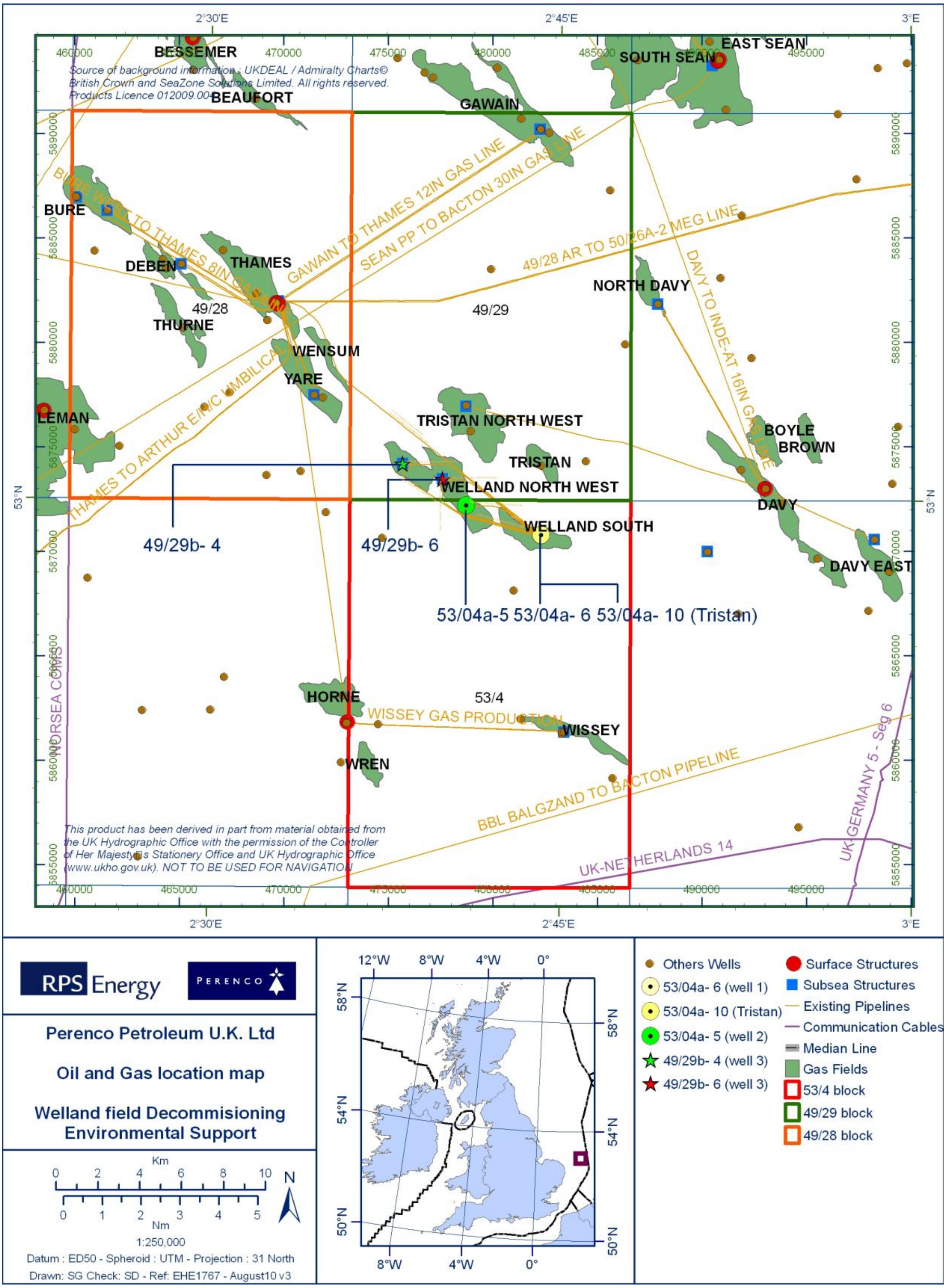
3.2 Geography

The Welland field is located in the southern North Sea in Blocks 49/28a, 49/29b and 53/4a, approximately 72 kilometres off the Norfolk coast (Figure 3.1). The Welland platform is located in Block 53/4 at latitude 52°, 59', 6.8701" North and longitude 02°, 44', 11.5861" East. The nearest international boundary to the development is the UK/Dutch median line, which lies approximately 26.5 kilometres to the east and the nearest coastline is located 76 kilometres to the south-west.

The Welland platform well is located in Block 53/4a and the subsea wells are located in Blocks 53/4a and 49/29b. The associated pipelines traverse Blocks 53/4, 49/29 and 49/28.

The eastern English coastline contains important examples of all the main soft coast habitat types and includes the nationally significant Humber Estuary, The Wash and the barrier island coast of north Norfolk. To the north of the region, at Flamborough Head, high chalk cliffs support important populations of seabirds, while further south, the Holderness coast predominantly comprises soft eroding cliffs of boulder clay which taper into a shingle spit at Spurn Head. Low glacial cliffs also dominate the east facing coast of Norfolk. The majority of the remaining coastline within this region is low-lying and mainly estuarine. The Humber Estuary is the only major industrial infrastructure development in the region (*Barne et al., 1995*).

Figure 3.1 Location of the Welland Field & Infrastructure



3.3 Bathymetry and Sediments

During April-May 2009, a detailed pipeline survey was undertaken by Noordhoek Survey B.V. (*Noordhoek, 2009*). The purpose of the survey was to establish seabed levels, sandwave activity, and any exposed areas of pipeline or umbilical. Sub-bottom profiler (SBP) crosslines were used to determine the depth of burial for each of the pipelines and umbilicals. The survey included the following elements:

- swathe bathymetry;
- sub-bottom profiling survey;
- side scan sonar;
- drop-camera video.

3.3.1 Bathymetry

Water depths within the southern North Sea tend to decrease in a southerly direction. South of Flamborough Head, depths vary between approximately 10 and 40 metres. Charted water depths within the vicinity of the Welland field range from 32 to 37 metres (*Noordhoek, 2009*).

The pipeline survey noted the seabed is generally flat and the entire area is covered with sand ripples (*Noordhoek, 2009*).

3.3.2 Sediments and Seabed Features

The nature of the local seabed sediments is an important factor in providing information to help assess the potential for sediment movement and is a determining factor in the flora and fauna present. The nature of the sediments, and the amount of sediment transport, can also provide evidence as to the potential effects from the planned operations, such as the extent of natural backfill.

The 2009 Noordhoek pipeline survey detected no significant obstructions, although four unspecified debris items were noted.

The shallow geology is very consistent throughout the Welland area. The most superficial layer has a thickness of 4 to 6 metres and consists of compact sand. Mega-ripples cover the entire area of Welland (*Noordhoek, 2009*).

The Welland development and pipelines lie over 8 kilometres outside the boundary of the North Norfolk Sandbanks possible Special Area of Conservation (pSAC) boundary (see Section 3.7.2). The North Norfolk Sandbanks are a series of sandbanks that radiate northeast from the Norfolk coast (*SEA-2, DTI 2001*). These sandbanks are the most extensive example in UK waters of offshore linear ridges. The series includes over ten sandbank ridges which are formed of sand and exhibit varying degrees of sandwaves (*Graham et al., 2001*). The inner banks have large sandwaves between 4 and 6 metres high associated with them, with size decreasing in the outer banks away from the shore (*Johnston et al., 2002*). Water depth within the general bank area varies from approximately 10 to 40 metres. No reefs structures have been noted in the Welland area.

3.4 Water

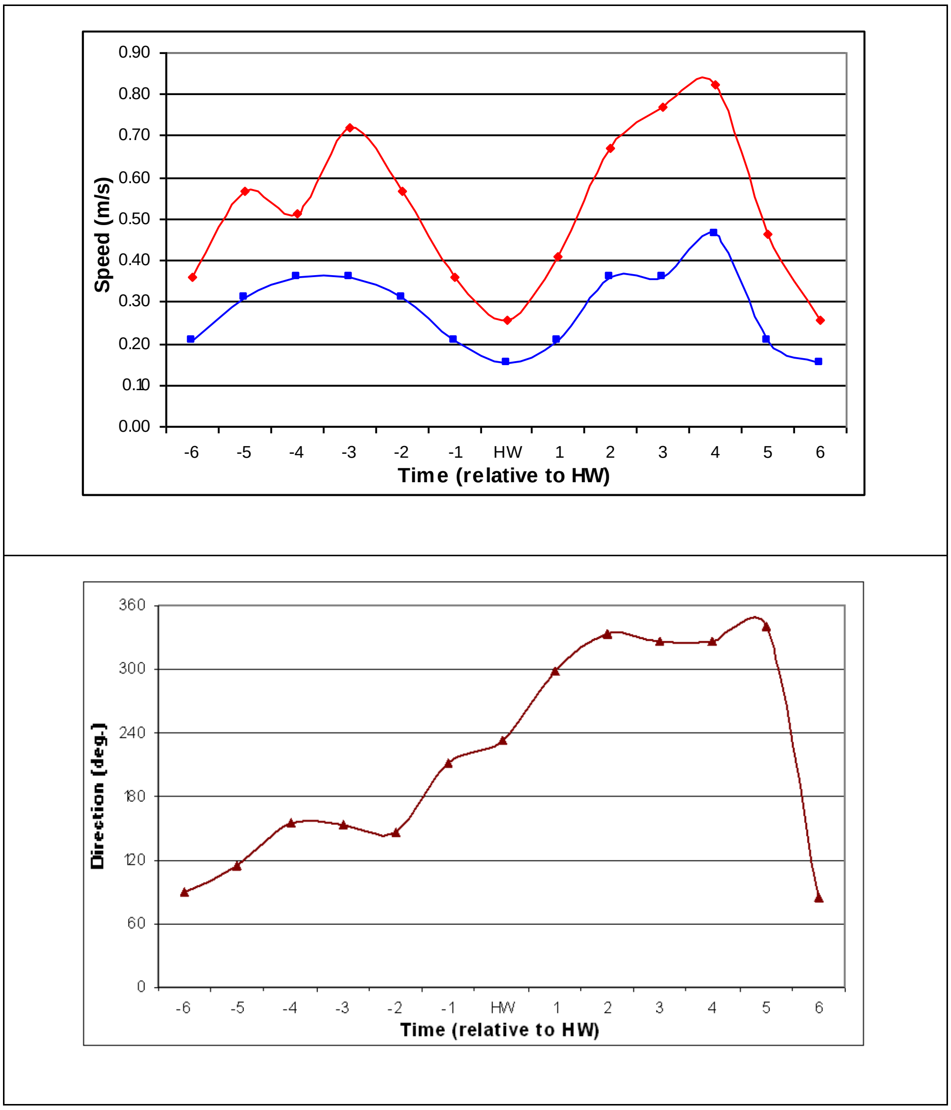
3.4.1 Oceanography

The general circulation of near-surface water masses in the North Sea is cyclonic, mostly driven by the ingression of Atlantic surface water in the western inlets of the northern North Sea. As a result, residual water currents near the sea surface tend to move in a south-easterly direction along the coast towards the English Channel. In addition, counter currents occur towards the English/Dutch sector median line, flowing north-east towards Denmark. The effect of this counter current in the Welland development area pushes the near-surface water movement towards a more easterly direction.

Tides in the southern North Sea are predominately semi-diurnal and tidal waters offshore in this area flood southwards and ebb northwards. Tidal currents are fairly strong in this region, with maximum tidal rates in the vicinity of the Welland development of 1.6 and 0.9 metres per second respectively for spring and neap tides (Figure 3.2) (*Hydrographer of the Navy, 1995*).

Currents in the vicinity of sandbanks can be highly affected by their presence. Indeed, residual currents near the seabed have been shown to be strongest towards the crest of a sandbank and in opposing directions on either side of the bank. Further studies on the Well Bank, for instance, have shown a clockwise near-bed residual circulation around the bank (*Howarth and Huthnance 1984, and Collins et al. 1995 in SEA-2, DTI 2001*). These currents are considered to be important in the formation and maintenance of linear sandbanks.

Figure 3.2 Tidal Current Speed & Direction at 53°27'05''N; 02°46'00''E. The red and blue lines represent spring and neap tide, respectively (Tidal Diamond K, Admiralty Chart 2182A, Hydrographer of the Navy, 1995)



3.4.2 Waves

Waves are the result of the action of wind on the surface of the sea and their size depends upon the distance or fetch over which the wind can operate. The height of a wave is the distance from the crest to trough but as the waves at any one time are not of equal size, the significant wave height (Hs) is taken and corresponds approximately to the mean height of the highest third of the waves. The wave period is the (mean) time between two wave crests, called the zero up-crossing period and is given in seconds. The wave climate of the area provides information on the physical energy acting on structures and dictates the structural design requirements.

Significant wave heights in the vicinity of the Welland field exceed 2 metres for only 10 percent of the year (Table 3.1). However, there is considerable seasonal variation with waves in excess of 4 metres recorded for 15 percent of the time in autumn and winter, but only 2 percent of the time in summer (*Smith, 1998*).

Table 3.1 Yearly Significant Wave Heights (BODC, 1998)

10% Exceedance	25% Exceedance	50% Exceedance	75% Exceedance
2 -2.5 metres	1.5 metres	1 metre	0.5 metres

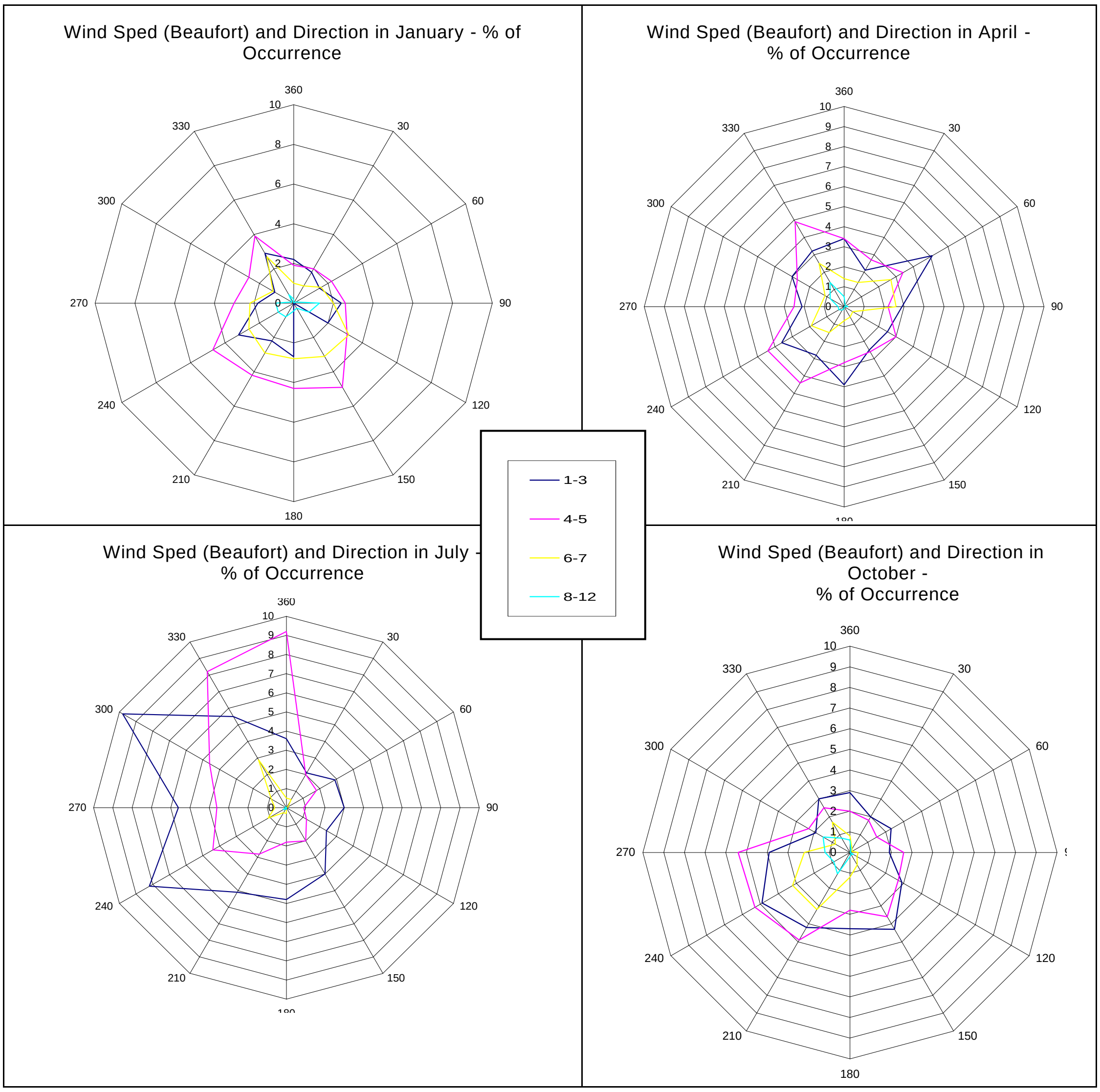
3.5 Air and Climate

3.5.1 Wind

Prevailing wind directions in the area are variable throughout the year, but south-westerly winds are the most frequent. During the winter and early summer north-easterly and south-westerly winds are most common. From July to September, however south-westerly and westerly winds predominate (Figure 3.3).

The windiest months are December and January, with wind speeds of greater than Beaufort Force 7 (14 to 16.5 metres per second) achieved on 6 to 10 days a month (Figure 3.3). The calmest months are May to August with wind speeds of Force 7 or more reached only on between 1 and 3 days each month (*Barne et al., 1995*).

Figure 3.3 Wind Roses for the Area 54.0N – 55.9N, 2.0E – 3.9E (Korevaar, 1990)



3.5.2 Air Quality

An understanding of the existing air quality in the Welland area is useful when assessing the potential impact upon air quality from the proposed operations. However, data on air quality offshore is limited due to an absence of an offshore air quality monitoring station network. Emissions of carbon dioxide (CO_2), oxides of nitrogen (NOx), and oxides of sulphur (SOx) will result from power generation from vessels used during decommissioning activities.

3.6 Flora and Fauna

3.6.1 Plankton

Plankton consists of the plants (phytoplankton) and animals (zooplankton) which live freely in the water column and drift with the water currents. Plankton forms a fundamental link in the food chain. They are vulnerable to discharges to the sea and accidental chemical or hydrocarbon spills. The composition of plankton communities at any time is variable and depends upon the circulation of water into and around the North Sea, the time of year and nutrient availability. Plankton abundance is strongly influenced by several factors such as; depth, tidal mixing, temperature stratification, nutrient concentrations and the location of oceanographic fronts.

Species distribution is directly influenced by temperature, salinity, water inflow and the presence of local benthic (bottom dwelling) communities.

In the North Sea phytoplankton is dominated by dinoflagellates and diatoms. In the north of the region the spring bloom begins with diatoms and is followed by dinoflagellates, which become prominent during summer. A second phytoplankton bloom also occurs in autumn, coinciding with a decrease in copepod numbers (*Smith, 1998*). In the southern North Sea the dinoflagellate genus *Ceratium* dominates the phytoplankton community, including *Ceratium fusus*, *Ceratium furca* and *Ceratium tripos*. High numbers of the genus *Cheaetoceros* (*Hyalochaere* and *Phaeoceros*) are also present (*SEA-2, DTI 2001*).

Zooplankton in the southern North Sea is mainly comprised of small copepod species including *Para-Pseudocalanus spp.*, with the second most abundant species being echinoderm larvae (*SEA-2, DTI 2001*). The large species of *Calanus helgolandicus* and *Metridia lucens* are also characteristic of deeper offshore waters (*Smith, 1998*). Studies indicate that zooplankton appear to be the most vulnerable group to toxic effects of discharges, whereas the phytoplankton and fish larvae tend to be more robust to any direct effects (*GESAMP*, *1993*). Planktonic organisms are generally short lived however and recovery following a pollution induced population reduction is usually rapid. It appears that dispersant treatment of spilled oil magnifies the effects on the plankton, though studies after spills from tankers have failed to find any significant effects (*SEA-2, DTI 2001*). Natural seasonality is also important as the plankton comprises different types and quantities of organisms at different times of the year.

3.6.2 Seabed Communities

The benthos describes the organisms that live in and on the seabed. Infauna live beneath the sediment surface, while epifauna live on the surface of the seabed. Activities that result in physical or chemical disturbance of the seabed such as the deposition of discharged drill cuttings and pipeline installation can impact these faunal communities. The benthic infauna of the offshore southern North Sea can be characterised by its tendency towards lower diversities than the northern areas (*Künitzer et al. 1992*).

Historic surveys of the North Sea show that the benthic fauna is characterised by thermal stability over time (*Glémarec, 1973*), water depth and seabed granulometry (*Künitzer et al, 1992*). The seabed community (benthos) in the vicinity of the Welland development is characteristic of wider areas of the southern North Sea with a 'coarser' sediment type. Typical species found in the area include the polychaete *Nephtys cirrosa*, the sea urchin *Echinocardium cordatum* and amphipod *Urothoe poseidonis* (*DTI, 2001*). Species such as the polychaetes *Ophelia limacina* and the amphipod *Bathyporeia spp.* and *Mysidacea* are also likely to be present. In areas where the sediment type is comprised of fine sand, the polychaetes *Ophelia borealis, Nephtys longosetosa, Scolopos armiger* and *Oligochaeta* are likely to be found (*Künitzer et al., 1992*).

The most abundant benthic species in the vicinity of the Welland development are the brittlestars *Ophelia limacine* and *Ophelia borealis, Bathyporeia sp*. (crustacean), *Nephtys cirrosa* (polychaete), the sea urchin *Echinocardium cordatum*, the amphipod *Urothoe brevicornis* (*UK Benthos, 2009*).

Sandbanks in shallow waters represent important habitats for various species of flora and fauna (refer to Section 3.7.2). The DTI commissioned detailed surveys of these habitats within the Strategic Environmental Assessment (SEA) 2 and adjacent areas showed that the fauna of the Norfolk Banks was typified by the sea urchin *Echinocardium cordatum* and the bivalve *Fabulina fabula*. Two species of sandeels were also found to be common. In addition, analysis of the 0.5mm sieved samples showed that the fauna of the bank flanks and crests is little different (*SEA-2, DTI 2001*).

The ICES Cooperative Research Report "Structure and Dynamics of the North Sea Benthos" (ICES, 2007) presented a comparison of more recent surveys to the ICES North Sea Benthos Survey conduced in 1986. The report concluded that North Sea benthic communities remain in equilibrium with natural environmental forces, which account for most of the observed variability in space and time. Traits of resilience and adaptability help to explain patterns and changes in the benthic communities at the level of the entire North Sea and more locally, respectively. This conclusion can be applied to the responses both to natural and human influences.

Drop-camera video captured as part of the detailed pipeline survey conducted in the Welland field in 2009 did not identify any evidence of *Sabellaria spinulosa* (*Noordhoek, 2009*).

3.6.3 Fish

Generally, there is little interaction between fish and offshore developments, although some species congregate around platforms and along pipelines. Spawning areas and juveniles, however, can be sensitive to installation activities, discharges to sea and, in some cases, accidental spills.

The Welland location is a potential spawning area for; mackerel (*Scomber scombrus*), lemon sole (*Microstomus kitt*), plaice (*Pleuronectes platessa*), sprat (*Sprattus sprattus*) and *Nephrops* (*Nephrops norvegicus*) (Table 3.2 and Figure 3.4).

In addition the area may be used as a nursery by; mackerel, lemon sole, cod (*Gadus morhua*) and whiting (*Merlangius merlangus*) (Table 3.2 and Figure 3.5).

Table 3.2 Fish Spawning and Nursery Areas in the vicinity of Welland Infrastructure (Blocks 53/4, 49/29 and 49/28) (Coull et al., 1998)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Mackerel (*Scomber scombrus*)							N	N	N	N		
Lemon sole (*Microstomus kitt*)						N	N	N	N	N	N	
Plaice (*Pleuronectes platesssa*)												
Sprat (*Sprattus sprattus*)												
Nephrops (*Nephrops norvegicus*)												
Cod (*Gadus morhua*)			N	N	N	N						
Whiting (*Merlangius merlangus*)				N	N	N	N	N				

Legend: Peak Spawning | Spawning | N Nursery

Chondrichthyan Fishes

Skates and rays (chondrichthyan fishes or elasmobranchs) are an important part of the North Sea ecosystem, although there is not enough known about their abundance and distribution to fully facilitate the protection they require in the marine environment. Elasmobranchs typically have a slow growth rate and low fecundity, leaving them vulnerable to over-fishing pressures and pollution events.

In a survey conducted by CEFAS *(Ellis et al, 2004)*, twenty six species were identified and recorded throughout the seas around the UK. Nursery areas were also studied, allowing knowledge of these regions to be a requirement of elasmobranch fisheries management in the area. Table 3.3 summarises the species.

Table 3.3 Summary of the Distribution and Abundance of the Species of Chondrichthyan Fishes found in southern North Sea Waters (after Ellis et al., 2004)

Species	Location	Depth range (metres)	Number (individuals/ hour)
Spurdog Squalus acamthias	widespread	15-528	-
Tope shark Galeorhinus galeus	widespread	17-200	(regular)
Starry smooth hound *Mustelus asterias*	widespread	10-199	-
Marbeled electric ray *Torpedo marmorata*	English Channel	13-109	(occasional)
Starry ray Amblyraja radiata	North Sea	32-209	232
Undulate ray *Raja undulata*	English Channel	0-72	8
Common stingray Dassyatis pastinaca	Western English Channel	17-160	(occasional)

Figure 3.4 Fish Spawning Areas in relation to Welland Infrastructure

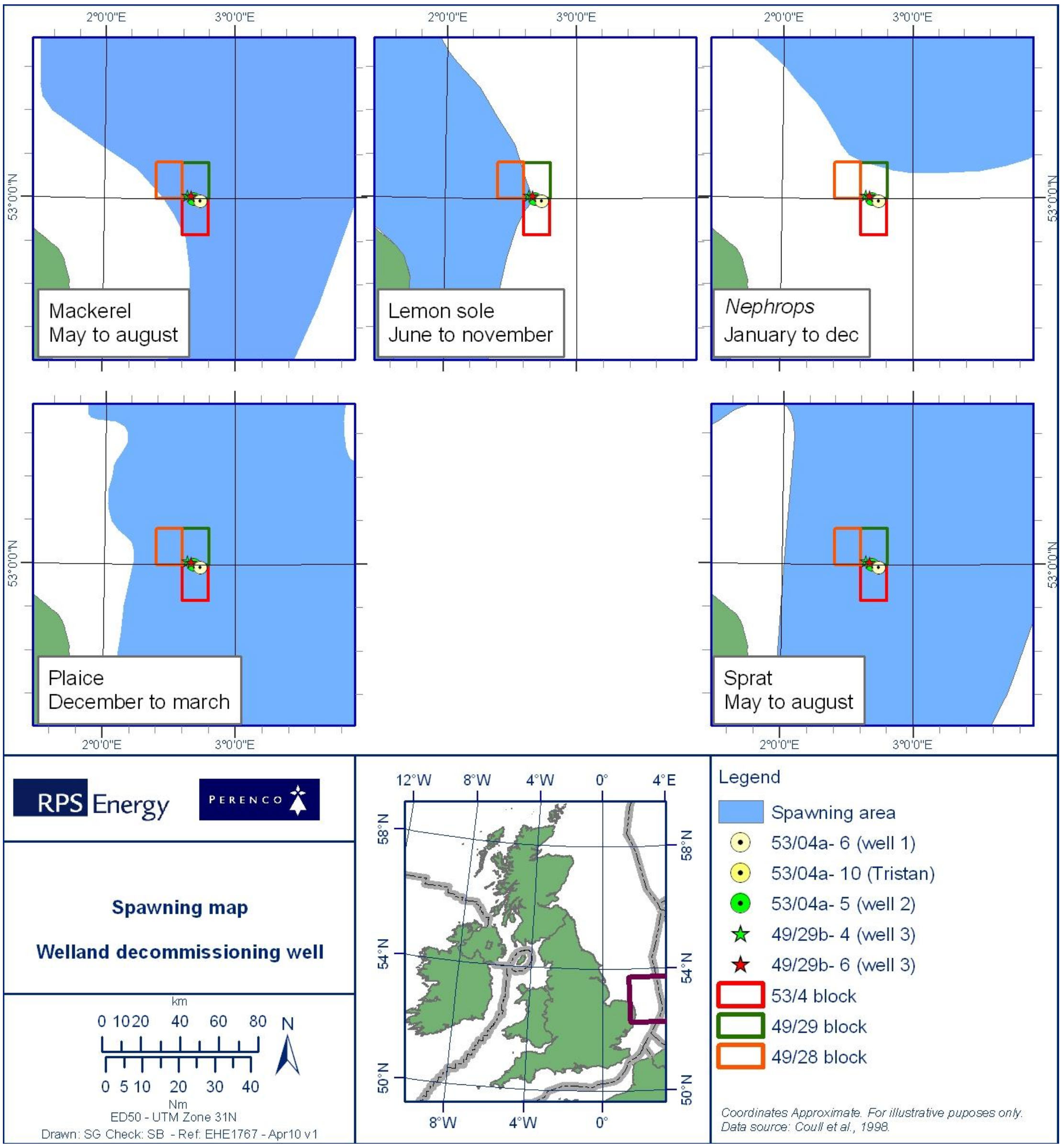
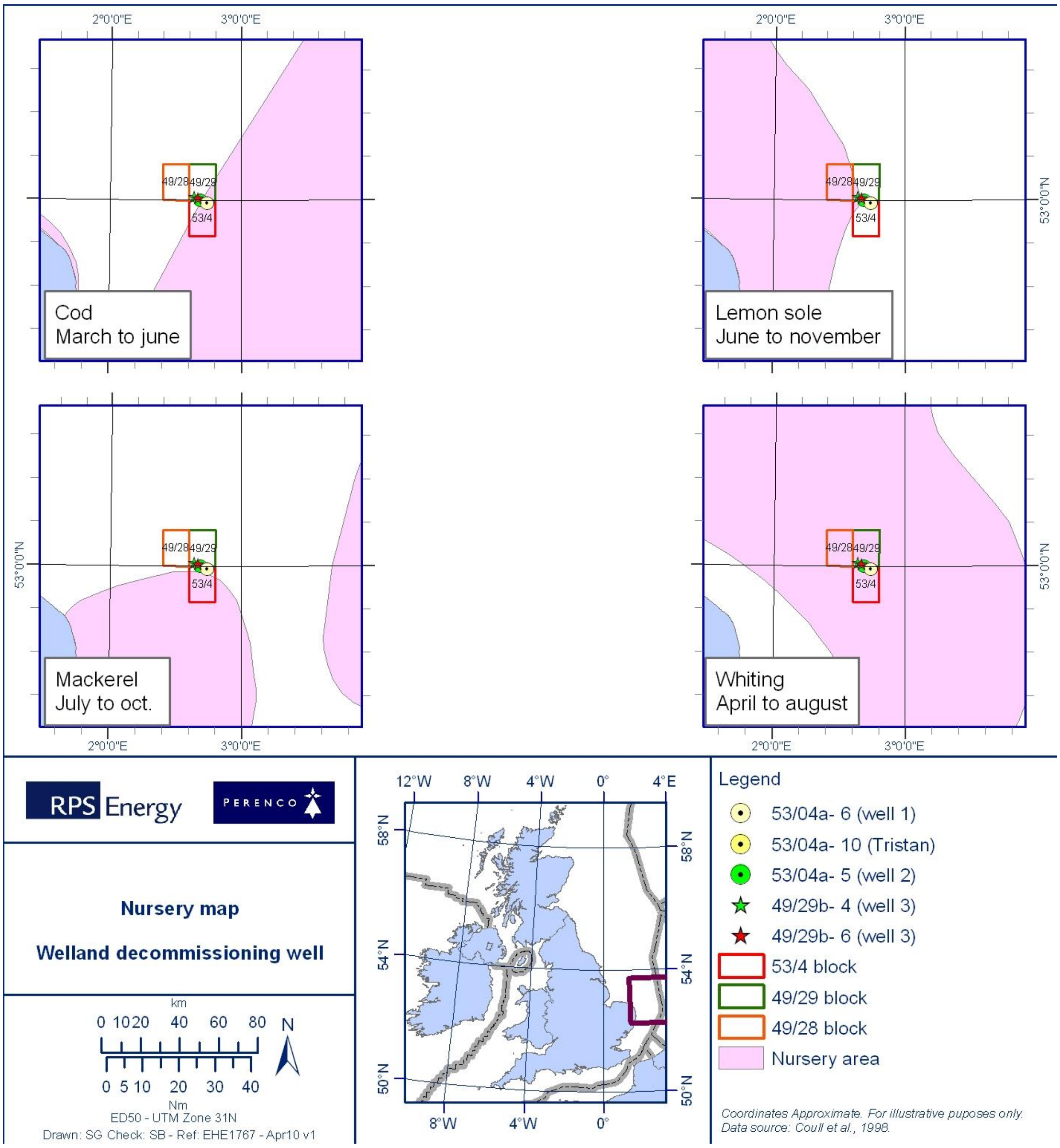


Figure 3.5 Fish Nursery Areas in relation to Welland Infrastructure



3.6.4 Seabirds

Internationally important numbers of several species of seabird breed on the North Sea coastal margin, and depend on the offshore North Sea for their food supply and, for much of the year, their habitat. Although there are no endemic seabird populations, the North Sea supports substantial proportions of the global population of some species (e.g. great skua). As specified by JNCC, seabird vulnerability refers to susceptibility to surface pollutants, specifically hydrocarbons, when seabirds are at sea following breeding and undergoing moulting. Seabirds are also vulnerable to oil spills during winter months (Table 3.4) when they congregate in large flocks on the water. Higher vulnerabilities are found further inshore (Figure 3.6).

The offshore waters of the southern North Sea are frequented by several seabird species mainly for feeding purposes. Species using the waters in the vicinity of the Welland field most notably include kittiwake (*Rissa tridactyla*), fulmar (*Fulmarus gracilis*), guillemot (*Uria aalge*) black-backed gull (*Larus fuscus*), herring gull (*Larus argentatus*), common gull (*Larus canus*), Arctic skua (*Stercorarius parasiticus*), gannet (*Morus bassanus*) and puffin (*Fratercula arctica*) (*UKDMap,* *1998*). Of these species, kittiwakes are present in high densities in the spring and late summer. Fulmar are present in highest numbers in the southern North Sea during the early and late breeding seasons, leading to peak densities in March and August. Common gull, herring gull, great gull and black-backed gull are mainly present in high numbers during February and March. In contrast guillemot numbers are present in greatest numbers during winter months. In addition, substantial numbers of terns migrate northwards through the offshore North Sea in April and May, with return passage from July to September (*SEA-2, DTI 2001*).

The JNCC ranks seabird vulnerabilities on a four point scale (one is the highest vulnerability and four the lowest). Seabird vulnerability in Blocks 53/04, 49/29 and 49/28 is highest (2 out of 4) during February, March and December and is moderate to low (3 or 4 out of 4) throughout the remainder of the year (Table 3.4 and Figure 3.6). Vulnerability in the surrounding blocks is also high (1 or 2 out of 4) in February, March and December.

Table 3.4 Seabird Vulnerability to Oiling in the vicinity of Blocks 53/04, 49/29 and 49/28 (JNCC, 1999)

Block	J	F	M	A	M	J	J	A	S	O	N	D
49/22	4	2	2	4	3	4	4	3	4	3	4	2
49/23	3	2	2	4	3	4	4	3	4	3	4	2
49/24	3	3	2	4	3	4	4	3	4	4	4	2
49/25	3	2	2	4	3	4	4	3	4	4	3	2
49/27	4	3	3	4	3	4	4	3	4	3	4	2
49/28	**4**	**3**	**3**	**4**	**3**	**4**	**4**	**3**	**4**	**3**	**4**	**2**
49/29	**4**	**3**	**2**	**4**	**3**	**4**	**4**	**3**	**4**	**4**	**4**	**2**
49/30	4	2	2	4	3	4	4	3	4	4	4	2
53/02	4	3	3	4	3	4	4	3	4	3	4	2
53/03	3	2	2	4	3	4	4	3	4	3	4	2
53/04	**3**	**2**	**2**	**4**	**3**	**4**	**4**	**3**	**4**	**4**	**4**	**2**
53/05	3	1	2	4	3	4	4	3	4	4	4	2
53/07	3	3	4	4	3	4	4	3	4	3	4	2
53/08	2	1	2	4	3	4	4	3	4	3	4	2
53/09	2	1	2	4	3	4	4	3	4	4	4	2
53/10	2	1	2	4	3	4	4	3	4	4	4	2

Key: High Sensitivity=1, Low Sensitivity=4. Licence Blocks relevant to the Welland field are shaded

Many of the birds recorded in the Welland development area are likely be flying out on feeding trips from the Flamborough Head and Bempton Cliffs Special Protection Area (SPA) which qualifies as such under Article 4.2 of the Habitats Directive as it supports a migratory kittiwake population of European Importance (83,370 pairs, representing at least 2.6 percent of the eastern Atlantic population). It also meets the qualification criteria of regularly supporting at least 20,000 seabirds. During the breeding season, the area supports 305,784 individual seabirds (*Stroud et al., 2001*) (Table 3.5).

Table 3.5 Populations of Qualifying Species Regularly Present at the Flamborough Head and Bempton Cliffs SPA (Stroud et al., 2001)

Species	Site Total	Percentage of Biogeographical Population	Percentage of National Population
Puffin	3,473	0.4	0.8
Gannet	2,501	0.95	1.2
Kittiwake	83,370	2.6	17.0
Herring Gull	1,110	01	0.7
Razorbill	5,133	0.9	5.2
Guillemot	16,150	0.7	2.3

As well as the Flamborough Head and Bempton Cliffs SPA, the coastline adjacent to the Welland field includes the North Norfolk Coast and The Wash SPAs, located approximately 70-120 kilometres to the west of the Welland Platform respectively. The North Norfolk Coast supports internationally important numbers of wintering wildfowl and nationally important numbers of wintering wildfowl, breeding waders and bearded tit (*Pritchard et al., 1992*).

Nearly the entire North Norfolk Coast is either estuarine or soft coast - habitats that support very high densities of breeding waterfowl, especially waders (*Stroud et al., 2001*) (Table 3.6). The seabirds from this site feed and raft in the waters around the coast, outside the SPA, and some also feed more distantly in the North Sea. As a result, species hosted in the Wash and North Norfolk Coast SPAs may be vulnerable at sea when feeding in close proximity to the planned operations. However, as the Welland area represents a small portion of a larger area of seabird foraging, it is very unlikely that the entire colony would gather on the development area at the same time.

Table 3.6 Populations of Qualifying Species Regularly Present at the nearest SPAs to the Proposed Development (Stroud et al., 2001; Kirby et al., 1993)

Species	Peak numbers	1% of GB	1% of NW Europe
The Wash			
Cormorant	239	130	1,200
Scaup	46	110	3,100
Common scoter	388	230	8,000
Red-breasted merganser	101	100	1,000
North Norfolk Coast			
Red-throated diver	59	50	750
Common scoter	907	230	8,000
Velvet scoter	35	30	2,500

Figure 3.6 Seabird Vulnerability to Oiling in relation to Blocks 53/04, 49/28 and 49/29 from January to June

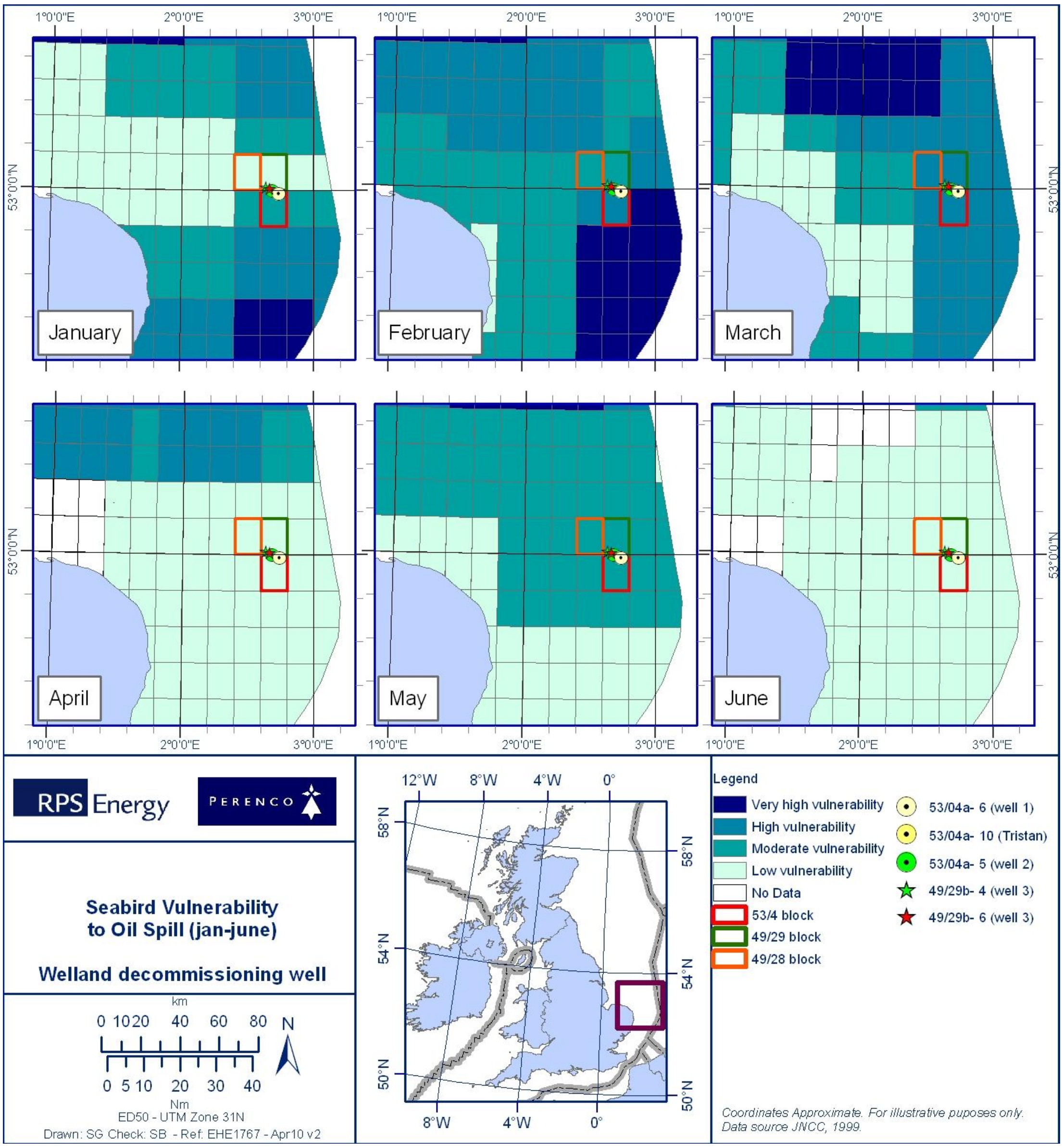
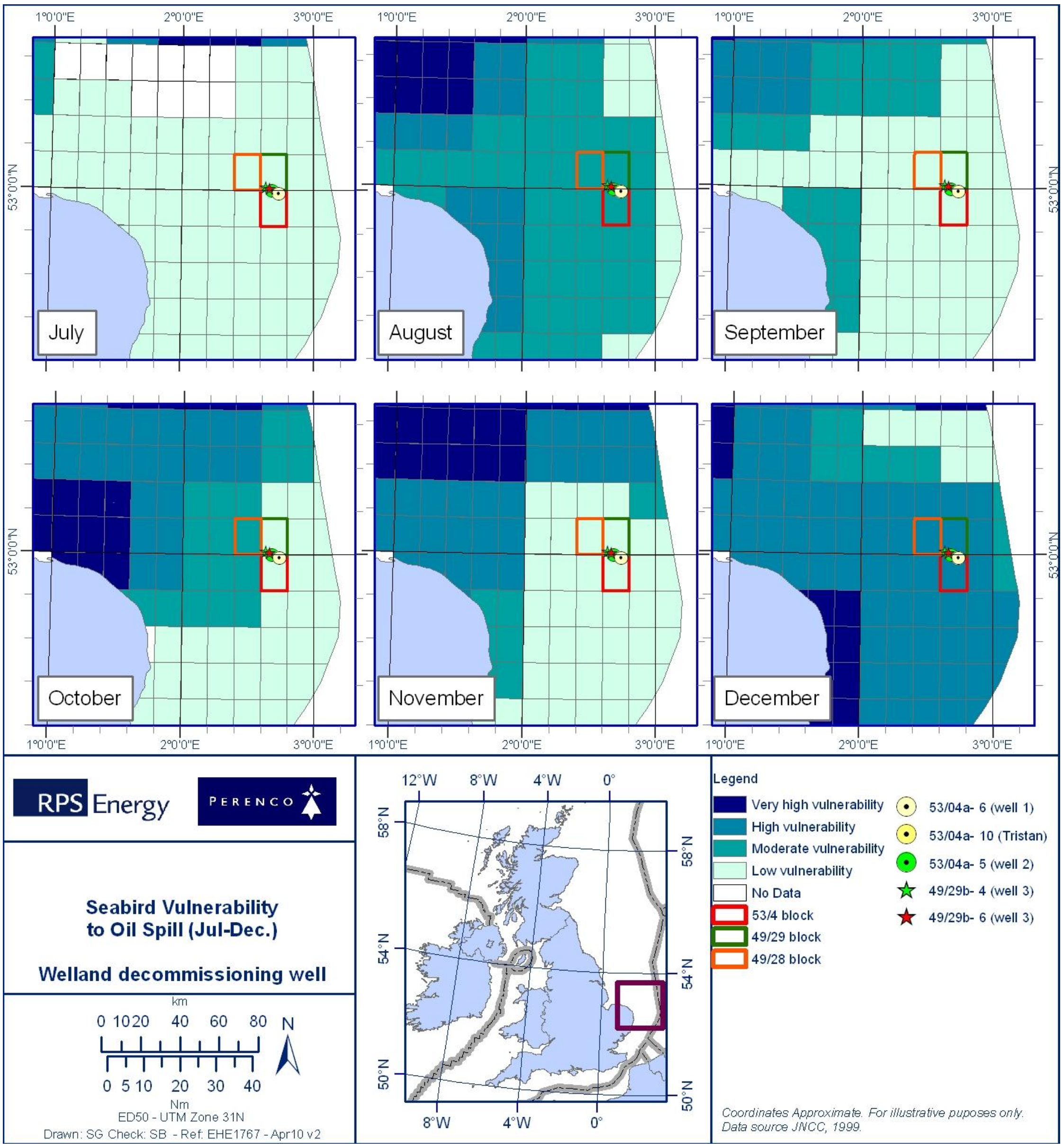


Figure 3.6 (continued). Seabird Vulnerability to Oiling in relation to Blocks 53/04, 49/28 and 49/29 from July to December



3.6.5 Marine Mammals

Cetaceans

Although five species of cetacean have been recorded in the southern North Sea; minke whale (*Balaenoptera acutorostrata*), harbour porpoise (*Phocoena phocoena*), white-beaked dolphin (*Lagenorhynchus albirostris*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*) and killer whale (*Orcinus orca*) (*Smith, 1998*), more recent data indicates that harbour porpoise is the only marine mammal occurring in the southern North Sea in densities similar to those found further north, and white-beaked dolphin sightings drop off sharply south of the Humber estuary. Atlantic white-sided dolphins are the only other species to have been sighted – albeit in extremely low numbers – in the southern North Sea (*JNCC, 2003*).

Only white-beaked dolphins and harbour porpoise have been sighted in the vicinity of the Welland field. White-beaked dolphins have been sighted in low numbers from March to April, and harbour porpoise have been sighted in low numbers from March, May to September and December (Table 3.7).

Table 3.7 Cetacean Sightings within Blocks 53/04, 49/29 and 49/28 and Surrounding Blocks (Reid et al., 2003)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Harbour porpoise (*Phocoena phocoena*)			V. Low		V. Low	Low	Low	V. Low	V. Low			V. Low
White-beaked dolphin (*Lagenorhynchus acutus*)			V. Low	V. Low	V. Low							

Key (Number of Cetacean Sightings per Kilometre Travelled)

High	Medium	Low	V. Low	No sighting

The Small Cetaceans in the European Atlantic and North Sea (SCANS II) project began in 2004 with the purpose of estimating small cetacean abundance in the UKCS area using both aerial and vessel based surveys. Abundance estimation was performed using line transect sampling. This method took into account, and attempted to reduce, bias in the data caused by the fact that not all animals are seen by vessel or aircraft observers, either because they are underwater, or missed, or because animals may initiate avoidance action in response to an approaching vessel. The survey results showed that harbour porpoises were the most commonly observed animals, with abundance in the North Sea area estimated at 335,000 animals, a figure largely similar to the estimate made in 1994 (340,000), indicating that population numbers have not changed significantly. However, large scale changes in the distribution data were observed between the 1994 and 2005 data. In 1994, harbour porpoises favoured areas off the north-eastern coast of the UK and waters around Denmark. In 2005, the main concentration had shifted to the southern North Sea area. Although it is not entirely clear as to why this change has occurred, it is thought that changes in the distribution and abundance of preferred prey may have led to harbour porpoises redistributing themselves either to follow their food sources or to find alternative prey (*SMRU, 2007*).

Pinnipeds

Both grey (*Halichoertus grypus*) and common (*Phoca vitulina*) seals habit the southern North Sea. Approximately 0.6 percent of the British grey seal population lives and breeds along the coastline between Newcastle and Great Yarmouth. The only significant common seal population in England occurs in the Wash, with numbers in the 1990s varying between 1,500 and 3,000 (representing less than 10 percent of the British total).

Common seals haul out every few days on tidally exposed areas of rock, sandbanks or mud. Pupping and moulting occur between May and August, during which time common seals will be ashore more often than at other times of the year. In general, common seals forage around their haul-out sites throughout the year and are not normally found more than 60 kilometres from shore (*SEA-2, DTI 2001*). A recent tracking study over five years (*SCOS, 2007*) suggested that common seals foraging distances varied to a great extent between individuals, with some animals making repetitive short distance trips of approximately 30 kilometres offshore whilst others travelled consistently to distances of up to 70 kilometres. It is unlikely therefore, that common or grey seals will spend time in the vicinity of the Welland infrastructure whilst foraging for food, given the distance to shore (over 71 kilometres). The diet of common seals is diverse and subject to seasonal and regional variation, and includes sandeels, whitefish and sprat, flatfish and cephalopods (*SEA-2, DTI 2001*).

Small numbers of grey seals breed on the sandbanks at Donna Nook, Lincolnshire, with occasional pups being born on the Norfolk coast. A haul-out site at Scroby Sands in Norfolk is also occasionally used for breeding (*Smith, 1998*). A mixed colony of common and grey seals breed, pup and moult at Blakeney Point. Grey and Common seal are also present at Blakeney point. Pupping in the southern North Sea occurs in January with the moulting season in February and March. During these periods the majority of the population will be on land for several weeks and subsequently densities at sea will be much lower than at other times of the year. Distribution data on British grey seals at sea, however, shows that they are unlikely to be found in the vicinity of the development given the distance from shore and, if present, would not spend any significant time in this area (*SEA-2, DTI 2001*). Although seasonal and regional variations may occur, the diet of grey seals is primarily composed (in order of importance) of sandeels, gadoids and flatfish (*SEA-2, DTI 2001*).

3.6.6 Marine Reptiles

Only one species of turtle, the leatherback turtle (*Dermochelys coriacea*), is reported in the North Sea. Densities of the leatherback turtle in the southern North Sea, however, are low, with the majority of sightings occurring in November (*Pierpoint, 2002*).

3.7 Protected Sites and Sensitive Coastal Habitats

3.7.1 Coastal Protected Sites

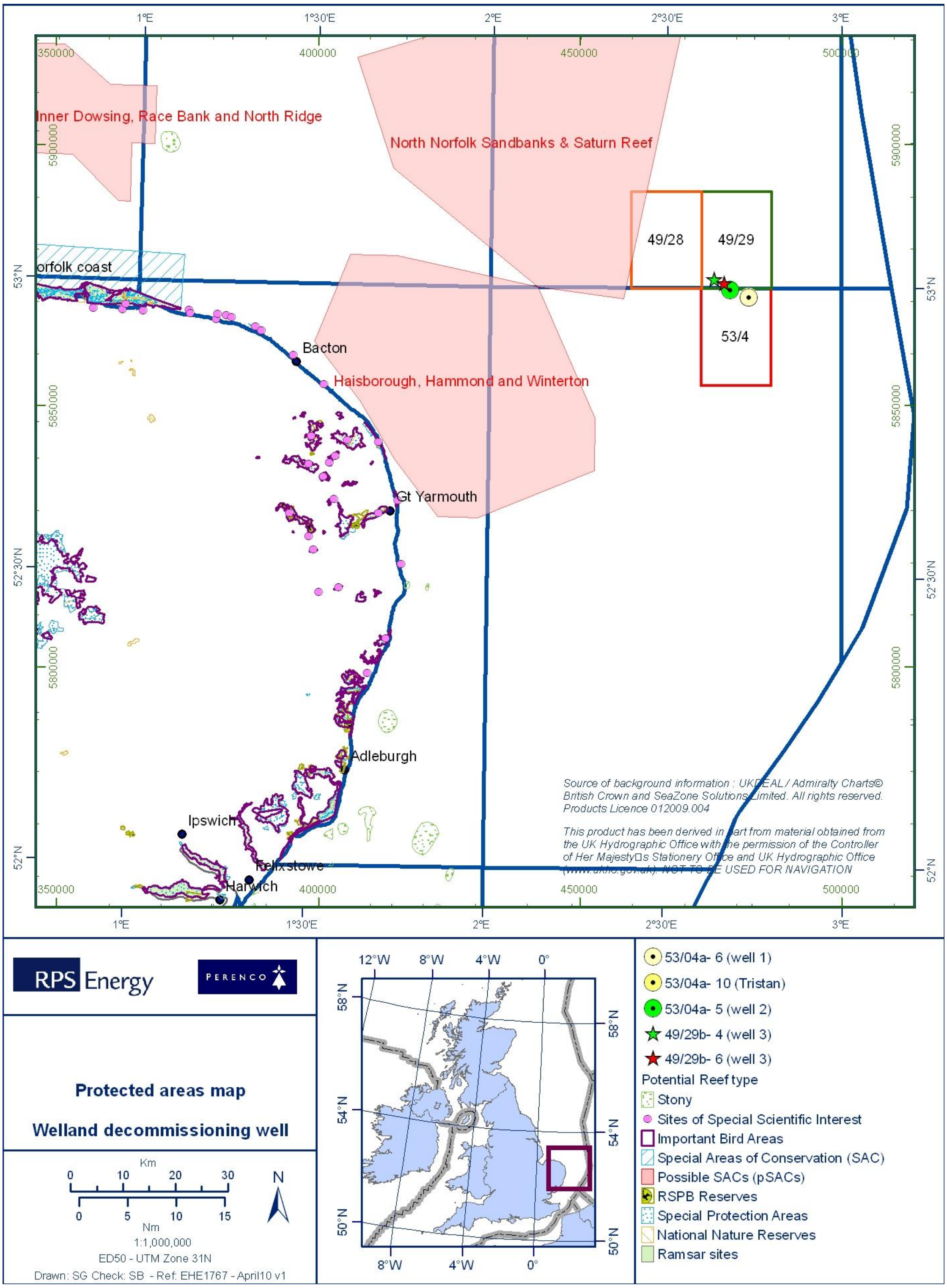
The North Norfolk coastline is the United Kingdom's most extensive and most geomorphologically and biologically important area of sand dune. It is made of a sequence of barrier island dunes, together with stretches of narrow mainland dunes cut off from active sandy beach by salt marsh. The coast of this region generally acts as a sediment sink with inter-tidal estuarine habitats, beaches, shingle structures and sand-dunes. Eroding cliffs can be also found along the north-east coast of Norfolk (*Barne et al., 1996*). Along 40 kilometres of coastline, there is a mosaic up to four kilometres wide of tidal flats, channels and salt-marshes formed in a shelter of beaches.

The protected coastal sites nearest to the Welland infrastructure are approximately 71 kilometres to the south-west on the adjacent coastline. International designations found in this region are described below and illustrated in Figure 3.7, and include:

- Ramsar and proposed Ramsar Sites (Internationally Important Wetlands of Importance, especially for Waterfowl, Ramsar 1971);
- Special Protection Areas (SPA), protecting rare and vulnerable species of wild birds (EC Directive on the Conservation of Wild Birds, 1979);
- Candidate Special Areas of Conservation (cSAC) (EC Directive for the Conservation of Natural Habitats and Wild Flora and Fauna 1992);
- Biogenic Reserves, to conserve representative examples of European flora and fauna (European Ministerial Conference 1973).

A large number of nationally designated sites are also present along the coast and include Sites of Special Scientific Interest (SSSIs) selected for geological interest or presence of special plants, terrestrial invertebrates, breeding seabirds or breeding waterfowl and National Nature Reserves (NNRs) which contain examples of some of the most important natural and semi-natural ecosystems in Britain including sand dune, shingle, saltmarsh, mudflat and wet grassland (Figure 3.7).

Figure 3.7 Protected Areas and Internationally Designated Habitats



3.7.2 Marine Protected Areas

The programme of protecting marine sites is driven by two European Council Directives, the ‘Habitats Directive’ and the ‘Birds Directive’. The Habitats Directive requires the identification of suitable areas for the protection of those habitat types and species listed by the Directive, leading to their designation as Special Areas of Conservation (SACs). The Birds Directive requires each Member State to identify the most suitable territories for the protection of those species listed by the Directive and also for regularly occurring migratory species, leading to their designation as Special Protection Areas (SPAs).

Together, the set of SAC and SPA sites form a network of protected sites across Europe, called the Natura 2000 network.

In August 2007, new regulations: The Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007 (OMCR), entered into force in the UK, extending the area over which SAC and SPA sites needed to be identified, designated and then protected, from 12 nautical miles (nm) to the 200nm extent of British fishery limits and the seabed within the UKCS area. The JNCC is responsible for identifying suitable offshore SAC and SPA sites.

To date, seven possible offshore SACs have been subject to public consultation, which took place from December 2007 to March 2008. As a result five candidate SACs and two possible SACs have been identified in UK offshore waters. All of the sites are chosen for their seabed habitats. Habitat types found in UK offshore waters listed in Annex I to the Directive and therefore requiring protection under the Habitats Directive are:

- Reefs;
- Sandbanks which are slightly covered by seawater all the time;
- Submarine structures made by leaking gases;

Species requiring protection under the Habitats Directive (listed in Annex II) which occur in UK offshore waters include harbour porpoise, bottlenose dolphin, grey seal and common seal. Analysis of existing data for harbour porpoise and bottlenose dolphin has not identified any suitable sites in UK offshore waters for these two species. Analysis of data for the two seals species is still ongoing to determine if any suitable sites can be identified in UK offshore waters (*JNCC, 2007*).

Prior to the identification of other SACs, locations supporting relevant features of interest should be treated with care to ensure that they are not damaged or altered in such a way that might affect their selection as Natura 2000 sites.

Annex I Habitats in the Vicinity of the Welland Infrastructure

Sandbanks

The main location of offshore sandbanks in the southern North Sea occurs around the north and north-east of Norfolk, in the outer Thames Estuary and off the south-east coast of Kent. These include areas of the Dogger Bank and the North Norfolk Sandbanks.

Sandbanks which are slightly covered by sea water all the time consist of sandy sediments that are permanently covered by shallow sea water, typically at depths of less than 20 metres below chart datum (but sometimes including channels or other areas greater than 20 metres deep). The habitat comprises distinct banks (i.e. elongated, rounded or irregular 'mound' shapes) which may arise from horizontal or sloping plains of sandy sediment. Where the areas of horizontal or sloping sandy habitat are closely associated with the banks, they are included within the Annex I type. The diversity and types of community associated with this habitat are determined particularly by sediment type together with a variety of other physical, chemical and hydrographic factors. These include geographical location (influencing water temperature), the relative exposure of the coast (from wave-exposed open coasts to tide-swept coasts or sheltered inlets and estuaries), the topographical structure of the habitat, and differences in the depth, turbidity and salinity of the surrounding water (*JNCC, 2007*).

The Welland insfrastructre is approximately eight kilometres outside the boundary of the North Norfolk Sandbanks possible Special Area of Conservation (pSAC) (Figure 3.7). The North Norfolk Sandbanks are a series of ten main sandbanks and associated fragmented smaller banks formed as a result of tidal processes. The sandbanks, which have a north-west to south-east orientation, are progressively, though very slowly, elongating in a north-westerly direction. The sandbank ridges are formed of sand and exhibit varying degrees of sandwaves (*Graham et al., 2001*).

Sandwaves are present and are best developed on the inner banks which have sandwaves between 4 and 6 metres high. The outer banks have small or no sandwaves associated with them. The outer banks are the best example of open sea, tidal sandbanks in a moderate current strength in UK waters. The sandbanks are not vegetated, but support invertebrate communities characteristic of southern North Sea sandbanks, ranging from those typical of highly-mobile fine sand sublittoral sediments, to communities on the outer banks which are more species rich, reflecting the lower sediment mobility.

The bank system is the most extensive example in UK waters of offshore linear ridges, and extends an estimated 54,488 hectares (using the 20 metres (LAT) isobath). The total site surface area of the pSAC is 4,327 square kilometres. The pSAC boundary takes account of the north-westerly migration of the banks and the formation and maintenance of the bank structure through offshore sediment transport. It has been designed to encompass the whole linear sandbank system rather than just individual banks (*JNCC, 2005*).

In 2001, the DTI commissioned a SEA-2 habitat survey of the North Norfolk sandbanks. Results from this survey show a fauna typified by the sea urchin *Echinocardium cordatum* and the bivalve *Fabulina fabula* with two species of sandeels common (*SEA-2, 2001*). In general, the biological communities on the North Norfolk Sandbanks, as analysed by JNCC, are typical of highly mobile fine sand sublittoral sediments, with the communities present all representative of the infralittoral mobile sand (SS.SSa.IFiSa.IMoSa) biotope. Species typical of this habitat include the polychaete *Nephtys cirrosa* and the isopod *Eurydice pulchra*. Opportunistic populations of infaunal amphipods and low numbers of mysids such as *Gastrosaccus spinifer* are also typical in more stable examples of this biotope. Sandeels *Ammodytes spp*. may occasionally be observed in association with this biotope (and others) as well as other common epifaunal species such as the crustacea *Pagurus bernhardus*, *Liocarcinus depurator*, *Carcinus maenas* and the echinoderm *Asterias rubens* (*JNCC, 2005*).

The biological and physical structure of habitats on the North Norfolk sandbanks have been impacted locally by some gas extraction infrastructure (mainly pipelines across banks) on the two inner banks of the Indefatigables, the north-west tip of Broken bank, the south-east portions of Well, Ower and Welland banks and the north-west tip of Ower bank. However, the physical structure of the banks is intact, if not pristine, and the biology is representative of the habitat. Current pressures from the oil and gas industry include installation, presence and maintenance of pipelines, installations and other sub-sea infrastructure, and potential pollution from drilling muds and other discharges, all of which may affect the structure and functions of the habitat (*JNCC, 2005*).

Reefs

Reefs are rocky substrates and biogenic concentrations, which arise from the sea floor in the sublittoral zone, but may extend into the littoral zone where there is an uninterrupted zonation of plant and animal communities. These reefs generally support a zonation of benthic communities of algae and animal species including concretions, encrustations and corrallogenic concretions. Reefs are scarce in UK offshore waters in the North Sea, however, the presence of biogenic reefs formed by the Ross worm *Sabellaria spinulosa* has been discovered in the southern North Sea (*Johnston et al., 2002*).

Sabellaria reefs are present offshore in the southern North Sea and are commonly found in the vicinity of shallow sandbanks. Of particular note is the Saturn (*Sabellaria*) biogenic reef located approximately 64 kilometres north-north-west from the Welland infrastructure in Block 48/20, first discovered in 2003. In 2003, the Saturn reef covered an area of approximately 750 metres by 500 metres just to the south of the Swarte Bank, varying in density over this area (*BMT Cordah, 2003* in *JNCC, 2007*). More recent surveys in the Saturn area did not find the extensive reef found in 2003, but whether this absence is as a result of damage to the reef structures (e.g. by bottom trawling) or whether such reefs are naturally ephemeral is not yet known. However, formation of such a substantial reef of *Sabellaria spinulosa* in this area in 2003 indicates favourable conditions for reef formation (*JNCC, 2007*). It should be noted that *Sabellaria spinulosa* is a frequently occurring species and patchy distribution on gravels and mixed sandy sediments or as thin crusts is not uncommon.

The detailed pipeline survey carried out by Noordhoek in 2009 for the Welland pipelines (*Noordhoek, 2009*) using sidescan sonar and drop-camera video found no *Sabellaria* in the vicinity of any of the Welland field pipelines.

Submarine structures made by leaking gas

No evidence of such structures has been reported within the vicinity of the Welland infrastructure, and the known areas of distribution of submarine structures made by leaking gasses (commonly known as 'pockmarks') and similar features do not include the study area. Pockmarks are more commonly known to occur within central and northern North Sea regions (*SEA2 DTI, 2001*).

Annex II Species in the Vicinity of the Welland Infrastructure

Of the species listed in Annex II, common seal, grey seal, bottlenose dolphin, white-beaked dolphin and harbour porpoise have distributions that potentially overlap the Welland field area. Common seals generally forage around their haul-out sites and are not normally found more than 60 kilometres from shore. Similarly, grey seals are mainly distributed around and between haul-out sites and foraging areas. Given the distance of the Welland field from the coastline, it is possible that common or grey seals may be present in the vicinity of the proposed decommissioning whilst foraging for food, although they are unlikely to spend any significant amounts of time in the area.

Bottlenose dolphins are rare in the southern North Sea and are reported to be infrequently recorded in the JNCC Atlas of Marine Mammals Distribution sighting effort. However, no sightings of bottlenose dolphins have been reported in the vicinity of the Welland infrastructure (*Reid et al., 2003*) (refer to Section 3.6.5).

Harbour porpoise have been sighted in the vicinity of Blocks 53/04, 49/29 and 49/28, but only in low numbers from February to June, and in August, September and December (refer to Section 3.6.5). White-beaked dolphins have also been sighted in the vicinity of Blocks 53/04, 49/29 and 49/28 from March to May, but again only in low numbers. Therefore it is unlikely that either harbour porpoises or white-beaked dolphins will be found in significant numbers in the vicinity of the Welland field.

3.8 Human Populations

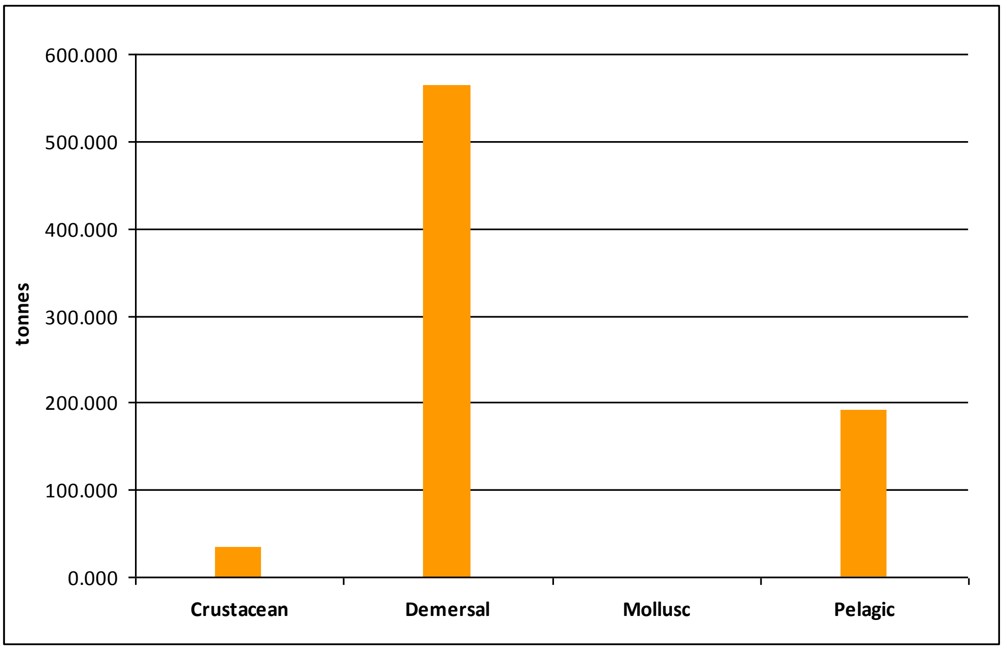
3.8.1 Commercial Fisheries

Decommissioning operations can potentially interfere with commercial fishing activities. The North Sea is one of the world's most important fishing grounds and major UK and international fishing fleets operate in the southern North Sea, including vessels from Belgium, Holland, Denmark and France. The Welland field lies within ICES rectangle 34F2 and 35F2.

The highest tonnages landed from ICES rectangles 34F2 and 35F2 by all vessels are demersal species including sole (*Solea solea*), plaice (*Pleuronectes platessa*), cod (*Gadus morhua*), dabs (*Limanda limanda*) and skates and rays (Figure 3.8). Other species include whelks, flounder (*Platichthys flesus*), turbot (*Psetta maxima*), and brill (*Scopthalamus rhombus*) but these are landed in considerably lower numbers. Demersal fish are taken by trawlers and fixed gear fishermen using fixed nets, longlines and trawls. However, the majority of static gear activity occurs to the west of the Welland field in ICES rectangles 34F1 and 35F1 (*CEFAS, pers. comm.)* North Sea plaice and sole are taken in a mixed flatfish fishery by mainly Dutch and UK registered beam trawlers in the southern and south-eastern North Sea (*SEA-2, DTI 2001*).

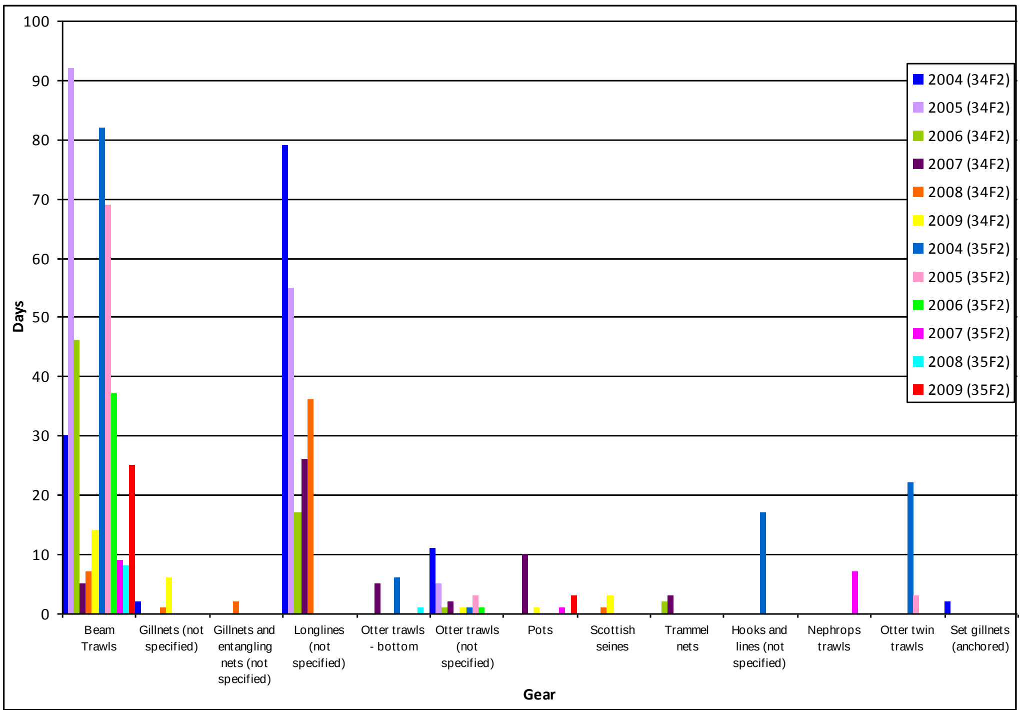
Landings data for 2007 shows that fishing in the area at this time was low. The species landed was mainly crabs, *Nephrops* and plaice from nephrops trawlers (*CEFAS, pers. comm*). Recent data shows that catches of pelagic species are virtually non-existent from this area, with shellfish, namely whelks and crabs, making up just over two percent of the total landings, in weight (*Marine Fisheries Agency, 2009*). However, an important fishery for brown shrimp (*Crangon crangon*) and pink shrimp (*Pandalus montagui*) is located further inshore, off the coast of Great Yarmouth, with species targeted by inshore beam trawlers between autumn and spring (*Smith,* *1998*). In addition, to the west of the development towards the Humber region, there is a prolific shell-fishery proving valuable catches of crab, lobster and whelk for local boasts based in East Anglia ports and North Norfolk (*NFFO, pers. comm.*).

Figure 3.8 Total Landings by Species Group (liveweight) in tonnes for all UK Vessels from ICES Rectangles 34F2 and 35F2 between 2004-2009 (Marine Fisheries Agency, 2009)



Cumulative fishing effort for English, Scottish and Belgian vessels in Rectangle 34F2 and 35F2 from 2004 to 2009 is shown in Figure 3.9. This shows that fishing effort, in terms of hours fished, was focused on the use of beam trawls. Overall fishing effort declined markedly between 2004 and 2008 but increased in 2009 (Jan-Oct).

Figure 3.9 Fishing effort in ICES rectangle 34F2 and 35F2 in number of days fished from 2004 to 2009 (Marine Fisheries Agency, 2009)



3.8.2 Shipping and Ports

Vessels associated with the planned decommissioning operations pose a potential hazard to shipping in the vicinity of the Welland field.

The density of shipping traffic within the southern North Sea is relatively high, due to the presence of a number of international ports within the region. Major ports within this region include Hull (a commercial and passenger port, with ro-ro ferry services to Zeebrugge and Rotterdam), Grimsby (the main port on the Humber, particularly important for commercial fishing landings) and Great Yarmouth (a supply/fabrication base for the offshore oil and gas industry with ro-ro facilities and a ferry service to The Netherlands).

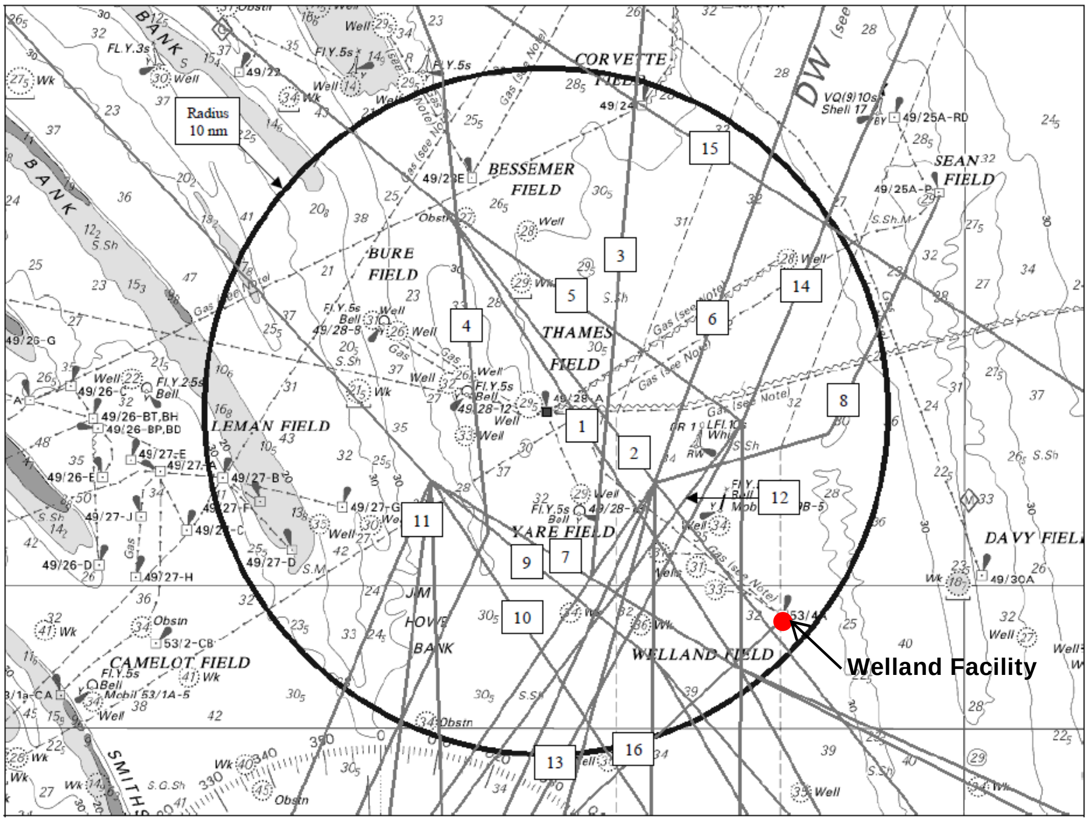
A shipping traffic study and collision risk assessment was carried out for the Thames installation in 2001 using the COAST database and the COLLIDE risk model. This identified 16 shipping routes passing within 10 nautical miles of the Thames installation. These routes are trafficked by an estimated 6,981 vessels per annum, which corresponds to an average of approximately 19 vessels per day (Table 3.8; Figure 3.12). Traffic within this area was found to be predominantly comprised of ferries, cargo vessels and tankers (*Safetec, 2001*). A shipping traffic study carried out for the Davy Development location in 2005 identified additional routes passing the vicinity of the Welland field including; Humber-Ijsselmeer, Zeebrugge-Rosyth Superfast and Harwich-Gothenburg DFDS. The Zeebrugge-Rosyth Superfast route was noted to have 2,974 ships per year and passes within 1.5 nm of the Welland field (*Perenco, pers. comm.*)

The routes passing closest to the Welland Facility are Routes 1, 2, 5, 7 and 16 (Table 3.8; Figure 3.10).

Table 3.8 Routes Identified Passing within 10 nautical miles of the Thames Installation (Safetec, 2001)

Route No.	Description	CPA (nm)	Bearing (°)	Ships Per Year
1	Rotterdam-Tees	0.6	57	16
2	Firth of Forth-Flushing	1.1	52	38
3	Indefatigable-Lowestoft	1.6	95	130
4	Great Yarmouth-Viking	2.2	264	147
5	Flushing-Firth of Forth	3.0	36	20
6	DWR Southbound Lane	3.6	110	2,467
7	DWR-Lerwick	3.6	211	518
8	Lowestoft-Sean	3.7	124	130
9	Lerwick-DWR	3.8	219	729
10	Rotterdam-Burghead	4.0	237	116
11	Tyne-Thames	4.0	240	122
12	Lowestoft-N Norway	4.7	126	145
13	Felixstowe-Boknafjorden	5.1	118	739
14	DWR Northbound Lane	5.6	93	1,551
15	Amsterdam-Firth of Forth	8.9	33	31
16	Great Yarmouth-Welland	9.0	137	82
TOTAL				6,981

Figure 3.10 Plot of Shipping Routes passing within 10 nautical miles of the Thames Installation (Welland Facility marked)



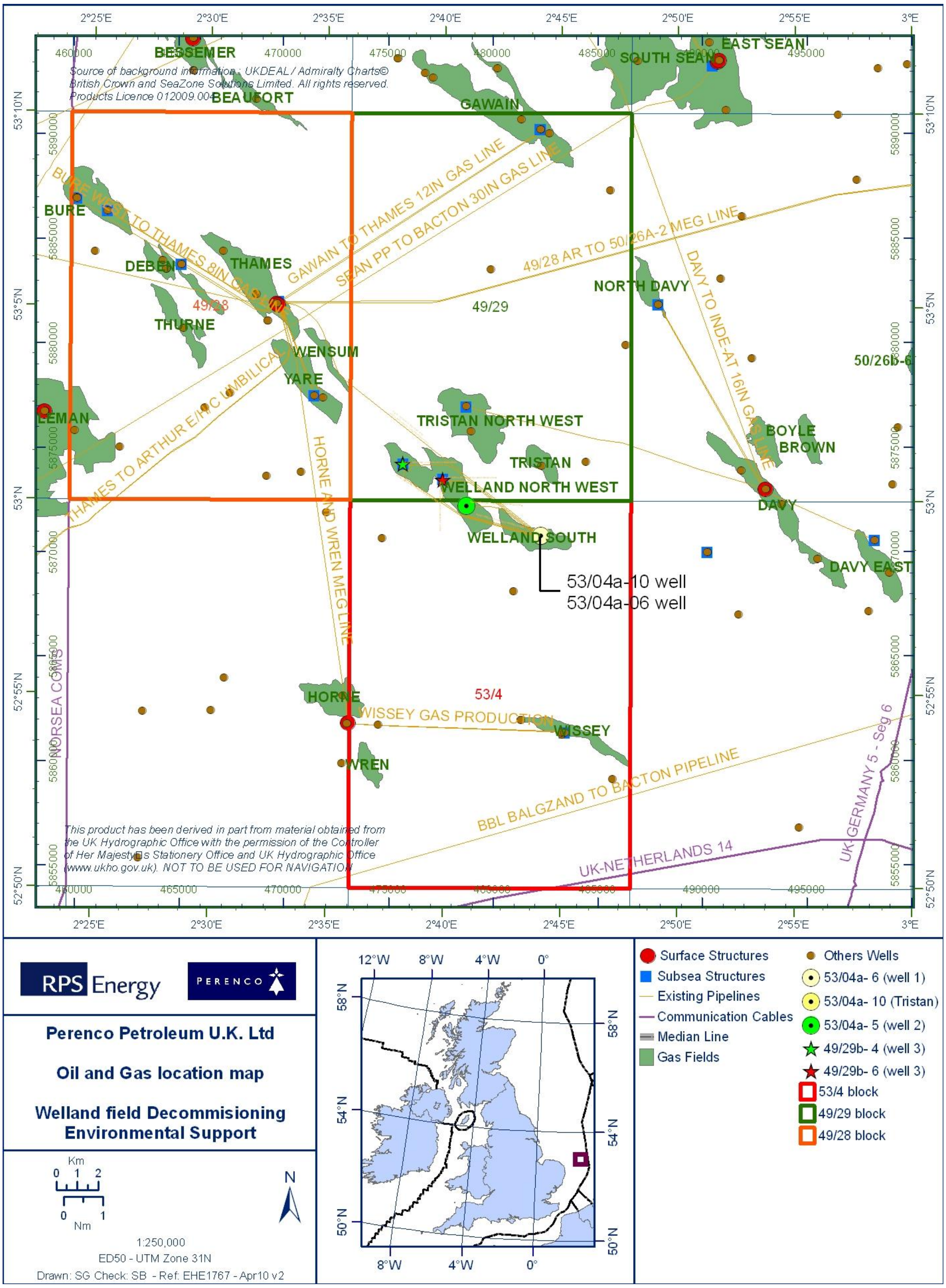
3.8.3 Military Activity

There are no charted or known areas of military activity within Blocks 53/4, 49/29 or 49/28 (*Hydrographer of the Navy, 1995; SEA-2, DTI 2001; BERR, 2008*).

3.8.4 Pipelines, Wells and Submarine Cables

Levels of oil and gas activity are high within Blocks 53/04, 49/29 and 49/28. Existing gas developments in Block 53/04 consist almost entirely of the Welland field. Wissley, Wren and Horne developments (owned by Tullow) are found in the southern section of the Block. In Block 49/29 the Welland Development is joined by Tristan and Tristan North West (owned by Silverstone). Pipelines in the area include mainly gas connections to the Thames field development in the north-west (Figure 3.11).

Figure 3.11 Existing Oil and Gas Activity in the Vicinity of the Welland infrastructure (UKDEAL, 2009)



3.8.5 Dredging and Dumping Activity

No commercial or capital dredging is undertaken, nor are there sites licensed for disposal of dredged material within Blocks 53/04, 49/29 and 49/28 (*DECC, 2008; Crown Estates, 2009*).

3.8.6 Wind Farms

The closest offshore wind farms to the Welland facility are Somerton and Scroby Sands, both located approximately 75 kilometres west on the Norfolk coast. Somerton has been operational since July 2000, whereas Scroby Sands came online in March 2004. Directly south of Scroby Sands, and approximately 80 kilometres from the Welland Facility, lies the Ness Point Offshore Wind Farm which has been operational since January 2005. B&Q Manton Wood Offshore Wind Farm is located in the Wash approximately 110 kilometres west of the Welland Facility (*Crown Estate, 2009; BWEA, 2009*) (Figure 3.13).

A number of potential wind farm sites in this area of the southern North Sea have also been awarded through Round 2 (*BWEA, 2009*; *The Crown Estate, 2009*; *DECC, 2009*) (Figure 3.13; Table 3.9).

3.8.7 Archaeology

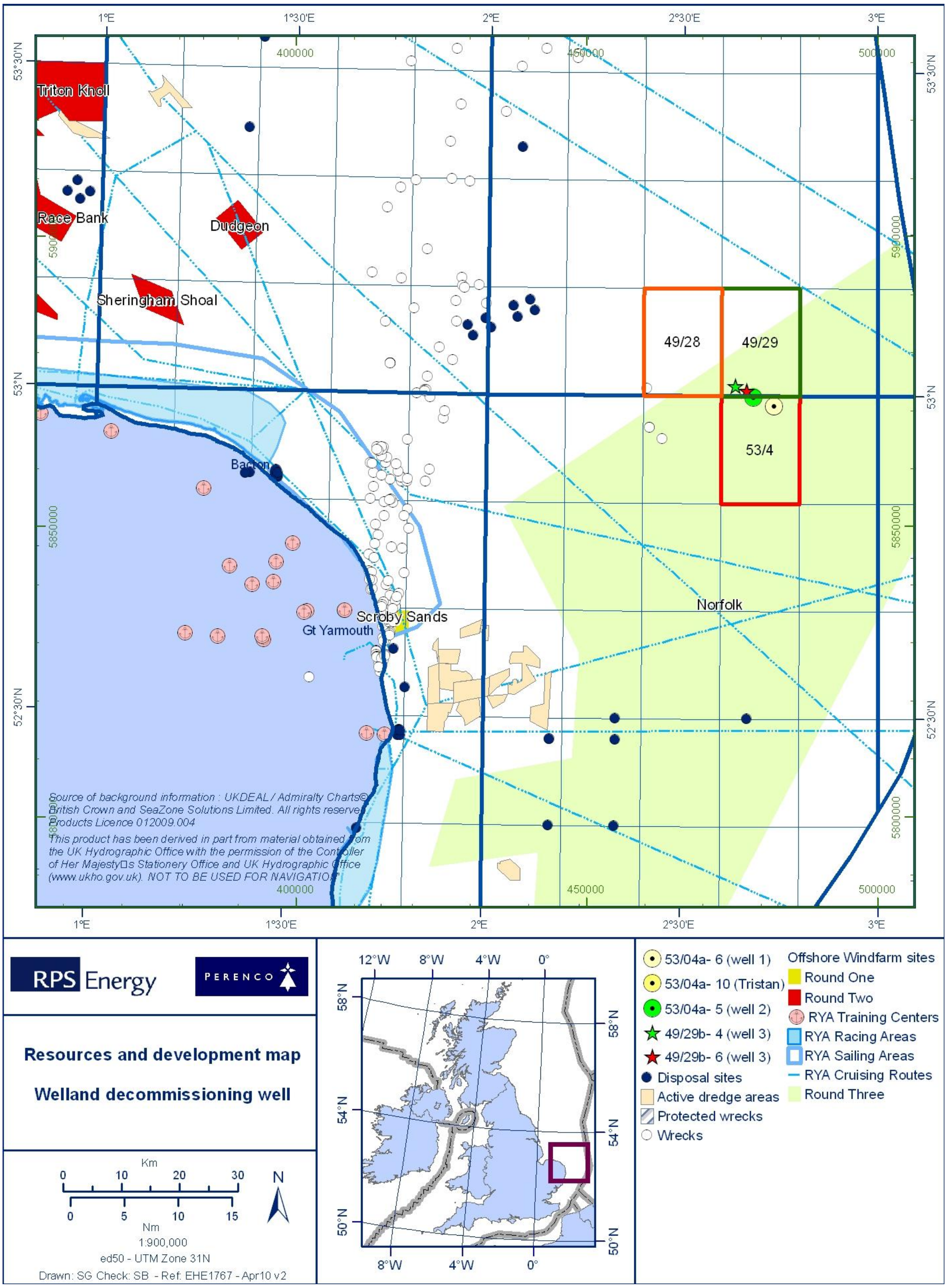
A charted wreck is located on the south-westernmost boundary of Block 49/28 (see Figure 3.13) approximately 15 km from the Welland installation (*Hydrographer of the Navy, 1995*). Another two wrecks are noted in the western part of Block 53/03 (*Hydrographer of the Navy, 1995*) at a similar distance from the Welland infrastructure. The proposed decommissioning operations are not expected to have any impact on the status of these wrecks.

3.8.8 Tourism and Leisure

Leisure based and tourist activities are fairly widespread along the east coast of England. Along the Lincolnshire Coast, Mablethorpe and Skegness are important areas for the holiday industry, but tourist facilities are also widespread between the Humber and The Wash. The north Norfolk coast is an important area for water-based activities, particularly dinghy sailing and wind-surfing. Bridlington and Great Yarmouth are both popular embarkation points for sea angling trips. The wildlife in the area is also a significant attraction and during the summer there are regular seal watching trips to Blakeney Point (*Smith, 1998*).

Although the tourism industry in the adjacent coastline is not expected to be impacted by decommissioning operations at the Welland field, leisure activities could be threatened in the event of a major accidental spill approaching the coast. The risks associated with oil spills are detailed in Section 4.10.

Figure 3.14. Resources and Development in the vicinity of UKCS Blocks 49/28, 49/29 and 53/04.



3.9 Key Environmental Sensitivities

The key environmental sensitivities (summarised in Table 3.9 below) identified during this environmental impact assessment are:

- Fish spawning area for mackerel, plaice, lemon sole, sprat and *Nephrops*, with peak spawning periods in January and February and from May to July;
- Fish nursery area for mackerel, lemon sole, cod and whiting;
- Highest seabird vulnerability (2 out of 4) in December;
- Cetacean numbers overall are low compared to areas in the north, with low densities of harbour porpoise from March to September, and in December. Low numbers of white-beaked dolphin sighted from March to May;
- Welland facilities located within the boundary of the North Norfolk Sandbanks dSAC;
- Shipping densities within the vicinity of the development are relatively high;
- Fishing effort within Blocks 53/4a, 49/29b and 49/28 is relatively low, mainly targeting demersal species. Peaks in activity in terms of hours fished have been recorded from January to March and from June to September.

Table 3.9. Seasonal Environmental Sensitivities in the Vicinity of the Welland Location

Activity in Blocks 53/04, 49/28, 49/29, surrounding waters and adjacent coast													
Component	**Abundance/Activity**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Plankton	Phytoplankton and zooplankton												
Benthic Fauna	Benthic faunal communities												
Fish Spawning	Mackerel (*Scomber scombrus*)							N	N	N	N		
	Lemon sole (*Microstomus kitt*)						N	N	N	N	N	N	
	Plaice (*Pleuronectes platesssa*)												
	Sprat (*Sprattus sprattus*)												
	Nephrops (*Nephrops norvegicus)*												
	Cod (*Gadus morhua*)			N	N	N	N						
	Whiting (*Merlangius merlangus)*				N	N	N	N	N				
Seabirds	Blocks 53/04, 49/29 and 49/27 vulnerability to oiling	3	2	2	4	3	4	4	3	4	3	4	2
Cetaceans	Harbour porpoise (*Phocoena phocoena*) abundance												
	White-beaked dolphin (*Lagenorhynchus acutus*) abundance												
Resource Users	Commercial fishing (ICES rectangle 35F2)												
	Shipping and ports												
	Military Activity												
	Oil and gas activity (inc. pipelines / cables)												
	Dredging and dumping												
	Protected Sites												
	Tourism, recreation & leisure activities												

Numbers refer to the seabird vulnerability index used by JNCC (1999) ranging from highest vulnerability (1) to lowest (4).

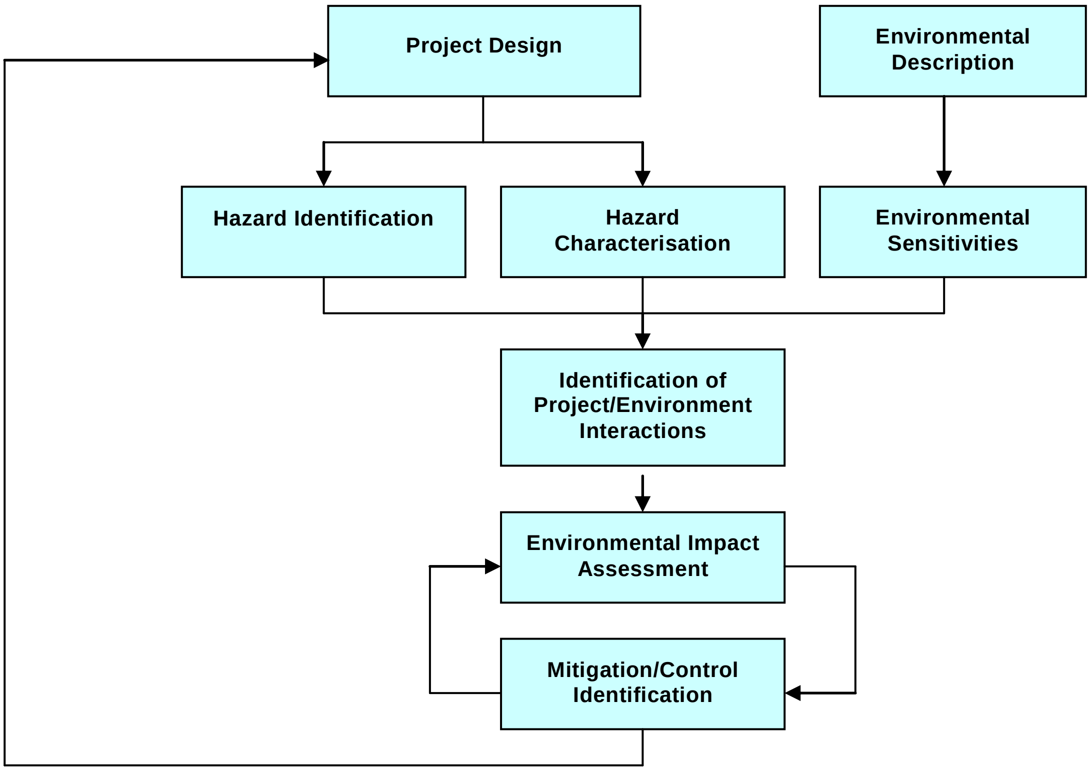
Coastal occurrence						Activity in Block 53/4a, 49/28a and 49/29b and, and surrounding waters									
	Peak		Low		None		Peak		Moderate		Low		None	N	Nursery

4 Environmental Hazards, Effects and Mitigation Measures

4.1 EIA Methodology

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 for this environmental impact assessment includes a description of the project (Section 2.0) based on the outcome of the Comparative Assessment study and the environment in which it will take place (Section 3.0).

This section further explores the interactions likely to occur between the proposed project and the surrounding environment, identifying the potential impacts and assess any effects. All mitigation measures currently proposed by the project proponents have been taken into account during this process.

4.2 Environmental Assessment Methodology

The first stage identifies hazards and associated impacts by examining the interactions between the hazards and the environment.

The process of environmental impact assessment considers each interaction qualitatively on the basis of the criteria of expected consequence provided in Table 4.1. This qualitative scale helps to rank hazards on a relative basis and identify areas where additional control measures may be required.

Table 4.1. Assessment of Consequence of Impact

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.

4.3 Identification of interactions

Table 4.2 presents a summary of the environmental impact identification and ranking exercise carried out for the project.

Table 4.2 Potential Hazards and Impacts for the Welland Decommissioning Project

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

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

1	Severe	2	Major	3	Moderate	4	Minor	5	Negligible		None

4.4 Physical Presence

Physical presence covers two main hazards: one associated with the presence of vessels at the Welland field during the operational phase of decommissioning; the other associated with ongoing physical presence of any material left, placed or displaced during the operational phase.

4.4.1 Physical Presence during Operations

During the operational phase of the decommissioning project, the physical presence of vessels (such as those required for cutting, lifting, removal and diver intervention, etc.) will pose a number of potential hazards. It is anticipated that the main potential hazard associated with physical presence will be disturbance to fishing/shipping in the area. The estimated duration of the on-site elements of the proposed decommissioning operations is 303 days.

Given that there is currently a 500m exclusion zone around the Welland installation within which the more complex decommissioning options will take place, and that operations will be of a limited, relatively short duration the impact of physical presence associated with decommissioning the installation is expected to be negligible. However, there will be an impact related to physical presence outwith the 500m exclusion zone such as with decommissioning the Subsea Wellhead Protection Structures, pipeline flushing and burying operations and transfer of decommissioned material. Overall, it is considered that the impact on other sea users should be classed as minor.

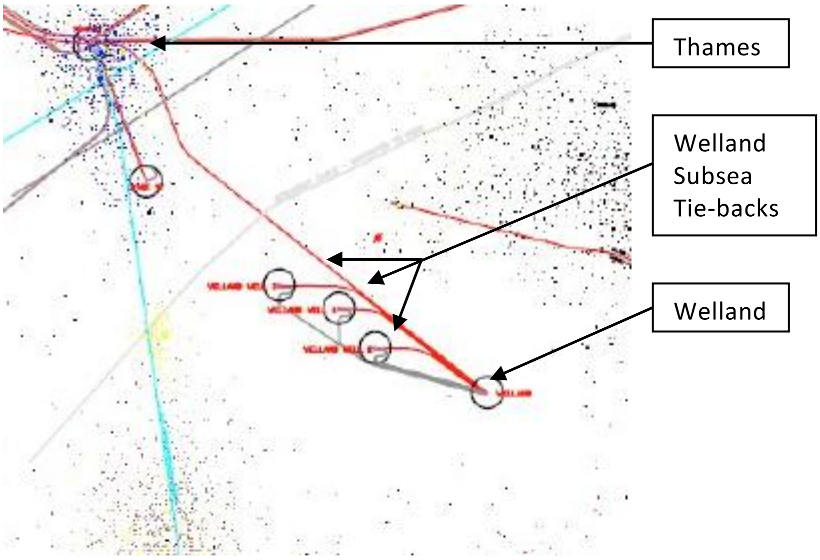
Prior to operations commencing, the appropriate notifications will be made & maritime notices posted. All vessel activities will be in accordance with national & international regulations. Appropriate navigation aids will be used to ensure other users of the sea are made aware of the presence of vessels.

4.4.2 Physical Presence following Operations

Once the offshore activities have ceased, there will be no impact to shipping. However as the export pipeline, MEG piggyback line, flowlines, umbilicals and mattresses will be left in place there is potential for ongoing impact to trawling vessels.

The fishing data provided in Section 3.8.1 indicates that fishing effort for ICES rectangle 35F2 is generally been declining since 2004 (with the exception of increased beam trawl effort in 2009). Data compiled by the MFA has been plotted for the specific Welland location (Fishing Patterns – Southern North Sea, 2009) and indicates that the area around the Welland field is relatively unused by fishing boats greater than 15m in length (see Figure 4.2) when compared to the nearby Thames and Davy fields.

Figure 4.2 Fishing Vessels >15m in Length – GPS Track Data in the Welland Field Area



Operations are planned to take place during the summer months when the weather is more conducive to decommissioning operations. However this will mean that operations will coincide with mackerel, lemon sole, plaice, sprat, and *Nephrops* spawning periods.

As the Welland topsides, jacket and subsea wellhead protection structures will be removed, together with the requirement for a 500m exclusion zone, the physical presence aspect in the Welland field will be greatly reduced following decommissioning operations.

The effects of leaving pipelines and umbilicals *in situ* will be minimal provided the cut ends are satisfactorily buried and spans do not appear. Pipelines will remain charted, however it is envisaged that as they are buried along their lengths (*Noordhoek, 2009*) they will not present an obstruction to trawling. Options for mattress removal / burial will depend upon an initial trial, which will be conducted to test if it is safe to remove concrete mattresses from the seabed. If shown that leaving *in situ* is a safer option, mattresses will be buried to ensure no interference with fishing activity.

4.5 Seabed Disturbance

Decommissioning of the Welland topsides, jacket, subsea wellhead protection structures, export pipeline, MEG line and flowlines will require work at, or near, the seabed; cutting of anchoring piles, flushing, cutting and burying pipe ends will all require divers and/or ROVs present near or at seabed level. This will increase sediment movement and water column turbidity, and subsequently re-deposition of fine sediments.

The deposition of fine solids described above has a direct effect on 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 can differ from that of the surrounding unaffected sediments. Such effects have been well studied and have shown that impacts from smothering can occur where the depth of re-deposition of sediment is one millimetre or more (*Bakke et al., 1986*).

Smothering will therefore affect an area surrounding the decommissioning operations but will likely be temporary in nature. As smothering will only be as a result of local sediment re-distribution, there is no toxic effect expected and so the impacted area will begin to recover soon after decommissioning operations have ceased.

Re-colonisation of the impacted area can take place in a number of ways including mobile species moving in from the edges of the area, juvenile recruitment from the plankton or from burrowing species digging back to the surface (*AUMS, 1987*).

Reef-building species are of particular importance in this area of the North Sea, and are often protected under European legislation. One such species, *Lophelia pertusa*, is found predominantly in deep waters off the shelf and is therefore unlikely to be found in the shallow Southern North Sea. A more prolific species in the area is *Sabellaria spinulosa*, a reef-building species which has been encountered during a vast number of operations in the area.

The total area affected by the decommissioning of the pipelines is limited to 1380m^3. Pipeline surveys conducted in 2009 (*Noordhoek, 2009*), which included drop-down camera imagery, found no evidence of *Sabellaria spinulosa* along the pipeline route. It is therefore considered unlikely that any *Sabellaria* reefs will be encountered during the proposed operations. In the event that Perenco finds evidence of Sabellaria during decommissioning activities, they will notify DECC.

The area around the Welland infrastructure is not a known herring spawning location (one of the commercially important species whose eggs are affected by smothering) and due to the localised nature of the seabed disturbance (only the ends of pipelines and the area around the base of subsea wellhead protection structures and jacket) it is considered that the potential for smothering of benthos and fish eggs is minor.

It is expected that the strong seabed currents and mobile sediments typical of the Welland area of the southern North Sea will mean that any seabed disturbances will be in-filled and/or weathered in line with the typical seabed undulations in the area. It is not expected that the seabed disturbances caused by decommissioning the Welland infrastructure will impact on fishing activities in the area due to their limited size and longevity.

4.6 Noise and Vibration

The Welland decommissioning activities will generate noise, both above and below the sea surface. Noise has the potential to impact fauna in the area, particularly some fish species and cetaceans, modifying their behaviour patterns.

Noise will be generated from machinery vibrations and from the power generators. The vessels that will be used to support the decommissioning operations include those that maintain their position by using thrusters when manoeuvring close to the operations (known as Dynamically Positioned (DP) vessels). Typically these vessels tend to generate more noise and of a higher frequency than a vessel’s main engines (up to 170 dB) (*Richardson et al, 1995*).

Typical subsea noise levels from offshore operations and expected natural attenuation are shown in Table 4.3.

Table 4.3 Typical Noise Levels Associated with Offshore Operations and their Natural Attenuation (adapted from: Evans & Nice, 1996; Richardson et al, 1995)

Activity	Frequency range (kHz)	Average source level (dB re 1µPa-m)	Estimated received level at different ranges (km) by spherical spreading (dB re 1µPa-m)			
			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 - 0.2	248	210	144	118	102
			208	187	162	87
Vertical Seismic Profiling	0.005 - 0.1	190	150	129	104	29
Production drilling	0.25	163	123	102	77	2
Jack-up drilling rig	0.005 - 1.2	85 - 127	45 - 87	24 - 66	<41	0
Semi-submersible rig	0.016 - 0.2	167 - 171	127 - 131	106 - 110	81 - 85	6 - 10
Drill ship	0.01 - 10	175 - 191	139 - 151	118 - 130	93 - 105	18 - 30
Large merchant vessel	0.005 - 0.9	160 - 190	120 - 150	99 - 129	74 - 104	<29
Super tanker	0.02 - 0.1	187 - 232	147 - 192	126 - 171	101 - 146	26 - 71

(dB) The magnitude of the sound manifests itself as pressure, i.e. 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)). In this report all dB reported are re 1µPa @ one metre in water. Source: *Richardson et al 1995.*

4.6.1 Potential Impacts on Marine Mammals

Marine Mammals Deliberate Disturbance and Injury

The proposed activities undertaken as part of the decommissioning program will cause underwater noise. Recent amendments to the Habitats Regulations (HR) 1994 and the Offshore Marine Regulations (OMR) 2007 make it an offence to cause either deliberate disturbance or injury to marine EPS (under regulation 39(1) (b) of both the HR and the OMR) in such a way as to be likely to significantly affect:

- the ability of any significant group of animals of that species to survive, breed, or rear or nurture their young; or
- the local distribution or abundance of that species.

Consequently, the JNCC released a guidance document entitled The Protection of Marine European Protected Species from Injury and Disturbance (JNCC, 2009) to enable operators to conform to the requirements of the HR and OMR regulations.

The Welland field is not an important area for European Protected Species (see Section 3.7.2). Furthermore, the planned decommissioning activities will not use explosives for dismantling infrastructure. Therefore, it is considered that the planned decommissioning activities do not constitute a deliberate disturbance.

Sound Propagation

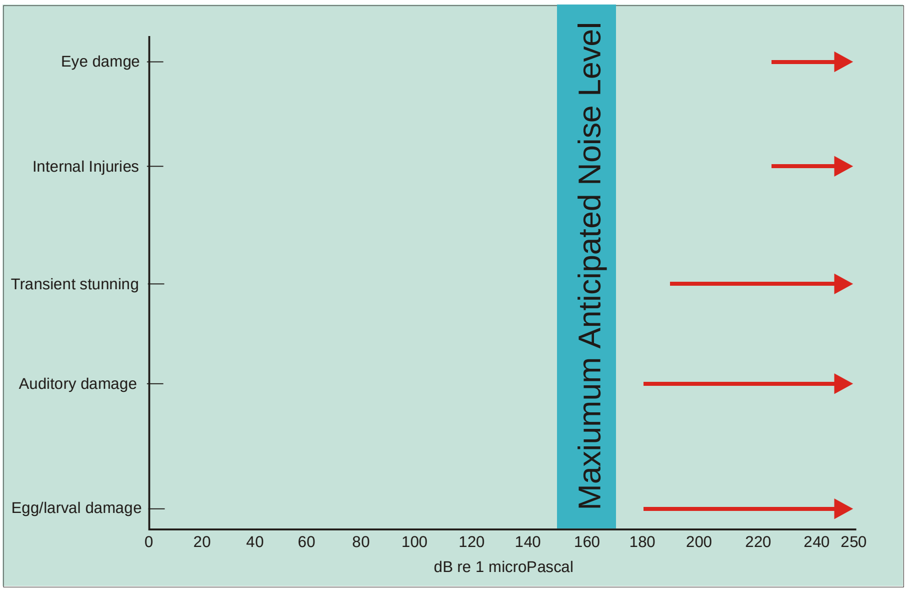
As sound spreads underwater, it decreases in strength with distance from source, this sound transmission loss is the sum of spreading loss and attenuation loss. Attenuation losses are the physical processes in the oceans that distort the mathematical spreading laws. Factors include sound absorption or scattering by organisms in the water column, reflection or scattering at the seabed and sea surface, and the effects of temperature, pressure, stratification and salinity. Actual sound transmission therefore has considerable temporal and spatial variability that is difficult to quantify.

Of note is that marine mammals are typically more tolerant of fixed location noise sources than moving sources and reactions to semi-submersible noise has been observed to be less severe than reactions to motor boats with outboards (*LGL, 2000*). Dolphins and other toothed whales show considerable tolerance of drill rigs and support vessels (*Richardson et al, 1995*).

4.6.2 Potential Impacts on Fish

Given the magnitude of sounds expected to be produced by the proposed decommissioning activities there are not expected to be any physical impacts on fish (Figure 4.3).

Figure 4.3. Sound Pressure Level Thresholds for the Onset of Fish Injuries (after Turnpenny & Nedwell, 1994)



4.7 Atmospheric Emissions

The main sources of atmospheric emissions during decommissioning will result from fuel burnt for power generation for the vessels in the field. Fuel burnt for power generation will give rise to emissions of carbon dioxide (CO_2), oxides of nitrogen (NOx) and sulphur dioxide (SOx). Total estimated fuel use for the selected decommissioning options is; 1230.75 Te of Marine Diesel, 680 Te of Heavy Oil and 88 Te of Aviation Fuel. Table 4.4 below indicates the estimated atmospheric emissions associated with this level of fuel use.

Table 4.4. Predicted Atmospheric Emissions during Decommissioning Activity

Gas[1]	Total Emissions for Preferred Decommissioning Options[2]
Carbon dioxide	6334.28
Oxides of nitrogen	112.74
Sulphur dioxide	9.43

Note:

1 Emission factors used from UKOOA 2002 based on methodology proposed by OGP

The UKCS annual emissions of CO_2 from production and drilling activity during 2007 was 19,750,849 tonnes (*DECC, 2007*). The incremental contribution of Welland decommissioning to UK CO_2 emissions is therefore insignificant (approximately 0.03% of 2007 UKCS emissions).

A simple dispersion model (Appendix B) has been used to predict the concentration of some of the key gases in the air at various distances from the Leadon location with an HLV and a DSV on location (the maximum daily fuel consumption). These calculations show that atmospheric emissions disperse rapidly and are orders of magnitude below health or environmental guidelines (Appendix C) within a short distance of the activities. Although all such emissions will contribute in a small way to the overall pool of greenhouse and acidic gases in the atmosphere, local environmental effects will be negligible and there will be no transboundary effects. Perenco will ensure that contract specification and control processes require all equipment and generators to be well maintained and operated.

Table 4.5 Predicted Combustion Gases Contributions to Atmospheric Concentrations Downwind during Combined HLV and DSV Operations

Pollutant	Concentration (μg/m3)									
	0.5km	1km	2km	3 km	4km	5 km	10 km	20km	30km	50km
CO_2	80.79	32.70	12.25	6.52	4.29	2.99	1.06	0.34	0.20	0.11
NOx	1.5036	0.6086	0.2279	0.1213	0.0798	0.0556	0.0196	0.0064	0.0037	0.0021
SO_2	0.2257	0.0914	0.0342	0.0182	0.0120	0.0083	0.0029	0.00096	0.00056	0.00031

All values based on Oil and Gas UK emission factors for diesel fuelled engine combustion

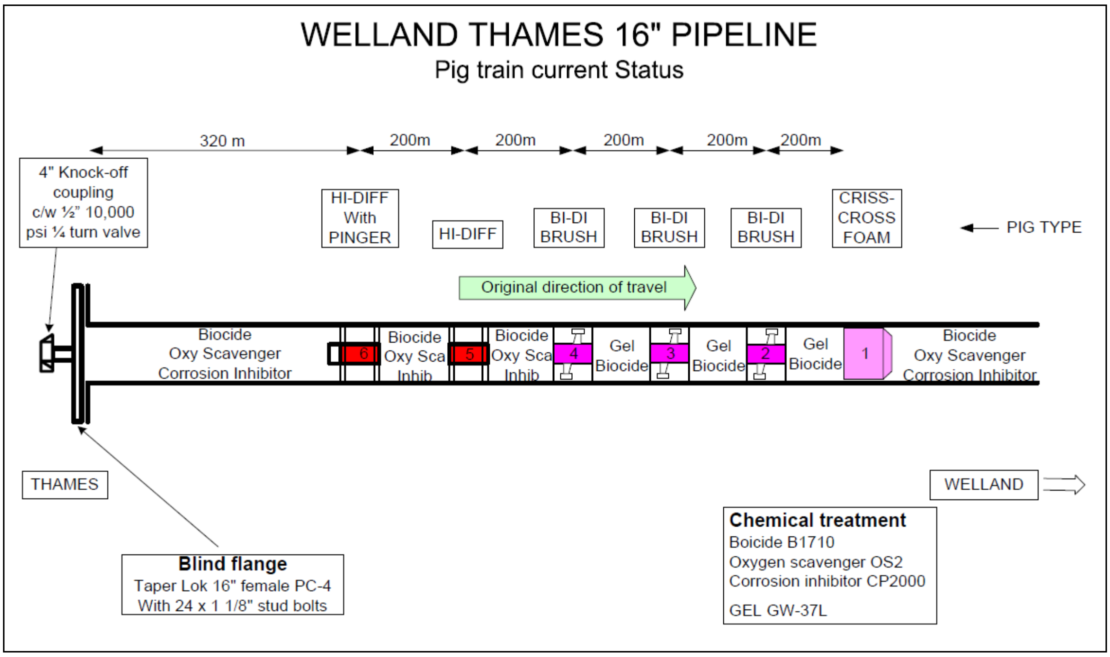
4.8 Marine Discharges

The Welland field produced gas and condensate and when production from the Welland field ceased in 2003 the 16″ export line was flushed with seawater from the Thames end to reduce the hydrocarbon contents of the pipeline prior to mothballing. A line volume flush was carried out and flushing was continued thereafter until the oil-in-water concentration measured at the Welland installation was <40ppm (it is understood the final concentration achieved was approximately 20ppm). Well 1 at the Welland installation was used as the donor well into which the fluids from the flush were disposed.

Following the flushing of the 16″ export line, the line was filled with inhibited seawater containing biocide (Bactron B1710), oxygen scavenger (OS-2) and corrosion inhibitor (Cortron CP2000). A multi-pig train (6 mechanical pigs – see Figure 4.4) was then introduced into the pipeline with the addition of a viscosifier (GW-37) between the first four pigs.

When the Welland-Thames pipeline was subsequently disconnected to allow re-allocation of the riser on Thames to the Arthur development, the Thames end of the 16″ export line was cut and a blind flange installed. It is envisaged that the planned decommissioning option will involve burying the Thames end of the pipeline and cutting, capping and burying the Welland end of the pipeline. Therefore there may be some discharge of chemicals currently in the pipeline from the Welland end of the pipeline when the pipeline is cut, limited only to that which may diffuse from the cut end in the period between cutting and re-burial.

Figure 4.4 Pig Train in Welland-Thames Export Pipeline



4.8.1 Pipeline Chemicals

Under the Offshore Chemicals Regulations 2002, operators require a permit to use and discharge chemicals. Operators need to assess the risks to the environment, which might arise from particular use and discharge. A formal process of risk assessment is required to support the permit application and shall be conducted prior to detailed design.

The chemicals currently contained within the pipeline were permitted following an application for a variation to Thames' Offshore Chemicals permit submitted by ExxonMobil in 2003. They were applied from the Thames installation with flush directed to a donor well at the Welland installation. Due to the length of the pipeline and the presence of the mechanical pigs, it is expected that only a fraction of the pipeline contents – and then only biocide (Bactron B1710), oxygen scavenger (OS-2) and corrosion inhibitor (Cortron CP2000) – will be discharged when the Welland end is cut. Additionally, it should also be noted that it is reasonable to expect the efficacy of the chemicals to have decreased after the prolonged application period (approximately 7 years). A PON15C will be submitted if required to cover the planned discharge of chemicals as part of the decommissioning operations.

The MEG piggyback line is currently filled with 40 m^3 Monoethylene Glycol (MEG). Additionally, the control umbilicals also contain 11.3 m^3 Monoethylene Glycol. A limited quantity of the MEG line contents will be discharged to sea when the lines are depressured as part of the decommissioning program. If required, this discharge will be permitted through a PON15C application. Monoethylene Glycol is described as PLONOR (Poses Little or No Risk) by CEFAS indicating that its discharge is not expected that the discharge will result in a significant impact on the surrounding marine environment.

4.8.2 Hydraulic Fluid

The three Welland control umbilicals contain 5.4 m^3 Castrol Transaqua HT hydraulic fluid. Hydraulic fluid is typically discharged to sea when controls valves on the wellhead are actuated. Although Castrol Transaqua HT would have originally been selected for use based on previous assessment of its environmental impact (previously labelled OCNS E), more recent criteria used by CEFAS to determine potential for environmental impact now identify Castrol Transaqua HT as OCNS C. Additionally, Castrol Transaqua HT is a chemical flagged for substitution. A replacement product is now available (Castrol Transaqua HT2) which is not flagged for substitution. However, as the decommissioning operations do not intend to use any additional hydraulic fluid, if required, a PON15C will be submitted to cover the discharge of Castrol Transaqua HT in the control umbilicals. An initial assessment of the impact of discharging the entire volume of Castrol Transaqua HT (5.4 m^3) using the Osborne-Adams model for subsea discharges indicates that the discharge would not be expected to have a significant impact on the surrounding marine environment.

4.8.3 Residual Oil

16″ Export Pipeline & 8″ Flowlines

The Welland field produced gas and condensate, and so although all lines have been or will be flushed with seawater, there is likely to be some liquid hydrocarbon residue adsorbed to the internal surfaces of the export pipeline. The export pipeline was flushed when production from the Welland field ceased in 2003 to an oil-in-water concentration of approximately 20ppm. The flowlines will be flushed back to a donor well at the Welland installation as part of the decommissioning operations. Flushing, however, cannot reasonably be expected to remove all hydrocarbons as a thin laminar layer adjacent to the pipeline wall is less likely to be removed at the flushing velocities employed. Approx. 618 litres of residual hydrocarbon is estimated to remain adhering to the export pipeline wall and 106 litres similarly adhering to the walls of the flowlines.

When the export line and flowlines are cut as part of the planned decommissioning operations there is the possibility that the discharge of treated seawater expected will contain traces of condensate. The concentration of oil-in-water that may be discharged when the pipeline or flowlines are cut will be at the concentrations remaining in the pipelines. The target post flushing concentration for the flowlines is <30 ppm, or that concentration remaining following flushing of each flowline with 2 volumes of seawater. Discharges on cutting the pipeline and flowlines will be limited to the diffusion of these low concentrations out of the cut ends over the period between cutting and re-burial of the lines. It should also be noted that it is planned to undertake these operations during a period of relatively low seabird vulnerability.

If required, any such release will be governed by a permit under the Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005. These regulations seek to ensure that oil discharges have been minimised where practicable.

Following decommissioning operations, the pipeline and flowlines will still contain traces of condensate. Over time as the pipeline integrity becomes compromised it is expected that the remaining pipeline and flowline contents will be discharged. However, the overall quantity and rate of discharge in this manner will be extremely low.

4.9 Solid Waste

The selected decommissioning options for Welland determine the overall waste to landfill. A summary of the material that may be disposed of to landfill is presented in Table 4.6.

It is Perenco’s intention to re-use or recycle as much of the recovered material as possible. The major impact from landfill disposal is the depletion of resources (i.e. land). Therefore, in order to minimise resource depletion, recovered material will be re-used or recycled to the maximum extent technically and financially viable.

All vessels used during decommissioning operations will implement appropriate Waste Management Plans and store and dispose of all solid wastes onshore accordingly. All discharges from the vessels will be treated and discharged in according to the MARPOL convention.

Table 4.6 Summary of Material Disposal to Landfill Associated with Welland Decommissioning

Infrastructure Item	Estimated Material Discarded to Landfill	Comments
Jacket & Topsides	0-20%	Majority of structure is steel and will be recycled. Other materials will be recycled, or reused. Paint/coatings, anodes, some plastics may be disposed to landfill. As one-piece removal the option for re-use remains and will be undertaken if possible.
Subsea Wellhead Protection Structures	0%	Comprised of steel so 100% can be recycled
16" Export Pipeline	0-20%	Cut sections of pipeline - concrete coating disposed to landfill
3" MEG Piggyback Line	0%	Cut sections of MEG line comprised of steel so 100% can be recycled
8" Subsea Flowlines	0-20%	Cut sections of pipeline - concrete coating disposed to landfill
4" Subsea Control Umbilicals	0-20%	Cut sections of umbilical - may be disposed to landfill as separation of components for recycling is technically and financially prohibitive
Pipeline Crossing Points	0%	Will not be removed - no material to landfill
Mattresses	0%	Will not be removed - no material to landfill

4.10 Loss of Containment

Accidental Oil Spill

The only causes of oil spill would be incidents such as vessel grounding, collision or explosion resulting in total loss of cargo. The largest fuel inventories will be associated with vessel fuel stores onboard (which is likely to be a mixture of heavy fuel oil and marine diesel). Nevertheless, from historical data it is possible to conclude that the probability of such incidents for offshore vessels is extremely remote.

As it is recognised that an oil spill could result in an environmental impact, Perenco has a number of management control and mitigation measures in place to ensure that any impact is avoided or minimised. For instance, all vessels will comply with IMO/MCA codes for prevention of oil pollution, and will also have onboard Shipboard Oil Pollution Emergency Plans (SOPEPS). An approved Perenco Offshore Oil Pollution Emergency Plan (OPEP) has been developed in accordance with the Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998. This details the actions to be taken in the event of a spill as well as the resources available to deal with it. Dispersants are available on the standby vessel and Perenco is a member of Oil Spill Response (OSR).

Although there are numerous species of seabird that use the waters in the vicinity of the Welland field, it is the winter months during which their numbers are greatest. Given that the Welland decommissioning works are scheduled to take place during summer months, no significant impacts on bird populations are expected should an oil spill occur.

Due to the relatively close proximity to the median line, it is appreciated that in the event of a large oil spill this could be expected to impact on the Dutch sector. However as stated above the probability of an oil spill occurring is low, and therefore the overall risk of a transboundary impact is considered insignificant.

Accidental Chemical Spill

The main factor causing loss of containment of chemicals is the technical failure of equipment, e.g. hose failure or leakage through loose fittings. However, as the planned decommissioning works do not require the use or discharge of chemicals in addition to those already present in the Welland infrastructure, any loss of containment will only result in the discharge of chemicals whose discharge has been assessed to be of potentially low impact significance. Therefore the overall risk posed by the discharge of chemicals is not increased by the potential for a spill occurring.

4.11 Cumulative Impacts

The general area surrounding Welland has been subject to development activity, including drilling with a range of water and oil based drilling muds, as well as atmospheric and waste emissions from vessels and offshore oil installations.

Potential cumulative impacts of the decommissioning activities are summarised in Table 4.7.

Table 4.7 Potential Cumulative Impacts from Welland Decommissioning

Hazard	Potential Cumulative Impact / Mitigation Measures
Physical Presence	No licensed dredging areas are located in the general development area. In terms of disturbance to shipping, most of the work will take place within existing exclusion zones over a limited period (approximately three months). If the mattresses and pipelines remain in place, there is limited potential for impact to fishing. This will be minimised by burying.
Seabed Disturbance	Following removal of jacket, topsides and subsea wellhead protection structures and burying of pipelines and mattresses, the seabed will recover in time and the cumulative impact is considered negligible.
Marine Discharges	All discharges are limited quantities, however with potential for long term release of hydrocarbons (although at an extremely low rate). In addition, all releases are considered low risk to the receiving environment. Cumulative impacts are therefore not considered significant.
Noise and Vibration	Noise will be generated by the vessels in the field and subsea cutting and ROV operations. This will have a cumulative impact in the area that will be limited to the duration of the works. No permanent modification in behaviour (of either fish or cetaceans) is expected.
Atmospheric Emissions	Predicted atmospheric emissions are of very low importance when compared to the overall levels of emissions from offshore exploration and production activities on the UKCS and the UK as a whole. In addition there will be no long term emissions.
Loss of Containment	There will only be a cumulative impact from accidental emissions if an incident occurs. Although there is a slight increase in the risk of an incident occurring as a result of having more vessels in the area, the preventative and mitigation measures employed during the project will ensure that the incremental risk is minimised and no cumulative impacts are therefore anticipated.

In summary, environmental impacts offshore will be confined to short term disruption from decommissioning activities and from one-off discharges.

4.12 Transboundary Impacts

The issues with the potential for transboundary effects, in the context of this project, are atmospheric emissions and accidental events leading to a fuel spill. The closest international boundary, between the U.K. and Holland, is 26.5 kilometres east of the Welland field. It is unlikely that atmospheric emissions from the vessels would be detectable at the median line, being indistinguishable from normal vessel activity in the area.

There is potential, in the very unlikely event of a spill during operations, for fuel oil to cross the median line and therefore Perenco will ensure that all OPEPs fully consider the interfaces between the UK and Dutch resources and discuss response strategy, resources and any potential impacts in detail.

5 Environmental Management

5.1 Introduction

The Environmental Management chapter is intended to provide an outline of the arrangements that will be put in place to ensure that the mitigation and other measures to control or reduce predicted impacts are implemented and effective. These arrangements draw heavily on the environmental management system (EMS) operated by Perenco U.K. Limited and the control requirements emerging from the Environmental Statement (ES).

The following sections describe the key elements of Perenco's EMS, indicating how they will be applied to the Welland facilities Decommissioning project.

Environmental Impact Assessment (EIA) is a key principle of Perenco's EMS. It allows the comparison of the environmental impacts of alternative solutions during the evolution of the project from design through procurement and construction to installation and operation, and to seek mitigation and control measures that aim to prevent pollution and minimise waste.

In addition to providing the means to implement the identified mitigation and control measures, the EMS enables the monitoring of their effectiveness through checks on actual environmental performance.

Figure 6.1 illustrates the relationship between the ES and the different components of Perenco's EMS, which broadly follows the ISO 14001 structure. The EMS will allow Perenco to control environmental impacts and will provide assurance that the environmental management is effective. The basis of the EMS is the Environmental Policy statement.

5.2 Decommissioning of Facilities

Management of the impacts associated with the project's decommissioning places a considerable environmental responsibility on the contractors. These responsibilities will be incorporated into the contracts that will be issued for the works.

Contractors will be required to submit QHSE plans that explain their approach to the work. The plans will be reviewed by Perenco to ensure that environmental performance standards will be met.

The ES provides four key inputs to Perenco's EMS:

- The definition of significant impacts;
- Regulatory requirements;
- Operational control measures proposed to address the significant impacts (mitigation); and
- Monitoring requirements.

5.3 Operational Controls

5.3.1 Decommissioning Contractors

The contractors' HSE Plans will be the primary means of implementing the mitigation measures during the decommissioning of the development. In conjunction with Perenco's HSE support staff, Perenco's project engineers will be responsible for the review and acceptance of the contractors' plans and confirming that they incorporate appropriate mitigation measures for the installation phase of the project.

5.4 Improvement Programmes and the Management of Change

The purpose of improvement programmes is to:

- Drive Perenco's policy commitment to continuous improvement; and
- Introduce changes that ensure the achievement of performance standards where current performance is below expectations.

The EMS also makes provision for the management of change. Change may occur for a number of reasons, and at a number of levels. A 'management of change' procedure specifies the circumstances when formal control of change is required to ensure that significant impacts remain under control and/or new impacts are identified, evaluated and controlled, for example the management of future decommissioning.

5.5 Roles and Responsibilities

Perenco will review existing environmental roles and responsibilities for staff and these will be amended and recorded in individual job descriptions to ensure that they take account of changes required for the management of the impacts identified in this ES.

5.6 Training and Competence

The competence of staff with environmental responsibilities is a critical means of control. The EMS, in conjunction with Perenco's Human Resources ensures the appointment of suitably competent staff and the development and implementation of training programmes to ensure that environmental control requirements are understood and applied.

5.7 Communication

Internal environmental communication generally employs existing channels such as management meetings, minutes, poster displays, etc.

External communication with stakeholders and interested parties is controlled through a communication programme. This establishes links between each stakeholder, the issues that are of concern to them, and the information they require to assure them that their concerns and expectations are being addressed. This ES and the consultation process that informed its production will be used to design the on-going communication programme. Communication and reporting will employ information derived from the monitoring programme.

5.8 Document Control

The control of EMS documents is managed in Perenco's Document Control System (DCS).

5.9 Records

Records provide the evidence of conformance with the requirements of the EMS and of the achievement of the objectives and targets in the Improvement Programmes. Perenco's EMS specifies those records that are to be generated for these purposes, and controls their creation, storage, assess and retention.

5.10 Monitoring & Audit

Checking techniques employed within Perenco's EMS are a combination of monitoring, inspection activities and periodic audits.

The requirement for monitoring and inspection stems from the need to provide information to a number of different stakeholders, but primarily regulators, and Perenco management. As such, there is a requirement for the results of monitoring and inspection to be integrated with the Perenco's internal and external communication programme.

Monitoring and inspection activities focus on:

- Checks that process parameters remain within design boundaries – process monitoring;
- Checks that emissions and discharges remain within specified performance standards – emissions monitoring; and
- Checks that the impacts of emissions and discharges are within acceptable limits – ambient monitoring.

5.11 Incident Reporting & Investigation

The HSE MS includes documented procedures to control the reporting and investigation of incidents. Specifically, EMP 021 details the requirements and arrangements for the reporting of spills (PON1) or dropped objects (PON2).

5.12 Non-conformance and Corrective Action

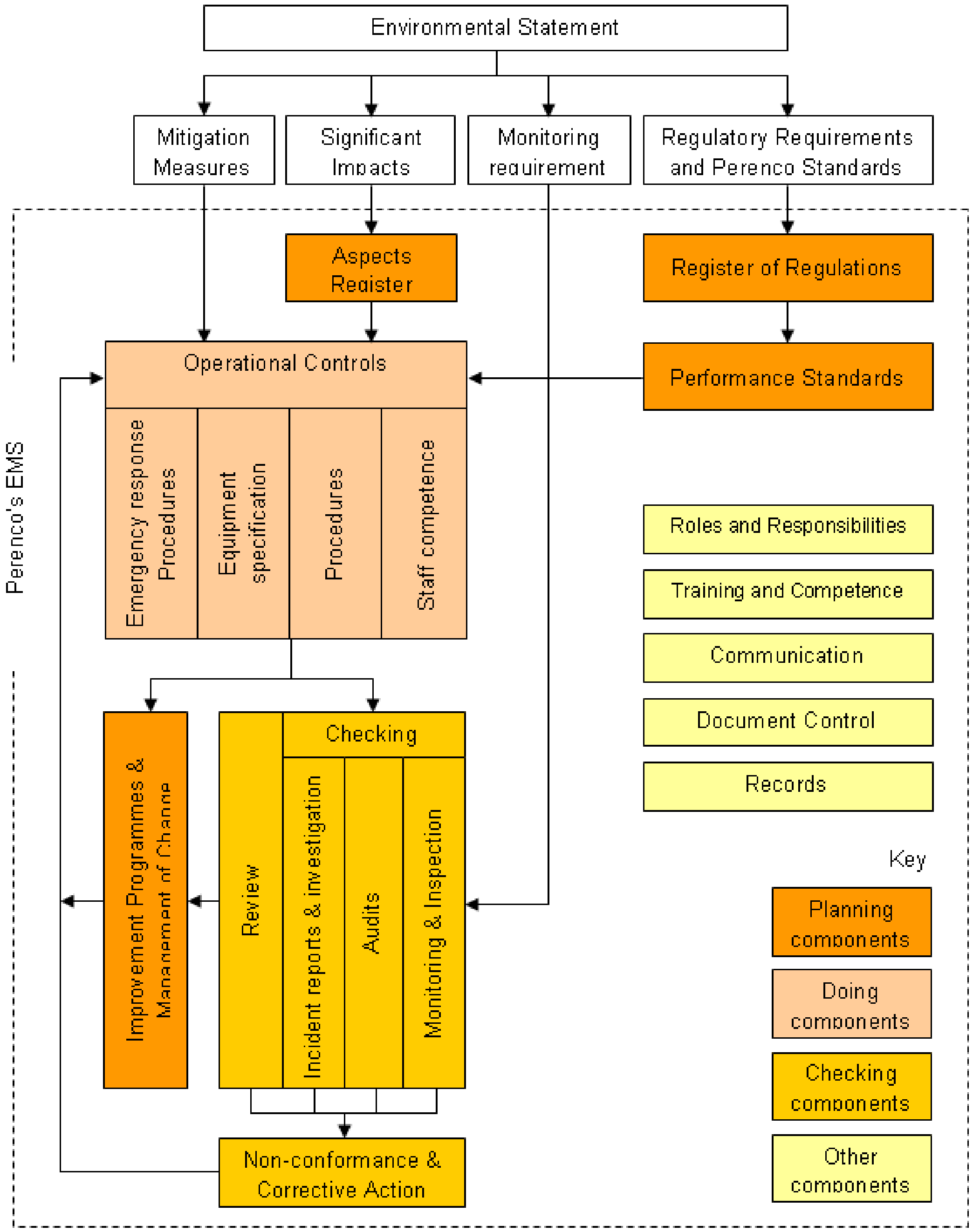
The checking techniques outlined above are the means of detecting error or non-conformances. Perenco's HSE MS includes procedures for the formal recording and reporting of detected non-conformance, the definition of appropriate corrective action, the allocation of responsibilities and monitoring of close out.

5.13 Review

Perenco's HSE MS includes arrangements for management review. This provides the means to ensure that the HSE MS remains an effective tool to control the environmental impacts of operations, and to re-configure the EMS in the light of internal or external change affecting the scope or significance of the impacts.

Of particular importance is the role management review plays in the definition and implementation of the improvement programme, and the management of change.

Figure 5.1. The Relationship between the ES and Perenco's Environmental Management System



6 Conclusions

Perenco U.K. Limited is proposing to decommission the Welland installation and associated infrastructure, which is located in Blocks 53/4a, 49/29b and 49/29 of the southern North Sea. The Welland infrastructure consists of; the Welland installation topsides and jacket, three subsea wellhead protection structures, a 16 inch gas export line and associated 3 inch MEG piggyback line spanning approximately 17.5 kilometres from Welland to Thames (including three pipeline crossing points), three 8 inch subsea flowlines (approximately 18 kilometres in total) and three 4 inch control umbilicals (approximately 21.6 kilometres in total), and 128 mattresses (43 flexible mattresses and 85 frond mattresses).

The key hazards, resulting environmental effects and mitigation measures proposed by Perenco to mitigate those effects are identified in Table 6.1, below.

The environmental impact assessment reviewed the selected decommissioning options identified during the comparative assessment process for the Welland infrastructure. No significant environmental impacts were identified, with all impacts expected to be either minor or negligible. In addition, incremental cumulative impacts and trans-boundary effects associated with the planned decommissioning operations are expected to be negligible.

Table 6.1 Conclusions

ROUTINE HAZARDS		
Hazard & Effect(s)	**Effects and Mitigation**	**Residual Impact**
Physical Presence Disruption to other sea users	Total vessel time in the field is estimated to be approximately 303 days. The main structures being decommissioned are located within the Welland exclusion zone and therefore decommissioning activities are not expected to impact on other shipping activities. However, the Subsea Wellhead Protection Structures are located in a shipping lane and although they would not normally impact shipping, during structure removal and pipeline cutting and burying there will be an impact. Any interference with fishing will be limited to temporary localized restrictions around the HLV, DSV, and PSVs, as appropriate. Prior to operations commencing, the appropriate notifications will be made & maritime notices posted. All vessel activities will be in accordance with national & international regulations. Appropriate navigation aids will be used to ensure other users of the sea are made aware of the presence of vessels.	The presence of vessels in the field is expected to have only a limited effect on third parties. Existing shipping routes in the area give due consideration to existing platform exclusion zones, however there will be a potential impact to the navigation of vessels in this area from the decommissioning of the Subsea Wellhead Protection Structures. This impact is therefore assessed as ***minor***. Leaving the infrastructure on the seabed (pipeline, MEG line, flowlines, umbilicals, pipeline crossing points and mattresses) has been assessed as having a ***minor*** impact on fishing activities in the area and this will be minimised by ensuring that all infrastructure remaining on the seabed is suitably buried. For infrastructure that will be removed from the seabed (jacket and subsea wellhead protection structures) the impact has been assessed as ***negligible/beneficial*** as there will be no obstruction to fishing activities compared with the current status.
Seabed Disturbance Disturbance will occur from the removal of jacket, subsea wellheads, pipe ends and the burial of pipe ends and mattresses.	Cutting of jacket and subsea wellhead protection structures pilings, and pipe ends will require divers and/or ROVs present near or at seabed level. This will increase sediment movement and water column turbidity, and subsequently re-deposition of fine sediment. Burial of cut pipe ends and any exposed mattresses will also involve disturbance of seabed sediments, with associated turbidity and re-deposition of fine sediments. Pipeline surveys in the Welland field have noted increasing depth of burial over time. Therefore it is expected that burial will only be necessary for newly disturbed infrastructure with the result that the area disturbed will be a small percentage of the total infrastructure footprint. Images from drop down camera deployed during the 2009 pipeline survey found no evidence of the presence of *Sabellaria spinulosa reefs.*	The impact on seabed fauna has been assessed as ***negligible***. Benthic communities found in the area of the proposed development are typical of those found over wide areas of the southern North Sea and the effects will be localised. No new materials will be added to the seabed (e.g. rock dump) as part of the planned decommissioning operations. If *Sabellaria spinulosa* is detected at any time during the decommissioning operations, Perenco will notify DECC to this effect.
Marine Discharges Will include discharge of treated seawater, MEG, hydraulic fluid	The export pipeline and flowlines contain an estimated 618 litres and 106 litres, respectively of HC remaining adhering to the pipeline walls. The Welland export pipeline has been left filled with approximately 1,828 m^3 of treated seawater (containing approximately; 350kg (191 mg/l) of biocide Bactron	***Negligible*** due to the low volume of the discharges, the nature of the chemicals (taking into account any reduction in efficacy) and the anticipated rapid dilution and dispersion, all impacts are predicted to be short-term and localised.

ROUTINE HAZARDS		
Hazard & Effect(s)	**Effects and Mitigation**	**Residual Impact**
and residual hydrocarbons.	B1710, 250 kg (138mg/l) of oxygen scavenger OS-2 and 390 kg (213 mg/l) of corrosion inhibitor Cortron CP2000). During the decommissioning process there is the potential for some of the treated seawater to be released to the marine environment. The export pipeline currently also contains approximately 90 m^3 of high-viscosity pills (comprised of 2,475 kg (40:1) of GW-37 viscosifier and 20 kg (222 mg/l) of biocide Bactron B1710). As these pills are contained behind mechanical pigs, no discharge is expected during decommissioning operations. The MEG piggyback line contains approximately 40 m^3 of 80:20 Monoethylene Glycol: water mix. The subsea control umbilicals also contain Monoethylene Glycol (approximately 11.3 m^3) There is potential for some of this to be discharged during decommissioning operations. The chemical risk assessment indicates that the discharge of treated seawater or Monoethylene Glycol is unlikely to have an impact on the receiving marine environment, either as a result of diffusion from the cuts ends in the period between cutting and re-burial, or over the much longer period as the structure of the pipelines degrades and their contents are slowly released to the environment. It is also reasonable to expect the efficacy of the chemicals to have decreased after the prolonged period subsea (approximately 7years). The total volume of hydraulic fluid contained within the control umbilicals tubing has been calculated at 5.4 m^3. There is potential for some of this to be discharged to sea during decommissioning operations. A conservative risk calculation (using the Osborne-Adams model) indicates that this discharge is not expected to have a significant impact on the surrounding marine environment. If required, a PON15C chemical permit will be in place to authorise all planned chemical discharges. The Welland export pipeline has been flushed, to an oil in water content of 77 - 155 ppm and the three 8" flowlines to 17 – 83 ppm. Any diffusion mediated discharge during subsea cutting of the export pipeline will be at lower concentrations than these . If required, any such release will be governed by a permit under the Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005.	
Noise & Vibration Noise is thought to have the potential to disturb or confuse	Noise will be generated from machinery vibrations and from the power generators. The vessels that will be used to support the decommissioning operations will maintain their position by using thrusters. The cutting of structures offshore has been limited but this will require use of large vessels to lift	Studies indicate effects are likely to be ***negligible*** (for fish) to ***minor*** (for cetaceans). In addition, densities of marine mammals in the vicinity of the development are relatively low.

ROUTINE HAZARDS		
Hazard & Effect(s)	**Effects and Mitigation**	**Residual Impact**
cetaceans	platform infrastructure. However this will reduce the time spent in the field (compared to cutting in-field). Pipelines and mattresses will remain with minimum disturbance further reducing time spend in the field.	
Atmospheric Emissions Emissions from vessels required for the decommissioning activities.	Power generation emissions during decommissioning activities will be minimised by advanced planning to ensure efficient operations; well maintained and operated equipment and generators and regular monitoring of fuel consumption. Perenco will ensure that contract specification and control processes require all equipment and generators to be well maintained and operated.	There will be a ***negligible*** local effect although emissions from gas combustion will contribute towards global greenhouse gas emissions.
Energy Use Energy used by vessels carrying out decommissioning operations, required for recycling or required to manufacture material left *in situ* from new	The total energy use figure for the selected options is approximately 543,593 GJ.	Depletion of non-renewable resources.
Solid Wastes Wastes will include scrap metal, plastics and coatings.	Perenco will ensure that, in order to minimise the impact on landfill resource, the amount of recovered material sent for recycling will be maximised as far as technically and financially viable.	***Negligible.*** Wastes will be recycled where practicable.

NON-ROUTINE HAZARDS	
Potential Spill Source	**Prevention & Mitigation Measures Planned**
Vessel grounding, collision or explosion resulting in total loss of cargo.	All vessels will comply with IMO/MCA codes for prevention of oil pollution, and will also have onboard Shipboard Oil Pollution Emergency Plans (SOPEPS). An approved Welland Field Oil Pollution Emergency Plan (OPEP) has been developed in accordance with the Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998.

Table 6.2. Summary of Commitments Made within this ES to ensure Impacts to the Environment from the Proposed Decommissioning Activities are Minimised As Far As Practicable

No.	Summary of Commitments as Detailed within this ES
1.	Operations are planned to take place outside the main period of fish spawning to limit impacts on fish stocks (Section 4.4)
2.	Perenco will ensure that contract specification and control processes require all equipment and generators to be well maintained and operated (Section 4.7).
3.	In order to minimise the uptake of resources, the amount of recovered material sent for recycling will be maximised as much as is technically and financially viable (Section 4.9).
4.	All vessels will implement appropriate Waste Management Plans and store and dispose of all solid wastes onshore accordingly (Section 4.9)
5.	Concrete mattresses will be recovered, subject to the results of an initial trial to ensure it is safe to do so. If left in situ, they and all other exposed structures will be buried to ensure no interference with fishing activities. (Section 4.4.2)
6.	Following completion of the decommissioning operations and a seabed survey, pipeline and other surveys will be integrated into Perenco's existing survey programme at a frequency of approximately 3 – 5 years. (Section 2.6)
7.	A seabed survey to determine the presence of remaining cuttings from past drilling activities will be undertaken (Section 2.4.7)
8.	In the event that *Sabellaria spinulosa* is detected during decommissioning operations, Perenco will notify DECC (Section 4.5)

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Appendix A – Energy Use and Emissions Calculations

A.1 Chemicals and Hydrocarbons

Table A.1 Predicted Emissions for Decommissioning Elements

	Chemical Discharge*	Hydrocarbon Discharge*
Jacket & Topsides	-	-
Subsea Wellhead Protection Structures	-	-
16" Export Pipeline	Biocide (Bactron B1710) – 575 litres Oxygen Scavenger (OS-2) – 397 litres Corrosion Inhibitor (Cortron CP2000) – 552 litres	618 litres (condensate)
3" MEG Piggyback Line	Gas Hydrate Inhibitor (Monoethylene Glycol) - 40 tonnes	-
8" Subsea Flowlines	-	106 litres (condensate)
4" Subsea Control Umbilicals	Gas Hydrate Inhibitor (Monoethylene Glycol) - 11.3 tonnes Hydraulic Fluid (Castrol Transaqua HT) – 5.4 tonnes	-
Pipeline Crossing Points	-	-
Mattresses	-	-

* Discharges of chemicals and hydrocarbons will largely be as a result of gradual loss of integrity of pipelines over time. Short-term discharges associated with decommissioning operations are expected to be a fraction of the total. However, no quantification of these operational discharges is possible as it will involve processes such as diffusion, etc.

A.2 Energy Use and Atmospheric Emissions

For each of the decommissioning activities, the vessels required and days in field were used to determine the fuel use. This information, in turn, was used to calculate the energy requirement. Data on vessel requirements is based on the latest operational schedules as provided by Perenco. Fuel use and energy requirements calculations are as described within the Institute of Petroleum Guideline for the Calculation of Estimates of Energy Use and Gaseous Emissions in the Decommissioning of Offshore Structures (2000).

The vessel fuel usage data used is given in Table A.2, below. The energy value associated with; marine diesel = 43.1 GJ per tonne; heavy oil = 40.6 GJ per tonne; Aviation Fuel = 46.1 GJ per tonne (*IP, 2000*).

Table A.2 Vessel Fuel Usage Data (IP, 2000)

Vessel Type	Rate of fuel use in field/on DP/working in field tonnes/day	Fuel use in transit tonnes/day
Heavy Lift Vessel (HLV)	40.0	50.0
Vessel with Crane	10.0	20.0
Diving Support Vessel (DSV)	12.0	7.0

ROV Support Vessel (RSV)	7.0	15.0

In order to account for the materials that are returned to shore and those potentially left on the seabed, the energy requirement to either recycle or produce from raw materials was calculated.

Table A.3 Manufacturing and Recycling Energy Requirement Data (IP, 2000)

Material	Energy to Manufacture from Raw Material (GJ/tonne)	Energy to Recycle (GJ/tonne)
Standard Steel	25	9
Copper	100	25
Concrete	1	-

Table A.4 Energy Consumption for the Recycling of Recovered Material or Manufacture of 'Lost' Material from Raw Material

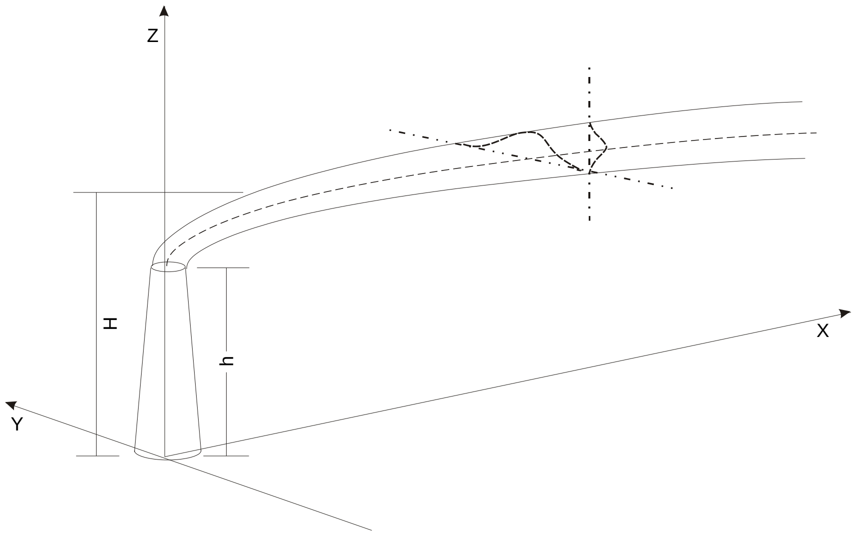
	Steel (tonnes)	Copper (tonnes)	Concrete (tonnes)	Energy to Recycle (GJ)	Energy to Manufacture New (GJ)
Jacket & Topsides	1,794.4	5.0	-	16,274.6	45,360.0
Subsea Wellhead Protection Structures	210	-	-	1,890	5,250
16″ Export Pipeline & 3″ MEG Piggyback Line & 8″ Subsea Flowlines	3,782	-	6,698.0	34,038	101,248.0
4″ Subsea Control Umbilicals	190.0	9.0	-	1,935	5,650
Pipeline Crossing Points	-	-	-	-	-
Mattresses	-	-	1280.5	-	1280.5

Carbon dioxide emissions associated with the preferred decommissioning options were calculated using the UKOOA (2002) emissions factors. The total is 6,334.28 tonnes CO_2

Appendix B - Atmospheric Dispersion Modelling

The simple model used is spreadsheet based and derived from "*Davis, M.L. and D.A. Cornwell. (1991). Introduction to Environmental Engineering. McGraw-Hill International. Page 459*".

The model is an analytical model based on the Gaussian diffusion equation. The Gaussian element refers to the observation that the concentration of a gas released from a point follows an approximate normal distribution perpendicular to the centre line of the plume.



The concentration along the centre line is inversely proportionate to the distance from the source although very close to the source the concentration is decreased due to plume rise. Thus, a skewed concentration curve is characteristic of this sort of model. The governing equation is:

$$X(x, y, 0, H) = \left[\frac{Q}{\pi s_y s_z u}\right]\left[\exp\left[-\frac{1}{2}\left(\frac{y}{s_y}\right)^2\right]\right]\left[\exp\left[-\frac{1}{2}\left(\frac{H}{s_z}\right)^2\right]\right]$$

where *X(x,y,0,H)* = downwind concentration at ground level, g/m^3

Q = emission rate of pollution, g/s

s_y, s_z = plume standard deviations, m

u = wind speed, m/s

The basic Gaussian diffusion equation has the following assumptions:

- Atmospheric stability, that is the amount of mechanical mixing in the air, is uniform throughout the layer into which the gas stream is discharged (normally the boundary layer)
- Turbulent diffusion is random and therefore the dilution of the contaminated gas stream in both the vertical and horizontal direction can be described by the Gaussian or normal equation
- The gas stream is released into the atmosphere at a distance above ground level that is equal to the stack height plus the plume rise (caused by convection if the released gas is hotter than the ambient temperature)
- The degree of dilution is inversely proportional to the wind speed (although wind speed data is not actually used within this model)

- Pollutant material that reaches the ground is totally reflected back into the atmosphere

The calculation of *H* is obtained from adding ΔH and h via Holland's formula:

$$\Delta H = \frac{v_s d}{u}\left[1.5 + \left(2.68 \times 10^{-2}(P)\left(\frac{T_s - T_a}{T_s}\right)d\right)\right]$$

where v_s = stack velocity, m/s

d = stack diameter

P = Pressure, kPa

T_s = stack temperature, K

T_a = air temperature, K

Specific assumptions for the modelling of the atmospheric emissions produced from power generation and testing of the York development well are:

Physical Parameters

- Height of discharge (h) 50 metres above LAT (taken to represent ground level).
- Flare diameter (d) of 0.762 metres.
- Temperature of (T_s) 200 degrees Celsius, 473 K.

Atmospheric Conditions

- Wind speed (u) of 10 metres per second.
- Temperature (T_a) 15 degrees Celsius, 288 K.
- Pressure (P) 95.0 kPA (thousand Pascals).
- Overcast conditions (neutral stability).

Discharge Characteristics

Power Generation:

- Maximum flare rate of 15 tonnes per day of diesel.
- Molecular weight of gas of 22.
- Emission factors from UKOOA, 1999.

Flaring during Well Clean-up:

- Maximum flare rate of 1,162 tonnes per day of gas.
- Molecular weight of gas of 17.
- Emission factors from UKOOA, 1999.

Appendix C - Air Quality Data

Data on air quality offshore is limited. Emissions of carbon dioxide (CO_2), oxides of nitrogen (NOx), and oxides of sulphur (SOx) will result from power generation from the rig, from vessels required for both drilling and installation of the development facilities and from possible well testing.

Air quality guidelines values have been set under UK legislation (Table C.1). The World Health Organisation (WHO) first published Air Quality Guidelines for Europe in 1987, which were subsequently updated in 1996 (Table C.2). It was the aim of the Guidelines to provide a basis for protecting public health from adverse effects of environmental pollutants and eliminating or reducing to a minimum exposure to those pollutants that are known or likely to be hazardous to human health or wellbeing.

Although health effects were the major consideration in establishing the Guidelines, ecologically based Guidelines for preventing adverse effects on terrestrial vegetation were also considered, and guideline values for vegetation protection for nitrogen and sulphur oxides and ozone have been established.

Table C.1. UK Legislative Air Quality Limit Values

Pollutant (averaging period in brackets)	Guideline			
	UK SI 2001/2315	PE	NAQS	PE
SO_2 (10 minute)	-	-	-	-
SO_2 (15 minute)	266 g/m3	35 per year	100 ppb	35 per year
SO_2 (1 hour)	350 µg/m3	24 per year	132 ppb	24 per year
SO_2 (24 Hours)	125 µg/m3	3 per year	47 ppb	3 per year
SO_2 (calendar year)	-	-	-	-
SO_2 (annual + winter)*	20 µg/m3 §	none	8 ppb §	none
NOx (1 hour)	200 µg/m3†	18 per year	105 ppb†	18 per year
NOx (8 hour)	-	-	-	-
NOx (calendar year)	40 µg/m3†	none	21 ppb†	none
NOx (calendar year)*	30 µg/m3 §	none	16 ppb §	none
CO (15 minutes)	-	-	-	-
CO (30 minute)	-	-	-	-
CO (1 hour)	-	-	-	-
CO (8 hour)	-	-	10 ppm	none
H_2S (24 hours)	-	-	-	-

* indicates value for protection of vegetation   † value is for NO_2 or NO_2 equivalent

‡ depends on vegetation type   § not regulatory, but part of the Local Air Quality Management targets

Key: PE = Permitted Exceedences, NAQS = National Air Quality Standards, µg/m^3 = microgram (1 x 10^{-6}) per cubic metre, ppm = parts per million (by volume), ppb = parts per billion (by volume)

Table C.2. WHO Air Quality Guidelines for Europe

Gas	Guideline Value	Averaging Time
Carbon Monoxide	100 mg/m3	15 min
	60 mg/m3	30 min
	30 mg/m3	1 hour
	10 mg/m3	8 hour
Ozone	120 µg/m3	8 hour
Nitrogen Dioxide	200 µg/m3	1 hour
	40 µg/m3	annual
Sulphur Dioxide	500 µg/m3	10 min
	125 µg/m3	24 hour
	50 µg/m3	annual
VOCS		
Benzene	6 x 10-6 (µg/m3)-1	UR / lifetime
1,3 butadiene	no guideline	
dichloromethane	3 mg/m3	24 hour
formaldehyde	0.1 mg/m3	30 min
PAH (BaP)	8.7 x 10-5 (ng/m3)-1	UR / lifetime
styrene	0.26 mg/m3	1 week
tetrachloroethylene	0.25 mg/m3	annual
toluene	0.26 mg/m3	1 week
trichloroethylene	4.3 x 10-7 (µg/m3)-1	UR / lifetime
Ecotoxic Effects		
SO2 critical level	10 - 30 µg/m3 a	annual
NOx critical level	30 µg/m3	annual
Ozone critical level	0.2 - 10 ppm.h a	5 days - 6 months

The European Commission (EC) has also set values for nitrogen dioxide and sulphur dioxide (Table C.3) both with regard to protecting human health (EC limit value) and contributing to protection of the environment (EC guide value).

In addition, the Meteorological Office quotes background sulphur dioxide concentrations for onshore rural locations to be three parts per billion (eight micrograms per cubic metre (µg/m^3). Odour thresholds for sulphur dioxide are of the order of 5-30 milligram per cubic metre (mg/m^3) (*Croner's 1996*).

Table C.3. Air Quality Limit and Guideline Values for NO_2 and SO_2 (ppb)

Gas	Source / Organisation	Annual Average	24 Hr Average	1 Hr Average	98th Percentile
NO_2	EC Directive Limit Value	-	-	-	105
	EC Directive Guide Value	-	-	-	71
SO_2	EC Directive Limit Value	30-45[1]	-	-	94-132[1]
	EC Directive Guide Value	15-23	-	-	-

Note [1]: Values change depending on associated smoke concentrations.