AECOM

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Block D-230 Seismic Survey

Environmental & Socio-Economic Impact Assessment

December 2018

Non-Technical Summary

This Non-Technical Summary (NTS) presents a concise overview of the Environmental and Socio-Economic Impact Assessment (ESIA) prepared for the 3D Seismic Survey to be undertaken in Block D230 with one acquisition line extending beyond the block boundary. It is intended to provide a summary of the project activities, the issues considered in the ESIA and the main conclusions on environmental and socio-economic impacts and their mitigation. Detailed technical descriptions of modelling studies, proposed mitigation measures and monitoring activities are presented in the main sections of the ESIA.

E.1 Introduction

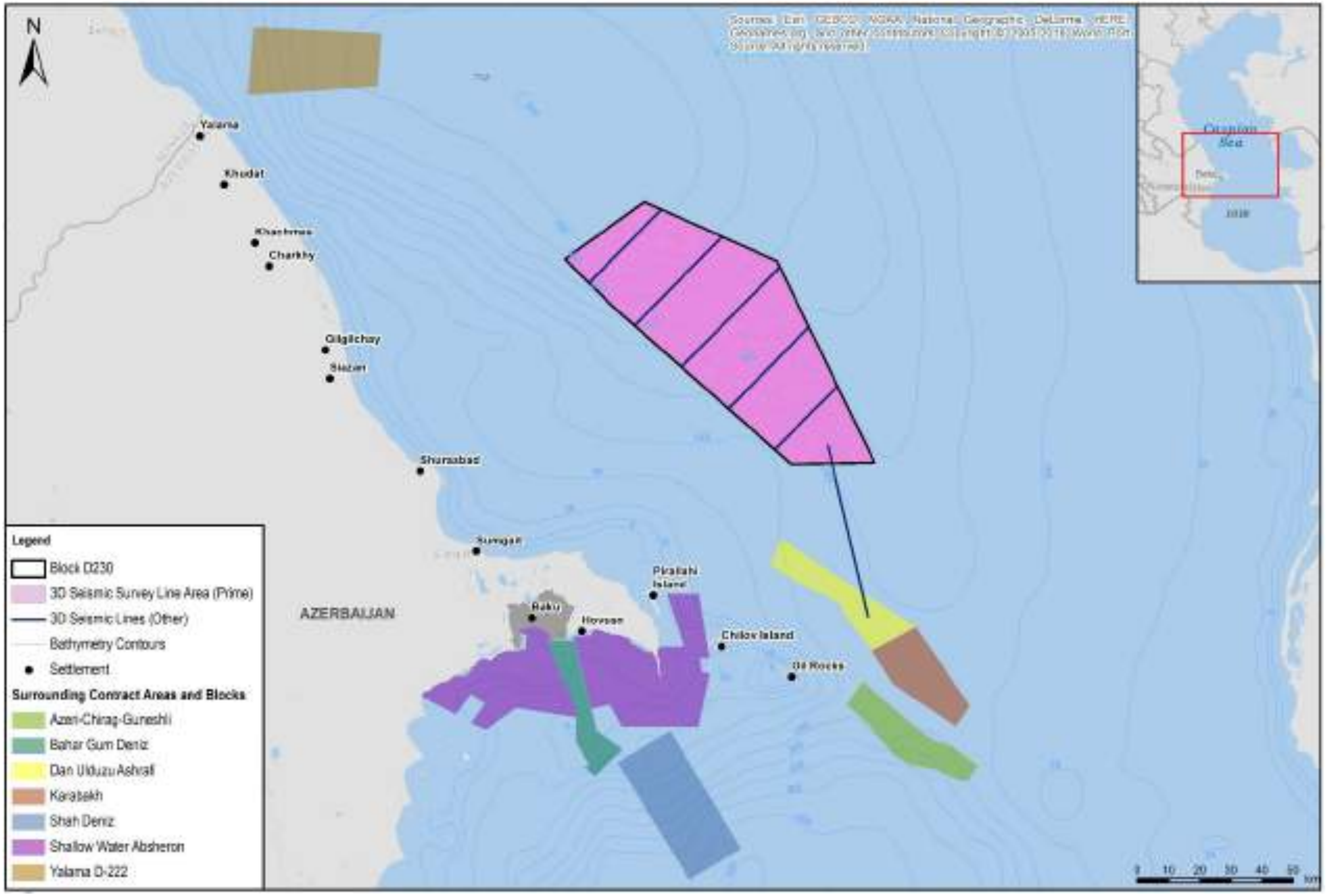
BP and SOCAR are proposing to undertake an exploration program, comprising a 3D seismic data acquisition across Block D230 and beyond, approximately 80km from the Azerbaijani coastline in water depths ranging between 100 and 800m. Figure E.1 shows the proposed survey lines, Block D230 and other Contract Areas in the Region. The seismic survey is planned to be undertaken in 2019/2020 over a maximum 6 month period.

The survey will comprise survey lines contained within Block D230, and one survey line extending to the Ashrafi-1 well in the Dan Ulduzu Ashrafi Contract Area. Vessel movement will not be restricted to the Block boundaries as it will be necessary for the vessels to travel outside Block D230 in order to turn at the end of each line. The vessel manoeuvring zone may extend as far as 10 km from the end of acquisition lines. Data acquisition may also be conducted when the vessel changes lines.

The purpose of the seismic survey is to assess hydrocarbon prospects within the basin; following which targets for potential future exploration drilling can be identified. The data will be used to inform scoping and planning of exploration and development of the area.

Given the location and scale of the planned activities associated with the Block D230 3D Seismic Survey, BP has taken the decision to prepare an ESIA. This approach was agreed with the Ministry of Ecology and Natural Resources (MENR) and is consistent with that taken by BP for similar seismic surveys completed in the Azerbaijani sector of the Southern Caspian Sea.

Figure E.1: Location of Block D230 Seismic Survey in Relation to other Contract Areas in the Region



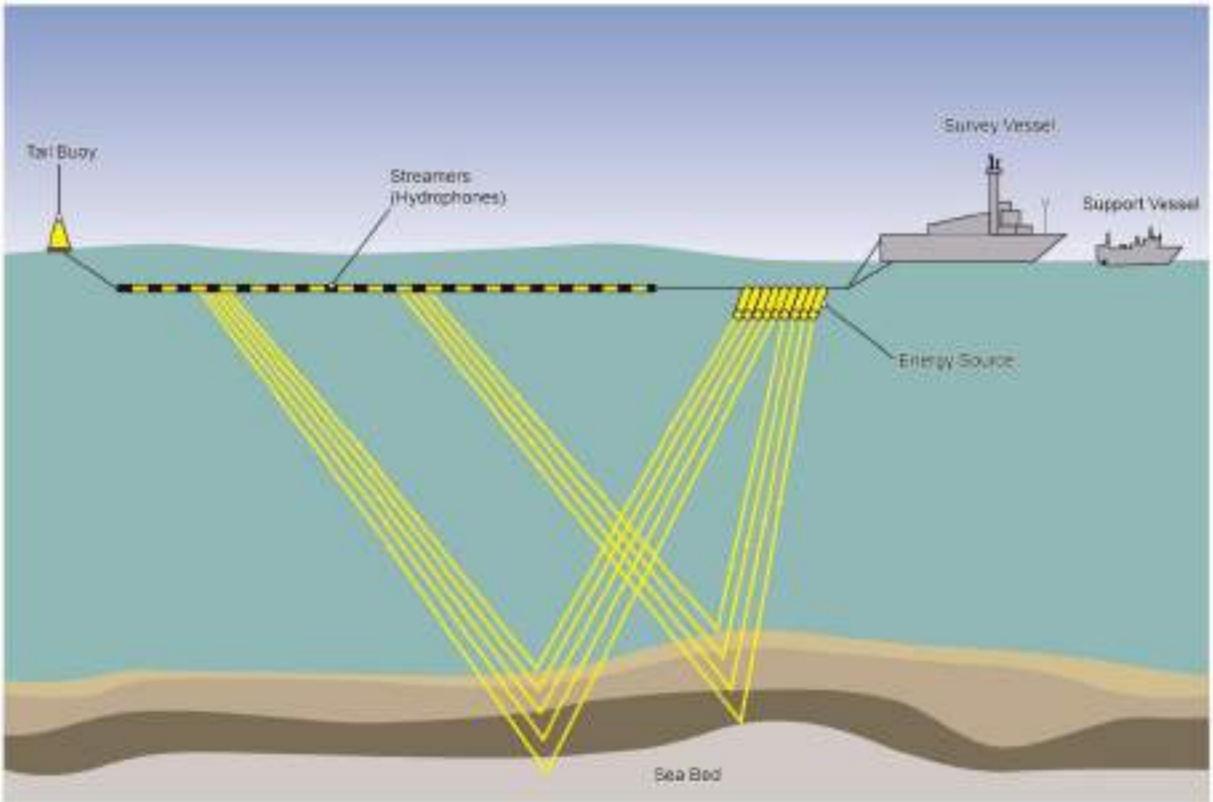
E.2 Overview of the 3D Seismic Survey

The 3D Seismic Survey will be undertaken by a seismic survey vessel using between four and six streamers[1] and multiple energy sources, which will both be towed behind the vessel. As the survey vessel travels along pre-determined survey lines, the energy source will release a controlled burst of energy which will travel through the water column to the seabed where it will penetrate the subsurface geological layers and reflect back towards the sea surface. The reflected energy will be recorded by the receivers (hydrophones) which are embedded in the streamer and the data sent back to the survey vessel, where it will be stored and processed. Tail buoy will be connected to the far end of the streamers to act as a hazard warning of the submerged towed streamer and provide positional information of the location and the depth of the equipment.

During the Survey, up to two support vessels will undertake activities including transporting supplies and crew to the survey vessel, transferring waste to shore and maintaining a safety exclusion zone around the survey vessel and towed equipment. The survey and support vessels will operate on a 24-hour basis.

Figure E.2 provides an illustration of a 3D seismic acquisition process.

Figure E.2 Illustration of the 3D Seismic Survey Process

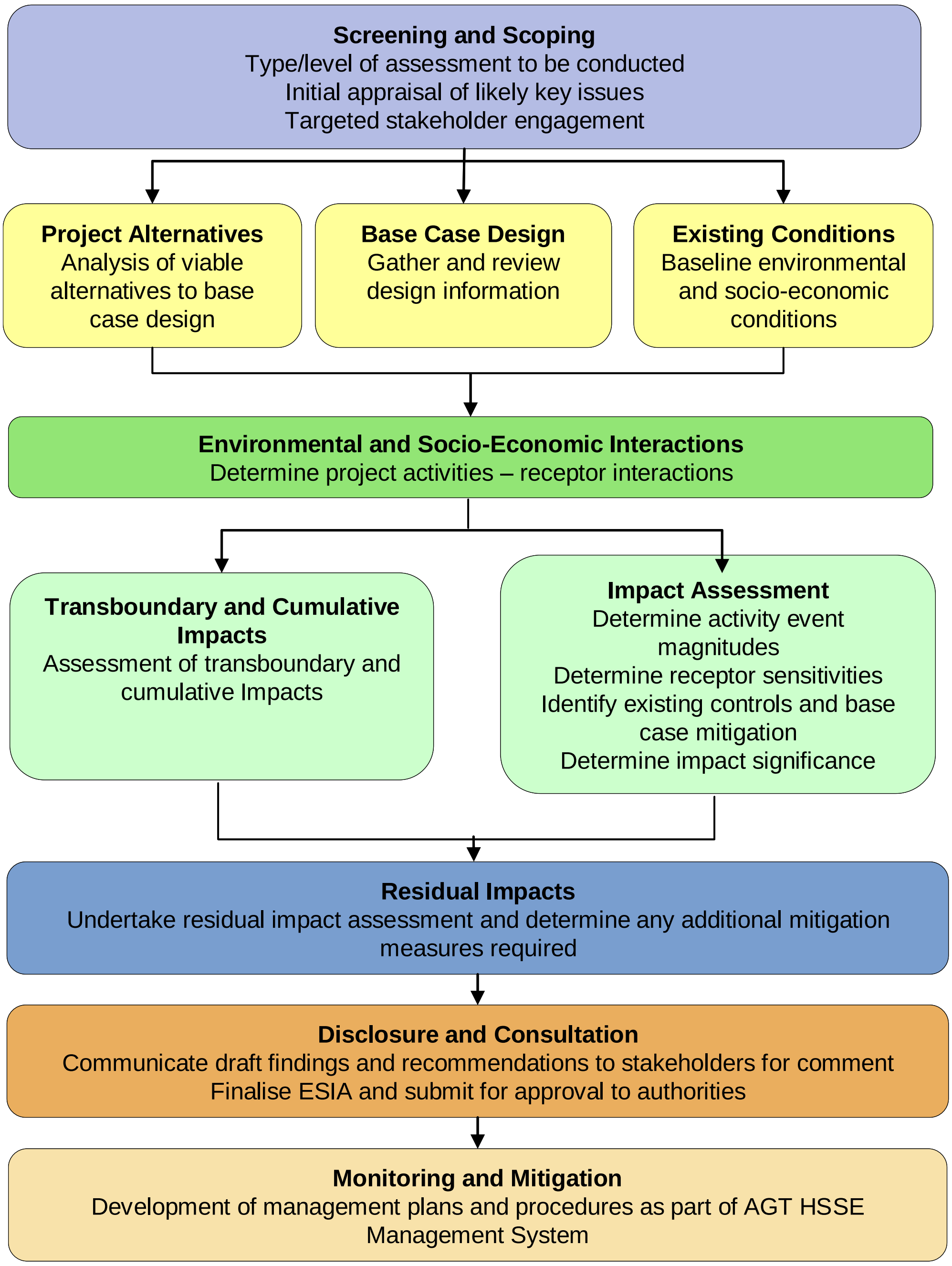


[1] A streamer is an electrical cable, floating on the surface of the water, to which the seismic receivers (termed hydrophones) are connected at regular intervals and along which the signals received by each hydrophone are sent to the seismic acquisition equipment on the survey vessel.

E.3 Assessment Methodology

The ESIA process constitutes a systematic approach to the evaluation of a project and its associated activities throughout the project lifecycle. The overall aim of the ESIA process is to identify, reduce and effectively manage potential negative environmental and socio-economic impacts arising from the Block D230 3D Seismic Survey activities.

Figure E.3: The ESIA Process



Assessment of the Block D230 3D Seismic Survey environmental and socio-economic impacts has been undertaken based on identified routine activities and accidental events that have the potential to interact with the environment. The impact significance considers receptor sensitivity and the magnitude of the impact and takes into account existing control measures embedded in the project design.

E.4 Consultation

The scope of the ESIA was agreed with the MENR at a scoping meeting held on 10th November 2016. Key issues raised by the MENR, which have subsequently been addressed within the ESIA, include the requirement to:

- Asses all impacts of transboundary nature and present the results in a standalone chapter;
- Provide clear definition of unplanned/accidental events;
- Provide robust baseline description for the Project Study Area; and
- Ensure impacts and mitigation are considered for the survey line outside the D230 block to prevent potential risks on existing well structures in the Dan Ulduzu Ashrafi Contract Area.

Public consultation and disclosure meetings will be planned following the submission of this ESIA.

E.5 Environmental and Socio-Economic Impacts

Environmental and socio-economic impacts have been assessed for routine Project activities and Table E.1 summarises the outcome of the impact assessment.

Table E.0.1: Summary of the Residual Environmental and Socio-Economic Impacts (taking into account control design and additional mitigation measures)

Event	Receptor	Receptor Sensitivity	Event Magnitude	Residual Impact Significance
Operation of Energy Source	Caspian seal	High	Low to Moderate (summer)	Moderate
			Moderate (autumn)	Moderate
			Low (winter)	Low
	Fish	High (sturgeon species)	Negligible	Low
		Moderate (kilka species)	Low	
		Low (other species)	Low	
	Plankton	Low	Low	Low
	Benthic	Low	Negligible	Not Significant
Planned Marine Discharges	Water Quality	Low	Negligible	Not Significant
	Fish	High	Negligible	Low
	Plankton	Low	Negligible	Not Significant
Survey Activities (excluding Operation of Energy Source)	Shipping and Navigation	High (international shipping)	Negligible	Low
		Low (national shipping)	Negligible	Not Significant
	Caspian seal	High	Negligible	Low

Underwater Sound

During the 3D Seismic Survey, the energy source (refer to Figure E2) will be moving and the underwater sound will occur repeatedly but intermittently, with the sound energy reducing with distance from the source. Therefore, a given sound level will last for a very short period of time in any one location.

Since underwater sound has the potential to impact fish and Caspian seals in the marine environment, underwater sound calculation were undertaken and a number of control measures (described below) have been included in the design of the Project to reduce potential impacts.

The endemic Caspian seal is a threatened species with an International Union for Conservation of Nature (IUCN) Red List 'Endangered' status. The Caspian seal population has dramatically declined over last century and is considered to be sensitive to anthropogenic factors, including underwater sound. Caspian seals are observed in different regions of the Caspian Sea depending on the season. They typically undertake annual migrations between breeding locations in the north (where pupping and mating occurs on the ice) to feeding locations in the Central and Southern Caspian during spring and autumn. Recent research conducted between 2009 and 2012 has also shown that migration routes are not limited to coastal areas as previously understood. This research showed that the Caspian seals use deeper waters of the Central Caspian, where the Study Area is located.

Design control measures will be adopted for the Project and have been designed to minimise the likelihood of harm to seals from seismic sound. Measures include the use of a soft-start procedure during the energy source activation, which involves a gradual increase in energy/ sound output over a period of time. A 700m buffer zone will be implemented around the sound source, within which trained observers on the survey vessel will undertake observations to ensure no seals are present prior to starting the planned soft start procedure. Furthermore, to mitigate potential impacts to the spring migration (most sensitive period for seals), the survey will commence in mid-2017. Taking into account these mitigation measures the residual impact to Caspian seals is expected to be **Low to Moderate**. In addition, monitoring and recording of Caspian seals will be undertaken by the trained vessel crew as part of the soft start procedure and at other times as far as practically possible; and a daily log will be submitted to BP as part of a final report summarising seal observations.

Endangered fish species and those sensitive to underwater sound are likely to be present in the Study Area. Sturgeon species are generally only found in water depth between 50m and 100m, so considering the survey is largely limited to water depths greater than 100m there is only a small region of the survey area where sturgeon may pass within the range of the propagated seismic sound. There are two kilka species (the anchovy (*Clupeonella engrauliformis*) and big-eyed kilka (*Clupeonella grimmi*)), that may be spawning and migrating in the Study Area in the period of April to August (peak period July) and two mullet species (*Lisa auratus* and *L. saliens*) that may be present in the period June to September. With the implementation of the soft start procedure, it is expected that fish will move away from the sound source before sound levels are likely to cause harm; and this response is unlikely to cause persistent disturbance on spawning fish population. Taking into account design controls it is expected that the impact to fish will be **Low**.

Plankton is distributed throughout the water column and has limited mobility, thus unable to move away from a potentially harmful sound source. Current scientific literature presents evidence that exposure to underwater sound generated by seismic sources elicits a response from zooplankton with any impact of seismic sound only likely to occur within metres of the source. Since plankton are generally distributed through the water column only a fraction of any population may be affected. The impacts would only exist at the population level for a short period of time (days and months) due to their high reproduction rate and current circulation. Taking into account receptor sensitivity and the anticipated potential magnitude of impacts, the significance of potential impacts to plankton is assessed as being **Low.**

Water Quality

Planned marine discharges (sewage; grey water, and ballast waters) have the potential to impact water quality and pollute the marine environment. Direct impacts from the controlled discharges may include localised nutrient enrichment, and low level pollution from trace residual chemicals. All discharges into the marine environment will conform with the national and international requirements. The assessment concluded that impacts to water quality and plankton are expected to be **Not Significant** and impacts to Fish would be **Low**, which has taken into consideration the highest sensitivity ranking (i.e. sturgeon).

Interference with other Marine Users

Given the location of the survey, no fishing activity is expected in the area, however there are four known shipping routes in the Study Area. A number of control measures will be implemented to minimise potential impacts to international and national shipping, including notifying maritime authorities and other sea users of the survey in advance; use of advanced positioning equipment and during the survey, notifying other vessels of the survey by appropriate signals. To further mitigate potential impacts BP will undertake a Shipping Risk Assessment to assess maritime traffic within and surrounding the D230 Block. Taking into account these measures the impact to shipping and navigation is expected to be **Low** and **Not Significant** for international and national shipping, respectively.

The potential for physical interaction between the survey vessel and equipment and Caspian seals was considered. However, seals are known to avoid the areas of increased underwater sound generated by seismic sources, and therefore unlikely to be present in the vicinity of the seismic vessel. Based on this, the impact significance is expected to be **Low**.

E.6 Cumulative and Accidental Events Impacts

Cumulative Impacts

Due to the nature of the residual impacts from the Block D230 Seismic Survey the potential for their in-combination interactions (intra-project effects) to give rise to significant cumulative impact on the receiving environment is considered to be unlikely.

In relation to the inter-project cumulative impacts (in-combination/ synergistic effects with other projects), the only known activities in the vicinity of the Study Area are a number of other seismic surveys that have already occurred or are planned. The assessment has focused on the 2015-2020 period to account for both historical and potential future disturbance to the marine receptors.

Underwater sound is the main stressor associated with the seismic data acquisition and will be generated over the maximum 6 month Block D230 Seismic Survey duration. The duration of the other surveys planned or undertaken within the Central Caspian between 2015 and 2020 totals to 20 months. Assuming 26 months of cumulative seismic survey effort during the 4 year period, the marine environment of the Central Caspian is exposed to seismic underwater sound for approximately 43% of the assessment period. The effects however are generally transient in nature and localised in their intensity (sound levels exceeding marine fauna disturbance thresholds being typically limited to a few km around energy sources), with seals and fish (excluding fish larvae) expected to move away and avoid areas of sound disturbance. The anticipated cumulative impacts are unlikely to be more significant than impacts from individual surveys given their spatial and temporal distribution. The D230 Seismic Survey will not take place during the most sensitive for seals spring migration thus precluding possible cumulative impacts during this time. However, given the moderate significance residual impact of the D230 Seismic Survey on seals during the autumn migration period, it is recommended that other seismic surveys being planned for the Central Caspian Area are timed to avoid the months of October and November.

An assessment of cumulative impacts to marine users (shipping) concluded that impacts are not expected to be significant. This takes into account control measures to be implemented to minimise impacts as far as possible i.e. communications with marine users and authorities.

Impacts from Accidental Events

Accidental Events are considered separately from routine and non-routine activities as they only arise as a result of a technical failure, human error or as a result of natural hazards. The following credible accidental events have been assessed:

- Diesel spill from loss of total inventory on the survey and support vessels;
- Release of chemicals from the survey and support vessels; and
- Collision between survey vessel and/or equipment and Caspian Seals.

As a worst case, the loss of the entire diesel inventory stored onboard the survey vessel has been modelled (800m^3). In general the diesel is not anticipated to persist in the environment in harmful concentrations in the water column or thickness on the sea surface for more than a few days following the release. Furthermore, the probability of any diesel reaching the shoreline from the release location is predicted to be low, typically occurring for <5% of the scenarios modelled using multiple variations in meteorological conditions representative of each season. Under worst case conditions, it was predicted that 486 tonnes of diesel could reach the shoreline, mainly of the Absheron Peninsula.

The potential impacts of diesel spill on plankton, benthic invertebrates and fish are unlikely to be significant. The seismic survey schedule has been planned to avoid the most sensitive spring migration period for Caspian seals (an IUCN Endangered species). However even a small to medium scale exposure to the toxic effects of diesel within offshore waters, and in the vicinity of the Absheron Peninsula and the adjacent islands, where seals will be present during summer and autumn could result in a potentially significant impact.

The spill modelling has shown that, in the event of a spill occurring in a location where the survey vessels may be operating closest to the shore, there are a number of sites of conservation and ecological importance that may be exposed to stranded diesel, although the probability of this occurring is low (less than 5%). These sites are located mostly along the coastline of Azerbaijan with a small number in Russia and Iran. Based on the predicted medium term recovery period (few months to a year) anticipated for potentially affected habitats from a diesel spill, and considering the international conservation status and ecological importance of these areas, the potential impacts from a spill are considered to be potentially significant.

A worst case major fuel spill may affect small scale fishing grounds along the coast, and commercial fishing. Although this impact is anticipated to be limited in time, the impact could potentially be significant if a fishing ban is imposed (due to diesel toxicity to fish) as fishing represents the primary source of household income for the majority of fishermen.

There is a very low likelihood of a mechanical failure or vessel collision resulting in the diesel inventory release to the sea. The loss of the entire diesel inventory from the survey vessel is considered particularly unlikely as diesel is stored on the survey vessel in a series of smaller tanks and it is improbable that the contents of all the tanks would be lost simultaneously. Technical and operational control measures will be in place to minimise the risk of spills during the survey. In the event of a spill to the sea, existing plans and procedures will be followed which cover the actions to be taken in the event of a spill, including notification, response actions, follow-up actions and reporting.

E.7 Transboundary Impacts

In order for a transboundary impact to occur, activities from the Project would need to generate an impact that has the potential to cross national jurisdictions as defined by the Exclusive Economic Zone (EEZ) boundaries of the coastal Caspian Sea countries. The distances from the Project area of influence (approximately 10 km around each seismic line) to the adjacent EEZ boundaries, are as follows:

- Kazakhstan – approximately 6.8 km;
- Turkmenistan - approximately 11.3 km; and
- Russia – approximately 91.4 km.

Given these distances and the anticipated distances over which the environmental and social impacts associated with the planned Project activities are likely to occur (as detailed in this ESIA) no transboundary impacts due to the effects from underwater sound, aqueous discharges, or physical presence of vessels and equipment on the international marine and coastal receptors are anticipated.

The only planned activities that may result in potential transboundary impacts are associated with the generation of atmospheric emissions including greenhouse gasses (GHGs), and gases that are known to contribute to acid rain (sulphur dioxide and nitrogen oxides). GHG emissions from the proposed survey are estimated to represent approximately 0.0214% to the annual national emissions (based on 2016 national greenhouse gases (GHG) inventory). Emissions of sulphur oxides and nitrogen oxides from the Project vessels are considered negligible compared to the overall emissions associated with shipping in the Caspian Sea.

During the D230 Seismic Survey there is a potential for accidental events to occur as a result of a technical failure, human error or other type of emergency, and pose risks to environmental and socio-economic receptors. The accidental events that may cause impacts in a wider transboundary context include a major release of hydrocarbons (a loss of full fuel inventory of 800 tonnes from the survey vessel) to the marine environment. Such event has a low likelihood of occurrence and strict management measures will be put in place to ensure that associated risks are minimised.

The predicted probability of the spilled diesel to reach the territorial waters and coastlines of the countries neighbouring Azerbaijan is predicted to be low (1 to 6%). The spill modelling indicates that the highest probability of a fuel spill to cross an international median line is for Turkmenistan – 6%. The probability of diesel reaching internationally protected / designated sites such as Chechen' Island and East Side of the Agrakhan Peninsula IBA, Sulakskaya Lagoon, Agrakhansky Zakaznik in Russian Federation, as well as Lisar Protected Area/ IBA and South Caspian shore from Astara to Gomishan IBA in the Islamic Republic of Iran, is extremely low (1%). Moreover, the spatial extent of the potentially affected areas is limited, with an expected short-term effect on the marine and coastal receptors (1 to 2 days for open waters and up to few months for shoreline habitats as a worst case scenario). The overall transboundary impact from a major fuel spill is therefore considered to be not significant.

E.8 Environmental and Socio-Economic Management

BP will have overall responsibility for managing the Block D230 Seismic Survey, which will include monitoring and verifying the implementation of environmental and socio-economic mitigation measures detailed in the ESIA.

The Block D230 Seismic Survey Contractor will be responsible for performing the Seismic Survey under their own HSSE Management System while complying with BP's corporate standards as well as commitments stipulated in the ESIA. Project management documentation will be developed, including plans Project specific plans, which will provide interface between the Block D230 Seismic Survey Contractor's HSSE System, BP Operating Management System and the ESIA. Management Plans will include:

- Environmental Management;
- Communication Management;
- Waste Management; and
- Spill Prevention and Emergency Response.

The Block D230 Seismic Survey Contractor will be expected to conform fully to the relevant aspects of these interface documents.

E.9 Conclusions

The assessments within the ESIA show that direct and indirect impacts from the Block D230 Seismic Survey can be minimised as far as reasonably practicable through the implementation of the control embedded into the project design and additional mitigation measures. All residual impacts are assessed to be of negligible or low significance, except the underwater sound effect on Caspian seals remaining moderate during the summer-autumn period.

The potential for cumulative impacts arising from the combined effects of separate project-related residual impacts is insignificant; and the potential for cumulative impacts with impacts arising from other seismic surveys in the region is not considered to be significant for marine fauna and other marine users, apart from the effect of underwater noise for Caspian Seals

Transboundary effects from the Project activities are not anticipated to be significant. For GHG emissions, the Project is expected to contribute approximately 0.0214% of the national total forecast for 2016. The predicted probability of the spilled diesel from a major fuel spill to reach the territorial waters and coastlines of the countries neighbouring Azerbaijan is predicted to be low (1-6%). Spill modelling has also indicated a limited spatial extent of the potentially affected areas, with an expected short term effect on the marine and coastal receptors (1 to 2 days for open waters and up to few months for shoreline habitats as a worst case scenario). Technical and operational control measures will be in place to minimise the potential for accidental events occurring during the 2D Seismic Survey.

The environmental and social performance of the Block D230 Seismic Survey will largely rely on the responsible operator's management. The project will be carried out in full compliance with applicable national and international regulations. Notifications on the survey programme will be issued to relevant authorities and stakeholders to ensure surveys proceed with minimal disruption to other marine users.

The survey seismic contractor will adopt good international industry practices, such as soft start procedures, effective waste and emissions management, strictly controlled refuelling procedures. Support vessels will be used to maintain the exclusion zone around the seismic vessel and associated equipment to ensure operational safety and prevent collision with other marine users. Trained vessel crew will undertake visual observations of Caspian seals as part of the soft start procedures and where possible throughout the seismic acquisition.

BP will have overall responsibility for managing the Project; for monitoring and auditing the performance of the Block D230 3D Seismic Survey Contractor; and for ensuring that project commitments are implemented.

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ABBREVIATIONS

%	Percent
+/-	Plus/minus
°	Degrees
°C	Degrees Celsius
µg/g	Micrograms per gram
µg/l	Micrograms per litre
µm	Micrometre
2D	Two Dimensional
3D	Three Dimensional
4D	Four Dimensional
ACG	Azeri-Chirag-Gunashli
AETC	Azerbaijan Environmental and Technology Centre
AGT	Azerbaijan-Georgia-Turkey
AIOC	Azerbaijan International Operating Company
ALARP	As Low As Reasonably Practicable
AZN	Azerbaijani Manat
AzRDB	Red Data Book of Azerbaijan
BAT	Best Available Techniques
BOD	Biological Oxygen Demand
BOEM	Bureau of Ocean Energy Management
CARs	Corrective action requests
CH_4	Methane
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMST	Center for Marine Science and Technology
cm/year	Centimetre per year
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CoM	Cabinet of Ministers
CSAS	Canadian Science Advisory Secretariat
Cu in	Cubic inches
CWAA	Central Waste Accumulation Area
days/year	Days per year
dB re 1 µPa	Decibels relative to one micropascal
dB	Decibel
DGPS	Differential Global Positioning System
DO	Dissolved Oxygen

DPRAB	Department on Protection and Reproduction of Aquatic Bioresources
EEZ	Exclusive Economic Zone
EIA	Energy Information Administration
EIA	Environmental Impact Assessment
EMP	Environmental Monitoring Programme
EN	Endangered
ENP	European Neighbourhood Policy
ERL	Effects Low Range
ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Management and Monitoring Plan
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
ETN	Environmental Technical Notes
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FHWG	Fisheries Hydroacoustic Working Group
g/l	Gram per Litre
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GIIP	Good International Industry Practice
GIWA	United Nations Environment Programme Global International Waters Assessment
GOST	Gosudarstvennye Standarty State Standard (Russian standard)
Ha	Hectare
HS	Hearing specialists with wide frequency hearing range
HSE	Health Safety and Environment
HSSE	Health, Safety, Security and Environment
Hz	Hertz
IAGC	International Association of Geophysical Contractors
IBA	Important Bird Areas
IEMA	Institute of Environmental Management and Assessment
IFC	International Finance Corporation
IMO	International Maritime Organisation
IOGP	International Association of Oil and Gas Producers
ISO	International Organization for Standardization
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
KBA	Key Biodiversity Areas
KHz	Kilohertz

Km	Kilometre
Km/hr	Kilometres per Hour
Km^2	Square Kilometre
kW	Kilowatt
LC	Least Concern
LC_{50}	Concentration of material resulting in a lethal exposure to 50% of species of organism exposed over a given time-period.
LCR	Logistics Control Room
LV	Low Vulnerability
m	Metres
m/s	Metres per second
m^3	Cubic Metres
m^3/day	Cubic Metres per Day
MAC	Maximum Allowable Concentrations
MARPOL	International Convention for the Prevention of Pollution from Ships/ Vessels, 1973 as amended by the protocol, 1978
MDO	Marine Diesel Oil
MENR	Ministry of Ecology and Natural Resources
MES	Ministry of Emergency Situations
MGO	Marine Gas Oil
mm	Millimetres
MoU	Memorandum of Understanding
MSDS	Materials Safety Data Sheets
NCRs	Non-conformance reports
NGO	Non- Governmental Organisation
NIP	National Indicative Programme
NOAA	National Oceanic and Atmospheric Administration
NOx	Nitrogen Oxides
NP	National Park
NR	National Reserve
O&G	Oil and Gas
OCS	Outer Continental Shelf
OMS	Operating Management System
OSCAR	Oil Spill Contingency And Response
OSRP	Oil Spill Response Plans
PCA	Partnership and Cooperation Agreement
PCB	Polychlorinated biphenyl
PDF	Potential Dangerous Facilities
ppb	parts per billion
PS	Performance Standard

PSA	Production Sharing Agreement
psi	Pounds per square inch
PTS	Permanent Threshold Shift
Q1	Quarter 1
SB	Fish with swim bladder
SD	Shah Deniz
SEE	State Ecological Expertise
SEL	Sound Exposure Level
SO_2	Sulphur Dioxide
SOCAR	State Oil Company of the Azerbaijan Republic
SOPEP	Shipboard Oil Pollution Emergency Plan
SOx	Sulphur Oxides
SPL	Sound Pressure Level
SWAP	Shallow Water Absheron Peninsula
THC	Total Hydrocarbon Concentrations
TSS	Total Suspended Solids
TTS	Temporary Threshold Shift
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNEP / GIWA	United Nations Environment Programme Global International Waters Assessment
UNESCO	United Nations Educational, Scientific and Cultural Organization
VOC	Volatile Organic Compounds
VU	Vulnerable
WDPA	World Database on Protected Areas
WTNs	Waste Transfer Notes
μPa	Micropascal

1 Introduction

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1.1 Introduction

In April 2018, BP signed a Production Sharing Agreement (PSA) with the State Oil Company of Azerbaijan Republic (SOCAR) to jointly explore potential prospects within Block D230 in the North Absheron Basin in the Azerbaijan sector of the Caspian Sea. The PSA was ratified by the Azerbaijani parliament in October 2018.

Block D230 is located approximately 80km from the Azerbaijani coastline, and covers an area of approximately 3,222km² (refer to Figure 1.1). The water depth ranges from 100m to 800m. BP is planning to conduct a seismic survey within Block D230 and extend one acquisition line beyond the block boundary to the Ashrafi-1 well located in the Dan Ulduzu Ashrafi Contract Area south of Block D230 (refer to Figure 1.1). The purpose of the seismic survey will be to assess hydrocarbon prospects within the basin; following which targets for potential future exploration drilling can be identified.

This Environmental and Socio-Economic Impact Assessment (ESIA) has been prepared to assess potential impacts from the proposed survey and to determine any required mitigation measures for the protection of the Caspian Sea environment.

1.1.1 Overview of 3D Seismic Survey

The 3D seismic survey will be undertaken by a seismic survey vessel using six 4-6 km length streamers[2] and two energy sources, which will be towed behind the vessel. One or two additional vessels will undertake a number of supporting activities including provision of supplies, crew change, transfer of waste to shore and maintaining a safety exclusion zone around the survey vessel and towed equipment.

The survey will involve the survey vessel travelling along pre-determined survey lines, acquiring geophysical data. During the acquisition, a controlled sound energy will be released and travel through the water column to the seabed, reflecting back from different subsurface geological layers. The reflected energy will be recorded by the receivers (termed hydrophones) embedded in the streamers and transmitted to the survey vessel where it will be analysed for quality control. Following this the data will be stored for processing and interpretation at a later stage.

The seismic survey is planned to be undertaken over a maximum 6 month period during 2019-2020.

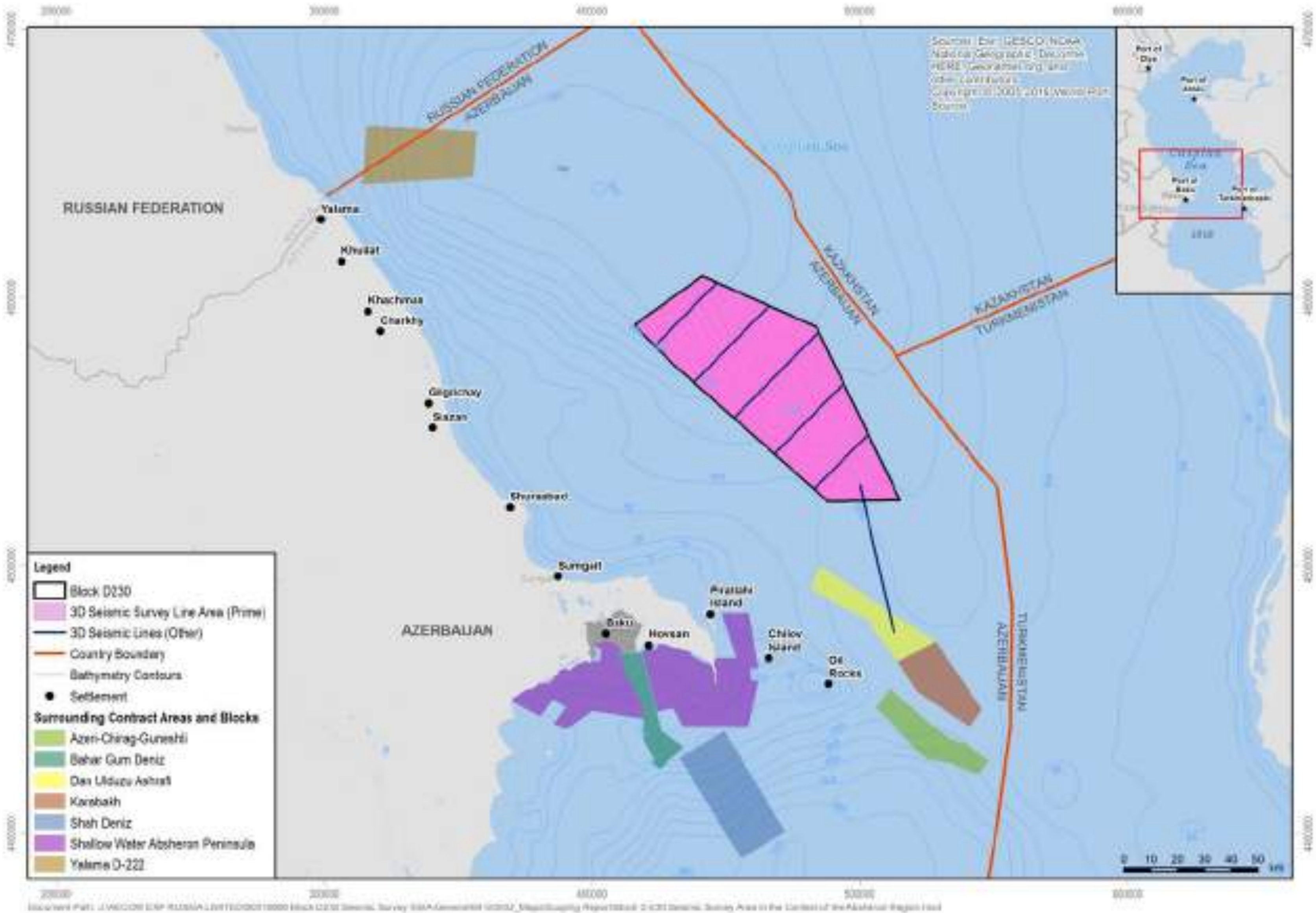
1.1.2 Other BP Exploration and Production Activities in the Block D230 Vicinity

Under the Shallow Water Absheron Peninsula (SWAP), Shafag-Asiman, Azeri Chirag Gunashli (ACG) and Shah Deniz (SD) PSAs, signed in 2015, 2010, 1994 and 1996 respectively, BP have been undertaking exploration and production activities since 1995 including the completion of offshore seismic surveys and drilling activities and the installation and operation of onshore and offshore production and export facilities (refer to Figure 1.1). Environmental and social data have been collected during this period through baseline and monitoring surveys and third party data collection with the purpose of informing assessments of potential environmental and social impacts and identifying trends observed in the environment including those that may be the result of BP’s activities.

The location of the SWAP, ACG and SD Contract Areas are shown in Figure 1.1. The Yalama D222 Contract Area, Dan Ulduzu Ashrafi Contract Area and Karabakh Contract Area, which are subject to separate PSAs between SOCAR and third parties are also shown.

[2] A streamer comprises a buoyant electrical cable to which the receivers (i.e. hydrophones) are connected at regular intervals and along which the signals received by each hydrophone are sent to the seismic acquisition equipment on the survey vessel.

Figure 1.1: Location of Block D230 and Existing Contract Areas in the Region



1.2 Scope of the Block D230 Seismic Survey ESIA

The overall objective of the Block D230 Seismic Survey ESIA process is to identify and outline the strategy for minimising and effectively managing potential negative environmental and socio-economic impacts from the proposed survey activities.

The purpose of this ESIA is to:

- Ensure that environmental and socio-economic considerations are integrated into the seismic survey design;
- Ensure that potential impacts from the seismic operations are identified, assessed and appropriate mitigation measures proposed to reduce their significance to acceptable levels;
- Consult with relevant stakeholders throughout the ESIA process; and
- Demonstrate that the seismic survey will be implemented with due regard to protecting the environment.

The ESIA process has commenced with the scoping exercise, where interactions anticipated between the Project activities (aspects) and bio-physical and socio-economic receptors have been analysed with the aim of identifying potentially significant interactions and scoping out activities with a limited potential to result in discernible impacts. Chapter 3 summarises key topics which were either scoped in or out from the full assessment.

1.3 ESIA Team and Structure

The details of the Block D230 Seismic Survey ESIA Team are provided in Table 1.1.

Table 1.1: Block D230 Seismic Survey ESIA Team

Team Member	Role
AECOM	ESIA Project Manager and Lead Authors
	Socio-Economic Assessment
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This ESIA Report comprises 10 chapters:

- Firstly, the Introduction provides an overview and background of the proposed Project, objectives of the ESIA study, and structure of the ESIA Report. Chapter 2 sets out the Legislative and Regulatory Context for the Project including the applicable national legal and administrative framework; the national and international laws and conventions relevant to the Project and the relevant national EIA guidance and regional processes. Chapter 3 describes the assessment methodology, approach to defining impact significance and approach to mitigation, Chapter 3 also summarises the scoping process.
- Chapter 4 provides an overview of the Project, including discussion of operational parameters, equipment specifications, emissions, resource utilisation and design control protection measures.
- Baseline Conditions are summarised in Chapter 5 including an overview of the biophysical and socio-economic environment and the key receptors located within the area that could be affected by the Project.
- The Environmental and Socio-economic Impact assessment is presented in Chapter 6 and identifies interactions of key aspects/ activities with the environment, and evaluates resulting direct and indirect effects. Mitigation measures are applied to evaluate residual impacts.
- Chapter 7 presents an assessment of potential cumulative impacts and unplanned events. The chapter describes the measures to manage risks and respond to unplanned incidents. Potential transboundary impacts are presented in Chapter 8 providing full justification for scoped out elements as well as detailed assumptions for scoped in risks.

- Chapter 9 presents the overarching Environmental and Socio-Economic Management Plan detailing project management systems, mitigation measures and requirements for subject specific management plans.
- A conclusion of the ESIA Report is presented in Chapter 10.

2 Legislative and Regulatory Context

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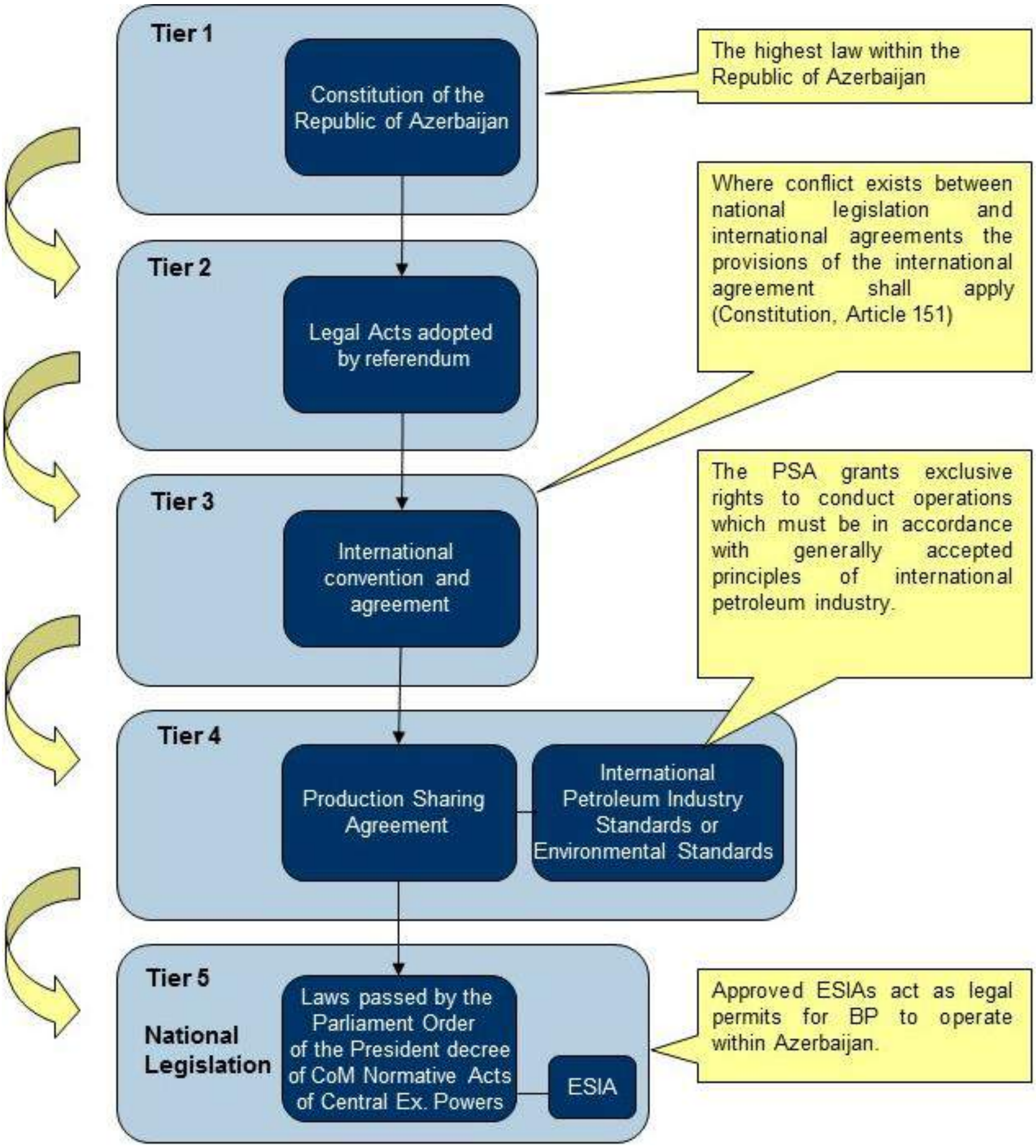
2.1 Overview

This Chapter provides an overview of the agreements, legislation, standards and guidelines which are applicable to the Project including the following:

- Block D230 Production Sharing Agreement (PSA);
- Applicable requirements of international and regional conventions ratified by the Azerbaijani government;
- Applicable national legislation and guidance;
- Regional processes; and
- International petroleum industry standards and practices.

The legal hierarchy applicable to the Project is illustrated in Figure 2.1.

Figure 2.1: Azerbaijan Legal Hierarchy



In addition to the applicable legal requirements, the Block D230 Seismic Survey will be undertaken in accordance with BP Group, Segment and Regional guidelines.

2.2 Regulatory Agencies

The Ministry of Ecology and Natural Resources (MENR) has primary responsibility for environmental regulation. The MENR's statutes were adopted by presidential decree in 2001, making this body responsible for:

- Development of draft environmental legislation for submission to the Azerbaijan Parliament (Milli Mejlis[3]);
- Implementation of environmental policy;
- Enforcement of standards and requirements for environmental protection;
- Suspension or termination of activities not meeting set standards;
- Advising on environmental issues;
- Expert review and approval of environmental documentation, including Environmental Impact Assessment (EIA) and ESIA; and
- Implementation of the requirements set out in international conventions ratified by the Republic of Azerbaijan (within its competence).

Other ministries and committees have functions that relate to environmental regulation including:

- **Ministry of Emergency Situations (MES)** - responsible for the management of natural disasters and industrial accidents and the implementation of safety rules in construction, mining and industry. MES (along with the SOCAR, MENR and other appropriate Ministries) require prompt notification in the event of an emergency, or accident;
- **Ministry of Health** - state institution controlling the sanitary-epidemiological situation in the country and regulation of health protection in the work place; and
- **Ministry of Energy** - responsible for oil and gas activities, the sale of oil and gas products, and the efficient utilisation of Azerbaijan's energy resources.

2.3 The Constitution

The Constitution is the highest law in the Republic of Azerbaijan and prevails over national legislation and international agreements. The following Articles help determine the applicability of national and international requirements to the Project:

- **Article 148.II** - International agreements acceded to by the Republic of Azerbaijan become an integral part of the legislative system of Azerbaijan; and
- **Article 151** - If any conflicts arise between the normative-legal acts which constitute the legislative system of Azerbaijan (except for the Constitution and the acts adopted via referendum) and the international agreements acceded to by the Republic of Azerbaijan, the provisions of the international agreements shall apply.

Constitution (Article 39) also stipulates the basic rights of people to live in a healthy environment, to have access to information on the state of the environment and to obtain compensation for damage suffered as the result of a violation of environmental legislation.

2.4 Production Sharing Agreement

The PSA is the legally binding agreement for the joint exploration and development of Block D230 in the North Absheron basin in the Azerbaijan sector of the Caspian Sea. It was signed on 26th April 2018 between the State Oil Company of the Azerbaijan Republic (SOCAR) and BP. The PSA was ratified by the Azerbaijani parliament in October 2018. Under the PSA, which is for 25 years, BP will be the operator during the exploration phase holding a 50 per cent interest while SOCAR will hold the remaining 50 per cent interest., The operator has the right, for the entire term of the PSA, to explore, develop and produce hydrocarbons from Block D230.

Article 26.1 of the PSA states:

[3] Milli Mejlis is the name of the National Parliament of the Azerbaijan Republic.

"Contractor shall apply safety and environmental protection standards and practices that take account of the specific environmental characteristics of the Caspian Sea and draw, as appropriate, on (i) international Petroleum industry standards and experience with their implementation in exploration and production operations in other parts of the world and (ii) existing Azerbaijan safety and environmental legislation. In compilation of such standards and practices account shall be taken of such matters as environmental quality objectives, technical feasibility and economic and commercial viability."

Article 26.1 also requires that in developing relevant standards and practices, environmental quality objectives, technical feasibility and economic and commercial viability must also be taken into account and further states:

"Subject to the first sentence of Article 26.4, the standards which shall apply to Petroleum Operations from Effective Date shall be the standards and practices set out in Part II of Appendix 9 until substituted by new safety and environmental protection standards devised and agreed between Contractor, SOCAR and MENR. Such substitution shall take effect following the appropriate written agreement between Contractor, SOCAR and MENR on a date agreed between the Parties and MENR and from such date such agreed standards and practices shall have the force of law as if set out in full in this Agreement."

Article 26.2 of the PSA states:

"Contractor shall conduct the Petroleum Operations in a diligent, safe and efficient manner in accordance with the Environmental Standards and shall take all reasonable actions in accordance with the Environmental Standards to minimise any potential disturbance to the general environment, including without limitation the surface, subsurface, sea, air, lakes, rivers, animal life, plant life, crops and , other natural resources and property."

Article 26.4 of the PSA requires "Contractor" to *"…comply with present and future Azerbaijani laws or regulations of general applicability with respect to public health, safety and protection and restoration of the environment, to the extent that such laws and regulations are no more stringent than the Environmental Standards set out in Part II of Appendix 9."*

Appendix 9, Section II, Article A.1 of the PSA restricts the release of drilling discharges:

"There shall be no discharge of waste oil, produced water and sand, drilling fluids, drill cuttings or other wastes from exploration and production sites except in accordance with the following guidelines."

Appendix 9, Section II, Article B.3(a) of the PSA requires the Project to adhere to Good International Petroleum Industry Practice related to the discharge of sanitary and states the following:

"Sanitary waste and grey water may be discharged offshore after treatment in accordance with Good International Petroleum Industry Practice. No floating solids shall be observable in the treated waste water."

Until the written agreement on entrance into legal force of the Production Standards has been signed by all of the parties, the standards and practices set out in part II of Appendix 9 to the PSA shall continue to apply to petroleum operations.

2.5 International and Regional Environmental Conventions

Azerbaijan is signatory to numerous international and regional conventions that oblige the government to prevent pollution and protect specified habitats, flora and fauna. Those of relevance to the Project are listed in Tables 2.1 and 2.2.

Table 2.1:Summary of International Conventions

Convention	Purpose	Status
Bern Convention	Conservation of wild flora and fauna and their natural habitats.	In force in Azerbaijan since 2002.
Stockholm Convention on Persistent Organic Pollutants	Reduction in releases of dioxins, furans, hexachlorobenzene and PCBs with the aim of minimisation or elimination.	Azerbaijan acceded in 2004.
International Convention for the Prevention of Pollution from Ships/ Vessels (MARPOL), 1973 as amended by the protocol, 1978	The legislation giving effect to MARPOL 73/78 in Azerbaijan is the Protection of the Sea (Prevention of Pollution from Ships) Act 1983. Preventing and minimising pollution of the marine environment from ships - both accidental pollution and that from routine operations.	Azerbaijan acceded in 2004.
UN Convention on the Protection of the Ozone Layer (Vienna Convention)	Framework for directing international effort to protect the ozone layer, including legally binding requirements limiting the production and use of ozone depleting substances as defined in the Montreal Protocol to the Convention. Supported by the Montreal Protocol and amendments (see below).	Azerbaijan acceded in 1996.
Montreal Protocol on Substances that Deplete the Ozone Layer, 1987	Specific requirements for reductions in emissions of gases that deplete the ozone layer. Amended four times: London 1990, Copenhagen 1992, Montreal 1997 and Beijing 1999.	Azerbaijan acceded in 1996.
United Nations Framework Convention on Climate Change, 1992	Seeks to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, within a sufficient time frame to allow ecosystem to adapt naturally, protect food production and enable sustainable economic development.	Azerbaijan acceded in 1992 and not formally required to meet specific targets.
Kyoto Protocol, 1997	Follow on from the Framework Convention on Climate Change.	Azerbaijan acceded in 2000.
UN Convention on Biological Diversity, 1992	Conservation of biological diversity including the sustainable use of its components and the fair and equitable sharing of benefits.	Azerbaijan became party to the Convention in 2000.
International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990	Seeks to develop further measures to prevent pollution from ships.	Azerbaijan acceded in 2004.
Basel Convention on Control of Transboundary Movements of Hazardous Wastes and their Disposals	Seeks to control and reduce transboundary movements of hazardous wastes, minimise the hazardous wastes generated, ensure environmentally sound waste management and recovery practices and assist developing countries in improving waste management systems.	Azerbaijan ratified in 2001.

Table 2.2: Summary of Regional Conventions

Convention	Purpose	Status
Aarhus Convention*	To guarantee the rights of access to information, public participation in decision-making and access to justice in environmental matters.	Azerbaijan acceded in 2000.
Espoo Convention*	To promote environmentally sound and sustainable development through the application of ESIA, especially as a preventive measure against transboundary environmental degradation.	Azerbaijan acceded in 1999 and at the time of writing, Azerbaijan had not signed a related

Convention	Purpose	Status
		protocol on Strategic Environmental Assessment.
Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki Convention)*	To prevent, control or reduce transboundary impact resulting from the pollution of transboundary waters by human activity.	Azerbaijan acceded in 2002.
UN Convention on Control of Transboundary Movements of Hazardous Wastes and their Disposals	Regulates the transboundary movements of hazardous wastes and provides obligations to its Parties to ensure that such wastes are managed and disposed of in an environmentally sound manner.	Azerbaijan ratified in 2001.
Protocol on Water and Health*	To protect human health and well-being by better water management and by preventing, controlling and reducing water-related diseases.	Azerbaijan acceded in 2003.
UNECE Geneva Convention on Long-range Transboundary Air Pollution*	Provides a framework for controlling and reducing transboundary air pollution.	Entered into force in Azerbaijan in 2002. Has been extended by 8 protocols, none of which at the time of writing have been ratified by Azerbaijan.
Convention on the Transboundary Effects of Industrial Accidents*	To prevent industrial accidents that may have transboundary effects and to prepare for and respond to such events.	Azerbaijan acceded in 2004.
Tehran-Caspian Framework Convention	Ratified by all five littoral states and entered into force in 2006. Requires member states to take a number of generic measures to control pollution of the Caspian Sea. Three protocols have been adopted and therefore form the basis for national legislation and regulations. One protocol, namely Environment Impact Assessment in a Transboundary Context, has been drafted and was not adopted at the time of writing.	Convention is ratified, and the following protocols have been adopted: The Protocol Concerning Regional Preparedness, Response and Co-operation in Combating Oil Pollution Incidents ("Aktau Protocol") (August 2011); The Protocol for the Protection of the Caspian Sea against Pollution from Land-based Sources and Activities ("Moscow Protocol") (December 2012); and The Protocol for the Conservation of Biological Diversity ("Ashgabat Protocol") (May 2014).
* A UNECE agreement; Azerbaijan became a member of the UNECE in 1993. The major aim of the UNECE is to promote pan-European integration through the establishment of norms, standards and conventions.		

2.6 National Environmental Legislation

The Azerbaijani Government has committed to a process to align national environmental legislation with the principles of internationally recognised legislation, based on EU environmental legislation. As this process is on-going, the Project will comply with the intent of current national legal requirements where those requirements do not contradict, or are otherwise incompatible with, international petroleum industry standards and practice.

The framework for national environmental legislation in Azerbaijan is provided by the Law on the Protection of the Environment (1999), which addresses the following issues:

- The rights and responsibilities of the State, the citizens, public associations and local authorities;
- The use of natural resources;
- Monitoring, standardisation and certification;
- Economic regulation of environmental protection;
- State Ecological Expertise (SEE);
- Ecological requirements for economic activities;
- Education, scientific research, statistics and information;
- Ecological emergencies and ecological disaster zones;
- Control of environmental protection;
- Ecological auditing;
- Responsibility for the violation of environmental legislation; and
- International cooperation.

According to Article 54.2 of the Law on Protection of the Environment, EIAs are subject to SEE, which means that the environmental authority (MENR) is responsible for the review and approval of EIA reports submitted by developers. The Law establishes the basis for the SEE procedure, which can be seen as a “stand-alone” check of compliance of the proposed project with the relevant environmental standards (e.g. for pollution levels, discharges and noise). In addition the law determines that projects cannot be implemented without a positive SEE resolution.

The SEE approach requires state authorities to formally verify all submitted developments for their potential environmental impacts. Current internationally recognised practice emphasises a proportionate, consultative and publicly accountable approach to assessing impacts.

As of 12th June 2018, Azerbaijan introduced a law on Environmental Impact Assessment (EIA) which establishes a legal, economic and organisation framework for the assessment of impacts on the natural environment and human health associated with economic activities proposed by public and private developers[4]. The objectives and principles of this law, and how it interacts with existing guidance are outlined in Section 2.6.1.

Table 2.3 provides a summary of the key national environmental and social laws.

[4] Law ID 1175-VQ “Ətraf mühitə təsirin qiymətləndirilməsi haqqında”, dated 13/07/2018, available at http://www.e-qanun.az/framework/39511

Table 2.3: Key National Environmental and Social Laws[5]

Subject	Title	Description / Relevance to Block D230 Seismic Survey ESIA
General	Law of Azerbaijan Republic on Environmental Impact Assessment (EIA) No. 1175-VQ.	Determines the legal framework for the EIA process in Azerbaijan and outlines the objectives and principles of EIA. It also introduces a list of mandatory activities that require an EIA and identifies the rights and responsibilities of all parties involved in its preparation, approval and communication.
	Law of Azerbaijan Republic on the Protection of the Environment No. 678-IQ.	Establishes the main environmental protection principles and the rights and obligations of the State, public associations and citizens regarding environmental protection (described above).
	Law of Azerbaijan Republic on Ecological Safety No. 677-IQ.	One of two keystone laws of the country's environmental legislation (along with the *Law on the Protection of the Environment*). Its purpose is to establish a legal basis for the protection of life and health, society, the environment, including atmospheric air, space, water bodies, mineral resources, natural landscapes, plants and animals from natural and anthropogenic dangers. The Law assigns the rights and responsibilities of the State, citizens and public associations in ecological safety, including information and liability. The Law also deals with the regulation of economic activity, territorial zoning and the alleviation of the consequences of environmental disasters.
Ecosystems	Law of the Azerbaijan Republic on Specially Protected Natural Territories and Objects No. 840-IQ.	Determines the legal basis for protected natural areas and objects in Azerbaijan.
	Law of Azerbaijan Republic on Fauna No. 675-IQ.	Defines the animal world, property rights over fauna and legal relationships between parties. It also describes issues of State inventory and monitoring, and economic and punitive regulations.
Water	Water Code of Azerbaijan Republic (approved by Law No. 418-IQ).	Regulates the use of water bodies, sets property rights and covers issues of inventory and monitoring. The Code regulates the use of water bodies for drinking and service water and for medical treatment, spas, recreation and sports, agricultural needs, industrial needs and hydro energy, transport, fishing and hunting, discharge of waste water, fire protection and specially protected water bodies. It provides for zoning, maximum allowable concentrations of harmful substances and basic rules of industry conduct.
	Rules of Referral of Specially Protected Water Objects to Individual Categories, Cabinet of Ministers Decree No. 77.	The Caspian Sea is a specially protected water body. This resolution requires special permits for disposal if there are no other options for wastewater discharge. The resolution allows for restrictions to be placed on the use of specially protected water bodies, and for further development of regulations related to these water bodies. It requires consent from MENR for activities that modify the natural conditions of specially protected water bodies, and includes provisions for permitting of any discharges to water that cannot be avoided. There are also special requirements for the protection of water bodies designated for recreational or sports use (which includes the Caspian).

[5] This table is compiled from a variety of sources including: United Nations 2004, Environmental Performance Reviews Series No. 19 – Azerbaijan; Currie & Brown, 2008, Integrated Solid Waste Management System for the Absheron Peninsula Project, and Popov 2005, Azerbaijan Urban Environmental Profile (an ADB Publication).

Subject	Title	Description / Relevance to Block D230 Seismic Survey ESIA
	Rules for Protection of Surface Waters from Waste Water Pollution, State Committee of Ecology Decree No. 1.	Under this legislation the *Permitted Norms of Harmful Impact Upon Water Bodies of Importance to Fisheries* require discharges to meet several specified standards for designated water bodies in terms of suspended solids; floating matter; colour, smell and taste; temperature; dissolved oxygen; pH; Biological Oxygen Demand (BOD) and poisonous substances. Limits are based on Soviet era standards and are to be achieved at the boundary of the facility (specific "sanitary protection zone limits") rather than "end-of-pipe" limits. End of pipe limits are defined in facility-specific "eco-passports" and are established with the intent to ensure compliance with applicable ambient standards.
Air	Law of Azerbaijan Republic on Air Protection No. 109-IIQ.	Establishes the legal basis for the protection of air, thus implementing the constitutional right of the population to live in a healthy environment. It stipulates the rights and obligations of the authorities, legal and physical persons and non-governmental organisations (NGOs) in this respect, sets general requirements for air protection during economic activities, establishes norms for mitigating physical and chemical impacts to the atmosphere, establishes rules for the State inventory of harmful emissions and their sources and introduces general categories of breaches of the Law that will trigger punitive measures.
	Methodology to Define Facilities' Hazards Categories Subject to Hazardous Substance Emissions Levels and Need to Develop Projects' Maximum Permissible Emissions.	Under this methodology the maximum permissible concentrations of harmful substances and their hazard classes are provided. Limits are based on Soviet era standards.
Waste	Law of Azerbaijan Republic on Industrial and Domestic Waste No. 514-IQ.	Describes State policy in environmental protection from industrial and household waste including harmful gases, waste water and radioactive waste. It defines the rights and responsibilities of the State and other entities, sets requirements for the design and construction of waste-treatment installations, licensing of waste generating activities, and for the storage and transport of waste (including transboundary transportation). The Law also encourages the introduction of technologies for the minimisation of waste generation by industrial enterprises. There is a general description of responses to infringements. This law is specified by Resolutions of the Cabinet of Ministers on the rules of certification of hazardous wastes, state strategy on management of hazardous wastes in Azerbaijan and by Instructions on the Inventorisation Rules and Classification System of the Wastes generated by Industrial Processes and In the Field of Services approved by the MENR.
Subsurface	Law of the Azerbaijan Republic on Subsurface Resources No. 439-IQ.	Regulates the exploitation, rational use, safety and protection of subsurface resources and the Azerbaijani sector of the Caspian Sea. The Law lays down the principal property rights and responsibilities of users. It puts certain restrictions on the use of mineral resources, based on environmental protection considerations, public health and economic interests.
Information	Law of the Azerbaijan Republic on Access to Environmental Information No. 270-IIQ.	Establishes the classification of environmental information. If information is not explicitly classified "for restricted use" then it is available to the public. Procedures for the application of restrictions are described. Law aims to incorporate the provisions of the Aarhus Convention into Azerbaijani Law.
Health & Safety	Law on Sanitary-Epidemiological Services (authorised by Presidential Decree No. 371).	Establishes sanitary and epidemiological requirements for industrial entities to be met at design, construction and operational stages, and for other economic activities. Aims to protect the health of the population. It addresses the rights of citizens to live in a safe environment and to receive full and free information on sanitary-epidemic conditions, the environment and public health.

Subject	Title	Description / Relevance to Block D230 Seismic Survey ESIA
	Law of the Azerbaijan Republic on Protection of Public Health No. 360-IQ.	Sets out the basic principles of public health protection and the health care system. The Law assigns liability for harmful impact on public health, stipulating that damage to health that results from a polluted environment shall be compensated by the entity or person that caused the damage.
	Law of the Azerbaijan Republic on Public Radiation Safety No. 423-IQ.	Includes requirements for ensuring radiation safety in industrial entities. The Law establishes the main principles of government policy on radiation safety, as well as environmental norms protecting the safety of employees and populations in areas potentially affected by the use of radioactive sources. The Law provides for compensation for damage to health, property and life due to accidents.
	Law of Azerbaijan on Technical Safety - 733-IQ	The current law sets legislative, economic and social basis of PDF (Potential Dangerous Facilities) exploitation.
Liability	Law on Mandatory Insurances.	Identifies requirements for the mandatory insurance of civil liability for damage caused to life, health, property and the environment resulting from accidental environmental pollution.
Permitting	A System of Standards for the Environment Protection and Improvement of Natural Resources Utilisation. Industrial Enterprise Ecological Certificate Fundamental Regulations, GOST 17.0.0.04-90.	The MENR issues ecological documents on the impact on the environment of potentially polluting enterprises. The documents include maximum allowable emissions, maximum allowable discharges, and an “ecological passport.” The last item is specific to countries of the Former Soviet Union and contains a broad profile of an enterprise’s environmental impacts, including resource consumption, waste management, recycling, and the effectiveness of pollution treatment. Enterprises develop the draft passport themselves and submit it to MENR for approval.
Cultural heritage	Law on the Protection of Historical and Cultural Monuments.	Specifies the responsibilities of state and local authorities, and lays down principles for the use, study, conservation, restoration, reconstruction, renovation and safety of monuments. The Law declares that cultural objects with national status, historical and cultural monuments, cultural goods stored in state museums, archives, libraries, as well as the territories where they are situated, are not subject to privatisation. Requires archaeological studies prior to construction works in areas with archaeological significance.

2.6.1 National EIA Guidance

The mandatory EIA requirements within Azerbaijan are set out within the Law of Azerbaijan Republic on Environmental Impact Assessment ("EIA Law") The purpose of the EIA Law is to give effect to Article 54.2 of the Law on the Protection of the Environment in Azerbaijan, establishing the legal, economic and organisational framework for assessment of impacts on natural environment and human health associated with economic activities proposed by public and private developers.

Under this law, an EIA must be undertaken with reference to the following key principles:

- Based on an analysis of environmental and socio-economic effects of the proposed activity;
- Ensuring accuracy, transparency and reliability of environmental information relevant to the proposed activity;
- Taking into account the requirement for preservation of ecological balance and biodiversity;
- Forecasting all possible environmental impacts and assessment of risk;
- Confirming compliance of the proposed activity with established permissible limits;
- Ensuring public disclosure, consultation and consideration of public representatives in addition to participation of government and municipal bodies, physical and legal entities and non-governmental organisations; and
- Ensuring state control and public transparency of EIA.

The process to be followed to undertake an EIA is provided in Article 4 of the EIA legislation, including the roles and responsibilities of the Developer and Competent Authorities which includes the MENR. A summary of the EIA process, including the mandatory requirements are provided in Table 2.4 below.

Table 2.4: Summary of the EIA Process in Azerbaijan and Mandatory Requirements

Scoping and Requirement for EIA	
Activities Subject to EIA	The categories of economic developments that are subject to mandatory EIA are set out within an Appendix to the EIA Law. These include hydrocarbon exploration, development and extraction.
Scoping	The Developer is required to carry out the EIA of the proposed activity following a preliminary consultation with the Competent Authority (MENR). The preliminary consultation is required to define the content, scope and methodology of the assessment, and to ensure completeness and accuracy of the relevant documentation used in the EIA.
EIA Report	
General	The EIA Report shall be prepared during the project development stage and submitted to the Competent Authority to undertake a review of the EIA report in accordance with the Azerbaijan Republic Law on Environmental Protection. It shall be written in an understandable style and shall include a description of baseline conditions, potential environmental and public health impacts, mitigation measures and recommendations aimed at minimisation of the negative impacts and shall include introduction and conclusion sections.
Project Description	A full description of the proposed development, its purpose, phases, types of its environmental impacts and methodology used for assessing environmental risks shall be provided.
Project Alternatives	An overview of at least two options alternative to the proposal (including zero option), as well as environmental justification for the option of applying the best available technology shall be provided.
Legislative Requirements	A summary of the legal framework and references of statutory and normative documentation used in the EIA shall be included.
Environmental and Socio-economic Description	Baseline environmental and socio-economic conditions and sensitivity of the areas affected by the proposed development should be described.
Impact Assessment and Mitigation	All impacts (direct and indirect, onsite and offsite, acute and chronic, one-off and cumulative, emergency and non-routine, transient and irreversible) should be identified and evaluated according to its significance and severity and mitigation measures provided to avoid, reduce, or compensate for these impacts.
Transboundary and Accidental Impacts	Where transboundary impacts are identified, these should be assessed as per the procedure and terms established by the competent authority (Cabinet of Ministers) which are not yet adopted. Prediction of impacts associated with emergency events should be included within the EIA Report.

Environmental Management and Monitoring	An overview of the environmental management system to be adopted for the project through all project phases including relevant management and monitoring plans should be included.
Residual Impacts	A summary of the residual impacts and the prediction of their significance should be included.
EIA Disclosure	
Public Participation	The law requires that the public affected by the planned activities are informed during the EIA process. The developer is expected to involve the affected public in discussions on the proposal.
State Ecological Examination	The review of the EIA report in accordance with the Law on Environmental Protection will be undertaken by the MENR (over a statutory 3 month period), who will prepare an expert opinion. This will be published and made available to the relevant local executive authority where the development is located.

The approval of an EIA by the MENR establishes the compliance framework, including the environmental and social standards that an organisation should adhere to. The law requires that the EIA to be conducted by at least three Environmental Impact Assessors. These will be persons who are appropriately qualified, certified by the MENR and listed within a register. At the time of writing the procedures for certification and registration have yet to be established.

The Handbook for the Environmental Impact Assessment Process in Azerbaijan published in 1996, is aligned to the Law of Azerbaijan Republic on Environmental Impact Assessment and provides additional guidance on the EIA process and ongoing management and monitoring[6].

2.7 Regional Processes

2.7.1 European Union

EU relations with Azerbaijan are governed primarily by the EU-Azerbaijan Partnership and Cooperation Agreement (PCA) and the European Neighbourhood Policy (ENP).

The PCA entered into force in 1999. Under Article 43:

"The Republic of Azerbaijan should endeavour to ensure that its legislation will be gradually made compatible with that of the Community".

As part of the PCA an EU assessment of Azerbaijan's environmental legislation against EU Directives identified a number of recommendations for the approximation of national legislation with EU Directives[7]. Based on this, a draft national programme was developed that emphasises a flexible approach to amending national legislation to take account of institutional capacity and cost[8].

Following the enlargement of the European Union, the EU launched the ENP and Azerbaijan became part of this policy in 2004. The current National Indicative Programme for implementing the ENP[9] includes a commitment to support legislative reform in the environmental sector, including:

- Approximation of Azerbaijan's environmental legislation and standards with the EU's;
- Strengthening management capacity through integrated environmental authorisation;
- Improved procedures and structures for environmental impact assessment; and
- Development of sectoral environmental plans (waste and water management, air pollution, etc.).

[6] Azerbaijan State Committee on Ecology and Control of Natural Resources Utilization and United Nation Development Programme. Handbook for the Environmental Impact Assessment Process in Azerbaijan. Baku, 1996.
[7] Mammadov, A. & Apruzzi, F. (2004) Support for the Implementation of the Partnership Cooperation Agreement between EU-Azerbaijan. Scoreboard Report on Environment and Utilisation of Natural Resources. Report prepared for TACIS.
[8] SOFRECO (undated) Support for the Implementation of the PCA between EU-Azerbaijan, Draft Programme of legal Approximation.
[9] European Commission, 2007. European Neighbourhood and Partnership Instrument, Azerbaijan National Indicative Programme (NIP).

2.7.2 Environment for Europe

Environment for Europe[10] is a partnership of member states, including Azerbaijan, and other organisations within the UNECE region. Under the auspices of the Environment for Europe a series of ministerial conferences on the environment have been held that have resulted in the establishment of the UNECE conventions described in Section 2.5.

2.8 Industry Standards and Guidelines

The industry standards and guidelines applicable to the Project are produced by various organisations and are available either publicly via their websites or to members of the relevant association. Those specifically mentioned within the PSA include Oil Industry International Exploration and Production Forum (E&P Forum), the International Association of Geophysical Contractors (IAGC) and the International Association of Drilling Contractors (IADC). Other specific standards and guidance which is of relevance and represents international good industry practices (GIIP) includes:

- International Finance Corporation (IFC): Environmental, Health, and Safety Guidelines. Offshore Oil and Gas Development (2015) - IFC EHS Guidelines are technical reference documents with general and industry specific examples of good international industry practice. These guidelines include information relevant to seismic exploration, exploratory and production drilling, development and production activities, offshore pipeline operations, offshore transportation, tanker loading and unloading, ancillary and support operations, and decommissioning. It also addresses potential onshore impacts that may result from offshore oil and gas activities.
- The International Association of Oil & Gas producers (IOGP): Seismic Surveys & Marine Mammals (2008) - This position paper outlines seismic survey techniques and potential effects associated with marine mammals.
- Guidelines for Minimising the Risk of Injury and Disturbance to Marine Animals from Seismic Surveys (Joint Nature Conservation Committee, 2010) - These guidelines provide guidance aimed at reducing the risk of injury to negligible levels and potentially reducing the risk of disturbance from seismic surveys to marine mammals.

Specific IAGC guidance of relevance includes:

- Environmental Manual for Worldwide Geophysical Operations (2013) - This manual contains general operating procedures and standards for different environments where seismic acquisition may take place. These guidelines are most relevant to offshore seismic acquisition and survey work, although they are also applicable to vessel operations and general issues such as minimising risk and waste management.
- The International Association of Geophysical Contractors (IACG): Recommended Mitigation Measures for Cetaceans during Geophysical Operations (2015) - Provides a summary of recommended mitigation measures to be implemented during offshore seismic surveys to minimise their impact on cetaceans. The document explains the role and responsibilities of the Marine Mammal Observer, the role and responsibilities of the permit-holder and seismic contractor company, lines of communication between all on-board and information on reporting, conflict management, health, safety and environment (HSE) aspects and standards of conduct.

[10] United Nations Economic Commission for Europe UNECE (2008) Environment for Europe. Available at: http://www.unece.org/env/efe/welcome.html Accessed August 2015.

3 Impact Assessment Methodology

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3.1 Introduction

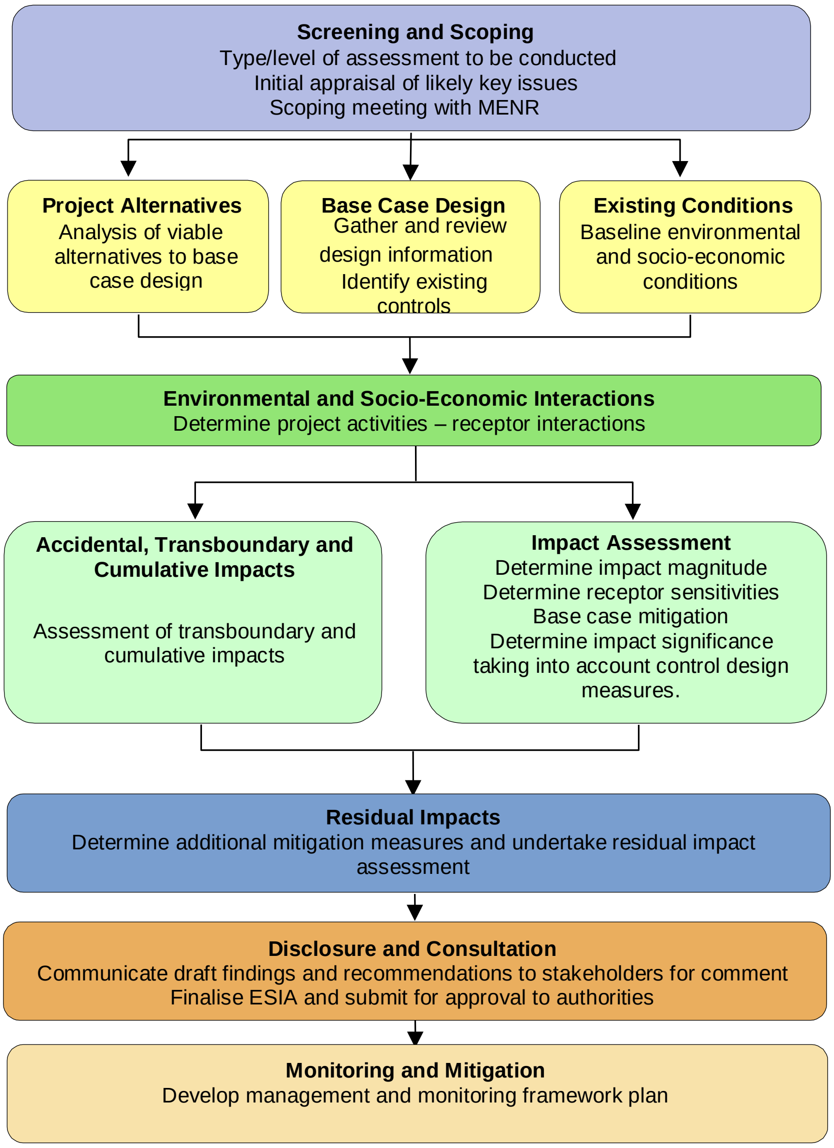
This Chapter of the Environmental and Socio-Economic Impact Assessment (ESIA) sets out the ESIA process adopted for the Project and the methodology used to assess impact significance.

3.2 ESIA Approach

The ESIA process constitutes a systematic approach to the evaluation of a project and its associated activities throughout the project lifecycle. The process (refer to Figure 3.1) includes:

- Screening and Scoping;
- Definition of Project Alternatives and Base Case Design;
- Description of the Existing Environmental and Socio-Economic Conditions within the Project Area of Influence as defined in Section 5.2 of Chapter 5 (also referred to as Study Area);
- Impact Assessment;
- Residual Impact Identification;
- Stakeholder Consultation and Disclosure; and
- Mitigation and Monitoring Framework.

Figure 3.1: The ESIA Process



3.3 Screening and Scoping

Screening is the first step in the assessment process. It confirms the need (or otherwise) for an ESIA by appraising the type of project and its associated activities throughout the project lifecycle in the context of its biophysical, socio-economic, policy and regulatory environments. Given the location, scale and planned activities associated with the Project and, taking into account national legislation, the requirement to complete an ESIA for the Block D230 Seismic Survey was identified. This is consistent with the approach taken for similar seismic surveys completed in the Shallow Water Absheron Peninsula (SWAP) Azeri Chirag Gunashli (ACG), Shah Deniz (SD) and Shafag-Asiman Contract Areas, which are all operated by BP and located in the Azerbaijani sector of the Caspian Sea. BP has undertaken a screening workshop to identify initial risks and concerns associated with the project.

Scoping is a high level assessment of anticipated **interactions** between **project activities** and **environmental and socio-economic receptors**. Its purpose is to focus the assessment on key issues and eliminate certain activities from the full impact assessment process based on their limited potential to result in discernible impacts. To arrive at a conclusion to 'scope out' an activity/event, a mixture of expert scientific judgement based on prior experience of similar activities and events and, in some instances, scoping level quantification/numerical analysis (e.g. emission and discharge modelling) is used. The Scoping process undertaken for the Project was also based on:

- The review of existing baseline data relevant to the Project Area of Influence (as defined within Section 3.4.2 below); and
- Liaison with the BP Project Team to gather data and to formulate an understanding of Project activities.

The results of the scoping exercise are presented in Section 6.1. of Chapter 6. A Scoping meeting was held with the MENR on 10th November 2016. The purpose of the meeting was to provide an overview of the project activities, the existing baseline conditions within the Project Area of Influence and the proposed scope of the assessments to be included within the ESIA. Key issues that were raised by the MENR and which have been addressed within this ESIA include the requirement to (i) assess all impacts of transboundary nature and present the results in a standalone chapter; (ii) provide clear definition of unplanned/accidental events; (iii) provide robust baseline description for the Project Study Area; (iv) ensure impacts and mitigation are considered for the survey line outside the D230 block to prevent potential risks on existing well structures in the Dan Ulduzu Ashrafi Contract Area.

3.4 Impact Assessment Process

The impact assessment methodology adopted takes into consideration an impact's nature (adverse or beneficial), type (direct, indirect or cumulative) and magnitude, and the sensitivity of the affected receptors, to yield a prediction of the impact's overall 'significance'.

Professional judgment and experience, data, regulatory and industry standards all contribute to the assessment of impacts, which ranges from technical analysis using quantitative criteria (such as analysis of underwater sound impacts based on modelling and appropriate underwater sound thresholds) to more qualitative evaluation, such as assessment for potential interference with sea users due to the project activities using baseline data and professional judgement.

It should be noted that impact significance is assessed taking into account existing control measures that are incorporated into the Project design (refer to Chapter 4.7). After the potential impacts have been identified and a preliminary assessment has been conducted, strategies to further avoid or mitigate the impacts are then developed (if required). The significance of the impacts is then re-evaluated based on these mitigation measures. The resulting impact is known as the 'residual' impact, and represents the impact that will remain following the application of mitigation and management measures, and thus the ultimate level of impact associated with the Project.

The basic process adopted for assessing potential impacts from the Project activities is depicted in Figure 3.2.

.

Figure 3.2: Impact Identification and Assessment Process

3.4.1 Project Aspect Identification

As defined by ISO14001:2015, a project aspect is: 'An element of an organisation's activities, products or services that can interact with the environment.'

To identify project aspects, all routine, irregular and unplanned activities are considered in terms of their direct or indirect potential to:

- Interact with the existing natural environment including its physical, biological and socioeconomic elements; and/or
- Breach relevant environmental policy, legal and administrative frameworks including national legislation, relevant international legislation, standards and guidelines, industry best practice and corporate environmental policy and management systems.

The assessed Project aspects include those resulting from:

- Planned activities: where the aspect is a result of a routine project activity; for example, emissions to atmosphere from routine operation of a vessel used for the Project; and
- Unplanned or accidental events: where an aspect is a result of mishaps or failures, including failure of equipment, procedures not being followed, human error, unforeseen events, or process equipment not performing as per design parameters. Typical examples are spills, leaks, emergency emissions and explosions.

Project aspects have been identified as part of the Scoping Phase and are presented in Table 3.1.

3.4.2 Definition of the Project Area of Influence

According to the International Finance Corporation (IFC) Performance Standard (PS) 1[11] the Project's area of influence should include the area affected by:

- The project activities and facilities that are (i) directly owned, operated or managed and are a component of the project; (ii) impacts from unplanned but predictable developments caused by the project that may occur later or at a different location; or (iii) indirect project impacts on biodiversity or on ecosystem services upon which peoples' livelihoods are dependent;
- Associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable; and
- Cumulative impacts[12] that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.

[11] IFC 2012. IFC Performance Standards on Environmental and Social Sustainability. 2012 Edition. 1 January 2012, International Finance Corporation, World Bank Group.
[12] Cumulative impacts are limited to those impacts generally recognised as important on the basis of scientific concerns and/or concerns from Affected Communities. Examples of cumulative impacts include: incremental contribution of gaseous emissions to

Given the nature of the proposed seismic activities and anticipated environmental and social-economic impacts, the zone of influence (hereafter referred as 'Project Area of Influence' or 'Study Area' where relevant) has been assumed to include:

- Block D230, a survey line extending to the Ashrafi-1 well located in Dan Ulduzu Ashrafi Contract Area (Figure 1.1), and a surrounding zone of approximately 10km, that can be potentially impacted by the physical presence of survey vessels / equipment. and underwater sound effects; and
- Block D230, the surrounding waters and adjacent coastline, which can potentially be affected by discharges to sea associated with accidental events (i.e. fuel, waste, chemicals due to spills and leaks).

3.4.3 Impact Significance Assessment

For the purpose of this ESIA environmental or socio-economic impact is defined as: "Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities or services." (ISO 14001:2015).

Where project activity-receptor interactions occur, an impact[13] is deemed to have occurred, and is categorised as defined within Table 3.1. The "significance" of the impact is determined by its magnitude and the sensitivity of the affected receptor.

Table 3.1: Definition of Impact Categories

Nature of Impact	**Adverse**	Considered to represent an adverse change from the baseline, or to introduce a new undesirable factor.
	Beneficial	Considered to represent an improvement to the baseline or to introduce a new desirable factor.
Type of Impact	**Direct**	Resulting from a direct interaction between a planned or unplanned project activity and the receiving environment/receptor.
	Indirect	Resulting from the Project but at a later time or at a removed distance or which may occur as a secondary effect of a direct impact.
	Cumulative	Resulting from (i) interactions between separate project-related residual impacts; and (ii) interactions between project-related residual impacts in combination with impacts from other projects and activities. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.
	Transboundary	Impacts that occur outside the jurisdictional borders of a project's host country i.e. pollution from spills or greenhouse gases (GHG) emissions.

3.4.4 Receptor Sensitivity

Within the Study Area the importance and sensitivity of environmental (physical and biological) and socio-economic receptors were determined based on:

- Relevant legislative or policy standards or guidelines;
- The relative importance/value assigned to existing socio-economic or environmental features/receptor;
- The capacity of the receptor to absorb change; and
- The recoverability of the receptor.

an airshed; reduction of water flows in a watershed due to multiple withdrawals; increases in sediment loads to a watershed; interference with migratory routes or wildlife movement; or more traffic congestion and accidents due to increases in vehicular traffic on community roadways (IFC, 2012).

[13] In this document, the terms 'effect' and 'impact' have been used interchangeably.

Tables 3.2 and 3.3 provide a general definition of sensitivity ranking for environmental and socio-economic receptors, respectively.

Table 3.2: Environmental Receptor Sensitivity Ranking Definitions

Sensitivity Ranking	Description
High	• **Ecosystem Value:** An area or species which is recognised as being of ***international and national importance and/or is legally protected*****;** and/or • **Capacity for Change and Recovery:** The receptor is highly sensitive to changes in the surrounding environment and has no / low capacity to absorb change without significantly altering its present character; no / slow natural recovery which may take longer than 5 years).
Moderate	• **Ecosystem Value:** An area or species which are recognised as being of ***regional importance***[14]; and/or • **Capacity for Change and Recovery:** The receptor is relatively sensitive to changes in the surrounding environment and has moderate capacity to absorb change without significantly altering its present character; natural recovery possible over medium term duration (more than one year but less than 5 years).
Low	• **Ecosystem Value:** An area or species which are recognised as being of ***local importance***; and/or • **Capacity for Change and Recovery:** The receptor is not sensitive to changes in the surrounding environment and has a natural ability (i.e. without human enhancement) for a rapid rate of recovery to pre-impacted status (less than a year).
Negligible	• **Ecosystem Value:** An area or species which has little or no value • **Capacity for Change and Recovery:** The receptor is not sensitive to changes in the surrounding environment and has a natural ability (i.e. without human enhancement) for a rapid rate of recovery to pre-impacted status within days/weeks).

Table 3.3: Socio-Economic Sensitivity Ranking Definitions

Sensitivity Ranking	Description
High	• **Socio-economic Value:** A socio-economic activity which is recognised as being of ***international / national importance and/or a resource or area which is legally protected****;* and/or • **Capacity for Change and Recovery:** The receptor has no / low capacity to absorb change without significantly altering its present character; no / slow natural recovery rates (more than 5 years)
Moderate	• **Socioeconomic Value:** A socio-economic activity which is recognised as being of ***regional importance;*** and/or • **Capacity for Change and Recovery:** A socio-economic activity which has the capacity to recover over medium term duration (more than 1 year but less than 5 years)
Low	• **Socioeconomic Value:** A socio-economic activity of ***local importance;*** and/or • **Capacity for Change and Recovery:** The receptor is sensitive to changes in the surrounding environment and has a natural ability (i.e. without human enhancement) for a rapid rate of recovery to pre-impacted status within less than a year.
Negligible	• **Socioeconomic Value:** A socio-economic activity of little or no value; and /or • **Capacity for Change and Recovery:** The receptor is not sensitive to changes in the surrounding environment and has a natural ability (i.e. without human enhancement) for a rapid rate of recovery to pre-impacted status within days/weeks.

3.4.5 Impact Magnitude

The magnitude of potential effects on the baseline conditions is identified through detailed consideration of the proposed project activities taking into account the following:

- Relevant legislative or policy standards or guidelines;
- The scale or degree of change from the existing baseline conditions as a result of the effects;
- The duration of the effect, e.g. whether it is temporary or long-term;
- The reversibility of the effect; and

[14] Regional refers to countries located around the Caspian Sea.

- For accidental unplanned events likelihood of effect occurring is also taken into account.

The potential impact consequence (magnitude) of each planned / unplanned activity on the environment and socio-economic receptors is evaluated using the matrix presented in Table 3.4.

Table 3.4: Impact Magnitude Ranking Definitions

Impact Magnitude Ranking	Environmental		Socio-Economic
	Physical	Biological	
High	Results in substantial adverse and long term (more than 5 years to permanent) changes to an ecosystem. Changes are evident and well outside the range of natural variation. Natural recovery is not possible and change is not reversible within assisted rehabilitation. Such impacts may result in immediate intervention by governmental bodies and stakeholders.	May affect a whole population or species causing a change in abundance and/or distribution, or the size of genetic pool such that natural recruitment would not return to that population, or any population of species dependent upon it; Such impacts may result in immediate intervention by governmental bodies and stakeholders.	Changes in social, economic or cultural dynamics with major adverse effect on any given sector performance and/or population wellbeing; Involves damage or permanent loss to natural resources of international/national importance. Such impacts may result in immediate intervention by governmental bodies and stakeholders.
Moderate	Results in moderate adverse change to an ecosystem or part of it. Changes may exceed the range of natural variation. There is potential for natural recovery in the medium term (more than 1 year but less than 5 years). Such impact may result in concerns being raised by governmental bodies or stakeholders.	May affect a portion of a population or species over one of more generations but does not change the integrity of the population as a whole. Such impact may result in concerns being raised by governmental bodies or stakeholders.	Changes in social, economic or cultural dynamics with moderate and noticeable adverse effect on any given sector performance and/or population wellbeing. Involves damage to natural resources of local importance. Such impact may result in concerns being raised by governmental bodies or stakeholders.
Low	Results in minor adverse changes to an ecosystem or part of it. Changes might be noticeable, but fall within the range of normal variation. Effects are short-lived and natural recovery takes place in the short term (< 1 year), however, it is recognised that a low level of localised impact may remain; Emissions and discharges to the environment within legal compliance.	May affect a group of individuals of a population at a localised area and/or over a short period (one generation or less). Does not affect other trophic levels or the integrity of the population itself.	Changes in social, economic or cultural dynamics with slight and temporary effect on any given sector performance and/ or population wellbeing; Limited impact to natural resources. Unlikely to result in concerns being raised by governmental bodies or stakeholders.
Negligible	Results in changes in an ecosystem that are unlikely to be noticeable (i.e. well within the scope of natural variation).	Changes to population or species that are unlikely to be noticeable (i.e. well within the scope of natural variation).	The social, economic or cultural impact is 'imperceptible' or unlikely to be noticed.

3.4.5.1 Evaluation of Impact Significance

Once the receptor sensitivity and impact magnitude have been ranked, the overall significance of the impact is predicted. This is completed using an impact assessment matrix as shown in Table 3.5 and impact significance definitions as presented in Table 3.6, which ensure a consistent approach throughout the impact assessment. The significance matrix provides basic guidance for the determination of impact significance. However, the resulting significance level is also interpreted based on professional judgement and expertise, and adjusted if necessary.

Table 3.5: Impact Significance Matrix

		Receptor Sensitivity			
		Negligible	Low	Moderate	High
Impact Magnitude	Negligible	Not significant	Not significant	Not significant	Not significant / Low*
	Low	Not significant	Low	Low / Moderate*	Moderate
	Moderate	Not significant	Low / Moderate*	Moderate	High
	High	Not significant / Low*	Moderate	High	High

* Professional expertise will determine the impact significance

Table 3.6: Impact of Significance Definitions (Adverse Impacts)

Significance	Definitions
High	**Significant**. Impacts with a "**High**" significance are likely to have damaging and lasting changes to the functioning of a receptor, and may have broader consequences (e.g. on function of the ecosystem or on community well-being). These impacts are a priority for mitigation in order to avoid or reduce their significance.
Moderate	**Significant**. Impacts with a "**Moderate**" significance are likely to be noticeable and result in lasting changes to baseline conditions, which may cause hardship to or degradation of the receptor. Broader consequences for the ecosystem or community are not anticipated. These impacts are a priority for mitigation in order to avoid or reduce their significance.
Low	Detectable but **Not Significant**. Impacts with a "**Low**" significance are expected to be noticeable changes to baseline conditions, beyond what would naturally occur, but are not expected to cause hardship or degradation. These impacts do not require mitigation and are not a concern of the decision-making process.
Not Significant	**Not Significant**. Impacts that are expected to be indistinguishable from the baseline or within the natural level of variation. These impacts do not require mitigation and are not a concern of the decision-making process.

The matrix and significance definitions will be used to assess adverse impacts of the Project. Significance rankings will not be determined for beneficial impacts; instead these will be described in qualitative terms and, where applicable, measures to maximise benefits will also be described.

3.4.6 Mitigation

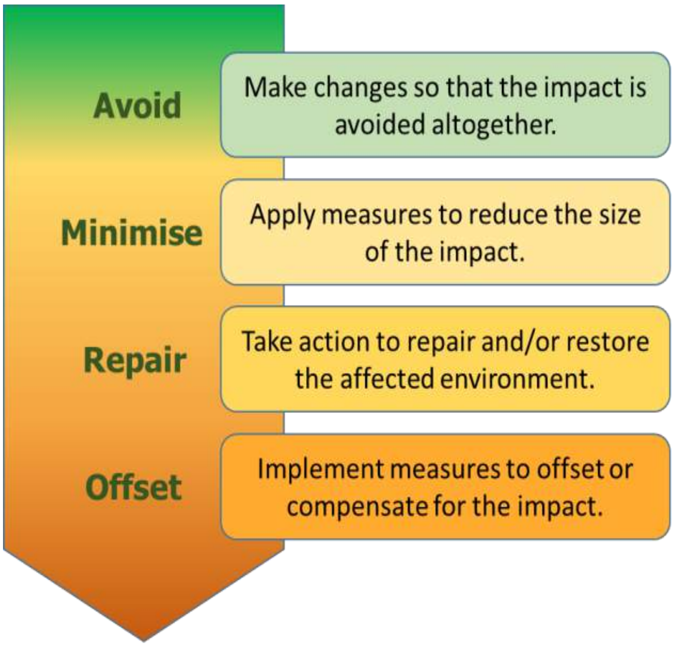
Mitigation is intended to avoid, reduce and offset potentially significant negative impacts as well as optimise the viability and potential benefits that the project may generate. The objectives of mitigation are often established through national legalisation or international conventions.

To alleviate possible impacts as far as possible, a mitigation hierarchy of prioritised steps through avoidance, minimisation (or reduction) and restoration has been established.

Mitigation measures are most effective when applied at the source of the impact; however, where this is not possible or does not completely mitigate the possible impact, other forms of mitigation are applied. The selection of mitigation measures will consider a standard mitigation hierarchy, whereby preference is given to avoiding impacts altogether and subsequently to minimising the impact, repairing its effects, and/ or offsetting the impact through actions in other areas as illustrated in Figure 3.3.

Where mitigation measures are identified, they will be communicated to the Project Team to be fed back into the Project design, and incorporated into the Project Environmental and Socio-Economic Management Plan.

Figure 3.3: Mitigation Hierarchy



3.4.7 Residual Impact

For all Significant impacts (Moderate or High) identified by the assessment, additional mitigation measures will be proposed aimed at reducing their magnitude to as low as reasonably practicable (ALARP). For Not Significant impacts (Low or Negligible), all design/control measures should be adhered to with monitoring and reporting implemented as required.

The significance of an impact will be assessed taking into account the design/control measures included within the Project Design, and following the inclusion of any additional mitigation measures identified; this allows for the effectiveness of the control measures to be gauged and further mitigation developed if required. Residual impacts refer to those environmental or socio-economic effects predicted to remain after the application of all mitigation.

3.4.8 Accidental Events

Accidental events are incidents and malfunctions that are not expected to occur during the Project's normal activities. Accidental events have the potential to result in a number of adverse impacts, varying in nature and magnitude depending on the type of event. The potential environmental and socio-economic impacts resulting from a range of accidental events assessed within the ESIA include a potential major fuel spill from a vessel. Although the likelihood of unplanned events is low, management and mitigations measures will be considered to ensure that their consequences are minimised and contained. The assessment of accidental events is presented in Chapter 7 of this ESIA.

3.4.9 Cumulative Impacts

Cumulative impacts can be defined as the effects on the environment that result from incremental changes caused by other past, present or reasonably foreseeable activities together with the proposed project. The UK Institute of Environmental Management and Assessment (IEMA) recognises two major sources of cumulative effects:

- Interactions between separate project related residual impacts (intra-project effects); and
- Interactions between project-related residual impacts in combination with impacts from other projects activities within the same area of influence (inter-project effects).

An example of an intra-project effect would be where a marine habitat is affected by multiple project operations including underwater sound, effluent discharges and physical disturbance from vessel movements, with the resultant effect being a greater nuisance than each individual effect alone.

In relation to the inter-project effects, the only known activities in the vicinity of the Study Area are other seismic surveys that have already occurred or planned. ESIA will focus on assessing cumulative impacts from the Project and other seismic surveys within the temporal scope before and after the anticipated Project mobilisation (the 2015-2020 assessment period).

Chapter 7 presents an assessment of cumulative impacts for the Project.

3.4.10 Transboundary Impacts

The ESIA will address impacts that could potentially cross the territorial boundaries of Azerbaijan into neighbouring countries. Transboundary issues will be discussed in the context of the Convention on Environmental Impact Assessment in a Transboundary Context 1991 (the Espoo Convention).

Transboundary impacts are defined as:

"any impact not exclusively of a global nature, within an area under the jurisdiction of a Party caused by a proposed activity the physical origin of which is situated wholly or in part within the area under the jurisdiction of another party"

With regard to the Block D230 Seismic Survey transboundary impacts are considered to be limited to:

- Potential impacts arising from a major fuel spill in an unlikely accidental event such as vessel collision for example; and
- Emissions to atmosphere from routine survey operations.

Transboundary atmospheric emissions include greenhouse gasses (GHGs), and gases that cause acid rain (sulphur dioxide and nitrogen oxides) controlled under the United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Pollution (1979).

The potential for transboundary impacts are evaluated within Chapter 8 of this ESIA.

4 Project Description

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4.1 Overview

BP and SOCAR are proposing to undertake an exploration program, comprising a 3D seismic data acquisition across Block D230 and beyond, in water depths ranging between 100 and 800m.

The survey will comprise ‘prime’ and ‘other’ survey lines as shown in Figure 4.1. The prime survey lines are contained within Block D230. Other survey lines include lines within the block and one survey line, which extends to the Ashrafi-1 well in the Dan Ulduzu Ashrafi Contract Area. Vessel movements will not be restricted to the Block boundaries as it will be necessary for the vessels to travel outside Block D230 in order to turn at the end of each line. The vessel manoeuvring zone may extend as far as 10 km from the end of acquisition lines. Data acquisition may also be conducted when the vessel changes lines.

The overall objective of the acquisition programme will be to:

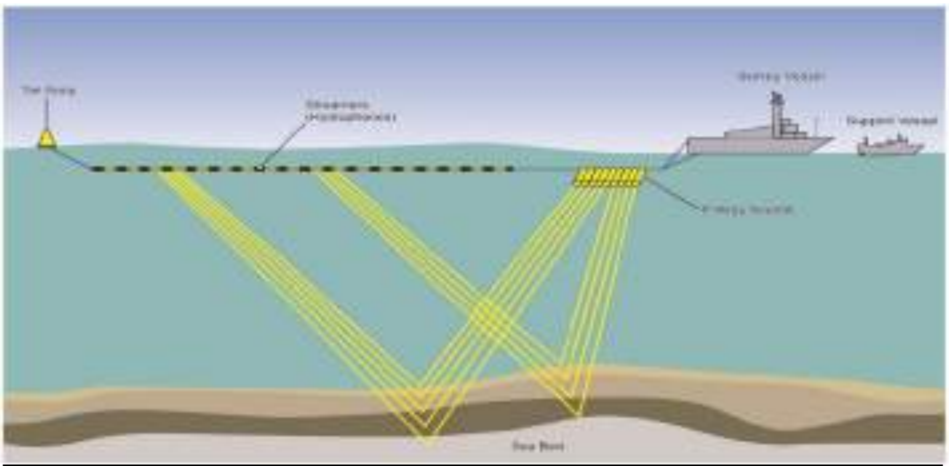
- Collect geophysical data for the prospects in the North Absheron Basin; and
- Identify geological structures containing hydrocarbons.

4.2 Survey Method

The geophysical method used in surveying is commonly referred to as ‘seismic-reflection’. The technique involves discharging directionally focused sound energy pulses into the water column. To reach the desired depths below the seabed, seismic surveys use low frequency sound waves that can penetrate more than 6,000m below the sea floor. These pulses travel through, and are reflected back from, geological formations exhibiting a difference in acoustic impedance. In towed streamer[15] surveys, such as planned for this Project, these reflections are recorded by receivers deployed in streamers towed behind the seismic survey vessel (Figure 4.1). Depths and spatial extent of the strata are then calculated and mapped, based upon the difference between the time of the energy being generated and subsequently recorded by the receivers.

Towed streamer surveys include two main categories – two-dimensional (2D) and 3D data acquisition. BP is proposing to use 3D seismic technique, which is commonly applied worldwide, both onshore and offshore. 3D surveys offer finer sub-surface sampling and are a preferred method for providing geoscientists with detailed subsurface information. 3D surveys involve multiple energy sources and streamers being towed behind the vessel, as depicted within Figure 4.2.

Figure 4.1: Marine Seismic Acquisition Using ‘Seismic-Reflection’ Method



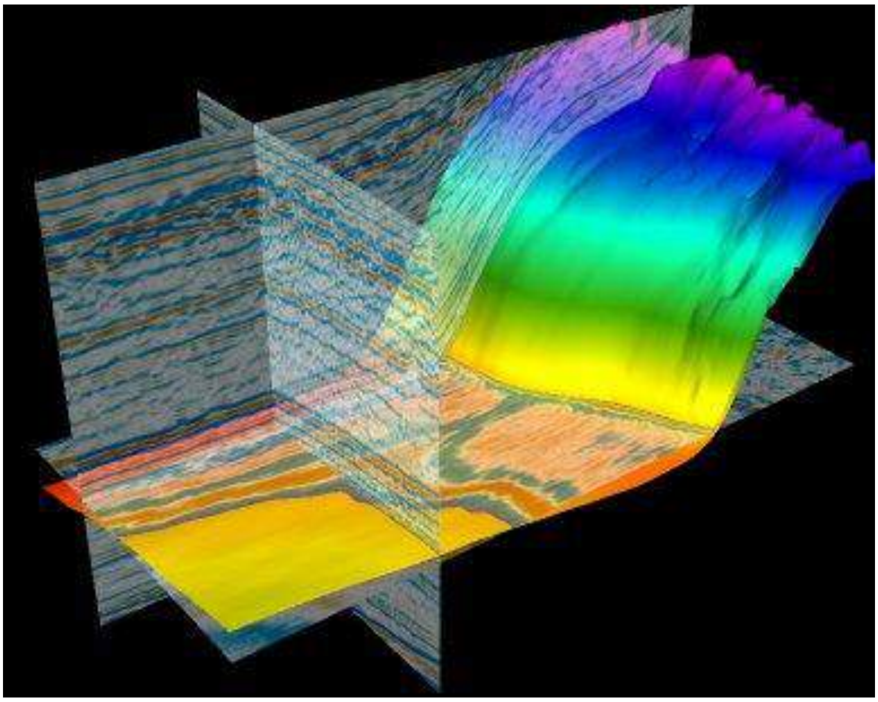
1 - Release of a controlled acoustic energy from a seismic source.
2 - Seismic energy is transmitted to the earth and reflected from the geological boundaries (layers).
3 - Reflected energy is detected by receivers (hydrophones).
4 - Acquisition system record and process the data on the seismic vessel.

[15] A marine cable, usually a buoyant assembly of electrical wires approximately 5m below the sea surface that connects hydrophones and relays seismic data to the recording survey vessel.

Figure 4.2: Example of Towed Streamer 3D Seismic Acquisition

Once the seismic data is acquired, hydrocarbon reservoirs can be imaged in three dimensions allowing interpreters to view the data in cross-sections along 360° of azimuth, in depth slices parallel to the ground surface, and along planes that cut arbitrarily through the data volume (Figure 4.3). Information such as faulting and fracturing, bedding plane direction, the presence of pore fluids, complex geologic structure, and detailed stratigraphy can be interpreted from 3D seismic data sets.

Figure 4.3: Seismic Data Imaging in 3D



4.3 Survey Equipment

4.3.1 Vessels

The survey vessel to be deployed during the seismic acquisition programme will be confirmed following the appointment of the Contractor. As an example, specifications for the *M/V Gilavar* (Figure 4.4), a vessel used by BP for a previous seismic survey in the Caspian Sea, are provided in Table 4.1, along with specifications for an example support vessel, *M/V Barra*.

Figure 4.4: Example of a Survey Vessel - M/V *Gilavar*

Table 4.1: Example Survey and Support Vessels Specifications

Parameter	Vessel Specification	
	M/V Gilavar	M/V Barra
Owner	Caspian Geophysical	BUE-Topaz
Type	Seismic research vessel	Support vessel
Vessel Length	84.90m	53.88m
Draught (Mean)	5.9m	4.22m
Tonnage (Gross)	3898 tonnes	977 tonnes
Engine Size	3136 kW	1491 kW
Max Number of Berths	50	22
Endurance	42 days	25 days
Fuel Capacity	$800m^3$	$210m^3$
Fuel Consumption	$20m^3$/day	$3m^3$/day
Lubricating Oil Capacity	$22m^3$	$5m^3$

Positioning of the survey vessel along the seismic grid is important for accurate data production, and will be undertaken using a differential global positioning system (DGPS) with a tail buoy attached to the streamer as described in Section 4.3.3 below.

Survey vessels have restricted manoeuvrability when towing streamers and, under maritime regulations, are given priority over vessels that are not similarly restricted. The survey vessel will therefore be accompanied by one or two support vessels which will:

- Ensure operational safety and maintaining a safety exclusion zone around the survey vessel and streamers;
- Monitor the towed equipment;
- Warn maritime traffic of the ongoing surveying to ensure that other vessels do not cross the safety zone;
- Provide supplies and fuel to the survey vessel and ship to shore solid and liquid waste for treatment and disposal;

- Provide support in emergency situations, including spills; and
- Conduct crew changes (if required).

The survey and support vessels will operate on a 24-hour basis during data acquisition.

4.3.2 Sound Energy Source

A seismic airgun is the most common sound energy source used in towed streamer seismic surveys (Figure 4.5). These are underwater pneumatic devices that expel a bubble of air under great pressure into the water. Once in the water, the pressure is released, the bubble collapses and may oscillate several times. The acoustic signal thus produced consists of a sequence of positive and negative pulses that are proportional to the rate of change of volume of the air bubbles.

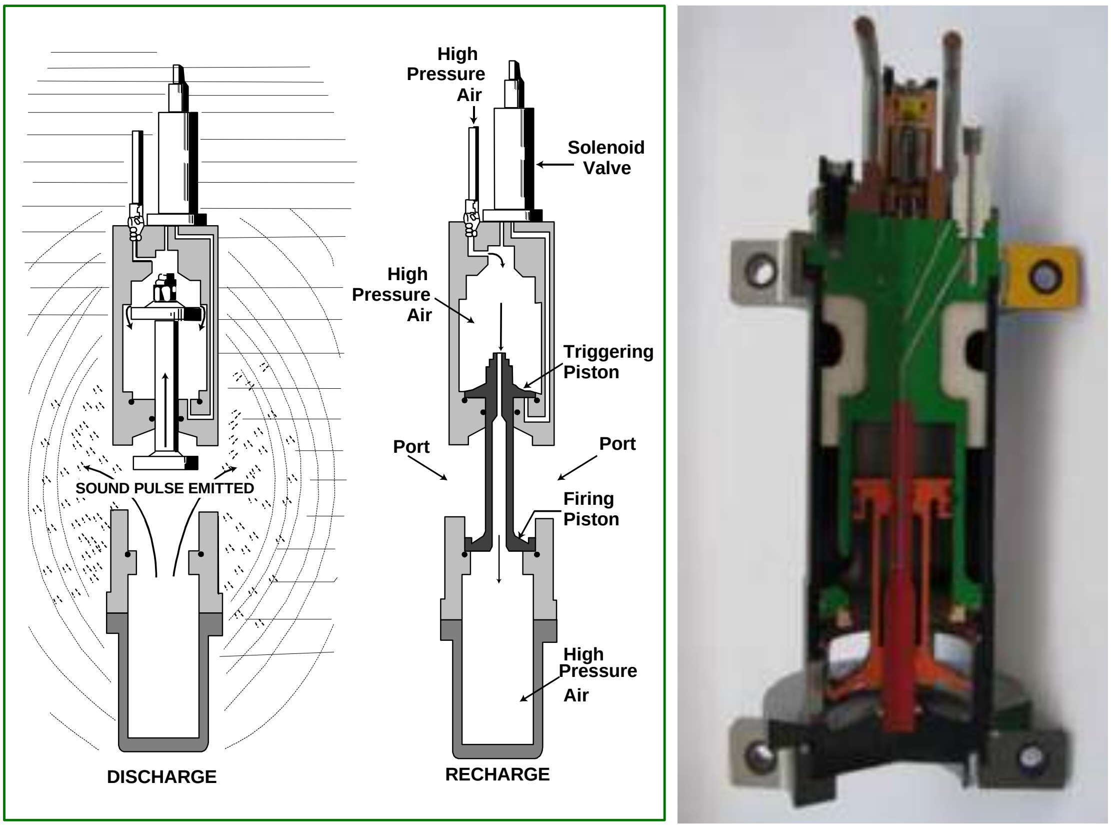
Seismic source arrays used during streamer towed surveys are made up of sub-arrays or single strings of multiple sound elements. The main principles of energy source operation are as follows:

- A source array is towed behind the survey vessel, under the surface of the water (usually at a depth between 3 and 20m, depending on the environmental characteristics of the marine environment, and also on the target geological structures being imaged);
- Compressed air at high pressure (2000 to 2500psi) is supplied continuously to the energy sources from air compressors on the survey vessel. It forces the piston downwards, and the chambers fill with high-pressure air while the piston remains in the closed position;
- When triggered (at prescribed time or distance intervals) the solenoid valve opens and the piston is forced upwards; and
- Compressed air in the lower chamber flows rapidly out. An air-filled cavity is produced in the water that expands and then collapses, then expands and collapses again and continues cyclically. This oscillation creates seismic pressure waves releasing the energy (sound) into the water column.

One of the objectives of using a source array is to increase the power and maximise source signal for best image quality.

For each energy source array the amplitude of the signal is a function of the volume and pressure of the air inside the cylinder and the cylinder’s depth under the water surface. The larger the volume and higher the pressure, the greater the amplitude.

Figure 4.5: Schematic Representation of a Typical Airgun and Photo of Airgun



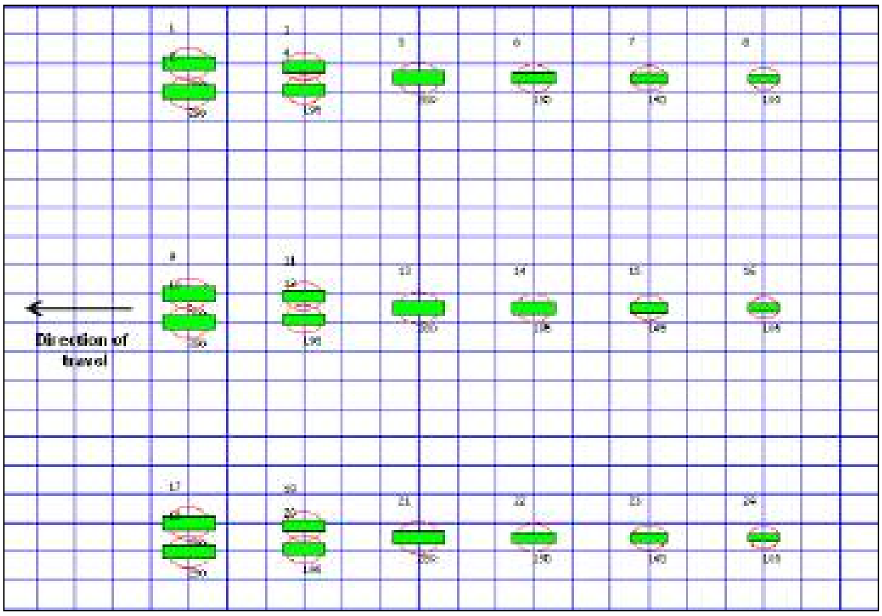
The seismic source to be used for the Project has not yet been determined. The details for the seismic source used for the *M/V Gilavar* 2012 survey in the ACG Contract Area are provided in Table 4.2. It is assumed for the purposes of this ESIA that the survey will be based on a similar design and arrangement. This represents the highest potential pressure level.

The energy source used for the M/V Gilavar 2012 survey in the ACG Contract Area comprised two Bolt 1500/1900 airgun arrays, each with a combined chamber volume of 3180 cubic inches (cu in), towed at a depth of 7 +/- 1m beneath water surface. In total the two arrays include 48 source elements. The energy source specifications are outlined in Table 4.2 and the array layout is presented in Figure 4.6.

Table 4.2: Provisional Seismic Source Specifications

Parameter	Specification
Total array volume	2 x 3180 cu in
Gun types	BOLT 1500 / BOLT 1900
Number of arrays	2
Number of sub arrays	6
Number of airguns per array	24 guns
Volume of each sub array	1060 inc max
Nominal operating pressure	2000 psi
Array length	15 m
Array width	16 m
Tow depth	7 m (+/- 1 m)

Figure 4.6: Provisional Layout of the Energy Source Array



The output characteristics of a seismic source array are commonly presented in terms of a nominal peak source level or sound pressure level (SPL), in decibels (dB) re 1 micropascals (µPa) @ 1 m. The sound levels emitted depend on source volume and array configuration[16]. The seismic source (assuming the specifications described above and in Table 4.2) will generate power of up to 109.9 bar-m peak-to-peak amplitude corresponding to 260.8 dB re 1 µPa @1 m.

When operating at full capacity for data acquisition, each source array will be activated at a minimum rate of once every 50 m in a flip-flop or alternating pattern, resulting in a source interval of 25 m. Based on the length of the longest line for the Project and the working speed of the *M/V Gilavar* vessel, the maximum duration of firing on any one 3D line is anticipated to be no more than 17 hours but may be more if firing is maintained between 3D lines during line turns.

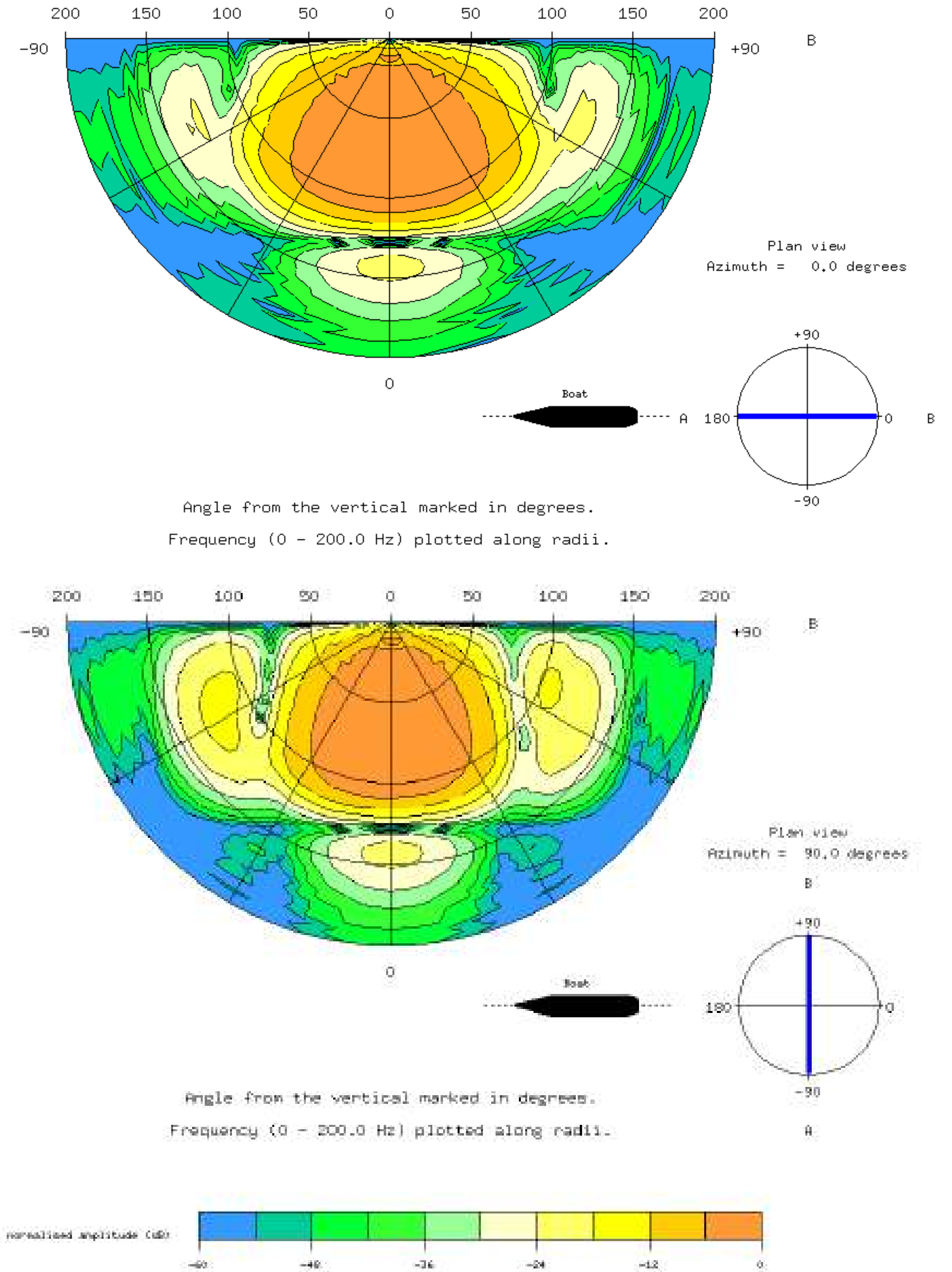
4.3.2.1 Source Frequency and Directivity

The optimal seismic source frequency range is dependent on the characteristics of the subsurface geological layers to be surveyed. High resolution surveys in shallow penetration surveys require relatively high frequencies of 100 – 1,000 hertz (Hz), while the optimum frequency for deep geological formations is in the 10 – 80 Hz range. Most of the source energy is in the 10-200 Hz band. Although the higher frequency components are weak compared to the low-frequency components, they are strong compared to the typical ambient or background sound levels.

Figure 4.7 illustrates the directivity pattern from a seismic source array (in the example provided, equivalent to 4135 cu in). The sound energy is released in all directions, but not in a symmetrical and uniform manner. The source array is designed so that the energy is predominantly directed vertically (downwards) towards the seabed, termed source directivity. The sound level therefore reduces more quickly with horizontal distance from the source than it does vertically. In the example provided, SPLs are approximately 10 to 30 dB less in the horizontal directions than the vertical axis.

[16] The sound power level is given for a nominal 1m distance from the source. For a distributed source such as a seismic array, the sound pressure level is either modelled or measured at some far distance from the source array (far-field), where energy from individual elements is assumed to add constructively and is corrected back to a theoretical 1 m distance from the source. This technique typically overestimates the sound level in the near field zone (few tens of metres) but is representative for far fields.

Figure 4.7: Source Directivity Plot, on a 4135 cu.in Source Array



Note: The example above is based on a 4135 cu in seismic array and frequency up to 200Hz. Colours indicate relative pressure levels: lowest (blue) to highest (orange).

4.3.3 Streamers

The seismic cable or streamer detects the very low level of reflected energy that travels from the seismic source, through the water downwards into and back from boundaries between subsurface geological structures, using pressure sensitive devices called hydrophones. The hydrophones convert the reflected pressure signals into electrical energy that is digitised and transmitted along the seismic streamer to the recording system on board the seismic vessel, where the data will be recorded onto computer hard drives and backed up to magnetic tape.

The streamer itself is made up of five principal components:

- Hydrophones, usually spaced one metre apart;
- Electronic modules, which digitise and transmit the seismic data;
- Stress membrane, constructed of steel or Kevlar to provide the physical strength required, allowing the streamer to be towed in the roughest of weather. Each streamer may be subjected to several tonnes of towing strain;
- An electrical transmission system, for power to the streamer electronic modules and peripheral devices, and for data telemetry; and
- The outer coating (also known as the skin) of the streamer in which all the above are housed.

Streamer geometry (length, spacing and overlap) varies depending on the acquisition parameters and objectives. Six streamers of 4 - 6km are expected to be towed behind the seismic survey vessel at a depth of 7m (+/- 1m) (Figure 4.8). A summary of the streamers specifications is provided in

Table 4.3.

Figure 4.8: Indicative Layout of the Towed Equipment

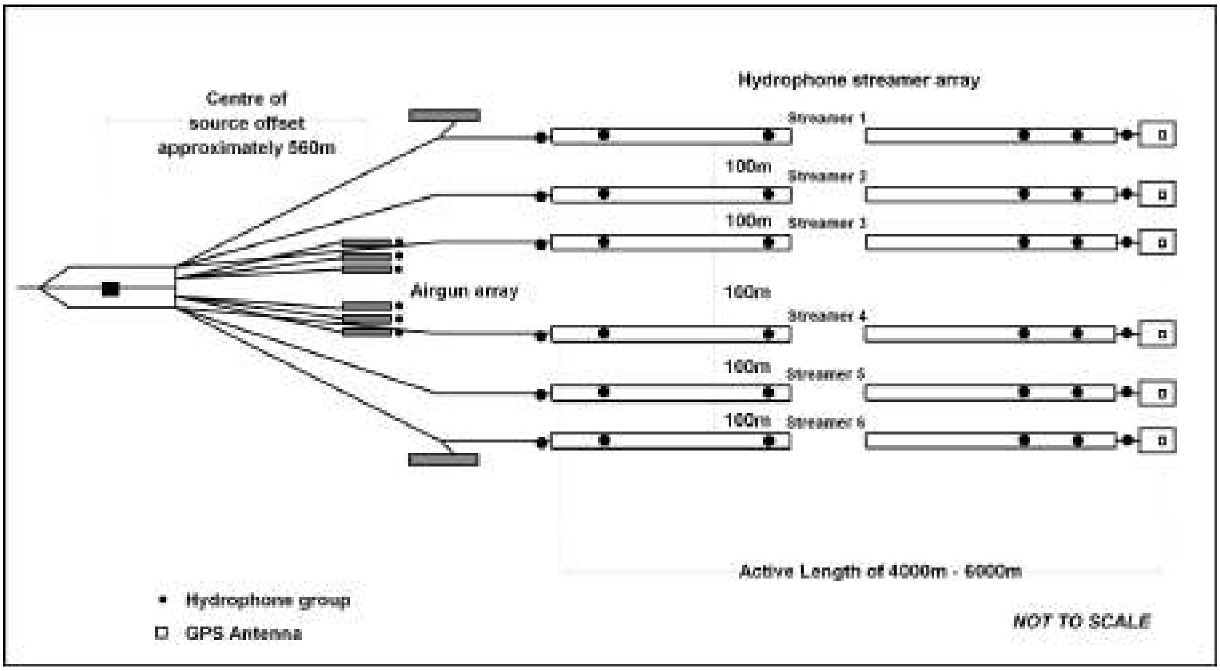


Table 4.3: Provisional Streamer Specifications

Parameter	Specification
Number of streamers	4 or 6
Streamer length	4 - 6 km
Towing depth	7m
Streamer type	Solid or gel filled

The streamer is equipped with multiple units of a streamer recovery device that automatically activates inflating buoys if streamer sinks to a depth of 48m, or a pressure of 70 psi is reached due to streamer sinking in unforeseen circumstances e.g. lack of forward momentum of vessel. This allows full recovery of the streamer. These are attached every 300 m along the streamer (Figure 4.9). A tail buoy (Figure 4.10) is connected to the far end of each streamer to provide warning to other sea users about the presence of the cable in the water and to act as a platform for the positioning systems.

Figure 4.9: Deployment of Solid Streamer with Depth Control Unit (or Bird) [17]

Figure 4.10: Deployment of a Tail Buoy Containing DGPS Receiver

The streamer is divided into sections (110m long) to allow modular replacement of damaged components. Each section is terminated with a connector unit, which houses electronic modules. The hydrophones are located at precise intervals along the streamer, with one group centre every 12.5m. Recent advances in cable technology have led to a new generation of seismic streamers, moving away from the traditional fluid filled (i.e. Isopar (high-purity synthetic isoparaffins) or equivalent) cable to a solid cable constructed of a gel or foam. The solid streamer is proven to provide superior sound performance, greater dynamic towing stability, optimised group-to-group sensitivity consistency and higher resistance to physical damage compared to fluid-filled streamers. It provides the capability of extending operations into marginal weather windows, allows stable towing at shallower depths to optimise high-frequency acquisition where required, and is environmentally benign, making it the streamer of choice in environmentally sensitive areas. During the proposed survey both solid and liquid streamers may be used.

As the cable is towed along, each hydrophone group will collect data from the same spot as the receiver that preceded it, allowing for a 'stack' of traces to be overlaid on top of each other. Random signals will

[17] http://soundwaves.usgs.gov/2013/08/ Accessed September 2016

be cancelled out and true events will be reinforced, improving the quality of data. The data from the cables will be recorded onto computer hard drives and backed up to magnetic tape.

4.4 Programme and Logistics

It is anticipated that the seismic survey will be conducted during 2019-2020 for a maximum duration of 6 months depending on which level of survey data acquisition is required[18].

4.4.1 Logistics

The survey programme is expected to include the following main activities:

- Mobilisation of the survey and support vessels;
- Deployment of the survey equipment;
- Data acquisition (which will comprise the bulk of the survey programme); and
- Retrieval of equipment and demobilisation.

In addition, vessels may be on standby during the survey due to adverse weather conditions, equipment repair etc. Survey and support vessels will mobilise from the base port with all necessary supplies and crews. Vessels will then sail to the survey area. As the survey area is approached, the crew will deploy the survey equipment in line with industry standard practices. At each sail line, the source array(s) will be activated at the first predetermined position, commencing data acquisition. This process is repeated at successive regularly spaced distance intervals, as pre-determined by the navigation system until the vessel has reached the pre-defined end of the sail line. During the line change the vessel will sail with the streamer fully extended as the ship turns. The survey vessel will be lined up on the sail line, all equipment is readied, the sources activated, and the activity cycle is repeated. In some occasions energy source operations will be kept active during line-change.

With a survey vessel length of up to 100m long, towing several kilometres of streamers behind a large area is required to enable the vessel and streamers to turn. 3D survey data is often acquired in a ‘racetrack’ pattern (

[18] Either partial or full data acquisition with the former typically requiring less effort and hence shorter duration

Figure 4.11), which offers the most efficient way of acquiring data, minimises processing anomalies, which could adversely affect data interpretation. The provisional sail line orientation depicted in Figure 4.11 may change when survey design is finalised.

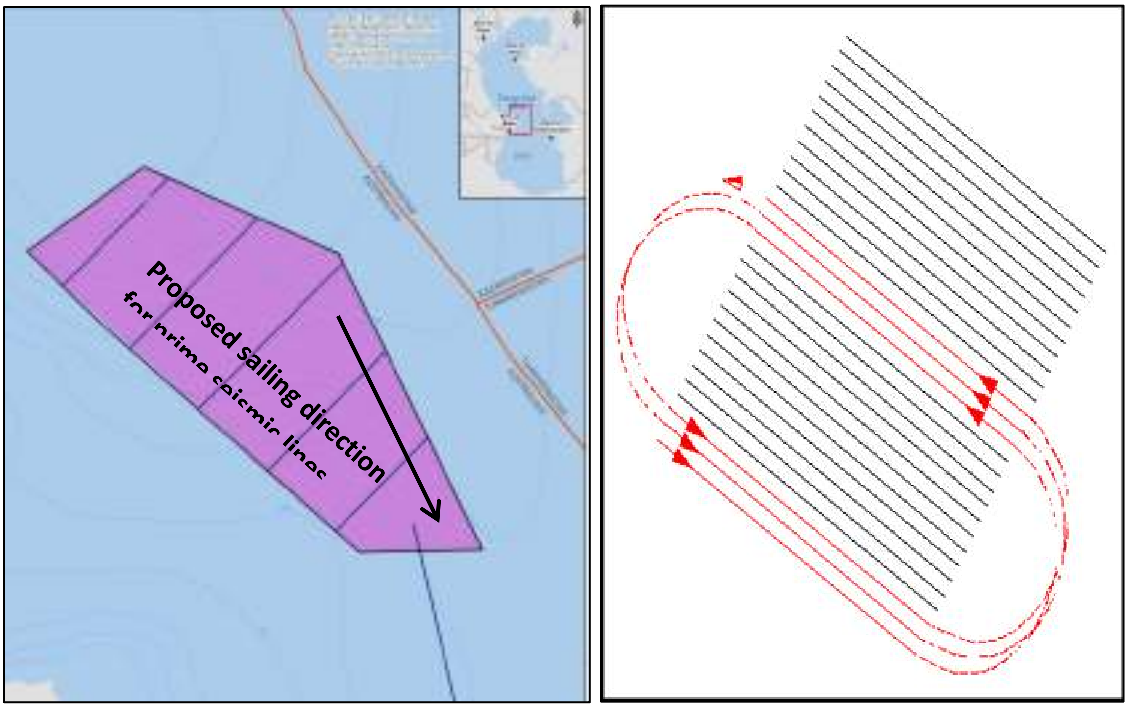
4.4.2 Supplies and Re-fuelling

Based on the endurance of the *M/V Gilavar* survey vessel of 1.5 months (refer to Table 4.1) it is anticipated that refuelling will be required at least once throughout the survey duration. The survey vessel will be bunkered/ refuelled at sea by the support vessel, following good international industry practice GIIP. The support vessel will be bunkered at one of the ports in Baku. Provisions of water, food and other supplies will also be undertaken by supply vessel.

At least one support vessel will operate in the vicinity of the survey vessel and its towed streamer array at all times, and will provide full emergency support if necessary.

BP Logistics Control Room (LCR) is responsible for controlling vessels delivering cargoes and passengers. The Project Team will advise the LCR of project vessel movements using a daily survey plan to reduce any conflict with activities under their control.

Figure 4.11: Provisional Racetrack Data Acquisition Pattern



Note: The distance between the prime acquisition lines can be between 300 and 720 metres.

4.4.3 Personnel

Approximately 40 to 60 personnel is planned to permanently stationed on the survey vessel, and an additional 10 to 20 personnel are planned to be stationed on each support vessel.

The seismic vessel crew will mobilise from Baku or one of the marine bases nearby. Crew changes will be completed by either the survey or support vessels returning to port or by helicopter. The frequency of crew change will depend on length of the survey programme and contractor’s requirements.

4.5 Project Alternatives

This section provides a brief discussion on the main alternatives considered during the Project design.

4.5.1 The ‘No Project’ Alternative

This ‘no project’ alternative refers to the option of withholding (indefinitely) any plans for the Project. This would mean that the Project would not be carried out, thus avoiding the Project’s potential environmental and socio-economic impacts.

Should the proposed exploration activities not go ahead, there will be no prospect for potentially negative impacts on marine habitats and marine users. However it would also eliminate any benefits that would otherwise have resulted from the establishment of the Project.

The consequence of the ‘no project’ alternative is related to the cost of the missed economic opportunity of exploiting a natural resource offshore Azerbaijan. Should viable oil and gas reserves be discovered as a result of exploration activities, subsequent development of these reserves will have the potential to bring substantial economic benefits to the country, generating government revenue, adding to the country’s Gross National Product, and creating job opportunities.

Geophysical surveys also provide a viable and less intrusive alternative to drilling a large series of test wells, which would potentially have far greater interference with the environment.

4.5.2 Alternative Survey Parameters

Survey parameters such as the location of survey lines and sampling stations, survey grid, seabed survey equipment, sources and streamer length/geometry are all determined based on the objectives of the survey and taking into account technical and economic objectives with the aim of acquiring sufficient data to fulfil the survey objectives without entailing excessive cost.

4.6 Emissions, Discharges, Waste and Chemicals

4.6.1 Underwater Sound

The seismic energy source will produce short duration sound pulses (impulsive sound) with sound pressure levels of short duration. Maximum sound source levels of approximately 260.8 dB re 1 µPa @1 m (based on the 2012 ACG survey) are estimated (refer to Section 4.3.2 above). It is important to note that source level is used as a measure of the strength of a sound source at a nominal 1m distance from the source, whereby for a distributed source such as an airgun array, a pressure level is either modelled or measured at some far distance from the source array (far-field), where energy from individual elements is assumed to add constructively and is corrected back to a theoretical 1m distance from the source. In reality the sound level close to a spatially distributed source (airgun array) is lower than this (typically by 15 to 20 dB) due to the interaction between source elements and energy from individual elements not adding constructively.

Underwater sound will also be generated by navigational, operational and safety equipment on board the vessels, such as echo sounders and sonar systems, and by vessels' engines. The characteristics and level of sound generated by the survey and support vessels during the course of the survey will vary between a source level of 130 and 182 dB re 1 µPa-m[19],[20]. The particular activity being conducted by the vessel will also greatly influence sound characteristics, for example, if it is idling in a holding position using bow thrusters or accelerating. These sound levels are much lower than those produced by seismic operations.

4.6.2 Emissions to Atmosphere

The main source of atmospheric emissions during the seismic acquisition programme will be from burning of fuel (marine diesel oil) to power the engines, compressors and electrical generators onboard survey and support vessels. Gases emitted from the fuel combustion processes comprise:

- Carbon dioxide (CO_2);
- Nitrogen oxides (NOx);
- Sulphur oxides (SO_x);
- Methane (CH_4);
- Volatile organic compounds (VOC);
- Carbon monoxide (CO), and
- Particulate matter.

All shipboard emissions will be in compliance with MARPOL 73/78 Regulations for the prevention of air pollution from ships (Annex VI), aiming to reduce global emissions of SO_x, NOx and particulate matter.

Estimates of gas emissions transboundary in nature, such as sulphur dioxide, nitrogen oxides, and greenhouse gas (GHG) emissions, have been calculated and presented in Chapter 8: Transboundary Impacts.

4.6.3 Waste

The types of wastes produced during a typical seismic survey are listed in Table 4.4 along with their constituents and proposed disposal routes. Grey and black water generation and disposal are presented separately in Section 4.6.4.

[19] Richardson, W.J., Green Jr, C.R., Malme, C.I. & Thomson, D.H. (1995). Marine Mammals and Noise. Academic Press, New York
[20] Caldwell J., Dragoset W., (2000). "A brief overview of seismic air-gun arrays", The Leading Edge, August 2000, 898-902

The towed streamer seismic surveys will be conducted using protocols for prevention of marine pollution in accordance with MARPOL 73/78 requirements, relevant national legislation and best practice principles. With the exception of incinerated waste, all waste will be segregated, labelled and stored in fit for purpose containers for the final disposal onshore. Authorised combustible waste, including food waste, will be incinerated using onboard incineration (where available) in compliance with MARPOL Annex VI regulations; residual ashes will also be stored onboard for final disposal at approved onshore facilities.

In addition to the compliance with the MARPOL 73/78 requirements, BP's AGT Region Waste Manual will be adhered to, to ensure that all wastes will also be managed in compliance with BP's standards.

Table 4.4: Management of Waste Streams Produced During the Seismic Survey[21]

Waste Category	Main Constituents	Handling and Disposal Route
Non Hazardous Waste		
Garbage (non-combustible)	Plastic, glass, domestic waste	Segregated and compacted waste is stored onboard for disposal at suitable facilities onshore.
Garbage (combustible)	Paper, packaging, wood	Incinerated using MARPOL compliant incineration facilities onboard the vessel (most garbage is amenable to incineration with the exception of metal and glass; special rules on incineration may apply under domestic law in some ports; the incineration of plastic is subject to specific regulations)
Food Waste	Organic nutrients	Incinerated using MARPOL compliant incineration facilities onboard the vessel; the resulting ashes will be transferred to shore for disposal at licensed facilities
Bilge water[22]	Residual hydrocarbons and inorganic substances	Stored on board and transferred onshore for treatment and disposal at licensed waste facilities.
Sludge	Residual hydrocarbons and organic and inorganic substances	Either incinerated onboard using an IMO approved incinerator or stored onboard and transferred onshore for treatment and disposal at licensed waste facilities.
Hazardous Waste		
Clinical waste	Pathogenic organisms, plastic, glass, medicines, needles	Segregated and stored separately for disposal/ incineration at authorised onshore medical facilities.
Acids	Acids refer to substances and mixtures with a pH less than 7.	Segregated and stored separately to be transferred to shore for safe disposal at licensed hazardous waste management facilities. All hazardous waste streams will be managed in compliance with the requirements of BP's AGT Regional Waste Manual.
Solvents, degreasers and thinners	Organic solvents used as industrial cleaning solutions (degreasers) and paint thinner.	
Paints and coatings	Water-based liquid paints and oil/solvent based liquid epoxy resin paints, lacquers and varnishes.	
Contaminated materials	Various materials that are lightly contaminated with oils, chemicals, etc.	
Adhesives, resins and sealants	Solvent based adhesives.	
Waste oil /fuel	Used refined petroleum distillates incl. engine lubrication oil, motor oil, transmission oil and hydraulic fluid. Diesel from generators etc. that cannot be reused.	
Batteries	General purpose batteries	

[21] Waste streams listed in the table have been categorizes based on MARPOL's waste categories and BP AGT Region Waste Manual. Refer to Appendix 4A for a comparison between these categories.

[22] Bilge water is water generated in the bilge of the ship's machinery spaces and therefore may be contaminated with oil and other substances, some of which may be harmful if discharged directly to the marine environment.

The following waste management criteria and protocols will be implemented throughout the seismic survey:

- In accordance with MARPOL 73/78 requirements, survey and support vessels will maintain an Oil Record Book. The book will be used to record how, when and where waste oil, bilge water, oily material, sludge etc., are disposed of. Recognised waste disposal authorities or contractors will undertake disposal of any waste generated onboard. Disposal details will be recorded in the vessel's Oil Record Book;
- Survey vessel and support vessels will maintain a Garbage Management Plan and Garbage Record Book to record how waste items, other than mentioned above, are managed and disposed of. The Garbage Management Plan will classify waste types according to MARPOL specification and BP's AGT Region Waste Manual and lists item type, quantity stored on-board, waste delivered ashore, and how much waste has been generated (e.g. food waste, incinerator ash); and
- All wastes[23] will be shipped to shore for disposal in accordance with the existing AGT Region waste management plans and procedures.

4.6.4 Discharges

Aqueous discharges from the vessels will comply with the standards set out by the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78 *(as amended)),* more specifically Annexes I and IV [24].

It is expected that the survey and support vessels will produce an estimated daily average of 5 and 200 litres of treated black (sewage) water and grey water per person, respectively. Grey water and black water will be discharged to sea in accordance with MARPOL 73/78 Annex IV: Prevention of Pollution by Sewage from Ships standards. If treatment is not possible (e.g. due to unavailability of the treatment unit) sewage will be stored and shipped to shore for treatment and disposal.

4.6.5 Light

The survey and support vessels to be deployed during the towed streamer seismic survey will carry appropriate navigation lights for operating during night-time and periods of poor visibility. The level of lighting will be in compliance with safety regulations at sea. While vessel lights will present localised disturbance to marine wildlife, they are necessary for human safety.

4.6.6 Chemicals and Hazardous Materials

Hazardous materials handled during proposed operations will include fuel (typically diesel), hydraulic and other utility oils, paints and solvents, batteries, refrigerants and cleaning chemicals. Strict handling procedures will be in place for all of the hazardous materials on board the vessels and the vessel crews will be trained in chemical handling and spill response.

4.7 Operational and Design Controls

The proposed Project will be conducted in compliance with the requirements of applicable national regulations and international good industry practice detailed in Chapter 2.

Survey specific management plans will be designed to address any risks associated with the maritime safety, waste management, emergencies and spills, etc**.**

4.7.1 Maritime Safety and Communications

Experience from seismic surveys show that impacts from the physical presence of vessels and equipment can be avoided by adhering to good management practices and operational protocols.

[23] Not including waste that is incinerated on board but including incineration ashes.
[24] MARPOL 73/78 Annex IV standards are considered international best practice with regard to vessel discharges and have been adopted for vessel discharges across the Azerbaijan sector of the Caspian Sea.

Specific control measures that will be implemented to minimise interference with other sea users will include:

- The seismic survey programme will be diligently planned and potential interference with sea users will be minimised through effective communications with the relevant authorities and stakeholders prior and during the survey. All appropriate permits and compliance conditions will be sought and obtained well in advance of the operations;
- Notifications regarding the survey programme will be issued to the relevant maritime and port authorities, as well as directly communicated with sea users where necessary, in advance of the survey;
- All vessels will operate in compliance with national and international maritime regulations for avoiding collisions at sea, use of signals and lights;
- Vessel movements will be directed by the seismic contractor's LCR but controlled by the navigation system and Master of the vessel. Clear lines of communication and operational procedures will be established between all survey and support vessels before the start of surveying;
- Advanced positioning equipment will provide accurate information on the position of the survey vessel and associated equipment, which will be communicated to other vessels;
- A safety exclusion zone will be maintained around the survey vessel to minimise the risk of collision;
- Support vessel(s) will be utilised throughout the seismic survey programme. These will be responsible for helping to keep the survey vessel and equipment safe from hazards such as other vessels and manmade obstructions along the survey lines. Support vessels will also provide additional safety cover to the survey vessel and can assist in the event of an emergency, whether health and safety or environmental.
- Survey will be only undertaken if pre-established operating criteria for weather conditions (e.g. wind, waves and visibility) is met; and
- Vessels will undergo HSE audits/checks prior and during the survey.

4.7.2 Underwater Sound Management

The lowest practicable seismic energy levels will be used throughout the survey, whilst still achieving the technical requirements. If necessary for data quality the energy source may stay active during line changes.

The Project will adopt the 'soft start' procedure, which is a process whereby airgun operation is initiated with a smallest source element, and slowly increased by adding source elements until the full working capacity is reached. Because power is built up over at least 20 minutes, it is believed that marine mammals and adult fish should have adequate time to leave the vicinity of the seismic operation. Provided no Caspian seals are sighted within the mitigation zone[25] over a period of at least 30 minutes before seismic source activation, a 'soft start' procedure of the airguns will commence. If seals are observed within the specified mitigation zone, the soft-start of the seismic sources will be delayed until their passage, or the transit of the vessel. In both cases, there will be a 20 minute delay from the time of the last sighting to the commencement of the soft-start, in order to determine whether the animals have left the area. If seals are detected whilst the source array is active, either during the soft start procedure or whilst at full power, there is no requirement to stop operations. A soft-start procedure will be applied each time when the energy source is activated.

[25] The area where trained vessel crew keeps watch for marine mammals (and delays the start of activity should any marine mammals be detected) to be established based on the results of the underwater sound calculations and specified in Chapter 6.

5 Environmental and Socio-Economic Description

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5.1 Introduction

This Chapter describes the environmental and socio-economic baseline conditions relevant to the Project and the wider area (‘Project Area of Influence’ or ‘Study Area’ as defined in Chapter 3) that may be affected by seismic survey operations. The purpose of the Chapter is to provide sufficient information to allow the potential impacts of the Project activities to be assessed in accordance with the assessment methodology as set out in Chapter 3. The scope and content of this Chapter has therefore been determined based on the anticipated environmental and socio-economic interactions identified during the scoping process.

Figure 1.1 shows the location of the Block D230 Seismic Survey Area relative to the Absheron Peninsula and the Absheron region, the city of Baku, the man made Oily Rocks industrial settlement and other key coastal locations including the towns. Other oil and gas fields and international Exclusive Economic Zone (EEZ) borders are also shown in Figure 1.1.

5.2 Data Sources

This Chapter has been prepared based on the following:

- Review of other available BP and third party ESIAs completed for projects in the Azerbaijan sector of the Caspian Sea within or in close proximity to the Study Area, including:
    - Azeri Chirag Guneshli (ACG) ESIAs and Environmental Technical Notes (ETNs). The ACG Contract Area is located approximately 75km south of Block D230 Seismic Survey Area. The ACG subsea export pipelines connect five production platforms in the ACG Contract Area to the onshore Sangachal Terminal. ACG ESIAs and ETNs reviewed include:
        - Azeri Central East ESIA, 2018[26]
        - ACG Regional Seismic EIA, 2015[27]
        - East Azeri 4D Seismic Survey ETN, 2011[28]
        - Chirag Oil Project ESIA, 2010[29]
        - ACG Phase 1-3 ESIAs, 2002 - 2004[30,31,32]
    - Block D222 Yamala ESIA. The Yamala Block is located approximately 80km northwest of Block D230. Seismic research was completed in 2004 and in 2008 and EIA was prepared for a number of exploration wells; two of which had been drilled by 2009[33].
    - Shallow Water Absheron Peninsula (SWAP) 2D Seismic Survey ESIA. The SWAP Contract Area is located approximately 50km southwest from Block D230 and extends from the coastline to a water depth of approximately 40m. The 2D seismic survey focused within the deeper waters of the SWAP Contract Area and the surrounding areas at water depths greater than approximately 10m [34].
    - SWAP 3D Seismic Survey ESIA. The 3D seismic survey focused on the shallower waters (less than approximately 25m water depth) of the SWAP Contract Area and the surrounding nearshore and onshore areas and included onshore survey areas[35].
    - Shah Deniz (SD) 2 Project ESIA. The SD Contract Area is located approximately 100km southwest of Block D230 and currently comprises one operational platform. The SD2 Project will comprise a new platform complex, pipelines and flowlines[36].
    - Bahar Gum Deniz ESIA. The Bahar Gum Deniz Contract Area is located approximately 100km southwest of Block D230. An ESIA was prepared to obtain permission to undertake

[26] AECOM, 2018, Azeri Central East Environmental and Social Impact Assessment (ESIA)
[27] AECOM, 2015, ACG Regional Seismic Environmental Impact Assessment (EIA)
[28] Azerbaijan Environmental and Technology Centre (AETC), 2011. East Azeri 4D Seismic Survey EIA
[29] URS, 2010, Chirag Oil Project Environmental and Socio-Economic Impact Assessment (ESIA)
[30] URS, 2002. Azeri, Chirag & Gunashli Full Field Development Phase 1 ESIA.
[31] RSK, 2002. Azeri, Chirag and Gunashli Full Field Development Phase 2 ESIA.
[32] URS, 2004, Azeri, Chirag & Gunashli Full Field Development Phase 3 ESIA.
[33] Block D-222 Yamala ESIA, 2008
[34] AECOM, 2015, SWAP 2D Seismic Survey ESIA
[35] AECOM, 2015, SWAP 3D Seismic Survey ESIA
[36] URS, 2013, SD2 Project ESIA

  - explorative activities (e.g. seismic survey, drilling of an exploration well and geotechnical investigations) and included primary data gathering[37].
  - Data collected by BP as part of their Regional Environmental Monitoring Programme (EMP) in the ACG and SD Contract Areas and along the ACG Pipeline corridor from the ACG Contract Area to shore.

- Secondary data collected through consultation with local specialists including:

  - Review of available fish and fisheries data relevant to the Block D230 Seismic Survey Area by Tamara Zarbaliyeva, a local expert in fish and fisheries; and
  - Review of the most recent available data relating to Caspian Seals completed by Dr. Tariel Eybatov of Natural History Museum, who is a recognised local seal expert.
- Secondary data and literature publically available on the internet including reports published by International Union for Conservation of Nature (IUCN); United Nations Environment Programme Global International Waters Assessment (UNEP / GIWA), BirdLife International; World Protected Areas Database (WDPA)and Casp Info.

There is currently no primary survey data available for Block D230.

5.3 Biophysical Environment

5.3.1 Geology and Seismicity

5.3.1.1 Tectonic Setting

The dominant geological structures of the Caspian region were formed during the period of tectonic movement between the Arabian and Indian continental plates that resulted in the formation of the Caucasus Mountains and the associated basin and plateau structures that form the Caspian and adjacent onshore regions. Subsequent periods of tectonic compression (mainly during the Late Pliocene period) resulted in the production of a number of folded structures within the region, forming a number of anticlines (upward thrusting folds)[31].

The Caspian Basin represents one of the largest continental lake systems in the world. The Absheron Ridge, which separates the Southern and Central Caspian Basins is considered to be the sea floor expression of the Absheron-Prebalkhan Uplift Zone[38], which lies along and defines the southern margin of the Central Caspian Basin.

5.3.1.2 Regional Geology and Seismicity

The recent geological sequence is characterised by Fluvial Deltaic sandstones and Lacustrine Shales. Sedimentation rates were rapid with 8km of sediment deposited over six to ten million years. Pliocene deposition in a low gradient, lacustrine basin formed regionally extensive sandstone sheets. Fluctuations in lake level, driven primarily by climate change, allowed rapid large scale avulsion of the Volga Delta and the deposition of laterally continuous lacustrine Shales. The structural geology of the Central Caspian is bounded by the Great Caucasus fold belt on the west and south-west, and the Karabogaz regional basement high on the east and south-east. The northern boundary of the basin extends along the Karpinsky ridge and the Mangyshlak fold belt[39]. A major feature of the Central Caspian is the isolated Darbent depression, located to the north of Block D230.

The convergent plate boundary between the Arabian and Indian continental plates in the Caspian region, which is part of the Eurasian continental plate, results in the region being subject to relatively high levels of seismic activity, typically accom panied by earthquakes and volcanism. Tectonic activity in the Caspian Sea is focused along the Absheron Ridge where a number of regional microplates and smaller plates meet. Current neotectonic (more recent) processes are leading to convergent movements of these plates of 1.8cm/year in the Caspian region[40].

[37] Ekol on behalf of Bahar Energy Ltd, 2012, Bahar Gum-Deniz Project EIA
[38] Azerbaijan Environmental and Technology Centre (AETC), 2011. East Azeri 4D Seismic Survey EIA
[39] http://www.cgg.com/technicalDocuments/cggv_0000022202.pdf
[40] Karabanov, Institute of Geology, *pers comm*.

A seismic assessment undertaken for the region in 1996 detected 565 earthquakes which occurred from 650 AD to 1996 and included a subset of nine significant (magnitude[41] 6-7.7) historic earthquakes since 1668. Despite its history and high level of seismic activity, the Caspian Basin, has been reported as having moderate seismicity as the majority of seismic epicentres have been registered around the margins[42]. Seismic monitoring of the region has been ongoing since early 2000 using modern telemetric stations with satellite communication systems. Since the 1996 study, there have been a further seven earthquakes with magnitude >5 within Azerbaijan, including a magnitude 6.8 event in 2000[43].

5.3.2 Meteorology and Climate

5.3.2.1 Temperature and Precipitation

The Caspian Sea region is climatically diverse and encompasses the basins of the vast semi-arid and hot arid plains of northern Kazakhstan and Turkmenistan in the east, and the humid Caucasus and Elburz Mountains in the south-west. The Caspian plays an important role in atmospheric processes, regional water balance and microclimate. Climate conditions in the Caspian region are linked to the Northern Atlantic Oscillation (fluctuations in atmospheric air pressure) which affects variations in temperatures, humidity and rainfall.

According to Kosarev and Yablonskaya[44], average air temperatures for the Caspian typically peak at 25.5^{0}C during the summer and drop to 0^{0}C in the winter. In the western part of the Southern Caspian where Azerbaijan is located, annual variations in the temperature regime are considerable, but in general air temperatures below freezing are uncommon.

Precipitation is highly variable throughout the Caspian region. The highest levels precipitation occurs between September and April where the monthly average can be up to 35mm. The driest months, July to August, have monthly average precipitation ranging from 7 to 8mm[28]. Annual average precipitation in the offshore environment of Azerbaijan is approximately 300 to 400mm.

5.3.2.2 Wind

The wind regime across the Caspian is determined by three factors; atmospheric circulation, field of temperature gradient and coastal relief.

The average annual wind speed across the Caspian Sea is around 5 to 6m/s. The greatest average speeds of 6 to 7m/s are observed in the Central Caspian Sea[45]. Highest annual average wind speeds of 8 to 9m/s are observed around the Absheron Peninsula which also experiences the largest number of stormy days (wind speed exceeding 15m/s) at 60 to 80 days/year. Strong winds and storms can arise at any time of the year but are more common during the winter months. In general, winds greater than 5m/s occur in the region of the Absheron Peninsula for 37% of the year. Winds greater than 10m/s occur for 18% of the year, whilst strong winds in excess of 20m/s are not uncommon[38].

5.3.2.3 Visibility

Moisture saturated air converges in the south-west Caspian giving rise to foggy conditions during the winter months. Such conditions are expected to occur for around 10% of the year, mainly between October and May[46].

5.3.3 Bathymetry and Oceanography

The Caspian Sea is the largest landlocked water body on earth with a surface area of approximately 371,000km^2. It is fed by numerous rivers; the largest of which is the Volga to the north. The Sea is made

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[41] The magnitude is a number that characterises the relative size of an earthquake. Magnitude is based on measurement of the maximum motion recorded by a seismograph.

[42] Aziz Zanjani, Asiye & Ghods, Abdolreza & Sobouti, Farhad & Bergman, Eric & Mortezanejad, Gholamreza & Priestley, Keith & Madanipour, Saeed & Rezaeian, Mahnaz. (2013). Seismicity in the western coast of the South Caspian Basin and the Talesh Mountains. Geophysical Journal International. 10.1093/gji/ggt299.

[43] https://earthquaketrack.com/r/caspian-sea-offshore-azerbaijan/

[44] Kosarev, A.N. & Yablonskaya, E.A. 1994. The Caspian Sea. SPB Publishing House, The Hague. Mentioned in AETC, 2011

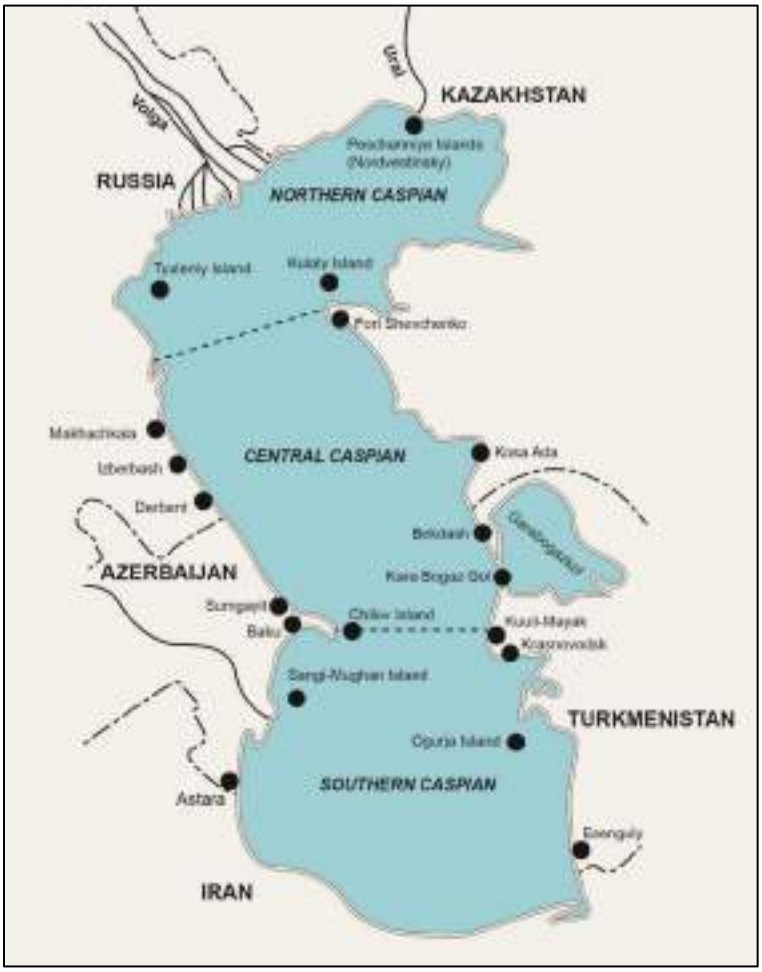
[45] http://www.caspinfo.net/content/content.asp?menu=0140000_000000. Accessed September 2016

[46] Wei Shi and Menghua Wang, 2010, 'Characterization of global ocean turbidity from Moderate Resolution Imaging Spectroradiometer Ocean Color Observations'

up of three basins: the Northern, Central and Southern Basins (refer to Figure 5.1). The Northern Basin is the smallest (about 25% of the total surface area), and is very shallow. The Central and Southern Basins have similar surface areas, but the Southern Basin is deeper and contains almost twice the volume of water as the Central Basin. The deepest recorded depth is in the Southern Basin at just over 1,000m.

The Absheron Ridge, which separates the Central and Southern Basins, is a narrow section of medium depth water (50 to 300m deep) which extends from Absheron Peninsula to the Khazar Peninsula on the east coast of Turkmenistan. The Study Area is located in the south of the Central Basin.

Figure 5.1: Location of the Northern, Central and Southern Basins of the Caspian Sea[47]



5.3.3.1 Sea Level

The Caspian Sea has experienced significant water level fluctuations over the past several hundred years, including changes of several metres within the past few decades. The Caspian Sea and is one of the few water bodies in the world where the water level is lower than the global mean sea level of the world's oceans. The variation in sea level is a result of changes in water inflow from rivers (mainly the Volga which represents 70% of total inflow), precipitation, loss from evaporation and discharge to the Kara-Bogaz-Gol in Turkmenistan. A recent study found that water levels in the Caspian Sea increased by approximately 12.74 cm/year during the period 1979–1995 and dropped approximately 6.72 cm/year during the period 1996–2015[48]. The study found that increased evaporation rates over the Caspian have significantly contributed to the recent drop in sea level and predicts accumulating evaporation rates over the Caspian Sea for the foreseeable future will lead to further sea level decline. The current Caspian Sea level is approximately 28 m below sea level.

[47] Aladin, N. and Plotnikov I., 2004, The Caspian Sea. Lake Basin Management Initiative, Thematic Paper

[48] Chen, J. L., T. Pekker, C. R. Wilson, B. D. Tapley, A. G. Kostianoy, J.-F. Cretaux, and E. S. Safarov (2017), Long-term Caspian Sea level change, Geophys. Res. Lett., 44, 6993–7001, doi:10.1002/2017GL073958

5.3.3.2 Wave and Current Regime

The main distinguishing features of the Caspian Sea are its isolation from the world's oceans and its intracontinental location. The Caspian is non-tidal, with the currents primarily influenced by wind, seabed relief, water density and temperature variations leading to some isolation between the Northern, Central and Southern Caspian areas[44]. The resulting large scale circulation pattern includes two anti-clockwise currents in the Northern and Central Caspian, and the western anticyclonic and the eastern cyclonic gyres in the Southern Caspian. According to Kosarev and Yablonskaya[44], inflowing rivers influence the current regime, creating a southwards flow down the west coast of the Central Caspian and a counter current up the east coast as well as small residual currents in the southwest of the Caspian Sea.

The predominant wave heights in the Caspian Sea are relatively low with a minor build-up of swells, given the sea's land-locked nature and absence of tides. The wave regime generally follows the prevailing wind patterns. The greatest wave development occurs from the western section of the Central Caspian basin down and across the central section of the Absheron Ridge. The strong north-western winds under the influence of costal and nearshore morphology of the Absheron Peninsula create waves directed to the east nearshore and to the northwest offshore.

Waves in the Absheron region are generally less than 2m in height[49]. In the area of Oil Rocks (west of the Absheron Peninsula), wave height can reach between 8 to 9m during storm conditions. Storms in the Caspian region blow along a north-westerly/northerly axis. The area of greatest wave development extends from the western portion of the Central Caspian Basin, down and across the central section of the Absheron Ridge.

The mechanism that drives the current can be traced back to the Northern Caspian Basin. Here, very cold winter air temperatures, shallow waters and large fluvial inputs from rivers, lead to rapid ice development and the formation of a reservoir of cold, dense water on the boundary with the Central Caspian Basin. The cold water is transported along the western Central Caspian Basin under the influence of cyclonic winds associated with the winter low pressure trough. A component sinks and flushes the bottom waters of the Central Caspian Basin, but in normal years a large volume finds its way over the western section of the Absheron sill and into the Southern Caspian Basin where it appears to mix and sink. A counter flow of relatively warm Southern Caspian Basin water along the eastern section of the Absheron sill balances the cold water inflow[36].

The irregular depth of the Absheron shelf complicates the winter seasonal flow further. The shelf is deeper on the western side (with a maximum depth of over 200m), than on the eastern side (where depths are usually less than 150m). Therefore, the cold water inflow penetrates beneath the level of the warm water outflow. This is thought to cause currents along the continental slope of the eastern shelf to flow towards the west[36].

Within the Study Area, surface currents vary throughout the year in direction and speed. Figure 5.2 shows the expected circulation variation in March, April, June, July, September, October and November in the vicinity of the Absheron Peninsula [50]. Strong northward currents can be observed at the beginning of March, later replaced in the summer by smaller anti-clockwise circulation areas near the shore. Stronger southwards currents resume in November at the beginning of winter.

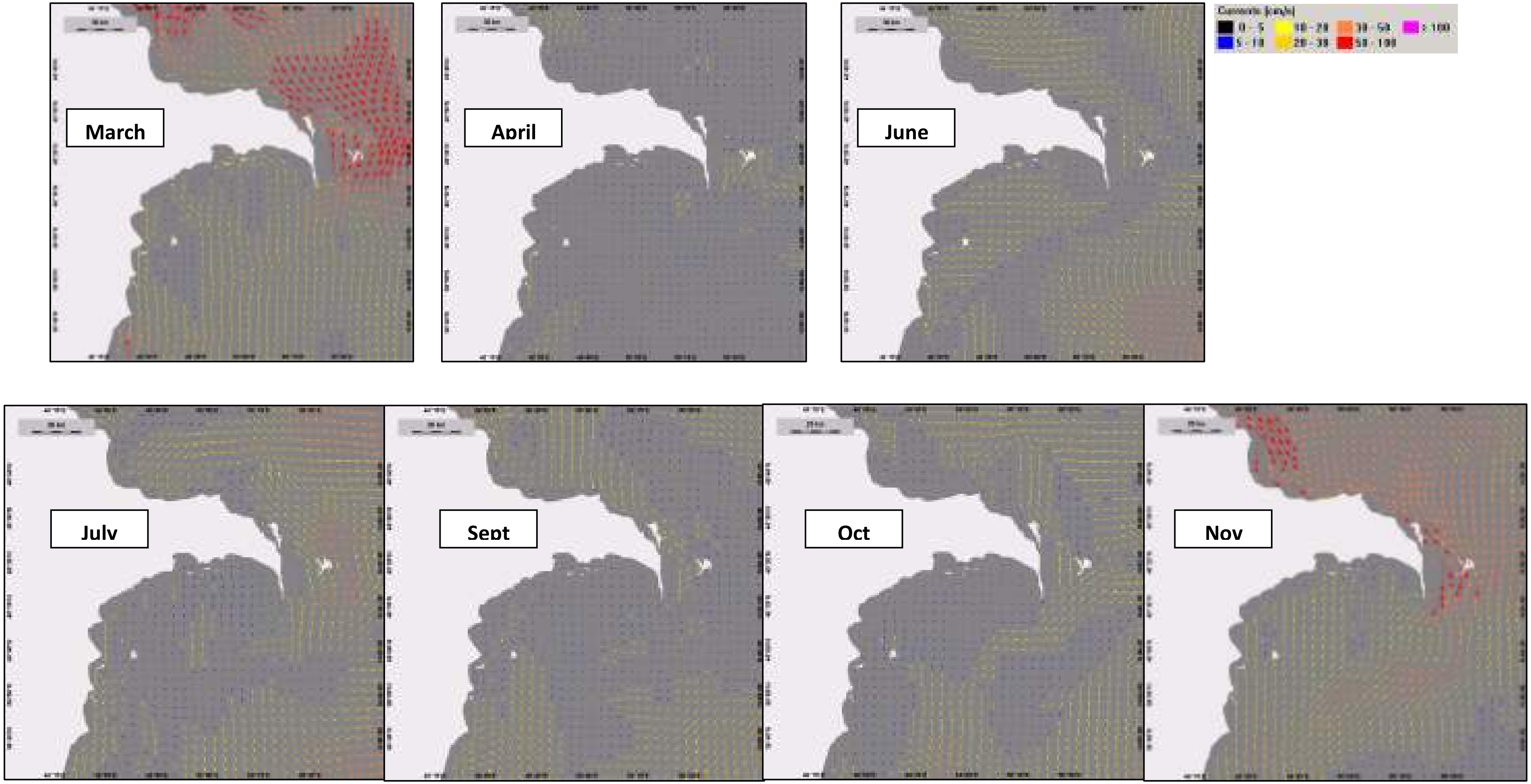
5.3.3.3 Storm Surges

Storm surges occur in the Caspian Sea causing temporary rises or falls in sea level. Significant sea level changes occur in the Central Caspian Basin. These events are associated with persistent strong winds, particularly the strong prevailing regional winds that blow along the axis of the Caspian Sea, from north and north west or from the south and south east. Strong winds from the north are more frequent and more severe than strong winds from the south. Waves in the Caspian Sea are wind driven and subsequently the windiest months also exhibit the greatest wave action.

[49] Igor S. Zonn, Aleksey N Kosarev, Michael H. Glantz, Andrey G. Kostianoy The Caspian Sea Encyclopedia, 2010

[50] Data from the Imperial College London, ReEMS dataset from 2007

Figure 5.2: Surface Currents Recorded in March, April, June, July, September, October and November



5.3.4 Seabed Physical and Chemical Environment

The Caspian Sea sediments are generally comprised of shell fragments and sand as well as silt, clay and gravel of geological and fluvial origins.

Baseline and monitoring surveys conducted in the ACG Contract Area since 1995 revealed that the sediments offshore from the Absheron Peninsula consist of two main types[51,52]:

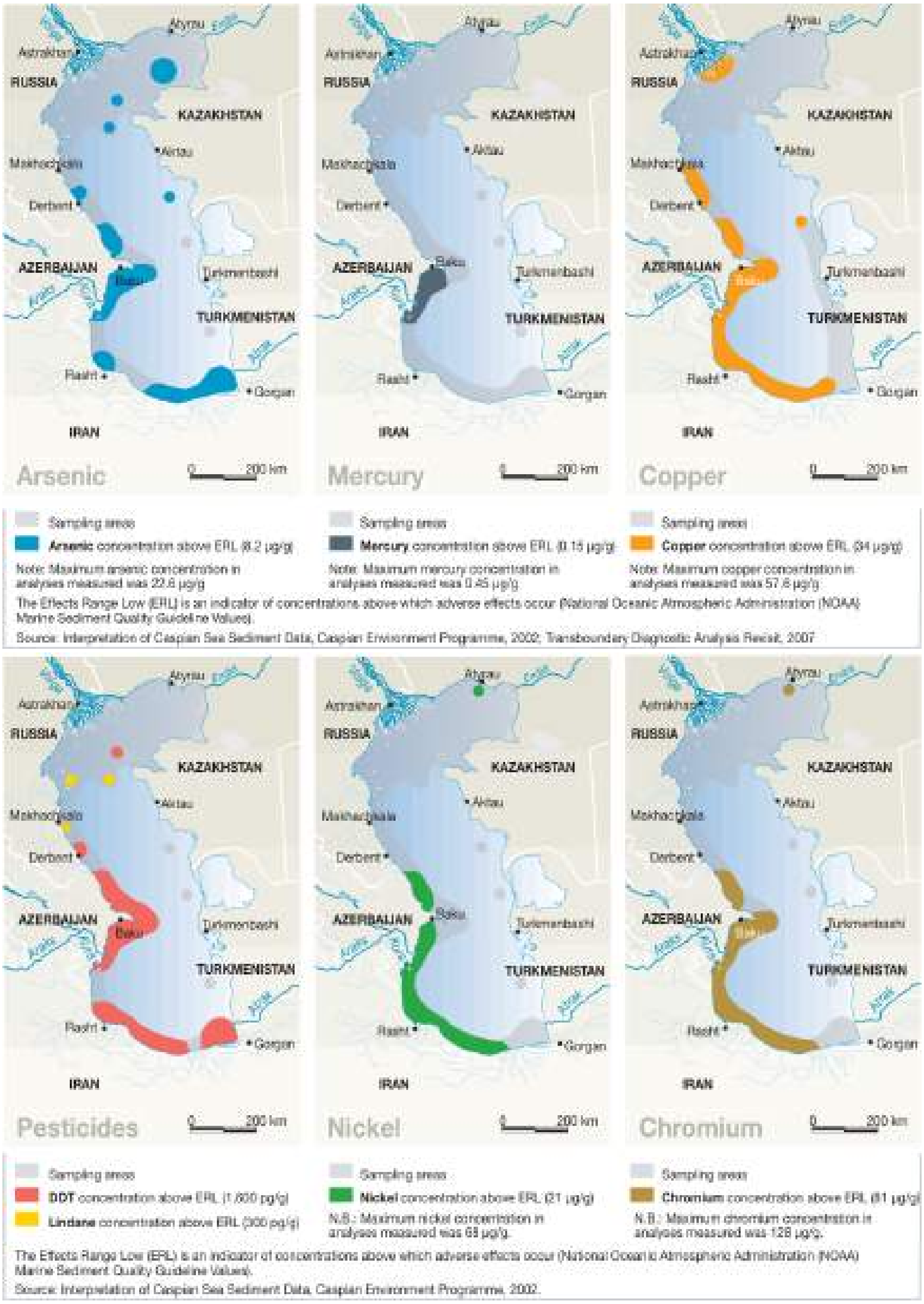
- Poly-modal, poorly sorted mixtures of mud, sand and shelly gravel were predominant, especially in the shallower waters of the northwest; and
- Uni-modal well sorted silts consisting of muddier more organically enriched sediments, recorded in the deeper waters of the southeast.

The Caspian seabed has been exposed to various anthropogenic impacts from land-based and offshore activities. Most important forms of pollution in the Caspian region are of a chemical and hydrocarbon nature or a result of nutrient overload causing eutrophication. These pollutants originate primarily from sewage, agricultural run-off and oil production related activities[53]. The most polluted coastal waters of Azerbaijan are near Sumgait, on the north side of the Absheron Peninsula, and Baku Bay[32,54]. High levels of pesticides and heavy metals have been identified by the Caspian Environmental Program in several areas of the Caspian, including territorial waters of Azerbaijan[55]. As demonstrated in Figure 5.3, the contamination zones extend some distance offshore the Absheron Peninsula, close to Block D230.

The seabed type in the Yalama Block[33] and ACG Contract Area[29,30,31,32] are considered typical of the Caspian Sea seabed, comprising sand, silt, clay and shelly sediments in varying quantities. Surveys carried out for the SWAP Survey Area also identified similar types of sediments but with a heterogeneous distribution in the proportions of the component sediment types[35].

[51] BP, 2002. Azeri, Chirag, Guneshli contract area. Regional seismic survey environmental impact assessment
[52] Akvamiljø Caspian, 2010. ACG Regional Environmental Survey for Water and Benthos, Report 10401-R2
[53] GIWA UNEP 2006. Regional Assessment Report 23 – the Caspian Sea. Global International Waters Assessment Program, UNEP
[54] http://www.grida.no/graphicslib/detail/heavy-metals-in-sediments_1bd5 . Accessed 18 August 2016
[55] http://www.grida.no/graphicslib/detail/pesticides-and-heavy-metals-in-sediments_b447 . Accessed 18 August 2016

Figure 5.3: Sediment Contamination Across the Caspian Sea[54]



5.3.5 Seabed Biological Environment

The benthic communities in the Caspian Sea reflect the fact it is the largest enclosed inland body of water on Earth (by area) with a very high proportion of endemic species. A total of 420 macrobenthic species have been recorded in the Caspian Sea[56] of which most are endemic to the Caspian and Black Sea basins, although most species ultimately originate from the Mediterranean. There are a number of non-native species that have been introduced to the Caspian Sea over the past 60 to 70 years, including benthic species such as the bivalve *Mytilaster lineatus* and the barnacle *Balanus improvisus*. The Northern Caspian is occupied mainly by fresh-water benthic species whereas the Central and Southern areas are occupied by brackish-water species[57]. The Caspian Sea benthos is predominantly characterised by highly patchy distribution of bivalve molluscs, polychaete worms and amphipod crustaceans with very few predatory invertebrates.

Typically, denser benthic populations are found in the coastal regions at depths of 50 to 75m. Diversity and abundance generally decrease with increase in water depths[38] with very low biomass of benthos beyond 200 m water depths[25]. The lowest biomass of benthic fauna is observed over the greater part of the Southern Caspian and in the central parts adjoining to deep-water areas. Benthic fauna distribution also varies throughout the year; overall benthic productivity peaks in the spring and summer (April to August) and then declines in the winter[58].

There is no specific information on the benthic communities within the Study Area. However, data from the nearest surveys (Yalama Block and ACG Contract Area[59]) indicate the presence of the species reported to be typical of the Central Caspian Basin.

Survey results from the Yalama Block showed that the biomass and abundance of benthic macroinvertebrates reached a peak at a water depth of approximately 50m. Abundance declined significantly with depth with very low levels recorded at a depth of 250m. Sediments in the area of the Yalama Block are considered typical of the Caspian Sea seabed, comprising sand, silt, clay and shelly sediments in varying quantities. The key species observed in water depths between 650 and 700 m were polychaetes and oligochaetes in very low biomass[33].

2012 survey results across 12 stations in water depth between 124m and 386m in the ACG Contract Area show the most abundant macrofauna were oligochaetes, polychaetes and amphipods. Gastropods and bivalves were also present. The higher abundances of amphipods were found at the shallow stations. As depth increased the number of species and the density of individuals decreased.

On the assumption that seabed sediment in the Study Area are expected to be comparable to those found in the ACG Contract Area, it can be concluded that macrofauna is likely to comprise similar benthic species, In particular, sediments would be expected to support polychaetes, oligochaetes, amphipods, bivalves and gastropods in proportions that will be, to some extent, determined by the exact sediment type, the water depth and the presence of any sediment contamination within the local area.

5.3.6 Water Column Physical and Chemical Environment

5.3.6.1 Water Temperature and Salinity

Differential climatic conditions between the Caspian Basins cause large latitudinal variations in sea surface temperature (Figure 5.4). During the winter, the Northern Caspian Basin freezes while temperatures in the Central and Southern Caspian Basins remain well above freezing (10 to 11°C), although some ice may form during severe winters.

During summer, the temperature of the waters in the Central Caspian Basin becomes stratified and a strong thermocline develops that inhibits vertical mixing at depths of 15 to 60m[49]. Surface water temperatures range from 23^0C to 26^0C in the summer months and 6^0C to 7^0C in winter[60]. During summer and autumn the thermocline moves deeper reflecting the increase in solar energy warming the surface water and forcing denser cold water to sink. As the thermocline deepens, the temperature stratification

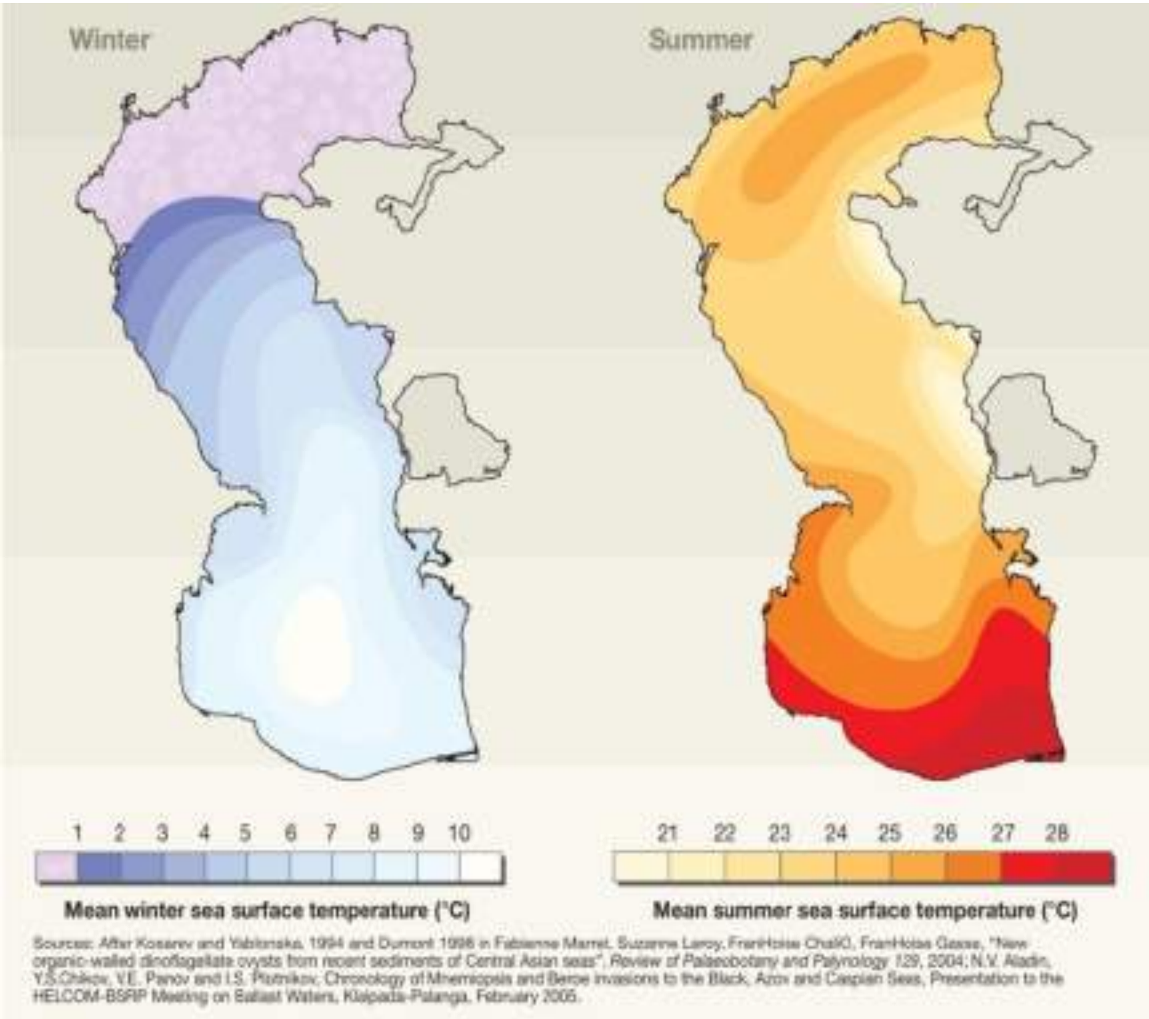
[56] Kasimov, A.G. 1994. The Ecology of the Caspian Sea. Azerbaijan Publishing House, Baku. Referred in BP, 2002
[57] Karpinsky, 2010. Review: The Caspian Sea benthos: Unique fauna and community formed under strong grazing pressure. Marine Pollution Bulletin, 61, 156-161.
[58] BP, 2002. Azeri, Chirag, Guneshli contract area. Regional seismic survey environmental impact assessment
[59] BP undertake routine surveys in the ACG Contract Area as part of their Environmental Monitoring Programme
[60] http://www.azerbaijan.az/_Geography/_Caspian/_caspian_e.html?caspian_05 Accessed 24 August 2016

becomes less significant until the thermocline eventually breaks down during late autumn and winter months[28].

The salinity of the Caspian Sea is attributed to its origin as an ancient ocean, named Tethys, which connected to the Atlantic and Pacific oceans fifty to sixty million years ago. As the gradual shift of continental plates gradually isolated it, the influx of fresh water from rivers, melting ice and precipitation diluted the salinity of the Caspian. The current salinity levels are almost three times lower than that of fully marine environments, averaging 12.8 to 12.9g/l.

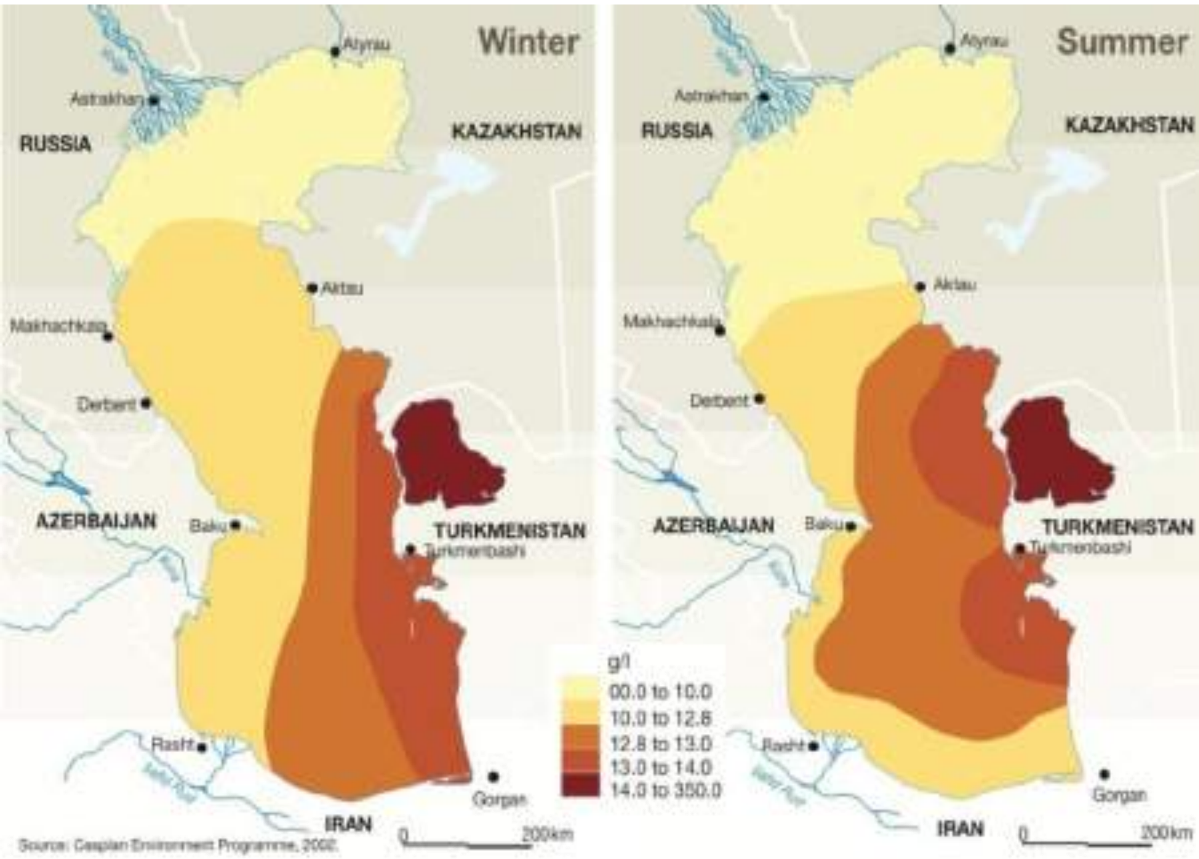
The surface salinity levels in the Caspian Sea vary with distance to fresh water sources and the riverine input and to a lesser extent with water temperature which influences evaporation rates. The salinity changes from 0.1 to 0.2g/l in the Northern Caspian near the deltas of the Volga and Ural rivers, through 10 to 11g/l on the shelf edge bordering the Central Caspian to a maximum of 13.5g/l in the southeast (Figure 5.5)[44]. Low input of fresh river flow into the southeast of the Caspian Sea explains the highest salinities being found in this area.

Figure 5.4: Mean Sea Surface Temperatures across the Caspian Sea[61]



[61] http://www.grida.no/graphicslib/detail/mean-sea-surface-temperature_eeff Accessed 19 August 2016

Figure 5.5: Sea Surface Salinity levels in the Caspian Sea[62]



5.3.6.2 Water Quality

No water quality monitoring has been undertaken for Block D230. The latest ACG Regional monitoring survey[63] for the ACG Contract Area provides water quality data of relevance to the Project Study Area. According to the survey surface Dissolved Oxygen (DO) levels varied between 7.11 and 8.22 mg/l across the ACG Contract Area while concentrations remained similar throughout the sampling depth of 350m. Water quality standards in Azerbaijan for fisheries require DO level in excess of 6 mg/l; all samples taken between surface waters and 350 metres depth were above the recommended level. Typical DO levels in the vicinity of the ACG Contract Area were found to vary between 12.3 mg/l at the surface and 4 mg/l at 500m depth during summer season, according to measurements from Hydrometeorology Annual Reference Book[64].

The findings from the ACG Regional monitoring survey also indicate low concentrations of inorganic nutrients, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS) in surface waters. The concentrations of nitrate, total N, phosphate, total P and silicates were higher at greater water depths. Similar trends were observed in previous ACG Regional surveys. Results from the same survey showed that the concentration of Total Hydrocarbon Concentrations (THC) and phenols were below the detection limit in all samples. Similarly low concentrations of hydrocarbons were observed during the 2008 and 2010 surveys, whereas higher concentrations were present in surveys prior to 2008. Metal concentrations were generally low when compared to Azerbaijan limit values and with little variation in concentration with location or depth[65]. The results for main water quality parameters were within the Azerbaijan water quality standards (maximum allowable concentrations (MAC)) for fisheries waters.

[62] http://www.grida.no/graphicslib/detail/sea-surface-salinity_14a1 Accessed 25 August 2016
[63] BP AIOC, 2012. ACG Regional Survey 2012 – Interpretative report
[64] AETC, 2011 - Environmental Impact Assessment for the East Azeri 4D Seismic Survey
[65] BP AIOC, 2012a. ACG Regional and Pipeline Water and Plankton Survey 2012 – Interpretative report

5.3.7 Water Column Biological Environment

5.3.7.1 Plankton

Plankton consists of the plants (phytoplankton) and animals (zooplankton) which live freely in the water column and drift with the water currents. Plankton community composition, production and turnover are influenced by season, depth, currents, salinity, temperature, and nutrient concentrations.

5.3.7.2 Phytoplankton

Phytoplankton species of the Central and Southern Caspian Sea includes marine, euryhaline, and brackish water forms which are considerably less influenced by the freshwater inputs as in the Northern Caspian Sea. The phytoplankton community is typically represented by diatoms, chlorophytes, cyanophytes, dinoflagellates, and to a lesser extent euglenophytes and chrysophytes. Species abundance and richness is significantly reduced from the north to the south. This difference can be explained by the less stratified and shallower waters in the Northern Caspian Sea as compared to the more homogenous and warmer temperatures, and greater light penetration in the South. The rate of photosynthesis, expressed as chlorophyll A concentration, is also much higher in the Northern Caspian after ice cover recedes (Figure 5.6). Phytoplankton growth follows a seasonal cycle that exhibits two periods of peak biomass in autumn and spring. During the winter, phytoplankton production is low due to the decrease in water temperatures and lower levels of sunlight. In spring there is a dramatic increase in growth throughout the summer but as the sea temperature increases, diatom growth is generally depressed while dinoflagellate growth such as *Propocentrum* spp, increases. Through the autumn the warm waters continue to be highly productive before phytoplankton biomass decreases again in winter[36]. In addition to solar energy, availability of nutrients in stratified water will influence this cycle; during spring months nutrients are freely available and diminish throughout summer, in autumn the thermocline breaks down releasing nutrients from deep cold water layers.

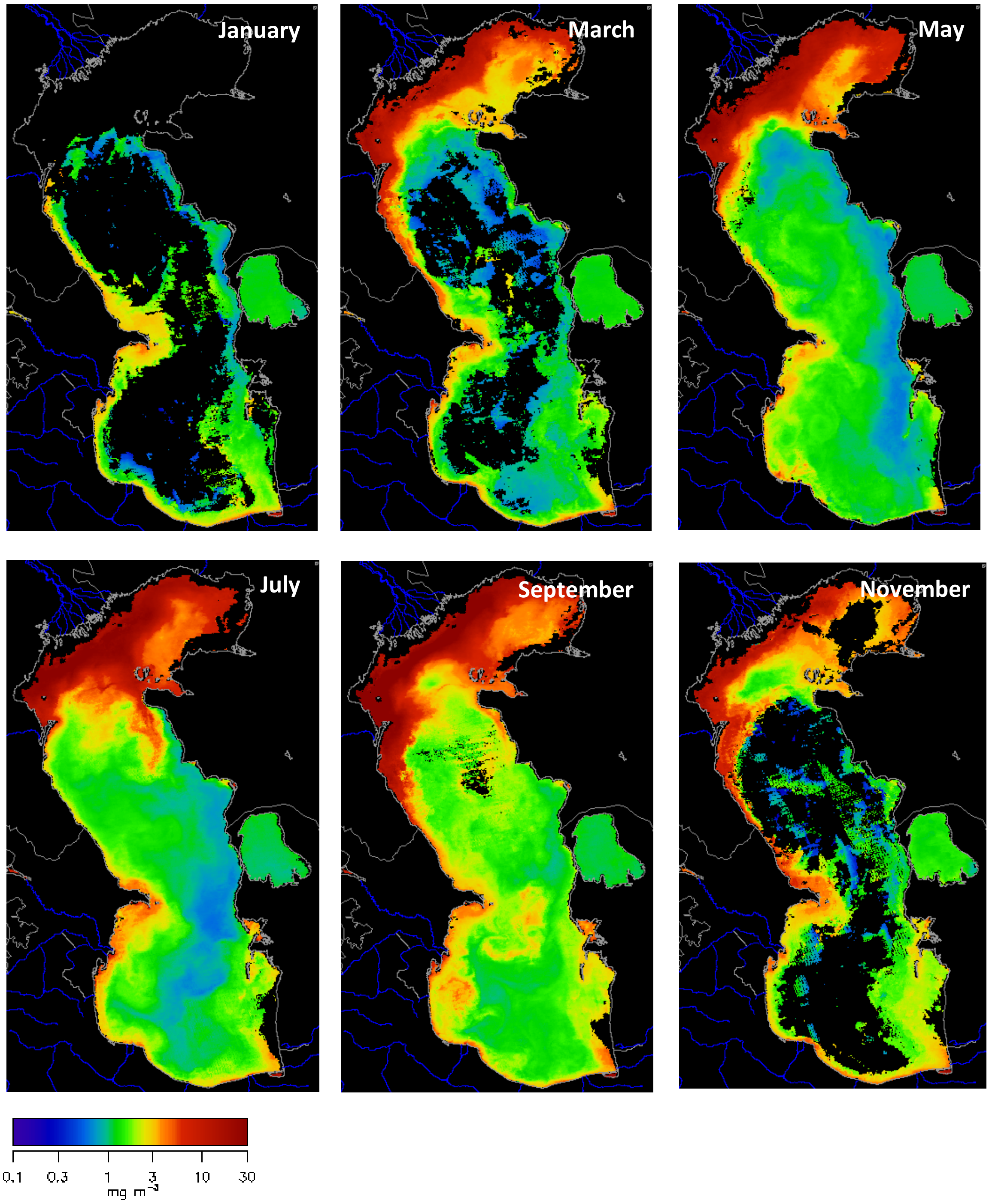
Aside from the above factors, other ecological and environmental conditions play an important role in phytoplankton distribution and abundance in the Caspian Sea. The introduced invasive species of ctenophore, *Mnemiopsis leidyi,* has led to a significant shift in the Caspian Sea food chain (see Zooplankton below). *Mnemiopsis leidyi* is recognised as a species that depresses zooplankton populations through heavy predation rates. Accordingly, as zooplankton numbers decrease, their main prey item, phytoplankton, experience abnormal increases[66]. The most numerous phytoplankton of the Central and Southern Caspian, in terms of both numbers and taxa are diatoms, followed by dinoflagellates and cyanophytes (blue-green algae). Of the diatoms, *Rhizosolenia* and *Pseudosolenia* are generally the most abundant, primarily represented by *Pseudosolenia calcar-avis*. This species (previously known by the no longer accepted name *Rhizosolenia calcar-avis)* is an invasive diatom from the Black Sea, and is now found to be generally present throughout the year. The species has an exceptionally large cell size, and combined with its abundance, can result in it constituting for up to 90% of the total phytoplankton biomass[38].

Although there is no specific information on the phytoplankton communities within the Study Area there are data from other surveys in the Central Caspian Sea. It is assumed that these groups of phytoplankton are likely to be also present in the Study Area. Table 5.1 presents phytoplankton results from surveys carried out in the Yalama Block and the ACG, SWAP and Bahar Gum Deniz Contract Areas.

Results from the winter season survey in the Yamala Block (Table 5.1) show that the phytoplankton community was made up of 8 species of diatoms (Bacillariophyta); 4 species of blue-green algae (Cyanophyta) and 4 species of dinoflagellates (Dinophyta). Abundance was dominated by blue-green algae and to a lesser extent dinoflagellates and this is likely to be attributable to the time of year as production by diatoms is much lower during the winter (Figure 5.6). However, biomass was dominated by diatoms, particularly *Pseudosolenia calcar-avis*[35,27]. The diversity, abundance and biomass of phytoplankton were highest in the surface waters (0 to 25m compared to 25 to 50m and 50 to 100m).

[66] Kideys, A.E. and M. Moghim. 2003. Distribution of the alien ctenophore Mnemiopsis leidyi in the Caspian Sea in August 2001. Marine Biology 142:163-171.Referred in AETC, 2011

Figure 5.6: Monthly Concentrations of Chlorophyll A across Caspian Sea in 2007[67]



[67] European Commission, Oceancolour Portal, http://oceancolour.jrc.ec.europa.eu. Accessed 2014

Table 5.1: Species of Phytoplankton Observed in Surveys in Central and Southern Caspian Sea

Species	Yalama Survey Area (2008)[33]	ACG Regional Survey (2012)	Bahar Gum Deniz (2011)[37]	3D SWAP Survey (2015)[35]
Diatoms				
Actinocyclus spp.		✓		✓
Amphiprora paludosa				✓
Amphora ovalis				✓
Chaetoceros spp.			✓	✓
Coscinodiscus spp.	✓	✓	✓	✓
Cyclotella caspia			✓	
Cyclotella meneghiniana				✓
Cymbella spp.				✓
Diploneis spp.		✓		✓
Fragilaria capucina				✓
Gyrosigma balticum		✓		
Navicula spp.	✓			✓
Nitzschia spp.		✓		✓
Pleurosigma spp.				✓
Pseudosolenia calcar-avis	✓	✓	✓	✓
Rhizosolenia fragilissima			✓	
Sceletonema costatum	✓		✓	
Synedra spp.	✓	✓		✓
Tabellaria fenestrata v. intermedia				✓
Thallasionema nitzschioides		✓	✓	✓
Thallassiosira decipiens		✓	✓	
Dinoflagellates				
Exuviaella spp.	✓		✓	
Glenodinium danicum		✓		
Goniaulax polyedra		✓	✓	✓
Goniaulax digitale		✓	✓	
Goniaulax polyedra				✓
Peridinium conicum				✓
Prorocentrum spp.	✓	✓	✓	✓
Cholorophytes				
Ankistrodesmus spp.				✓
Binuclearia spp.			✓	✓
Chlamydomonas sp.				✓
Pediastrum spp.			✓	✓
Ulotrix zonata				✓
Cyanophytes				
Anabaenopsis cunningtonii				✓
Gamphosphaeria spp.			✓	
Lyngbya limnetica		✓		
Merismopedia pynktata				✓
Microcystis spp.		✓	✓	
Oscillatoria spp.	✓	✓		✓

In the ACG Contract Area the phytoplankton communities sampled in July and August of 2012 were dominated, in terms of number of species, by diatoms and dinoflagellates. There were 25 species of diatom, 13 dinoflagellates, 6 blue-green algae and 5 green algae. The abundance and biomass was dominated by diatoms, particularly by the non-native diatom *Pseudosolenia calcar-avis.*

Based on the review of the results of the surveys, it is expected that communities within the Study Area will comprise diatoms, dinoflagellates, blue-green algae and green algae in proportions that vary throughout the year.

5.3.7.3 Zooplankton

Since the year 2000 the diversity of the zooplankton has been severely diminished across the Caspian Sea as a result of the introduced invasive ctenophore (*Mnemiopsis leidyi*). This is considered to be the most recent devastating event for the Caspian ecosystem due to *Mnemiopsis* species spreading rapidly and out-competing indigenous species. *Mnemiopsis* is a carnivore which feeds on zooplankton (including meroplankton, the larvae of benthic animals), fish eggs and fish larvae. It often feeds excessively, regurgitating excess ingested food, and it can consume up to ten times its own weight per day. Daily grazing by this invasive species of microzooplankton in the Black Sea was found to be upwards of 23 to 25% of its daily biomass[68]. The monitoring programs set up in Azerbaijan and Iran showed that zooplankton was the worst-affected component of the ecosystem in the Caspian Sea as a result of this species widespread distribution[66]. The impact on lower trophic levels was also reflected in the higher trophic levels. Another invasive species, the copepod Acartia tonsa, has come to dominate the abundance of the zooplankton community.

There is no specific information on the zooplankton communities within the Study Area; however communities are expected to be comparable across the Central and Southern Caspian Sea taking into consideration factors such as water depth. Data from the nearest surveys, the Yalama Block[33], ACG Contract Area and the Bahar Gum Deniz[34] indicate similar species are found in the Central and Southern Caspian Sea. The zooplankton communities expected in the Study Area are summarised in Table 5.2.

Table 5.2: Zooplankton Species Observed in Central and Southern Caspian Sea

Zooplankton Taxa	Yalama Survey Area (2008)[33]	ACG Regional Survey (2012)	Bahar Gum Deniz (2011)[37]
Copepods			
Acartia clausi	✓		
Acartia tonsa	✓	✓	✓
Eurytemora grimmi	✓		✓
Eurytemora minor	✓	✓	✓
Halicyclops sarsi	✓		✓
Limnocalanus grimaldi	✓		
Cladocerans			
Podon polyphemoides	✓	✓	
Polyphemus exiguous	✓		

[68] Finenko, G.A et.al. 2006. Invasive ctenophore, *Mnemiopsis leidyi*, in the Caspian Sea: feeding, respiration, reproduction andpredatory impact on the zooplankton community. Marine Ecology Progress Series. Vol. 314: 171–185

Evadne anonyx typical	✓	✓	
Podoevadne trigona intermedia	✓		✓
Podoevadne camptonyx podonoides	✓		
Cercopagis pengoi	✓		✓
Cercopagis prolongata	✓		
Others			
Mollusca larvae	✓	✓	✓
Balanus (barnacle) larvae	✓	✓	✓
Copepod larvae	✓	✓	✓

The zooplankton also includes the eggs and larvae of fish, termed the ichthyoplankton, that are planktonic for only a part of their life cycle. Several species, including the kilka species *Clupeonella engrauliformis* and *C. grimmi* that over-winter in the Central and Southern Caspian at depths of around 500m to 750m spawn in the spring. Thus, eggs and larvae of these species may be present in the Study Area in the spring and early summer (April to May/June)[69]. Similarly, grey mullet (*L. saliens*) also spawns in the Southern and Central Caspian, during June to July at a range of depths between 5m and 700m. The pre-larval and larval stages congregate at depth, until they are able to migrate from the Central Caspian towards the shallower coastal areas[70]. The eggs and larvae of non-commercial species such as gobies (*Gobiidae*) are recognised as being relatively abundant in the offshore area. Mass spawning takes place during June to July in central areas of the Southern and Central Caspian where eggs concentrate at water depths of 5m to 100m.

Thus, there may be ichthyoplankton in the water column in the Study Area depending on the time of year.

5.3.7.4 Fish

The Caspian Sea's unique geography, climate and hydrological characteristics create a range of different habitats that support a large diversity of fish species. The existence of shallow areas, deep depressions, and a wide range of salinities provide different environmental conditions and habitats favourable for species diversity. According to the latest literature, approximately 151 species and subspecies of fish can be found in the Caspian and associated river deltas[71]. Due to the Caspian Sea's isolation from other water bodies, the sea is characterised by the presence of many endemic species and the presence of 54 endemic fish species[72].

Fish commonly found in the Central Caspian Sea can be categorised into the three following types:

- **Migratory species**: this includes sturgeon and shad species whose key spawning grounds are the river Kura in the Southern Caspian and rivers Terek and Samar, which flow into the Central Caspian. These species migrate in waters between 50 to 100m, which is on the periphery of the proposed data acquisition area. Some species of sturgeon (i.e. Beluga) spend the spring and summer mostly in the Northern and Central Caspian and in autumn migrate southwards for wintering[73];

[69] Kouliev, Z. & Gasymov, A., 1999. Fishery characteristics of the Zafar Mashal Prospective Structure. Unpublished report. Referred in AETC, 2011
[70] AETC, 1999. Zafar-Mashal Seismic Survey Environmental Impact Assessment. Report prepared by Azerbaijan Environment and Technology Centre (AETC) for Exxon Azerbaijan Operating Company LLC. November 1999 Referred in AETC, 2011
[71] Ivanov V.P., Komarova G.V. Fishes of Caspian Sea (systematics, biology, industry). Astrakhan, 2008, p.224. Mentioned in AECOM and BP, 2013
[72] GIWA UNEP 2006. Regional Assessment Report 23 – the Caspian Sea. Global International Waters Assessment Program
[73] Gesner, J., Chebanov, M. & Freyhof, J. 2010. *Huso huso*. The IUCN Red List of Threatened Species 2010: e.T10269A3187455. Available at: http://dx.doi.org/10.2305/IUCN.UK.2010-1.RLTS.T10269A3187455.en

- **Other species (semi migratory)**: Kilka have a wide distribution in the Caspian with important areas in the Southern and the Central Caspian Sea, which is likely to include some parts of the Study Area during the winter months. Kilka are also important prey for other species such as sturgeon, salmon and the Caspian seal. Mullet were introduced from the Black Sea in the 1930s and normally overwinter in the southern Caspian. They migrate in the spring to feeding grounds in the Central and Northern Caspian. The key spawning period takes place between late August and early September in water depths typically between 300 to 600m; and
- **Resident species**: several non-commercial species such as gobies are found in all regions of the Caspian Sea, predominantly in shallower areas (up to 30 to 70m in spring and summer, migrating to greater depths in winter). Gobies are second only to herring in the number of species in the Caspian Sea.

The most common species of fish in the Caspian Sea are kilka, which are also commercially important species. However, in recent years the abundance and distribution of kilka has altered in response to a number of factors including overfishing and the presence of the invasive ctenophore (*Mnemiopsis leidyi*) which feeds on the zooplankton prey of many fish species. Data from Department on Protection and Reproduction of Aquatic Bioresources (DPRAB) indicates that the total quantity of kilka (traditionally the most important species for the fishing industry) landed in the Azerbaijan Sector of the Caspian Sea has reduced by 96% from 2002 (10,950 tonnes) to 2011 (485 tonnes)[36]. In addition, in April and May 2001, a mass mortality of 166,000 tonnes of kilka (mainly anchovy kilka) was recorded in the Central and Southern Caspian Sea. Earthquake data reveals that, in the first quarter of 2001, the local Absheron seismic plate was active, the water and gas systems in the soil were unstable suggesting a series of natural hydro-volcanic events occurred, resulting in the release of significant gas and poisonous substances into the water column. It is thought that this event was a significant contributor to the mass kill[74].

Data from Department on Protection and Reproduction of Aquatic Bioresources (DPRAB) indicates that the total quantity of kilka (traditionally the most important species for the fishing industry) landed in the Azerbaijan Sector of the Caspian Sea has reduced by 99% from 1999 (271,000 tonnes) to 2016 (316 tonnes). The reduction in kilka species caught by the commercial fishing fleet over the past 10-15 years is generally attributed to the impact of the increased presence of *M. leidyi*, which is particularly evident since 2001. Recently there is evidence to suggest that kilka have started feeding on zooplankton *Acartia*. The prevalence of *Acartia* (*clause and tonsa*) within the structure of current zooplankton communities instead of *Eurythemora, Limnocalanus* and *Calanipeda*, is leading to a change in composition of the diet of the kilka (mainly the anchovy kilka).

As well as a reduction in catch size the proportional share of species in catches has changed, from being dominated by anchovy kilka (*Clupeonella engrauliformis*) to ordinary Caspian kilka (*Clupeonella cultriventris*). In addition major aggregations of kilka have been observed in nearshore locations in less than 50 m of water, such as at Oil Rocks rather than in deeper waters at the traditional fishing banks[36]. The most common species of fish in the Caspian Sea after kilka is mullet.

With respect to overall ecosystem health, heavy metals are recognised as being toxic to and accumulate in living organisms, and because of this, fish samples are often used worldwide to monitor the quality of ecosystems[75]. Heavy metal concentrations within the Caspian Sea are thought to have accumulated mainly from the Volga River and known elevated concentrations of trace elements have been reported in coastal sediment samples[76]. The most recent published study, however, found that concentrations of heavy metals (chromium, cadmium, cobalt and lead) in the three commercial species of kilka were lower than international standards[77].

Throughout their lifecycle, fish use spawning, feeding and wintering habitats. For fish species with limited migratory range these three habitats often coincide. Some fish species spend a certain amount

[74] Daskalov, G. M., and Mamedov, E. V. 2007. Integrated fisheries assessment and possible causes for the collapse of anchovy kilka in the Caspian Sea. ICES Journal of Marine Science, Volume 64, Issue 3, 1 April 2007, Pages 503–511, https://doi.org/10.1093/icesjms/fsl047

[75] Devier, M.H., Augagneur, S., Budzinski, H., Le Menach, K., Mora, P., Narbonne, J.F., and Garrigues, P., 2005. One-year monitoring survey of organic compounds (PAHs, PCBs, TBT), heavy metals and biomarkers in blue mussels from the Arcachon Bay, France. Journal of Environment Monitoring, 7, 224–240.

[76] Mora, S., Sheikholeslami, M.R., Wyse, E., Azemard, S. and Cassi, R., 2004. An assessment of metal contamination in coastal sediments of the Caspian Sea. Marine Pollution Bulletin, 48, 61–77

[77] Taghavi Jelodar, Hassan & Fazli, Hasan & Salman Mahiny, Abdolrassoul. (2016). Study on heavy metals (Chromium, Cadmium, Cobalt and Lead) concentration in three pelagic species of Kilka (Genus Clupeonella) in the southern Caspian Sea. Iranian Journal of Fisheries Sciences. 15. 567-574.

of time at sea, but during the wintering and spawning seasons move to rivers. Some marine fish can undertake considerable migrations across the sea, while others inhabit relatively limited areas of the sea.

There is no specific information on the fish species within the Study Area. In general, the main distribution of fish species in the Caspian Sea is within the shallow water shelf areas. Maximum concentrations of fish are typically found at depths ranging between 50 to 75m for the majority of the year, with seasonal migrations into deeper water, often for overwintering and spawning. However, based on current knowledge of the depth and general migration routes and the depths at which certain species are known to spawn in the central Caspian Sea an assessment of the likely presence of fish species in the Study Area can be made.

It is understood that the area to the north of the Absheron Peninsula is important for spawning, feeding and migration, generally concentrated in water depths up to 75m. The migration routes and spawning areas of fish species passing through the Central Caspian are shown in Figure 5.7 and the depths where fish are likely to be present are shown in Table 5.3[78].

It can be concluded that up to 50 fish species (including 20 species of gobies) may be present in the Central Caspian to the north of the Absheron Peninsula at certain times of the year. The data in Table 5.3 indicates that several pelagic fish including (anchovy and big-sardines, mullet, and sturgeon) and nine benthic fish species (goby deep, goby nonultimus, pugolovka Grimm, transparent pugolovka, pugolovka Svetovidov, goby Ilina, narrow-pugolovka, Slender-snouted pugolovka, pugolovka-platypus) may potentially be present in the Study Area during all seasons for different reasons (spawning and wintering migrations, spawning, fattening, hibernation).

Most species found in this part of the Caspian Sea usually stay in the coastal area (water depth up to 75m), but it is common for Caspian fish to migrate to greater depths. For example, herring sometimes migrate to 100 m, anchovy and big eyed kilka migrate to the depth of 40-400m deep and the larvae of kilka lives at a depth of 350 to 450m.

Migration occurs from the south to north in the spring and north to south in the autumn. The mullet and golden mullet spawn within the Central and Southern Caspian from June to July and end of August to the early September, respectively. Goby species are very common and widespread in the Caspian Sea. Many goby species usually stay in shallow waters (up to 20 to 100m) and in rare occasions migrate into deeper waters (between 200-300m to 500m depths). They are mainly distributed in the Central and South Caspian and most species avoid the coastal areas freshened by river flows. Based on the information above and in Table 5.3, it can be concluded that most of the endemic species of gobies (Khvalynsky, deep, nonultimus, goby Ilyina) and pugolovkagobies (big-transparent, granular, narrow-headed, slender-snouted, pugolovka Baer, pugolovka-platypus) could potentially be present in the Study Area.

Pelagic species such as kilka, are likely to be found in the waters of the Central Caspian year round, although in smaller numbers in winter, outside the main spawning and migration periods. There are also seasonal migrations of sturgeon in spring and autumn (in water depth up to 100 meters water); mullet between April and September and the presence of some gobies during deep water winter migration and over-wintering between November and February.

There is therefore, potential for a number of fish species including mullet, kilka and gobies to be present in the Study Area and any sturgeon migrating in deeper waters (around the 100 m depth contour) could pass through a small section.

[78] *Per Comms* Mehman Akhundov, September 2016

Figure 5.7: Migration Routes for Herring/Shad, Mullet, Sturgeon and Kilka

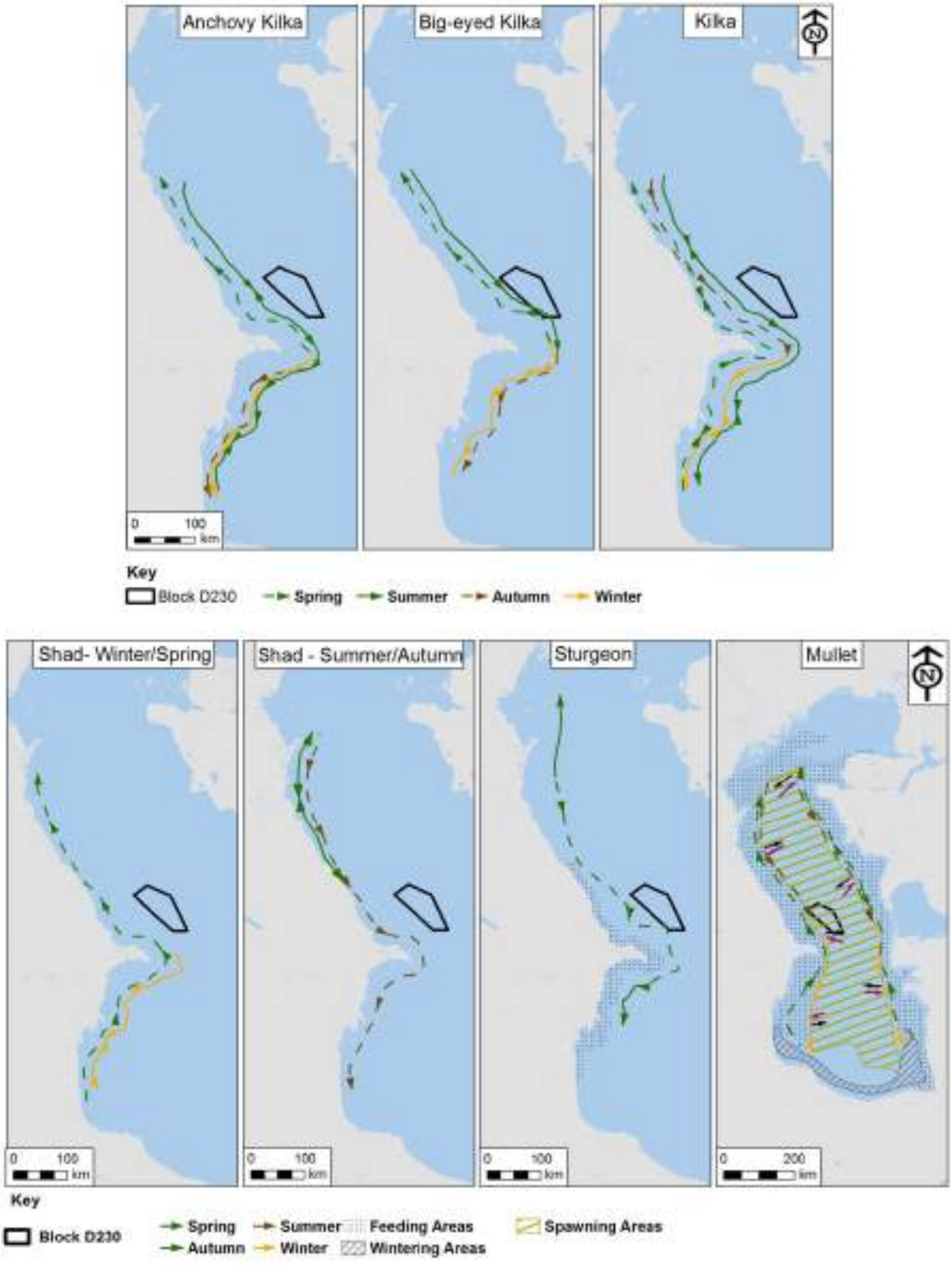


Table 5.3: Summary of the Fish Species Expected to Present in the Central Caspian Sea

Name of Species	Common name	Hearing group	IUCN Red List Status	Spawning Location	Reason for Presence in the Study Area
STURGEON (Family Acipenseridae)					
Huso huso	Beluga	SB	EN	River Volga, Ural, Kura, Sefidrud	Sturgeon may potentially be present during their migration periods in the spring and autumn, and feeding during summer in coastal waters up to 100 m water depth.
Acipenser guldenstadti	Russian sturgeion	SB	EN	River Volga and Ural	
Acipenser güldenstädtii persicus natio cyrensis	Kura (Persian) sturgeon	SB	EN	River Volga, Ural, Kura, Sefidrud	
Acipenser nudiventris	Kura barbel sturgeon	SB	EN		
Asipenser stellatus stellatus natio cyrensis	Kura (South-Caspian) stellate sturgeon	SB	EN		
KILKA (genus Clupeonella, family Clupeidae – herring)					
Clupeonella engrauliformis	Anchovy kilka	SB/HS	LV	The eastern part of the Central and South Caspian in the area of circular flows at depths of 50 to 200m in the upper layers of water not less than 15 to 20m from the surface	May potentially be present in April to August, at water depths between 200 to 700m for spawning migration or spawning in the direction of deep-central and eastern part of the Central and South Caspian.
Clupeonella grimmi	Big-eyed kilka	SB/HS	LV	The eastern part of the Central and South Caspian in the area of circular flows at depths of 350 to 450m in the upper layers of water not less than 15 to 20m from the surface	May potentially be present in April to May, at water depth up to 200 to 700m for spawning migration or spawning in the direction of deep-central and eastern part of the Central and South Caspian.
Clupeonella delicatula caspia	Caspian common kilka	SB/HS	LV	Northern Caspian and shallow waters of the western coasts of Central and Southern Caspian Sea to the depth up to 10m	**Not present**
SHAD (genus *Alosa* Cuvier, family Clupeidae – herring)					
Alosa caspia caspia	Caspian shad	SB/HS	LC	Northern Caspian	**Not present**
Alosa braschnikowii braschnikowii	Dolgin shad	SB/HS	LC	Northern Caspian	
Alosa saposchnikowii	big-eyed shad	SB/HS	LC	Northern Caspian	
Alosa brashnikovi autumnalis	Big-eyed shad	SB/HS	LC	The western and eastern coastal area of the South Caspian	
Alosa kessleri volgensis	Volga shad	SB/HS	LC	Volga, Ural and Terek Rivers	

Name of Species	Common name	Hearing group	IUCN Red List Status	Spawning Location	Reason for Presence in the Study Area
Alosa kessleri kessleri	Black-backed shad	SB	LC	Volga and Ural rivers	
CARP (family Cyprinidae)					
Rutilus frisii kutum	Kutum/Black Sea Roach	SB	LC	Coastal rivers	**Not present**
Rutilus rutilus caspicus	Roach	SB	LC		
Abramis brama orientalis	East bream	SB	LC		
Chalcalburnus chalcoides	Danube bleak	SB	LC		
Vimba vimba persa	Caspian bream	SB	LC		
Cyprinus carpio Linnaeus	Carp	SB	VU		
MULLET (family Mugilidae)					
Lisa auratus	Golden mullet	SB	LC	Entire Central Caspian (300 to 600m depth)	May potentially be present in August and September at water depths between 5 to 600m for spawning migration, and 300-600m for spawning, in the direction of the deep-water part of the Central Caspian.
Lisa saliens	Leaping mullet	SB	LC	Entire South and Central Caspian (5 to 700m depth)	May potentially be present in June to July at water depths between 5 to 700m for spawning migration and spawning in the direction of the deep-water part of the Central and South Caspian.
OTHERS					
*Atherina mochon pontica nation caspia**	Big-scale sandsmelt	SB	-	In all shallow regions of the sea, mainly in the Gulf of Alder	**Not present**
Gasterosteus aculeatus	Three-spined stickleback	SB	LC	Lower parts of the rivers flowing into the Caspian Sea (estuaries)	
Salmo trutta caspius	Caspian trout	SB	EN	Rivers of the western coast of the Central and South Caspian Sea, in rare occasions Volga and Ural rivers	
Stenodus leucichthys	White trout	SB	EN	Volga river, in rare occasions Ural River	
Syngnathus nigrolineatus caspius	Caspian Pipefish	SB	LC	In all shallow sections of the sea where *Zostera* plants are growing	
Sander marinus Cuvier	Sea pikeperch	SB/HS	EN	Central and Southern Caspian and Absheron islands	
GOBY (family Gobiidae)					
Neogobius bathybius	Deepwater goby	No SB	LC	Central, South Caspian, West Coast	May potentially be present in November to February in water depth up to 300m for wintering migration and wintering in an easterly direction to the deep-central part of the Central and South Caspian
Knipowitschia Iljini	Ilyin goby	SB	LC		May potentially be present in March to October in water depths up to 100 to 300m for spawning migration

Name of Species	Common name	Hearing group	IUCN Red List Status	Spawning Location	Reason for Presence in the Study Area
					in a westerly direction to the coastal part of the Central and South Caspian, May potentially be present between November to February at water depths up to 300 to 500m for wintering in the deep central part of the Central and South Caspian Sea
Mesogobius nonultimus	-	SB	LC		May potentially be present in November to February in water depth up to 300m for wintering migration and wintering in an easterly direction to the deep-central part of the Central and South Caspian
Benthophilus grimmi	Grimms' pugolovka	No SB	LC	Central, South Caspian, West Coast	May potentially be present in November to February in water depth up to 300m for wintering migration and wintering in an easterly direction to the deep-central part of the Central and South Caspian
Benthophilus ctenolepidus	Persian goby	No SB	LC		
Benthophilus svetovidovi	Pugolovka svetovidovi	No SB	LC		
Benthophilus leptocephalus	Slender-snouted pugolovka	No SB	LC		May potentially be present in March to October in water depths up to 100 to 300 for spawning migration in a westerly direction to the coastal part of the Central and South Caspian, Also can be present between November to February at water depths up to 300 to 500m for wintering in the deep central part of the Central and South Caspian Sea
Benthophilus leptorhynchus	Slender-snouted pugolovka	No SB	LC		
Anatrirostrum profundurum	Pugolovka-platypus	SB	LC		
Benthophilus stellatus leobergius Iljin	Caspian tadpole goby	No SB	LC	North, Central, South Caspian, West Coast up to 1-10m depth and deltas of Volga, Terek and Kura rivers	**Not present**
Neogobius melanostomus affinis	Round goby	No SB	LC		
Neogobius syrman eurystomus	Caspian syrman goby	No SB	LC		
Neogobius fluviatilis	Monkey goby	No SB	LC		
Knipowitschia longicaudata	Knipovich long-tailed goby	SB	LC		
Neogobius kessleri gorlap	Caspian big-headed pugolovka	No SB	LC		
Neogobius ratan goebeli	Ratan Goby	No SB	LC	Central, South Caspian, West Coast water depth up to 1 to 10m	
Benthophilus macrocephalus Pallas	Big-headed pugolovka	No SB	LC		**Not present**
Neogobius caspius	Caspian goby	No SB	LC		
Benthophilus granulosus	Granular pugolovka	No SB	LC	Central Caspian, West and East coasts water depth up to 1-10m	
Benthophilus Baeri	Baer pugolovka	No SB	LC		

5.3.8 Caspian Seals

The Caspian seal (*Phoca caspica*) is the only marine mammal present in the Caspian Sea. The species is endemic to the Caspian Sea and has been listed on the IUCN Red List of Threatened Species[79] as 'Endangered' since October 2008. The population of Caspian seal has decreased by more than 90% since the start of the 20th century, considered to be due to a combination of commercial hunting, habitat degradation (through introduction of invasive species), disease, industrial development, pollution and fishing operations using nets.[80] The population of seals has been estimated using a number of different methods. A 2012 paper[81], using an age-structured projection model and the annually recorded seal harvest, between 1867 and 2005 estimated the 2005 population to be 104,000. In comparison, data collected from aerial surveys in Kazakhstan and sea ice surveys resulted in estimates of between 100,000 and 170,000[82].

There have been a number of survey/research programmes undertaken to improve understanding of the distribution and population numbers of Caspian seals in the Caspian Sea. Data collection has included the following:

- **1980 – present**: Opportunistic monitoring of dead seals and confirmation of seal sightings by fishermen and helicopter pilots;
- **2005 - 2012**: Annual aerial surveys of the breeding population on the winter ice-field in the Northern Caspian from 18 to 27 February to estimate the overall breeding distribution; and
- **2009 - 2012**: Telemetry tagging survey, where 75 seals were tagged and their movements across the Caspian Sea were tracked. Data collection included dive depths.

Caspian seals are observed in many regions of the Caspian Sea depending on the season. They were typically thought to undertake annual migrations between breeding locations in the north (where pupping and mating occurs on the ice) to feeding locations in the Central and Southern Caspian during the spring months[83] (Figure 5.8 compiled by Dr Tariel Eybatov). However, recent research conducted between 2009 and 2012[84] has shown that this pattern of migration is not as prescribed as previously understood. The research was based on the tagging of 75 adult seals of both sexes. It was found that while seals migrated to the ice field in the Northern Caspian during autumn-winter months (depending on changeable metocean conditions) for breeding, they did not all migrate south in the spring – in 2011 40% of the tagged seals remained in Northern Caspian and were considered to be 'non-migratory'. The remaining 60% of the seals migrated to the Central and Southern Caspian in the spring for foraging and the routes taken were not restricted to proximity to haul out sites. Spring migration took place between April to May and autumn migration between October to December, although some did migrate north as early as August.

Assuming the findings of the research are representative of the wider population, there is the potential for migrating seals to pass through the Central Caspian, including the Study Area. In addition to seal presence during migration period, there is also the potential for seals that have not migrated to the southern Caspian to be present during from May to September for foraging with peak number coinciding with the peak kilka numbers in July. The smallest numbers of seals are expected be present in the Study Area between January and March when seals will be in the Northern Caspian pupping and mating, although this can vary by up to a month depending on weather.

The scientific opinion is that seals are showing signs of adaptation to anthropogenic disturbances. It is understood that, following increased disturbances within the Dagestan coastal area of Russia (including reported mass poaching), seals tended to avoid coastal areas during the autumn and spring migrations and use routes located as far as possible from the coast. The latest research has

[79] MENR, Azerbaijan Red Data Book (2015). Available at: http://www.redbook.az/
[80] Caspian Seal Project. Available at http://www.caspianseal.org/info.
[81] Harkonen T, Harding KC, Wilson S, Baimukanov M, Dmitrieva L, et al. (2012) Collapse of a Marine Mammal Species Driven by Human Impacts. PLoS ONE 7(9): e43130. doi:10.1371/journal.pone.0043130
[82] Arziqulov, J.A. et al, (2017). News of the National Academy of Sciences of The Republic Of Kazakhstan of the Institute of Plant Biology and Biotechnology, Biological and Medical Series Volume 6 (324), ISSN 2518-1629.
[83] Eybatov, T. M., 2015, Long term observations of seal population numbers and migration patterns by the seal research team at the Zardabi Natural History Museum
[84] Dmitrieva L., Jüssi M., Jüssi I., Kasymbekov Y., Verevkin M., Baimukanov M., Wilson S., Simon J. Goodman S.J - Individual variation in seasonal movements and foraging strategies of a land-locked, ice-breeding pinniped. Marine Ecology Progress Series 554: 241-256 (2016)

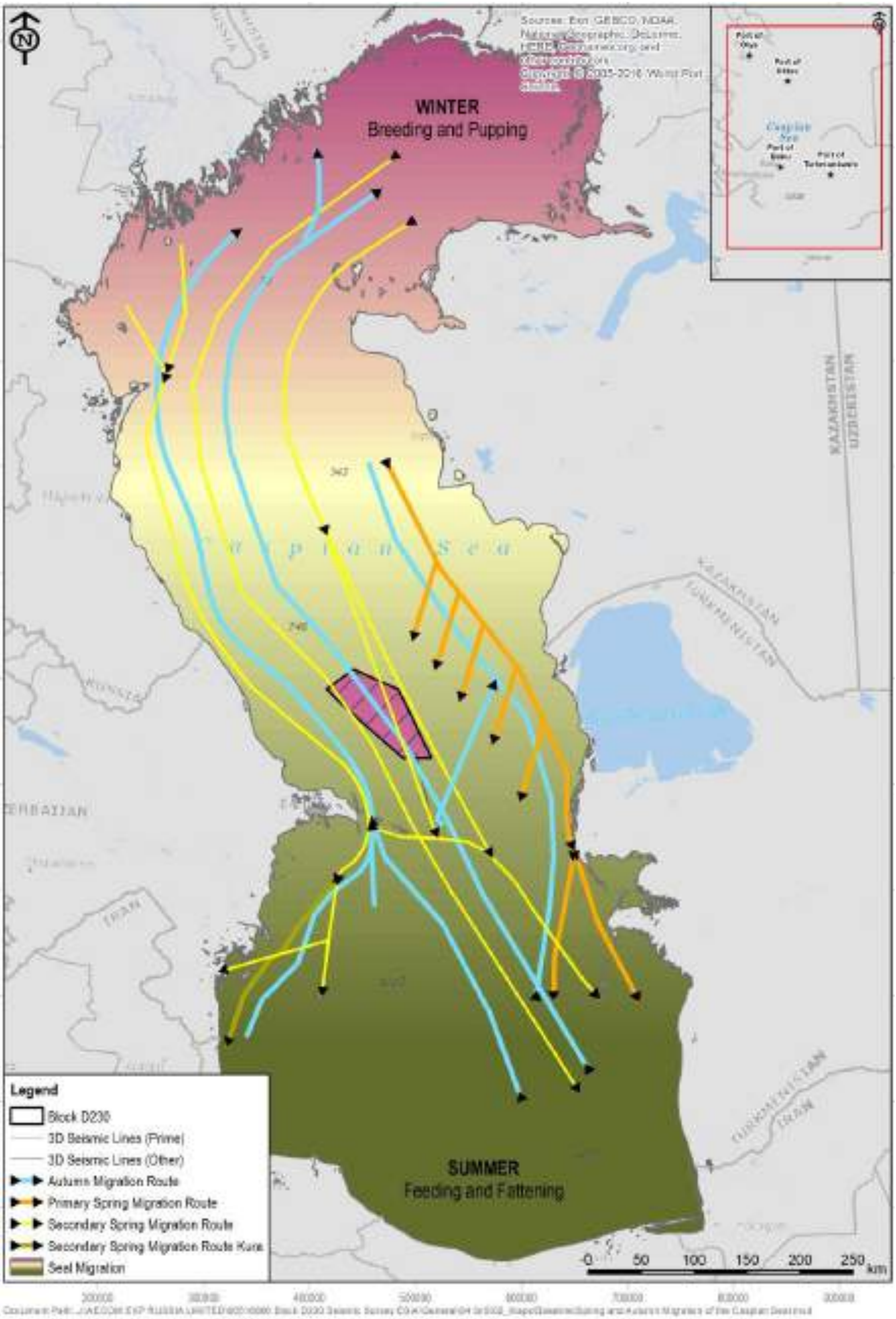
shown it is not possible to assume the seals will always follow the previously defined migratory paths (Figure 5.8). Therefore, the number of migrating seals in deeper waters including the Study Area can vary.

While this section presents an overview of expected seasonal distribution of the seals throughout the Caspian Sea, it does not represent a comprehensive understanding. There are a number of limitations in relation to the available data:

- The tagging research programme was based on a 3 year period (2009 to 2012); there is no ongoing survey programme in place to monitor long-term trends of distribution across the Caspian Sea. Prior to 2009, historic distribution data had been based on live seals sightings provided by vessels and helicopter pilots observation, opportunistic recordings which has not been collected as part of an ongoing scientific programme; and
- The research programme tagged 75 seals. This is not considered to be a representative number to enable an accurate conclusion of the distribution of seals across the Caspian Sea[85].

[85] Personal communications, Dr Simon Goodman, 2016

Figure 5.8: Spring and Autumn Migration of the Caspian Seal[86]



[86] Compiled by Dr Tariel Eybatov

5.3.9 Overwintering, Migrating and Nesting Birds

The Caspian region has a high diversity of bird species, with a large number of endemic species present. Migrating and overwintering birds tend to move widely along the Caspian coast. Consequently, at a regional level, the coastal zone of the Caspian Sea has been identified as an area of ornithological importance, supporting both internationally and nationally significant numbers of migrating and overwintering birds.

A large number of bird species have been recorded, with onshore and offshore areas providing habitat for 349 bird species including 31 species of seabirds[87]. In particular, the coastal region from the Absheron Peninsula to Gobustan, to the south and west of the Study Area, is of international and regional importance, providing habitat for breeding, nesting, migratory and overwintering birds. An estimated 128 species of waterfowl and coastal birds have been recorded, including many species of conservation importance. Approximately 21 species are included in the Red Data Book of Azerbaijan (AzRDB) and the IUCN Red List of Threatened Species[88].

There is limited data available on birds for the area of coastline closest to the Study Area and no specific information for the offshore Study Area itself. There is however, information available for Important Bird and Biodiversity Areas (IBAs) (Figure 5.9) along the coast in Azerbaijan. [89] The IBAs presented in Table 5.4, provide information on the types of birds using coastal and offshore areas that can be potentially affected by the Project (i.e. an accidental fuel spill).

Table 5.4: IBAs located Along the Azerbaijan Coastline

IBA	Description
Samur Delta	This site is located approximately 200km north west of Baku and covering approximately 6,000 hectares.
Divichi liman (or Lake Akzibir)	A 700 hectares site comprising a shallow (0.5 to 1.2m water depth) lake with vast reed beds on its western side in the Khachmas coastal lowland[90]. The site is especially important for the autumn migration of 70,000 to 80,000 waterbirds and also approximately 5,000 wintering ducks and 5,000 coots (Fulica atra)
Yashma Island	A low sandy island just north of the Absheron Peninsula. The 250 ha IBA consists of shallow, coastal areas, with patches of reeds. Sea inlets and coastal features constitute 20% of the overall area[91]. It is used as a stop over and wintering area for several species of waterbird.
Absheron archipelago (north) and Pirallahi Bay	A large area consisting of several different islands that is important for overwintering, migrating and breeding birds.
Shahdidi Spit	Located at the tip of the Absheron Peninsula near Baku, this IBA is notable for passage and wintering Pelecaniformes (includes cormorants, pelicans and other water birds) and Ciconiiformes (stork-like birds including bitterns and heron).
Red lake	This site is located approximately 20km SSW from Baku and hosts significant populations of globally threatened bird species. The area is important for breeding bird species.

[87] BirdLife International, 2014, Country profile: Azerbaijan. Available from: http://www.birdlife.org/datazone/country/azerbaijan Accessed September 2016
[88] http://www.iucnredlist.org/
[89] Some inland IBAs in the close proximity to coastline are included to indicate the presence of bird habitats that may utilise offshore environment for foraging.
[90] BirdLife International (2016) Important Bird and Biodiversity Area factsheet: Divichi liman (or Lake Akzibir). Downloaded from http://www.birdlife.org on 06/09/2016
[91] BirdLife International (2016) Important Bird and Biodiversity Area factsheet: Yashma Island. Downloaded from http://www.birdlife.org on 06/09/2016

IBA	Description
Sahil Settlement	Covering approximately 50,000 ha this site is located approximately 25km SSW from Baku and hosts significant populations of globally threatened bird species. The area is important for overwintering and migrating bird species.
Sangachal Bay	Located approximately 40km SSW from Baku, this site is important for overwintering and migrating bird species.
Glynanyi Island	A 200 ha site 62km SSW of Baku, which is the largest island of the Baku archipelago. It contains Azerbaijan's largest colony of Caspian gull (*Larus cachinnans*)[92].
Pirsagat Islands and Los Island	This 250 ha site approximately 73km SSW of Baku contains a number of islands, which form part of the Baku archipelago. The site is noted for Mediterranean gulls (*Larus melanocephalus*), which is the only colony in the Caspian Sea and various other breeding terns[93].
Shorgel lakes/Shirvan reserve	A 22,000 ha alluvial plain which extends inland from the Caspian Sea is located approximately 80km SSW of Baku. It contains a number of breeding bird species including wintering wildfowl[94].
Kura Delta	This 15,000 ha site 120km SSW of Baku contains reed beds, flooded areas, bushes and shallows. The site has excellent food sources and protective conditions for waterbirds. It is one of the two most important sites for wintering Pelicans (Pelecanus) in Azerbaijan and holds one of the biggest winter populations of Red-Crested Pochard (a diving duck)[95].
Gizilagach State Reserve	A 132,500 ha site 145km South-Southwest (SSW) of Baku containing Gizilagach Bay, which is an open bay connected to the Caspian. This IBA holds the largest colonies of Ciconiiformes in Europe[96].

The distribution and abundance of birds in the coastal region around these IBAs is likely to be subject to significant seasonal changes particularly during the spring and autumn migration periods as birds move between feeding, breeding and overwintering grounds. The species composition changes sharply during migration periods, leading to the coastal area being highly sensitive during periods of overwintering and migration.

Any wading birds present within these IBAs will unlikely be affected by routine Project activities although will be at risk from any major fuel spill. There may be some migratory and overwintering seabird species feeding in the waters of the project area but numbers are expected to be minimal. Seabirds are generally defined as those bird species that feed predominantly offshore and includes the gulls and plunge diving terns.

5.3.9.1 Migrating Birds

Azerbaijan's coastline is located within the bird migrating circuit of Europe, Asia and the Middle East.

In the autumn, birds nesting in western Russia, Siberia and northwest Kazakhstan migrate south to overwinter in the southern Caspian, south west Asia and Africa. Data suggests that just over half of birds fly along the Caspian Sea coast to the south, around 37% fly to the south west, while around 12% of the birds fly from the Absheron Peninsula to the south east. The most active migration period occurs

[92] BirdLife International (2016) Important Bird Areas factsheet: Glynanyi island. Downloaded from http://www.birdlife.org on 07/11/2016.
[93] BirdLife International (2016) Important Bird Areas factsheet: Pirsagat Islands and Los Island. Downloaded from http://www.birdlife.org on 07/11/2016.
[94] BirdLife International (2016) Important Bird and Biodiversity Area factsheet: Shorgel lakes/Shirvan reserve. Downloaded from http://www.birdlife.org on 07/11/2016
[95] BirdLife International (2016) Important Bird Areas factsheet: Kura Delta. Downloaded from http://www.birdlife.org on 07/11/2016
[96] BirdLife International (2016) Important Bird Areas factsheet: Gizilagach State Reserve. Downloaded from http://www.birdlife.org on 07/11/2016

from mid-August until mid-December though this may extend into January depending on the weather. The most active period of migration is generally November. Following the autumn migration, birds are widespread along the coastline, both on land and at sea. The migrating birds generally travel along the coastline so numbers are expected to decrease with distance offshore.

The spring migration starts in the second half of February and finishes in April with March being the most active period[97,98]. The migration routes along the Azerbaijani coastline of the central Caspian are shown in Figure 5.9. Birds use these routes primarily for migrating to the southern coast of the Caspian Sea, the Kur-Araz lowland, Turkmenistan, south west Asia and Africa for the winter and then fly north along the same route during spring (Figure 5.9).

Several migratory bird species are reported from areas both to the north and to the south of the Study Area and this data has been used to estimate which species may pass by the Study Area during the migratory period. Table 5.5 indicates the presence of birds within the four IBAs closest to the Study Area. Information available through Birdlife International suggests that some species (the Pygmy Cormorant, *Microcarbo pygmaeus,* in particular) may migrate through the Divichi liman IBA to winter in the Yashma Island IBA.

Table 5.5: Bird Species Present in IBAs Closest to the Study Area

Species Latin Name	Species Common Name	Yashma Island	Divichi Liman	Pirallahi Coastline	Shahdili Coastline
Glareola pratincola	Collared Pratincole		✓		
Fulica atra	Common Coot	✓		✓	✓
Sterna hirundo	Common Tern	✓			
Pelecanus crispus	Dalmatian Pelican	✓	✓		✓
Platalea leucorodia	Eurasian Spoonbill		✓		
Himantopus himantopus	Common Stilt		✓		
Tringa stagnatilis	Marsh Sandpiper		✓		
Recurvirostra avosetta	Pied Avocet		✓		
Microcarbo pygmaeus	Pygmy Cormorant	✓	✓		
Thalasseus sandvicensis	Sandwich Tern	✓			
Numenius tenuirostris	Slender-billed Curlew	✓			
Xenus cinereus	Terek Sandpiper		✓		
Aythya fuligula	Tufted Duck	✓		✓	✓
Oxyura leucocephala	White-headed Duck		✓		
Cygnus cygnus	Whooper Swan		✓	✓	✓

5.3.9.2 Overwintering Birds

Several areas of the Caspian coastline, particularly around the Absheron Peninsula and Shahdili Spit are important for overwintering birds. The majority are ducks (*Anas, Netta* and *Aythya* species) and coots (*Fulica atra*) but migrating herring, common, black-headed and great black-headed gulls (all of the genus *Larus*) also overwinter in this area. Yashma Island IBA, to the north of the Study Area also supports overwintering birds, particularly ducks and low numbers of coot and cormorants, though in lower numbers than the two IBAs to the south. No overwintering birds have been reported for the Divichi liman IBA.

The most abundant overwintering birds, particularly ducks, which dive to feed on small fish and benthic invertebrates on or near the seabed, and wading birds, will be common only in shallow coastal waters. Whilst some species, such as the gulls, will feed offshore at times there is not likely to be a significant density of overwintering birds observed within the Study Area.

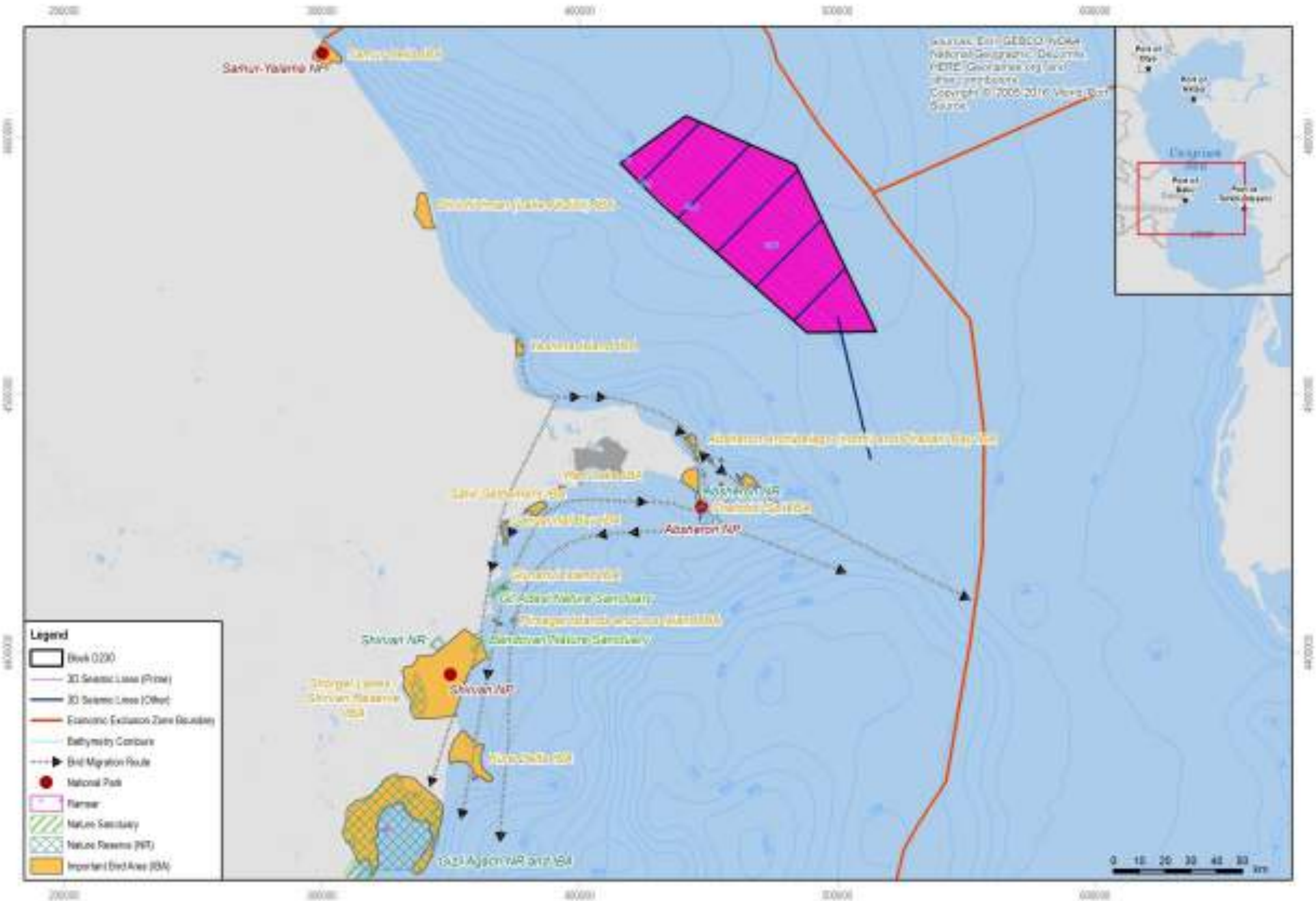
[97] Mustafayev G. T., Sadigova N. A., 2005, Azerbaijan Birds (defining monograph) Baku, "Çaşoğlu" publishing house.
[98] Tugayev D. G., 2000, Catalogue of Azerbaijan birds. Elm, Baku.

5.3.9.3 Nesting Birds

The most important area for nesting birds is the Absheron Peninsula and associated islands are located over 80km from the Block D230. This area is important for migratory seabirds, in particular the Mediterranean gull (*Larus melanocephalus*) (listed in the AzRDB) and the slender-billed gull (*Larus genei*), several tern species (of the genera *Sterna, Chlidonius* and *Hydroprogne*) and cormorants. Wading birds, including plover and avocet, herons, grebes and coots, are also found nesting here. Breeding birds are present at the Yashma Island and Divichi liman IBAs although in lower numbers and diversity (terns and the collared pratincole).

The key habitats for nesting birds include areas of open dry land, wet sandy areas, reed beds and marshes, open swamps, pilled shells and rocks and disused oil rigs. Several of these species, specifically seabirds, will feed offshore, particularly terns (of the genus *Sterna*) which are specialist plunge divers taking fast moving prey by diving into the water from height. Non-specialist feeders like the gulls may also dive to feed but do so with less skill and from lower height. However, such seabirds are sporadically distributed and often occur at low densities.

Figure 5.9: Protected Areas and Important Ornithological Sites Located on the Southwest Caspian Coast and Bird Migration Routes



5.3.10 Areas of Conservation Importance

The key areas of conservation importance are the coastal IBAs discussed in section 5.3.9 and the following national parks/nature reserves as shown in Figure 5.9:

- Samur-Yalama National Park – Established in 2012, the Park covers an area of approximately 1,800 hectares and includes coastal waters where sturgeon and kutum are found;
- Absheron National Park - established on 8 February 2005 within the existing Absheron State Nature Sanctuary. The Park covers 783 ha and is inhabited by some species of conservation importance, including Caspian seals (who use the shores for haul out) and many species of breeding and migratory birds. Salt marshes and seaweed meadows are also important for several species of fish;
- Shirvan National Park – located approximately 100km south west from Baku, was established in July 2003 in an area of 54373 ha, north of the Kura river delta and around the Byandovan Sanctuary (IBA). Up to 65 bird species inhabit its wetlands (Flamingo Lake) and sea shore;
- Gizilagach State Reserve – Established in 1929, the Reserve covers an area of approximately of 884 km² on Kyzylagach Bay to provide habitat for birds;
- Gil Adasi Nature Sanctuary – Located approximately 60km south west from Baku covering approximately 400ha, the site hosts protected bird species, including the silver gulls (*Chroicocephalus novaehollandiae*);
- Bandovan State Nature Sanctuary – Covering 4,930 hectares, the Sanctuary was designated in 1961 for the protection of the Persian gazelle (*Gazella sulgutturosa*), waterfowl birds and Little bustard (*Otis tetrax*); and
- Kichik Gizilagach Nature Sanctuary – Covering 10,700 hectares, the Sanctuary was designated in 1978 for the protection both wetlands and terrestrial areas used by migratory and local birds.

5.4 Socio-Economic Environment

5.4.1 Context

Azerbaijan comprises of 77 administrative districts including 11 city districts. Most of Azerbaijan's major settlements are coastal, with 22%[99] of the population resident in the Azerbaijani capital, Baku. In 2018, the population of Azerbaijan was 9,898,100 with a gender distribution of 49.9% male and 50.1% female. The proportion of the population resident in urban areas has remained relatively constant at around 50% over the past 20 years[99] Life expectancy in 2016 was 73 years (70 years for men and 76 years for women[100]) which reflected a significant, positive change since 1990 when average life expectancy was 71.1 years (67.0 for men and 74.8 years for women).

Azerbaijan's economy is heavily dependent on its energy exports, with more than 90% of total exports accounted for by oil and gas[101]. The contribution of the fisheries industry to the Azerbaijani economy as a whole is low, with a reported 1,400 people employed nationally in the fisheries industry in 2008[102]. The overall contribution of fisheries to national food security and poverty reduction is also therefore low; however there are local areas where fisheries are important for the rural economy and the livelihoods of coastal communities[103].

5.4.2 Fisheries

Fishing in the Azerbaijani sector of the Caspian Sea is known to comprise small scale coastal and large scale offshore commercial fishing. Historically, kilka has been the main commercial species caught in Azerbaijan. Kilka was the single authorised commercial fishing species until 2012. Commercial catch of anchovy kilka has gradually decreased during the last 12-15 years due to the reduction of kilka

[99] The State Statistical Committee of the Republic of Azerbaijan. Available at: http://www.stat.gov.az/source/demoqraphy/indexen.php Accessed November 2018.
[100] World Health Organisation, Global Health Observatory. Available at: https://www.who.int/countries/aze/en/
[101] US Energy Information Administration (EIA), 2014. Country Analysis Briefs: Azerbaijan. Available at: http://www.eia.gov/countries/cab.cfm?fips=AJ Accessed in August 2015.
[102] These numbers do not include employees in the processing industry, which are privately owned.
[103] Salmanov, Z., Qasimov, A., Fersoy, H. & van Anrooy, R., 2013. Fisheries and Aquaculture in the Republic of Azerbaijan: a review. FAO Fisheries and Aquaculture Circular No. 1030/4. Ankara, FAO. 42 pp. Available at: http://www.fao.org/docrep/017/i3113e/i3113e00.htm Accessed August 2015

reserves since 2001. Due to the reduced reserves of anchovy kilka, there has been a recent change (between 2012-2016) in the commercial fishing licences issued by MENR where both the number of licences issued and the number of larger kilka fishing vessels has decreased. In parallel, the number of licences issued for other fish species and for small boats has increased.

Azerbaijan has also experienced a reduction in the number of recorded violations of fish protection legislation. The likely reason for this change is decreased activity of the Department of Protection and Reproduction of Bioresources in Water Basins of MENR during the last 5-7 years in the prosecution of violations coupled with the reduction in natural reserves of sturgeon (including beluga, sturgeon, sturgeon stellate, ship sturgeon) and the corresponding reduction of illegal fishing of these prohibited species.

In recent years (2011-2016) the number of licences issued for fishing has increased compared to earlier years (2005-2010). This increase is associated with the additional number of licences issued for catching small fish (herring, roach, carp, small fry, bream, grey mullet, shemaya) and increased number of licences for small-capacity fleet (boats). The reduced weight of the landed commercial species of fish, which is a common trend for the entire Caspian Sea in recent years, is due to the reduced amount of kilka. The decreasing catch volume of kilka is becoming more significant, while the amount of small fish caught is increasing. Thus, as compared to 2005-2010, the trend in recent years (2011-2016) indicates a change in commercial fishing from targeting kilka to other small fish species. Due to the decreased amount of kilka landed, the number of fishing licences issued to large-capacity kilka vessels has reduced, while the number of licences issued for small fish harvesting and for small-capacity vessels (boats) has increased.

5.4.2.1 Commercial Fishing

The latest review of fishing activity (carried out in 2018) indicated that 10 commercial fishing vessels equipped with gear necessary for fishing of commercial species were sailing under the Azerbaijan flag. Nine of these vessels were ported in Lankaran city, while the remaining vessel previously ported in Pirallahi island, was moved to the Bibiheybat port of Baku city. Typically fishing is completed in shallower waters where the main accumulations of kilka are found.

There are no fishing grounds either within or in the vicinity of the Study Area and due to the adverse environmental conditions (northern storm winds) of the Central Caspian Sea, it is not an area where commercial vessels operate. As such, no commercial fishing is undertaken within or in the vicinity of Study Area[104].

5.4.2.2 Unlicensed Fishing

Unlicensed fishing activity relates to both fish catch exceeding the quota and species authorised by the regulatory authorities, as well as fishing without any license, i.e. unlicensed vessels or unlicensed fishermen.

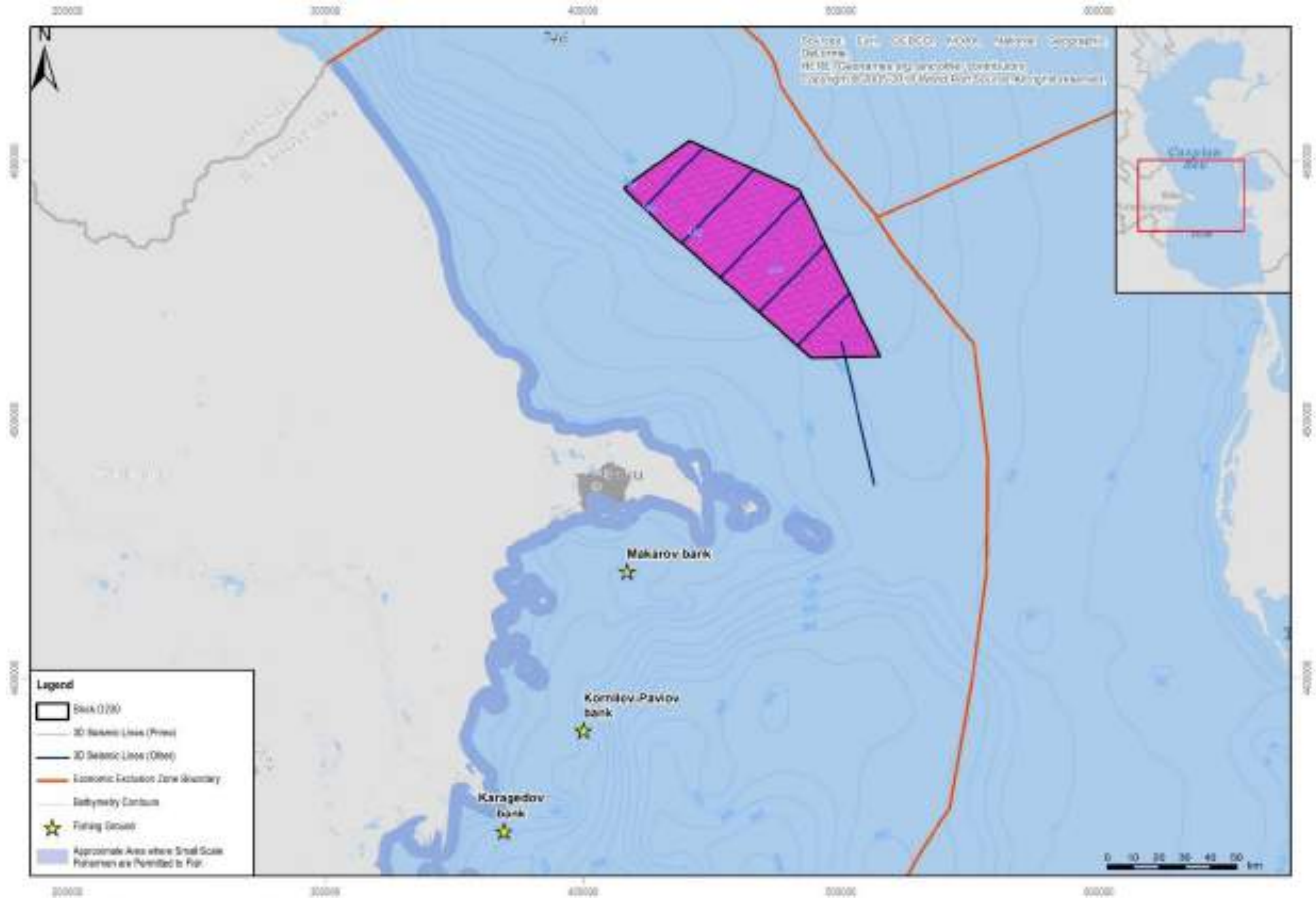
Unauthorised equipment, boats, vessels or species is prohibited and is otherwise confiscated by the authorities. There is evidence of violations of fishery protection legislation every year as well as instances of fishing gear and catch being confiscated. In 2017 for example, there were 272 violations of fish protection legislation and 122 people were prosecuted. Confiscations included 57 fishing boats, illegal fishing equipment (5,550 pieces) and various fish species. The sum of imposed fines for this period was 51,229 AZN[105].

5.4.2.3 Small Scale Fishing

Small scale coastal fishing is undertaken using medium sized small tonnage vessels. The “Classification of small tonnage vessels sailing under the state flag of the Republic of Azerbaijan”, Order 073 issued by the Ministry of Emergency Situations on 16 June 2007 and Ministry of Justice Certificate 3350 on 26 June 2007 stipulate that the region in which small-tonnage vessels can fish is limited to 2 to 3 nautical miles (5km) from the coastline. A 3 nautical mile buffer is shown on Figure 5.10.

[104] *Per Comms* Mehman Akhundov, September 2016
[105] Data from the Azerbaijan Fisheries Research Institute, 2018.

Figure 5.10: Licenced Fishing Area and Banks in the Vicinity of the Study Area



5.4.3 Shipping and Navigation

The primary commercial ports of Azerbaijan are situated on the Absheron Peninsula and in the vicinity of Baku. Shipping activities in the waters of the Central Caspian Sea include cargo shipping, passenger vessels, scientific surveys and other vessel movements supporting the oil and gas industry.

There is a dense network of navigation routes across the Central Caspian Sea (Figure 5.11), which are supported by a number of commercial ports, including the Port of Baku, Turkmanbashi (Turkmenistan), Aktau (Kazakhstan) and Olya (Russia). Known cargo and passenger ferries operate between Baku / Alat and Aktau and between Baku / Alat and Turkmenbashi; and between Olya and Turkmenbashi. They do not operate under a timetable; rather operations are dictated by passenger and cargo demand as well as the weather.[106]

The area of the proposed seismic acquisition (including survey vessel manoeuvring zone) is crossed by at least 4 shipping lanes, the traffic statistics for which is not known.

5.4.4 Offshore Infrastructure

The Study Area and surroundings have been subject to extensive oil and gas exploration and production for several decades. Contract Areas in the surrounding area are summarised below and shown in Figure 5.11:

- Dan Ulduzu Ashrafi Contract Area - located approximately 30km south of Block D230 and covers approximately 453km^2 within water depths ranging between 160 to 180m. There is one plugged and abandoned exploration well known to be present in this contract area;
- Oil Rocks - located approximately 100km east of Baku, the offshore area was developed in the 1950s and comprises over 1000 platforms, both operational and abandoned;
- Karabakh oil and gas field - located approximately 130km east of Baku in the northern part of Absheron archipelago;
- ACG Contract Area - located approximately 75km to the east of the Absheron Peninsula, in water depths varying between 150 and 400m;
- SWAP Contract Area covers approximately 1,900km^2 and comprising both onshore and offshore elements. It extends from the coastline to a water depth of approximately 25m; and
- Yalama Block D-222 - located approximately 50km off the coast of the Russian republic of Dagestan in water depths of between 80 to 700m.

5.4.5 Tourism and Recreation

There are a number of locations along the coast of the Absheron Region that are used for recreational activities and water sports (including diving, sailing and kite surfing) and available for beach users particularly in the beach clubs and hotels.

While diving for recreation is not known to be a popular recreational activity in the Azerbaijan sector of the Caspian Sea, three diving clubs are active in the Absheron Region who undertake diving in locations illustrated in Figure 5.12. Diving is undertaken near to Boyuk Zira Island (just south of Baku Bay) and near to Chilov and Malaya Plita Islands. Boyuk Zira Island is understood to be visited less frequently than the sites to the east of the Absheron Peninsula and is generally used by experienced divers who travel to the island by boat. Diving is known to take place year round; although is less popular during winter months and not undertaken during windy or stormy weather.

[106] Alat Port Authority, personal communication, 13 August 2018..

Figure 5.11: Shipping Routes and Offshore Infrastructure

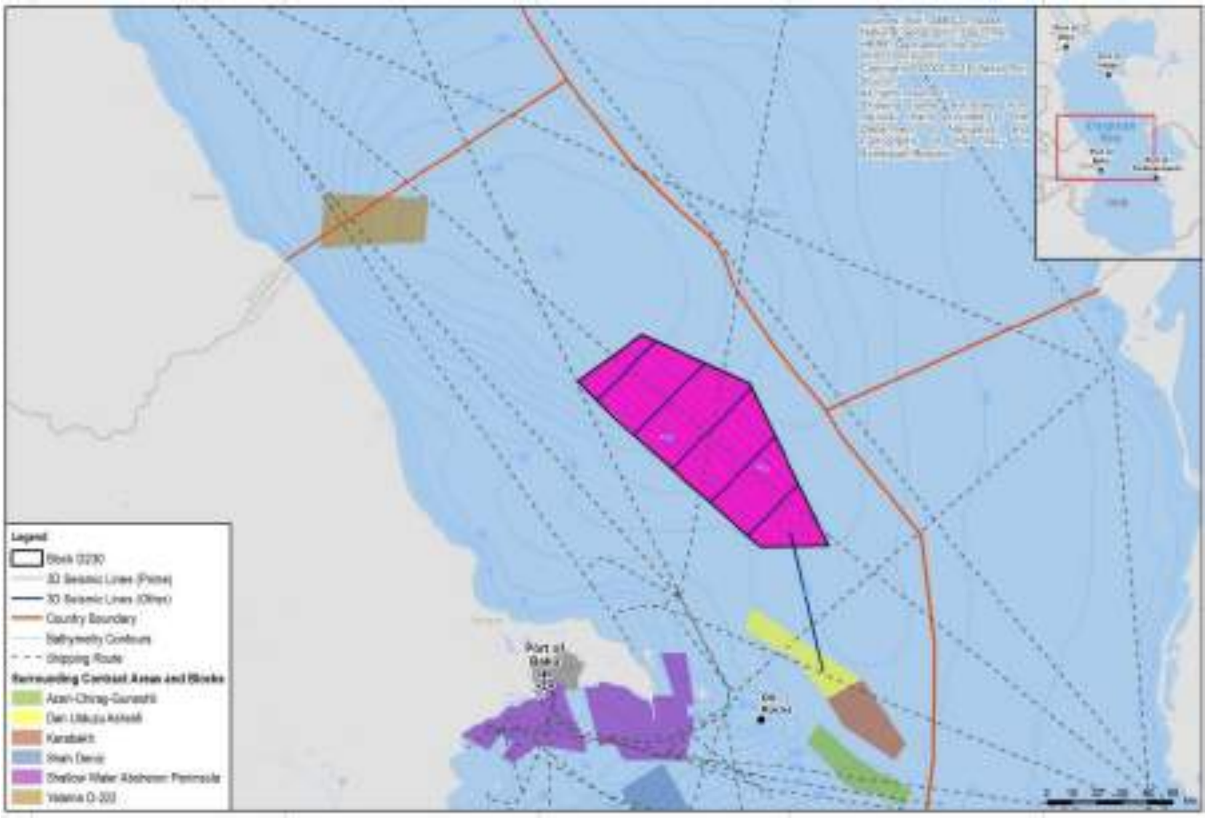
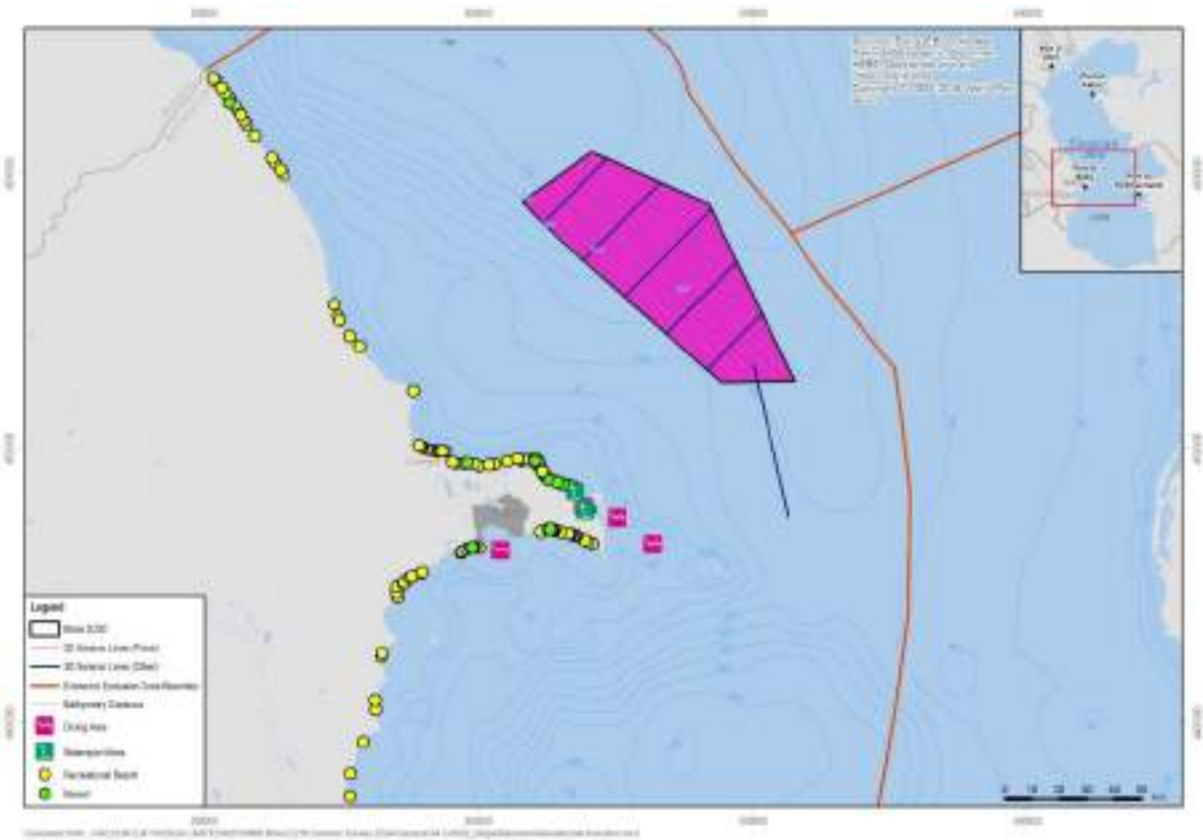


Figure 5.12: Recreational Areas Within or Proximity to the Study Area



6 Environmental & Socio-Economic Impact Assessment, Mitigation and Management

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6.1 Introduction

This section of the ESIA presents the assessment of the potentially significant impacts on the environmental and socio-economic receptors (discussed within Chapter 5) which may occur as a result of the planned activities associated with the Project (described within Chapter 4).

The impact assessment has been undertaken in accordance with the impact assessment methodology presented in Chapter 3.

6.2 Scoping

The scoping was completed as the first stage of the impact assessment process using the approach outlined in Section 3.4 of Chapter 3. The results of the scoping assessment are presented in Table 6.1 which shows the anticipated interactions between the proposed Project activities and the environmental and socio-economic receptors. The table indicates which interactions are considered to have limited potential to result in discernible impacts and can be "scoped out", and those that are potentially significant and "scoped in" for further assessment.

Table 6.2 provides the justification for the interactions, which have been "scoped out".

Table 6.1: Project Activity (Aspect) - Receptor Interaction Matrix (Scoped In and Scoped Out Interactions)

Project Activity / Aspect	Environmental										Socio-economic			
	Physical			Biological										
	Water Quality	Air Quality	Sediments and Seabed Features	Plankton	Benthic Habitats / Communities	Fish n and Spawning	Seabirds	Marine Mammals	Protected/Designated Sites	Onshore / Coastal Habitats	Fishing	Shipping	Offshore Infrastructure	Onshore Resources / Infrastructure
Physical presence of vessels & seismic equipment (incl. interference with mariner users & wildlife disturbance)				Scoped Out		Scoped Out	Scoped Out	Scoped In			Scoped Out	Scoped In	Scoped Out	Scoped Out
Sound generation by a seismic source				Scoped In	Scoped In	Scoped In	Scoped Out	Scoped In	Scoped Out		Scoped Out			
Sound generation by routine vessel operations				Scoped Out		Scoped Out		Scoped Out						
Atmospheric emissions (incl. fuel combustion and waste incineration emissions)		Scoped Out												
Planned marine discharges (incl. grey water, sewage, and ballast water)	Scoped In			Scoped In		Scoped In	Scoped Out	Scoped Out						
Accidental event resulting in a spill (incl. spills of fuel, oils, chemicals, wastes)	Scoped In	Scoped Out	Scoped In	Scoped In	Scoped In	Scoped In	Scoped In	Scoped In	Scoped In	Scoped In	Scoped In	Scoped In	Scoped Out	Scoped Out
Accidental event (Vessel collision with other marine users, and Caspian seals;)			Scoped Out		Scoped Out			Scoped In			Scoped Out	Scoped In	Scoped Out	
Use of resources (fuel, food, water)														Scoped Out
Onshore support operations including waste disposal		Scoped Out								Scoped Out				Scoped Out

(blank)	No interaction
Scoped Out	Scoped Out: Potentially insignificant impact or where no O&G Industry evidence exists to indicate interaction is potentially significant.
Scoped In	Scoped In: Potential for significant impact or where insufficient information was available at the time to designate interaction as insignificant.

Table 6.2: Justification for 'Scoped Out' Interactions

Interaction	Justification for Scoping Out
Impacts on plankton, fish and seabirds due to physical presence of vessels & equipment	The incremental vessel movement associated with the proposed seismic surveys, i.e. 2-3 vessels operating across the Study Area over a few months duration, was judged to be insignificant compared with the existing background of shipping activities (refer to Section 5.4.3 of this ESIA). The presence of towed equipment can cause some level of nuisance to marine fauna; however this interference will be limited to operating lines, which compared to the vast open waters are spatially insignificant.
Impacts to offshore infrastructure from survey activities	The Dan Ulduzu Ashrafi Contract Area is the closest field to the Study Area, located approximately 30km south from the D230 block boundary. It is understood there are no activities taking place within this contract area and there is only one known plugged and abandoned well. It is therefore assumed that there is no major offshore infrastructure in the vicinity of the Study Area.
Underwater sound impact from routine vessel operations	The level of sound produced by the survey and support vessels is comparable to small-medium size ships operating in the Caspian Sea. The transient survey activities are not expected to introduce a sustained adverse effect on the ambient sound levels.
Underwater sound impact on seabirds and protected areas from seismic energy source (airguns)	Most seabird species spend their time in flight or on the water surface; therefore, underwater sound will only affect a limited number of diving birds that will feed over large areas of the Caspian Sea. There are a number of Important Bird Areas (IBAs)/Protected Areas along the Azerbaijani coastline. The Absheron Peninsula and associated IBAs are located approximately 60km southwest (refer to Section 5.3.9). The Project is not expected to interact with IBAs or affect their integrity.
Emissions of gases to the atmosphere from survey vessel operations, with exception of emissions considered transboundary in nature (GHG, sulphur dioxide, and nitrogen oxides)	Emissions of non GHG to atmosphere will arise from the operation of the survey and support vessel engines. However, given the relatively small volume released and that there are no onshore receptors within 70km of the Project activities it is anticipated that there will be no discernible impact to air quality at onshore receptors. Furthermore, the low volume of emissions released will be dispersed across the entire survey area and the wider area. Increases in pollutant concentrations are expected to be indistinguishable from existing background concentrations at onshore receptors. Vessels will be well maintained and use low sulphur fuel as per MARPOL Annex VI requirements.
Impacts on the port environment from accidental spills	Onshore activities will be limited. Support vessels will bunker fuel in one of the dedicated ports in Baku which are adequately equipped and have oil spill contingency plans in place. The likelihood of a large fuel spill occurring in the port is highly improbable. Minor spills may occur and are not expected to pose significant risk to the coastal environment.
Impacts on onshore resources due to survey activities	Due to the short-term nature of seismic survey the scale of resources (fuel, food products, water etc.) to be used are not anticipated to be substantial to cause any significant impact on other users.
Impact to fisheries (small scale and commercial fishing) due to survey activities	Small scale fishing is limited to within approximately 5km of the coastline, so interaction with the Project (refer to Section 5.4.2.3) are not expected to occur. Commercial fishing is not known to be undertaken in the vicinity of the Study Area; there are no fishing grounds and the waters are considered too rough. No significant impacts to fisheries are expected as a result of the Project.
Impacts to the atmosphere and local traffic from onshore support operations	Emissions of non GHG to atmosphere: Impacts to the atmosphere resulting from the operation of onshore vehicle use / staff mobilisation will be very low due to the limited number of onshore vehicle movements. Increased Onshore Traffic: Impacts resulting from additional traffic on local roads as a result of supplies provision and staff mobilisation for the Project will be insignificant due to the small number of vehicle movements needed for the Project and the current volume of onshore vehicles regularly traversing the local area.
Impact to waste management onshore due to project-generated waste	Waste generated during the Project will be consistent with the type and quantity that have been routinely generated during previous seismic surveys managed by BP within the Azerbaijan sector of the Caspian Sea. All wastes will be shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures. No significant impacts are expected to result from waste generation.

Project activity-receptor interactions that have been scoped in are summarised in Table 6.3 and assessed within Sections 6.3 and 6.5 of this chapter.

Table 6.3: Scoped in Project Activity (Aspect) – Receptor Interactions

Activity / Event	Chapter 4 Project Description Ref	Event / Aspect	Receptor(s)
Operation of energy source	4.3.2	Generation of underwater sound	• Caspian seals • Fish • Plankton community • Benthic community
Planned marine discharges (incl. grey water, sewage, and ballast water)	4.6.4	Controlled discharges to the marine environment	• Fish • Water quality • Plankton community
Survey Activities (excluding the operation of the energy source)	4.1 & 4.3.3	Physical presence of the survey and support vessels and equipment	• Shipping and navigation • Caspian seals

Assessments of cumulative and transboundary impacts as well as potential effects from accidental events are presented within Chapters 7 and 8.

6.3 Operation of Energy Source

6.3.1 Existing Design Controls

Design and control measures of relevance to underwater sound include:

- The lowest practicable seismic energy levels will be used throughout the survey, whilst still achieving the technical requirements;
- The energy source will be turned off during line changes where feasible but data acquisition may also be conducted uninterrupted;
- Prior to the energy source being activated a soft-start procedure, as detailed below, will be employed:
  - o Marine mammal monitoring will be conducted for a 30 minute period to observe whether there are any Caspian seals within a 700m radius[107] of the sound source (buffer zone).
  - o If Caspian seals are sighted, the soft-start procedure will be delayed for at least 20 minutes following which the trained crew will confirm no Caspian seals are within the buffer zone and the soft-start procedure can start.
- A soft-start procedure will be used at the start of each new survey line where there has been an interruption in data acquisition of more than 10 minutes;

In addition to the control measures listed above the following will also be implemented:

- Key crew members on the deck will be trained to undertake marine mammal observations;
- Trained vessel crew will conduct ongoing ad-hoc visual observations of Caspian seals in the vicinity of the survey vessel.
- All observations will be logged including location of sighting and number of individuals seen; and
- Survey and support vessels will not intentionally approach seals for the purposes of casual marine mammal viewing.

[107] A 700m exclusion zone will be established based on the results of the underwater sound calculation which identified the potential injury impacts up to 680m from the energy source.

6.3.2 Impact Assessment

6.3.2.1 Receptor Sensitivity

The sensitivity of the receptors that can be affected by the operation of energy source has been ranked and summarised in Table 6.4.

Table 6.4: Receptor Sensitivity

Receptor	Explanation	Sensitivity
Caspian seal	The endemic Caspian seal, *Phoca caspia*, is a threatened species with an IUCN Red List 'Endangered' status. Seals have the ability to hear underwater and are known to respond to underwater sound. The Caspian seal population has a low capacity for change given the existing factors that have caused such a significant decline in numbers over the last century.	High
Fish	The Caspian Sea is an important habitat for a number of sturgeon species, all of which have an IUCN Red List status of Endangered. These species have been heavily fished in recent times; an activity that can disrupt the ecological cycle by removing immature fish and decreasing the spawning population. This leaves sturgeon species sensitive to changes in the environment with a low capacity to absorb change. These species have a swim bladder and can therefore detect underwater sound pressure changes.	High (sturgeon)
	There are a number of kilka species in the central Caspian, which are an important component of the marine food chain and prey species for the Caspian seal. The number of kilka has significantly declined in recent years and therefore the population has a reduced capacity to absorb change. Kilka are hearing specialists, species with a swim bladder that it also used in hearing.	Moderate (kilka)
	The remaining common fish expected to be found in the Study Area include mullet and gobies including the endemic goby *Mesogobius nonultimus.* None of these species are protected or of particular ecosystem importance and whilst many have a swim bladder they are not hearing specialists.	Low (other species)
Plankton Community[108]	In general, the phytoplankton and zooplankton communities of the Caspian Sea are typical of those observed in brackish and marine environment with phytoplankton dominated by diatoms and zooplankton dominated by copepods. There are no species of international concern; only of local importance. There is scientific evidence to suggest that seismic airgun sound exposure elicits a response from zooplankton[109,110] with the majority of the literature indicating the extent of impact being no more than 10-100m	Low
Benthic Community	There are no protected or internationally important benthic species but communities do have local importance, and potential food sources for some fish species. However, these organisms are generally lacking specific hearing apparatus or sound receptors and so largely unaffected by underwater sound. Therefore, benthic invertebrates can absorb change without detriment to populations.	Low

[108] Plankton includes the ichthyoplankton, the eggs and larvae of fish species; this has been evaluated under Fish.

[109] Nedelec S.L., Radford, A.N., Simpson, S.D., Nedelec, B., Lecchini, D., and Mills, S.C. 2014 Anthropogenic noise playback impairs embryonic development and increases mortality in a marine invertebrate. Sci. Rep. 4, 5891. (doi:10.1038/srep05891).

[110] McCauley, R., Day, R.D., Swadling, K.M., Fitzgibbon, Q.P., Watson, R.A., and Semmens, J.M. 2017. Widely used marine seismic survey air gun operations negatively impact zooplankton. Nature Ecol. & Evol. 1: 1-8.

6.3.2.2 Sound Exposure Determination

To evaluate the magnitude of the impact of underwater sound on the biological receptors in the marine environment, an underwater sound study was undertaken (refer to Appendix 6A) based on the proposed survey activities and the proposed energy source specifications as described within Chapter 4 of this ESIA. The propagation of underwater sound was estimated using theoretical sound calculations. The propagated sound levels were compared to the sound threshold criteria to assess the radius from the source where potential injury and behaviour impacts for Caspian seals and fish can occur.

Underwater Sound Modelling

In order to estimate sound source level for the proposed energy source array, a simple propagation model, based on the water depths at the survey area, was used:

$$\text{Transmission Loss} = 15 \log (r) + B\, r + C$$

where B is an attenuation factor that is dependent on water depth and sea bottom conditions, assumed for the purposes of this assessment to be 0, C is a fixed attenuation due to acoustic screening which, in open water will be 0 and r is the distance in metres between the airgun array centre and a given location down-range.

For the sound calculations, a 15 log(r) relationship was used which is considered appropriate for seismic airgun array sound propagating out to several kilometres. This value applies for mid-water depths, half way between the applicability of cylindrical spreading (where 10 log (r)) for shallow-to-mid water depths, and spherical spreading (where 20 log (r)) for deep water depths. Although the definition of deep vs shallow is somewhat dependent on wavelength, Richardson *et al.*[111] suggests that depths <200 m are commonly regarded as "shallow" and >2000 m are commonly regarded as "deep" regardless of source wavelength. Depths in the Study Area range from 100 to 800 m and so a mid-point between cylindrical and geometric spreading is appropriate.

The purpose of the calculations was to estimate the distance from the energy source at which sound levels would decrease to below each of the relevant sound threshold criteria and hence the distance within which the potential acoustic effects to fish and seals may occur if they were present within this distance.

The energy source is estimated to have a far-field peak-to-peak source sound level of 260.8 $dB_{peak\text{-}peak}$ re 1 µPa-m, equivalent to 255 dB_{peak} re 1 µPa-m. The distances at which the sound levels would be below the thresholds were modelled and are shown in Table 6.5 and Table 6.7 below. Detailed results of the calculations are presented in Appendix 6A.

Sound Threshold Criteria

The responses of larger marine receptors, particularly marine mammals and fish, to underwater sound have been studied and reported within scientific literature over many years with thresholds developed for a number of species and groups of species. Thresholds are usually proposed for different levels of impact ranging from physiological damage to behavioural responses.

Thresholds for physiological damage consider potential permanent and temporary effects on hearing where animals exposed to sufficiently intense sound exhibit an increased hearing threshold (i.e. poorer sensitivity) for some period of time following exposure. This is called a sound-induced threshold shift and the amount of shift is determined by the species activity at the time of hearing the sound, the distance between a sound and species in combination with the amplitude, duration, frequency content, temporal pattern, and energy distribution of sound exposure relative to the hearing sensitivity of the species and background sound levels. Hearing threshold shifts may be permanent (PTS) or temporary (TTS) and thus physiological impacts are generally considered at these two levels:

- **Permanent threshold shift (PTS)** is a permanent, irreversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range above a previously established reference level. Available data from humans and other terrestrial mammals indicate that a 40 dB threshold shift approximates PTS onset[112]. Permanent threshold shift (PTS) is considered to be auditory injury.

[111] Richardson W. J., Green Jr, C. R., Malme C. I., Thomson, D. H., (1995), Marine Mammals and Noise. Academic Press, New York.

- **Temporary threshold shift (TTS)** is a temporary, reversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range above a previously established reference level. Based on data from cetacean TTS studies[112], a TTS of 6 dB is considered the minimum threshold shift clearly larger than any natural variation in an animal's normal hearing.

Behavioural reactions to acoustic exposure are generally more variable, context-dependent, and less predictable than effects of noise exposure on hearing or physiology. In particular, determining behavioural reactions to the multiple pulses of seismic surveys is particularly difficult and the available threshold from Southall 2007 relates to a single pulse instead.

Thresholds for Seals

Thresholds have been developed for both the onset of PTS and TTS in seals (based on data for the northern elephant seal and harbour seal)[112]. A recent study[113] based on the underwater hearing ability of two captive spotted seals suggested that their hearing ability was similar to harbour seals, and lower than other Arctic species tested (i.e., harp and ringed seals). This suggests that harbour seals are an appropriate model for the impact of underwater sound for other ice seals, such as the Caspian seal, for which no specific sound thresholds exist.

With regard to behavioural reactions, indicative thresholds have been developed for seals based on a very small number of studies of ringed, spotted and bearded seals. The thresholds relate to the onset of avoidance behaviour, limited disturbance and low level disturbance in seals due to impulsive sound[112].

Table 6.5 presents the impact thresholds for Caspian seals that have been adopted for the purpose of this impact assessment.

Table 6.5: Acoustic Impact Thresholds for Caspian Seals Adopted

Threshold level	Effect	Study
218 dB re 1 µPa Peak OR 186 dB re.1µPa^{2}s SEL[114] M-Weighted	Onset of Permanent Threshold Shift (PTS)	Southall *et al.* (2007) Dual criteria – applicable for multiple pulses
212 dB re 1 µPa Peak OR 171 dB re.1µPa^{2}s SEL M-Weighted	Onset of Temporary Threshold Shift (TTS) also indicating significant behavioural disturbance.	Southall *et al.* (2007) For TTS, dual criteria – applicable for multiple pulses
190 dB re 1 µPa RMS	Avoidance behaviour in pinnipeds exposed to impulsive sounds	Southall *et al.* (2007) For disturbance, dual criteria – applicable for single pulses
150-180 dB re 1 µPa RMS	Limited disturbance expected in pinnipeds exposed to impulsive sounds	

[112] Southall, B.L., Bowles, A.E., Ellison W.T., Finneran J.J., Gentry, R.J., Greene Jr, C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, J.W., Thomas, J.A, and Tyack P.L. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals, Vol 33, 411–522.
[113] Sills, J.M., Southall, B.L. and Reichmuth, C. 2014. Amphibious hearing in ringed seals (Pusa hispida): underwater audiograms, aerial audiograms and critical ratio measurements. The Journal of Experimental Biology. Vol 217, 726-734.
[114] Sound Exposure Level: SEL is the Logarithmic measure of the A-weighted Sound Pressure Level squared and integrated over a stated period of time or event, relative to a reference sound pressure value. The units are the decibel (dBA).

Thresholds for Fish

There is limited data on the impact of seismic sound sources in relation to injury in fish and so the currently available injury guidelines for fish are based on predictions derived from the effects of other impulsive sounds.[115,116].

The PTS thresholds for fish have been developed based on the following fish hearing categories[115]:

- High hearing sensitivity fish, particularly herring and related species (Clupeidae), use the swim bladder (comprising a gas filled organ) in hearing;
- Medium sensitivity fish including sturgeon have a swim bladder but it is not used in hearing; fish eggs and larvae are included in this category; and
- Low sensitivity fish, particularly sharks and rays, do not have any gas filled organs.

TTS has been demonstrated in some fish but there are high levels of variability in the duration and magnitude of the shift depending on many factors, including the intensity and duration of sound exposure, the species and life stage of fish[115]. TTS thresholds for all fish (regardless of hearing ability) are based on a number of studies including the exposure of several riverine species to a seismic airgun array[115].

There are no definitive thresholds for fish behavioural changes but TTS can be used as an estimate of the point at which a significant behavioural response would be expected[112].

Table 6.6 presents the impact thresholds for fish that have been adopted for the purpose of this impact assessment.

Table 6.6: Adopted Frequency Spectrum Sound Metrics for Fish

Threshold level	Effect	Study
213 dB re 1 µPa Peak OR 219 dB re 1 µPa^2 s SEL	Potential mortal injury in fish with low hearing sensitivity exposed to seismic sound	Popper *et al.* (2014)
207 dB re 1 µPa Peak OR 210 dB re 1 µPa^2 s SEL	Potential mortal injury in fish with medium hearing sensitivity exposed to seismic sound & Potential mortal injury in fish eggs and larvae exposed to seismic sound	Popper *et al.* (2014)
207 dB re 1 µPa Peak OR 207 dB re 1 µPa^2 s SEL	Potential mortal injury in fish with high hearing sensitivity exposed to seismic sound	Popper *et al.* (2014)
213 dB re 1 µPa Peak OR 216 dB re 1 µPa^2 s SEL	Recoverable injury in fish with low hearing sensitivity exposed to seismic sound	Popper *et al.* (2014)
203 dB re 1 µPa Peak OR 207 dB re 1 µPa^2 s SEL	Recoverable injury in fish with high or medium hearing sensitivity exposed to seismic sound	Popper *et al.* (2014)
186 dB re 1 µPa^2 s SEL	TTS in all fish exposed to seismic sound	Popper *et al.* (2014)

Thresholds for Plankton and Benthic Communities

There are no thresholds for benthic invertebrates and most plankton because they have generally been considered to be insensitive or, in the case of plankton affected only on a very localised basis, to underwater sound. Although there has been some recent research in this area it is limited but can be used to make some judgements regarding likely impacts.

[115] Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D., Bartol, S., Carlson, T., Coombs, S., Ellison, W.T., Gentry, R., Halvorsen, M.B., Løkkeborg, S., Rogers, P., Southall, B.L., Zeddies, D. and Tavolga, W.N. 2014. ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Springer and ASA Press, Cham, Switzerland.

[116] Fisheries Hydroacoustic Working Group (FHWG), 2008. US National Marine Fisheries Service interim criteria for pile driving.

There are however, proposed thresholds for potential mortal injury in fish eggs and larvae, as set out within Table 6.6 above.

6.3.2.3 Caspian Seal Impact Magnitude and Impact Significance

A summary of the sound modelling results obtained from the underwater sound modelling study relating to Caspian Seals are provided within Table 6.7 below.

Table 6.7: Distance from Seismic Sound Source Where Sound Levels Are Predicted to be Below Relevant Thresholds (Caspian Seals)

Response	SEL	SPL_{rms}	SPL_{peak}
Onset of Permanent Threshold Shift (PTS)	290m	-	680m
Onset of Temporary Threshold Shift (TTS) also indicating significant behavioural disturbance.	690m	-	6,800m
Avoidance behaviour in pinnipeds exposed to impulsive sounds	-	2,800m	-
Limited disturbance expected in pinnipeds exposed to impulsive sounds	-	>12,000m	-

The results show that the estimated distance at which the onset of PTS occurs is 680 m from the sound source. The soft-start observation zone for this survey has been extended beyond the usual 500m to 700 m. Thus, taking into account this observation zone, the deployment of the soft-start procedure and the slow movement of the survey vessel the likelihood of injury to seals is considered to be low.

For TTS and/or significant behavioural disturbance the sound modelling estimates threshold levels could occur as far away as between 2.8 and 6.8 km, and that limited behavioural disturbance could take place over 12 km away. While these distances are estimated based on operation of the source array at full power and do not account of the movement of either the vessel or the seal, behavioural disturbance is likely to occur if any seals are present a few kilometres in the vicinity of the seismic vessel.

The Caspian seal is an intelligent animal and known to move away from disturbance or sound. Seals dive to feed on fish and may be vulnerable during feeding. Recent telemetry research shows that although Caspian seals can dive to depths greater than 200 m, with a maximum observed duration over 20 minutes, most dives (80%) were shallower than 15 m and shorter than 5 minutes[117]. Thus, most seals undertaking foraging dives in the vicinity of the seismic vessel will be able to rapidly return to the surface or move away from the survey vessel. As stated above for PTS, the soft-start and slow movement of the vessel will ensure the sound levels increase only slowly and seals can avoid the area. Thus, although there is likely to be some behavioural disturbance, it has been shown that seals utilise a wide area for migration and can easily move if necessary. Seals are likely to be foraging where high abundance of fish will be found and fish are also expected likely to move away from the sound source, thus reducing the potential for seals to be present in the close vicinity of the sound source to feed.

In the spring however, seals are likely to be at their most vulnerable as they have depleted fat reserves after the breeding season on the northern ice and need to use energy to forage and replenish their fat stores. The seals are still likely to move away from the sound source but there will be a higher energetic effort involved in doing so at a time when foraging success is particularly important.

The magnitude of the impact of underwater sound is therefore dependant on the season, and the likely presence of seals in the area, when the survey takes place. The magnitude for the seasons is as follows:

- Spring (Mar - May): period when seals, at their most vulnerable, are expected to be migrating through the Study Area. Even taking into account the existing control measures (e.g. soft start procedure), impacts may affect a portion of the population, resulting in changes that exceed natural variation (e.g. possible changes to migration routes). Potential impact is considered to be of **moderate** magnitude.
- Summer (Jun - Sep): period when seals may be present foraging in the area (peaking in July when peak numbers of kilka are expected to be present in the Central Caspian). During this period they will be easily able to respond and move away from the source to other nearby feeding areas. The area available for foraging is extensive and seals would not use the waters

[117] Dmitrieva L., Jüssi M., Jüssi I., Kasymbekov Y., Verevkin M., Baimukanov M., Wilson S., Simon J. Goodman S.J - Individual variation in seasonal movements and foraging strategies of a land-locked, ice-breeding pinniped. Marine Ecology Progress Series 554: 241-256 (2016)

of the Study Area exclusively. It is important to note that present fish will move away from the sound source and the seals typically follow the fish (refer to Section 6.3.2.5 below). On the basis of the likely limited presence of the seals within the area of impact and taking into account the soft start procedure, the potential magnitude of impact in the summer months is considered to be of **low** to **negligible** magnitude.

- Autumn (Oct-Dec): period when seals are migrating towards the winter breeding grounds and so behavioural responses may be more constrained than in the summer months by the motivation to move northwards. However, seals have spent the summer feeding and should be in good condition[118] . Also, seals have been seen to move away, and haul out where possible, in response to the presence of the seismic vessel. On the basis of the soft-start and the expectation that seals will move away from the sound source, the potential impact magnitude is considered to be **low** magnitude.
- Winter (Jan – Feb) – in winter there are very few seals expected to be in the Central Caspian Sea as such the magnitude of the impact is considered be of **negligible**.

Taking into account receptor sensitivity (assessed as **high** for Caspian Seals) and the anticipated potential magnitude of impacts per season, the significance of potential impacts is assessed as:

- Spring (Mar-Apr): High
- Summer (mid-May - Sept): Low to Moderate
- Autumn (Oct-Dec): Moderate
- Winter (Jan – Feb): Low

6.3.2.4 Caspian Seal Residual Impact Significance after Mitigation and Monitoring

In accordance with the impact assessment methodology where impacts are assessed as being of moderate or high significance, additional mitigation measures are required to reduce the impact.

To mitigate high impact significance during the sensitive spring migration period BP proposes to commence seismic survey in mid 2019. No other additional mitigation are proposed, leaving significance of residual impacts **low** to **moderate,** however the following monitoring and reporting activities will be undertaken to ensure existing measures are fully implemented:

- In addition to the monitoring and recording Caspian seals as part of the soft start procedure, the trained vessel crew will endeavour to record Caspian seal sightings at other times as far as practicably possible;
- Daily logs of Caspian Seal sightings will be completed by the trained vessel crew using the relevant marine mammal forms in line with JNCC guidelines; and
- A final report summarising the Caspian seal observations over the duration of the survey and including all the daily log forms will be submitted to BP upon completion of the survey.

6.3.2.5 Fish Impact Magnitude and Impact Significance

A summary of the sound modelling results obtained from the underwater sound calculation study relating to fish are provided within Table 6.8 below.

Table 6.8: Distance from Source Array Where Sound Levels Are Predicted to be Below Relevant Thresholds (Fish)

Fish Hearing Group	Potential Mortal Injury Threshold (m)		Onset of Recoverable Injury (m)		Onset of TTS (m)
	SEL	SPL	SEL	SPL	SEL
High hearing sensitivity	40	1500	40	2800	1000
Medium hearing sensitivity	25	1500	40	2800	
Low hearing sensitivity	7	680	10	680	

[118] Confirmed by recent observations in Oct-Nov 2016; pers.comm. T.Eybatov (6th December 2016)

The table shows that for low hearing sensitivity fish species, sound levels decrease to below thresholds associated with potential mortal injury and recoverable injury beyond 680m of the source array. For medium or high hearing sensitivity fish this extends to 1500m for permanent injury and 2,800m for temporary injury. These mortality and recoverable injury guidelines for fish are based on predictions derived from effects of impulsive sounds (piling), since there are no quantified data for seismic airguns. Therefore, the results should be considered indicative distance guidelines rather than an exact point at which injury may occur.

There are few studies regarding the specific effects of seismic airguns on fish mortality and damage to organ systems but a few studies have indicated that fish with swim bladders, which includes the sturgeon, kilka, mullet and some goby species, have not shown mortality (Popper et al. 2007; Hastings et al. 2008; McCauley and Kent, 2012).

Therefore, as there will be a soft-start before any survey operations begin and the seismic vessel moves slowly there is significant prior warning of increasing sound levels and any fish in the vicinity can move away before any harm occurs. Where spawning occurs the motivation to move away may be reduced but this is only likely in species that exhibit very strong habitat fidelity. There are two kilka species (the anchovy and big-eyed kilka), that may be spawning and migrating in the Study Area in the period April to August (peak period July) and two mullet species (*Lisa auratus* and *L. saliens*) that may be present in the period June to September. Kilka are hearing 'specialists' where the swim bladder is used in hearing as well as being important for buoyancy and so the distance at which they may respond is more extensive. However, there is no particular spawning site fidelity observed in any of these fish and the suitable area for both migration and spawning is extensive. Thus, all fish species likely to be in the Study Area are able to move away from the sound source before any injury is likely to occur.

The TTS threshold, a criterion that applies to all hearing groups of fish, estimates impacts as far as 1000 m away from the sound source. These guidelines for TTS are based upon data from Popper et al. (2005) for exposure of several riverine species, with swim bladders, to a seismic airgun array. The species showed TTS after exposure but in all cases normal hearing levels were restored within 18-24 hours. Thus, some TTS may occur in fish with swim bladders that remain in the vicinity of the survey vessel though there are no species that cannot move away. TTS is also considered the point at which receptors are likely to demonstrate a strong behavioural response.

Sturgeon species may be present in the survey area at particular times of the year, most especially during migration in the spring and autumn, to and from spawning grounds in rivers in the southern Caspian. They are reported to migrate in water depths between 50 and 100 m. As the survey is largely in water depths greater than 100m there is only a small region of the survey area where sturgeon may pass within the range of the propagated sound. Since the migration route covers a large depth range, any sturgeon within the range of the underwater sound will be able to sense this and easily move to other areas. These species have a swim bladder but as it is not involved in hearing they are included in the medium sensitivity group of fish. Also, as sturgeon is migrating they will have a strong motivation to travel towards their spawning grounds; any impact is likely to be very short-lived, recoverable. Thus, the magnitude of the impact of underwater sound on sturgeon is considered to be **negligible**.

A number of studies have demonstrated that exposure to seismic airguns can have an impact on fish catch, presumably as a result of changes in fish behaviour and distribution during and after sound exposure (Popper et al., 2014). In some studies it was apparent that some species moved into deeper water during seismic activity, as well as moving away geographically and that catch rates returned to normal once the seismic survey stopped. However, this impact on catch rates has not been observed in all studies. For example, in one study no impact was observed on herring behaviour[119]. The unexpected lack of a response to the seismic survey was interpreted as a combination of a strong motivation for feeding by the fish, a lack of suddenness of the seismic sound source stimulus, and an increased level of tolerance to sound from the source array.

These results show that behavioural responses in fish are likely to be context specific and where strong habitat fidelity exists, for feeding or spawning for example, there may be no response. The fish likely to be present in the area can be divided into those that are migrating and spawning and those that are non-migratory or resident. The migrating and/or spawning fish include kilka and mullet that use the deep waters (200-700m) of the central Caspian Sea. Kilka are believed to spawn in central and eastern areas and mullet in all deep water areas of the central sea. Gobies are resident all over the Caspian Sea and

[119] Peña H, Handegard NO, Ona E (2013) Feeding herring schools do not react to seismic airgun surveys. ICES J of Marine Science. doi: 10.1093/icesjms/fst079

are expected to have the capability to move freely between different areas. Thus, none of the fish species that could occur in the Study Area exhibit strong fidelity to the region and would move away from sound impacts.

Although the seismic survey may take up to six months to complete, subjecting a large area to varying but repeated levels of sound, it is expected most fish will have the capacity to move away and find other suitable areas for feeding, migrating and spawning. Therefore, the magnitude of the impact of underwater sound on kilka, mullet, gobies and any other occurring fish species is considered to be **low**.

The presence of fish eggs and larvae will occur in the waters of the Study Area and as they have very limited mobility they may occur within close proximity of the energy source. Damage caused to eggs and larvae from seismic surveys has generally been found to be limited to the proximity of a sound source (Popper, 2012[120]). For example, in a study by Turnpenny & Nedwell (1994[121]) examination of the effects of seismic sound on ichthyoplankton indicated that injury and mortality is only likely to occur at sound levels in excess of 230 dB re 1µPa @ 1 m, with egg injury rates recorded at 7.8 percent for fish species (anchovy). In another study Booman (1996[122]) investigated the impact of seismic sound on eggs, larvae and juveniles (fry) of clupeidae species (which are the most sensitive hearing specialists and includes kilka), cod and flatfish species, found that mortality occurred within 5 m from the airguns with the most substantial effects within 1.4 m for peak sound pressure levels of 220 to 242 dB re 1 µPa @ 1 m. The estimated mortality was less than 1% of the total larvae population.

There is therefore the potential for some fish eggs and larvae to be killed or damaged by the energy source, but only those that are within proximity to the source. However, plankton are widely distributed in the water column and since impacts are only expected within a few metres of the sound source the extent of the impact, in terms of numbers is expected to be very low and below levels at which there could be population reproduction effects. The impact is therefore considered to be of **low** magnitude for fish eggs and larvae.

Taking into account receptor sensitivity and the anticipated potential magnitude of impacts, the significance of potential impacts to fish (Sturgeon, Kilka, Mullet, gobies and other fish species) is assessed as **Low.**

6.3.2.6 Plankton Impact Magnitude and Impact Significance

Plankton is distributed throughout the water column and has limited mobility, thus unable to move away from a potentially harmful sound source. Recently, new scientific data has suggested that seismic airgun sound exposure causes mortality and / or displacement in zooplankton populations within approximately 1km of an energy source[110]. This single study is in contrast to a number of published studies that found no evidence of effects on plankton at ranges greater than 10-100m[122 123 124 125 126]. It can be concluded therefore that the existing scientific literature suggests that airgun sound exposure does elicit a response from zooplankton with the majority of the literature indicating the extent of impact being very localised.

There are a few, mostly laboratory based studies, of the effect of underwater sound on the early life stages of invertebrates and fish. For example, experiments conducted on the early life stages of Dungeness crabs (Pearson et al., 1994) observed damage to be limited to the proximity of the sound source and a reduction in survival of less than 10% for the larvae was reported. In a similar experiment (Aguilar de Soto et al., 2013) it was observed that seismic pulses during larval development caused

[120] Popper, A.N. 2012. Fish Hearing and Sensitivity to Acoustic Impacts. Appendix J. Atlantic OCS proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas, Draft Programmatic Environmental Impact Statement. OCS EIS/EA BOEM 2012-005. March 2012. 2 vols. Available from http://www.cbd.int

[121] Turnpenny, A.W.H., and Nedwell, J.R. 1994. The Effects on Marine Fish, Diving Mammals and Birds of Underwater Sound Generated by Seismic Surveys: Consultancy Report. Fawley Aquatic Research Laboratories.

[122] Booman, C., Dalen, J., Leivestad, H., Levsen, A., van der Meeren, T. og Toklum, K. 1996. Effekter av luftkanonskyting på egg, larver og yngel. Undersøkelser ved Havforskningsinstituttet og Zoologisk Laboratorium, UiB. (Engelsk sammendrag og figurtekster). Havforskningsinstituttet, Bergen. Fisken og Havet, nr. 3 (1996). 83 s.

[123] Dalen, J. and G.M. Knutsen. 1987. Scaring effects in fish and harmful effects on eggs, larvae and fry by offshore seismic explorations. In: Merklinger, H.M., ed. Progress in underwater acoustics. London: Plenum Press. Pp. 93-102.

[124] Kostyuchenko, L. P. 1971. Effects of elastic waves generated in marine seismic prospecting on fish eggs in the Black Sea. Hydrobiol. J. 9, 45-48.

[125] McCauley, R.D. *et al*. 2008. Impacts of seismic survey pass-bys on fish and zooplankton, Scott Reef Lagoon, Western Australia: Full report of Curtin University findings. Center for Marine Science and Technology, Curtin University, Perth WA. 92 pp. CMST Report 2008-32.

[126] Payne, J. F. 2004. Potential Effect of Seismic Surveys on Fish Eggs, Larvae and Zooplankton. Canadian Science Advisory Secretariat (CSAS/CSSC), Fisheries and Oceans Canada. ISSN 1499-3848. http://www.dfo-mpo.gc.ca/csas/. 16 pp.

developmental delays and in 46%, body malformations in scallops, potentially affecting recruitment of wild scallop larvae. Przwsalwski *et al* (2017) reviewed seven years of bivalve harvest data located within sites of seismic surveying and found no effect on abundance or catch rate[127].

Any impact of seismic sound is only likely to occur within metres of the source and since plankton are generally distributed through the water column only a fraction of any population may be involved. In addition, the impacts would only exist at the population level for a short period of time (days and months) due to their high reproduction rate and current circulation. Thus, the magnitude of the impact for plankton (excluding fish eggs and larvae which are discussed in the fish section) is expected to be **low.**

Taking into account receptor sensitivity (excluding fish eggs and larvae) and the anticipated potential magnitude of impacts, the significance of potential impacts to plankton is assessed as being **Low.**

6.3.2.7 Benthos Impact Magnitude and Impact Significance

The sensitivity of marine invertebrates to active acoustic sound sources has not been well studied to-date, probably because most lack the sensory organs that can perceive sound pressure. There is therefore very limited data on impacts and no threshold criteria are available. However, many species have tactile hairs or limited sensory organs that may be sensitive to underwater sound and there are a small number of studies indicating there is some potential for injury in adult or developmental stages of individual invertebrates but only if they are present in very close proximity to an operating source array (McCauley et al. 200128). Crustaceans, for example, are believed to detect the particle motion component of sound (Lovell, 2005) and the prevalence of sounds from aquatic crustaceans suggests that sounds are important for communication between individuals (Spiga et al., 2012[129]). It is estimated that many invertebrates are likely to perceive sound at very close range from the seismic sound source (up to 20 m) via mechano-receptors (Hirst and Rodhouse, 2000[130]; McCauley, 1994[131]).

With the water depth of the survey area being over 100m, the benthic invertebrates are highly unlikely to respond to the seismic sound source and so the magnitude of the impact on benthic communities is considered to be **negligible**.

Taking into account receptor sensitivity and the anticipated potential magnitude of impacts, the significance of potential impacts to benthic communities is assessed as being **not significant.**

6.4 Planned Marine Discharges

6.4.1 Existing Design Controls

The discharges into the marine environment will be in conformity with the national and international requirements, including those promulgated by The Framework Convention for the Protection of the Marine Environment of the Caspian Sea and the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78 (as amended)). Food waste will not be discharged offshore.

Project vessels will be equipped with an IMO certified sewage treatment system and effluent composition will be regularly monitored against the established discharge criteria.

Ballast water intake will be from the Caspian Sea and will not represent a risk of introducing invasive species.

[127] R. Przeslawski, B. Bruce, A. Carroll, J. Anderson, R. Bradford, M. Brock, A. Durrant, M. Edmunds, S. Foster, Z. Huang, L. Hurt, M. Lansdell, K. Lee, C. Lees, P. Nichols, S. Williams. Marine Seismic Survey Impacts on Fish and Invertebrates: Final Report for the Gippsland Marine Environmental Monitoring Project Geoscience Australia, Canberra (2017)
[128] McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner; M.N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J. and McCabe, K. 2000. Marine seismic surveys: Analysis and propogation of air-gun signals; and effect of air-gun exposure on humpback whales, sea turtles, fishes, and squid. In “Environmental implications of offshore oil and gas development in Australia: further research.” (APPEA Secretriat.) Pp. 364–521. (Australian Petroleum production and exploration Association Limited: Canberra.) Myrberg Jr, A. A. 2001. The acoustical biology of elasmobranchs. Environmental Biology of Fishes, 60(1-3), 31-46.
[129] Spiga, I, Cheesman, S, Hawkins, A, Perez-Dominguez, R, Roberts, L, Hughes, D, Elliott, M, Nedwell, J, Bentley, M (2012). Understanding the Scale and Impacts of Anthropogenic Noise upon Fish and Invertebrates in the Marine Environment. SoundWaves Consortium Technical Review (ME5205).
[130] Hirst. A.G. & Rodhouse, P.G. 2000. Impacts of geophysical seismic surveying on fishing success. Reviews in Fish Biology and Fisheries. 10, 113-118.
[131] McCauley, R. D. "Seismic Surveys//Environmental implications of offshore oil and gas development in Australia." Sydney: Australian Petroleum Exploration Association (1994): 23-118.

6.4.2 Impact Assessment

6.4.2.1 Receptor Sensitivity

The sensitivity of the identified receptors that can be affected by marine discharges is summarised in Table 6.9

Table 6.9: Receptor Sensitivity

Receptor	Explanation	Sensitivity
Water Quality	Water quality in the central Caspian is reported to be good with low levels of inorganic nutrients, hydrocarbons and metals and no indication of reduced oxygen content (BP AIOC, 2012[132]; AETC, 2011[133]; BP AIOC, 2012a[134]). There is therefore, some capacity to absorb small inputs of nutrients and other discharges without detectable changes in regional water quality.	Low
Fish	There are fish species of international importance that may be present in the Study Area. Fish can be sensitive to water quality, particularly factors such as oxygen concentration and pollutants.	High
Plankton	There are no phytoplankton and zooplankton species of international concern and are of local importance only. Phytoplankton communities in particular will respond to water quality changes, including increasing growth rates in response to an increase in organic nutrients or reduced growth with increased turbidity. However, these communities are widespread and rapidly reproducing so can recover rapidly from any detrimental impacts.	Low

6.4.2.2 Impact Magnitude and Significance

Planned marine discharges (sewage; grey water, and ballast waters) have the potential to impact water quality and pollute the marine environment. Direct impacts from the controlled discharges may include localised nutrient enrichment, and low level pollution from trace residual chemicals.

All discharges into the marine environment will be in conformity with national regulatory requirements and MARPOL 73/78 Regulations, including sewage treatment in IMO certified treatment plant. Ballast waters are not expected to have any detrimental impact on the local ecosystem considering that project vessels operate solely within the Caspian Sea thus minimising the risk of introducing invasive species to the water column.

During the proposed survey programme, volumes and rates of effluent discharges will be limited and temporary in nature and will have a short-term localised impact on water quality, plankton and fish species. The magnitude of the potential impact from marine discharges is anticipated to be **negligible,** and the resultant impact significance will be either **low** or **not significant.**

6.5 Survey Activities (Excluding the Operation of the Energy Source)

6.5.1 Existing Design Controls

The Project features a variety of design measures in place to mitigate impacts from the physical presence of vessels and survey equipment.

Design controls relevant to Shipping and Navigation include:

- Notifications regarding the survey programme will be issued to the relevant maritime and port authorities, as well as directly communicated with sea users where necessary, in advance of survey commencing;

[132] BP AIOC, 2012. ACG Regional Survey 2012 – Interpretative report
[133] AETC, 2011 - Environmental Impact Assessment for the East Azeri 4D Seismic Survey
[134] BP AIOC, 2012a. ACG Regional and Pipeline Water and Plankton Survey 2012 – Interpretative report

- All vessels will operate in compliance with national and international maritime regulations for avoiding collisions at sea, including the use of signals and lights;
- Advanced positioning equipment will provide accurate information on the position of the survey vessel and associated equipment, which will be communicated to other vessels e.g. AIS, Navigation Warnings, etc. Safety exclusion zone will be maintained around seismic vessels to minimise the risk of collision;
- Logistical planning to optimise vessel trips to Baku ports; and
- Support vessels will be present throughout the Project duration. These will be responsible for keeping the seismic vessel and equipment safe from hazards such as other vessels and manmade obstructions along the survey lines. Support vessels will provide additional safety cover to the survey vessel and can assist in the event of an emergency, whether health and safety or environmental.

Design controls relevant to Caspian seals include:

- Project vessels will not intentionally approach Caspian seals for the purposes of casual viewing;
- Trained vessel crew members will undertake Caspian seal observations during the soft start period (described in Section 4.7.2 in Chapter 4) and where feasible at other times during the seismic acquisition; and
- Project vessels will take the necessary action to avoid the imminent risk of collision with a seal, unless doing so poses an unacceptable risk to the vessel and the crew.

6.5.2 Impact Assessment

6.5.2.1 Receptor Sensitivity

The sensitivity of the identified receptors that can be affected by planned survey activities is summarised in Table 6.10

Table 6.10: Receptor Sensitivity

Receptor	Explanation	Sensitivity
Shipping and Navigation	International shipping involves transit of various goods and materials to and from Azerbaijan and between other Caspian nations and further afield via the Don-Volga or Baltic-Volga canal and river systems (although these routes are not open during winter). There are at least four shipping routes passing through the Project Area. International shipping is of high importance to worldwide users, and ships are typically large with somewhat restricted manoeuvrability and of limited ability to adapt to change (i.e. an introduced seismic exclusion zone). National and regional shipping typically comprises vessels with increased manoeuvrability and more adaptable to changes.	High (International shipping) Low (national shipping)
Caspian seal	Caspian seals are of international conservation importance, listed as Endangered on the IUCN Red List.	High

6.5.2.2 Impact Magnitude and Significance

As described within Chapter 4 Section 4.4, it is anticipated that the seismic survey will be conducted for a maximum duration of 6 months. The survey vessel will travel along pre-determined lines at an approximate speed of 4 to 5 knots per hour (7.4 – 9.3 km/hr) on a 24-hour basis. The survey vessel will be equipped with six streamers (4 to 6km length) which will be towed behind the vessel. The survey vessel will be accompanied by up to two support vessels. The support vessels will undertake a number of activities including enforcing a safety exclusion zone around the survey vessel and the streamer. Due to its restricted manoeuvrability, the survey vessel will be given priority over vessels that are not similarly restricted under maritime regulations.

The survey vessel and streamer will be continuously moving and not present in an area for any significant period of time. The survey programme, including timing and locations, will be communicated to all maritime users and vessels prior to commencement and during the survey. It is therefore anticipated that the effect of the survey on shipping would be limited to intermittent short periods of time.

It is considered unlikely that survey activities would result in concerns being raised by stakeholders or governmental bodies. The impact magnitude for the physical presence of the survey and support vessels and equipment is considered to be of **low** magnitude**.**

The overall impact significance for international shipping (high sensitivity) is considered to be **moderate** and for regional/national shipping (low sensitivity) **low.**

In accordance with the impact assessment methodology where impacts are assessed as being of moderate or high significance, additional mitigation measures are required to reduce the impact. The measures to be implemented to minimise impacts to international shipping include the following:

- Prior to the seismic survey BP will undertake a Shipping Risk Assessment to assess maritime traffic within and surrounding the D230 Block. The assessment will identify the type of vessels, frequency and the destination; and
- Following the review of the Shipping Risk Assessment it may be deemed necessary to use additional support vessels to enforce the exclusion zone.

Based on the implementation of the mitigation measures presented above, the impact magnitude will be reduced to **negligible**, resulting in residual impact significance for international and regional/national shipping as **low** and **not significant**, respectively.

The D230 Seismic Survey will deploy one survey and at least two support vessels. Vessel movement is unlikely to cause a significant disturbance to seals as they are accustomed to the waters transited by maritime traffic. Caspian seals are also known to avoid the areas of increased underwater sound generated by seismic sources, and therefore unlikely to be present in the vicinity of the seismic vessel. The magnitude of impacts associated with the physical survey presence is therefore considered to be **negligible** and the overall impact significance is assessed as being of **low** significance[135].

[135] The assessment of unplanned events presented in Chapter 8 of this ESIA considers potential for accidental events such as collisions and streamer entanglement.

7 Cumulative Impacts and Accidental Events

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7.1 Introduction

This section of the ESIA presents the assessment of:

- Cumulative impacts that could result from the Block D230 Seismic Survey and other projects activities, which may occur simultaneously, sequentially, or in an interactive manner; and
- Impacts associated with accidental events that could potentially occur during the Block D230 Seismic Survey.

The impact assessment has been prepared in accordance with the impact assessment methodology described within Chapter 3.

7.2 Cumulative Impacts

Cumulative impacts can be defined as the effects on the environment that result from incremental changes caused by other past, present or reasonably foreseeable future activities together with the proposed project. Cumulative impacts can arise from individually minor but collectively significant activities/events, which may occur simultaneously, sequentially, or in an interactive manner.

As outlined in Chapter 3, cumulative impacts can arise from:

- Interactions between separate project-related residual impacts (Intra-project effects); and
- Interactions between project-related residual impacts in combination with impacts from other projects and their associated activities (Inter-project effects).

Due to the nature of the residual impacts from the Block D230 Seismic Survey the potential for synergistic or in-combination interactions which could give rise to significant cumulative intra-project effects on the receiving environment is considered to be unlikely and has been scoped out from this assessment.

In relation to the inter-project cumulative impacts, the only known activities in the vicinity of the Project Area are a number of other seismic surveys that have already occurred or are planned (Table 7.1)[136].

Table 7.1: Details of seismic surveys undertaken or planned during 2015-2019 period.

Offshore Seismic Survey	Operational period	Approximate Data Acquisition area	Approximate Duration (months)
Shah Deniz (SD) 3D Survey	Oct-Nov 2015	475 km^2	1.5
Azeri Chirag Guneshli (ACG) 3D Survey	Jan-Mar 2016	400 km^2	3
ACG 3D Survey	2019	400 km^2	3
ACG Ocean Bottom Seismic Survey	2019	200 km^2	3
Shallow Water Absheron Peninsula (SWAP) 2D Survey	Nov-Dec 2015	1400 km	1.5
SWAP 3D Survey	Jun 2016- Jan 2017	1150 km^2	8

Note: The Contract Areas associated with the above surveys are depicted in Figure 1.1, Chapter 1 of this report.

Using professional judgement and based on the known information relating to the schedule of the other seismic activities described above, the inter-project cumulative effects have been assessed for the following key receptor groups:

- Marine Users; and
- Marine Fauna (Caspian seal and fish).

[136] *Per comms* BP, 2016

The D230 Seismic Survey is planned to be undertaken between 2019 and 2020 with a duration of up to 6 months. The assessment has focused on the 2015-2020 period to account for both historical and potential future disturbance to the marine receptors.

7.2.1 Marine Users

As summarised within Chapter 5 Section 5.4.3 of this ESIA, the Study Area (including survey vessel manoeuvring zone) is predominantly used by national, regional and international vessels transiting along a number of shipping lanes (see Figure 5.12). There are no fishing grounds or other marine users known to be present within 40 km of the proposed survey lines.

Project vessels and equipment will be operating for a period of up to 6 months, including time allowed for mobilisation, downtime, and demobilisation. This period may potentially coincide with the ACG 3D Survey and ACG Ocean Bottom Seismic Survey planned for 2019 (both expected to take approximately 3 months duration each). The ACG Contract Area is located approximately 10 km from the D230 Block and will not be used by the same marine traffic that could be affected by the D230 Seismic Survey activities.

Furthermore, mitigation measures proposed for the D230 Seismic Survey Project (detailed in Section 6.4.3), including a safety exclusion zone enforced around the survey vessel and the towed equipment, (which have limited maneuverability) and continuous communications with marine users and authorities, will ensure no significant cumulative impact on the regional and international shipping would occur.

There will be support vessels associated with the Project infrequently travelling to and from the ports of Baku to refuel and collect supplies. These will add to the general marine traffic but are considered unlikely to cause significant cumulative impact or increased risk of collision for other marine users.

7.2.2 Marine Fauna

Exposing living organisms to individual stressors or a suite of stressors that are associated with a single seismic survey may be insignificant or minor when considered in isolation. However, they may have significant adverse consequences when they are added to other seismic efforts, or operate synergistically in combination with other stressors. Furthermore, disease, dietary stress, age, and reproductive state, among many other phenomena can “accumulate” resulting in cumulative impacts on an organism, or a population, upon subsequent exposure to seismic activities.

Underwater sound is the main stressor associated with the seismic data acquisition and will be generated over the maximum 6 month Project duration. As shown in Table 7.1 the duration of the other surveys planned or undertaken within the Central Caspian between the 2015-2020 period total 20 months. The potential surveys that the D230 Seismic Survey may overlap with temporally are limited to the ACG 3D survey and ACG Ocean Bottom Seismic Survey, although the zones of influence (the area over which impacts may occur) are considered unlikely to overlap considering the distances between the respective contract areas. Whilst sound levels associated with other seismic surveys will vary both spatially and temporally, cumulative impacts due to sound on marine fauna are possible, particularly on moderate to highly sensitive species such as Caspian seal and some fish species.

Assuming 26 months of cumulative seismic survey effort during the 2015-2020 period, the marine environment of the Central Caspian will be affected by various seismic activities for about 43% of the assessment period. These effects will generally be transient in nature and localised in their intensity (sound levels exceeding marine fauna disturbance thresholds being typically limited to a few km around energy sources), with seals and fish (excluding fish larvae) expected to move away and avoid areas of sound disturbance. The anticipated cumulative impacts are unlikely to be more significant than impacts from individual surveys given their spatial and temporal distribution. The D230 Seismic Survey will not take place during the most sensitive for seals spring migration thus precluding possible cumulative impacts during this time. During winter and partially summer period the significance of residual impacts from underwater sound on the marine fauna was assessed as low or not significant for the proposed survey, therefore any in-combination effects with other known surveys are unlikely to be significant. However, given the moderate significance residual impact of the D230 Seismic Survey on seals during the autumn migration period, it is recommended that other seismic surveys being planned in the Central Caspian are scheduled to avoid the months of October and November.

Immobile fish larvae are more susceptible to the effect of seismic sound. Evidence indicates that the loss of fish eggs/larvae due to injury and mortality as a result of sound from seismic surveys is limited to the close proximity of the sound source. These losses would not be statistically significant compared to the overall numbers that are produced within spawning grounds, which are spread over larger areas. Only a few species of fish (low to medium sensitivity) are thought to spawn within the Study Area (see Chapter 5 Section 5.3.7.4). Thus the proposed Project, in combination with other seismic surveys, is unlikely to have a significant cumulative impact on regional fish recruitment and populations during the assessment period.

7.3 Accidental Events

Accidental events are considered separately from routine activities as they only arise as a result of a technical failure, human error, or other types of emergency. High operational performance and compliance with good industry practices will be maintained at all times by BP and the seismic contractors. However, as with most projects of this nature, a low probability of an accidental event does exist.

Potential accidental events that may result in potentially significant environmental impacts during the Block D230 Seismic Survey have been identified and include:

- Vessel collision with other marine users, and Caspian seals;
- Release of chemicals/ waste from the Project vessels; and
- Hydrocarbon spills, including marine diesel oil (MDO[137]) and lube oil used by the Project vessels. A worst case scenario considers a full fuel inventory loss from a survey vessel (maximum 800 tonnes of MDO and 22m^3 of lube oil).

The likelihood of these events occurring, the consequences and mitigation control and response measures designed to minimise event likelihood and impact magnitude, are described in the sections below.

7.3.1 Vessel Collision

The proposed seismic survey lines and the vessel manoeuvring zone are located within the shipping area, through which international, regional and national marine traffic passes regularly. Other marine users such as fishing, oil and gas or other industries are not known to use the Project Area. The survey activities will take place in water depths between 100 and 800 m, hence any possible interference of the seismic equipment with seabed features or infrastructure is unlikely. There is potential for a collision between Project vessels and shipping traffic. However, the risk of a potential collision would be minimised through the implementation of the maritime and navigation safety measures outlined in Chapter 4 Section 4.7.1 and Chapter 6 Section 6.4.3. With preventative measures in place, the potential impacts on other marine users as a result of collision are unlikely to be significant.

Although unlikely, the potential for collision of Caspian seals with the vessels or source arrays cannot be excluded, and may cause injury or a lethal outcome for individual seals. The survey vessel will operate at a slow speed (7.4 – 9.3 km/h) and will have trained observers on board monitoring animal movement during daylight hours. Caspian seals are also expected to avoid areas of increased underwater sound, therefore collision risk is likely to be limited and of low significance for the population.

7.3.2 Release of Chemicals / Waste

A small volume of chemicals for cleaning and maintenance purposes e.g. cleaning fluids, paints etc., will be used on board the survey and support vessels throughout the survey. All chemicals will be stored in sealed containers and in areas with secondary containment. Any waste streams generated during the seismic survey activities will also be stored on board in fit for purpose containment and transferred to shore by support vessels using good industry practices and duty of care procedures. The likelihood of an accidental release of chemicals or waste to the marine environment is considered to be very low given the control mitigation measures are implemented as set out in Section 7.4.3 below. In the unlikely event of loss of containment and release of hazardous substances overboard, the impact significance

[137] MDO is a blend of light and heavy hydrocarbons, with the overall density higher than MGO. Worldwide, marine diesel has a sulphur content between approx. 0.3 and 2.0 m/m %. Due to recent EU legislation (Directive 2005/33/EC amending Directive 1999/32/EC), the sale of marine diesel oil with a sulphur content above 1.5 m/m % within the EU is prohibited as of August 11, 2006)

is expected to be low due to the limited volume of any substances released and their localised impact. Where loss of high risk hazardous chemicals and waste occurs, salvage operations will be organised promptly (no later than 24 hours after the reported accident) to minimise potential toxic effects on the marine biota.

7.3.3 Hydrocarbon Spills

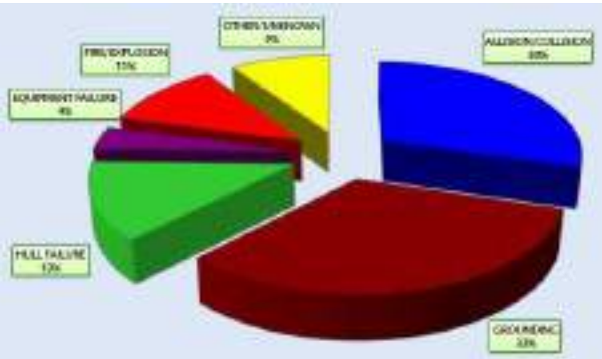
Potential accidental discharges of hydrocarbons that may lead to pollution of the marine environment during the proposed D230 Seismic Survey programme include spills during refuelling, equipment maintenance, vessel collision, fuel tank failure, fire or explosion. The resulting potential discharges can be broadly categorised as follows:

- Major (large) spill of marine diesel from the survey vessel.
- Minor spillages of fuel, lube/maintenance oils, and streamer fluid.

The probability of a large fuel spill is remote. The size of typical hydrocarbon spills reported during similar exploration activities are in the range of 50 litres[138]. Analysis of water transport accident statistics by the International Association of Oil & Gas Producers[139] shows that ship to ship collisions represent only 12% of total ship losses and that the likelihood of this occurring is extremely low.

According to the International Tanker Owners Pollution Federation (ITOPF)[140] statistics the main causes of major spills are allisions[141]/collisions (30%) and groundings (33%). Other significant causes include hull failures and fire/explosion (Figure 7.1).

Figure 7.1: Causes of Large Oil Spills (700m^3), 1970-2013 (ITOFP, 2014/2015)



A quantitative oil spill risk assessment was performed based on modelling worst case scenario releases of the full fuel and lube oil inventories from the survey vessel (800 tonnes and 22 m^3, respectively), which are discussed below. In reality this is considered unlikely as fuel is typically stored in a series of smaller tanks which are double bottomed and connected by valves and it is unlikely that contents of all the tanks would be lost simultaneously. Furthermore, the hull of the survey vessel is double skinned.

7.3.3.1 Minor Spillages

Minor hydrocarbon spills may occur as a result of leaking hydraulic hoses, equipment, storage containers, or spillages during refuelling. The vessels will carry relatively small volumes of lube oil and hydraulic fluids. Modelling of an instantaneous release of full engine lube oil inventory from a survey vessel (22m^3) showed that no shoreline oiling or significant surface oiling occurring despite persistence of heavy hydrocarbons such as lube oil in the environment (see Appendix 7A). Given the implementation of the preventative and mitigation measures set out in Section 7.4.3, the impacts from minor spills are not expected to be significant as they would disperse and biodegrade in the marine environment relatively quickly.

[138] Oil and Gas UK. http://www.oilandgasuk.co.uk/ Accessed in October 2016.
[139] International Association of Oil & Gas Producers (OGP), 2010. Water Transport Accident Statistics, Risk Assessment Data Directory, Report No. 434 – 10.
[140] The International Tanker Owners Pollution Federation (ITOPF) Handbook, 2014/15.
[141] Defined as when a moving objects collides with a stationary object

The streamers to be used during the seismic programme may be both fluid filled (i.e. Isopar M, a mixture of light petroleum distillates, predominantly C2 - C5 iso-paraffinic hydrocarbons similar to kerosene) and/or a 'solid' type with foam or gel filling for buoyancy. The release of a fluid from a ruptured /damaged streamer will be limited because streamer cables are subdivided into approximately 100 m self-contained cells/sections. Thus, when one section is damaged others remain intact. Each cell would typically hold 1-5 m^3 of fluid. It is highly unlikely for a whole streamer to be lost, even in the event of collision of the streamer with another vessel, due to the configuration and design of fluid streamers. The use of solid streamers eliminates the risk of a fluid leak altogether. Therefore, no significant impact on the marine environment is expected from the streamers' fluid.

7.3.3.2 Major Marine Diesel Spill

Fate of Marine Diesel in the Marine Environment

The key processes that govern the fate of hydrocarbons at sea are shown in Figure 7.2. When oil is released into the marine environment it undergoes a number of physical and chemical changes as a result of evaporation, dissolution, dispersion, emulsification, sedimentation, photo-oxidation and bio-degradation processes, collectively known as weathering. These changes are dependent upon the type and volume of oil spilt and the prevailing weather and sea conditions.

Diesel fuel is a light, refined petroleum product, and what is commonly referred to as "marine diesel" is a blend of gasoil and heavy fuel oil with a low viscosity (up to 12 centistokes (cSt)/400 C). When spilled on water, diesel fuel spreads very quickly to a thin film of rainbow and silver sheens, whereas marine diesel may form a thicker film of dull or dark colours and persist on the surface for longer.

Evaporation and dispersion are the two main mechanisms that act to remove diesel type fuels from the sea surface, whilst oxidation and biodegradation break down hydrocarbons into basic elements over a longer time period.

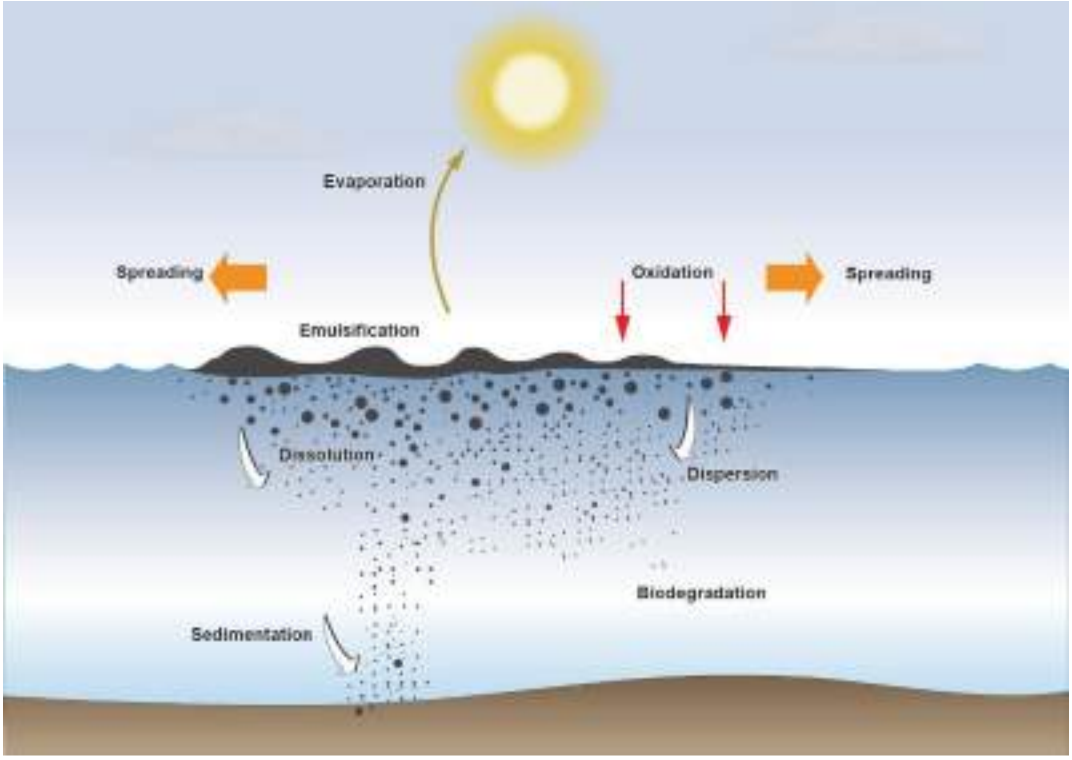
Marine diesel is readily dispersed into the water column when wind speeds reach 5 to 7 knots, or the sea state is approximately Force 2 Beaufort scale or higher. It is much lighter than water, therefore it is not possible for the diesel to sink and accumulate on the seabed as pooled or free oil. However, diesel may be physically mixed into the water column by wave action, forming small droplets that are carried and kept in suspension by the currents. Diesel dispersed in the water column can adhere to suspended sediments, which then settle out and are deposited on the seabed. This process is more likely to occur in near shore areas or river estuaries rather than in the open marine environment.

Compared to unrefined crude oils, marine diesel is not sticky or viscous. When stranded on the shoreline, diesel tends to penetrate porous sediments quickly whereas if it is deposited on hard surfaces, it will be quickly washed off by wave action. In both situations, marine diesel is readily degraded by naturally occurring microbes, typically within one to two months.

In terms of toxicity to marine organisms, diesel is considered to be one of the most acutely toxic oil types.[142]

[142] NOAA Office of Response and Restoration. http://response.restoration.noaa.gov (accessed November 2015).

Figure 7.2: Weathering Processes Acting on Spilled Oil

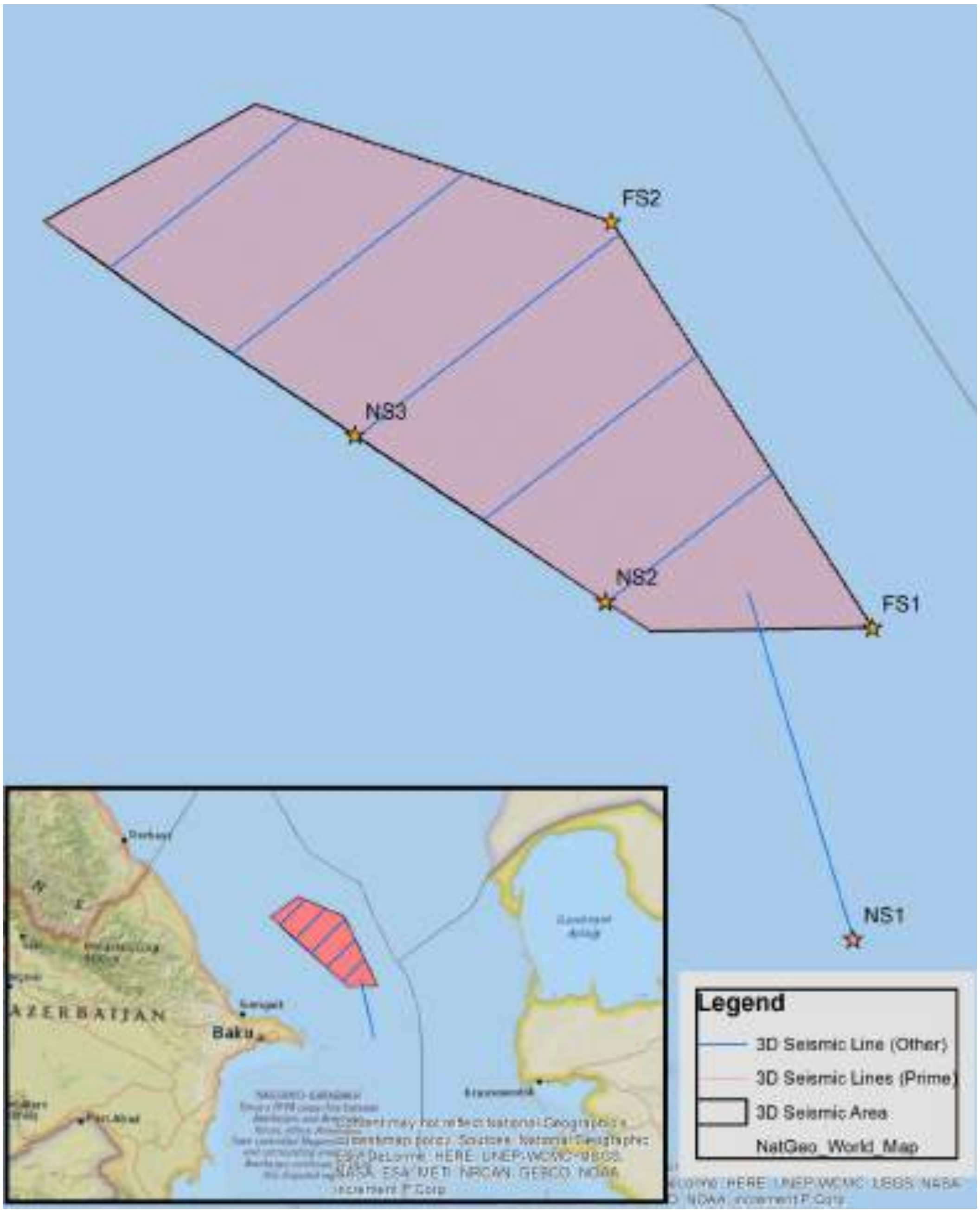


Vessel Marine Diesel Spill Modelling

To assess the potential impact of the major fuel spill from the survey vessel, modelling was undertaken using SINTEF's Oil Spill Contingency And Response (OSCAR) modelling software (see Appendix 7A for a description of the model). Five release locations were modelled to identify the worst case release location in terms of environmental impact (Figure 7.3). The modelling was completed for spring, summer and autumn seasons at each of these release locations. Spring was modelled as the proposed timing of the survey was not confirmed at the time of the modelling study. Due to the temporal nature of the key environmental sensitivities, particularly those associated with the lower presence of Caspian Seals between December and March months, modelling was not completed for the winter season.

For the purposes of this ESIA, the results for the scenarios causing the greatest shoreline oiling (release site NS3 - Scenario 3), and the most water surface oiling outside the Azerbaijan exclusive economic zone (EEZ) (release site FS1 - Scenario 5) are summarised in Tables 7.2 & 7.3, and discussed below. All mapped modelling outputs are provided in Appendix 7A, with selected graphics presented below.

Figure 7.3: Vessel Marine Diesel Spill Modelling Release Locations



Note: Stars shown within the figure indicate modelled release locations.

Table 7.2: Probabilistic Simulation Results for Worst Case Scenario 5

Oil Spill Modelling Summary						
Spill scenario / descriptor	Seismic Vessel Diesel Release – 800 tonnes release at FS1 Location					
Transboundary waters						
Identified median line	Probability (> 1%) of crossing and minimum time to reach (days)					
	5a (FS1 Spring)		5b (FS1 Summer)		5c (FS1 Autumn)	
	Probability	Time	Probability	Time	Probability	Time
Azerbaijan-Iran	3	15	1	11		
Azerbaijan-Kazakstan	5	1	3	2	2	2

Azerbaijan-Russia	1	26	1	10	1	10
Azerbaijan-Turkmenistan	6	1	2	2	2	2
Kazakstan-Turkmenistan	4	1	2	5	1	3
Russian-Kazakstan	2	12				
Turkmenistan-Iran	3	15	1	11		
Landfall						
	Probability of beaching and minimum time to beach (days)					
Predicted locations	5a (FS1 Spring)		5b (FS1 Summer)		5c (FS1 Autumn)	
	Probability	Time	Probability	Time	Probability	Time
Azerbaijan	5	3	3	2	3	2
Iran			1	15	1	15
Russia			1	18		
Diesel beached (worst case)	243 tonnes		240 tonnes		255 tonnes	

Table 7.3: Probabilistic Simulation Results for Worst Case Scenario 3

Oil Spill Modelling Summary						
Spill scenario / descriptor	Seismic Vessel Diesel Release – 800 tonnes release at NS3 Location					
Transboundary waters						
Identified median line	Probability (> 1%) of crossing and minimum time to reach (days)					
	3a (NS3 Spring)		3b (NS3 Summer)		3c (NS3 Autumn)	
	Probability	Time	Probability	Time	Probability	Time
Azerbaijan-Iran			1	8		
Azerbaijan-Kazakstan	2	2	1	4	1	5
Azerbaijan-Russia	2	10	2	5	2	6
Azerbaijan-Turkmenistan	2	8				
Kazakstan-Turkmenistan	1	8				
Russian-Kazakstan	1	11				
Turkmenistan-Iran	1	16				
Landfall						
	Probability of beaching and minimum time to beach (days)					
Predicted locations	3a (NS3 Spring)		3b (NS3 Summer)		3c (NS3 Autumn)	
	Probability	Time	Probability	Time	Probability	Time
Azerbaijan	3	4	7	2	3	2
Iran			1	13		
Russia	1	22				
Diesel beached (worst case)	356 tonnes		486 tonnes		269 tonnes	

Surface Oil – Probabilistic Modelling

Modelling results show that the presence of any surface oil (diesel) from a seismic vessel release at a thickness > 0.04 µm and based on a probability greater than 5% (>5%) would be very close to the release location for all scenarios and all seasons. The >5% probability of surface oiling for the FS1 release location (Scenario 5) during autumn is shown in Figure 7.4. In general, surface oil is restricted to the economic waters of Azerbaijan, although some surface oil is predicted in the economic waters of Russia, Iran, Kazakhstan, and Turkmenistan for probabilities >1% (Tables 7.2-7.3; Figure 7.5).

The results also show that the released diesel tends to migrate parallel to the Azerbaijan coast, in either a northerly or southerly direction (see Appendix 7A). Surface oil is shown to travel further in autumn and spring than in summer with more surface oiling occurs across the Azerbaijan-Kazakhstan and Azerbaijan-Turkmenistan median lines, although at probabilities <5%. In the transboundary context, the extent of a diesel slick into territorial waters is limited and constitutes approximately 10% of the water surface being affected by visible oiling (surface oil thickness > 0.04 µm).

Based on the predicted thickness of the surface diesel, it is predicted to have a visual “metallic” appearance in the area immediately adjacent to the release (see Figure 7.5). Further away, surface diesel was predicted to appear as a “sheen” or “rainbow” oil slick on the sea surface. In the calmer waters closer to shore there is also a greater chance of surface oil being “rainbow” in appearance. Modelling showed that diesel does not persist for longer than 3 days on the sea surface within most areas of the modelling domain, and generally for less than 2 days (refer to Appendix 7A).

Surface Oil – Deterministic Modelling

The worst case deterministic simulation shows the dynamics of the probabilistic simulation resulting in the most shoreline oiling from Scenario 3 (summer season; see Table 7.3). Whilst stochastic results better represent the overall environmental risk, a single deterministic simulation shows how spilled diesel at sea might be expected to behave during a worst-case shoreline oiling event.

It can be seen in Figure 7.6 that the surface oil coverage is limited.

Mass balance analysis (Figure 7.7) shows that evaporation of diesel from the sea surface occurs rapidly following a release (within the first 5 days). Evaporation rates then slow significantly and biodegradation becomes the most active degradation process when the diesel is stranded.

After 10 days no diesel is predicted to remain on sea surface. A small proportion (1-2%) of the diesel remains dispersed and entrained in the water column after 10 days but is biodegraded to insignificant proportions after 20 days from the release.

Shoreline Oil – Probabilistic Modelling

The results of the modelling show that shoreline oiling would be expected to occur mainly along the eastern and northern shores of the Absheron Peninsula, although some shoreline oiling may occur in isolated and more distant locations. Figure 7.8 and Table 7.3 shows the probability and minimum arrival time of stranded diesel to shoreline for the worst case Scenario 3. The largest amount of beached diesel (486 tonnes) is predicted to occur during summer, even with the warmer sea and higher air temperatures, which would induce higher evaporation rates. The severity of shoreline oiling is greater for the northern part of the Absheron Peninsula, where heavy oiling (>10mm thick) is predicted (based on the ITOPF Classification[143]) along a 30 – 40 km section of coastline within the first 7 days of the release (see Figure 7.9).

Arrival times were shown to increase with distance from the release site. Shoreline diesel accumulation tends to occur within the first 10 days on the Absheron Peninsula (see Tables 7.2 and 7.3; probabilities <5%), and after 20-25 days at more distant and isolated locations in Russia and Iran (1% probability)[144]. The modelling predicts that a number of national and international protected / designated areas may be impacted (albeit at low probability) from shoreline oiling (see Table 7.5 and Figure 7.8).

[143] The International Tanker Owners Pollution Federation (ITOPF, 2011). *Recognition of Oil on Shorelines: Technical Information Paper (TIP) 6*. UK. pp12

[144] Habitat management area and Species management area — IUCN Category IV.

Shoreline Oil – Deterministic Modelling

The worst case release trajectory was characterised by diesel being driven by currents and winds south from the release site NS3 (see Figure 7.6). The modelling results indicate that the majority of the released diesel does not disperse to a significant extent and most of it either evaporates or is stranded onshore in a relatively concentrated mass. Evaporation is the main weathering process prior to the stranding event. After the main stranding event, biodegradation becomes another important fate for the diesel, particularly after 20 days from the release. Little remobilisation of diesel from the shoreline back into the water column is predicted.

The modelling results suggest that stranded oil would persist on the shoreline for more than a few months (see Figure 7.7), with the highest amounts of beached oil occurring along the shoreline directly south of the release. Significant quantities of emulsified diesel (200 tonnes) were shown to still persist on the shoreline after 100 days of beaching.

Diesel Dispersion in the Water Column

Hydrocarbons in the water column pose a risk to aquatic organisms when they exceed a certain concentration. Research completed by Johnrsen (2005)[145] and Det Norsk Veritas (2008)[146] resulted in the development of species sensitivity dose-response curves to assess the impact to organisms from different water column hydrocarbon concentrations. A 5th percentile LC_{50}[147] for total hydrocarbon concentrations was found to be 58 ppb, which was applied in modelling as the lower threshold for potential acute toxicological responses.

The probabilistic modelling results (Appendix 7A) showed a constrained region where diesel exists in the water column at total hydrocarbon concentrations >58 ppb. When considering the >5% probability envelope, the extents are localised to the release location. The areas with <5% probability of total hydrocarbons >58 ppb extend over 50 km from the release site in both northwards and southwards directions parallel to the shoreline. This zone is generally also shown to be constrained within the Azerbaijan EEZ. Modelling shows that probabilities as high as 20% for total hydrocarbon concentrations in the water column exist within 10 km of the release site. Generally however, probabilities are shown to be <5%. The modelling indicated that dispersed and dissolved diesel >58 ppb in the water column generally persists for less than a day at any location.

[145] Johnsen H, Nordtug T & Nilsen H. (2005). Calculation of PNEC values for the water column applied in environmental risk management for accidental discharges. Statoil rapport C.FOU.DE.B02. Threshold values and exposure to risk functions for oil components in the water column to be used for risk assessment of acute discharges

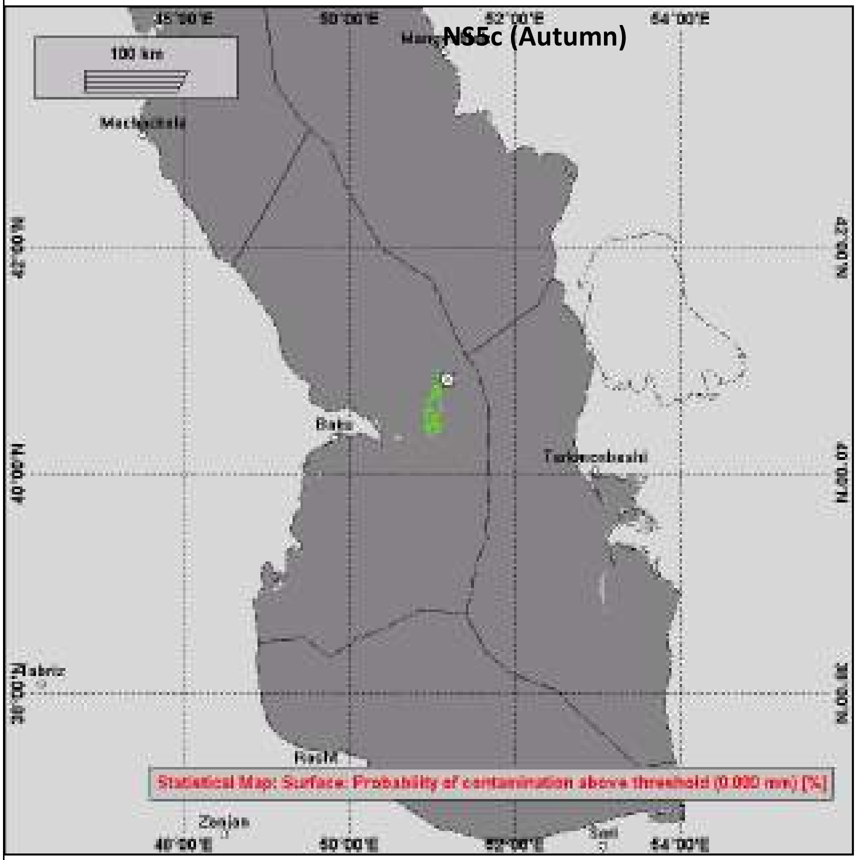
[146] DNV. (2008). Norwegian Oil Industry Association. Guideline for risk assessment of effects on fish from acute oil pollution. Report No 2007- 2075

[147] LC_{50} refers to a concentration of diesel (dissolved and dispersed) in the water column resulting in a lethal exposure to 50% of species of organism exposed over a given time-period.

Figure 7.4: Surface Oiling Probability for Worst Case Scenario 5 (Autumn)

Surface Oil Thicker than 0.04µm (Visible Sheen) (Probability >5%)

Surface Oiling Probability (> 5%) where surface oil is thicker than 0.04 µm (the minimum visible thickness from the Bonn Agreement Oil Appearance Code system[148].



Map Key

Probability of Surface Oiling

5 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90

Release Site

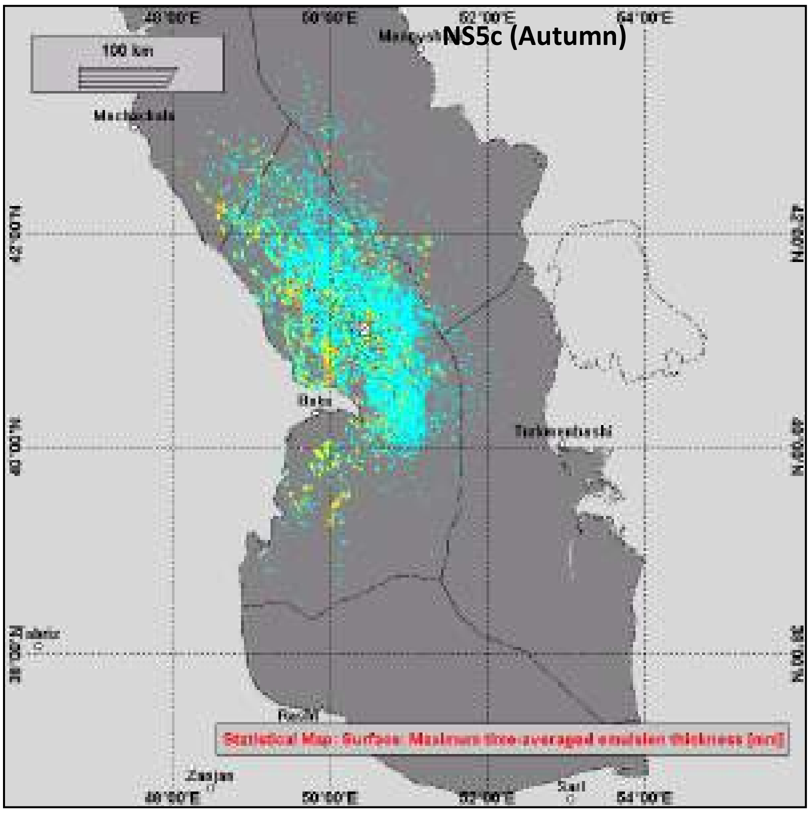
Median Line

[148] Lewis, A. (2007). Current Status of the BAOAC (Bonn Agreement Oil Appearance Code): A report to the Netherlands North Sea Agency - Directie Noordzee.

Figure 7.5: Probabilistic Simulation Results - Surface Oil Thickness for Worst Case Scenario 5 (Autumn)

Surface Oil Thickness (Probability >1%)

Surface Oiling Average Thickness based on the Bonn Agreement Oil Appearance Code BAOAC system.



Map Key

Surface Oil Thickness (Bonn Agreement Oil Appearance Code)

- Sheen (0.04 - 0.3 um)
- Rainbow (0.3 - 5 um)
- Metallic (5 - 50 um)
- DTOC (50 - 200 um)
- CTOC (>200 um)

Release Site

Figure 7.6: Deterministic Simulation Results: Maximum surface diesel thickness (>0.04µm) in any cell at any time-step within the modelling domain for Worst Case Scenario 3 (Summer)

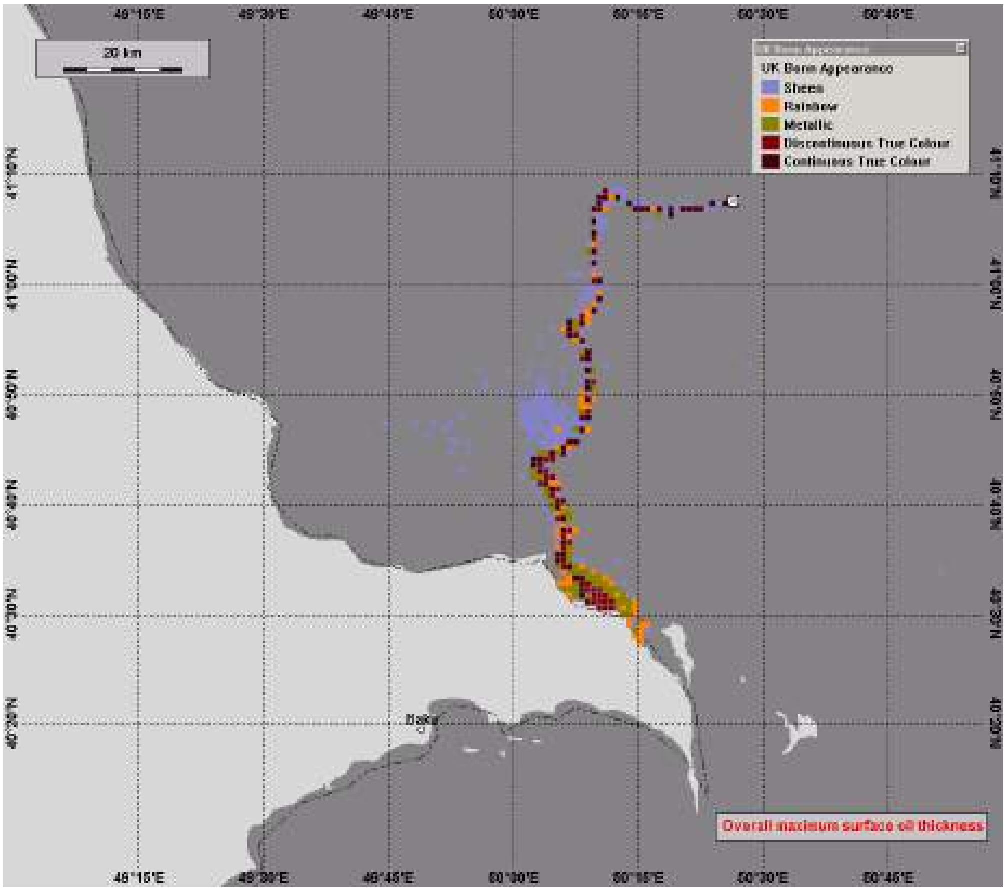


Figure 7.7: Fate of diesel (mass) for the Worst Case Scenario 3 (summer)

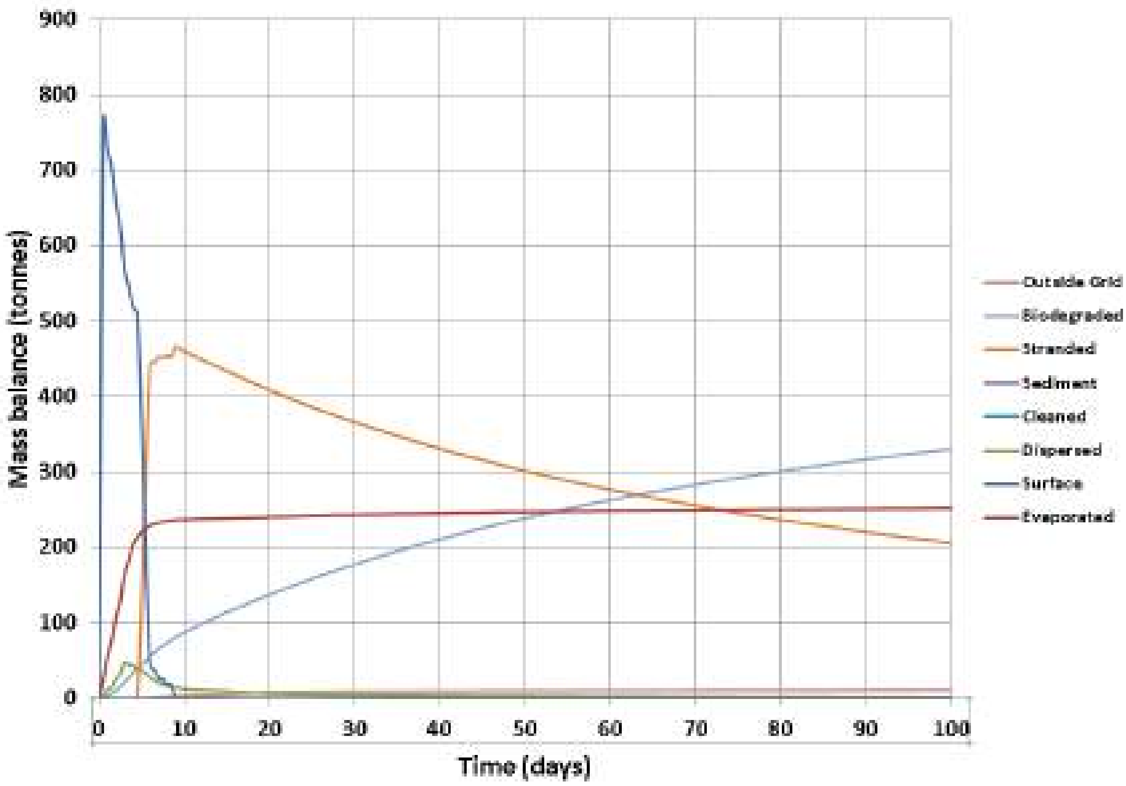


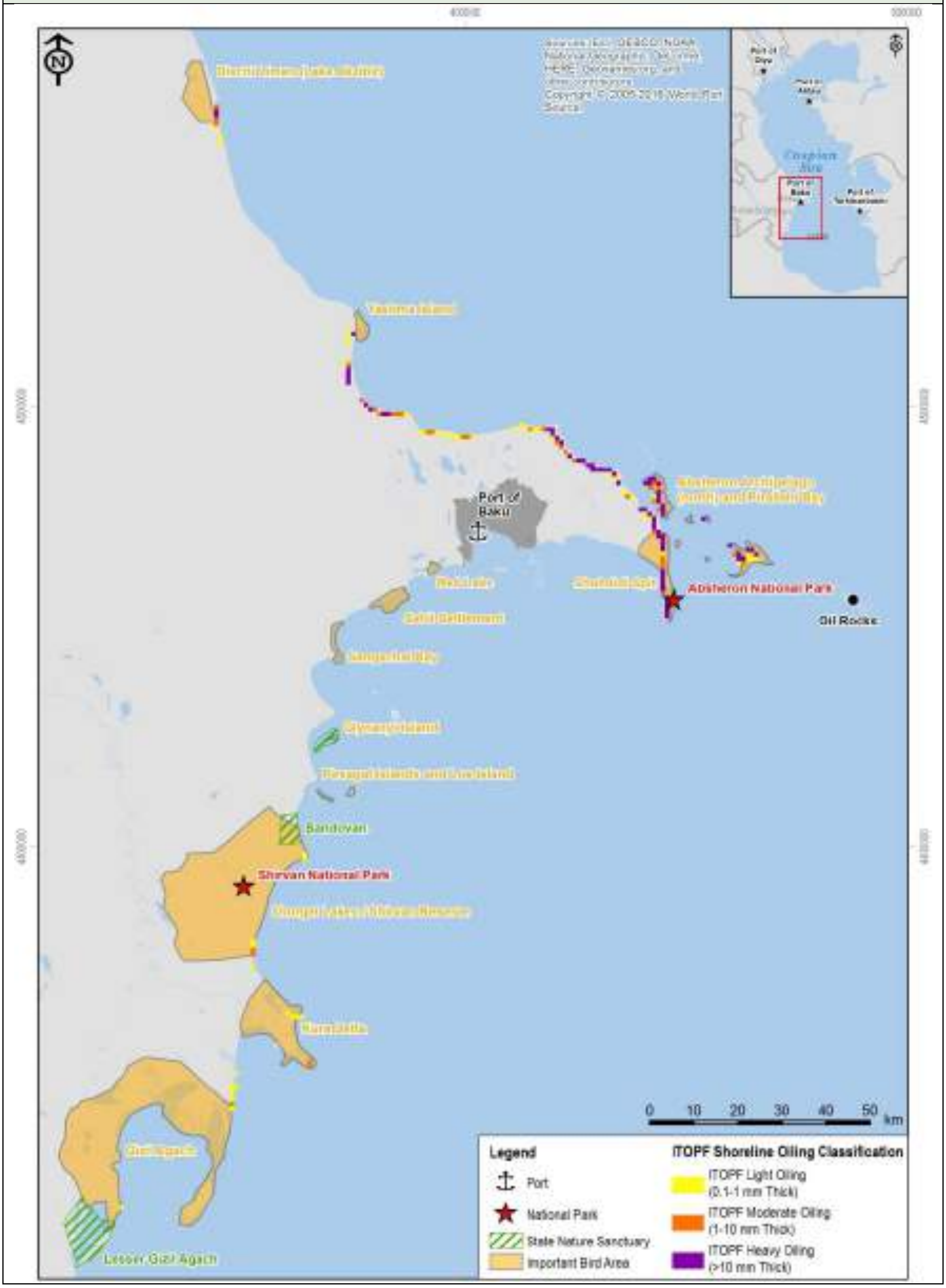
Figure 7.8: Shoreline Oiling Probability for Worst Case Scenario 3 (Summer)

Probability (>1%) of Shoreline Oiling
Shoreline Oiling Probability (> 1%) where shoreline oil mass exceed 0.169 tonnes/km (the minimum value of the ITOPT "Light Oiling" range [149].

[149] A minimum threshold for shoreline emulsion mass of 0.169 tonnes/km was used within the stochastic simulations. These values are the lower limit of the "Light Oiling" threshold used by ITOPF.

Figure 7.9: Shoreline Oiling Severity for Worst Case Scenario 3 (Summer)

Severity of Shoreline Oiling (ITOPF Classification)
Severity of shoreline oiling (ITOPF Classification) where it exceeds the ITOPF “Light Oiling” threshold of 0.169 tonnes/km. Results show locations where the probability of shoreline diesel >1%.



Discussion of Impacts from the Major Hydrocarbon Spill on the Marine and Coastal Receptors

Hydrocarbons have the potential to cause detrimental effects on water and sediment quality, marine and coastal flora and fauna, including plankton, benthic invertebrates, fish, seabirds, and marine mammals that may come into contact with an area of a spill. Impact on fisheries and indirectly on human health via the food chain is also possible depending on the scale of the spill and its proximity to the fishing grounds. The vulnerability of marine and coastal receptors, including fisheries, to hydrocarbon spills is summarised in Table 7.4.

An assessment of the potential impacts to these receptors is presented below. The assessment is based on the results of the diesel spill modelling and specific sensitivity to hydrocarbon spills as summarised above, and the existing environmental and socio-economic baseline conditions discussed in Chapter 5.

Plankton

The oil spill modelling indicates that for all release locations the concentrations of diesel in water above the 58 ppb threshold are limited to the point of release and are not expected to persist for longer than 1-2 days. The exposure of plankton (excluding fish larvae) to toxic levels of hydrocarbons is therefore expected to be short term and localised.

During the peak period of plankton production (spring and autumn) the biomass exposed to diesel would increase resulting in reduced growth levels and mortality. However, this is not expected to be significant in comparison to the total production level over the long term. Furthermore, it should be noted that it is not planned to undertake the D230 Seismic Survey during spring. Zooplankton may also suffer mortality as a result of a hydrocarbon spill, but the large number of early life stages produced and short reproductive cycles, will act as a buffer for recruitment from areas outside the spill affected region. Thus, plankton concentrations are expected to return to baseline levels after a relatively short period of time. As a result, the overall impact on the plankton communities is not considered to be significant.

Benthic Invertebrates

As detailed in Chapter 5 Section 5.3.5, the benthic community likely to be present in the Study Area is not expected to support any species of conservation significance. Nevertheless, benthic communities do play an important role in supporting critical functions of the local ecosystem, particularly as prey items for other species, including fish such as sturgeon. There are a number of taxa that are important prey items, e.g. amphipod crustaceans, which are known to be sensitive to hydrocarbons.

The diesel is unlikely to sink to the seabed but may become washed onto the shore in coastal areas. The diesel spill modelling suggests that exposure of benthic communities and sediments to diesel is possible due to wave and wind driven water movement. Potential impacts can include: (i) rapid mortality of sensitive species such as crustaceans, amphipods, and bivalves; (ii) a period of reduced species population and abundance; (iii) a period of altered community structure with increased abundance of opportunistic species. It should be noted that bivalves and crustaceans located in shallower water are particularly vulnerable to toxicity of the light aromatic compounds in diesel.

The predicted maximum amount of diesel beached ashore is 486 tonnes for the worst case summer scenario. The recovery times for benthos would vary depending on the environmental conditions and species affected. For lighter type hydrocarbons such as diesel, the recovery of predominantly open sandy/silty coastal/ shallow water benthic habitats is likely to be in the region of a few months, up to a year.

Considering the low probability of oil beaching, the limited area of the coastal zone being affected by stranded diesel and medium term recovery rates, the overall impact to low sensitivity benthic invertebrates is expected to be low.

Table 7.4: Vulnerability of Marine and Coastal Receptors to Hydrocarbon Spills[150,151,152,153]

Receptor	Vulnerability to Hydrocarbons
Plankton	• Abundance of phytoplankton may increase after a hydrocarbon spill due to increased nutrient availability, while zooplankton, fish larvae and eggs may suffer increased mortality due to toxicity in the water column, and therefore can affect the food chain of other fish species. • Although localised mortality is likely, the overall effect on plankton communities is not statistically significant and generally short-term. Following a spill plankton biomass may fall, however, after a few weeks, population often returns to baseline levels as a as a result of high reproductive rates and redistribution of species from outside the affected area.
Benthic Invertebrates	• Effects on the benthos include acute toxicity and organic enrichment. Offshore impacts are typically minimal, and influenced by water depth and local hydrography. Sub-tidal regions generally have lower hydrocarbon concentrations after a spill than inter-tidal regions as often the hydrocarbon is carried and spread at the sea surface. Recovery times are variable, and for light hydrocarbons are generally in the region of a few months to a few years. • Impacts can include rapid mortality of sensitive species such as crustaceans and amphipods; a period of reduced species population and abundance; a period of altered community structure with increased abundance of opportunistic species.
Fish	• Evidence suggests that fish are able to detect and avoid hydrocarbon-contaminated waters. This avoidance may cause disruption to migration or spawning patterns. • Hydrocarbon exposure in fish can lead to mortality or sub-lethal impacts on growth, physiology, behaviour and lowered disease resistance. • Fish populations are more sensitive to hydrocarbon pollution in shallow waters than in deep waters, with hydrocarbon concentrations being typically higher in the upper column. • Fish may ingest large amounts of hydrocarbons through their gills. Fish that have been exposed to hydrocarbons may suffer from changes in heart and respiratory rate, enlarged livers, reduced growth, fin erosion and a variety of effects at biochemical and cellular levels. Hydrocarbons toxicity can also affect reproductive capacity negatively and/or result in deformed fry. • Fish eggs and larvae are more vulnerable to hydrocarbon pollution than adults. In many fish species, these stages float to the surface where contact with spilt hydrocarbons is more likely. However, as most fish species have extensive spawning grounds and produce large numbers of eggs, there is unlikely to be any effect on numbers in the adult populations. Stocks may be at risk from a spill if it is large and coincides with spawning periods. • Longer term impacts of a hydrocarbon spill have shown genetic damage, physical deformities, reduced abundance and growth, and compromised survival of some life stages.
Birds	• The spilled hydrocarbon can penetrate into the plumage of sea birds, reducing its insulating ability, and making them more vulnerable to temperature fluctuations and much less buoyant in the water. This can lead to death from hypothermia or drowning. • In their efforts to clean themselves from hydrocarbon, the birds may inhale or ingest the hydrocarbon. As hydrocarbons are toxic, this may result in serious injuries/health effects such as pneumonia, congested lungs, intestinal or lung haemorrhage, liver and kidney damage. • Hydrocarbons may also affect the reproductive success of the birds as hydrocarbons from feathers of a bird that is laying on eggs may pass through the pores in the eggshells and either kill the embryos or lead to malformations.
Seals	• Seals are very vulnerable to hydrocarbon pollution because they spend much of their time on or near the surface of the water. They need to surface to breathe, and regularly haul out onto beaches. During the course of a hydrocarbon pollution incident, they are at risk both when surfacing and when hauling out. • Seals may be damaged through the ingestion of food contaminated by hydrocarbons or the inhalation of hydrocarbon droplets and vapours. Oil, especially light oils and hydrocarbon vapours, will attack exposed sensitive tissues. These include mucous membranes that surround the eyes and line the oral cavity, respiratory surfaces, anal and urogenital orifices. This can cause corneal abrasions, conjunctivitis and ulcers. Consumption of contaminated prey can lead to the accumulation of hydrocarbons in tissues and organs.
Fisheries	• Fish exposed to hydrocarbons may become tainted, defined as giving the product a petroleum taste or smell. Commercial fish species rarely become tainted in open deep waters, as they are able to avoid the affected area. However, major spills can result in loss of fishing days and exclusion zones and bans on certain species lasting for a whole season may be enforced.

[150] U.S. National Oceanic and Atmospheric Administration (NOAA) Office of Response and Restoration (http://response.restoration.noaa.gov).
[151] Petroleum Industry Environmental Conservation Association (IPIECA), 1997. Guidelines on Biological Impacts of Oil Pollution. Volume 8: Biological Impacts of Oil Pollution: Fisheries. International.
[152] Effects of Oil Pollution on the Marine Environment, 2011. Technical Information Paper 13. International Tanker Owners Pollution Federation Limited (ITOPF)..
[153] The Ireland Department of Communications, Energy and Natural Resources, Petroleum Affairs Division, 2011. Rules and Procedures for Offshore Petroleum Exploration and Appraisal Operations.

Fish

The key locations for fish species are in the shallow water shelf areas. Maximum concentrations of fish are typically found at depths of up to 50 m throughout most of the year and the coastal region is important for non-migratory (resident) species and provides breeding and nursery habitats for almost all commercial fish species. This area is particularly sensitive in spring, summer and autumn, when resident species are spawning. Migration of sturgeon and grey mullet takes place along the coast in water depths up to 100 m. This occurs from the south to north in the spring and north to south in the autumn. There are several species of sturgeon, classified as Endangered in the International Union for Conservation of Nature (IUCN) Red List and most likely to be present in waters up to 100 m deep during spring and summer migrations.

Fish have the ability to detect hydrocarbons in water through olfactory (smell) or gustatory (taste) systems and tend to avoid contaminated areas. It can be assumed therefore that the majority of adult fish would avoid the area of a spill, although in very shallow waters fish may be more restricted between the seabed and the diesel on the sea surface. Spill avoidance behaviour can disrupt migration routes for some fish species. This has the potential to impact the migration of species of sturgeon and shad and semi-migratory species such kilka and mullet. Juveniles and larvae are more vulnerable to oil spills as they have limited ability to move away from the contaminated zone, which may have implications for the reproduction of these species. It should be noted that protected sturgeon species do not spawn within Azerbaijani waters but will be migrating in spring and summer and may be feeding during summer in coastal waters up to 100 m water depth.

If a worst case spill was to occur at any time during the planned seismic survey, different groups of fish species may be affected. The D230 Seismic Survey is planned to commence in mid-2017 and therefore will avoid the spring. Oil spill modelling indicates that diesel concentrations in the water column, which might cause toxic effects on fish, are non-persistent with a large proportion of the diesel evaporating within the first few days after the release. Considering the low probability, spatial and temporal limitations of a worst case spill and the ability of fish to move away from affected areas, no significant impacts on fish population are anticipated.

Seals

If Caspian seals are within the area of a spill, or if the spill affects any resting or haul out sites, there could be irreversible impacts from a hydrocarbon spill through coating, inhalation and ingestion.

As discussed within Chapter 5 Section 5.3.8 seals are likely to be present within the Central Caspian in peak numbers in April-May (peak spring migration), July (summer foraging), and November (peak autumn migration). The D230 Seismic Survey is planned to commence in mid-2017 and therefore will avoid sensitive spring migration season. Recent research indicates that a significant proportion of seals remain to feed in the Central Caspian (to the north of the Absheron Peninsula) throughout summer and autumn. The seals are known to typically maintain a distance of 1-2 km away from the coastline, although they can be observed anywhere between the coast and the central part of the Caspian Sea. The migration routes and distribution of seals are not fixed and are closely linked with the variable distribution of kilka, which is the main source of food for seals.

The oil spill modelling confirmed that surface diesel thicknesses will be greatest near the spill location, dispersing and thinning out with distance and time. Thus, seals within a few kilometres of the release location are most likely to come into contact with diesel. The duration of diesel remaining on the sea surface in most areas is not predicted to exceed 24 hours and the probability of shoreline oiling in areas which are known to be used by seals for haul out (e.g. the Absheron Peninsula and the adjacent islands) is relatively low (less than 5% probability). Therefore, any exposure of seals to spilled diesel is likely to be limited.

Despite the limited spatial and temporal scale of a potential spill, seals are known to be highly sensitive to oiling and have slow recovery rates once coated, even when smeared with small amounts of hydrocarbons. Caspian seals are an IUCN endangered species and are under pressure from various natural and anthropogenic stressors. Therefore, even small-medium scale exposure to toxic effects of diesel, within sensitive areas for seals, could result in a potentially significant impact.

Areas of Conservation and Ecological Importance

There are a number of Protected Areas, Important Bird and Biodiversity Areas (IBAs), and Key Biodiversity Areas (KBA) located along the coastline that could be affected by oiling in the event of a spill. These are summarised in Table 7.5 below. These areas are shown on the shoreline oiling probability maps (Figures 7-8 and 7-9) (with the exception of the remote sites in Russia and Iran which are discussed in Chapter 8 *Transboundary Impacts*).

Table 7.5: Shoreline Oiling Probabilities for Protected and Designated Areas

Designated / Protected Areas[1]	Ornithological Important Area	Designation	Country	Probability of Shoreline Oiling (%)
Absheron National Park	✓	National Park IUCN Category II	Azerbaijan	4
Absheron Archipelago (north) & Pirallahi Bay	✓	IBA/KBA	Azerbaijan	5
Shirvan National Park	✓	National Park IUCN Category II	Azerbaijan	2
Kura Delta	✓	IBA/KBA	Azerbaijan	3
Bandovan	✓	State Nature Sanctuary IUCN Category IV	Azerbaijan	2
Gizil Agach	✓	IBA/KBA	Azerbaijan	2
Gizil Agach State Nature Reserve	✓	State Nature Sanctuary	Azerbaijan	3
Shahdidi Spit	✓	IBA/KBA	Azerbaijan	4
Shorgel Lakes / Shirvan Reserve	✓	IBA/KBA	Azerbaijan	2
Kichik Gizilagach state Nature Sanctuary	✓	State Nature Sanctuary	Azerbaijan	2
Yashma Island	✓	IBA/KBA	Azerbaijan	2
Divchi Liman (Lake Akzibir)	✓	IBA/KBA	Azerbaijan	2
Chechen' Island and East Side of the Agrakhan Peninsula	✓	IBA/KBA	Russian Federation	1
Sulakskaya Lagoon	✓	IBA/KBA	Russian Federation	1
Agrakhansky Zakaznik	✓	Habitat/ Species Management Area IUCN Category IV	Russian Federation	1
Lisar Protected Area	✓	IBA/KBA	Islamic Republic of Iran	1
South Caspian shore, from Astara to Gomishan	✓	IBA/KBA	Islamic republic of Iran	1

The shoreline oiling probabilities predicted by the modelling are very low (1-5%). The recovery of different habitats from an oil spill varies, but for light oil types such as diesel the recovery of predominantly open coastal habitats is likely to be in the region of a few months, up to a year. Based on this medium term recovery and low probability but also considering the International Conservation status and ecological importance of these areas, the potential impacts are assumed to be potentially significant. Potential effects on the IBAs are further discussed below.

Birds and Important Bird and Biodiversity Areas

The Caspian region supports a high diversity of bird species, with a large number of endemic and protected species present. The western coastal zone of the Central Caspian is an area of ornithological importance, supporting both internationally and nationally significant numbers of migrating and overwintering birds, which is reflected in the designation of a number of important bird and biodiversity areas (see Section 5.3.9 of Chapter 5).

The species presence changes significantly during the migration and overwintering periods. A large number of overwintering and migrating birds will be present offshore and along the Central Caspian coastline within a number of IBAs identified as areas of potential impact from an oil spill (Table 7.5).

There are, however, some key periods and areas of higher sensitivity. Ducks and coots are overwintering from December to February and the presence of migrating species peaks in March and November. The IBAs are the key habitats for these groups of birds, particularly for nesting and breeding. The bird nesting season begins at the end of April/beginning May and continues until mid-July. Limited information is available regarding the offshore distribution and abundance of birds in the Central Caspian; however it is expected that there will be birds such as terns that plunge dive to feed and species that spend the majority of their time on the sea surface present throughout the year.

An accidental release of diesel can impact birds offshore and in the nearshore / coastal areas. The typical impacts to birds include toxic effects, mortality, as well as reduced reproduction. Although the modelling indicates some of the IBA and KBAs may be exposed to elevated hydrocarbon concentrations as a result of surface oiling and beaching on the shoreline, the extent of persistent pollution offshore is limited to 1-2 days. However, it should be noted that, once stranded onshore, the diesel biodegrades at slower rates and it is predicted to persist for more than a few months. Therefore, although the probability of diesel arriving at important bird and biodiversity areas is low, it is considered that the impact of a diesel release on birds at sea and the IBAs and KBAs could be a significant impact for the reasons mentioned above and due to the spill potentially occurring during the most sensitive time of year for nesting birds in the region.

Other Marine and Coastal Users

Socio-economic receptors such as fisheries and coastal tourism could be exposed to the risk from an accidental spill. The probabilities of a large fuel spill (800 tonnes) reaching coastal areas or fishing grounds are less than 5%. If released into the marine environment, marine diesel is expected to weather relatively fast. The modelled maximum exposure of the water surface to diesel is limited to 1-2 days, and water column exposure to diesel concentrations exceeding 58 ppm is not expected to exceed two days. Once onshore, the diesel biodegrades and evaporates, although even after few months significant quantities of emulsified diesel (20% of the spilled volume) were shown to persist, mainly along the northern shoreline of the Absheron Peninsula.

Although the likelihood of a large diesel spill having a significant effect on the marine and coastal receptors is low, the consequences including a negative public perception and media attention can have reputational implications. There is potential for tourist businesses located within the spill area of influence (Figure 7.10) to be affected, particularly during the summer period when tourist activities peak. While offshore oil will disperse within 1-2 days, it may remain stranded for months on the affected recreational beaches (mainly along the northern coast of the Absheron Peninsula), hence potentially having significant impacts on the recreational businesses within the affected area.

Fisheries can also be exposed to the effects of a worst case scenario fuel spill. Small scale fishing is predominantly concentrated within 3 nautical miles of the Azerbaijan coastline (see Figure 7.10). Commercial fishing is focused on fishing areas towards the south of Azerbaijan. It is understood that the high season for commercial fishing is during March to April and September to November whereas the peak fishing period for small scale fishing occurs between September and May, although fishing takes place throughout the year.

Table 7.4 outlines how hydrocarbon spills have the potential to affect fishery resources in a number of ways. Despite the susceptibility of fish larvae and juveniles to relatively low concentrations of hydrocarbons in the water column, adult free swimming fish and wild stocks of commercially important species are likely to detect and avoid hydrocarbon contaminated areas. Following a spill, the reproductive success of unaffected fish, as well as the influx of larvae from unaffected areas should lead to the recovery of stock numbers. Given that many marine species produce vast numbers of eggs that are widely distributed by sea currents this means that species can recover from small mortality events relatively quickly.

However, fish can become tainted and contaminated with hydrocarbons. If there are signs of fish oil tainting or contamination, in the event of a hydrocarbon spill, any resultant imposed authority restrictions on fishing activities could result in detrimental financial impact upon local fisheries. Equally, a lack of timely restrictions, or illegal fishing, can create a risk to human health from contaminated product consumption. A worst case scenario spill (800 tonnes) may affect some small scale fishing grounds along the coast. Although the impact is likely to be limited to a small number of fishermen, it can potentially be significant, as fishing represents the primary source of household income for the majority of fishermen. Commercial fishing can also be impacted by the spill. Although there is a low probability (< 5%) of a diesel spill reaching the commercial fishing grounds, the potential for toxic effects to fish and indirectly on human health that could trigger a temporary fishing ban, the impact to the large commercial fishing industry is considered to be potentially significant.

Summary of Major Spill Impacts

The loss of the entire diesel inventory from the seismic survey vessel (800 tonnes) has been modelled and the resulting impacts to environmental and socio-economic receptors have been assessed. As discussed above, in general the diesel is not anticipated to persist in the environment in harmful concentrations in the water column or thickness on the sea surface for more than a few days following the release. Furthermore, the probability of any diesel reaching the shoreline from the release location is predicted to be low, typically occurring for <5% of the scenarios modelled using multiple variations in meteorological conditions representative of each season. Under worst case conditions, it was predicted that 486 tonnes of diesel could reach the shoreline.

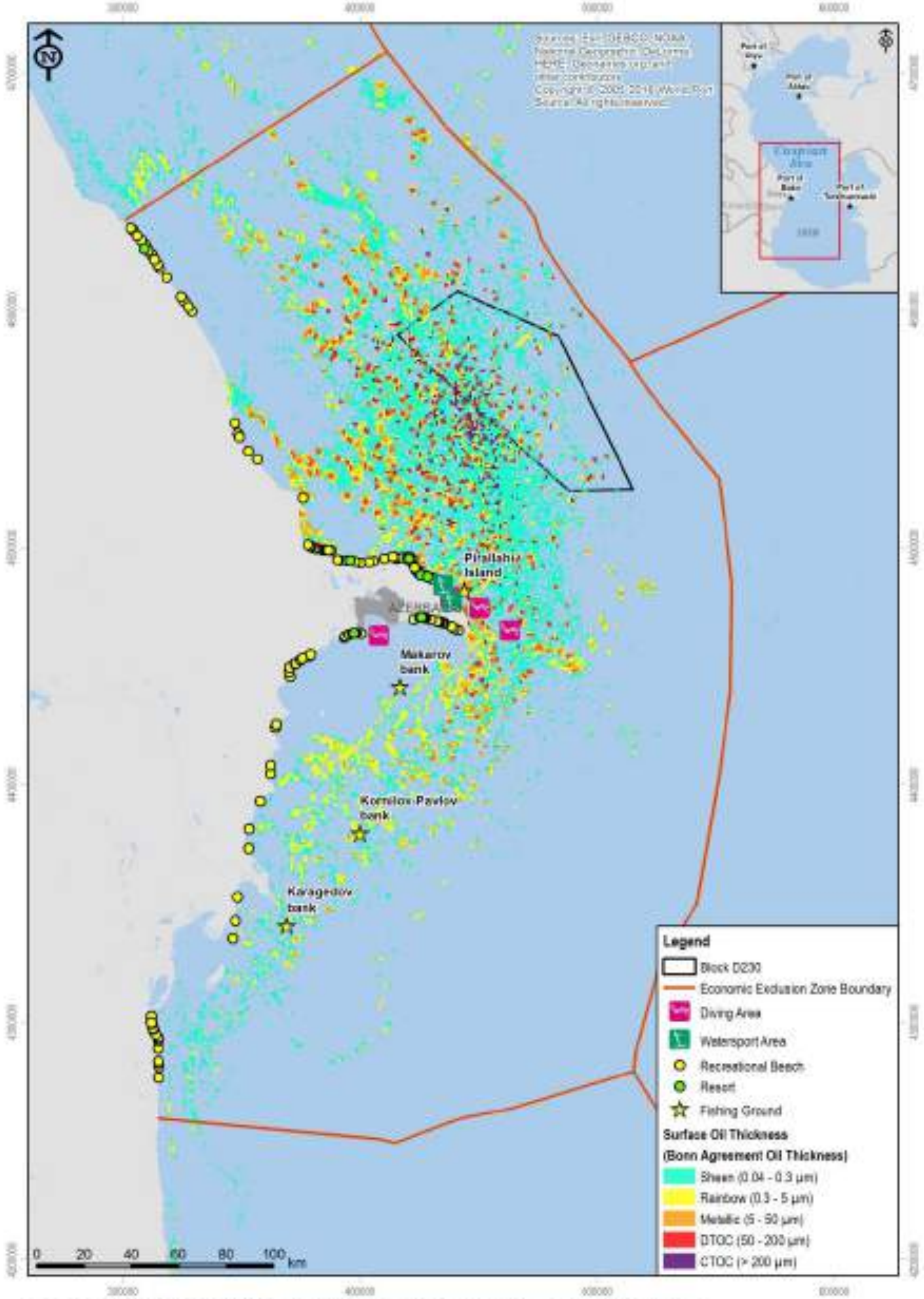
The potential impacts of the 800 tonnes diesel spill on plankton, benthic invertebrates and fish are considered to be insignificant. The seismic survey schedule has been planned to avoid the most sensitive spring migration period for Caspian seals (an IUCN Endangered species). However even a small to medium scale exposure to the toxic effects of diesel within offshore waters, and in the vicinity of the Absheron Peninsula and the adjacent islands, where seals will be present during summer and autumn could result in a potentially significant impact.

The spill modelling has shown that in the event of a spill occurring in a location where the survey vessels may be operating closest to the shore, there are a number of sites of conservation and ecological importance that may be exposed to stranded diesel, although the probability of this occurring is low (less than 5%). These sites are located mostly along the coastline of Azerbaijan with a small number in Russia and Iran (see Table 7.5). Based on the predicted medium term recovery period (few months to a year) anticipated for potentially affected habitats from a diesel spill, and considering the international conservation status and ecological importance of these areas, the potential impacts from a spill are considered to be potentially significant.

The modelling shows that a number of IBAs and KBAs, and associated bird species may be exposed to elevated hydrocarbon concentrations as a result of surface or dispersed / dissolved diesel beaching on the shoreline following a spill. However, the extent of and persistence of any pollution is likely to be spatially and temporally limited. Nevertheless, it is considered that the potential impact on IBAs and KBAs (and the birds present there) could have a potentially significant impact, especially if the release occurs at the beginning of the survey period, which overlaps with the most sensitive time of year for nesting birds in the region.

A worst case major fuel spill may affect small scale fishing grounds along the coast, and commercial fishing. Although this impact is anticipated to be limited in time, the impact could potentially be significant if a fishing ban is imposed (due to diesel toxicity to fish) as fishing represents the primary source of household income for the majority of fishermen.

Figure 7.10: Marine Users affected by Worst Case Scenario Spill (Summer)[154]



[154] it is understood that at the time of writing Piralli Island is no longer a key fishing ground.

7.3.4 Spill Prevention and Response Planning

The technical and operational control measures to minimise the risk of any diesel or hazardous material spill and the response measures to be implemented in the unlikely event a spill occurring are described below.

Spill Prevention

The specific technical and operational control measures in place to minimise the potential for spills during the D230 Seismic Survey offshore include:

- Audits of the seismic survey and support vessels will be undertaken to ensure vessels meet relevant IMO standards (e.g. condition of the vessel) and BP contract requirements;
- The seismic contractor will have a Shipboard Oil Pollution Emergency Plan (SOPEP) in place, in accordance with IMO guidelines. The SOPEP will include among others, oil spill contingency and response procedures to be implemented during refuelling operations. The contractor will ensure competency of the vessel crew in SOPEP implementation;
- Survey activities will be undertaken in compliance with operational weather restrictions for vessels in line with BP's existing marine operations and geophysical survey procedures;
- Regular maintenance and inspection of equipment and high risk spill points (in particular bunkering hoses, bunds, storage tank valves etc.) will be undertaken;
- Chemical selection procedures will be implemented to minimise chemical use;
- Strict refuelling procedures to be followed will be implemented and bunkering operations will be supervised at all times for both the seismic and support vessels;
- Non-return valves will be installed on fuel transfer hoses;
- Regular preventative maintenance to prevent leaks by repairing or replacing equipment such as hoses and tanks will be undertaken;
- Staff training in hazardous materials management, refuelling and waste management roles, as applicable to their roles will be provided;
- Implementation of appropriate handling and storage procedures and storage of all hazardous substances within designated areas and in fit for purpose containers (i.e. sealed/hermetic drums) to minimise the risk of leaks and spillage will be undertaken;
- Materials Safety data Sheets (MSDS) for all chemicals stored on board will be made available to facilitate efficient spill response;
- Reporting of all minor spills will be undertaken to detect underlying trends, and task risk assessments; and
- Appropriate spill response and containment equipment will be provided at specific locations based on risk assessment. This will allow rapid response should a spill occur.

Response Planning

BP has developed and maintains an Offshore Facilities Oil Spill Contingency Plan for its offshore operations in Azerbaijan. This plan establishes the notification, response and follow-up actions that must be implemented should an accidental spill occur. Under MARPOL regulations the seismic survey and support vessels (over 400 tonnes gross tonnage) are required to develop and maintain a Shipboard Oil Pollution Emergency Plan (SOPEP). This document specifies the control and response measures specific to the vessel, focused on the actions to be taken to stop or minimise the spill and to mitigate the effects. The plan also includes responsibilities and lines of communication with regard to notification and reporting. The seismic contractor and BP will be responsible for ensuring the SOPEP for each vessel is aligned with the relevant AGT Region OSRPs and spill response procedures prior to the survey mobilisation.

Under the AGT spill procedures, spill incidents are categorised according to the level of resource required to mitigate them. BP has adopted the internationally recognised tiered response concept to oil spill response as shown in Table 7.6.

Table 7.6: Oil Spill Response Tiers

Tier 1	Tier 1 spills are defined as small operational spills that can be can be handled immediately by on-site personnel. In most cases, the response would be to clean up using on site resources.
Tier 2	Tier 2 spills are defined as spills that require additional local (in-country) resources and manpower that are not available on the site that the spill occurs. The site response team would carry out cleanup, aided by the dedicated Tier 2 oil spill contractor.
Tier 3	Tier 3 spills are very large, possibly ongoing spills, which will require additional resources from outside the country of spill origin. Such spills are very rare and would only occur through events such as a well blowout or full diameter pipe rupture. All available spill contractors (from within and outside Azerbaijan) would carry out the physical response, with extensive support from the BP Incident Management Team and the Business Support Team.

Reporting

Under the AGT spill reporting procedures, all accidental and non-authorised releases (liquids, gases or solids) will be internally reported and investigated. Existing external notification requirements agreed with the MENR will be adopted during the D230 Seismic Survey are:

- For liquid releases to the environment exceeding a volume of 50 litres, notification will be made to the MENR within 24 hours after the incident verbally and within 72 hours in the written form; and
- If the release to the environment is less than 50 litres, then information about the release will be included into the BP AGT Region Report on Unplanned Releases and sent to the MENR on a monthly basis.

A Protocol “On Agreeing the Main Principles of Cooperation for Regulation of Unplanned Material Releases” signed between BP and MENR in December 2012 defines an approved release as “a release that is permitted by applicable PSA, MENR permitted and/or approved documents including ESIA, EIA, Technical Note, Technical Letter, individual discharge request letters to MENR or any other written agreement with the MENR”. Unapproved releases are those that do not fall into this definition.

8 Transboundary Impacts

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8.1 Introduction

This Chapter of the Block D230 Seismic Survey Environmental and Socio-Economic Impact Assessment (ESIA) presents the assessment of transboundary impacts that may cross the territorial boundaries of Azerbaijan into neighbouring countries.

Under the terms of the Espoo Convention on Environmental Assessment[155], a transboundary impact is defined as:

"any impact not exclusively of a global nature, within an area under the jurisdiction of a Party caused by a proposed activity the physical origin of which is situated wholly or in part within the area under the jurisdiction of another party"

The main objective of the Espoo Convention is to promote environmentally sustainable economic development as a preventative measure against transboundary environmental degradation. The Espoo Convention stipulates obligations of parties to assess the transboundary environmental impacts of a project in the early planning stages. The Espoo Convention specifies the obligation of Parties of Origin to notify and consult Affected Parties when a project in their territory is likely to have a significant adverse transboundary impact. Parties of Origin can ask the developer to undertake further public consultation, in addition to normal EIA requirements.

The World Bank /International Finance Corporation Performance Standard (PS) 1 guidance also states that the risks and impacts identification process needs to consider "potential transboundary effects, such as pollution of air, or use or pollution of international waterways, as well as global impacts, such as the emission of greenhouse gases".

The sections below consider the potential for transboundary impacts from both planned and accidental events associated with the proposed seismic survey.

8.2 Potential for Transboundary Impact Assessment

8.2.1 Planned Project Activities

In order for a transboundary impact to occur, activities from the Project would need to generate an impact that has the potential to cross national jurisdictions as defined by the Exclusive Economic Zone (EEZ) boundaries of the coastal Caspian Sea countries. Figure 8.1 illustrates the area of influence defined for the Project routine operations (refer to Section 3.4.2 in Chapter 3). The distances from the boundary of the area of influence to the adjacent EEZ boundaries, are as follows:

- Kazakhstan – approximately 6.8 km;
- Turkmenistan - approximately 11.3 km; and
- Russia – approximately 91.4 km.

Given these distances and the anticipated distances over which the environmental and social impacts associated with the planned Project activities are likely to occur (as detailed within Chapter 6 of this ESIA and shown in Figure 8.1) no transboundary impacts due to the effects from underwater sound, aqueous discharges, or physical presence of vessels and equipment on the international marine and coastal receptors are anticipated.

The only planned activities that may result in potential transboundary impacts are associated with the generation of atmospheric emissions including greenhouse gasses (GHGs), and gases that are known to contribute to acid rain (sulphur dioxide and nitrogen oxides) and regulated under the United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Pollution. The estimated volumes of GHG (CO_2 and CH_4), NO_X and SO_2 emissions generated over the maximum duration of the Block D230 Seismic Survey programme (6 months) are summarised in Table 8.1.

[155] As set out in Chapter 2 of this ESIA, the Espoo Convention was acceded by Azerbaijan on 1st February 1999 by Order No. 616-IQ of the President of Azerbaijan Republic and came into force on the same date.

Table 8.1: Estimated GHG (CO_2 and CH_4), NO_X and SO_2 Emissions Generated Over the Block D230 Seismic Survey Programme

Emission	Estimated Volume (tonnes)
CO_2	14035
NO_x	260
CH_4	1.2
SO_x	35
Total GHG	14324

Notes:
1. Emission Factors for vessels are adopted from the E&P Forum Report (No. 2.59/197);
2. Number of vessels has been calculated based on information provided in Section 4.4 of Chapter 4;
3. Calculations assume simultaneous operation of 1 Survey Vessel and 1 Support Vessel for the duration of the offshore survey;
4. Calculations assume that the second support vessel will carry out approximately 4 trips for refuelling of the survey vessel;
5. Duration of survey is assumed to be maximum to 6 months;
6. Vessel daily operational hours and fuel consumption are based on information provided in Section 4.3.1.
7. It is assumed all SO_2 and SOx volumes are equivalent.

Figure 8.2 shows that the estimated Project GHG emissions represent approximately 0.40% of the annual GHG emission volumes reported for BP's Azerbaijan upstream operations in the AGT Region in 2016[156].

The most recently published GHG emissions data for Azerbaijan estimated a total of 48,209 kilotonnes of GHG emissions emitted in 2010[157]; 76% of which was estimated to be generated by the energy sector. Total GHG emissions for 2016 were forecasted to be approximately 67,000 kilotonnes. On this basis, the estimated GHG emissions for the proposed D230 seismic survey represent approximately 0.0214% of national GHG emission based on the 2016 estimate.

The main sources of sulphur oxide and nitrogen oxide emissions during the Block D230 Seismic Survey will be from burning of fuel (marine diesel oil) to power the engines, compressors and electrical generators onboard survey and support vessels. All shipboard emissions will be in compliance with MARPOL 73/78 Regulations for the prevention of air pollution from ships (Annex VI), aiming to reduce global emissions of SO_x, NO_x. Therefore, sulphur oxide and nitrogen oxide emissions from the Project are considered to be minimal compared to the overall emissions from shipping operating in the Caspian Sea.

In conclusion, the transboundary effects from the planned Project activities are not anticipated to be significant.

[156] BP Exploration (Caspian Sea) Limited, 2015, BP in Azerbaijan Sustainability Report 2016
[157] UN Framework Convention on Climate Change (UNFCCC), 2014. The First Biennial Updated Report of the Republic of Azerbaijan to the UN Framework Convention on Climate Change. Submitted in accordance with the UN Framework Convention on Climate Change Conference of the Parties (COP) Decision 1/CP.16. Baku. Available at: http://unfccc.int/resource/docs/natc/aze_bur1_eng.pdf?bcsi_scan_e956bcbe8adbc89f=0&bcsi_scan_filename=aze_bur1_eng.pdf Accessed August 2015

Figure 8.1: D230 Seismic Survey Area in the Transboundary Context.

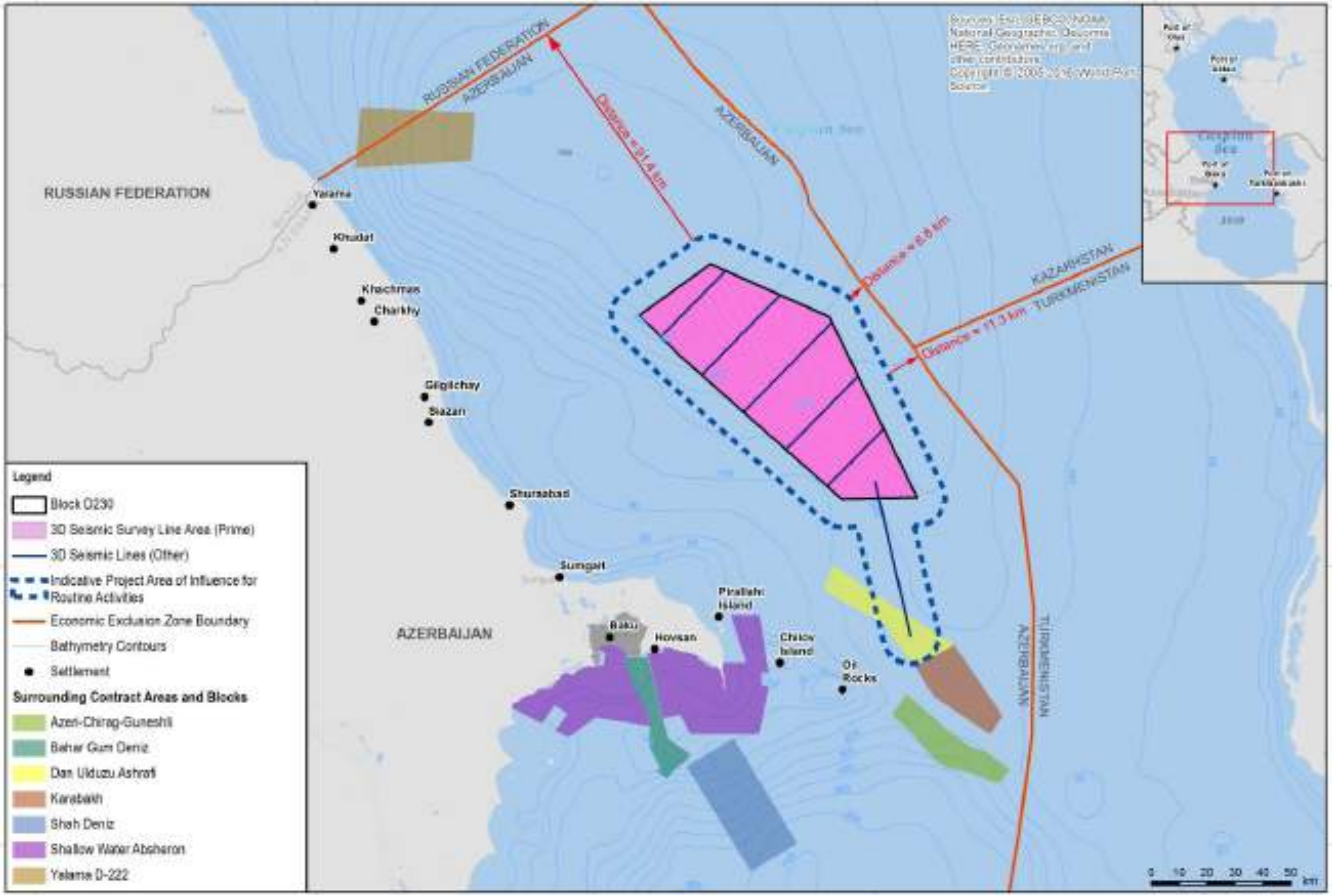
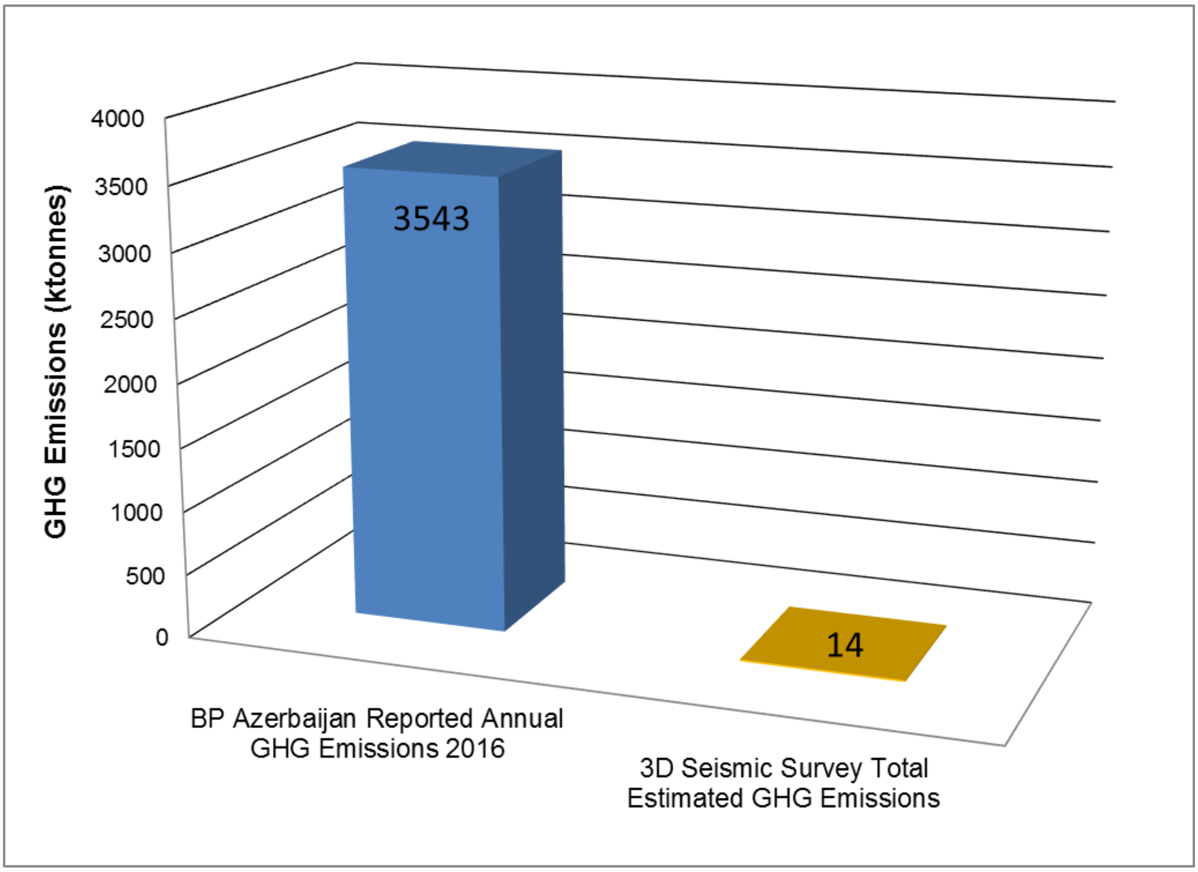


Figure 8.2: Estimated D230 Seismic Survey Total GHG Emissions Compared to Reported 2016 BP Azerbaijan Annual GHG Emissions



8.2.2 Accidental Project Events

During the D230 Seismic Survey there is a potential for accidental events to occur as a result of a technical failure, human error or other type of emergency, and pose risks to environmental and socio-economic receptors. As discussed Section 7.3.3 in Chapter 7, the accidental events that may cause impacts in a wider transboundary context include a major release of hydrocarbons (a loss of full fuel inventory of 800 tonnes from the survey vessel) to the marine environment. Such event has a low likelihood of occurrence and strict management measures will be put in place to ensure that associated risks are minimised (Section 7.3.4, Chapter 7).

To predict major spill impacts a probabilistic (stochastic) spill modelling was undertaken and included 100 simulations for five release scenarios under various meteorological conditions (see Figure 7.3 in Chapter 7). For the purposes of this transboundary impact assessment, the results for the scenarios causing the greatest shoreline oiling (release site NS3 - Scenario 3), and the most water surface oiling outside of the Azerbaijan EEZ (release site FS1 - Scenario 5) are discussed below.

The spill modelling indicates that the highest probability of a fuel spill to cross an international median line is for Turkmenistan – 6% (Table 8.2) with the oil slick potentially reaching territorial waters of other countries between 1 and 26 days after the spill occurring . In autumn (and also spring) surface oil is shown to travel further than in summer and greater surface oiling is predicted to occur across the Azerbaijan-Kazakhstan and Azerbaijan-Turkmenistan median lines, although at probabilities <5%. However, the extent of the oil slick in the territorial waters is limited as shown in Figures 8.3 and 8.4. Based on the predicted thickness of the surface diesel, it is expected to have a visual “metallic” appearance in the area immediately adjacent to the release location, whereas in the territorial waters of other countries surface diesel may appear in “sheen” or “rainbow” colour (Figure 8.3), and will not persist for longer than one day (Figure 8.4).

Table 8.2: Probabilistic Simulation Results – Water Surface Oiling Transboundary Context

Oil Spill Modelling Summary						
Spill scenario / descriptor	Seismic Vessel Diesel Release – 800 tonnes release at FS1 Location					
Worst Case Spill Scenario 5 (Release Location FS1)						
Exclusive economic zone (EEZ) waters median line	Probability (> 1%) of crossing and minimum time to reach (days)					
	5a (FS1 Spring)		5b (FS1 Summer)		5c (FS1 Autumn)	
	Probability	Time	Probability	Time	Probability	Time
Azerbaijan-Iran	3	15	1	11		
Azerbaijan-Kazakhstan	5	1	3	2	2	2
Azerbaijan-Russia	1	26	1	10	1	10
Azerbaijan-Turkmenistan	6	1	2	2	2	2
Kazakhstan-Turkmenistan	4	1	2	5	1	3
Russian-Kazakhstan	2	12				
Turkmenistan-Iran	3	15	1	11		
Worst Case Spill Scenario 5 (Release Location NS3)						
Exclusive economic zone (EEZ) waters median line	Probability (> 1%) of crossing and minimum time to reach (days)					
	3a (NS3 Spring)		3b (NS3 Summer)		3c (NS3 Autumn)	
	Probability	Time	Probability	Time	Probability	Time
Azerbaijan-Iran			1	8		
Azerbaijan-Kazakhstan	2	2	1	4	1	5
Azerbaijan-Russia	2	10	2	5	2	6
Azerbaijan-Turkmenistan	2	8				
Kazakhstan-Turkmenistan	1	8				
Russian-Kazakhstan	1	11				
Turkmenistan-Iran	1	16				

Note: the highlighted cell shows the highest probability of water surface oiling outside the Azerbaijan EEZ.

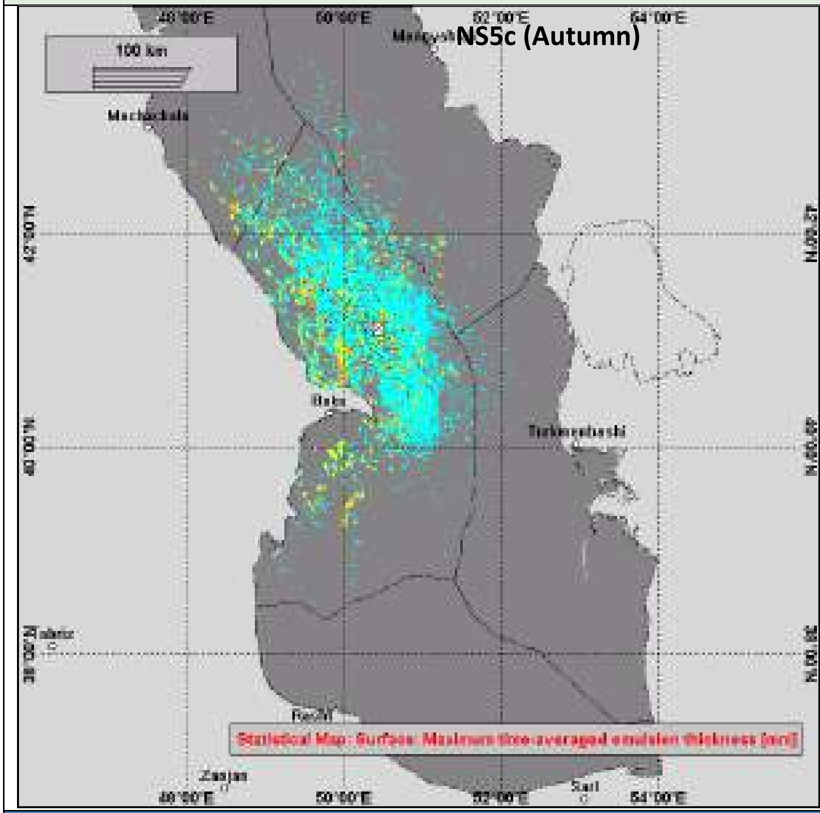
Hydrocarbons in the water column pose a risk to aquatic organisms when they exceed a certain concentration. Research completed by Johnsen (2005)[158] and Det Norsk Veritas (2008)[159] resulted in the development of species sensitivity dose-response curves to assess the impact to organisms from different water column hydrocarbon concentrations. A 5th percentile LC_{50}[160] for total hydrocarbon concentrations was found to be 58 ppb, which was applied in modelling as the lower threshold for potential acute toxicological responses. The modelling results show total hydrocarbon concentrations in water column exceeding 58 ppb are localised and limited to the release location when considering the >5% probability envelope (Figure 8.5). The areas with <5% probability of total hydrocarbons concentration exceeding 58ppb extend over 50km from the release site, but the zone is predominantly constrained within the Azerbaijan EEZ with exposure time limited to two days (Figure 8.6).

[158] Johnsen H, Nordtug T & Nilsen H. (2005). Calculation of PNEC values for the water column applied in environmental risk management for accidental discharges. Statoil rapport C.FOU.DE.B02. Threshold values and exposure to risk functions for oil components in the water column to be used for risk assessment of acute discharges
[159] DNV. (2008). Norwegian Oil Industry Association. Guideline for risk assessment of effects on fish from acute oil pollution. Report No 2007- 2075
[160] LC_{50} refers to a concentration of diesel (dissolved and dispersed) in the water column resulting in a lethal exposure to 50% of species of organism exposed over a given time-period.

Figure 8.3: Probabilistic Simulation Results - Surface Oil Thickness for Worst Case Scenario 5 (Autumn)

Surface Oil Thickness (Probability >1%)

Surface Oiling Average Thickness based on the Bonn Agreement Oil Appearance Code BAOAC system.



Map Key

Surface Oil Thickness (Bonn Agreement Oil Appearance Code)

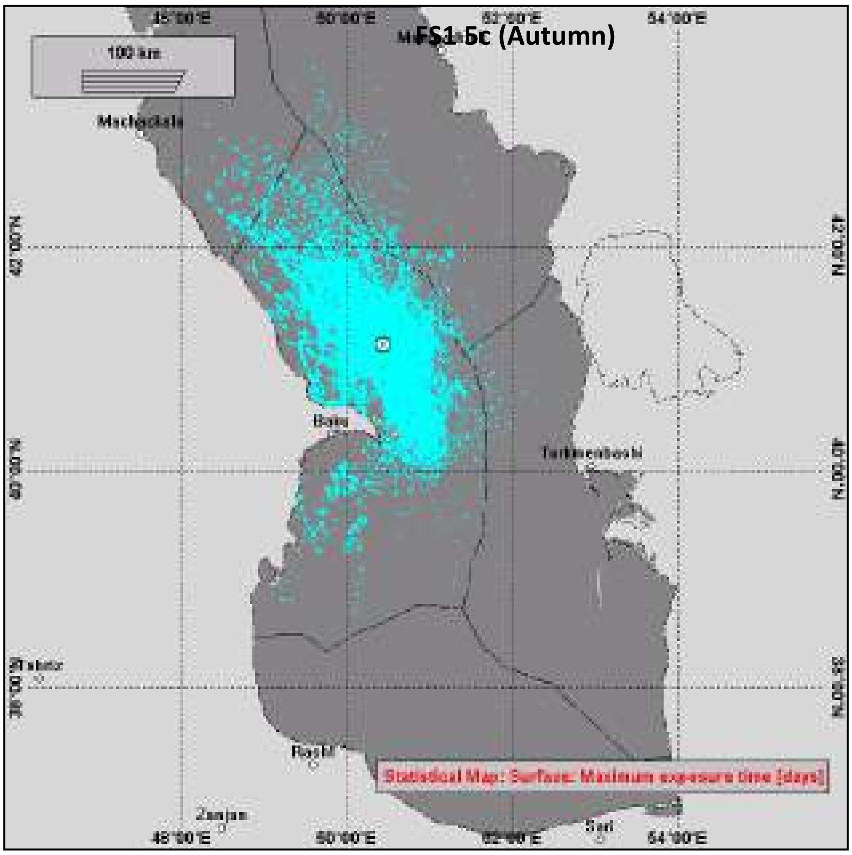
- Sheen (0.04 - 0.3 um)
- Rainbow (0.3 - 5 um)
- Metallic (5 - 50 um)
- DTOC (50 - 200 um)
- CTOC (>200 um)

Release Site

Figure 8.4: Probabilistic Simulation Results – Surface Oiling Exposure Time for Worst Case Scenario 5 (Autumn)

Maximum Exposure Time of Water Surface to Oiling (Probability >1%)

Maximum surface oil exposure in days.



Map Key

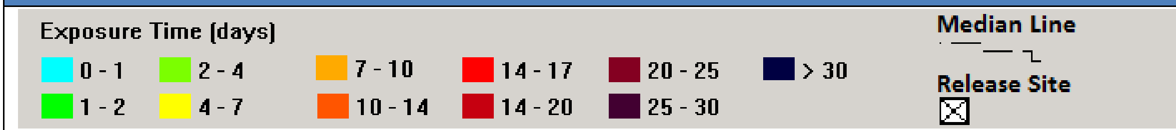
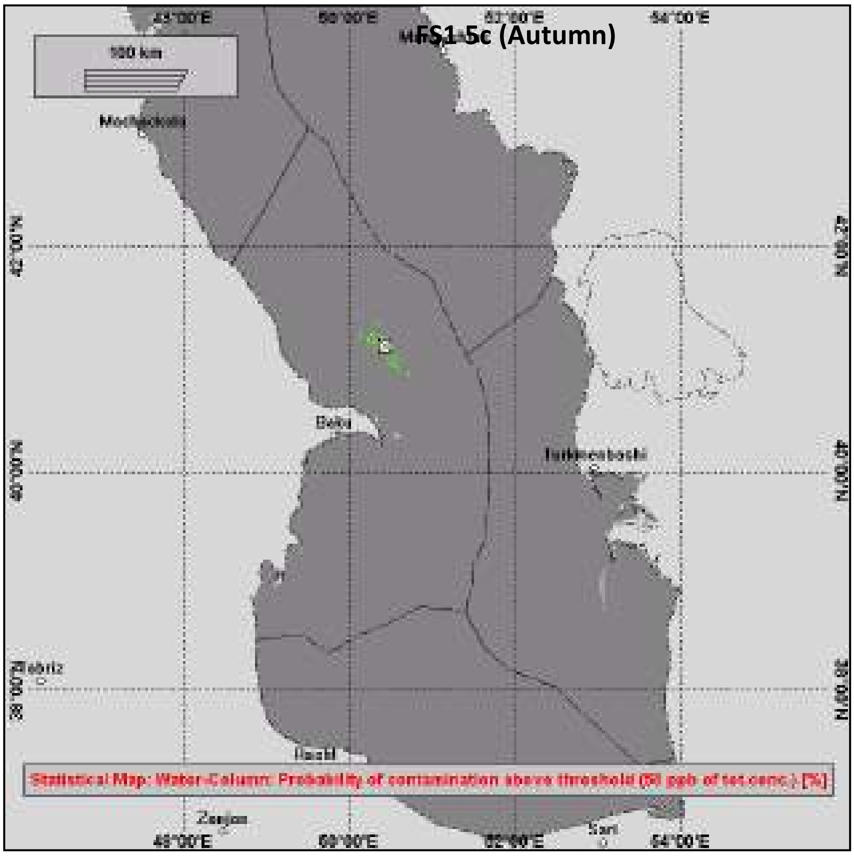


Figure 8.5: Probabilistic Simulation Results – Probability of Water Column Concentrations of Diesel Exceeding 58 µg/l (ppb) for Worst Case Scenario 5 (Autumn)

Water Column Concentrations of Diesel >58 µg/l (ppb) (Probability >5%)

Probability (>5%) of diesel concentrations > 58 ppb being exceeded in the water column. This is the total concentration including dispersed and dissolved diesel.

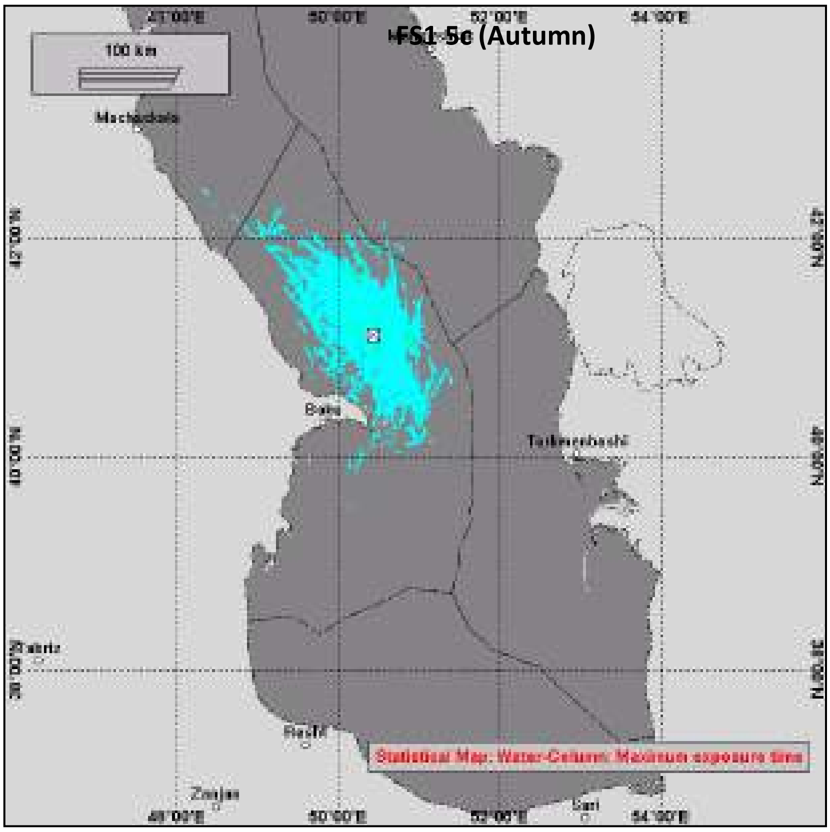


Map Key

Figure 8.6: Probabilistic Simulation Results – Duration of Diesel Concentrations in Water Exceeding 58 µg/l (ppb) for Worst Case Scenario 5 (Autumn)

Maximum Water Column Exposure to Diesel Concentrations exceeding 58 ppb (Probability >1%)

Maximum water column exposure in days where diesel concentrations (dispersed and dissolved) exceed 58 ppb (Probability >1%)



Map Key

Exposure Time (days)

- 0 - 1
- 1 - 2
- 2 - 4
- 4 - 7
- 7 - 10
- 10 - 14
- 14 - 17
- 14 - 20
- 20 - 25
- 25 - 30
- > 30

Median Line

Release Site

The shoreline oiling is expected to occur mainly along the northern coast of the Absheron Peninsula, although some shoreline oiling may occur in isolated and more distant locations, including the following designated/protected areas outside Azerbaijan with a probability of 1% (Figure 8.7):

- In Russian Federation:
  - **Chechen' Island and East Side of the Agrakhan Peninsula IBA** - Located approximately 420 km NNW of Baku, the area provides habitat for resident, breeding and migratory birds, including the Little Bustard and the Ferruginous Duck (Aythya nyroca)) which are both Near Threatened on the ICUN Red Data List;
  - **Sulakskaya Lagoon** - Covering an approximate 2,000 hectare, the area is located approximately 400 km NNW of Baku. The IBA has been triggered by the presence of the Little Bustard;
  - **Agrakhansky Zakaznik** - An IUCN IV category area located approximately 420 km NNW of Baku covering approximately 390km2. The boundary for the site overlaps with the Chechen' Island and East Side of the Agrakhan Peninsula IBA; and
- In Islamic Republic of Iran
  - **Lisar Protected Area and IBA** - Located approximately 300 km SSW of Baku and covering an area covering approximately 31,000 hectares. The area includes the entire watershed of the Lisar River from its source near the crest of the Alborz Mountains to the Caspian Sea. The area hosts species and has been designated as an IBA. Coastal bird species include the Osprey (Pandion haliaetus) and White-tailed eagle (Haliaeetus albicilla); both are categorized as of LC under the ICUN Red Data List;
  - **South Caspian shore, from Astara to Gomishan IBA** - Covering approximately 65,000 hectares, the area extents for the whole length of the Iranian Caspian Sea coastline. The area is important for a wide variety of migratory waterfowl, diving ducks and gulls in winter and terns on migration.

Figure 8.7: Shoreline Oiling Probabilities combined for Worst Case Scenarios 3 and 5

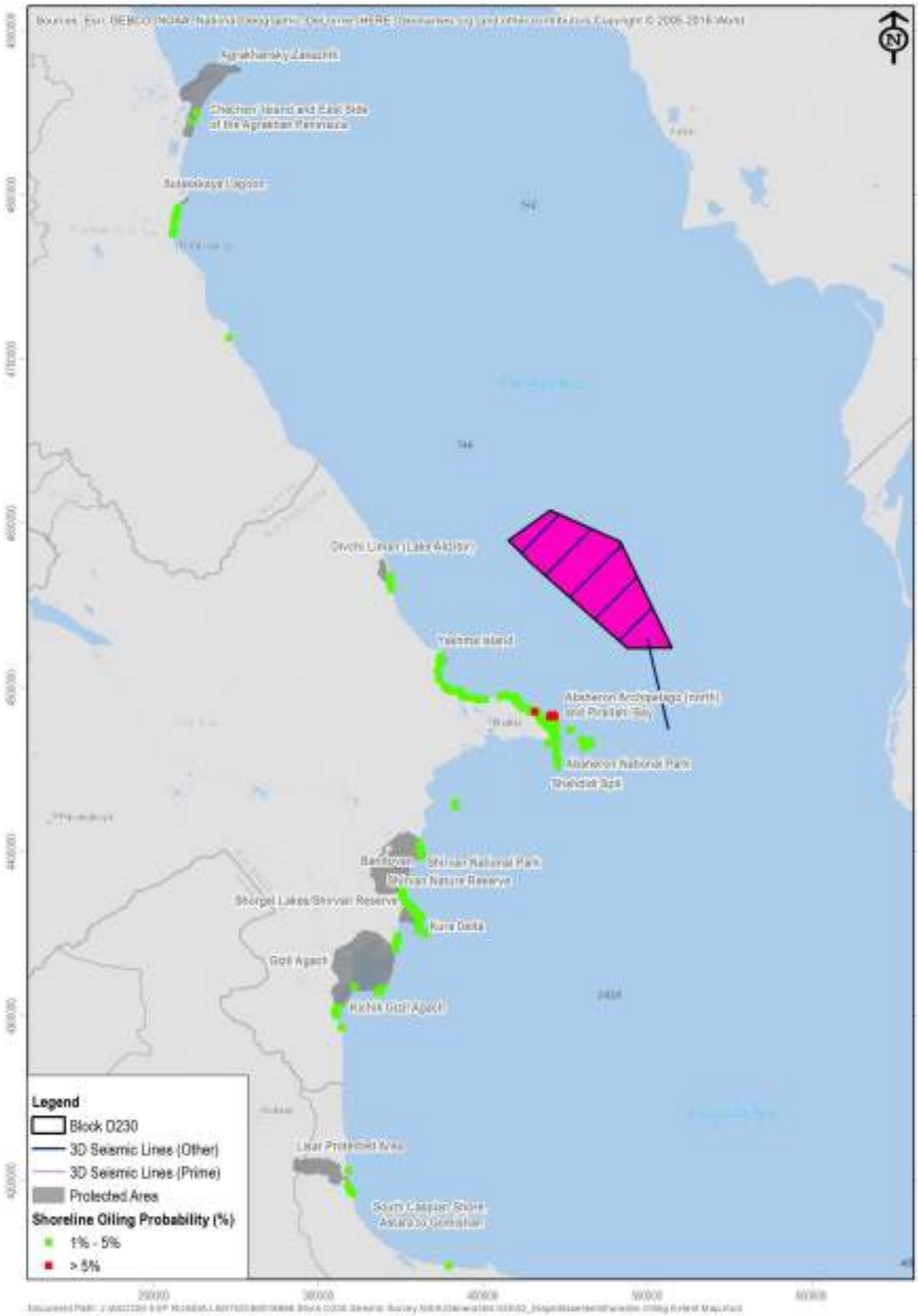


Table 8.3 below shows the probability and minimum arrival time of diesel to international shorelines for both Worst Case Spill Scenarios 3 and 5 predicted by the modelling with the probability of diesel beaching in Russia and Iran predicted to be 1% after a minimum of 13 days from the time of release.

Table 8.3: Probabilistic Simulation Results – Shoreline Oiling in Transboundary Context

Oil Spill Modelling Summary						
Spill scenario / descriptor	Seismic Vessel Diesel Release – 800 tonnes release at FS1 Location					
Worst Case Spill Scenario 5 (Release Location FS1)						
Predicted beaching locations	Probability of beaching and minimum time to beach (days)					
	5a (FS1 Spring)		5b (FS1 Summer)		5c (FS1 Autumn)	
	Probability	Time	Probability	Time	Probability	Time
Iran			1	15	1	15
Russia			1	18		
Worst Case Spill Scenario 5 (Release Location NS3)						
Predicted beaching locations	Probability of beaching and minimum time to beach (days)					
	3a (NS3 Spring)		3b (NS3 Summer)		3c (NS3 Autumn)	
	Probability	Time	Probability	Time	Probability	Time
Iran			1	13		
Russia	1	22				

Table 8.4 summarises the shoreline oil beaching probabilities for the designated/protected areas outside of Azerbaijan. It should be noted that beaching at the protected sites in Russia is more likely to occur under spring metocean conditions, outside of the planned survey operational period. Low volumes of diesel that may reach the remote coastal areas outside Azerbaijan are expected to biodegrade within a short period of time (weeks to months).

The effect of hydrocarbons have the potential to cause detrimental effects on water and sediment quality, marine and coastal flora and fauna, including plankton, benthic invertebrates, fish, seabirds, and marine mammals that may come into contact with an area of a spill. Impact on fisheries and indirectly on human health via the food chain is also possible depending on the scale of the spill and its proximity to the fishing grounds. The vulnerability of marine and coastal receptors, including fisheries, to hydrocarbon spills is summarised in Table 7.4 in Chapter 7. All of these receptors including protected areas and IBAs are present in the international waters and shorelines that can be affected by the spill. However, considering the predicted low probability of a major fuel spill (800 tonnes) to affect the territorial waters (1-6%) and coastline of neighbouring countries (1%), as well as limited spatial and short term effects on the marine and coastal receptors, the overall potential transboundary impact from a major fuel spill is considered to be not significant.

Table 8.4: Probabilistic Simulation Results – Shoreline Oiling of Designated / Protected Areas in Transboundary Context

Designated / Protected Areas[1]	Ornithological Important Area	Designation	Country	Probability of Shoreline Oiling
Chechen' Island and East Side of the Agrakhan Peninsula	✓	IBA/KBA	Russian Federation	1
Sulakskaya Lagoon	✓	IBA/KBA	Russian Federation	1
Agrakhansky Zakaznik	✓	Habitat/ Species Management Area IUCN Category IV	Russian Federation	1
South Caspian shore, from Astara to Gomishan	✓	IBA/KBA	Islamic republic of Iran	1
Lisar Protected Area	✓	IBA/KBA	Islamic Republic of Iran	1

8.3 Conclusion

The proposed D230 Seismic Survey activities have the potential to result in the following transboundary impacts:

- Contribution to the global climate change from the emissions of greenhouse gasses (GHGs), and gases contributing to acid rain effect (sulphur dioxide and nitrogen oxides);
- Marine pollution resulting from a *major* fuel spill in an unlikely accidental event (i.e. vessel collision).

The potential for other planned seismic survey activities and aspects (i.e. generation of underwater sound, physical presence of vessels and equipment; aqueous discharges etc.) to cause transboundary impacts is considered unlikely taking into account the Project area of influence is limited to the seismic data acquisition area and the surrounding approximately 10 kilometres (as defined within Section 3.4.2 and informed through the specific impact assessments presented within Chapter 6). None of the EEZs for neighbouring countries overlap with the Project area of influence, with the nearest boundary located approximately 6.8km from the area of influence boundary.

GHG emissions from the proposed survey are estimated to represent approximately 0.0214% to the annual national emissions (based on 2016 national GHG inventory). Emissions of sulphur oxides and nitrogen oxides from the Project vessels are considered negligible compared to the overall emissions associated with shipping in the Caspian Sea.

The predicted probability of the spilled diesel from a major fuel spill to reach the territorial waters and coastlines of the countries neighbouring Azerbaijan is predicted to be low (1-6%). Spill modelling has also indicated a limited spatial extent of the potentially affected areas, with an expected short term effect on the marine and coastal receptors (1-2 days for open waters and up to few months for shoreline habitats as a worst case scenario). The overall transboundary impact from a major fuel spill (a loss of full fuel inventory of 800 tonnes from the survey vessel) is therefore considered to be not significant.

In conclusion, the transboundary effects from the Project activities are not anticipated to be significant.

9 Environmental and Socio-Economic Management

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9.1 Introduction

This Chapter provides an overview of the overarching BP operational management system under which environmental and socio-economic issues associated with the Block D230 Seismic Survey will be managed. Seismic Contractor has not yet been identified but will have their own HSSE management system in place that will be compliant with BP corporate requirements.

9.1.1 Overview of AGT Region Operating Management System

The Azerbaijan Georgia Turkey (AGT) Region manages BP's operations in Azerbaijan and have an established Operating Management System (OMS). The OMS is a structured set of processes designed to keep operations safe, compliant and reliable. This system forms the structured framework to the Health, Safety, Security and Environment (HSSE) performance of the organisation for which there are six key stages as set out in Figure 9.1:

- Intent;
- Risk Assessment & Prioritisation;
- Planning & Controls;
- Implementation & Operation;
- Measurement, Evaluation & Corrective Action; and
- Management Review & Improvement.

Figure 9.1: AGT Region Operating Management System

9.2 Implementation

9.2.1 Roles and Responsibilities

BP will have overall responsibility for managing the Block D230 Seismic Survey and will be monitoring and verifying the implementation of environmental and socio-economic mitigation measures detailed in this ESIA.

The Block D230 Seismic Survey Contractor will be responsible for performing the Seismic Survey under their own HSSE Management System while complying with BP's corporate standards as well as commitments stipulated in this ESIA. Project management documentation will be developed, including plans detailed in Section 9.3 below, which will provide interface between the Block D230 Seismic Survey Contractor's HSSE System, BP Operating Management System and the ESIA. The Block D230 Seismic Survey Contractor will be expected to conform fully to the relevant aspects of these interface documents.

9.2.2 Training

Vessel crews will be trained to undertake seismic operations in compliance with national and international requirements. Dedicated marine mammal observation training will take place prior to project commencing. All training material will be reviewed and agreed with BP. The training will involve presentations and distribution of guidance documents to vessel crews that will include, but will not be limited to:

- Caspian seal identification;
- Observation methods and techniques;
- Communication protocols between trained vessel crew and vessel Master;
- Actions to take in the event of observing a seal during the 3D Seismic Survey; and
- Recording and reporting requirements.

Furthermore, there will be overall training to raise the environmental and social awareness of seismic contractor's personnel.

9.2.3 Project Environmental and Social Management Framework

Environmental and socio-economic mitigations and management measures discussed in this ESIA will form the Environmental and Social Management framework for managing social and environmental issues throughout the duration of the D230 Seismic Survey including 'pre-survey, 'during survey' and 'post survey' stages.

The D230 Seismic Survey Contractor will develop a Project specific Environmental and Social Management and Monitoring Plans (ESMP) under their existing HSSE Management System; which will be reviewed and approved by BP before the Project begins. The plans will cover the following topics:

- Environmental Management;
- Communication Management;
- Waste Management; and
- Spill Prevention and Emergency Response.

The plans will identify key criteria (e.g. waste volumes, discharge parameters, marine mammal observations, communication frequency etc.) that will be used to measure environmental and social performance.

BP will verify that mitigation measures and commitments set in this ESIA are implemented. This will be achieved through inspections, the results of which will be documented within "Site Inspection Reports". An action-tracking system will be maintained to monitor the effectiveness of the closure of actions.

9.3 Management Plans

The section below provides an overview of the plans, which will be developed specifically for the Project by the D230 Seismic Survey Contractor. Reference is made to Table 9.1, which provides a summary of the key design controls and mitigation measures set out in Chapters 4, 6 and 7 of this ESIA and includes cross references to the location of these measures within this document.

9.3.1 Environmental Management Plan

The Project specific Environmental Management Plan will set out the necessary measures (presented in Chapters 4 and 6 of this ESIA, and summarised in Table 9.1) to prevent pollution and limit impacts on the marine environment. The plan will also detail Caspian seal observation protocols in compliance with JNCC Guidelines.

9.3.2 Communication Management Plan

A Communication Management Plan will set out the communication protocols and key requirement as presented in this ESIA (Chapters 4 and 6) and set out in Table 9.1. This includes communicating the survey programme to the relevant authorities and stakeholders both prior to and during the survey.

9.3.3 Waste Management Plan

The D230 Seismic Survey Contractor will develop a Waste Management Plan which they will maintain throughout entire duration of the Block D230 Seismic Survey. The Plan will address the anticipated waste streams, likely quantities and any special handling requirements.

The Plan will be developed to ensure waste management is undertaken in line with the applicable national regulatory requirements, good international industry practices, BP's AGT Region Waste Manual. Key aspects of the Plan include the following points:

- Waste will only be routed to those waste disposal facilities that have been approved for use by the AGT Region.
- Non-hazardous waste generated offshore will be segregated, compacted and stored on-board vessels, and then transferred to shore to BP approved waste management facilities for disposal or recycling.
- The seismic survey vessel will have onboard incineration facilities for wastes that are appropriate to burn at sea (in compliance with MARPOL 73/78 Regulations), such as food waste. Resultant incineration residues will be returned to shore for disposal at an appropriate licenced onshore waste reception facility.
- Hazardous waste streams will be segregated and stored separately to prevent contact between incompatible waste streams. Hazardous waste generated offshore will be stored on board the vessels in fit for purpose containers and in designated areas and transferred onshore to licensed waste facilities for treatment and disposal.
- All waste transfers will be accompanied by individual Waste Transfer Notes (WTNs), confirming the waste type, quantity, waste generator, consignee, consignor (if different from the generator) and in the case of hazardous wastes, Material Safety Data Sheet (MSDS) and Waste Passports, where required. Hazardous Waste consignments will be accompanied with Hazardous Waste Passports.

9.3.4 Spill Prevention and Emergency Response Plan

The Spill Prevention and Emergency Response Plan will provide guidance and actions to be taken during a spill incident associated with the Project and will include the measures outlined in Chapters 6 and 7 of this ESIA as briefly summarised in Table 9.1.

The vessels will have Ship Oil Pollution Emergency Plans (SOPEP) detailing response resources and action required to manage fuel spills and to minimise associated impacts on the marine environment.

Table 9.1: Summary of Key Design Controls, Mitigation Measures, Monitoring and Reporting Requirements

Theme	Reference	Summary of Key Measures Outlined in ESIA Report	Execution Stage161
Environmental Management and Pollution Prevention	Chapter 4 Project Description, Section 4.6.2 Emissions to Atmosphere	All shipboard emissions will be in compliance with MARPOL 73/78 Regulations for the prevention of air pollution from ships (Annex VI), aiming to reduce global emissions of SO_x, NOx and particulate matter.	DS
	Chapter 4 Project Description, Section 4.6.5 Light	The survey and support vessels to be deployed during the towed streamer seismic survey will carry appropriate navigation lights for operating during night-time and periods of poor visibility. The level of lighting will be in compliance with safety regulations at sea.	DS
	Chapter 4 Project Description, Section 4.7 Operational and Design Controls	Develop Project specific management plans and procedures to address any risks associated with the maritime safety, waste management, emergencies and spills, etc.	Pre-S
	Chapter 4 Project Description, Section 4.7.2 Underwater Sound Management	The Project will comply with JNCC guidelines for minimising the risk of injury and disturbance to marine mammals from seismic operations. The mitigation and observation zone will be 700m around the energy source.	DS
		The lowest practicable seismic energy levels will be used throughout the survey. The energy source will be turned off during line changes where feasible but data acquisition may also be conducted uninterrupted.	DS
	Chapter 6 Environmental and Socio-Economic Impact Assessment, Mitigation and Management, Section 6.3.2.4 Caspian Seal Impact Significance, Mitigation, Monitoring and Reporting	A final report summarising the Caspian seal observations over the duration of the survey and including all the daily log forms will be submitted to BP upon completion of the survey.	PS
	Chapter 6 Environmental and Socio-Economic Impact Assessment, Mitigation and Management, Section 6.4.1 Existing Design Controls	Ballast water intake will be from the Caspian Sea and will not represent a risk of introducing invasive species.	DS
	Chapter 4 Project Description, Section 4.6.4 Discharges Chapter 6 Environmental and Socio-Economic Impact Assessment, Mitigation and Management, Section 6.4.2.2 Impact Magnitude and Significance	Aqueous discharges from the vessels will comply with the standards set out by the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78 (as amended)), more specifically Annexes I and IV. The sewage treatment plant (if available) will be certified to IMO standards. Effluent composition will be regularly monitored against the established discharge criteria. If treatment is not possible (e.g. due to unavailability of the treatment unit) sewage will be stored and shipped to shore for treatment and disposal.	DS
	Chapter 4 Project Description, Section 4.6.6 Chemical and Hazardous Materials	Strict handling procedures will be in place for all of the hazardous materials on board the vessels and the vessel crews will be trained in chemical handling and spill response.	DS

Theme	Reference	Summary of Key Measures Outlined in ESIA Report	Execution Stage161
	Chapter 4 Project Description, Section 4.7.1 Maritime Safety and Communications	Survey will be only undertaken if pre-established operating criteria for weather conditions (e.g. wind, waves and visibility) is met	Pre-S, DS
Waste Management	Chapter 4 Project Description, Section 4.6.3 Waste	With the exception of incinerated waste, all waste will be segregated, labelled and stored in fit for purpose containers for the final disposal onshore.	DS
		Authorised combustible waste, including food waste, will be incinerated using onboard incinerator (where available) in compliance with MARPOL Annex VI regulations; residual ashes will also be stored onboard for final disposal at approved onshore facilities.	DS
		The following waste management criteria and protocols will be implemented throughout the seismic survey: • An overarching Contractor's Waste Management Plan • In accordance with MARPOL 73/78 requirements, survey and support vessels will maintain an Oil Record Book. The book will be used to record how, when and where waste oil, bilge water, oily material, sludge etc., are disposed of. Recognised waste disposal authorities or contractors will undertake disposal of any waste generated onboard. Disposal details will be recorded in the vessel's Oil Record Book; • Survey vessel and support vessels will maintain a Garbage Management Plan and Garbage Record Book to record how waste items, other than mentioned above, are managed and disposed of. The Garbage Management Plan will classify waste types according to MARPOL specification and BP's AGT Region Waste Manual and lists item type, quantity stored on-board, waste delivered ashore, and how much waste has been generated (e.g. food waste, incinerator ash); and • All wastes[9] will be shipped to shore for disposal in accordance with the existing AGT Region Waste Manual. ([9] Not including waste that is incinerated on board but including incineration ashes.)	DS
Communication	Chapter 4 Project Description, Section 4.7.1 Maritime Safety and Communications	The seismic survey programme will be diligently planned and potential interference with sea users will be minimised through effective communications with the relevant authorities and stakeholders prior and during the survey. All appropriate permits and compliance conditions will be sought and obtained well in advance of the operations;	Pre-S
		Notifications regarding the survey programme (including timing and locations) will be issued to the relevant maritime and port authorities, as well as directly communicated with sea users where necessary, in advance of the survey.	Pre-S
		The Project Team will advise the LCR of project vessel movements using a daily survey plan to reduce any conflict with activities under their control.	Pre-S, DS
		Vessel movements will be directed by the seismic contractor's LCR, but controlled by the navigation system and Master of the vessel. Clear lines of communication and operational procedures will be established between all survey and support vessels before the start of surveying;	Pre-S, DS
		Advanced positioning equipment will provide accurate information on the position of the survey vessel and associated equipment, which will be communicated to other vessels.	Pre-S, DS

Theme	Reference	Summary of Key Measures Outlined in ESIA Report	Execution Stage161
	Chapter 6 Environmental and Socio-Economic Impact Assessment, Mitigation and Management, Section 6.5.2.2 Impact Magnitude and Significance	The measures to be implemented to minimise impacts to international shipping include the following: • Prior to the seismic survey BP will undertake a Shipping Risk Assessment to assess maritime traffic within and surrounding the D230 Block. The assessment will identify the type of vessels, frequency and the destination; and • Following the review of the Shipping Risk Assessment it may be deemed necessary to use additional support vessels to enforce the exclusion zone.	Pre-S, DS
Spill Prevention, Response	Chapter 6 Environmental and Socio-Economic Impact Assessment, Mitigation and Management, Section 6.2 Scoping	Vessels will be well maintained and use low sulphur fuel as per MARPOL Annex VI requirements.	Pre-S
		Support vessels will bunker fuel in one of the dedicated ports in Baku which are adequately equipped and have oil spill contingency plans in place.	DS
	Chapter 7 Cumulative and Accidental Events, Section 7.3 Accidental Events	High operational performance and compliance with good industry practices will be maintained at all times by BP and the seismic contractors;	DS
	Chapter 7 Cumulative and Accidental Events, Section 7.3.2 Release of Chemicals / Waste	All chemicals will be stored in sealed containers and in areas with secondary containment. Any waste streams generated during the seismic survey activities will also be stored on board in fit for purpose containment and transferred to shore by support vessels using good industry practices and duty of care procedures.	DS
	Chapter 7 Cumulative and Accidental Events, Section 7.3.2 Release of Chemicals / Waste	Where loss of high risk hazardous chemicals and waste occurs, salvage operations will be organised promptly (no later than 24 hours after the reported accident) to minimise potential toxic effects on the marine biota.	DS
	Chapter 7 Cumulative and Accidental Events, Section 7.3.4 Spill Prevention and Response Planning	The specific technical and operational control measures in place to minimise the potential for spills during the D230 Seismic Survey offshore include: • Audits of the seismic survey and support vessels will be undertaken to ensure vessels meet relevant IMO standards (e.g. condition of the vessel) and BP contract requirements; • The seismic contractor will have a Shipboard Oil Pollution Emergency Plan (SOPEP) in place, in accordance with IMO guidelines. The SOPEP will include among others, oil spill contingency and response procedures to be implemented during refuelling operations. The contractor will ensure competency of the vessel crew in SOPEP implementation; • Survey activities will be undertaken in compliance with operational weather restrictions for vessels in line with BP's existing marine operations and geophysical survey procedures; • Regular maintenance and inspection of equipment and high risk spill points (in particular bunkering hoses, bunds, storage tank valves etc.) will be undertaken; • Chemical selection procedures will be implemented to minimise chemical use; • Strict refuelling procedures to be followed will be implemented and bunkering operations will be supervised at all times for both the seismic and support vessels; • Non-return valves will be installed on fuel transfer hoses; • Regular preventative maintenance to prevent leaks by repairing or replacing equipment such as hoses and tanks will be undertaken; • Staff training in hazardous materials management, refuelling and waste management roles, as applicable to their roles will be provided;	Pre-S, DS

Theme	Reference	Summary of Key Measures Outlined in ESIA Report	Execution Stage161
		• Implementation of appropriate handling and storage procedures and storage of all hazardous substances within designated areas and in fit for purpose containers (i.e. sealed/hermetic drums) to minimise the risk of leaks and spillage will be undertaken; • Materials Safety data Sheets (MSDS) for all chemicals stored on board will be made available to facilitate efficient spill response; • Reporting of all minor spills will be undertaken to detect underlying trends, and task risk assessments; and • Appropriate spill response and containment equipment will be provided at specific locations based on risk assessment. This will allow rapid response should a spill occur.	
		Under MARPOL regulations the seismic survey and support vessels (over 400 tonnes gross tonnage) are required to develop and maintain a Shipboard Oil Pollution Emergency Plan (SOPEP). The seismic contractor and BP will be responsible for ensuring the SOPEP for each vessel is aligned with the relevant AGT Region OSRPs and spill response procedures prior to the survey mobilisation.	Pre-S

10 Conclusions

This Report presents the findings of the Environmental and Social Impact Assessment (ESIA) for the Block D230 Seismic Survey covering approximately 4,000 km², and including acquisition line extending south of the block boundary into the Dan Ulduzu Ashrafi Contract Area. The assessment process has systematically identified and evaluated impacts associated with routine operations and accidental events.

The main environmental sensitivities identified in the Project area of influence include Caspian Seal (IUCN[162] Endangered), birds and fish species (including sturgeon, IUCN Critically Endangered). The benthic communities and plankton are considered of value to the local ecosystem, however not of conservation importance. There are no protected areas in the vicinity of the survey area, with the closest being Absheron National Park and a number of coastal Important Bird and Biodiversity Areas (IBAs) such as Divichi liman, Yashma Island, Shahdili Spit and Pirallahi Bay, all of which are at least 50 km away.

The key socio-economic sensitivities include international shipping lanes transecting Block D230. Fishing grounds are predominantly located to the south and along the coast of Azerbaijan. There are also a number of coastal sites in the Absheron Region used for recreational activities and water sports, including beach clubs and hotels.

The assessments within the ESIA show that majority of impacts from the proposed survey will be minimised to low and negligible significance through the implementation of the control measures embedded into the project design. The project will be carried out in a full compliance with applicable national and international regulations. Notifications on the survey programme will be issued to relevant authorities and stakeholders to ensure surveys proceed with minimal disruption to other marine users. The survey seismic contractor will adopt good international industry practices, such as soft start procedures, effective waste and emissions management, strictly controlled refuelling procedures. Support vessels will be used to maintain the exclusion zone around the seismic vessel and associated equipment to ensure operational safety and prevent collision with other marine users. Trained vessel crew will undertake visual observations of Caspian seals as part of the soft start procedures and where possible throughout the seismic acquisition.

Survey activities that have the potential to cause impacts of moderate to high significance following the implementation of control measures embedded in the survey design include: (i) physical presence of vessels and equipment (ii) operation of seismic energy sources generating low frequency impulsive underwater sound (iii) accidental major spill (800 tonnes of marine diesel – worst case scenario of a full seismic vessel fuel inventory). The potentially significant impacts associated with the routine survey operations include disturbance or injury to protected Caspian seals, and interference with international shipping. The potentially significant impacts from a major fuel spill may result in a wider pollution of the marine environment and protected coastal sites; oiling of Caspian seals and birds leading to chronic illness and mortality; and indirect effect on fisheries. To mitigate these potentially significant impacts additional mitigation measures will be implemented to reduce their significance as far as practicable:

- Seismic acquisition to avoid most sensitive period for Caspian seals, spring season;
- Undertake a Shipping Risk Assessment to assess maritime traffic within and surrounding the D230 Block. Following the review of the Shipping Risk Assessment it may be deemed necessary to use additional support vessels to enforce the exclusion zone; and

Verification of spill prevention and response planning activities aiming to minimise the risk of the major spill occurring and its consequences.

Following the implementation of additional mitigation measures all residual impacts from routine survey activities are assessed to be of negligible or low significance, except the underwater sound effect on Caspian seals remaining moderate during the summer-autumn period.

The proposed D230 Seismic Survey activities, in combination with other seismic surveys that have already occurred or planned during the 2015-2020 period, is unlikely to have significant cumulative impacts on the marine fauna and marine users, with the exception of the effect of seismic sound on

[162] International Union for Conservation of Nature and Natural Resources (IUCN)

Caspian seals during autumn migration. It has been recommended that other seismic surveys being planned in the Central Caspian are timed to avoid the months of October and November.

In addition to the above, this report also considered potential transboundary impacts that include:

- Greenhouse gas (GHG) emissions from the proposed survey, which is estimated to represent approximately 0.0214% to the annual national emissions (based on 2016 national GHG inventory). Emissions of sulphur oxides and nitrogen oxides from the Project vessels are therefore considered negligible compared to the overall emissions associated with shipping in the Caspian Sea.
- Marine pollution resulting from a *major* fuel spill in an unlikely accidental event (worst case scenario i.e. vessel collision).

The predicted probability of the spilled diesel to reach the territorial waters and coastlines of the countries neighbouring Azerbaijan is predicted to be low (1 to 6%). The spill modelling indicates that the highest probability of a fuel spill to cross an international median line is for Turkmenistan – 6%. The probability of diesel reaching internationally protected / designated sites such as Chechen' Island and East Side of the Agrakhan Peninsula IBA, Sulakskaya Lagoon, Agrakhansky Zakaznik in Russian Federation, as well as Lisar Protected Area/ IBA and South Caspian shore from Astara to Gomishan IBA in the In Islamic Republic of Iran, is extremely low (1%). Moreover, the spatial extent of the potentially affected areas is limited, with an expected short-term effect on the marine and coastal receptors (1 to 2 days for open waters and up to few months for shoreline habitats as a worst case scenario). The overall transboundary impact from a major fuel spill is therefore considered to be not significant.

The environmental and social performance of the Block D230 Seismic Survey will largely rely on the responsible operator's management. BP will have overall responsibility for managing the Project, which will include monitoring and verifying the implementation of environmental and socio-economic mitigation measures stipulated in this ESIA.

APPENDICES

APPENDIX 4A

Waste Categories

Waste Category (MARPOL)	Main Constituents	Waste Category (AGT)	Handling and Disposal Route
Non Hazardous Waste			
Garbage (non-combustible)	Plastic, glass, domestic waste, cooking oil and incinerator ash	• Domestic/office wastes • Plastics - recyclable (HDPE) • Oils - cooking oil • Incinerator ash	Segregated and compacted waste is stored onboard for disposal at suitable facilities onshore.
Garbage (combustible)	Non-recyclable paper, packaging, wood and food waste	• Incinerator ash (following incineration)	Incinerated using MARPOL compliant onboard incineration facilities (most garbage is amenable to incineration with the exception of metal and glass; special rules on incineration may apply under domestic law in some ports; the incineration of plastic is subject to specific regulations). The resulting ash will be transferred to shore for disposal at licensed facilities.
Bilge water	Residual hydrocarbons and inorganic substances	• Water - oily	Stored on board and transferred onshore for treatment and disposal at licensed waste facilities.
Sludge	Residual hydrocarbons and organic and inorganic substances	• Sewage sludge • Tank bottom sludge (if not incinerated)	Either incinerated onboard using an International Marine Organisation (IMO) approved incinerator or stored onboard and transferred onshore for treatment and disposal at licensed waste facilities.
Hazardous Waste			
Clinical waste	Pathogenic organisms, plastic, glass, medicines and needles	• Clinical waste	Segregated and stored separately for disposal/ incineration at authorised onshore medical facilities.
Acids	Acids refer to substances and mixtures with a pH less than 7	• Acids	Segregated and stored separately to be transferred to shore for safe disposal at licensed hazardous waste management facilities. All hazardous waste streams will be managed in compliance with the requirements of BP's AGT Regional Waste Manual.
Solvents, degreasers and thinners	Organic solvents used as industrial cleaning solutions (degreasers) and paint thinner	• Solvents, degreasers and thinners	
Paints and coatings	Water-based liquid paints and oil/solvent based liquid epoxy resin paints, lacquers and varnishes.	• Paints and coatings	
Contaminated materials	Various materials that are lightly contaminated with oils, chemicals, etc.	• Contaminated materials	
Adhesives, resins and sealants	Solvent based adhesives	• Adhesives, resins and sealants	
Waste oil /fuel	Used refined petroleum distillates incl. engine lubrication oil, motor oil, transmission oil and hydraulic fluid. Diesel from generators etc. that cannot be reused	• Oils – fuel	
Batteries	General purpose batteries	• Batteries - dry cell • Batteries - wet cell	

APPENDIX 5A

Caspian Seal Report for D230 Seismic Survey

T.M.Eybatov, Zardabi Natural History Museum

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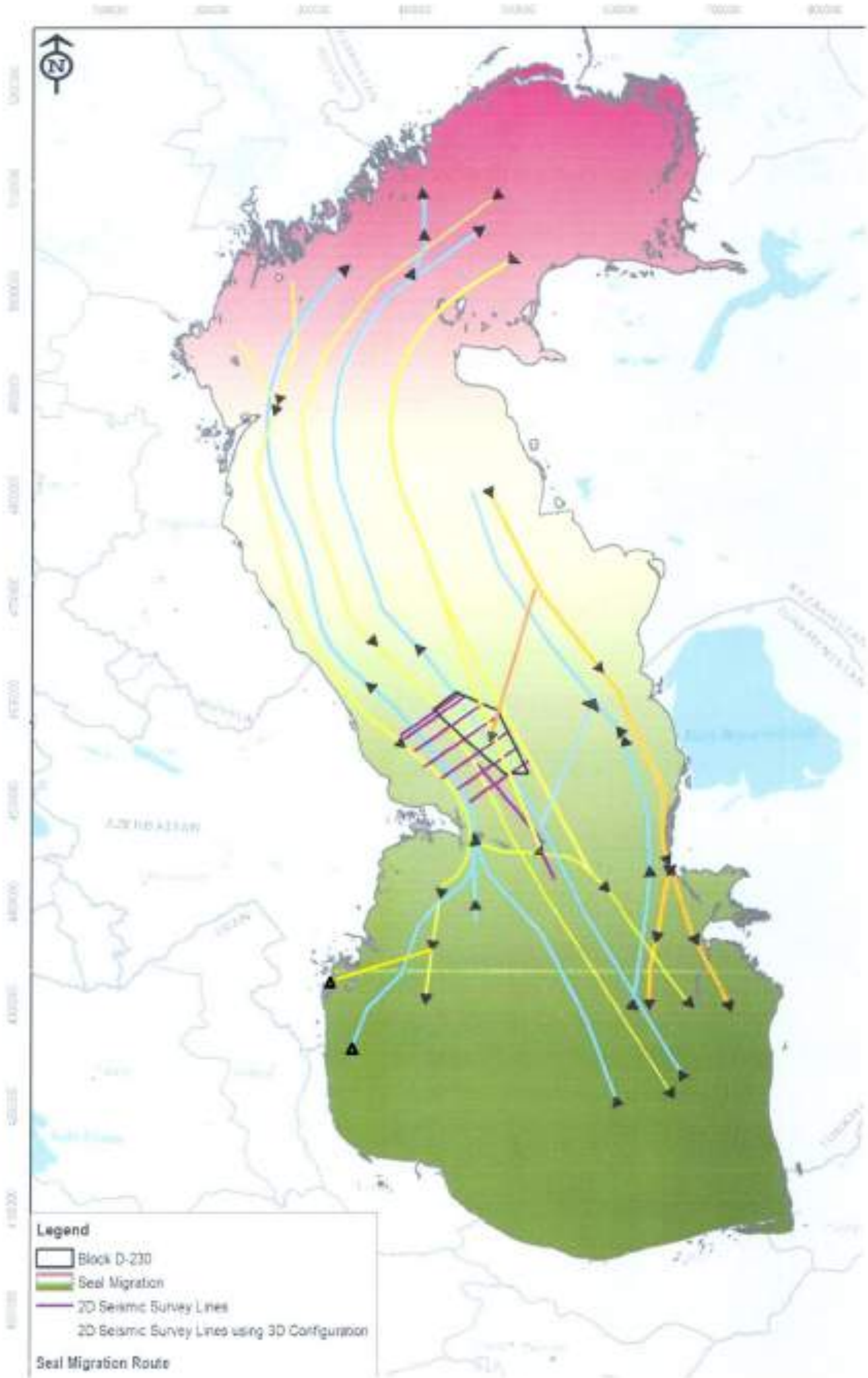
Introduction

The Caspian seal is a unique species endemic for the Caspian basin, a universal biological indicator of any environmental impact. The seal is the only marine mammal in the Caspian basin. It is included in the IUCN Red List of Threatened Species and the Red Book of Azerbaijan as vulnerable species. Maximum lifespan of the Caspian seal is identified as 50 years (Ref. 29 - Eybatov, 1976). Age of maturity of females is 7 or 8 years. Climax starts at 30 or 32. Only one 34 year old female was found with an embryo. Male species mature at the age of 8 or 9 years of age. Physical maturity age is 18-22 years. Signs of aging (osteochondrosis, osteoporosis, deforming arthrosis, root fragmentation in teeth) occur at 28-32 years of age (Ref.23 - D.B. Hajiyev, T.M. Eybatov, 1995). Throughout their life Caspian seals migrate from the North Caspian into the South Caspian where they spend summer months and come back in winter to pup on ice. Pupping occurs between the 25th of January and the 5th of February; the new born is called a “white pup” (“belyok”) due to the colour of his long fur; it weighs about 5 kg. Two weeks after birth moulting commences: long white fur is replaced with grey, and a new development stage begins (“tulupka”). A month later moulting completes, and the grey stage of development begins; it lasts up to 6 months and grey fur is then replaced with yellowish (yellow stage, “jeltyak”). A year later adult colours appear: males are usually bluish dark with bright spots, the colour of females is lighter. Seals mate on ice rather than in water, soon after females finish nursing white pups, i.e. a month after pupping. Males spend feeding period on ice and wait for the lactation to finish, then mate and stay on ice with females for some time; spring moulting occurs on ice. Females do not take any further care of their pups. When ice melts, seals start migrating south in two directions: the majority goes along the east coast of the Caspian, and the minority – down the west coast. They appear in the waters of Azerbaijan usually in late April – early May. Depending on weather, pupping and migration can move in time by a month. In the Absheron peninsula seals are found in the largest numbers in late April – early July. Later seals migrate to South and Middle Caspian; they feed in the central part and along the coast of Iran. They appear in Iran in June. The reverse migration starts in October and finishes in late November – early December. Figure 1 provided below illustrates seals migration routes in different seasons.

Figure 1: Updated Spring and Autumn Migration of Caspian Seal



Migration routes provided on the map above have been updated based on new data on the nature of migration of the Caspian seals obtained from the results of a seals tagging exercise (telemetry tags were used). A report on this research was published in 2016. (Dmitrieva L., Jüssi M., Jüssi I., Kasymbekov Y., Verevkin M., Baimukanov M., Wilson S., Simon J. Goodman S.J - Individual variation in seasonal movements and foraging strategies of a land-locked, ice-breeding pinniped. Marine Ecology Progress Series 554: 241-256 (2016)).

Note that the migration route from north to south followed by seals in spring is very wide and goes to the central section of the Caspian Sea. A significant number of seals stay at the north of the Absheron Peninsula, but most of them migrate to the east and south-east towards the Turkmen and Iranian waters. Autumn migration routes look similar to spring migration routes, but seals move in the opposite direction. It has been identified that seals migrating along the western coast for wintering, now migrate not only to Russian but also to Kazakh waters.

Tagging exercise results showed that migration is also carried out through the central part of the Caspian Sea. It was also identified that a large number of seals stay in the northern part of Azerbaijani water and some individuals travel to the deeper waters in the south part of Azerbaijani waters. Furthermore, results of the tracking of individual animal’s movement dynamics have established a chaotic movement of seals i.e. individual seals can move to the north, then to the south, then to the east and to the west in a single season. This process occurs even in winter because of icy conditions. This data have been obtained for the first time from this research.

It should be noted that spring migration flow in the north-south direction is not narrow; it is observed as a wide strip to the centre of Caspian. Significant part of seals remains in the north from the Absheron Peninsula, whilst major part migrates to the east and south-east towards Turkmenistan and Iranian waters. In spring some seals in small groups migrate to the south along the shallow near-shore zone through Shirvan and Kyzyl-Agach National Reserves. Small group moves to the deeper area of Caspian. Autumn migration follows practically same route in reverse direction. It was found that seals migrating along the western coast travel for wintering both to Russian and Kazakhstan water areas.

Following personal communications with Liliya Dmitriyeva, UK, it was possible to review papers on the airborne survey of seals in the North Caspian during 2005-2012 and a paper on seals' tagging with the purpose of the study of seasonal migrations. These papers are currently being reviewed and will soon be published. After a review of the aforementioned papers, an updated picture of seal migration in the area has emerged. Seal tagging showed that migration takes place also through the central part of Caspian. Also, in summer months many seals remain in the northern part of the Azerbaijan waters, and to a lesser degree found in deeper southern waters of the Republic. In the southern part of Azerbaijan territorial waters Caspian seals are mainly concentrated in the central part of the Caspian.

If in the late 19th century the population was, according to estimates, 1-2 million species, at the beginning of the 20th century the population was estimated at 1 million species approximately. During XIX and XX centuries hunting for seals, mainly white-coat seals, continued on the ice of North Caspian. At the end of XIX, beginning of XX century 115 thousand seals in average were caught every year. During 30-s of the XX century seals' catch was maximum - 227.6 thousand animals. Average catch in those years was 164.6 thousand animals (Ref. 24 - Caspian Sea, 1989). During 60-s of XX century seals' catch reached 85-100 thousand animals.

As a result of barbarian hunting population of seals was reduced to 350,000-400,000 species by 1980-1990 leaving just one seal per square kilometre of the Caspian Sea in average. Recent estimates for the number of seals in the Caspian Sea vary between 105,000 and 110,000 seals. This figure is presented in the Caspian Seal International Survey Report, according to abundance estimate of the Caspian seal conducted in 2006 (Ref. - 9). Dynamics of seal mortality in Azerbaijan confirms this figure as well. Recent mass mortality cases of the Caspian seal reduced the seals abundance significantly. Thus, in 2000 mass mortality resulted in the loss of several tens of thousands of seals in the entire Caspian Sea (Azerbaijan, Kazakhstan, Russia and Turkmenistan). Scientists have long been noting on the accumulation of various parasitic infections, heavy metals and pesticides (DDT and its derivatives, in particular) in the Caspian basin, but the main agent, which caused seal mortality in 2000, was identified as canine distemper virus or morbilli virus (Ref. 34 - Forsyth M.A., Kennedy S., Wilson S., Eybatov T.M., Barret T., 1998). Almost all seals studied at the time, tested positive for this morbilli virus. Previous studies (Ref. 28 - V.I.Krylov et al, 1990) also showed that pollution can cause infertility of females (some believe that female fertility reaches 70 per cent). The ratio of females not participating in reproduction still remains high (according to some data, up to 80 per cent).

According to V.I. Krylov et al. (1990), mercury levels in liver of youngs-of-the year and immature seals vary in the range of 1.84-4.52 mg/kg. High Hg content was established in dry and miscarried seal females, less often in pregnant females. Strong contamination of the Caspian basin had negative impact on reproduction and population of Caspian seals in recent years. Eildness of females varies from 39.8 to 59.8%. Toxicity studies carried out within the framework of ECOTOX program showed (Sh.Tanabe, 2002) that concentrations of 15 microelements (V, Mn, Fe, Cr, Co, Cu, Zn, As, Se, Mo, Ag, Cd, Tl, Hg, Pb) and organic mercury (Org-Hg) in liver, kidneys and muscles of Caspian seal.

The highest concentrations of these elements were observed in this order: liver, then kidneys and muscles of seals. In 2000 and 2001 concentrations of toxic elements (As, Ag, Cd, Tl, Hg, Pb, and Org-Hg) were registered in the organisms of Caspian seals, which were equal or lower than levels of same elements in the seals' organisms in 1993, or seals from other regions; this means that probably these elements are not the reason of mortality of Caspian seals. Alternatively, concentration of Zn and Fe in the affected organs of Caspian seals apparently was higher than that found in seals from other regions, which indicates to violation of homeostatic control and content of vitally important elements in the diet of Caspian seal.

According to V.I. Krylov et al. (1990), accumulation of pesticides (DDT and its metabolites, alpha- and gamma- hexachlorocyclohexane) in fat tissue varies in the range of 6.05-64.3 mg/kg of tissue mass, depending on the age, sex and capturing site. According to Sh. Tanabe and N.Kajiwara (ECOTOX 2002, 2008), polychlorinated biphenyls, dibenzo-p-dioxins and dibenzofurans, organochlorinated pesticides and organo-tin compounds were found in the liver oil of Caspian seals washed to the Caspian shores during unusually frequent cases of mass mortality in 2000 and 2001.

DDT contaminants, with concentrations from 3.1 to 560ng/g dominated among the investigated organochlorinated compounds based on lipidic-weight investigation. Content of organochlorinated compounds in Caspian seals washed to the Iranian shores was lower than in seals washed ashore in other regions. However, blubber layer was significantly thicker in seals washed ashore in Iran, and negative relationship between the contaminants' concentration and thickness of blubber layer in Caspian seals was observed.

Seasonal variation of blubber layer was evident, as this layer is thinning after the season of feeding and shedding. Consequently seals could be subjected to higher risk in spring, due to the impact of organochlorinated compounds. Levels of organochlorinated compounds found in Caspian seals in 2000 and 2001 were comparable to the levels of organochlorinated compounds in other marine mammals that have suffered from epizootics. Concentrations of dibenzo-p-dioxins / dibenzofurans in sick Caspian seals were lower than concentrations in seals from other regions, which meant that toxic effects of these contaminants were weaker, and they were not related to mass mortality of seals. Although level of toxic equivalent (TE) in seals was relatively low, current status of contamination with polychlorinated biphenyls and organochlorinated pesticides identified in Caspian seals poses a risk of immunodepression. Concentration of butylin compounds in livers of seals ranged from 0.49 to 17 ng/g on a wet-weight basis, and octyltin compounds were below limit of detection in all analyzed samples, suggesting less contamination with organo-tin compounds in the Caspian seals.

In addition to hunting and pollution, the Caspian seal is affected by other factors. For a long time, one of the main food sources of the seal was kilka (Clupeonella), small and highly abundant fish. During the last decade its stock has significantly reduced for various reasons: mass mortality in 2001; increased harvesting in 1990-2000; invasion of comb jelly fish *Mnemiopsis leidyi*.

Anxiety during pupping and nursing became another threat to the seals which was assessed only in recent years.

The same sharp decline in seal numbers occurred in Turkmenistan sector of the Caspian. According to our colleagues, in the 1980's-1990's V.I. Krylov conducted several surveys (Ref. 25 - 1982, Ref. 27 - 1983, Ref. 26 - 1984, 1990) and counted up to 12,000 seals in Ogurchinsky island, but during the last 4 or 5 years, according to P.Yerokhin, the abundance has not exceeded 2,000 specimens, i.e. it is obvious that the population of seals in the rookeries has reduced by 6 times. The number of new born pups has also reduced abruptly.

There is a similar trend in Kazakhstan, however, our Kazakh colleagues have only recently started studying seals in rookeries, so the real scale of reduction is not clear; but if previously on the islands and sand islands of Kazakhstan the abundance of seals was described in tens of thousands species, at present their number is much less. As for the Iranian sector, there were never any rookeries there, and at present projects of building sand islands are considered, in order to create rookeries there.

From 1997 to 2001 unusually an extraordinary numbers of dead bodies of Caspian seals were observed on the Caspian coast. Whereas, if earlier certain numbers of seal bodies had been found only on the northern coast of the Absheron Peninsula, in these years masses of dead seal bodies were registered in the near-shore area of Kazakhstan, i.e. in the regions where such cases had not been registered over a century. Unusually numerous were also dead seal bodies on the western shores of Caspian. In 1997 this figure only during one month (July) was about 10 thousand, and approximately 6 thousand of them - on the Azerbaijan shores (Ref. 32 - T.M. Eybatov, 1997). Numbers of dead seal bodies in 2000-2001 were even more unusual. Only officially registered seals' mortality on the territory of Kazakhstan within a short period was over 10 thousand and over 30 thousand animals all across the Caspian (Ref. 30 - Eybatov, 2010). Main reason of mass mortality of seals in the first place was epidemic induced by canine distemper virus. It is possible that this virus earlier was also present in Caspian seals, however mass epidemic took place during this period owing to concurrence of several circumstances (drastic fall of fish reserves, mass poisoning with DDT, which is widely used in agriculture of Caspian littoral states, mass disturbances for seals both offshore, and on the rookeries due to active oil-gas exploration and production, uncontrolled fishery when large numbers of animals get caught in nets, etc.). As for dead seal bodies found on the eastern shore, it is explained by the fact that earlier such investigations were not carried out there. With the appearance of Oil Company's interest in seals soared (see also Appendix 1).

11 Ecology of the Caspian Seal

11.1 Environmental Monitoring

No organizations in Azerbaijan carry out systematic studies of seals. Our group (late D.V. Gadzhiyev - world known paleontologist and anthropologist) and T.M. Eybatov studied seals as a model group of mammals (for the development of complex osteology) as private initiative. These studies were never financed by the state organizations. Acquisition of information from fishermen, oilmen and helicopter pilots has been done using friendly relations. Vast collection of skeletons (more than 600) and large number of skulls of Caspian Seal accumulated by our team is stored in the Azerbaijan Medical University, where Professor Gadzhiyev many years was the Head of the Chair of Biology and Genetics. Key information about the seals from the air we obtain from the helicopter pilots who transport oilmen shifts to Chilov island and Oil Rocks.

Employees of our laboratory carry out monitoring of dynamics of Caspian seal bodies washed ashore on the northern coast of the Absheron Peninsula since 1971 until present. During this time regular surveys were conducted over the Caspian shores, in particular over northern coast of the Absheron Peninsula, due to its geographic position with unique burials of dead seal bodies. Monitoring included calculation of seals on the coast, space distribution, sex-age composition and potential causes of death. Key monitoring area where investigations were carried out more regularly and comprehensively is 10-km coastal zone from the beach in Buzovny residential settlement to the North Power Station. Long-term observations have shown that dynamics of dead seal bodies washed ashore in this zone corresponds to averaged figure of dead seal bodies in the whole 100-km near-shore zone of North Absheron. (see main monitoring reports: Ref.: 29, 30, 31, 32, 33, 34, 35, 36 and also in the project: National report on the status of Caspian seal population in the Azerbaijan water of Caspian Sea. CaspEco project, T.M. Eybatov, K.M. Rustamova, 2010, 14 p. - Ref-17.

On 17-19 September 2009 International Workshop was held in Atyrau city (Kazakhstan) on Caspian Seal conservation: "Threats to existence of Caspian Seals. Obtained data, required investigations and mitigation measures". Workshop was organized by the Caspian International Seal Survey group (CISS); oil company Agip KCO jointly with the Darwin Caspian Seal Project research groups, and also representatives of the Caspian states involved in Caspian seal monitoring (Ref.20). As leader of the Caspian Seal research group within the framework of Darwin Initiative project for the Azerbaijan waters of the Caspian I presented results of monitoring studies of the Caspian seal in Azerbaijan.

Studies within the framework of Darwin Initiative project began on 1 July 2006 and were completed on 1 July 2010. Results of this project were partly published (Ref. 36 - Wilson S., Eybatov T. et al. 2014), or are in the editors offices of scientific journals.

The studies conducted during the previous years identified the following:

1. The aerial survey conducted in the North Caspian in winter, during the pupping of seals in ice rookeries, from 2005 till present, showed that the total abundance of pregnant females and, accordingly, pups, had reduced by a factor of 4, compared with 1990; it is 20,000 specimens at present. Thus, the abundance of the Caspian seal population at present is 100,000-110,000 specimens (CISS report).

2. It was also found that during the last three years from 2006 to 2009 pup production declined by 60%, namely besides general decline of seals population, birth rate falls down even more (Ref. 20 - CISS Report -2009 -Atyrau);

3. It was also identified that the total area of ice tends to reduce, which also affects the abundance of seals who pup on the ice (report by L. Dmitriyeva in 2015). Meeting in Moscow. 12-13 March 2015 "Caspian Seal: current status and problems of preservation and use"

4. Special attention is given to the mass death of seals during illegal fishing (poaching) and the preventive measures. It is believed at present, that the main reason of the mass death of seals in the Caspian is fishing with nets. Death in nets was always considered one of the main causes of seals' mortality; this was discussed practically at all meetings, however after the collapse of the USSR in all Caspian states, due to the absence of proper control over the fishery large-scale illegal fishing was observed (Ref. 17, 21, 22, 30, 31, 32)

5. It was also found that illegal seal fishing exists practically in all Caspian littoral states. For the first time it was reported at the meeting that in the Russian sector of Caspian Sea, in addition to licensed commercial fishing, illegal fishing and commercial processing of seals also took place in Dagestan Ref. 12 and Ref. 19 (report of the Russian research group led by A.Kondakov, 2009; in 2015 this information was confirmed: Ilya Yermolin and Linas Svolkinas - Fishing for Caspian Seal and use of products thereof in the Republic of Dagestan, Russia). Group of Kondakov also initiated monitoring

of dead seal bodies found on the Russian coast of the Caspian Sea, which would enable in future comparison of obtained data with numbers of dead seal bodies in Azerbaijan and Iran.

6. A group of Iranian colleagues presented information about measures combating death of seals in nets, including preventive activities (awareness campaigns among fishermen and local population, ref 21). The workshop also discussed the experience of colleagues from the European countries who designed nets safe for seals.

Monitoring conducted on the coast of the Absheron peninsula and on the island of the Absheron and Baku archipelagos, in the Azerbaijani sector of the Caspian, showed that since 2005 there were no permanent rookeries. Temporary haul-out sites are only observed during the spring migration from the north to the south (from April till May) and during autumn migration from the south to the north (in October-December). And these temporary haul-out sites are only found on the Southern spit and Urunos on Chilov island, as well as on small islands between Pirallahi and Chilov islands (Malaya Plita, Bolshaya Plita, Podplitochny and Dardanella, Coltush, Baklaniy and so on). There are no haul out sites or rookeries on the Shakhova spit any more. (Ref. 17. National report on the status of Caspian seal population in the Azerbaijan waters of Caspian Sea. CaspEco project, T.M. Eybatov, K.M. Rustamova, 2010, 14 p.)

In this report coordinates of seal rookeries (haul-outs) and sites visited by seals, as well as reasons of seals' absence at Shakhova spit are given. Absence of permanent rookeries on the territory of Azerbaijan and decline of sites of temporary seals' haul-outs to the islands at present is absolutely logical. As a result of violent urbanization - large scale construction in the coastal zone, population increase in the coastal zone, sharp increase of number of vessels involved in commercial transportation and activity of oil companies, as well as appearance of a large number of yachts and motor boats with high-power engines seals lost the areas of exit to the shore.

In 2009 helicopter pilots found an early migration of the Caspian seal in the Caspian. The first large group of seals, 300-500 specimens, was found on the 1st of April in the area of the Southern spit and islands located Pirallahi and Chilov islands (Malaya Plita, Bolshaya Plita, Podplitochny and Dardanella) (Ref. 30 - T.M. Eybatov. Caspian Seal (Pusa Caspica Gmel.) - Endemic of Caspian. News of the Azerbaijan National Academy of Sciences, Geosciences, № 4, 2010 p. 151-169 pp.

In the last 35 years seal monitoring has been conducted using vessels; observations have been recorded by offshore platforms staff and residents of Chilov Island. In addition, observations on the northern shores of Absheron peninsula, on Shakhova spit and Chilov Island have also been recorded. Since 1997, this data has been supported by ad-hoc observations by helicopter pilots. Based on the results of this monitoring, spring migration of seals has never commenced as early as did in 2009. Usually seals appeared in the area of Absheron archipelago at the end of April, beginning of May, occasionally at the end of May, and mass wash-outs of dead bodies to the northern shore was mainly observed in May and June. However beginning from 2009 this tendency changed and continued later. E.g., in 2011 and 2014 seals appeared in the area of Absheron archipelago on 1 April, and in the Azerbaijani waters - on 20 March. In these periods' dead bodies of seals appeared on the northern shore earlier. There are many causes of mass mortality. In the first place Absheron peninsula is unique natural burial ground of Caspian seals - it protrudes far to the East and main directions of currents and wind rose from the North Caspian bring dead seal bodies to its gently sloping shores. (Ref. 30 - Eybatov, 2010). Main causes of the first deaths are fishing nets, wherein mainly youngs of the current year and undernourished pups are caught.

11.2 Information on the Caspian Seal for the Last 5 years, 2010-2015 (A Meeting in Moscow on the 13th -14th March 2015)

The name of the meeting: The Caspian seal (CS): current status and problems of conservation and use.

Organizers:
IEE RAS, Marine Mammal Council, Russian Theriological Society, UNDP, University of Leeds

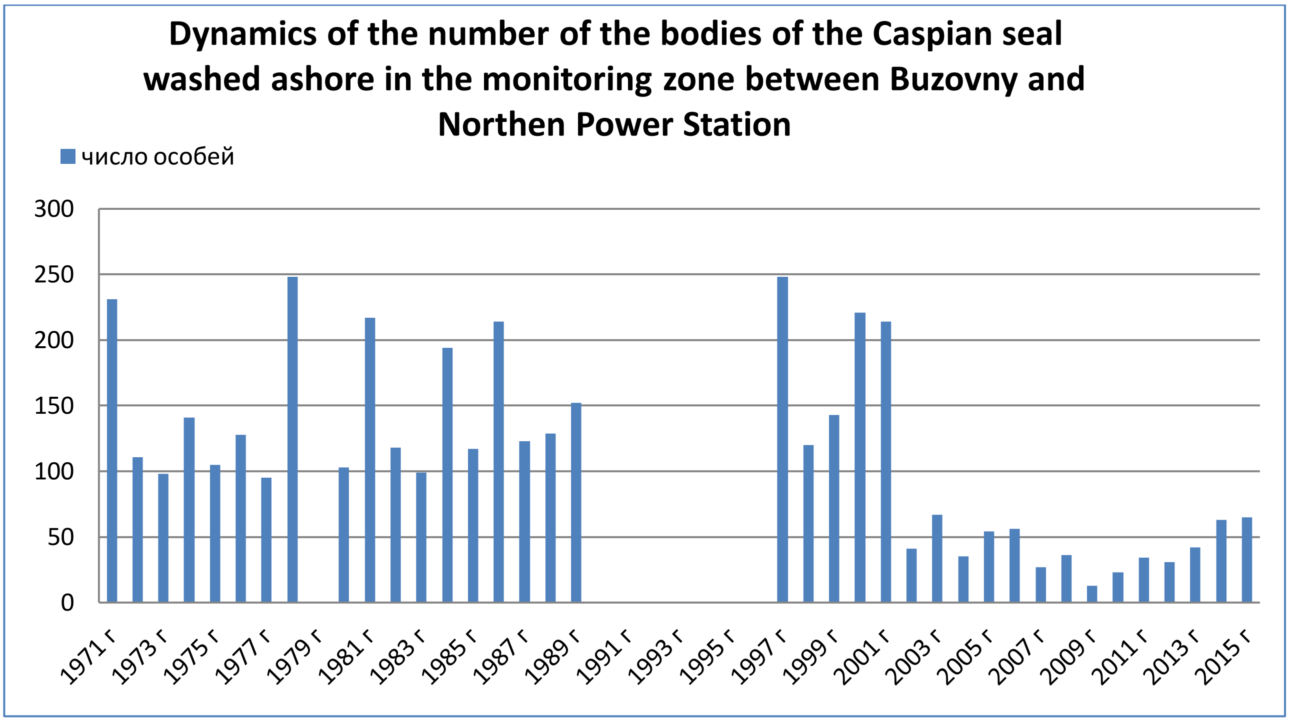
The dates and venue of the workshop - 11th to 13th March 2015, in Severtsov Institute of Ecology and

Evolution RAS (IPEE RAS), 33 Leninski prosp., Moscow, 119071, RUSSIA.

Two presentations were conducted by Tariel Eybatov:
1. The current state of the Caspian seals in Azerbaijan. Conservation of the seal habitats - status and prospects.

2. Caspian seal mortality in Azerbaijan – causes and solutions

Figure 2: The Total Abundance of Seals in the Caspian, According to the Last Meeting on the Caspian Seal which was Held in Moscow on the 13th-14th March 2016:



At present the total abundance of seals in the Caspian is identified at 100,000-105,000 species. The abundance was identified on the basis of aerial surveys made in the North Caspian during 10 years by CISS (the Darwin Initiative project) (L. Dmitriyeva, 2015. Registration of the Caspian seal rookeries by aerial survey in 2005-2012, summary). In Moscow Russian scientists tried to oppose this data with the information that the abundance of seals is much higher, that is between 400,000 and 450,000, i.e. it has not really changed in the last 20 years. They attempted to base their conclusion on thermal aerial survey in the Russian sector of the Caspian (V. Chernook, S. Shipulin, V. Kuznetsov, 2015. However, first, they carried out their investigations only during one year and just on the territory of Russia, not regularly, whilst at present most seals are breeding on the territory of Kazakhstan. On the territory of Russia seals breeding usually takes place in mild winters, in harsh winters - only on the eastern shores of Kazakhstan.

Table 1: Sex Composition of the Bodies Washed Ashore and the Ratio of Pregnant Females in the North Coast of the Absheron Peninsula

Sex composition of the bodies washed ashore and the ratio of pregnant females in the North coast of the Absheron peninsula				
2000	221	57,5%	42,5%	2,7 %
2001	214	63,5%	36,5%	0,5%
2002	41	41,5%	58,5%	2,4%
2003	67	31,3%	68,7%	6%
2004	35	42,8 %	57,2%	2,8%
2005	54	51,5 %	48,5%	3,7%
2006	56	32%	68%	8,9%
2007	27	40,7%	59,3%	11,1%
2008	36	38,9%	61,1%	16,6%
2009	13	38,5%	61,5%	7,7 %
2010	23	52,2%	47,8%	13%
2011	34	58,8%	41,2%	11,8%
2012	31	48,4%	51,6%	9,7%

2013	42	42,5%	57,5%	11.9%
2014	63	55,5%	44,5%	6,3%

As the graph shows (Fig.1), the abrupt reduction of the number of seals commenced in the early 21st century. Significant mortality of seals in 2000 and 2001 resulted in the fact that the abundance of seals did not exceed 100,000-105,000 starting from 2002, and this trend continued till 2009. In 2009 the number of bodies washed ashore was the lowest (13 specimens) since 1971. In the following years the number of bodies washed ashore remained low; however, their number tended to increase slowly, as did the abundance of seals in the Caspian. In 2014 the number of bodies washed ashore in the North Absheron increased significantly although not in the monitored area Buzovny-North Power Station, but in the villages of Nardaran, Pirshagi, Noukhani and the city of Sumgait. It is too early to speak about stabilization of the abundance of seals in the Caspian but there are two possible interpretations of the increased number of bodies washed ashore: either the abundance of seals is slowly increasing, or the number of bodies washed ashore in 2014 increased due to the increase in poaching. The animals found onshore were not skinny or sick. They were all well-nourished and had enough subcutaneous fat.

There were no very early migrations or bodies washed ashore since 1971, however, from 2009 till recent cases of early appearance of seals in Azerbaijani sector of the sea have become more often (see Table 3). Obviously, it is connected with the reduction of the area of ice in the North Caspian and early melting of the ice which made seals migrate south earlier.

It is also possible that the pups were undernourished and the mortality rate was higher among young specimens. At the meeting in Moscow L. Dmitriyeva also mentioned the reduction of the area of ice in the North Caspian during the last years.

In the past it was assumed that during spring migrations of seals to the Middle and South Caspian the majority of seals moves along the east coast (approximately 75,000-80,000 specimens), and the rest – along the west coast (15,000-20,000 specimens). Recently (Dmitriev et al. 2016) it was possible to determine that during spring and autumn migrations, seals move not only along the east and west coasts, but also through the central part of Caspian Sea (periodically shifting from east to west). Based on these observations, it can be concluded that the number of seals migrating through the waters of Azerbaijan can be much greater than previously thought.

Part of seals (5,000-10,000 specimens) stays in the North Caspian. In spring, from April till June, until seals reach Iran, their abundance in Azerbaijan can reach 20,000. In spring a significant number of seals (up to 500) rest on the island of the Absheron peninsula (Malaya Plita, Bolshaya Plita, Podplitochny, Dardanella, Baklaniy, the Southern Spit and Urunos Island, a part of Chilov Island).

Beginning from June, significant part of seals migrates from the Azerbaijan aquatic area to the territorial waters of Iran (10-15 thousand seals) (South Caspian) for summer fattening where they often get into the fishermen nets. (Correct: Absheron archipelago and aquatic area of Azerbaijan are different notions. Absheron archipelago is a small group of islands located to the east from the Absheron Peninsula, whereas aquatic area of Azerbaijan is a large territory that begins in the north with Yalama seashore and ends near Astara, in the south of Azerbaijan. (Ref. 30 - Eybatov, 2010).

In summer period not more than 5-10 thousand seals remain in the whole aquatic area of Azerbaijan; during this period they avoid the nearshore zone and are distributed more or less evenly in the deep-water area of Caspian as small groups. Between April and October seals are feeding all across the aquatic area of Azerbaijan, 1-3 km away from the shoreline and deeper offshore, they dive to 100-150 m depth and can stay underwater up to 30 minutes (Ref.23 - D.B.Hajiyev, T.M.Eybatov, 1995). Small groups of seals, usually 2-3 individuals, swim to the islands Bolshaya Plita, Malaya Plita, Podplitochny, Dardanella, Baklaniy and also to the Southern spit and Urunos island, Chilov island (see Table 4).

Table 2: Seasonal Distribution of Seals in the Aquatic Area of Azerbaijan

Jan											
	The least vulnerable period – no seals or small number										
	The most sensitive period/ spring and autumn migrations/ peak abundance										
	Seals are distributing by groups according to the migration of food components										

Main changes in the nature of Caspian Seal migration during the last 5-6 years:

1. Earlier appearance of seals in the aquatic area of Azerbaijan and on the islands of Absheron archipelago comparing to previous years. Whilst earlier seals appeared in the Azerbaijani waters in the beginning of April, and on the islands of Absheron archipelago at the end of April - beginning of May, recently they most often appear in the north of Azerbaijan, at Yalama seashore in mid-March and on the islands of Absheron archipelago at the end of March, beginning of April. Thus, when planning surveys we must include the last decade of March and April month as the periods of intensive spring migrations (Table 2-3)

2. It is also necessary to take into account that unlike in previous years during the autumn migration major part of seals continue moving to the north in the first half of December, and during this period significant number of seals may still remain in the aquatic area of Azerbaijan, hence half of December must be also included into the blue zone of seals' distribution (Table 2-3). The 1st and 2nd changes are probably related to the earlier melting of ice in the North Caspian, and also to the fact (December delay) that seals need more time for fattening because of depletion of fish reserves, first of all kilka.

3. One should also take into account potential gradual increase of seals population in the Caspian, and accordingly in the Azerbaijani waters. (This assumption is based only on dynamics of numbers of dead seal bodies found on the Northern shore of the Absheron Peninsula (Figure 2). It is shown that recently number of dead seal bodies again slightly increased. In previous years numbers of washed ashore dead seal bodies closely correlated with the population of seals in the Caspian.)

It should be noted that in summer 10-15 thousand seals accumulate in the Azerbaijan waters and one third of this number - 3-5 thousand seals feed in the northern part of Caspian waters., northwards from the Absheron Peninsula, where they stay 1-2 km away from the shoreline to the middle part of Caspian; their maximum concentration is observed at 2-8 km distance from the shoreline.

As it was noted earlier in this report, 10-15 thousand seals stay in the northern Caspian Sea during the summer months. The Northern Caspian includes waters of Russia and Kazakhstan only. Kazakhstan has a much greater part of the northern Caspian Sea, as well as larger part of the coastline (2320 km) than Russia (695 km) and therefore more seals are present in Kazakh waters in all seasons of the year. The central part of the Caspian Sea is almost evenly distributed between all four littoral countries (except Iran). The total number of seals found in the central Caspian Sea during summer months is estimated to be approximately 30-40 thousand individuals.

During spring migration from the islands of Absheron archipelago and Oil Rocks in the beginning or mid-May main mass of seals instead of south moves to the east and south-east, to the central part of Caspian or closer to Turkmenistan waters, and from there most seals move towards Iran.

In the deep-water zone of Azerbaijan located to the south from the Absheron Peninsula population of seals is not usually high. Their small number in the area of Shirvan National Reserve is probably related to the nets for small (ordinary) fish, as seals heartily steal small fish from the nets (herring, Caspian roach, etc., as well as crayfish), occasionally eating out the whole catch.

Appearance of significant numbers of seals in summer, in the area of Kyzyl-Agach Natural Reserve can be explained by migration of Caspian roach (vobla) in delta of Kura River. Thus, minor flow of seals migrating in spring takes place in the shallow zone near the southern shores of Azerbaijan.

Autumn migration takes place in the opposite direction. Again, from the central part of Caspian to the islands of Absheron archipelago, and from there, as a wide front along the western shores to Russian waters and partly - to the north-east, to Kazakhstan territory. Unlike spring migration, autumn migration is characterized by lower speed of movement that is why large accumulations of seals are not observed on the islands of Absheron archipelago.

Table 3: Observation[163] of Seal Presence and Activity During the Last 5 Years in the Vicinity of the Absheron Peninsula, Mainly in the Project Impacted Region (Up to 40 Km Offshore from the Coast, where Seals Could be Affected by the Sounds of Seismic Survey).

2010	Seals appeared in the area Pirallahi island - Chilov island - Oil Rocks at the end of April. In this year unusual (diffuse) spring migration was observed. Seals arrived in small groups - 3-5 individuals in a group and distributed evenly in the aquatic area up to Oil Rocks. There were no seal accumulations at the island haul-out sites.	Small groups of seals - 2 to 10 individuals swim along the shores of aquatic area of Azerbaijan, from Yalama to Lenkoran, at approximately 1 km from the shore.	In this year also very unusual autumn migration took lace - no accumulations. At all sites of monitoring (about 20 altogether) 2-3 seals swam.	On 5.12.2010 analyses were done on two seal bodies in the monitoring zone Buzovny - North Power Station: female with embryo and male individual with GPS coordinates. In January and February no seals were observed on the islands; in December seals were observed on the Southern spit, Chilov island and Podplitochny (2-3 individuals at each site).

2011	Early migration, 1 April. Concentration of seals again is related to migration of herring. The first large shoal of seals (200 – 400 individuals) was registered on 1 April in the area of Southern spit and islands between Pirallahi island and Chilov (Malaya Plita, Bolshaya Plita, Podplitochny, Dardanella). According to fishermen, at that time mass migration of small herrings took place. At the end of April - beginning of May seals moved to the sea area between Chilov island and Shakhova spit. Small groups of seals were also observed by oilmen at Oil Rocks. The first seals appeared in the Iranian waters in the beginning of June.	Small groups of seals (2-3-7 individuals) swim in the area of Oil Rocks between Chilov and Pirallahi islands. Small groups of seals accompany ships that service offshore platforms.	Significant accumulations of seals on the islands between Pirallahi and Chilov islands began appearing at the end of October, beginning of November. To the end of November practically all seals disappeared.	Neither fishermen, no helicopter pilots did not see seals during this period.
2012	Helicopter pilots informed that seals came to the islands between Pirallahi and Chilov at the end of April, and disappeared one week later. In some places occasionally individual seals can be seen. Migration of seals was related to migration of kilka, then migration of Black sea roach (small kutum) began, and only now - migration of gray mullet. Diffuse migration in the beginning of May.	Seals are distributed evenly as small groups all across the aquatic area of Azerbaijan.	Seal migration without large accumulations on the islands of Absheron archipelago	Individual seals on the Urunos, Southern spit and 2-3 individuals on Baklaniy island.
2013	Migration began in mid-April. Significant accumulations were observed westward from Chilov island. Large group of seals swam in waters of Lebyazhi island, which seals usually do not visit	Small groups of seals swam to the south from Shakhova spit and in the east between Chilov island and Oil Rocks	Shoals of several hundred seals around the islands of Absheron archipelago	Small groups of seals (2-5 individuals) on Dardanella island, Malaya Plita and Podplitochny. One seal lies on the Southern spit of Chilov island.

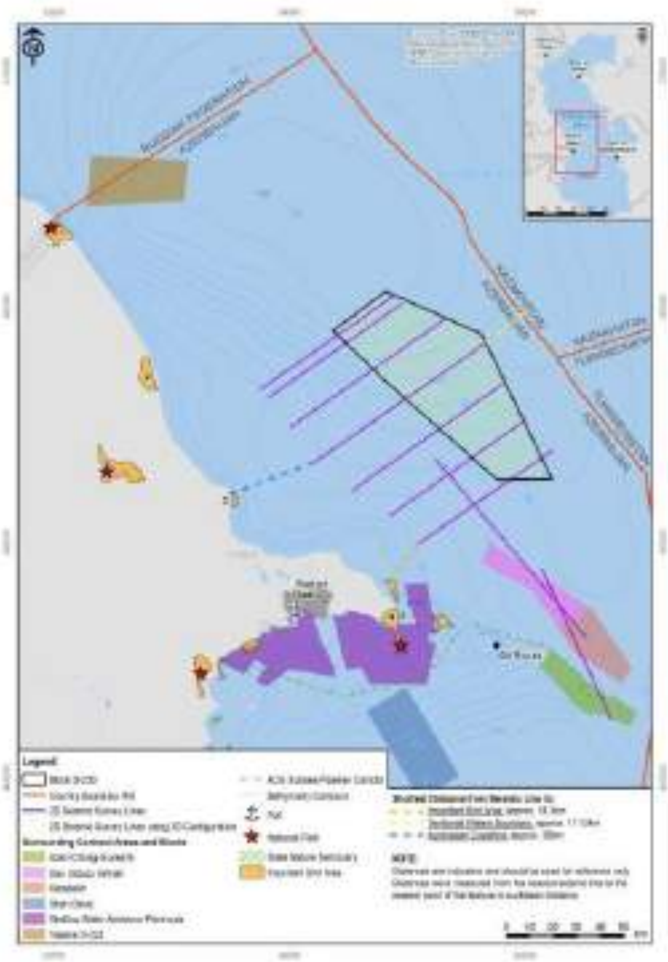
2014	1 April - early migration was observed. Namely, seals appeared in the Azerbaijan waters, in the area of Yalama seashore at the end of March. Usually one week prior to appearance on the islands of Absheron archipelago. In the recent years migration of seals in the first place was related to migration of shoals of herring. Fishermen complain that seals eat out fish in the nets.	Seals are distributed evenly, as small groups in the aquatic area, at significant distance from the coast - 1-2 km. Groups of 7-15 seals periodically appeared in the area of Oil Rocks. In dark hours also small groups of seals swam around the brightly illuminated ships.	Small groups of seals around Shakhova spit and also numerous groups of seals to the south from Shakhova spit at the level of Sangachal terminal. There are numerous seals in the area of Kyzyl-Agach National Reserve and Shirvan National Reserve	Individual seals (1-2) on the Southern spit, 2-3 seals on Urunos. Groups of seals - 1-3 animals swim between Chilov island and Oil Rocks.
2015	Mass spring migration in the area between Pirallahi and Chilov islands was observed on 19-20 April. The largest number of seals was observed near Baklaniy and Urunos islands	Seals are evenly distributed in small groups within the waters at a considerable distance from the shore. Small seal groups of 2-3 individuals on Chilov and other islands located between Pirrallahi and Chilov islands	Small groups of seals moving to the North in regular and periodical intervals.	2-5 individuals on the Shahdili Spit and Urunose (Chilov island). Small groups of 2-3 individuals move between Chilov and Oil Rocks.
2016	For the first time in many years there was no mass spring migration of seals. The ice melted earlier in the northern Caspian Sea and small groups of seals started migration to the southern regions in March. Aggregations of seals on the islands of the Absheron archipelago were observed in the spring. Fishermen also noted that there were no spring herring migrations in this region. Also on the north coast of the Absheron peninsula there were no seal corpses washed up onto the coast, commonly observed here each year	During summer months, seals were not observed. Dramatically reduced number of corpses, washed up onto the coast in the summer.		

Table 4: Expected Maximum Number of Seals that supposedly can be found in the Block D230 Contract Area

200	150	250	2-3 ths.	-1 ths.	700	900	700	700	2-3 ths.	2-3 ths.	600

11.3 Seasonal Distribution of Seals in the Contract Area

Figure 3: A Map of the Contract Area – the Shaded Area Indicates Where the Survey will be conducted



The total area of the territory in which BP plans to conduct seismic surveys is 3222km^2. The project area is in the zone of active seasonal migrations of the Caspian seal (Belyaev et al. 1998). Therefore, it can be expected that there will be between 150 and 3 thousands of seals present within the Contract area and in surrounding waters. During spring and autumn migrations, number of transit seals passing through the Contract Area can be between 3 and 7 thousands individuals. The nature of seasonal migrations can vary from year to year. For example, in 2016 possibly due to a very early melting of ice in the northern Caspian Sea (or for other unknown reasons) spring migration was extended in time and for the first time in many years no seals were observed on the islands of the Absheron archipelago or around them. This means that in some years, the migration takes place with significant accumulations of seals, and sometimes with no accumulation at all. The maximum peak of permanent concentration of seals (for feeding) in the contract area is expected to be in July, during the period of maximum concentration of sprat in this area. The Minimum number of seals present in the contract area is expected to be between the end of January and beginning of February – the period of milk feeding and start of pairing. Due to a sharp increase in seal disturbance in recent years (mass poaching on the territory of Dagestan), seals are expected to avoid coastal areas during the autumn and spring migrations and use routes located as far as possible from the coastlines, and this may lead to a significant increase in seals passing the Block D230 contract area.

All calculations are extrapolation of data obtained by Russian specialists during 1980-1990, in the first place by V.I. Krylov (Krylov - 1979, Ref. 27 - 1983, 1990), who based on results of surveys from vessels investigated distribution of seals in the middle and southern Caspian (except Iranian water with forbidden access). Due to the 4-fold drop of seals population in the Caspian during the last 25 years, results of calculations of their population in the Azerbaijan waters were also divided by 4.

Our calculations are also based on local surveys of seals on the islands and from the air during helicopter fly-overs organized by BP, and interviews of fishermen and helicopter pilots transporting oilmen to the Pirallahi, Chilov, Oil Rocks and individual offshore platforms. It is pointless to observe the seals from the coastal line, as they do not swim so close to the shore.

<table>
<tr><th>2016</th><th>Jan</th><th>Feb</th><th>March</th><th>April</th><th>May</th><th>June</th><th>July</th><th>Aug</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
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<tr><td></td><td colspan="12">The period of the smallest number of seals present in the contract area – it is possible that there will be no seals at all in the contract area, however as tagging exercises have shown a significant number of seals (primarily males and immatures) can be moving across northern and central Caspian Sea even in winter months. Group's consisting of 1-3 individuals may be present on the islands of the Absheron archipelago. Also small groups of young seals can be present far from the shore in deeper parts of the Azerbaijani section of the Caspian Sea.</td></tr>
<tr><td></td><td colspan="12">Active feeding period - during this period, seals will migrate in small groups through the contract area. Total number of seals in the contract area can reach 2000-3000 individuals. The greatest number of them can be observed far from the coast (10-70 kilometers away from the coastline), due to the massive coastal capture of seals carried out in the Dagestan area. (Ermolin, Svolkinas).</td></tr>
<tr><td></td><td colspan="12">The period of largest presence of seals – this expected to be observed during spring and autumn migrations. 4-8 thousand of seals can be passing through the contract area during this period. Spring migration seals passing the contract area will be coming both from Russia and Kazakhstan. A small percentage of seals can arrive to the contract area from the Turkmen waters (Dmitriev et al. 2016). During the autumn migration seals will move through the contract area from the islands of the Absheron archipelago, as well as a significant portion of seals arriving from Turkmen waters.</td></tr>
</table>

One must also pay attention to concentration of seals in the delta of Kura during migrations, which could be related to migration of the Azerbaijan population of Caspian roach in this area. Fattening period of Caspian seals earlier lasted 5-6 months, from May to October. Currently it is somehow longer - from April to November-December, i.e. it lasts 7-8 months.

It is necessary to consider that the Caspian seal mainly feeds on Anchovy, big-eyed and common kilka; gobies, roach, silverback and fingerlings of other species. Anchovy kilka is endemic to the Caspian; it inhabits deep water (up to 500 m), and it is the main component of the ration of the Caspian seal. It is also the most harvested species. The big eyed kilka is second after the Anchovy. Both the Anchovy and the big eyed kilka inhabit only the Middle and the South Caspian. It stays at the depth of at least 20 m, far from the coast, mainly between 50 and 200 m (20-1989). In spite that most seals migrate along the east coast of the Caspian, Anchovy kilka migrates mainly along the west coast of the Middle and South Caspian. It is also necessary to mention that the highest concentrations of kilka (Anchovy) are observed in July, and the lowest in May (20.1989). As the Contract Area in on the migration route of both Anchovy and big-eyed kilka, it is necessary to remember that the highest number of seals will be seen in the zone of the highest concentration of these fish species. It should be mentioned that we had to use outdated information of 1989-1990, as currently fishing is in the hands of commercial organizations, which do not provide information to scientific institutions about the sites and volumes of catches.

An extract from the National report on the status of population of Caspian seals in the Azerbaijan waters of the Caspian Sea (Ref. 17 CaspEco project. T.M. Eybatov, K.M. Rustamova - 2010) Chapter 3: "Within the framework of reforms of state organizations undertaken in the Azerbaijan Republic, in 2001 fishing industry of the country was divided into 2 parts: commercial fishing, processing of raw products, commercial fish-farming and fish & fish products trading were handed over to private sector, whilst reproduction, protection and control of fisheries were assigned to Department of

Reproduction and Conservation of Water Bioresources under the Ministry of Ecology and Natural Resources of the Azerbaijan Republic.

Hence, as fishing was handed over to private sector, it was very difficult to fully understand an impact of this activity on seals' mortality. Although there are relevant teams issuing quotas /licenses and responsible for the protection of aquatic bioresources in the Ministry of Ecology and Natural Resources, it is impossible to keep full control over the process, first of all because illegal fishing always dominated.

Practically all kinds of fishing to some extent result in death of seals. In the first instance this concerns coarse nets for sturgeon and fine-meshed nets for ordinary fish. We often found dead seal bodies entrapped in nets, or bodies with the marks on the skin from nets (see files album). Long ago we noticed that most fresh dead bodies were washed-out on the shore near the sites with fishermen's cooperatives, however fishermen usually keep back this information. Questioning of fishermen that we carried out in 1996 and 1997 demonstrated that in average 5 seals fall per one net in a year."

Let us add that fly-overs of the coast in 1996-1997 were done jointly with the employees of BP (T.Glushko) and figure 5 seals/year was confirmed when we landed on the shore of Shirvan and Kyzyl-Agach Natural Reserves.

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Appendix 1

Seals Death Causes Summary

Part of Published article:

T.M. Eybatov. **Caspian seal (Pusa Caspica Gmel.) - endemic of Caspian**. News of the Azerbaijan National Academy of Sciences, Geosciences, № 4, 2010, p. 151-169.

Dead seal bodies washed ashore on the Caspian coast ("drifts")

The first comprehensive study of dead seals found on the shores was carried out by K.K. Chapski (1932), who investigated an issue of the appearance of dead seals drifting in water. The author noticed regular appearance of dead seals in autumn. Dead seals are found on the shores of Dagestan from the end of August and till the freeze-up near Chechen island. Distribution of dead seal bodies in this area is not even: most dead seals are found on Uch spit, where Chapski investigated up to 30 dead seals washed ashore. Their age composition was the following: of breeding age 6, adults 13, old 3, male 10 , female 12 (only one female was with an embryo). It was difficult to investigate all seal bodies due to strong deterioration of some of them. The author did not make any well-founded conclusions about the causes of seals' death. Investigation of this issue is a matter for the future (S.I. Ognev, 1935). Ognev (1935) writes: "Drifts. After the Caspian opening in spring in some years large number of dead seals appear, locally referred to as "plavun" ("drifts"). It is possible that those are animals that accidentally suffocated under the ice, as they could not get out (because of the frozen holes, collision of big ice fields, etc.) page 559. S.V. Dorofeev and S.Yu. Freyman (cited from Badamshin, 1971) noted cases of dead seals found on the coast, however they did not try to explain the cause of their depth.

They began talking about the dead seals washed ashore since 1875, however only S.I. Ognev (1935) assumed that the main cause of the appearance of dead seals was their death under the ice and collision and overlapping of the blocks of ice. K.K. Chapski (1930-1932) investigated dead seal bodies on the western shore, mainly on the territory of Dagestan, however he did not interpret the reasons because of the poor knowledge of the process. B.I. Badamshin was the first who attempted to explain the cause of mass appearance of dead seals on the shore (1971). According to Badamshin, main cause of mass deaths of seals is related to late hunting, i.e. during the period when most ice has been melted, half of wounded seals goes down under own weight and only after certain time they rise to the surface and move southwards (before Badamshin some researchers thought that seals died of diseases, another that they suffocated under the ice, however without any strong arguments). Seals lie at the edge of ice-cakes, usually with the head towards water. Hunters on small boats swim to the shoals of seals, at 30-40 m distance and begin shooting. They rarely manage to make more than two shots, as the seals hearing noise leave the resting place. Fatally wounded animals very often jump to the sea and immediately sink. The same fate expects seals killed while swimming. As a result hunters get maximum 2-3 animals of 4-5 killed or heavily wounded. Considering that during spring hunt catch earlier was up to 30 thousand animals and more, losses were significant: "Sunken dead bodies had no time to decompose underwater; with the accumulation of gases in the gastrointestinal system they rise to the surface and under the action of wind and currents are washed ashore. In cold spring water dead seals probably may remain under water quite long, however in summer, as is evident from the tagged bodies (investigation in 1968) they rise to the surface within 1-3 days.

Unlike dead seals found during spring-summer, which usually takes place in the North Caspian and partly on the western shore of Middle Caspian, where dead bodies are brought by the western branch of permanent circular current, at the end of 1955 and beginning of 1956 masses of dead seals were found on both shores of Middle and South Caspian. This was not observed earlier.

During 3 to 12 March 1956 Badamshin surveyed the shores, from Chechen island and to Pervomaiski fish processing plant. Along the overall length of survey (260 km) he discovered 108 dead seals. Whilst when moving from the north to the south number of "plavuns" increases. Most dead animals were mature. Of 108 seals 31 females were with embryo.

According to B.I. Badamshin, based on the size of embryos, dead seals found on the shore died at the end of October - beginning of November.

Previous researchers stated that main cause of dead bodies found ashore was specificity of hunting and explosive works during prospecting for oil and gas.

Our studies demonstrated (my researches since 1971 and earlier researches by D.V. Gadzhiyev, since 1961) that there are many causes of seals mortality:

Hunting for seals, its shortcomings and inefficiency: in the first place incorrect quotas for shooting, and low efficiency when about 50-60% of hunted seals are lost.

Poaching: earlier it was shooting of seals using shotguns (in our collection there are dozens of seals' skeletons with shots. Illegal fishing for sturgeons using self-made devices "kaladas" (sets of large hooks. In our collection in twenty dead seals found on the shore had kalada hooks in their mouths. In recent years, as a result of mass poaching - illegal fishing for sturgeons using nets - large number of seals dies: in average 5 seals/year per each net, both coarse and fine-meshed (photo № 15 and photo №16 - three seals get ensnared in one of the nets, and were washed ashore together with the net in highly macerated form. Certain share of seals is killed by oilmen on Oil Rocks and individual offshore platforms: during the spring-summer fattening period seals often interfere with fishing, so oilmen try to shoot them. Besides, recently local population use seals caught in the nets for food: mainly liver and fat, skins are used by some people for manufacturing fur hats. Fat of seals is especially valued by local population (it is considered healing and is used as ointment). Hunting for seals reached special scope island: here you could always buy both fat and liver of seals; most locals on the island wear hats of seal skins, and this despite the fact that just two rookeries remain in the Azerbaijan waters - Shakhova spit and Chilov island. Only minor part of seals occasionally rests on Malaya Plita and Podplitochny islands. Surveys show that islands of Baku archipelago, beginning from 1997, are not any longer used as rookeries. Even during the period of mass spring migration southwards seals recently avoid this group of islands (to our mind, due to permanent disturbances, dirty water, reduction of fish population in this region because of intensive multiple net fishing).

Urbanization - in recent years number of built-up beaches increased sharply, they cover Absheron coast all along perimeter: maintenance facilities & personnel are permanently at the coast and frighten away seals, especially during spring migration, when hungry animals, in particular young pups need to come ashore. Same picture is observed across the whole Caspian. In the first place this concerns fishermen - earlier major part of the nearshore zone and islands in the Caspian were uninhabited and seals during mass migration periods could rest on the shore and sea cliffs). Now fishery cooperative associations are located compactly all along the coast.

Owing to our long-term surveys and statements of in 70-80 and in the beginning of 90-s during spring migrations and in summer seals often come ashore to the Absheron beaches and to the sea cliffs. As for the recent years (1997-2002), such cases practically were not observed. Only in 2000, in the area of Sumgait city local citizens caught sivar (seal's pup eye-witnesses, after the first change of coat) and kept it on the sunken ship. Besides, only occasionally one can see swimming seals in the aquatic area of Absheron and on surrounding territories.

Killing seals onshore: only in 2001 in the monitoring zone Buzovny- North Power Station we found three dead seals with the broken skulls recently killed by people. According to eye-witnesses, one of the seals was caught by local people in the evening in the area of North Power Station. They tied him with then rope to a stone. Early in the morning vacationers going to the beach broke the skull of live animal with stone. The same attitude is observed in other regions. Fishermen are against Caspian seals, as they regard them as competitor and guilty in driving away fish shoals and eating out fish in the nets. That is why when possible they kill seals. Residents of coastal zones are frightened by the cases of seals attacking people (which is highly exaggerated) and also kill seals where possible.

Natural enemies: occasionally wolves, foxes, racoon dogs, white-tailed eagles and earlier very large beluga.

PARASITES OF CASPIAN SEAL

A large number of helminths was found in the organism of Caspian seal (currently more than 28 species are described pertaining to 5 classes: cestodes (tapeworm), nematodes (roundworms), trematodes (flat worms), acantocephala (thorn-headed worms) and proboscis worms:

Helminth fauna of Caspian seal:

Trematodes: according to data of V.N. Popov and M.Taikov (1982, 1986, 1990), 13 trematode species were registered in Caspian seals:

- Bolbophorus cinfusus
- Hysteromorpha triloba
- Tylodelphys podicipina
- Mesorchis advena
- Cryptocotyle lingua
- Parascocotyle sinoecum
- Pigidiopsis genata
- Miritrema sobolevi
- Opishorchis felineus
- Pseudavphistomm truncatum
- Ciureana badamschini
- Cyatocotylidae gen. sp.
- Paracoenogonivus ovatus

Nematodes:

- Anisakis schupakovi Mosgovoy, 1951
- Parafilaroides caspicus Kurotsckin et Zablozky, 1958
- Eustrongylides excisus Jagerskiold, 1908
- Nematoda gen sp. (Larva)
- Dioctophyme sp.
- Contracoecum sp.
- Dioctophyme renale

Cestodes:

- Diphyllobothrium phocarum
- Cestoda gen. sp.

Proboscis worms:

- Acantocephala Corynosoma strumosum (Rudolphi, 1802)
- Corynosoma caspicum

Some of them should be particularly mentioned as major impact sources: mass infection with helminths and their large numbers in the animals' organisms also may result in death of seals. Of this number only 13 trematode species, 3 nematode species: Anisakis schupakovi, seal is accidental (optional) host for nematods Eustrongylides excisus Jagerskiold, 1908 (Yu.V. Kurochkin, 1961). From proboscis worms Corynosoma strumosum was registered. The third species of nematodes found in Caspian seals is Parafilaroides caspicus Kurotschkin et Zablozky, 1958; the fourth nematode (Kurochkin, 1961) has not been defined to species.

Ectoparasites in Caspian seals are represented by seal louse Echinophtirius horridus.

Of virus infections only *morbilli* virus giving rise to canine distemper was found.

Of bacterial infections currently only diplococcoid infection induced by diplococcus *Badamschini caspii* (Vilegzhanin), red staphylococcus and salmonella have been confirmed. This shows that virus and bacterial infections of Caspian seal are not studied well enough: there cannot be so little micro-infections. Initially number of helminths in Caspian seal was also estimated as 6, however later more than 27 species were defined.

So, 28 various forms of helminths were established in Caspian seal, 18 of them were identified to a species.

Also, it should be noted that not all helminths are equally dangerous, many of them use Caspian seal as a transition form and are not so dangerous for health.

According to data of S.L. Delyamure (1961) 174 kinds of helminths parasitizing in various organs of pinnipeds and cetaecean have been described up to 1961. Delyamure wrote about this with certain purpose: some researchers (other than helminthologists) working with marine mammals were mistaken stating that helminths were parasitizing only within the intestines of these animals. However, this was not so: the following parasites are found in the blood circulatory system: Tictyocaulides, Pseudoaliides, Filariides, Setariides (Nematodes), in lungs and nasal cavities - Dictyocaulides, Philarioidides, Pseudoaliides, in the hearing organs - Pseudoaliides, in the intestines - Campulides, Echinostomatides, Galactosamatides, Heterophyides, Opisthorchid flukes, Browniides, Notocotylidae, Pholetereides (Trematodes), Tetrabotriides, Difillobotriides (Cestodes), Anisakides, Ancylostomatides /hookworm (Nematodes), Polymorphids (proboscis worms), in liver - Campulidae, Opisthorchidae, Radziidae (Trematodes), occasionally Diphyllobothriides, in urinary system - Krassicaudides (Nematodes), in skin and blubber - larvae of phyllobothriides (Cestodes). Thus, idea that helminths in marine mammals infect only stomach and intestines is outdated and must be rejected.

Contaminations of Caspian basin

Heavy metals. According to data obtained by V.I. Krylov et al. (1990) level of mercury accumulated in this year youngs and impuberal animals in liver varies within the range 1.84-4.52 mg/kg. High content of mercury was also established in dry and miscarried, more rarely in pregnant females. Strong contamination of Caspian basin has adverse effect on the reproduction and population of Caspian seal: in recent years eildness of females varies from 39.8-59.8%. Toxicity studies carried out within the framework of Ecotox program demonstrated (Sh.Tanabe et al., 2002) concentrations of 15 microelements (V, Mn, Fe, Cr, Co, Zn, As, Se, Mo, Ar, Cd, Tl, Hg, Pb) and organic mercury (OrgHg) in liver, kidneys and muscles of Caspian seal. The highest concentration of these elements was observed in the first place in liver, then in kidneys and muscles. In 2000 and 2001 concentrations of toxic elements (As, Ag, Cd, Tl, Hg, Pb and organic Hg) that were equal or less that concentrations of same elements in Caspian seals in 1993, and seals from other regions, meaning that these elements may not be specific cause of mortality of Caspian seals. Alternatively, concentration of Zn and Fe in infected of Caspian seal presumably was higher than that registered in seals from other regions. This indicates to violation of homeostatic control and content of vital important elements in food of Caspian seal.

Chloroorganic and organophosphorous poisonous compounds. According to of V.I. Krylov et al. (1990), accumulation of pesticides (DDT and its metabolites, α and γ-hexachlorocyclohexane) in fat tissue varies from 6.05 to 64.3 mg/kg of mass of tissue, depending on the age, sex and place of catch. According to Sh.Tanabe and N. Kajivara (Ecotox, 2002, 2008), polychlorinated biphenyls

(PXB_1) dibenzo-p-dioxins ($PXDD_1$) and dibenzofurans ($PXDF_1$), chloroorganic pesticides and organo-tin compounds were found in the liver fat of Caspian seals on the shores of Caspian during unusually frequent mass mortality cases in 2000 and 2001. Lipidic-weight investigation showed that DDT contaminants were predominant among the investigated chloroorganic compounds with concentrations 3.1 to 560 ng/g. Content of chloroorganic compounds in the organisms of Caspian seals found on the shores of Iran was less than in other regions. However adipose (fatty) layer in seals found ashore in Iran was significantly investigated thicker, and negative relationship between the concentration of contaminants and adipose layer was observed in Caspian seals.

Seasonal change of the adipose layer was obvious as this layer is thinning after the season of fattening and change of coat. Consequently, seals could be subject to higher risk in spring under the impact of chloroorganic compounds. Levels of chloroorganic compounds established in Caspian seals in 2000 and 2001 were comparable with the levels of chloroorganic compounds established in other mammals suffering from epizootic diseases. Concentrations of PXDD/F in ill Caspian seals were lower than concentrations of these compounds in seals from other regions, which means that toxic effect of tee contaminants is weaker and they are not responsible for mass mortality of seals. Although level of TE (toxic equivalent) in seals was relatively low, current status of infection with polychlorbiphenyls and chloroorganic pecticides found in Caspian seals is dangerous in terms of immunodepression. Concentration of botulinum toxin in liver of seals varies in the range of 0.49 to 17 ng/g of wet weight, and compounds of octyltyne were below detection level in all studied samples, which indicates to lower level of contamination with organostannum compounds in the Caspian Sea.

Factors influencing seals' mortality:

- Drilling mud
- Formation water
- Corrosion-preventive chemical reagents
- Black water
- Radioactive elements used in drilling
- Household wastes
- Radioactive contamination related to the washaway of eastern shores of Caspian
- Discharges of hydrogen sulphide in Kazakhstan
- Introduction - invasion of comb jelly fish - *Mnemiopsis leidyi* to the Caspian
- Seismic survey; methods, scale and intensity of shooting
- Rock outbursts while drilling
- Oil discharges
- Paraffinic wastes
- Ethyleneglycol, sludge
- Permanent disturbance (stress for young animals)
- Commercial fishing
- Natural mortality because of age: in average about 8% from total number of found dead seals

Recommendations for Preservation of Caspian Seal

1. General prohibition for hunting for Caspian seal.
2. Strengthening of control and elimination of illegal fishing for sturgeon and small fish.
3. Coordination of investigations all across the aquatic area of the Caspian agreed with all littoral states: Russia, Kazakhstan, Turkmenistan, Iran, Azerbaijan and international environmental organizations.
4. Apply to law enforcement agencies in order to stop killing seals on Chilov island and introduce fines for the hunting for seals on Oil Rocks and in other oil production areas.
5. Ban on fishing in the areas of mass migration and accumulation of seals.
6. Organize TV broadcasting and attract other mass media, as well as NGOs and educational organizations for the promotion of measures on protection and preservation of Caspian seals.
7. Strengthen control over discharges of various toxic chemicals (mainly DDT) and toxic metals into rivers, sewage systems and sea.

8. Develop various vaccination schemes against infections, in the first place against *morbilli* virus.
9. Improve control over the oil-producing companies in the Caspian through the Ministry of Ecology, so that they carry out seismic survey, drilling and operations accounting for specifics of seals' migration.

Appendix 6A

Underwater Sound Modelling Report

Underwater Sound Modelling - Scoping Document for offshore 2D and 3D seismic surveys, Block D230, Caspian Sea

P D Ward

Award Environmental Consultants Ltd

Rep: 201606-002-V3

5 October 2016

Glossary

Ambient sound	Background environmental sound
dB	Decibel, unit used in the logarithmic measure of sound strength
dB_{peak}	Peak sound pressure over the measurement period, expressed in dB re 1 µPa
dB_{rms}	Root mean square sound pressure over the measurement period, expressed in dB re 1 µPa.
Hz	Hertz. The number of cycles per second and refers to the frequency of the particular sound
M-weighting	Frequency weightings designed to best reflect the hearing sensitivity of marine mammals, similar to the use of the A-weighting for measuring sound impacts on humans. Sound levels for phocid pinnipeds are expressed in decibels using the Phocid Pinniped M-weighting function, annotated as $dB(M_{pp})$
PTS	Permanent Threshold Shift. Irreversible and permanent reduction in auditory sensitivity.
SEL	Sound Exposure Level. Sound energy over the measurement period expressed in dB re 1 $\mu Pa^2 s$. SEL is commonly used for impulsive underwater sound sources such as seismic survey because it allows a comparison of the energy contained in impulsive signals of different duration and peak levels. The measurement period for impulsive signals is usually defined as the time period containing 90% of the sound energy.
SPL	Sound Pressure Level. The sound pressure averaged over the measurement period, expressed in dB re 1 µPa. Continuous sound sources such as drilling are commonly characterized in terms of an SPL.
SL	Source Level. The intensity of underwater sound sources is compared by their source level, expressed in dB re 1 µPa for SPLs and dB re 1 $\mu Pa^2 s$ for SELs. The source level is defined as the sound pressure (or energy) level that would be measured at 1 meter from an ideal point source radiating the same amount of sound as the actual source being measured.
TTS	Temporary Threshold Shift. Short-term reversible reduction in auditory sensitivity. TTS will be gradually reversed upon removing exposure to the high sound levels that cause the change in hearing sensitivity.

1. Nature of Underwater Sound

This section provides a brief review of the characteristics of underwater sound and describes a number of metrics used to measure and assess underwater sound propagation in the marine environment.

Sound is an acoustic pressure wave that travels through a medium, such as water or air, and occurs as an oscillatory motion of the water or air particles. The magnitude of the water or air particle motion determines the intensity of the sound. The rate at which the water or air particles oscillate determines their frequency and is given in cycles per second or Hertz (Hz).

Sound travels about four-and-a-half times faster in water than in air. Underwater acoustic propagation depends on a number of factors such as the bathymetry; the type and nature of the seabed sediments; and the structure of the sound speed profile in the water which itself depends on the depth, temperature and salinity. Very simply, as sound propagates underwater there is a reduction in the sound intensity over increasing ranges as the area of the pressure wavefront extends radially from the source.

Many sources of sound, including vessels and seismic survey airgun arrays generate acoustic energy over a broad range of frequencies. For instance, airgun arrays generate predominantly low frequency sound with a peak or series of peaks in the range 50-500 Hz. High frequency components have however been recorded at frequencies up to 100 kHz. Other sources operate over a much narrower range of frequencies: echo sounders may emit energy over narrow bands centred on 25 kHz or 50 kHz.

Sound is usually characterised according to its continuous or impulsive character. Continuous sounds occur without pauses, and examples include sound from shipping and dredging. Impulsive sounds are of short duration and can occur singularly, at regular intervals over a period of time, irregularly, or as part of a repeating pattern. Underwater sound from seismic sources (e.g. typically arrays made up of multiple individual compressed air source elements) during seismic surveys is impulsive. Each time the source array is activated, it represents a single impulsive event while over the course of the entire seismic survey the events build up into a patterned, impulsive sequence.

Sound pressures are measured with a hydrophone when underwater. The international standard unit of sound pressure is the Pascal (Pa). The unit of pressure is given in Pascals (Pa) or Newtons per square metre (N/m^2). Levels of sound pressure however cover a very wide range of values, typically from 1×10^{-3} Pa for the hearing threshold value of a human diver at 1 kHz to 1×10^{7} Pa for the sound of a lightening strike on the sea surface. For convenience therefore, sound levels are expressed on a logarithmic scale given by decibels (dB) relative to a fixed reference pressure commonly 1 μPa for measurements made underwater.

The Sound Pressure Level (SPL) can be described using several different measures the appropriate use of which is dependent on the type of the sound signal, i.e. continuous or impulsive, and the amplitude of the waveform:

Peak sound pressure level - For transient pressure pulses such as an impulse generated by a seismic source, the peak sound level is the maximum absolute value of the instantaneous sound pressure recorded over a given time interval. Hence:

$$\text{Peak Level (zero-to-peak)} = 20 \times \log_{10}(P_{peak} / P_{ref})$$

Peak-peak sound pressure level - This is equivalent to the sum of the magnitudes of the peak positive and peak negative pressures. When a pulse has approximately equal positive and negative parts to the waveform, the peak-to-peak level is often quoted and this is equal to twice the peak level or 6 dB higher.

RMS sound pressure level - The Root-Mean-Square (RMS) Sound Pressure Level (SPL) is typically used to quantify sound of a continuous nature, from activities such as shipping, sonar transmissions, drilling or cutting operations, or background sea sound; however it has also been used to characterise impulsive sound signals such as that from seismic source arrays. RMS SPL is the mean square pressure level measured over a given time interval (t), and hence represents a measure of the average SPL over that time. It is expressed as:

$$\text{RMS Sound Pressure Level} = 20 \times \log_{10} (P_{RMS}/P_{ref})$$

For a continuous sound, the time period over which measurements or calculations are made is not relevant as the calculation will give the same result regardless of the time period over which it is averaged. For impulsive sounds, the time period over which the calculation is averaged may vary and must be quoted as the RMS value will vary with the averaging time period: generally the longer the averaging period, the greater the RMS SPL.

In addition to SPL, a sound signal may be expressed in terms of its Sound Exposure Level (SEL). This is defined as the time integral of the square pressure over a time window long enough to include the entire pressure-time history. The SEL is therefore the sum of the acoustic energy over a measurement period, and effectively takes account of both the level of the sound, and the duration over which the sound is present in the acoustic environment. Sound Exposure (SE) is defined by the equation:

$$SE = \int_0^T p^2(t)dt$$

where p is the acoustic pressure in Pascals, T is the duration of the sound in seconds and t is time. The Sound Exposure is a measure of the acoustic energy and therefore has units of Pascal squared seconds (Pa^2-s).

For continuous sources, the RMS SPL and the SEL of 1 second duration are equal. Where a sound time period is less than 1 second, the RMS SPL will be greater than the SEL. For signals of greater than 1 second, the SEL will be greater than the RMS SPL.

2. Characteristics of Propagation

The operation of an underwater energy source creates propagating pressure (sound) waves through the water and to a much lesser extent through the air. The sound waves thus generated propagate radially from the source until they meet an obstruction or reflective boundary which impedes further progress. Sound energy which travels upwards reach the surface of the sea and to a large extent is reflected (resulting in an image source and sometimes referred to as a "surface ghost") or else dissipated at the air-sea interface due to surface scattering. Some sound energy escapes into the air to create the "muffled" sound that characterises marine seismic operations at the surface. The sound waves that travel downwards reach the seabed and further reflection, transmission and attenuation occurs, although enough energy penetrates and returns from the subsurface rock layers and are recorded as data that is processed to provide an image of the sub-surface geology. The sound waves that travel sideways in the water continue until they meet an object and are dissipated by normal decay of the signal164).

The amplitude of sound waves generally decreases with distance from the source, due to spreading or propagation loss. As the sound waves travel away from the source, absorption and scattering also occurs. The resulting weakening of the signal with distance, termed attenuation, is frequency dependent, with stronger attenuation at higher frequencies. The main factors determining the amount of attenuation of a sound signal with distance are:

Geometrical spreading - in deep water, such as that found in the proposed seismic survey area, pressure waves propagate as a spherical wave, the energy of which will decay at a rate proportional to the inverse of the distance squared;

Transmission / reflection - pressure waves transmitted downwards to the seabed and geologic structure below the seabed are reflected from boundaries that mark a change in acoustic impedance. The transmitted/reflected signals will in some cases be stronger than the primary signal transmitted in the water but, due to different propagation paths, the transmitted/reflected signal will not have the same characteristics as the original pulse close to the signal source;

Absorption - transmission loss due to frictional dissipation and heat which is an exponential function of distance, weak in sea water but more significant in the seabed; and

Scattering - reflection, refraction and diffraction from inhomogeneities in the propagating medium causing transmission loss and an important part of the weakening of the seismic signal, especially in the sea floor.

In practice, the decay of a sound wave will be dependent on the local conditions such as water temperature, salinity (which determine speed of sound propagation), depth, seabed conditions, and the frequency range of the sound signal. Localised heating at the surface

layers of the sea such as that which occurs during the spring and summer months in the Caspian Sea can cause the sound to be strongly refracted towards the seabed consequently giving rise to acoustically quiet "shadow zones" at distances further away from the sound source. These oceanographic structures change over time, in late autumn/early winter as the seasonal weather conditions mix the surface layers. As the surface layers cool down, the sound becomes refracted back towards the sea surface. The resulting sound channels act like ducts that tend to focus the

[164] Macduff-Duncan, C. R., & Davies, G., 1995. Managing Seismic Exploration in a Nearshore Environmentally Sensitive Area. Society of Petroleum Engineers Technical Paper. SPE 030431

sound energy (i.e. "convergence zones") and attenuation in these ducts can be significantly less than normal spherical spreading. Under such conditions when sound channels form, there may be a significant influence on sound propagation.

3. Seismic Energy Source Specifications

The precise details of the seismic source to be used for the proposed survey are currently unknown. For the purposes of this summary scoping report, underwater sound modelling has been undertaken using operational parameters from a previous BP survey conducted in 2012 (Table 1 and Figure 1; AECOM communication, 2016).

Table 1: Summary Details for a 3D Seismic Source (AECOM communication, 2016)

Parameter	Specification
Total array volume	2 x 3180 cu in
Gun types	BOLT 1500 / BOLT 1900
Number of arrays	2
Number of sub arrays	6
Number of air guns per array	24 guns
Volume of each sub array	1060 cu in max
Nominal operating pressure	2000 psi
Array length	15 m
Array width	16 m
Tow depth	6 m (+/- 1 m)

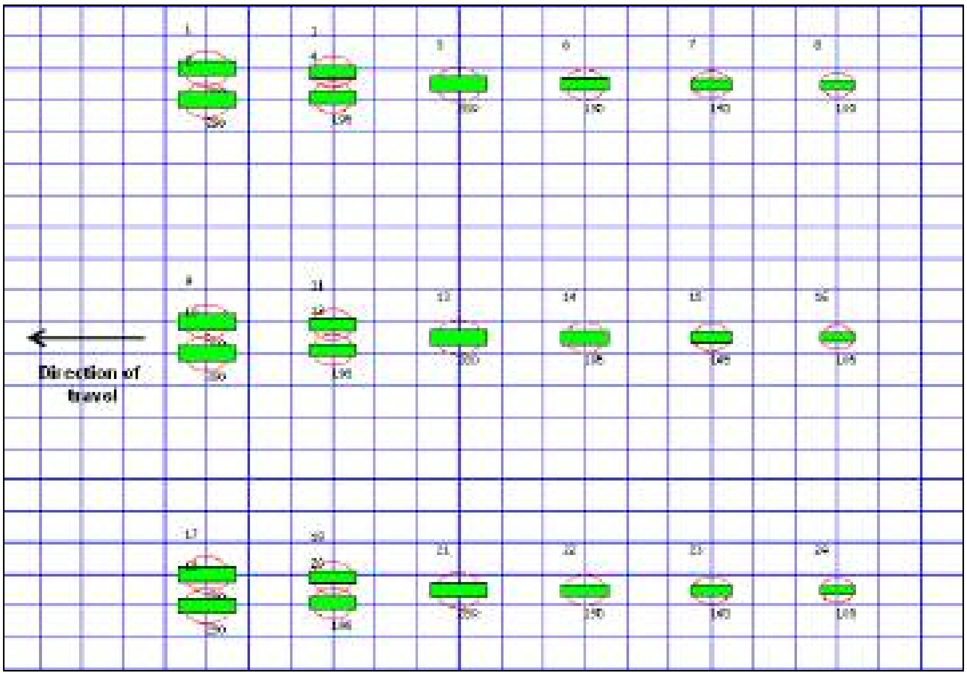

Figure 1: Layout of an air gun array

During data acquisition, two source arrays will be activated alternately (flip-flop mode) at regular distance intervals of 25m. Therefore each source array will be activated at 50m distance intervals. Based on the length of the longest data acquisition line and the working speed of the vessel (approximately 4.5 knots for a towed streamer survey but may vary), the maximum duration of the source being activated on any one 3D data acquisition line is anticipated to be no more than 14 hours.

Within each source array there will be three sub-arrays or strings. Each of the sub-arrays will have eight individual source elements of various volume sizes, with a total sub-array volume of 1060 cubic inches. The total source array volume will be 3180 cubic inches. In total there will be 48 source elements in the two arrays (i.e. 4 single and 2 clusters in each of the six sub-arrays) (see Figure 1). The seismic source is estimated to have a far-field peak-to-peak source sound level of 260.8 $dB_{peak-peak}$ re 1 µPa-m.

The source level of a seismic source array may be estimated by either modelling or measuring underwater SPL at some far distance - often 100's m to several kms - from the source array itself To allow for comparisons to be made between various source arrays, it is necessary to propagate the data back to a reference distance of 1 m from the array. The main assumption is that in the far-field, SPLs from individual source elements add constructively and that this simple representation of the acoustic sound level can be corrected by back-propagating to represent source sound level. However, this process leads to an estimate of source level which can be in excess of the actual level by up to 20 dB as it does not consider the near-field interaction effects between individual source elements.

The underlying assumption while back-propagating the data, is that the source is ultimately a point source and that it radiates sound equally in all directions. When an array consists of a number of source elements positioned over a finite sized area, this simple description is no longer valid. In acoustic terms, the array is now a distributed source, that is, it consists of a number of individual acoustic point sources each with its own acoustic intensity and which all contribute to the overall acoustic field. Close to the array, the sound output from individual elements no longer add constructively as sound energy no longer arrives at a location at the same time due to the distributed nature of the array.

Acoustic propagation modelling tools typically use a single source level number as input data. Whilst using a source level based on far field assumptions will have no influence on modelled sound levels at distances beyond the near field of the source array. For potential impact assessment purposes, it is important to note that source level and therefore sound levels very close to the source array will be lower.

Acoustic impact thresholds are often given in units other than $dB_{peak-peak}$ re 1 µPa hence it is helpful to recast the source level of the airgun array into alternative units. Zero-peak levels are given by subtracting 6 dB from the peak to peak value (see Section 1). Sound Exposure Level (SEL) and rms source levels were derived from the zero-peak source levels by applying empirical corrections provided by McCauley *et al*.[165]. The unweighted SEL source level was calculated by applying a correction of -24 dB to the zero-peak value while the rms source level was calculated by applying a correction of +11 dB to the calculated unweighted SEL source level.

When applying underwater sound impact criteria that are frequency dependent, for example, SEL; M-weighting scales are applied to account for the variation of hearing capability with frequency

[165] McCauley, R. D., Duncan, A. J., Penrose, J. D., (2000). Marine seismic surveys – a study of environmental implications. APPEA J 40: 692–706.

(Southall *et al*.[166]) For this analysis, a fixed correction factor of -3 dB (derived from historical modelling studies) has been applied to the un-weighted SEL source level to account for M-weighting.[167]

The measured sound metrics for the array and relationship between them is shown in Table 2.

As part of environmental best practice on seismic survey vessels, activation of the seismic source is initiated using a "soft-start" procedure. This is the process whereby a single small-volume source element is initially activated, gradually introducing both more source elements of a larger volume, until the full working source array volume is reached. In general, the soft start period is a minimum of 20 minutes duration; a maximum of 40 minutes should elapse between the end of a soft start and the start of a seismic line[168].

Table 2: Adopted Sound Metrics and Source Levels for Seismic Survey Array

Sound Metric	Source Level
Peak-to-peak SPL ($dB_{peak\text{-}peak}$)	260.8 $dB_{peak\text{-}peak}$ re 1 µPa-m[169]
Peak SPL (dB_{peak})	255 dB_{peak} re 1 µPa-m
Average sound pressure level (dB_{rms})	242 dB_{rms} re 1 µPa-m
Sound Exposure Level (SEL) - unweighted	231 dB SEL re 1 $µPa^2$-s-m
Sound Exposure Level (SEL) - M-weighted pinniped	228 dB SEL re 1 $µPa^2$-s-m

[166] Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr., C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A., Tyack, P.L., 2007. “Marine mammal noise exposure criteria: initial scientific recommendations”. Aquatic Mammals 33, 411–521.

[167] Ward P. D., SWAP 3D Seismic Survey -Underwater Sound Study, Award Env. Cons. Ltd Report No. PDW/2015-03-003-V3, produced for AECOM Ltd, December 2015.

[168] UK JNCC Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Seismic Surveys, (2010).

[169] In the near -field, ie. within and in the immediate vicinity of the seismic array, the source level may be 5 to 20 dB lower than that estimated by simple back-propagation.

4. Acoustic Impact Thresholds

The extent to which a given species might be affected or impacted by man-made underwater sound depends on the hearing ability of the species, the activity and behaviour of the individuals during exposure, and the level, frequency and duration of the sound. The potential impacts range from mortality and physical injury through to auditory impairment and changes in behaviour.

Mortality may occur when an animal is very close to a sound source and the magnitude and rise-time of the pressure wave effects some or all of the body organs. Auditory impairment, more often referred to in terms of permanent and temporary hearing loss may occur when marine animals are exposed to sound levels lower than those which are commonly associated with potential mortality. Permanent hearing loss in mammals results from non-recoverable damage to the sensory hair cells of the inner ear and therefore may be considered a form of physical injury. The resulting permanent increase in threshold sensitivity over the affected frequencies is known as Permanent Threshold Shift (PTS). It is noted that PTS has not been measured in marine mammals following exposure to loud sounds. Thresholds for PTS are based on Temporary Threshold Shift (TTS) thresholds. Temporary Threshold Shift (TTS) is commonly considered to be a temporary and recoverable hearing impairment and not typically considered an injury. At still lower levels of sound, it has been observed that animals may exhibit changes in behaviour in response to underwater sound. These changes can range from a startle reaction to the sound, a cessation of their current activities (e.g. feeding, nursing, breeding) or a movement away from the sound source for a period of time. Often behavioural responses are context-dependent and very subtle.

Southall *et al*.[166] reviewed the published data concerning measurements of sound pressure level and sound exposure level together with data on hearing damage or behavioural characteristics. Subsequently, a set of acoustic impact criteria for marine mammals was produced. Popper *et al*.[170] undertook a similar review and defined a set of acoustic impact criteria for fish having varying levels of sensitivity to underwater sound. The criteria are summarised in Tables 3 and 4 for pinnipeds and fish respectively.

[170] Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D., Bartol, S., Carlson, T., Coombs, S., Ellison, W. T., Gentry, R., Halvorsen, M. B., Løkkeborg, S., Rogers, P., Southall, B. L., Zeddies, D., and Tavolga, W. N. (2014). “Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report,” ASA S3/SC1.4 TR-2014 prepared by ANSI Accredited Standards Committee S3/SC1 and registered with ANSI. Springer and ASA Press, Cham, Switzerland.

Table 3: Acoustic Impact Thresholds for Pinnipeds

Threshold level	Effect	Study
218 dB re 1 µPa Peak OR 186 dB re.1µPa^{2}s SEL M-Weighted	Onset of Permanent Threshold Shift (PTS)	Southall *et al.* (2007) Dual criteria – applicable for multiple pulses
212 dB re 1 µPa Peak OR 171 dB re.1µPa^{2}s SEL M-Weighted	Onset of Temporary Threshold Shift (TTS) also indicating significant behavioural disturbance.	Southall *et al.* (2007) For TTS, dual criteria – applicable for multiple pulses For disturbance, dual criteria – applicable for single pulses
190 dB re 1 µPa RMS	Avoidance behaviour in pinnipeds exposed to impulsive sounds	Southall *et al.* (2007)
150-180 dB re 1 µPa RMS	Limited disturbance expected in pinnipeds exposed to impulsive sounds	Southall *et al.* (2007)

Table 4: Adopted Frequency Spectrum Sound Metrics for Fish

Threshold level	Effect	Study
213 dB re 1 µPa Peak OR 219 dB re 1 µPa^2 s SEL	Potential mortal injury in fish with low hearing sensitivity exposed to seismic sound	Popper *et al.* (2014)
207 dB re 1 µPa Peak OR 210 dB re 1 µPa^2 s SEL	Potential mortal injury in fish with medium hearing sensitivity exposed to seismic sound & Potential mortal injury in fish eggs and larvae exposed to seismic sound	Popper *et al.* (2014)
207 dB re 1 µPa Peak OR 207 dB re 1 µPa^2 s SEL	Potential mortal injury in fish with high hearing sensitivity exposed to seismic sound	Popper *et al.* (2014)
213 dB re 1 µPa Peak OR 216 dB re 1 µPa^2 s SEL	Recoverable injury in fish with low hearing sensitivity exposed to seismic sound	Popper *et al.* (2014)
203 dB re 1 µPa Peak OR 207 dB re 1 µPa^2 s SEL	Recoverable injury in fish with high or medium hearing sensitivity exposed to seismic sound	Popper *et al.* (2014)
186 dB re 1 µPa^2 s SEL	TTS in all fish exposed to seismic sound	Popper *et al.* (2014)

5. Sound Propagation Modelling

The seismic survey source array will produce multiple short duration sound pulses. Sound will also be produced by support or chase/guard vessels that may accompany the main seismic vessel. The level of sound related to vessel activity can vary over time and will be influenced by the particular activity being conducted by the vessel (for example, if it is idle, holding position using bow thrusters, or accelerating). However, as the seismic source will be the dominant sound source, sound from other activities are consequently not considered for the purpose of this assessment.

In order to assess the potential impact of underwater sound on marine life, it is necessary to estimate the variation of sound level with distance. This can be achieved through the use of complex modelling techniques using site-specific data describing the bathymetry, sound velocity profile and seabed sediments[171]. An alternative approach makes use of simplified propagation models based on water depths, which although may be less accurate than using more complex modelling techniques, offer the advantage of providing an initial indication of sound levels.

For this analysis, given the majority of the proposed survey area is in relatively deep water a simplified propagation or transmission loss model approach has been adopted using the expression below:

$TL = A \log (r) + B r + C$

where:

TL is the transmission at a distance r from the source;

A is a constant the value of which depends on the nature of sound propagation. For spherical waves A=20, and for cylindrical waves A=10. For the purposes of this assessment and to provide a conservative but realistic estimate of sound propagation, a value of A=15 has been used based on the justification given below;

B is an attenuation factor that is dependent on water depth and sea bottom conditions. For the purposes of this assessment the attenuation factor has been assumed to be 0;

C is a fixed attenuation due to acoustic screening. In open water this will be 0;

r is the distance in metres between the airgun array centre and a given location down-range.

Note that the use of cylindrical spreading (A=10) is generally suited to shallow-to-mid water depths, and spherical spreading (A=20) is generally applicable to deep water depths. Although the definition of deep vs shallow is somewhat dependent on

wavelength, Richardson *et al.*[172] suggests that depths <200 m are commonly regarded as "shallow" and >2000 m are commonly regarded as "deep" regardless of source wavelength.

Cylindrical spreading (A=10) is more conservative (i.e. predicts lower transmission loss, and therefore sound travels further distances for a given source level compared to spherical spreading)

[171] Etter Paul C., Underwater Acoustic Modeling and Simulation , 3rd edition, Spon Press, New York, 2003, ISBN 0-419-26220-2

[172] Richardson W. J., Green Jr, C. R., Malme C. I., Thomson, D. H., (1995), Marine Mammals and Noise. Academic Press, New York.

but is deemed overly conservative for this assessment. Richardson *et al.*172 suggests using A=15 for underwater transmission in shallow water conditions where the depth is greater than 5 times the wavelength. At high frequencies, the shorter wavelength sound is going to tend toward A=20. Considering that seismic surveys generate predominantly low frequency sound, and taking into account the depth within the project area (150 - 1000 meters), a value of A=15 is considered appropriate for this assessment.

For the sound calculations given below, a 15 log(r) relationship was used which is considered appropriate for seismic airgun array sound propagating out to several kilometres; where the potential sensitive receptors are located at a large distance from the source in comparison to the water depth.

Although the use of spherical and cylindrical formula for predicting the sound propagation loss is widely used as a simple and fast way of evaluating sound level variation with distance, this methodology does not take into account the influence of both environmental characteristics (bathymetry, seabed properties, water salinity and temperature etc.) nor the signal frequency on the propagation of sound and hence the propagation loss may be under- or over-estimated. In addition, it assumes that the sound source itself is represented by a point source which radiates sound equally in all directions. In reality, an airgun array is a distributed source that emits sound predominantly downwards. In the acoustic near-field (out to a range of approximately 100 m or so) the simple expressions given above, can over-estimate sound pressure levels by 5-20 dB.

Figure 2 presents a summary of the predicted Sound Pressure Level (dB re 1 µPa) in peak to peak, zero to peak and rms metrics as well as Sound Exposure Level (dB re 1 $\mu Pa^2 s$) in unweighted (for fish) and M-weighted (for pinnipeds) metrics; as a function of range. Note that in each case, the SEL data has been calculated for a single pulse event. In reality, the receptors are more likely to be exposed to a sequence of pulses over a longer period of time with the source-receptor distance also varying. A more realistic approach therefore involves adopting a moving receptor / source model from which it is possible to determine the build-up of SEL over a specific period of time.

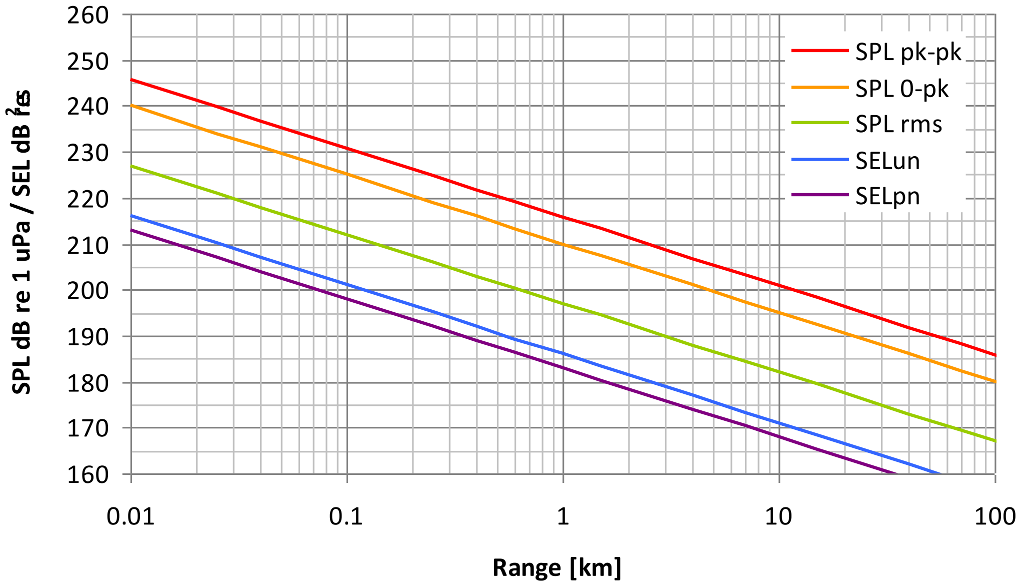

Figure 2: Modelled SPL and SEL as a function of range for the airgun array

6. Summary of POTENTIAL Impact Ranges

The ranges at which each of the acoustic impact criteria are met can be found by applying the criteria given in Tables 3 and 4, with the modelled SPL and SEL given in Figure 2. It is noted that for fish, the threshold distances for the SEL impact criteria are all very short and within the acoustic near-field of the source. As a result, the distances are likely to be even lower than indicated due to the constructive interference of individual airguns in the array (see Section 3).

The impact ranges are summarised in Tables 5 and 6 for pinnipeds and fish respectively.

Table 5: Summary of Acoustic Impact Ranges for Pinnipeds

Criterion	Sound level	Threshold distance
Onset of Permanent Threshold Shift (PTS)	218 dB re 1 µPa Peak	290 m
	186 dB re.1µPa^{2}s SEL M-Weighted	680 m
Onset of Temporary Threshold Shift (TTS) also indicating significant behavioural disturbance.	212 dB re 1 µPa Peak	690 m
	171 dB re.1µPa^{2}s SEL M-Weighted	6.8 km
Avoidance behaviour in pinnipeds exposed to impulsive sounds	190 dB re 1 µPa RMS	2.8 km
Limited disturbance expected in pinnipeds exposed to impulsive sounds	150-180 dB re 1 µPa RMS	> 12 km

Table 6: Summary of Acoustic Impact Ranges for Fish

Criterion	Sound level	Threshold distance
Potential mortal injury in fish with low hearing sensitivity exposed to seismic sound	213 dB re 1 µPa Peak	680 m
	219 dB re.1µPa^{2}s SEL Unweighted	7 m
Potential mortal injury in fish with medium hearing sensitivity exposed to seismic sound & Potential mortal injury in fish eggs and larvae exposed to seismic sound	207 dB re 1 µPa Peak	1.5 km
	210 dB re.1µPa^{2}s SEL Unweighted	25 m
Potential mortal injury in fish with high hearing sensitivity exposed to seismic sound	207 dB re 1 µPa Peak	1.5 km
	207 dB re.1µPa^{2}s SEL Unweighted	40 m
Recoverable injury in fish with low hearing sensitivity exposed to seismic sound	213 dB re 1 µPa Peak	680 m
	216 dB re 1 µPa^2 s SEL Unweighted	10 m
Recoverable injury in fish with high or medium hearing sensitivity exposed to seismic sound	203 dB re 1 µPa Peak	2.8 km
	207 dB re 1 µPa^2 s SEL Unweighted	40 m
TTS in all fish exposed to seismic sound	186 dB re 1 µPa^2 s SEL Unweighted	1.0 km

Appendix 7A

D230 Seismic Survey Oil Spill Contingency and Response (OSCAR) Modelling Report

Technical Report

Oil Spill Modelling: D230 Seismic Survey Vessel Diesel and Lube Oil Releases

Document No: UHSE-RCE-REP-2016-0324

C01	Issued for Use	A. Woods	21/10/2016	P. Page	21/10/2016	P. Page	05/12/2016
01	Draft Issued for Comment	A. Woods	24/09/2016	O. Shtepenko Z. Hasanov	24/09/2016	P. Page	21/10/2016
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Amendment Record

Version	Date	Author	Summary of Changes	Status

Virtual Copyholders

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Contents

1 Introduction

1.1 Driver and Scope of Modelling Work

This report describes the results of a number of modelling scenarios conducted to support the D230 seismic survey.

This modelling exercise has been completed to support the Environmental and Social Impact Assessment (ESIA) for the seismic survey.

These scenarios to be defined by;

- Event (i.e. location, causes, and barriers failed and/or intact);
- Oil type(s) (i.e. physical and chemical properties);
- Release rate; duration; and volume.

1.2 Scenarios Modelled

2 release scenarios were identified for modelling for the D230 seismic survey project. These involve a full seismic vessel inventory release of marine diesel and a full inventory release of lube oil at a number of locations within and outside the acquisition area.

The scenarios are further defined as:

- An 800 te instantaneous release of marine diesel at the sea surface (worst case scenario).
- A 22m^3 instantaneous release of engine lube oil at the sea surface

The fates of marine diesel and lube oil were modelled for a period of 100 days following the release.

2 Project Description

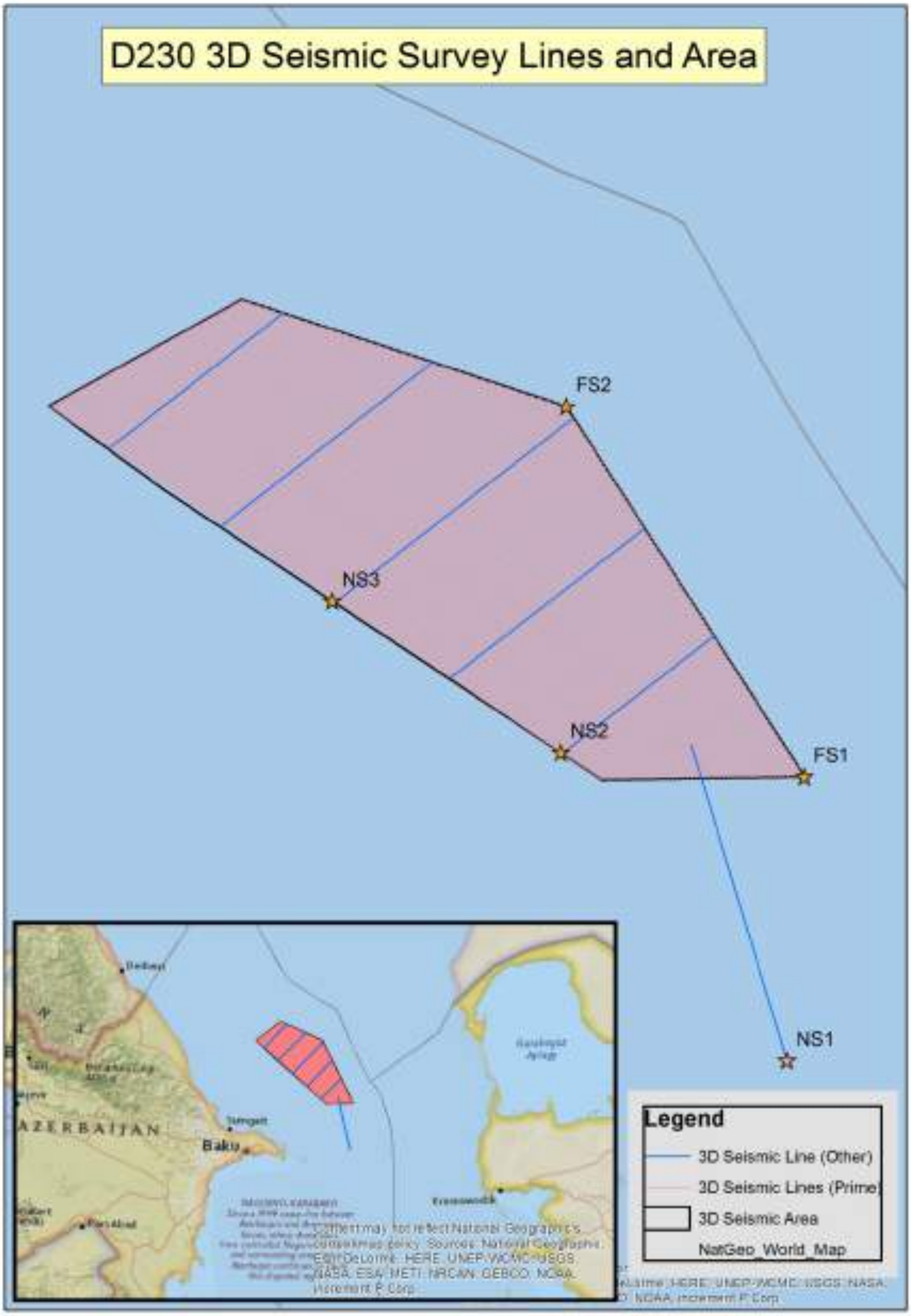
2.1 D230 Seismic Program

Block D230 is located within the Azerbaijan sector of the Caspian Sea, approximately 80km from the coastline, and covers an area of approximately 4,000km^2 (refer to Figure 1.1). The water depth ranges from 100m to 800m.

In April 2018, BP signed a Production Sharing Agreement (PSA) with the State Oil Company of Azerbaijan Republic (SOCAR) to jointly explore potential prospects within Block D230 in the North Absheron Basin in the Azerbaijan sector of the Caspian Sea.

BP are planning to conduct a seismic survey in Block D230 and with one acquisition line extending beyond the Block boundary to the Ashrafi-1 well located in the Dan Ulduzu Ashrafi Contract Area south of Block D230 (refer to Figure 1). The survey will be undertaken by a competent geophysical contractor using one seismic vessel and two support vessels. Refuelling of a seismic vessel will take place offshore by one of the supply vessels. The seismic survey is expected to take up to 6 months to complete and is planned to be undertaken between 2019-2020;

Figure 2: D230 seismic survey lines and modelled release locations.



2.2 Seismic Vessel Diesel Release – worst case scenario

As described in Section 1.2 this modelling report considers a potential collision that occurs with the seismic vessel, either while working within the D230 survey area, or whilst obtaining seismic data from the tie-in line running north-south from the southern boundary of the survey area. Modelling assumes any such collision results in a full inventory release of marine diesel or lube oil. Due to the metocean dynamics 5 release locations were modelled for the marine diesel release to identify the worst credible case release location (in terms of environmental impact) for the assessment. Once potential collision sites were identified for a near shore and further offshore location, modelling was completed for Spring (March – May), Summer (June – August) and Autumn (September – November) seasons at each release location. Due to the temporal nature of the key environmental sensitivities, particularly those associated with the lower presence of Caspian Seals between December and March months, modelling was not completed for the Winter season (Olga Shtepenko, *pers.comm*). Following completion of the diesel release simulations, a full inventory release of lube oil was modelled from the location where the most shoreline oiling occurred in the diesel scenarios to ensure a lube oil release represent a worst credible case. The seismic vessel will not be carrying any inventories of heavy fuel oil (HFO), so a release of this type of hydrocarbon was not modelled.

3 Oil Spill Contingency and Response (OSCAR) Modelling

3.1 How OSCAR Works

The SINTEF Oil Spill Contingency And Response model (OSCAR) is the BP Upstream Segment preferred oil spill fate and trajectory model The use of this model is defined in GDPs 4.6-0002 Annex 2.

OSCAR is a 3-dimensional model that calculates and records the distribution (as mass and concentrations) of contaminants on the water surface, on shorelines, in the water column, and in sediments.

The model output is recorded in three physical dimensions plus time. The model databases supply values for water depth, sediment type, ecological habitat, and shoreline type. The system has an oil physical-chemical database that supplies physical and chemical parameters required by the model.

The model computes surface spreading, slick transport, entrainment into the water column, evaporation, emulsification and shoreline interactions to determine oil drift and fate at the surface. In the water column, horizontal and vertical transport by currents, dissolution, adsorption, settling and degradation are simulated. The varying solubility, volatility, and aquatic toxicity of oil components are accounted by representing the oil in terms of a number of pseudo-components. By modelling the fate of individual pseudo-components, changes in the oil composition due to evaporation and degradation may be accounted for in the toxicity of the dissolved oil fraction.

OSCAR may compute oil weathering from crude assay data, although results that are more reliable are produced if the target oil has been through a standardized set of laboratory weathering procedures established by the SINTEF laboratories. Alternatively, the model may use oil weathering properties from oils for which data already exists, selecting the crude oil in the oil database that most closely matches the composition of the oil of concern.

3.2 Input Data to run OSCAR

OSCAR accepts as input both 2- and 3-dimensional current data from hydrodynamic models, and single point or gridded wind data from meteorological models.

The surface spreading, slick transport, entrainment into the water column, evaporation, emulsification and shoreline interactions processes that determine oil drift and fate are linked to an oil properties database. Each oil type stored in the database is characterised by 25 key hydrocarbon component groups analysed in accordance with the SINTEF oil weathering protocols. This ensures accurate representation of physical, chemical and biological behaviour of each hydrocarbon as it is released into the model.

OSCAR accepts as input both 2- and 3-dimensional current data from hydrodynamic models, and single point or gridded wind data from meteorological models. An Ekman model integrated into OSCAR computes a wind-driven current which transports entrained oil on the surface

3.3 Outputs from OSCAR

3.3.1 Types of Output

Both single spill scenarios and stochastic scenarios with variable start times can be simulated. In the stochastic simulations, a specified number of scenarios are simulated subsequently in one run. The set of scenarios to be run may be specified either by selecting the number of scenarios to be simulated within a specified time period (single year statistics), or by specifying the number of scenarios to be run each year in a specified season (multiyear statistics). In order to provide data for computing oil drift statistics, certain oil drift parameters are accumulated for each scenario in each impacted grid cell. These results are in the end used to calculate probabilities for impact in a given cell. The impact is defined in terms of exceeding certain threshold values for oil concentration, thickness or mass. The results are presented as probabilistic maps for the different environmental compartments (sea surface, water column or shoreline).

3.3.2 Stochastic Modelling and Probabilistic Results

The following section describes some of the technical details regarding the statistical output from OSCAR.

The notion of a grid cell will be used, referring to the two-dimensional surface or shoreline grid, or the three-dimensional concentration grid. Each of these grids consists of cells, which represent the smallest area (highest spatial resolution) on which OSCAR operates when producing statistics.

OSCAR produces a set of statistics in its stochastic outputs including:

- maximum or minimum;
- time-averaged;
- maximum time-averaged;
- Probability.

A map of maximum or minimum values can be produced from a stochastic simulation (for example maximum accumulated oil or minimum arrival time). This means that for all time steps and for all simulations, OSCAR has kept a record of the maximum or minimum for that particular value in each grid cell.

For example, the maximum accumulated shoreline oil map, the oil mass in every shoreline cell is checked every time step for every simulation. Whenever OSCAR detects that a shoreline cell has more oil than previously recorded, it will record this new value as the maximum. After all simulations have been performed, this maximum can then be reported for each cell.

Time-averaged statistics are used to produce an average value for a variable. For each simulation, OSCAR monitors each grid cell and records its value unless it has no impact (for example no surface oil or no total concentration). At the end of the simulation, these values are then averaged to produce the time-average. Whenever thresholds are applied pre-processing, the time-average will also exclude values below these specified thresholds.

Maximum time-averaged values can be presented as maps (such as the maximum time-averaged value total concentration). This means that for each grid cell, the value from the simulation with the largest time-average is selected and reported.

Probability maps can also be produced by the stochastic simulation. These maps indicate in the fraction or percentage of the stochastic simulations that reported the specified event (for example oil thicker than some threshold) for each cell. This can be oil on the surface, oil on the shoreline etc.

For example, the shoreline impact probability records each simulation that has some oil that hits a specific grid cell. If then three out of a total of ten simulations record oil hitting this shore cell, the probability for shoreline impact for this cell is 30%. Here there is no weighting for the frequency of oil coming ashore within each scenario.

3.4 OSCAR Outputs Used in this Report

The OSCAR outputs employed in this report are summarised below. Deterministic modelling was only carried out for Scenario NS3:

- Surface oil extent, probability, arrival time, persistence, and time-averaged thickness
- Shoreline oil extent, probability, arrival time, persistence, and time-averaged thickness
- Occurrence and probability of surface oil crossing maritime boundary (median) lines
- Surface / Shoreline oil intersecting environmental protected areas
- Maximum mass of shoreline oiling (tonnes)

4 OSCAR Set-Up for this Report

4.1 Hydrodynamic and wind data

Metocean data from the Imperial College London ReEMS model (Regional Environmental Modelling System) (White and Toumi, 2013a,b; Nicholls *et al.,* 2014) was used for modelling all scenarios. Data was provided in the form of 3D currents and 2D winds.

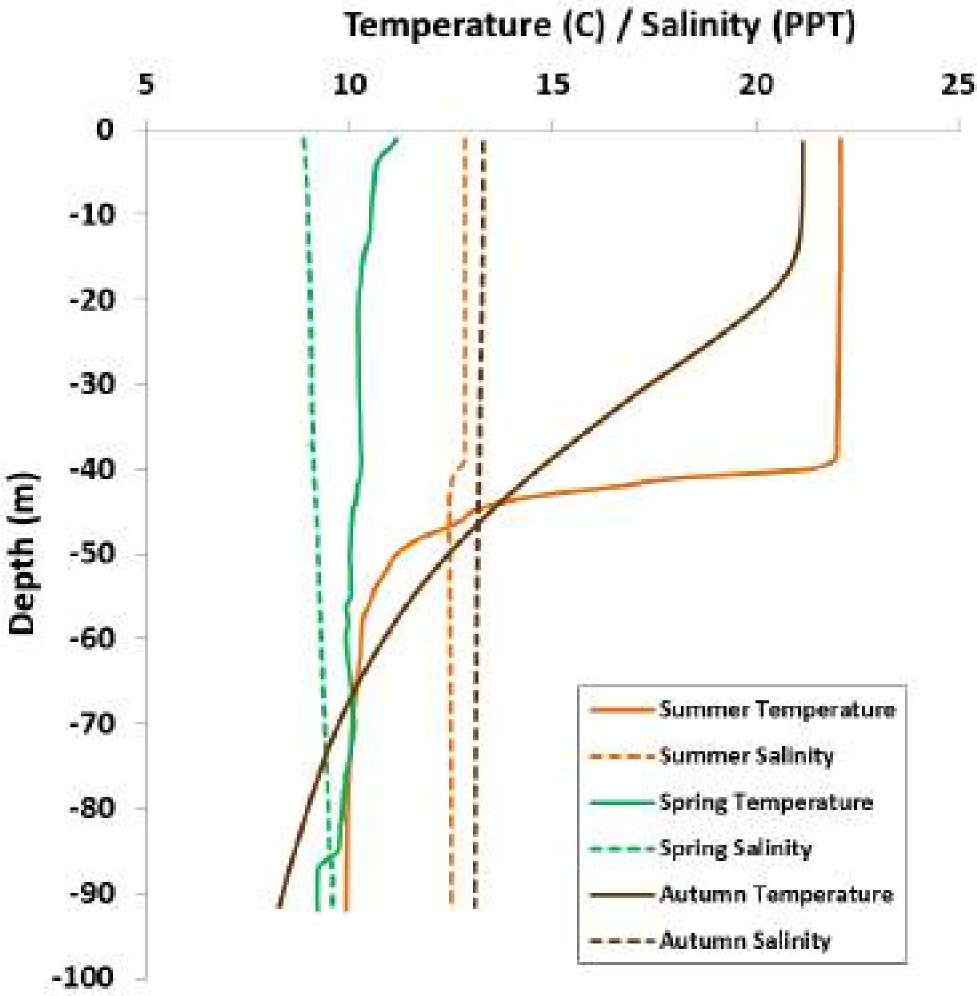
Table 2: ReEMS current and wind data

Current and Wind	Imperial College London ReEMS
Data Coverage	01/01/2006 – 31/12/2009
Depth	32 levels, full depth
Horizontal Resolution	4 km
Temporal Resolution	3 hourly
Atmospheric Forcing	ROMS WRF (3-hour)
Vertical Diffusion	Calculated
Tide	Yes
Boundary	Volga, Ural, Samur, Sulak, Terek and Kura Rivers
Current / Wind Domain	36.5ºN - 47.7ºN, 46.5ºE - 55ºE

4.1.1 Hydrographical profiles

Temperature and salinity data is used within OSCAR to calculate the trajectory and fate of released hydrocarbons. The water column temperature and salinity data for Spring and Autumn was obtained from field measurements taken from the Caspian Sea in 2000 and 2001 (NOAA, 2016). The data obtained for summer was exported from the ReEMS hydrodynamic data used within the simulations (see **Error! Reference source not found.**).

Figure 2: Salinity and Temperature profiles used within the OSCAR simulations for Summer and Winter. Oxygen content of 10 mg/l was used throughout for both Summer and Winter scenarios



4.2 Surface, Shoreline, and Water Column Oil Thresholds

4.2.1 Surface Oil Thickness

A minimum oil thickness threshold of 0.04 µm was used within the stochastic simulations. This value is the lower limit of the thinnest oil appearance classification – Sheen – within the Bonn Agreement (Lewis, 2007). Any oil present on the surface thinner than 0.04 µm is not included in the stochastic outputs. Surface oil values below this BAOAC minimum threshold were not exported from OSCAR.

4.2.2 Shoreline Emulsion Mass

A minimum threshold for shoreline emulsion mass of 0.169 tonnes/km was used within the stochastic simulations for condensate releases. These values are the lower limit of the “Light Oiling” threshold used by The International Tanker Owners Pollution Federation Ltd (ITOPF, 2011). Shoreline oiling values below this ITOPF minimum threshold were not exported from OSCAR.

The threshold of 0.169 tonnes/km for diesel releases was calculated based on:

a) the length of the hypotenuse of each surface grid (1,414 m)

b) a mean shoreline width of 2 m,

c) minimum Light Oiling threshold of 0.1 litres/m^2

d) emulsion density of 846kg/m^3 @STP (based on 2% water uptake)

The threshold of 0.174 tonnes/km for lube oil releases was calculated based on:

a) the length of the hypotenuse of each surface grid (1,414 m)

b) a mean shoreline width of 2 m,

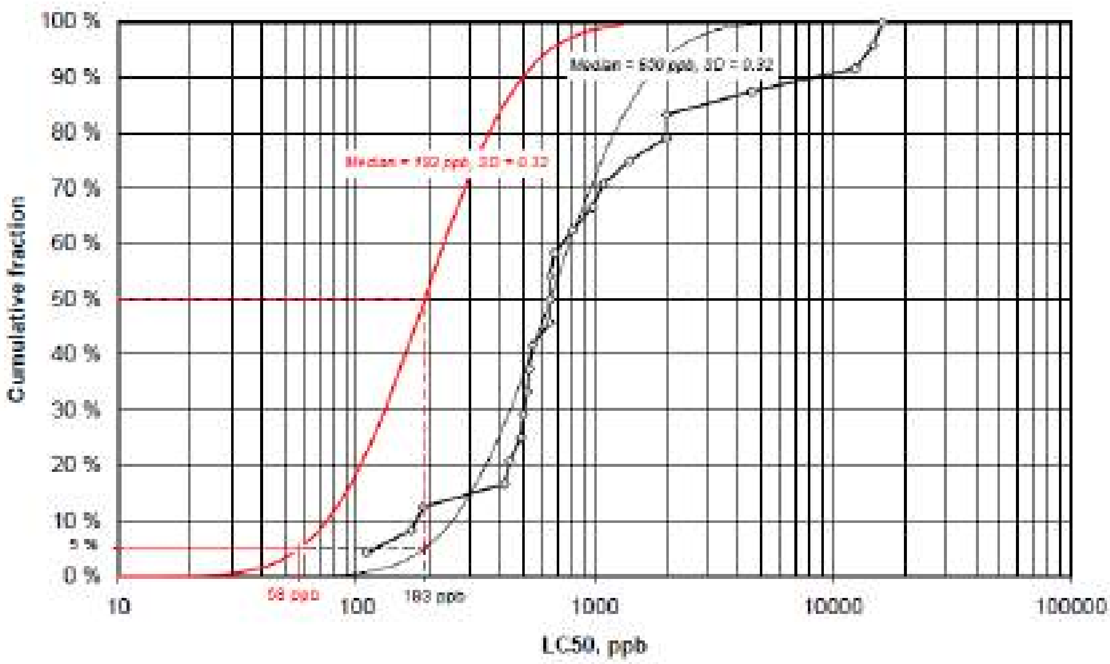
c) minimum Light Oiling threshold of 0.1 litres/m^2

d) emulsion density of 846kg/m^3 @STP (based on 0% water uptake)

4.2.3 Total Hydrocarbon Concentrations in the Water Column

Total hydrocarbon concentrations in the water column pose a risk to aquatic organisms when they exceed a certain concentration. Research completed by Johnsen et al (2005) and Det Norsk Veritas (2008) resulted in the development of species sensitivity dose-response curves to assess the impact to organisms from different water column hydrocarbon concentrations. A 5^{th} percentile LC_{50}[173] for total hydrocarbon concentrations was found to be 58 ppb (see Figure). This value of 58 ppb was applied in this modelling as the lower threshold for potential acute toxicological responses. Concentrations below this threshold are not exported from OSCAR. This is a conservative value as 58 ppb is below the LC_{50} for 95% of species as can be seen from Figure .

Figure 3: LC50 values from toxicity studies on dispersed oil on various aquatic species. The red line is the cumulative distribution curve of interest. This sensitive species dose-response curve shows the 5 % percentile LC_{50} value and SD = 0.32. From this dose-response curve, the threshold value (5 % lethal risk) is found to be 58 ppb.



[173] LC_{50} refers to a concentration of diesel (dissolved and dispersed) in the water column resulting in a lethal exposure to 50% of species of organism exposed over a given time-period.

4.3 OSCAR Set-Up

The modelling domain used for the D230 Seismic Survey diesel releases covers an area from 47° 31’ 21” E, 37° 27’ 37” N – 54° 07’ 09” E, 42° 52@ 50” N (550km x 600km) which equals 330,000 km^2. The modelling domain with bathymetry is shown in Figure 3 and other OSCAR modelling set-up parameters and release data are outlined in Table 3 and Table 4 respectively.

OSCAR modelling domain and modelling parameters were set-up the same for all 7 scenarios:

- Scenario 1a: NS1 Spring Diesel Release
- Scenario 1b: NS1 Summer Diesel Release
- Scenario 1c: NS1 Autumn Diesel Release
- Scenario 2a: NS2 Spring Diesel Release
- Scenario 2b: NS2 Summer Diesel Release
- Scenario 2c: NS2 Autumn Diesel Release
- Scenario 3a: NS3 Spring Diesel Release
- Scenario 3b: NS3 Summer Diesel Release
- Scenario 3c: NS3 Autumn Diesel Release
- Scenario 5a: FS1 Spring Diesel Release
- Scenario 5b: FS1 Summer Diesel Release
- Scenario 5c: FS1 Autumn Diesel Release
- Scenario 6a: FS2 Spring Diesel Release
- Scenario 6b: FS2 Summer Diesel Release
- Scenario 6c: FS2 Autumn Diesel Release
- Scenario 7a: NS3 Spring Lube Oil Release
- Scenario 7b: NS3 Summer Lube Oil Release
- Scenario 7c: NS3 Autumn Lube Oil Release

Each of the scenarios differs in terms of location (5 in total), season (3 in total) or type of hydrocarbon (2 in total) released. The coordinates of the release locations are provided in Table 3. Differences in the time of year (Spring, Summer, and Autumn) are reflected in the air temperatures in Table 3 and the water column temperature and salinity profiles in Figure 2.

Figure 3: Map showing OSCAR modelling domain used with bathymetric data. Release location NS1 is shown as a white square.

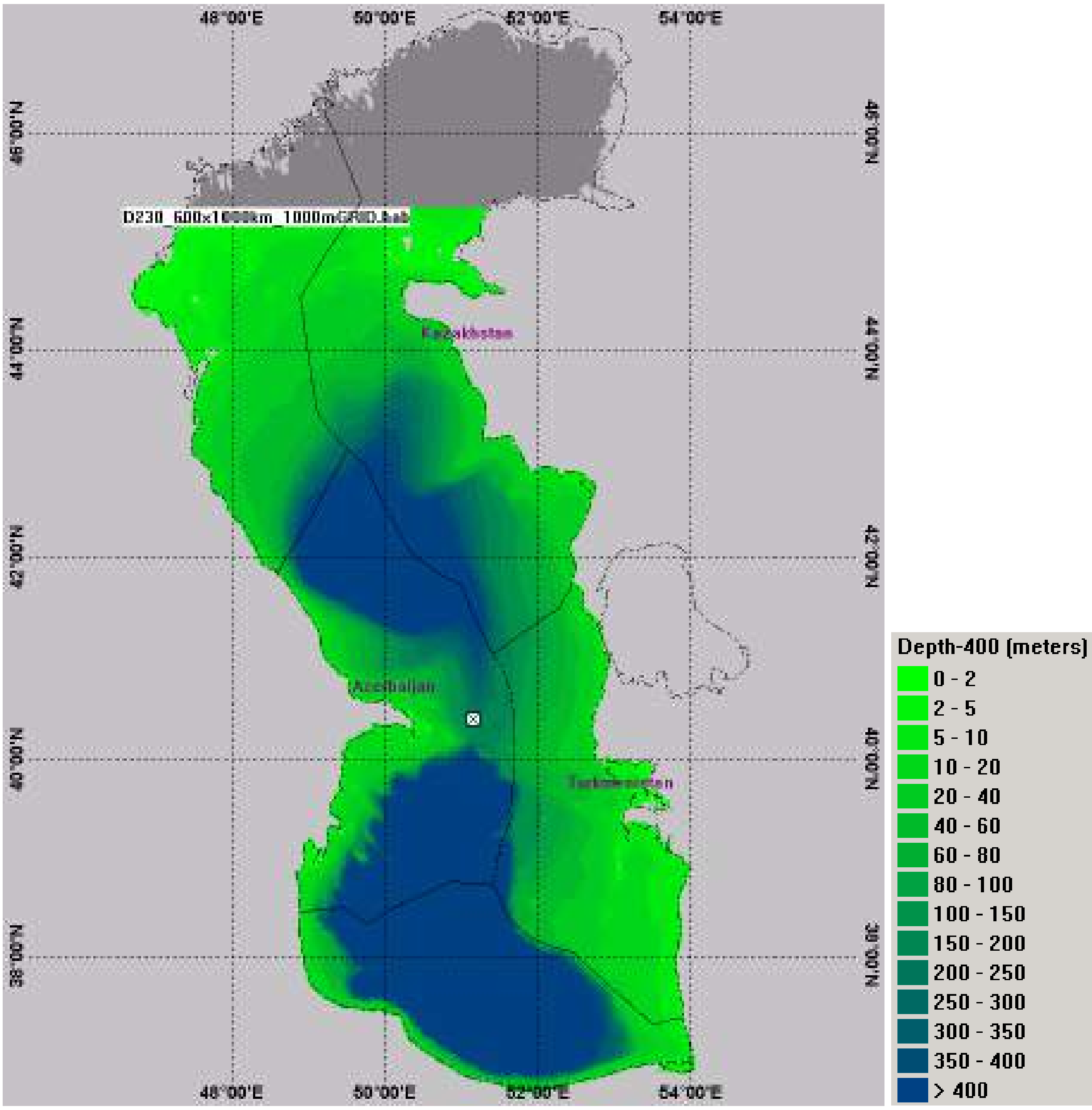


Table 3: OSCAR Set-up parameters used for the vessel diesel release.

Model Set-up Parameters				
Release Diameter			N/A	m
Release Locations	NS1	Longitude	51.149° E	
		Latitude	40.409° N	
	NS2	Longitude	50.804° E	
		Latitude	40.888° N	
	NS3	Longitude	50.440° E	
		Latitude	41.126° N	
	FS1	Longitude	51.178° E	
		Latitude	40.849° N	
	FS2	Longitude	50.808° E	
		Latitude	41.426° N	
	Liquid / Solid Particles	5,000		
	Dissolved Particles	5,000		
Number of Particles	Resolution in the x-direction (longitude)		1,000	M
	Resolution in the y-direction (latitude)		1,000	M
Habitat Grid Spatial Resolution	Sandy Beach		2	M
	Resolution in the x-direction (longitude)		1,000	M
Shoreline Type / Width	Resolution in the y-direction (latitude)		1,000	M
Concentration Grid Resolution	Resolution in the z-direction (depth)		5	M
	Resolution in the x-direction (longitude)		1,000	m
	Resolution in the y-direction (latitude)		1,000	m
Surface Grid Spatial Resolution	Min:		0	m
	Max:		50	m
Concentration Grid Depth			58	ppb
	Initial Thickness		1	mm
Lower Concentration Limit	Thick Limit		0.1	mm
Surface Film Thickness	Terminal Thickness		0.04	µm
	Output Interval		12	hours
	Computational Time-step		10	minutes
Computational / Output Time-step			10	minutes
			100	days
Release Period	Spring/Summer/Autumn		10/23/15	°C
Simulation Period				
Air Temperature				

Table 4: OSCAR release data for D230 seismic vessel diesel inventory release

Scenario: Seismic Vessel Diesel Release				**Well/inventory loss parameters**				
Loss from well / FPSO / rig / Other (please specify)			Vessel	Instantaneous loss?	Yes – 10 minutes			
Worst case volume			800 te Diesel 22m^3 Lube Oil	Will the well self-kill? If yes then when?	N/A			
Flow rate			N/A					
Justification for predicted worst case volume			Provisionla vessel inventories					
Location								
Spill source point	Latitude	See Table 3	Longitude	See Table 3				
Installation / Facility name	Seismic Vessel							
Hydrocarbon 1 properties								
Hydrocarbon name		Marine Diesel						
Assay available		Yes	Was an analogue used for spill modelling?			No		
	Name	ITOPF category	Specific gravity	API	Viscosity (cp @°C)	Asphaltene (%)	Wax (%)	Pour point (°C)
Hydrocarbon	Marine Diesel (IKU)		0.843	36.4	3.9 (Ref Temp)	N/A	N/A	-36
Analogue								
Fuel loss	Marine Diesel							
Hydrocarbon 2 properties								
Hydrocarbon name		Lube Oil						
Assay available		No	Was an analogue used for spill modelling?			Yes		
	Name	ITOPF category	Specific gravity	API	Viscosity (cp @°C)	Asphaltene (%)	Wax (%)	Pour point (°C)
Hydrocarbon	Castrol MHP		0.890		10.235 (13°C)	No Data	No Data	-12
Analogue	Neptune Composite		0.869	31.3	10 (13°C)	No Data	No Data	-9
Fuel loss	Lube Oil							
Metocean Parameters								
Air temperature	Spring = 10°C Summer = 23°C Autumn = 8°C	Water Column Temperature	**Error! Reference source not found.**					
Wind data	Data period:	2006 – 2009 (4 years)						
Wind data reference	Imperial College London ReEMS							

Current data	Data period:	2006 – 2009 (4 years)	
Current data reference	Imperial College London ReEMS		
Modelled release parameters			
Surface or subsurface	Surface	Depth	0 m
Release duration	10 minutes	Instantaneous Release?	Yes
Total simulation time	100 days	Total release	Diesel = 800 te Lube Oil = $22m^3$
Oil spill modelling software			
Name of software	MEMW (OSCAR)	Version	7.0.1

5 Protected and Environmentally Sensitive Areas

The potential impact of a diesel release from a seismic vessel is assessed by analysing the proximity and persistence of probabilistic hydrocarbon extents to Protected and Environmentally Sensitive Areas.

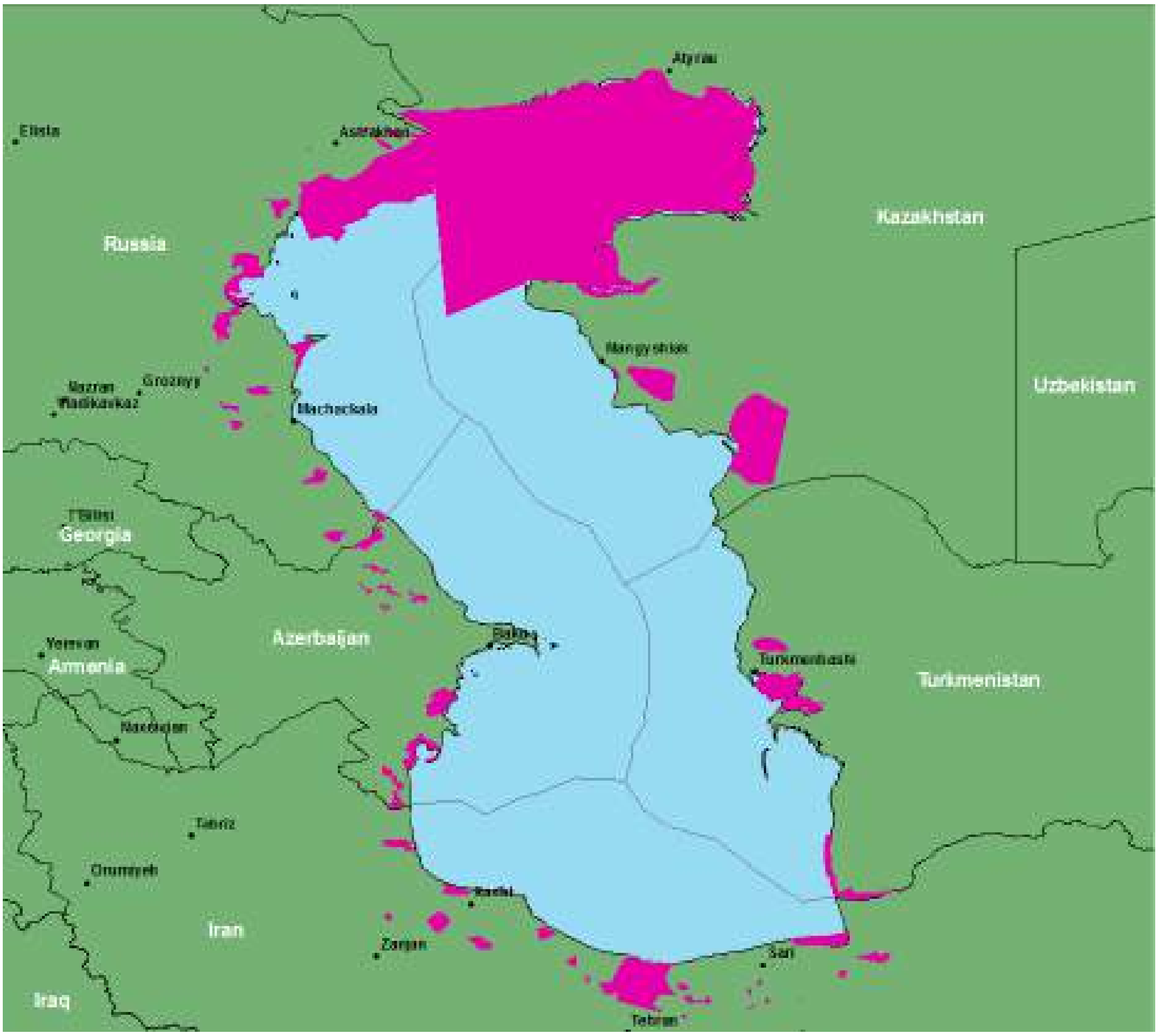
5.1 Protected Areas

Protected areas that could be impact from hydrocarbon releases were identified by finding areas where probabilistic outputs from OSCAR showed:

- Surface oiling >0.04 µm thick with greater than 5% probability of occurring
- Shoreline oiling (Marine Diesel) >0.169 tonnes / km with greater than 1% probability of occurring
- Shoreline oiling (Lube oil) >0.174 tonnes / km with greater than 1% probability of occurring

A detailed analysis of potentially impacted PAs will be undertaken by the D230 ESIA team based on higher resolution local datasets. A high-level analysis is provided in this report based global protected area data provided in the World Database on Protected Areas (WDPA) (UNEP-WCMC and IUCN, 2015) and the RAMSAR protected wetlands (RAMSAR, 2015) (see Figure 4).

Figure 4: Location of relevant median lines (VLIZ, 2015). Magenta polygons represent protected areas from the World Database of Protected Areas (WDPA) (UNEP-WCMC and IUCN, 2015) and RAMSAR protected wetlands (RAMSAR, 2015)



6 Coastlines and Median Lines

6.1 Median Lines

The highest probability and minimum time to cross an Economic Exclusion Zone (EEZ) for spilled diesel/lube oil in each scenario (based on the 100 stochastic simulations completed for each scenario) are captured in section 7. A map showing the location of these EEZs is shown in Figure 5.

Figure 5: Economic Exclusion Zones (EEZs) and boundaries in the Caspian Sea (VLIZ, 2014).

6.2 Coastlines

The location of shoreline oiling and the minimum time to oil landfall after the beginning of a hydrocarbon release is provided in the summary tables for each scenario.

Azerbaijan and the wider Caspian coastlines have been divided into discrete regions (see Figure 6) to provide greater resolution of the probability, minimum arrival time and persistence of diesel on the sea surface (>0.04µm), on the shoreline (>0.169tonnes/km for diesel and (>0.174 tonnes/km for lube oil) and dispersed oil in the water column (>58 ppb).

Figure 6: Coastal regions of the Caspian Sea

7 Results

This section presents the results from the vessel release modelling. The results for each scenario are tabulated in Table 5. For the purposes of supporting the D230 ESIA, this study is focussed on the results of the scenario causing the greatest shoreline oiling, and the scenario resulting in the most surface oil entering the Economic Exclusion Zones (EEZs) of other countries bordering the Caspian Sea outside the Azerbaijan EEZ. These occur from release site NS3 (Scenario 3) and FS1 (Scenario 5) respectively. Modelling output maps for the worst case shoreline oiling release location (NS3) are provided in the main section of this report. Results for the most surface oiling outside the Azerbaijan EEZ (FS1) are provided in Appendix 1.

The mapped results for locations NS3 and FS1 represent different fate and trajectory information related to potential oil spill releases derived from the stochastic simulations. A brief explanation is provided below of what the different output results represent:

12.1.1.1 Surface Oiling

- Probability of Surface Oiling

- Probability (%) of surface hydrocarbon >0.04 µm thick. 0.04 µm is the lower limit of visible oil on the sea surface – a "sheen"- based on the Bonn Agreement Oil Appearance Code (BAOAC) (Lewis, 2007).

- Minimum Arrival Time of Surface Oil
  - Shows the quickest time from the start of the release when hydrocarbons >0.04 µm thick appear on the sea surface at a given location.
- Maximum Surface Oil Thickness
  - Shows the maximum thickness of oil that is predicted to occur on the sea surface during a release from the diesel release based on the BAOAC.
- Surface Oiling Exposure Time
  - Shows the maximum length of time that diesel >0.04 µm thick is predicted to be present on the sea surface from the vessel release.

12.1.1.2 Water Column Dispersion

- Probability of Dispersed Hydrocarbon in the Water Column
  - Shows the probability (%) that there will be hydrocarbons (dispersed and dissolved) in the water column at total concentrations >58 ppb from the release.
- Minimum Arrival Time of Dispersed Hydrocarbon
  - Shows the quickest time from the start of the release that dispersed hydrocarbons at total concentrations >58 ppb reach a certain location.
- Dispersed Hydrocarbon Exposure Time
  - Shows the maximum length of time that dispersed hydrocarbons at total concentrations >58 ppb are predicted to occur in the water column.

12.1.1.3 Shoreline Oiling

- Probability of Shoreline Oiling
  - Shows probability (%) of shoreline oiling occurring at >0.169 tonnes/km for diesel or >0.174 tonnes/km for lube oil - ITOPF "Light Oiling" threshold.
- Minimum Arrival Time of Shoreline Oil
  - Shows the quickest time from the start of the release when hydrocarbon oiling >0.169 tonnes/km for diesel or >0.174 tonnes/km for lube oil occurs along the shoreline

Table 5: Tabulated shoreline oiling >0.169te/km for diesel and >0.174 te/km for lube oil. Yellow cells show worst case shoreline oiling scenario. Results for these worst case scenarios are mapped and discussed in detail in section 7.1.

Scenario	Release Location	Season	Hydrocarbon	Maximum Shoreline Oiling (tonnes)
1a	NS1	Spring	Marine Diesel	358
1b	NS1	Summer	Marine Diesel	479
1c	NS1	Autumn	Marine Diesel	383
2a	NS2	Spring	Marine Diesel	321

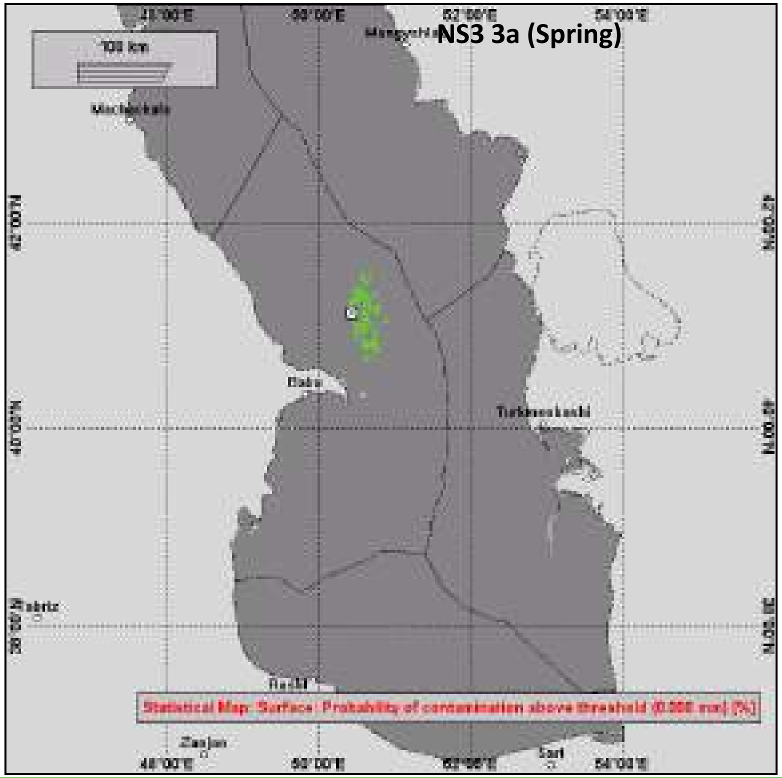
2b	NS2	Summer	Marine Diesel	453
2c	NS2	Autumn	Marine Diesel	384
3a	NS3	Spring	Marine Diesel	356
3b	NS3	Summer	Marine Diesel	486
3c	NS3	Autumn	Marine Diesel	269
5a	FS1	Spring	Marine Diesel	243
5b	FS1	Summer	Marine Diesel	240
5c	FS1	Autumn	Marine Diesel	255
6a	FS2	Spring	Marine Diesel	
6b	FS2	Summer	Marine Diesel	
6c	FS2	Autumn	Marine Diesel	34
7a	NS3	Spring	Lube Oil	0
7b	NS3	Summer	Lube Oil	0
7c	NS3	Autumn	Lube Oil	0

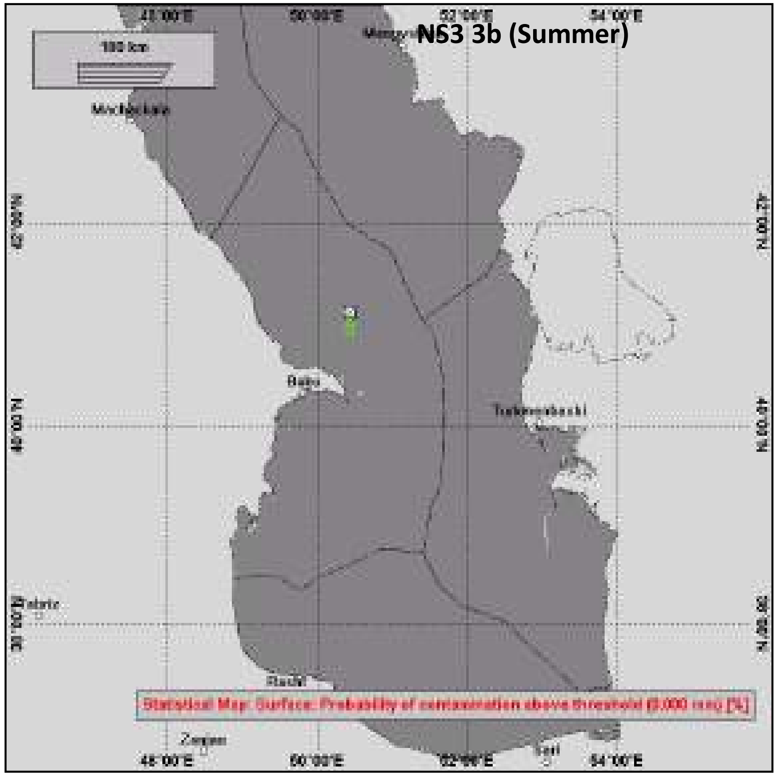
7.1 Scenario 3 (Release Site – NS3)

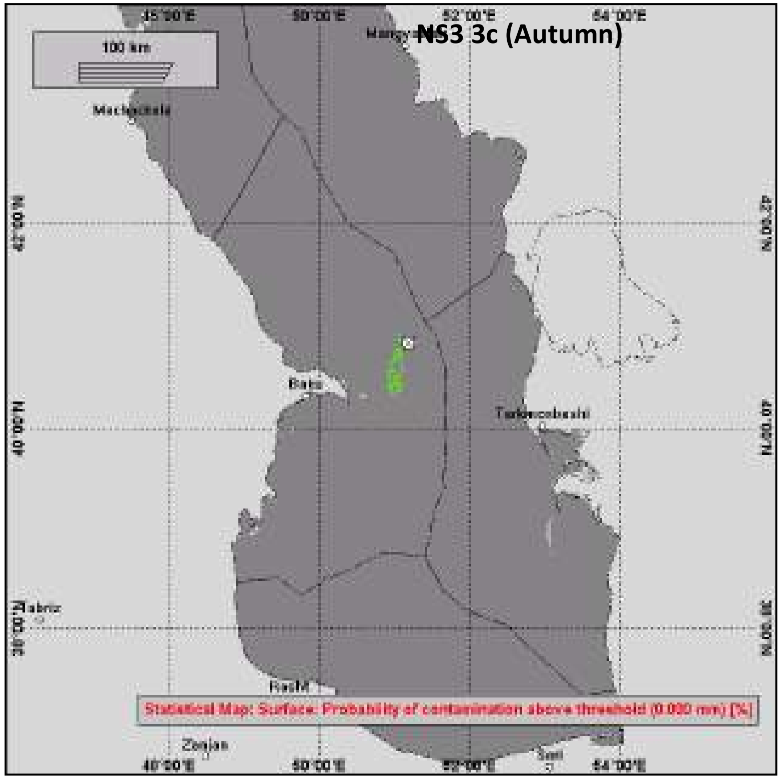
7.1.1 Surface Oiling

12.1.1.4 Surface Oiling Probability

Surface Oil Thicker than 0.04µm (Visible Sheen) (Probability >5%) **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Surface Oiling Probability (> 5%) where surface oil is thicker than 0.04 µm (the minimum visible thickness from the Bonn Agreement Oil Appearance Code system (Lewis, 2007).







Map Key

Probability of Surface Oiling

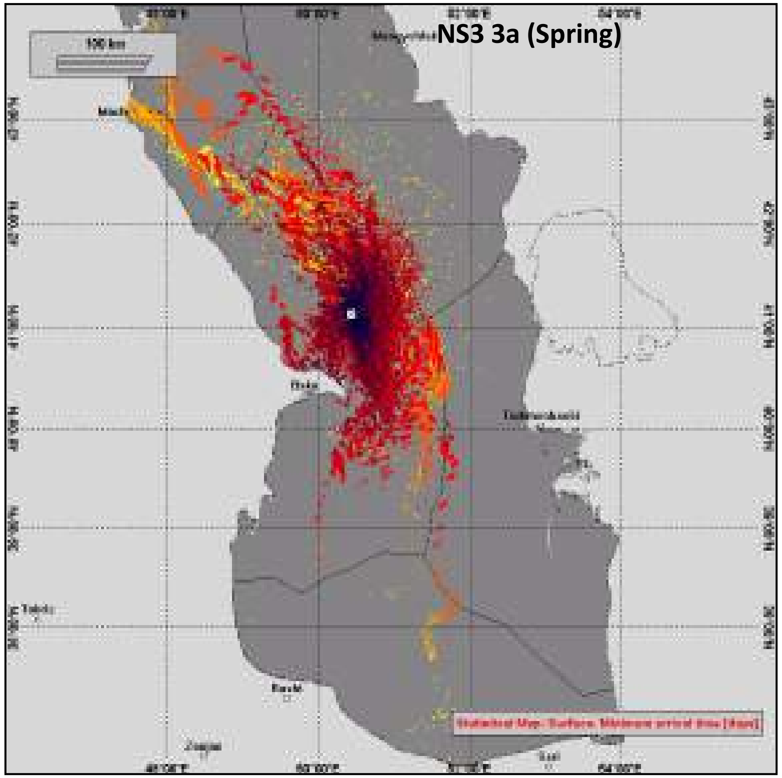
5, 10, 20, 30, 40, 50, 60, 70, 80, 90

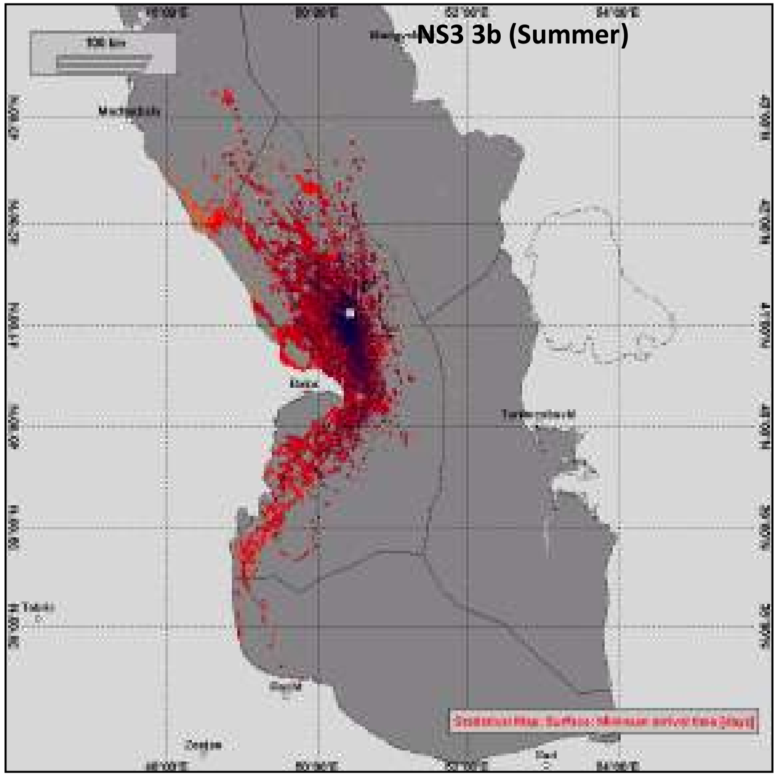
Release Site

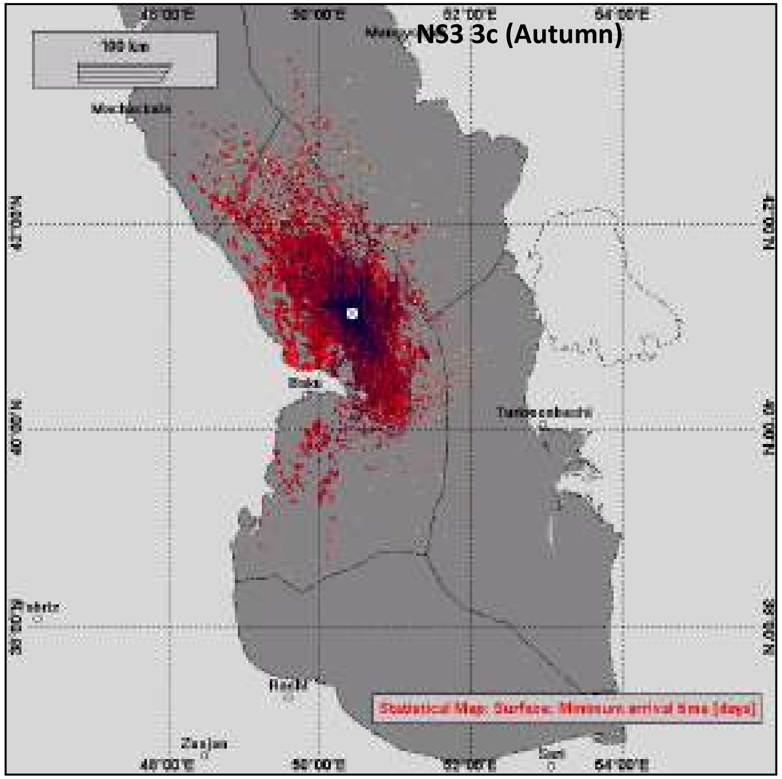
Median Line

12.1.1.5 Surface Oiling Arrival Time

Minimum Arrival Time (Days) of Surface Oil Thicker than 0.04µm (Probability >1%) **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Minimum arrival time of surface oil thicker than 0.04 µm (BAOAC "Sheen"). No probability threshold is applied due to limited functionality in OSCAR so the extents represent locations where the probability of surface oil is >1% rather than the >5% threshold used in the probability extent maps.







Map Key

Arrival Time (days)

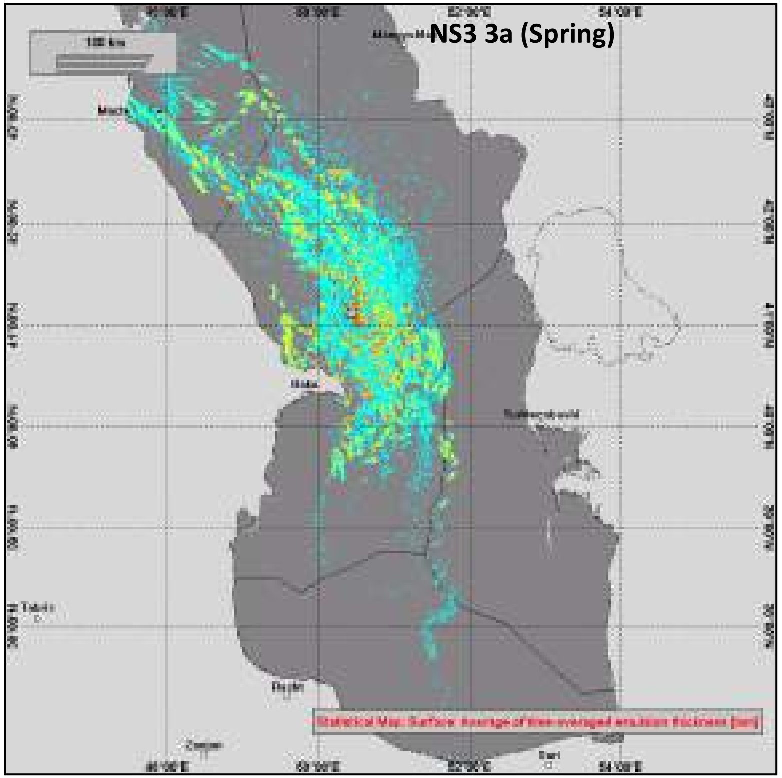
0-1	2-4	7-10	14-17	20-25	30-45	60-90
1-2	4-7	10-14	17-20	25-30	45-60	>90

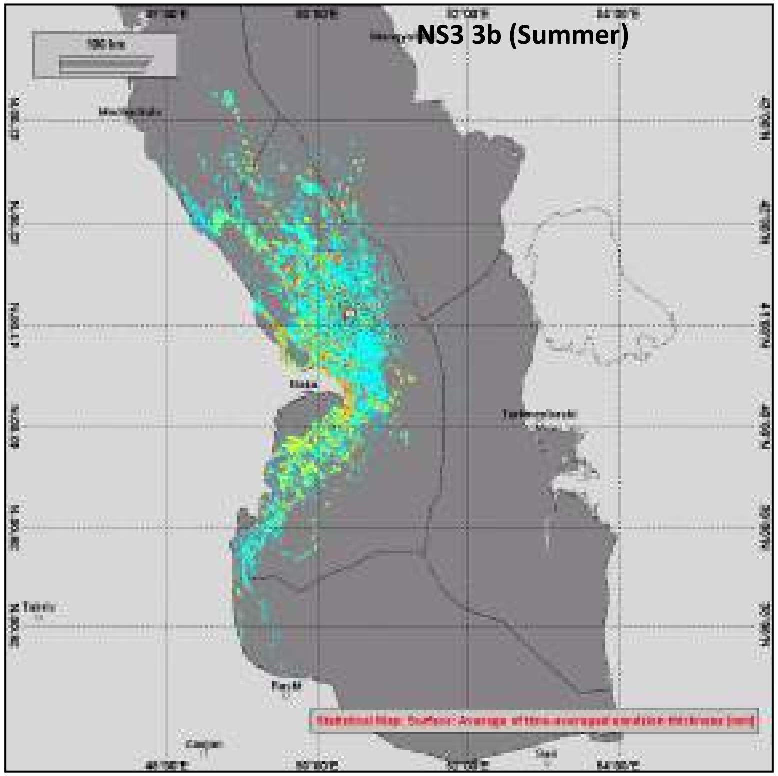
Release Site

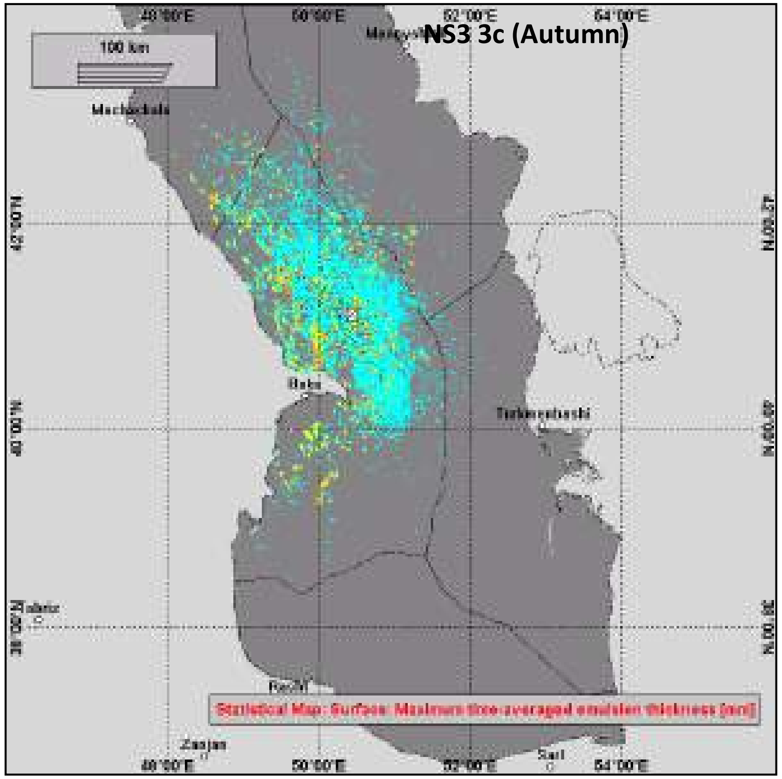
Median Line

12.1.1.6 Surface Oiling Average Thickness (BAOAC)

Surface Oil Thickness (Bonn Agreement Oil Appearance Code) (Probability >1%) **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Surface Oiling Average Thickness based on the BAOAC groups. No probability threshold is applied due to limited functionality in OSCAR so the extents represent locations where the probability of surface oil is >1% rather than the >5% threshold used in the probability extent maps.







Map Key

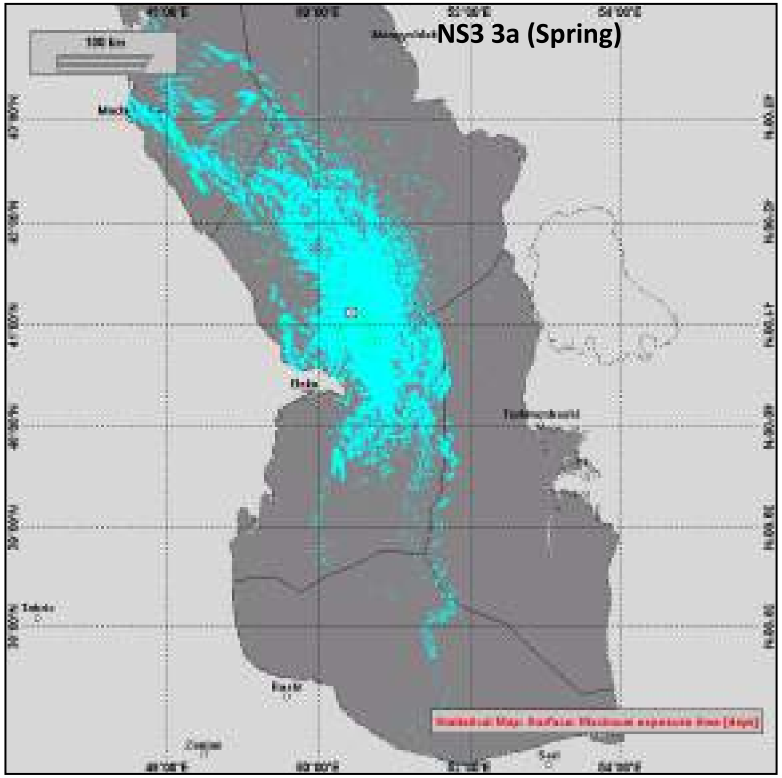
Surface Oil Thickness (Bonn Agreement Oil Appearance Code)

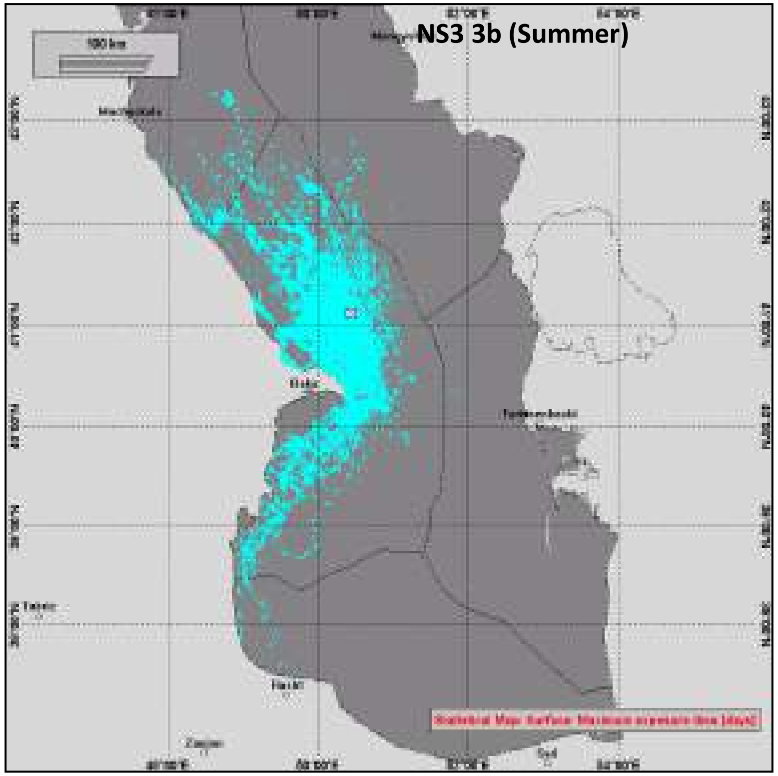
- Sheen (0.04 - 0.3 um)
- Rainbow (0.3 - 5 um)
- Metallic (5 - 50 um)
- DTOC (50 - 200 um)
- CTOC (>200 um)

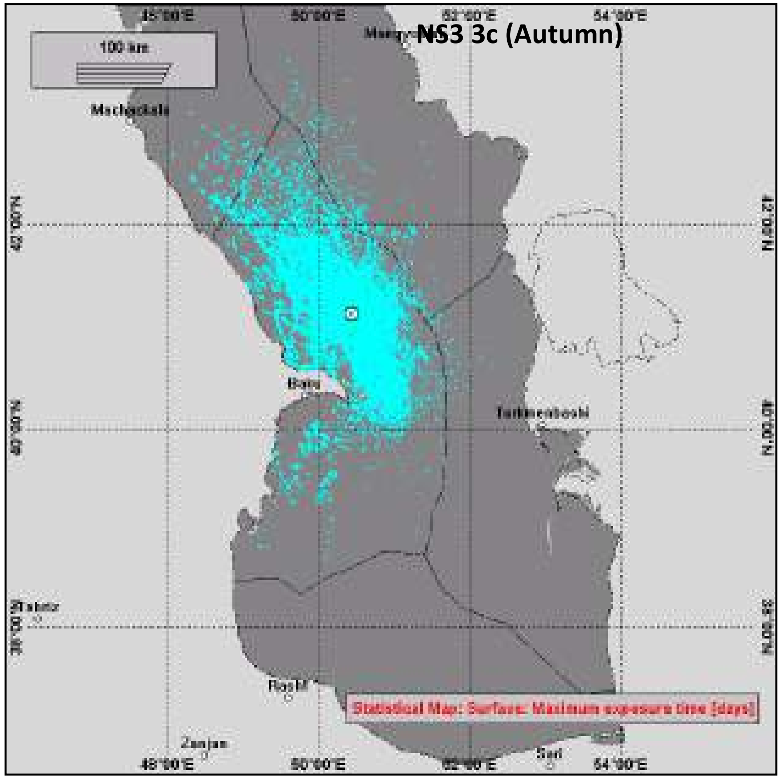
Release Site

12.1.1.7 Surface Oiling Exposure Time (Days)

Maximum Exposure Time (Days) (Probability >1%) **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Maximum surface oil exposure in days. No probability threshold is applied due to limited functionality in OSCAR so the extents represent locations where the probability of surface oil is >1% rather than the >5% threshold used in the probability extent maps.







Map Key

Exposure Time (days)

0 - 1	2 - 4	7 - 10	14 - 17	20 - 25	> 30
1 - 2	4 - 7	10 - 14	14 - 20	25 - 30	

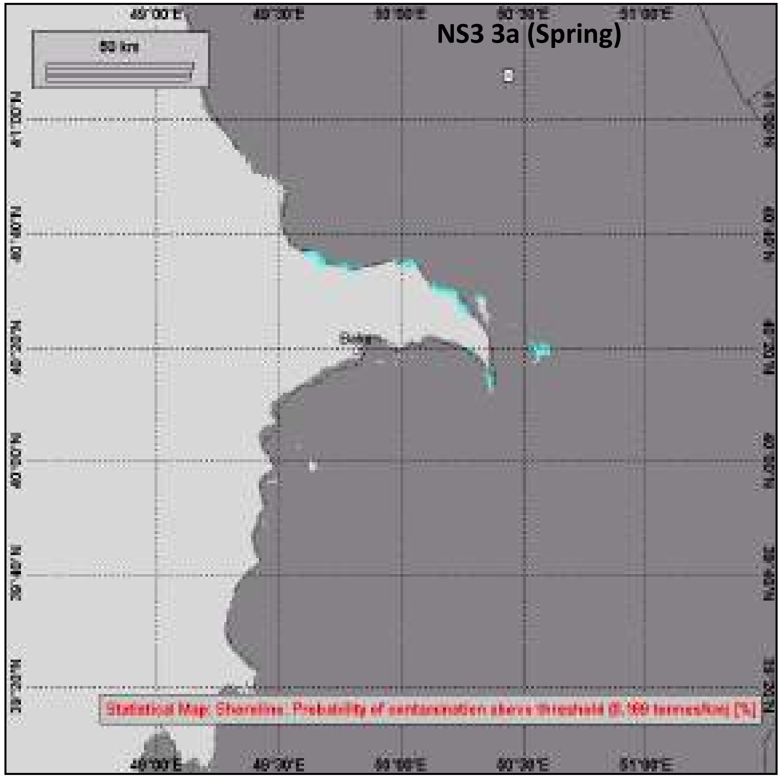
Median Line

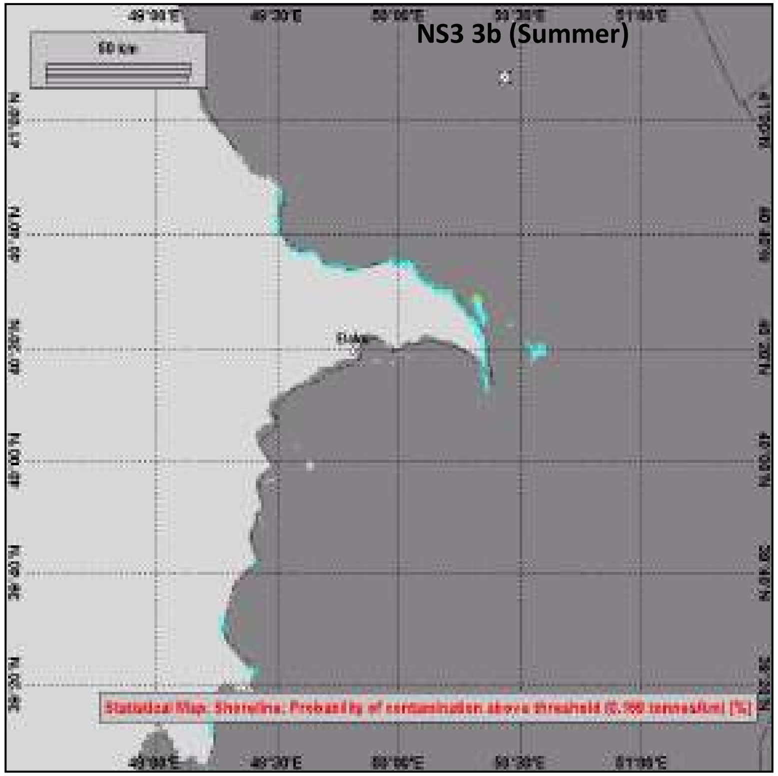
Release Site

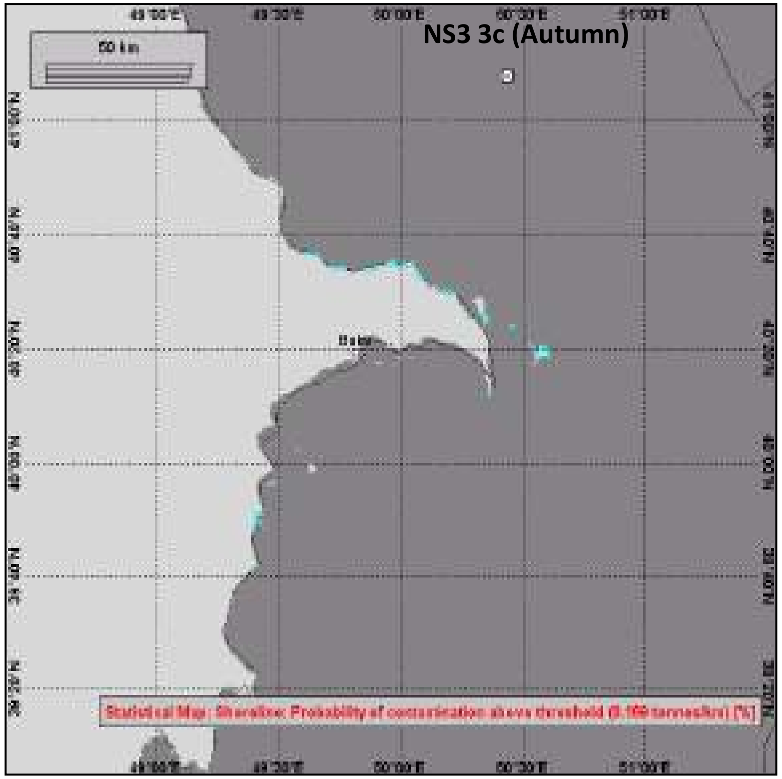
7.1.2 Shoreline Oiling

12.1.1.8 Shoreline Oiling probability

Probability (>1%) of Shoreline Oiling exceeding 0.169tonnes/km (ITOPF "Light Oiling" Threshold) **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Shoreline Oiling Probability (> 1%) where shoreline oil mass exceed 0.169 tonnes/km (the minimum value of the ITOPT "Light Oiling" range (ITOPF, 2011).





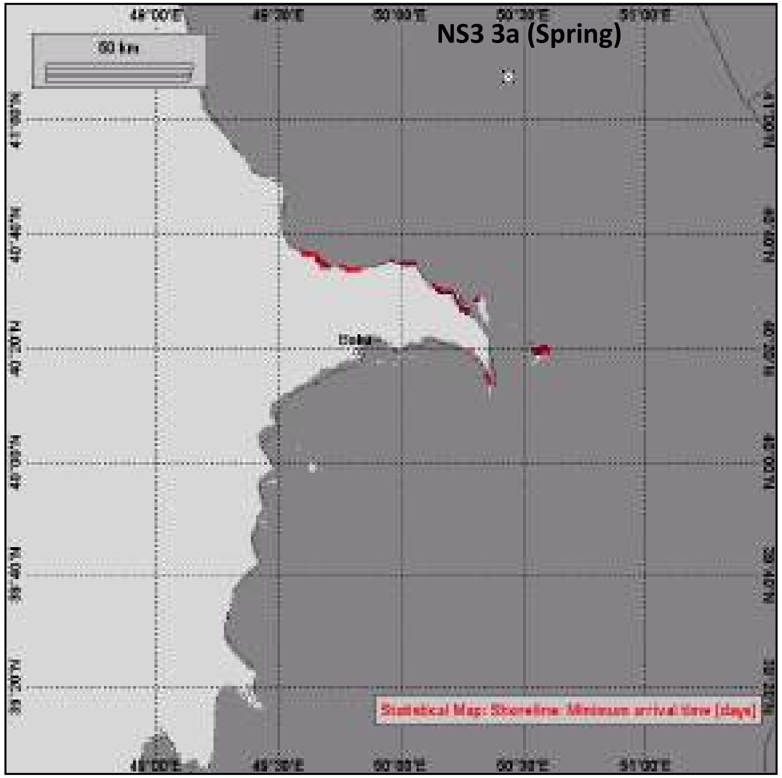

NS3 3c (Autumn)
50 km

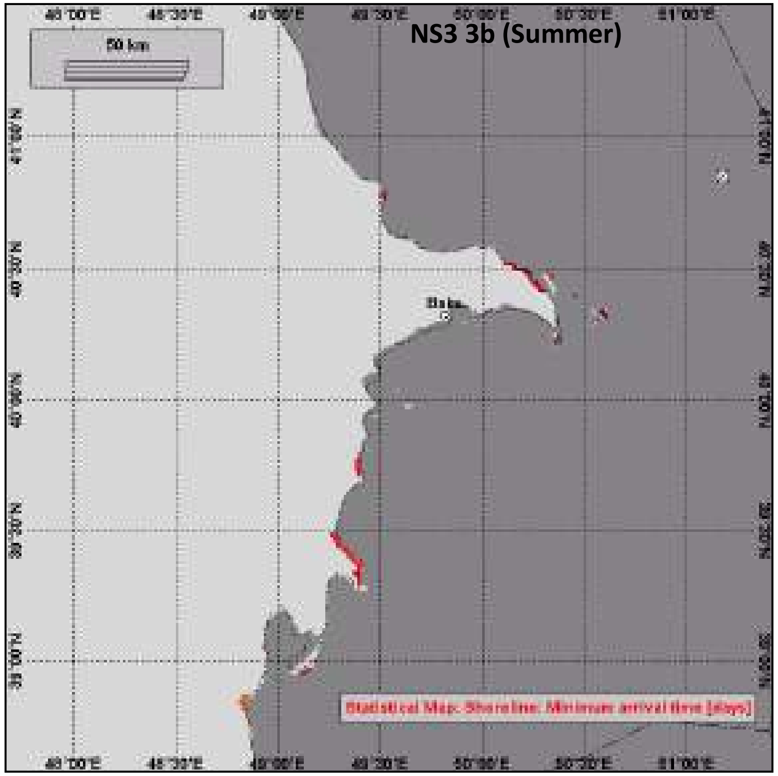
Map Key

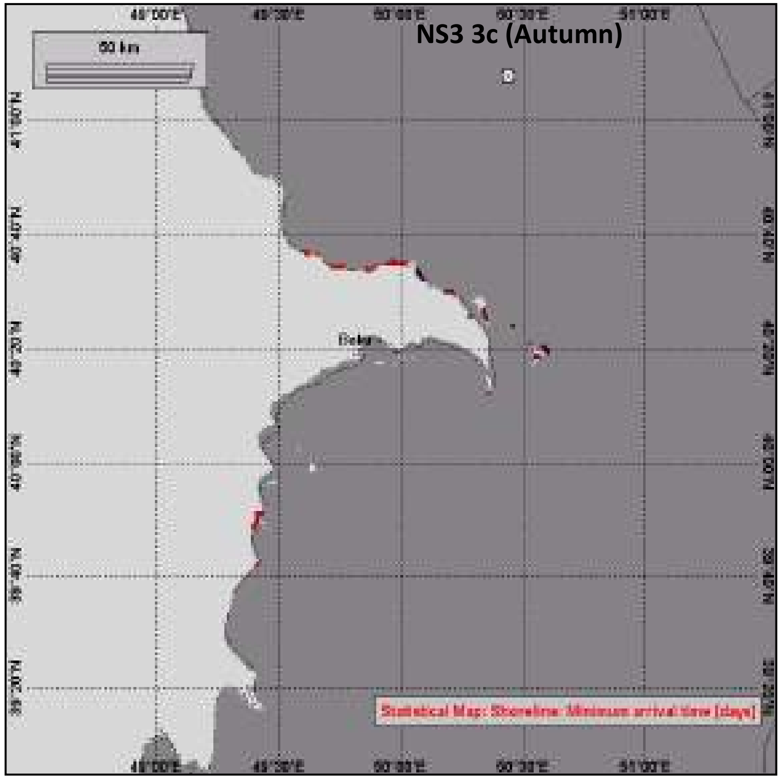

Oiling Probability (%)
1 - 5
5 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100
Release Site

12.1.1.9 Shoreline Oiling Arrival Time

Minimum Arrival Time (Days) of Shoreline Oil exceeding 0.169tonnes/km (ITOPF “Light Oiling” Threshold) **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Minimum arrival time of diesel on the shoreline exceeding 0.169 tonnes/km (Minimum ITOPF “Light Oiling” Threshold). Results show locations where the probability of shoreline diesel >1%.







Map Key

Arrival Time (days)

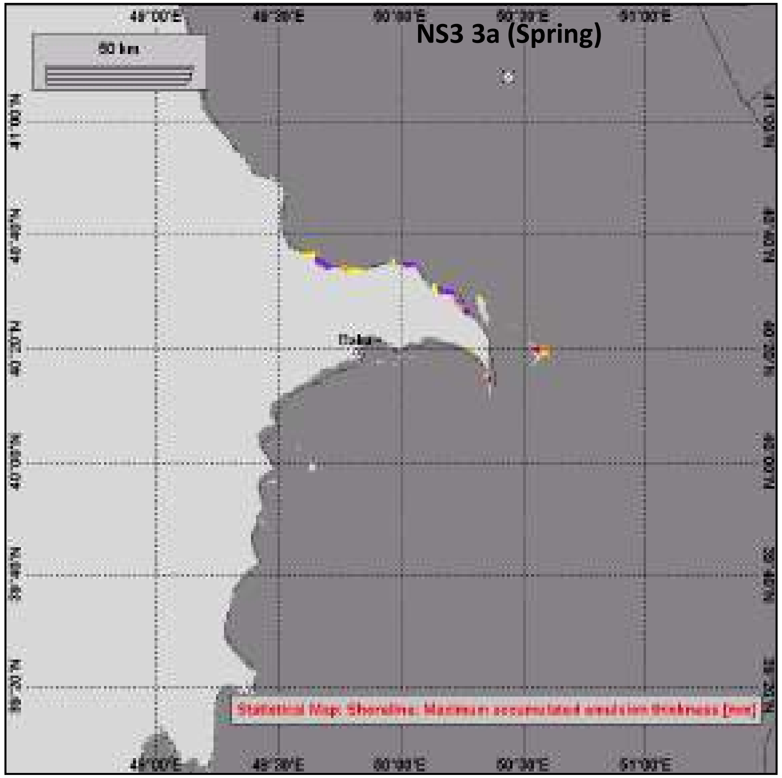
0-1, 1-2, 2-4, 4-7, 7-10, 10-14, 14-17, 17-20, 20-25, 25-30, 30-45, 45-60, 60-90, >90

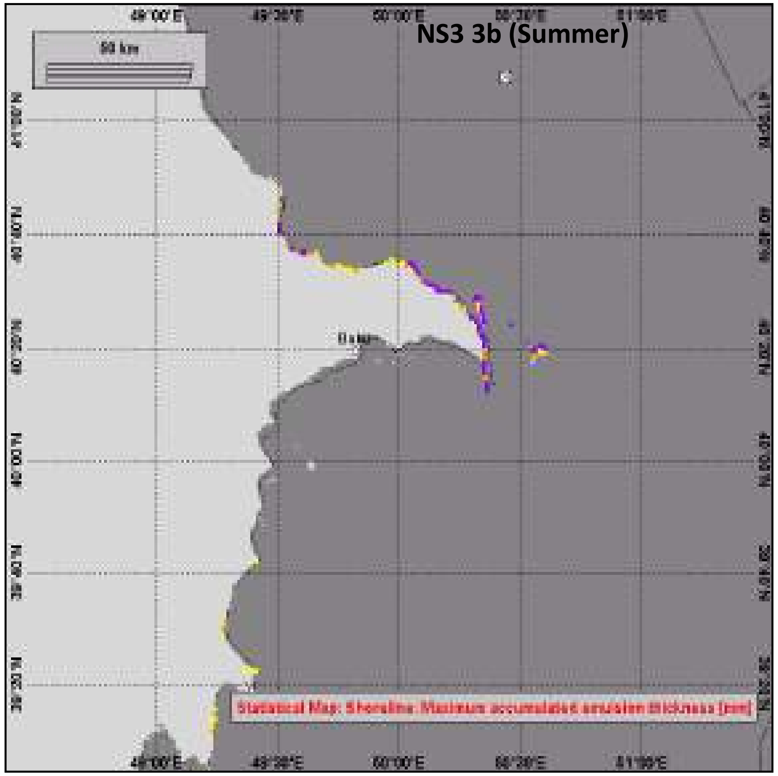
Release Site

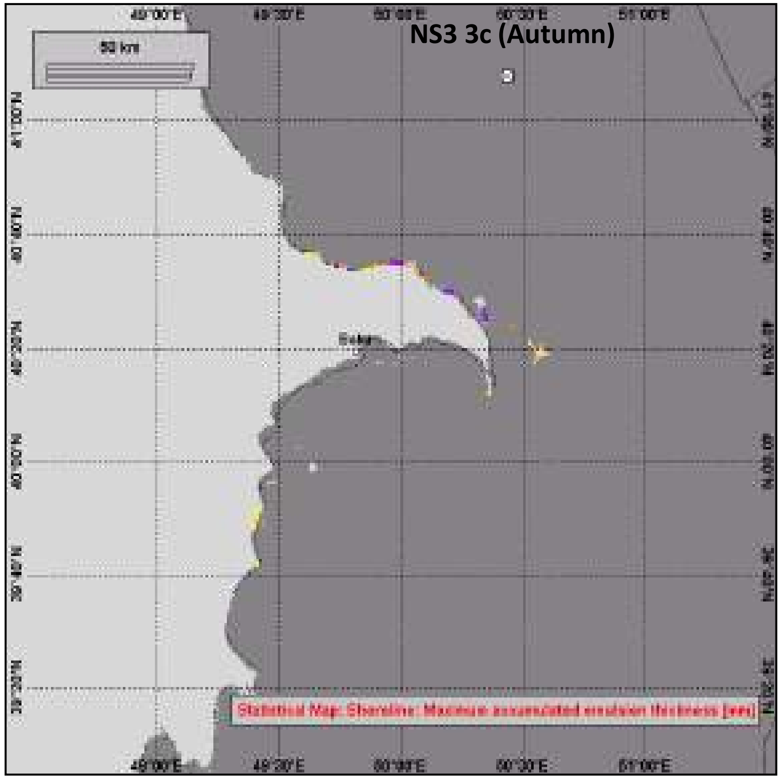
Median Line

12.1.1.10 Shoreline Oiling Severity

Severity of Shoreline Oiling (ITOPF Classification) **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Severity of shoreline oiling (ITOPF Classification) where it exceeds the ITOPF "Light Oiling" threshold of 0.169 tonnes/km. Results show locations where the probability of shoreline diesel >1%.







Map Key

ITOPF Shoreling Oiling Classification

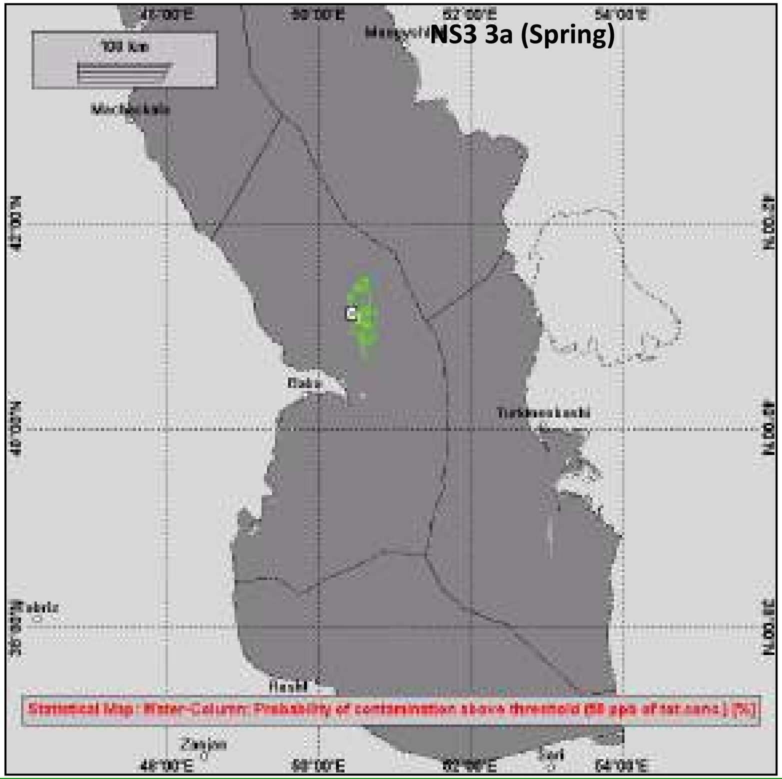
- ITOPF Light Oiling (0.1-1mm Thick)
- ITOPF Moderate Oiling (1-10mm Thick)
- ITOPF Heavy Oiling (>10mm Thick)

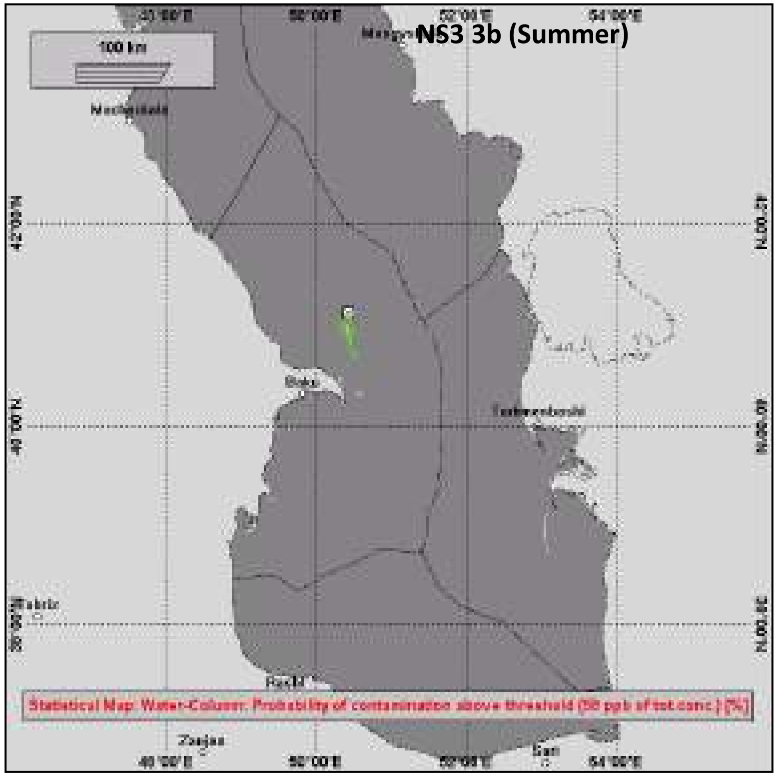
Release Site

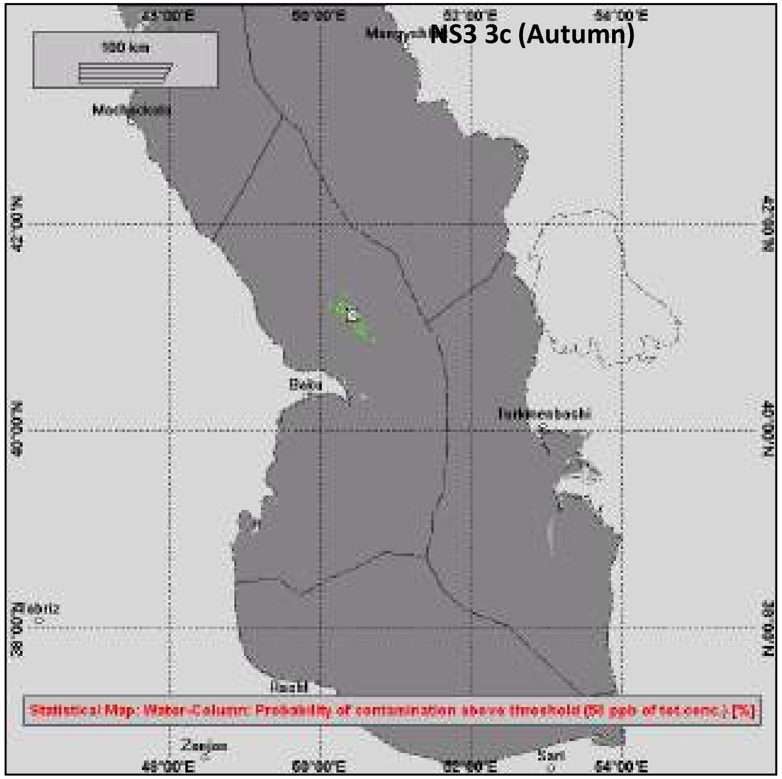
7.1.3 Water Column Concentrations

12.1.1.11 Probability of water column concentrations of diesel (dispersed and dissolved) exceeding 58 µg/l (ppb)

Probability (>5%) of Water Column Concentrations >58 µg/l (ppb). **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Probability (>5%) of diesel concentrations > 58 ppb being exceeded in the water column. This is the total concentration including dispersed and dissolved diesel.

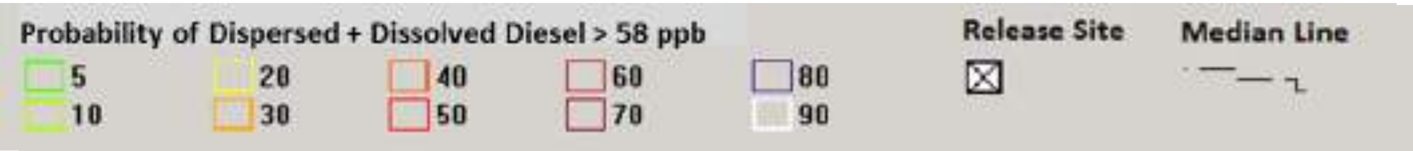






NS3 3c (Autumn)
100 km
Baku
Turkmenbashi
Rasht
Sari
Statistical Map: Water-Column: Probability of contamination above threshold (58 ppb of tot.conc.) [%]

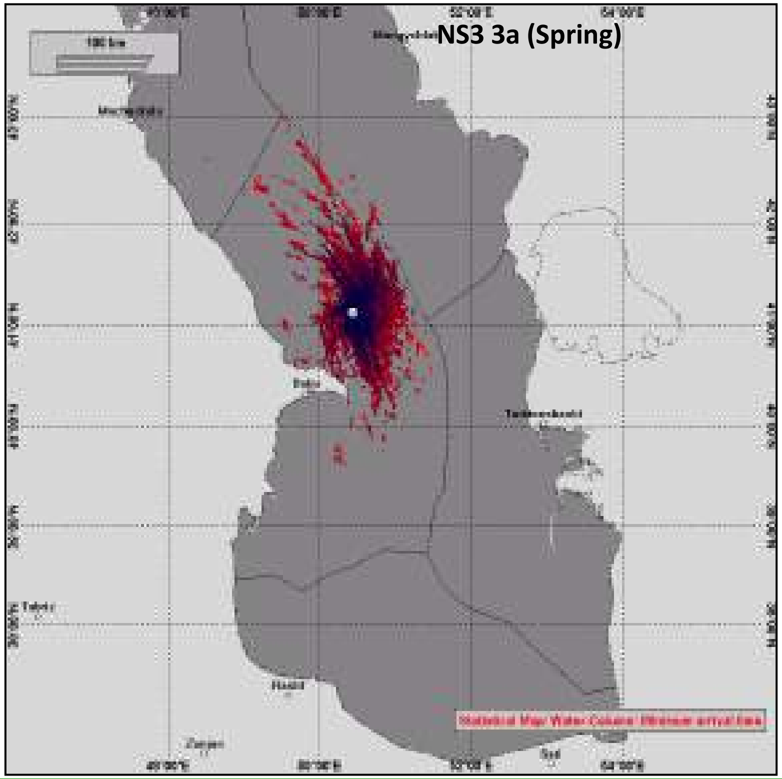
Map Key

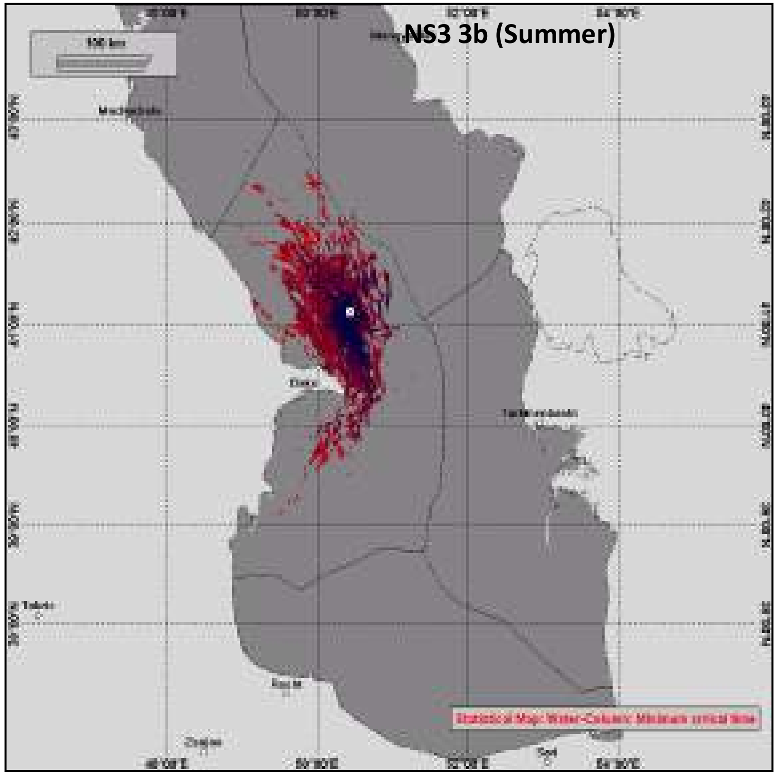


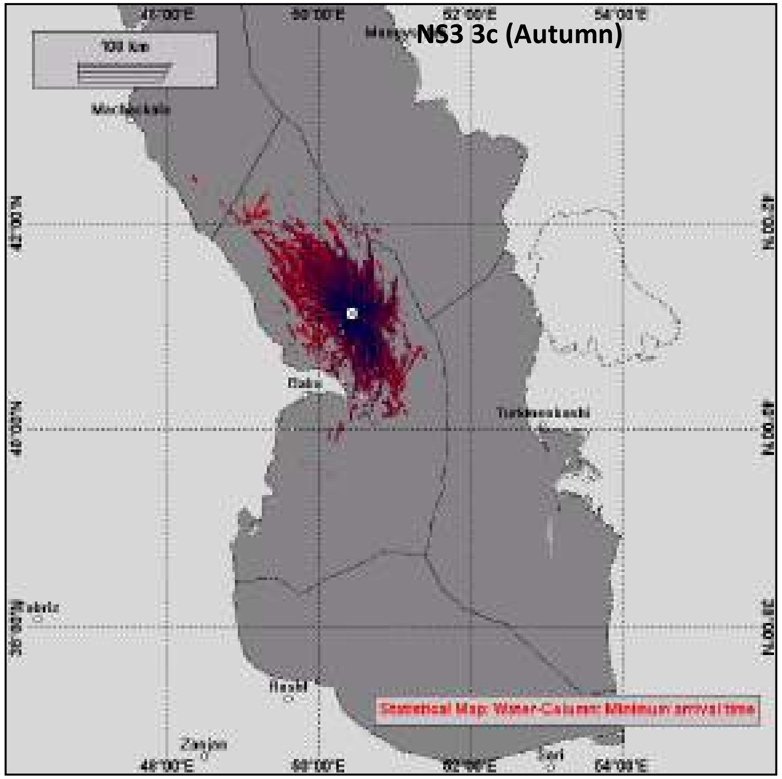
Probability of Dispersed + Dissolved Diesel > 58 ppb
5
10
20
30
40
50
60
70
80
90
Release Site
Median Line

12.1.1.12 Minimum Arrival Time of Water Column Concentrations of Diesel (Dispersed and Dissolved) exceeding 58 µg/l (ppb)

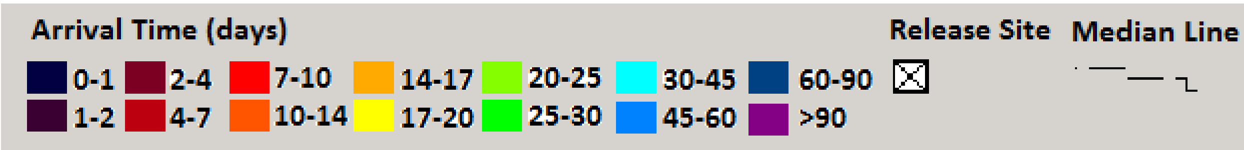
Minimum Arrival Time (Days) of Water Column Diesel Concentrations exceeding 58 ppb **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Minimum arrival time of water column diesel concentrations (dispersed and dissolved) exceeding 58 ppb (Statoil, 2006). No probability threshold is applied due to limited functionality in OSCAR so the extents represent locations where the probability of surface oil is >1% rather than the >5% threshold used in the probability extent maps.





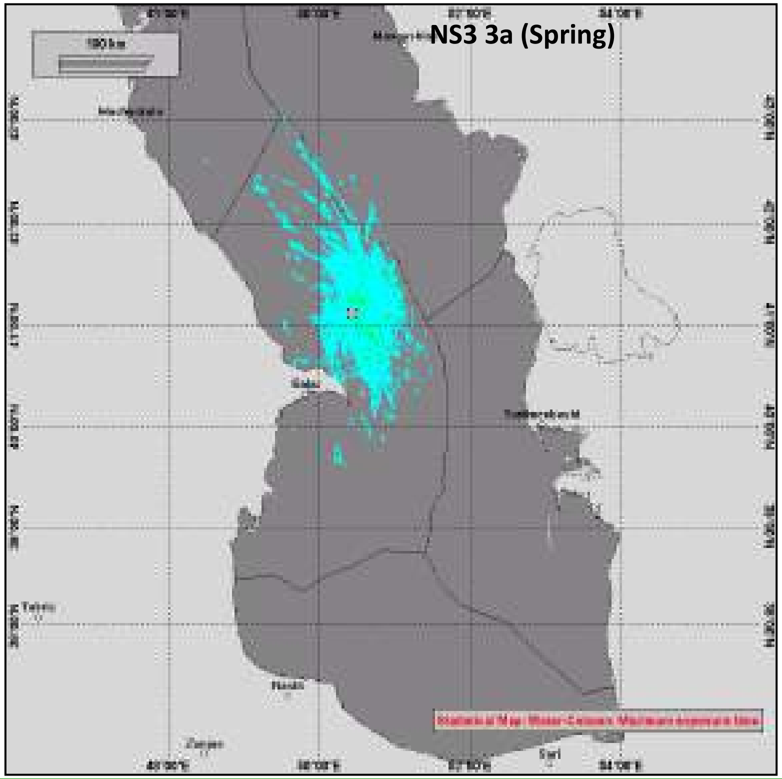

NS3 3c (Autumn)
100 km
Baku
Rasht
Zanjan
Sari
Statistical Map: Water-Column: Minimum arrival time

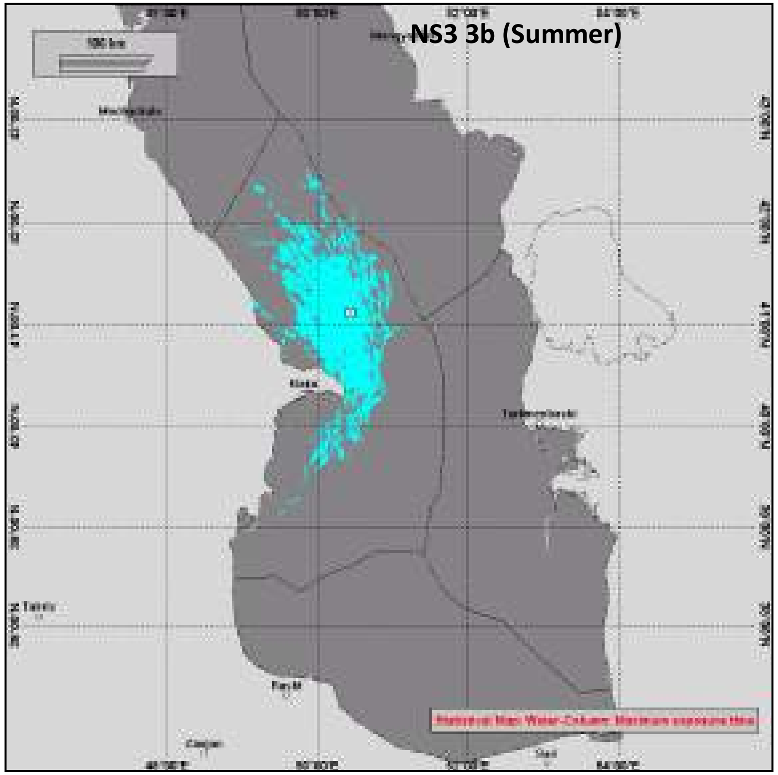
Map Key

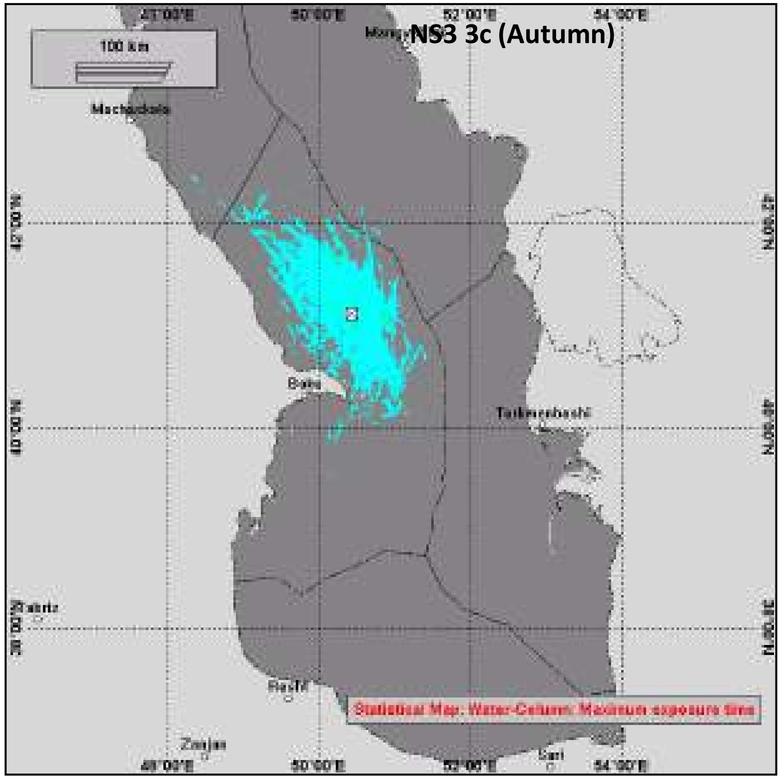

Arrival Time (days)
0-1
1-2
2-4
4-7
7-10
10-14
14-17
17-20
20-25
25-30
30-45
45-60
60-90
>90
Release Site
Median Line

12.1.1.13 Duration of Diesel Concentrations in the Water Column (Dispersed and Dissolved) exceeding 58 µg/l (ppb)

Maximum Exposure Time (Days) of Water Column Diesel Concentrations exceeding 58 ppb **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Maximum water column exposure in days where diesel concentrations (dispersed and dissolved) exceed 58 ppb. No probability threshold is applied due to limited functionality in OSCAR so the extents represent locations where the probability of surface oil is >1% rather than the >5% threshold used in the probability extent maps.







Map Key

Exposure Time (days)

0 - 1	2 - 4	7 - 10	14 - 17	20 - 25	> 30
1 - 2	4 - 7	10 - 14	14 - 20	25 - 30	

Median Line

Release Site

12.1.1.14 Tabulated Stochastic Results

The table below synthesises key outputs from the stochastic modelling. The probability and minimum arrival time of surface diesel at an international economic exclusion zone boundary are shown for each scenario in the section entitled “Median Crossing”.

Oil Spill Modelling Summary						
Spill scenario / descriptor	Seismic Vessel Diesel Release – 800 te over 10 minutes					
Median Crossing						
Identified median line	Probability (> 1%) of crossing and minimum time to reach (hrs)					
	3a (NS3 Spring)		3b (NS3 Summer)		3c (NS3 Autumn)	
	Prob	Days	Prob	Days	Prob	Days
Azerbaijan-Iran			1	8		
Azerbaijan-Kazakstan	2	2	1	4	1	5
Azerbaijan-Russia	2	10	2	5	2	6
Azerbaijan-Turkmenistan	2	8				
Kazakstan-Turkmenistan	1	8				
Russian-Kazakstan	1	11				
Turkmenistan-Iran	1	16				
Landfall						
	Probability of beaching and minimum time to beach (hrs)					
Predicted locations	3a (NS3 Spring)		3b (NS3 Summer)		3c (NS3 Autumn)	
	Prob	Days	Prob	Days	Prob	Days
Azerbaijan	3	4	7	2	3	2
Iran			1	13		
Russia	1	22				
Mass beached (worst case)	356 te		486 te		269 te	
Key sensitivities at risk						
Protected Area Potentially Impacted	See Appendix 2					
Surface, Shoreline and Water Column Diesel Shapefiles (Projection – Geographic Coordinate System WGS 84)	**Stochastic Surface OSCAR Results**		**Stochastic Shoreline OSCAR Results**		**Stochastic Water Column OSCAR Results**	
	OSCAR Results Attribute Table Details					
Spring – Scenario 3a						
Summer – Scenario 3b						
Autumn – Scenario 3c						

7.2 Scenario 5 (Release Site - FS1)

Results for Scenario 5 are presented in Appendix 1 as maps and tabulated results. Intersections between surface and shoreline oiling and protected and internationally protected areas within the Caspian Sea are presenting in Appendix 2 and Appendix 3 for scenarios 3 and 5 respectively. These Appendices provide a high level analysis of the protected /designated areas affected by oiling. A full analysis is provided in the ESIA report.

7.3 Scenario 7 (Release Site – NS3)

Modelling of a 22m^3 lube oil full inventory lube oil release was undertaken at site NS3 where the maximum shoreline oiling from the diesel release scenarios occurred. This modelling was undertaken to confirm that the 800m^3 diesel release did represent a worst credible case. Modelling showed that no shoreline oiling occurs at the ITOPF “Light Oiling” threshold or greater (see Table 5) and the diesel release of Scenario 3 therefore represented the worst credible case event. As such no further analysis or mapping of the results from Scenario 7 are included in this report.

8 Release Dynamics and Mass Balance

8.1 Worst Case Shoreline Oiling (Scenario 3b – 12/08/2008)

From the stochastic simulations the maximum amount of shoreline oiling that occurred during any one of the 100 individual trajectory simulations was 486 tonnes. This worst case shoreline oiling scenario was re-run as a single deterministic simulation so the evolution of this spill and the fate of the diesel could be analysed. The start date of this scenario was 12th August 2008 at 15:00.

Modelling shows that diesel is immediately driven west and then south following the release; impacting the northern shoreline of the Absheron peninsular. Most of the diesel comes ashore along a 30 - 40km section of coastline within the first 7 days of the release. The predicted maximum mass of diesel accumulating on the shoreline was 486 tonnes (see Table 6).

The modelling results suggest that shoreline oiling would persist for more than 30 days, with highest amounts of stranded oil occurring along the shoreline directly south of the release. Following the main shoreline accumulation, evaporation and biodegradation reduce the mass of diesel on the shoreline over time. Little remobilisation of diesel from the shoreline back into the water column is predicted.

The predicted fates and mass balance for the diesel release re shown in tonnes in Figure 7 and as percentages of the total release in Figure 8. These figures show that a significant proportion of the diesel is evaporated within the first 5 days of the release whilst mainly at sea. After the main stranding event biodegradation becomes another important fate for the diesel, particularly after 20 days from the release. Biodegradation in particular begins to remediate the mass of diesel that is washed ashore after it is stranded. Evaporation is a more important fate prior to the stranding event.

After 10 days no diesel is predicted to remain on sea surface. A small proportion (1-2%) of the diesel remains dispersed and entrained in the water column after 10 days but is biodegraded to insignificant proportions after 20 days from the release.

Maps showing the maximum thickness of diesel on the sea surface during the whole simulation, and the region where total concentrations of diesel in the water column (dispersed and dissolved) exceed 58 ppb at any point in the simulation, are also provided in Figure 9 and Figure 10 respectively.

Figure 7: Fate of diesel (mass) once release from a seismic vessel into the Caspian Sea (Worst Case Shoreline Oiling).

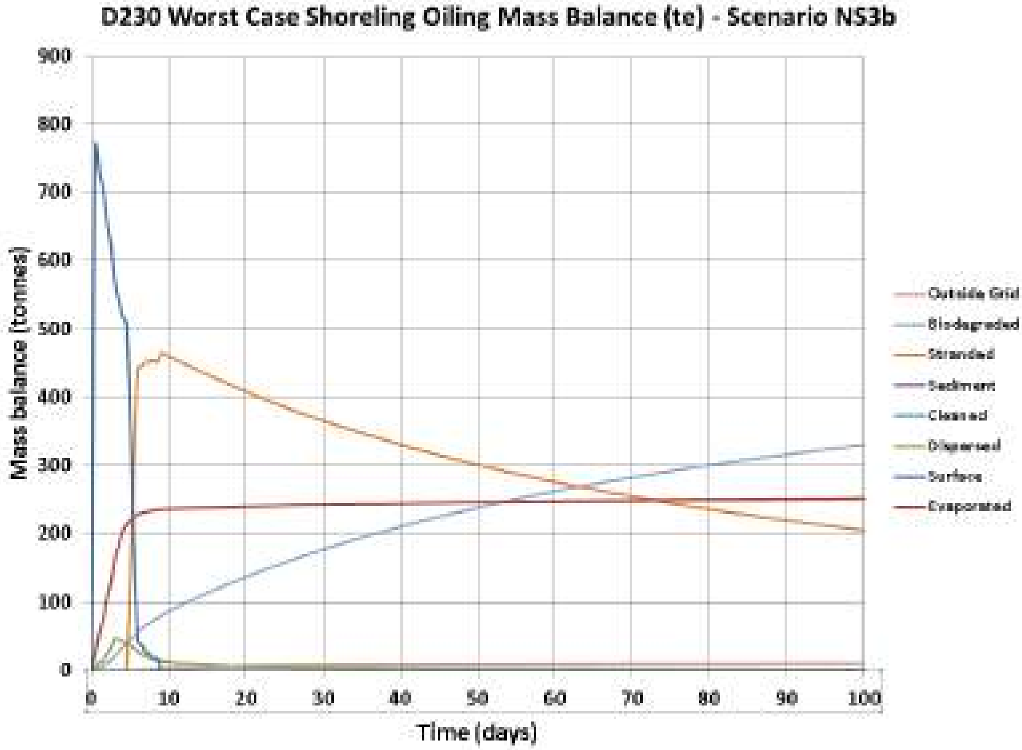
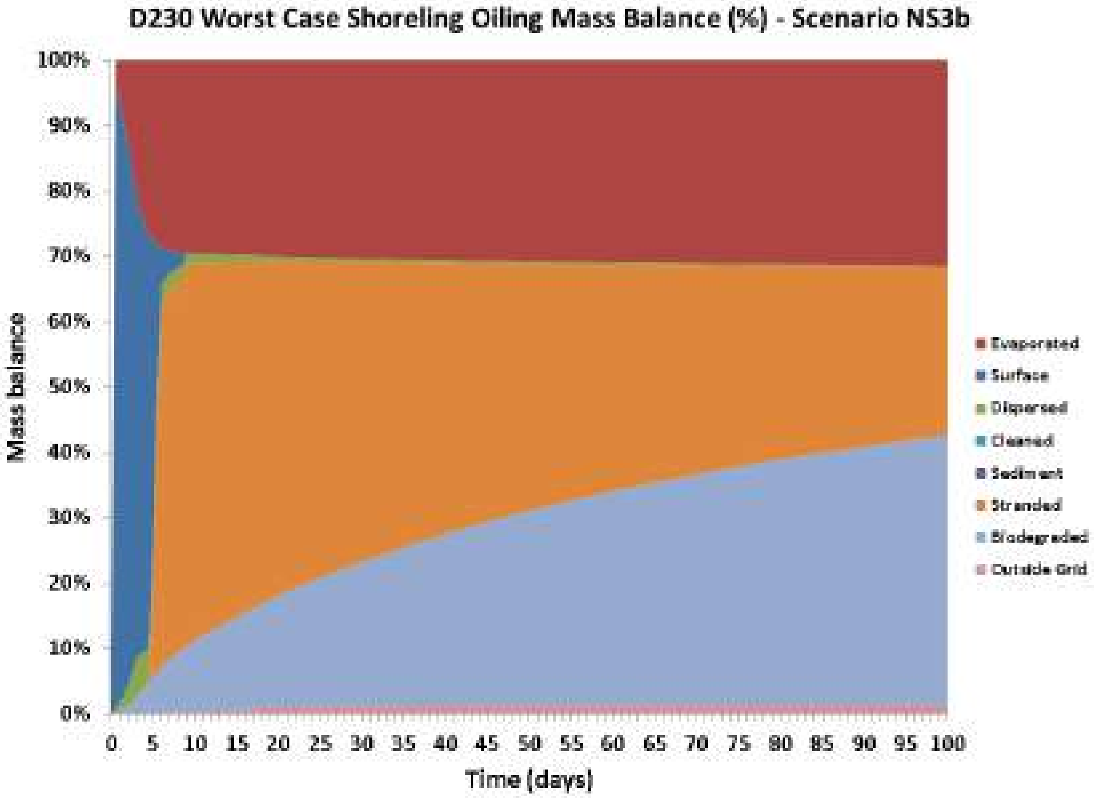


Figure 8: Fate of diesel (%) once release from a seismic vessel into the Caspian Sea (Worst Case Shoreline Oiling).



By day 60 around 325 tonnes of emulsified diesel is predicted to remain on the shoreline approximately 500 tonnes has either evaporated or biodegraded. After 100 days nearly 200 tonnes of emulsified diesel is predicted to remain on the shoreline, with approximately 575 tonnes having evaporated or been biodegraded.

Table 6: Maximum mass of diesel onshore and largest spatial extent of diesel thicker than 0,04 µm on the sea surface during the Worst Case (Scenario 3b Summer – 12/08/2008) deterministic simulation.

Maximum Diesel Onshore (te)	**Cumulative Areal Coverage of Surface Diesel >0.04µm (km^2)**
486	394

Figure 9: Maximum surface diesel thickness (>0.04µm) in any cell at any time-step within the modelling domain during the Worst Case Shoreline Oiling (Scenario 3b – NS3 Summer - 12/08/2008) deterministic simulation from section 8.1.

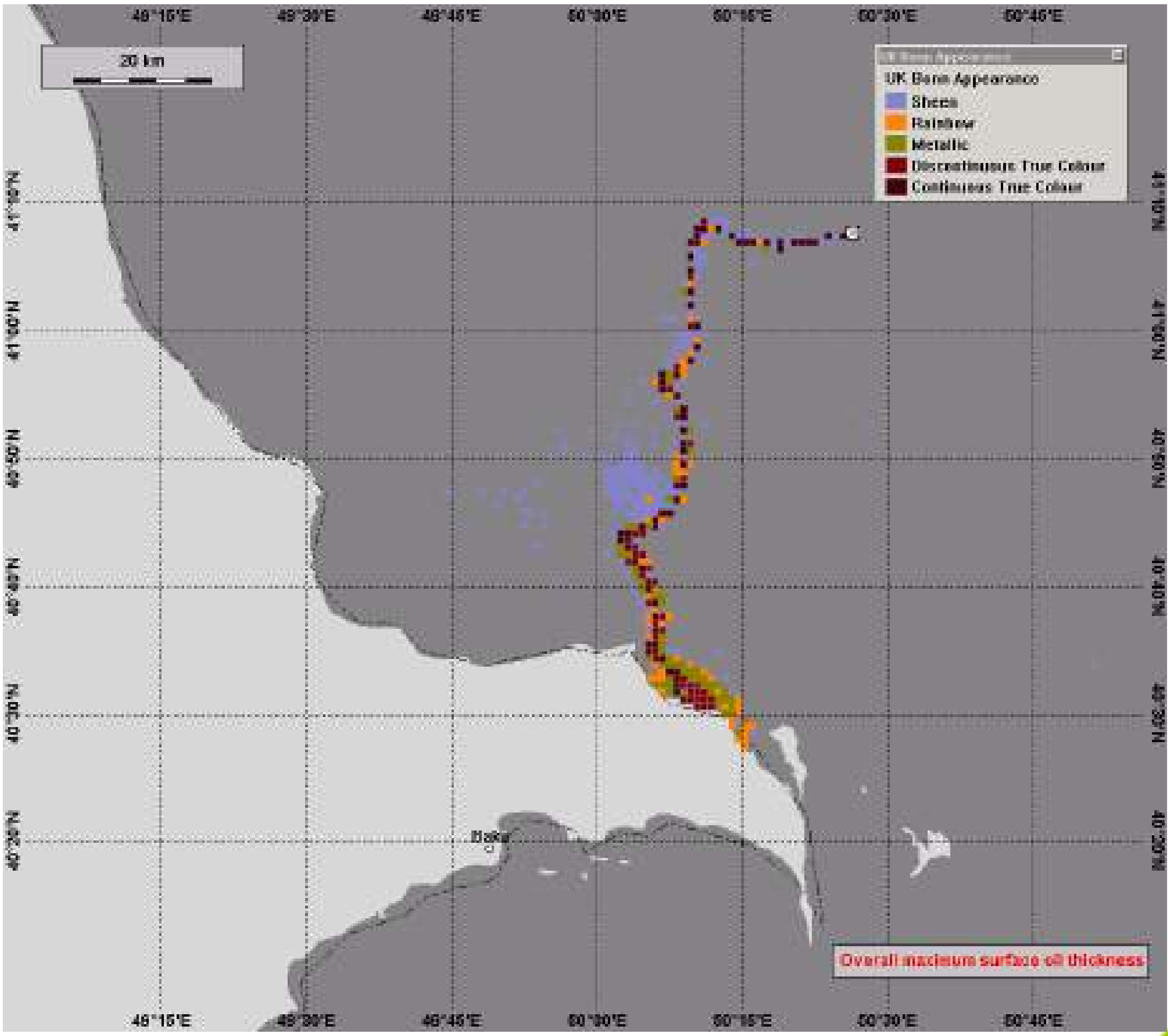


Figure 10: Maximum total diesel concentrations in the water column (> 58ppb) in any cell at any time-step within the modelling domain during the Worst Case Shoreline Oiling (Scenario 3b – NS3 Summer - 12/08/2008) deterministic simulation from section 8.1.

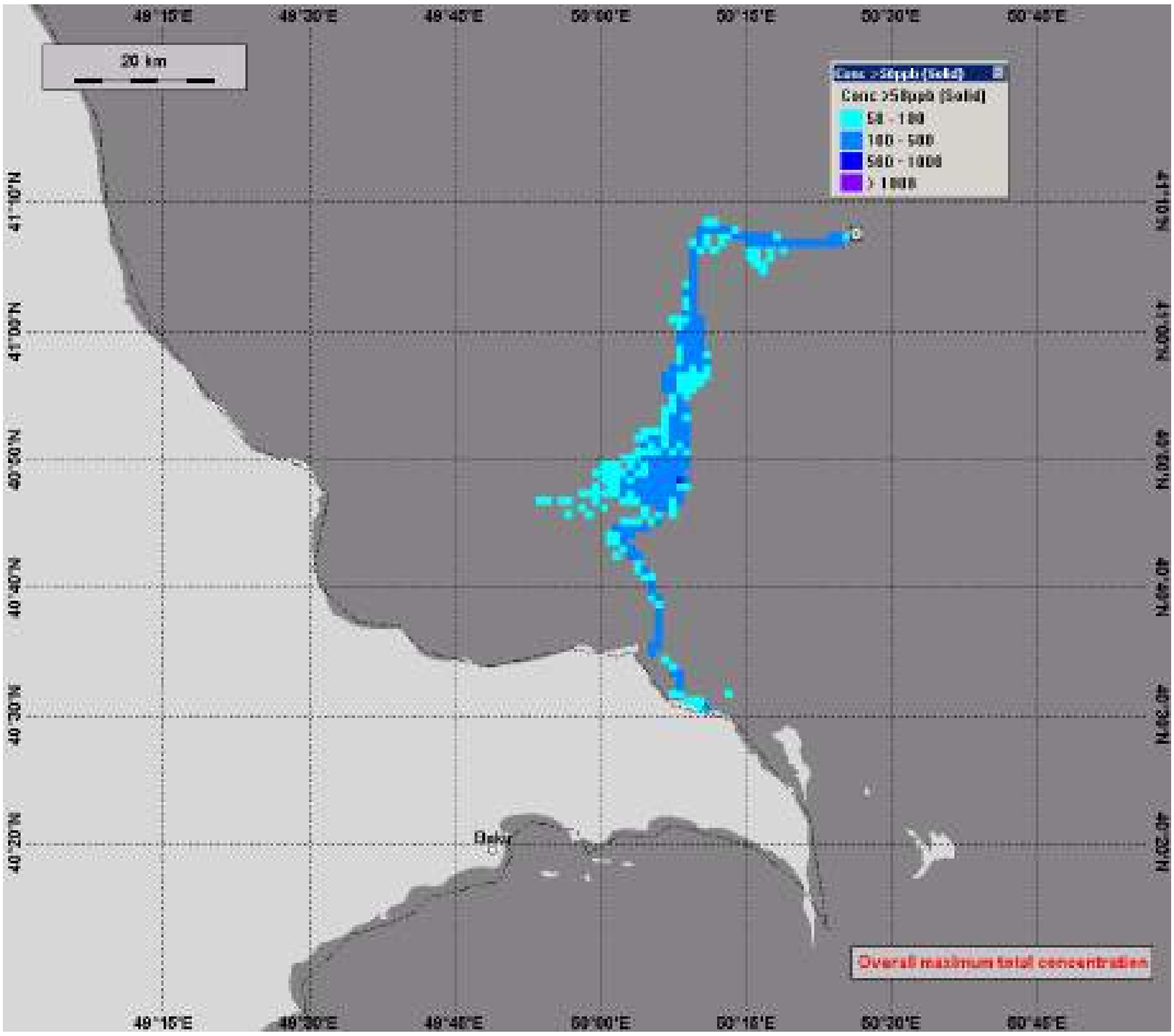


Figure 11: Maximum shoreline oiling 491 te) occurring at 00:00 on Day 7 of the Worst Case Shoreline Oiling (Scenario 3b – NS3 Summer - 12/08/2008) deterministic simulation from section 8.1.

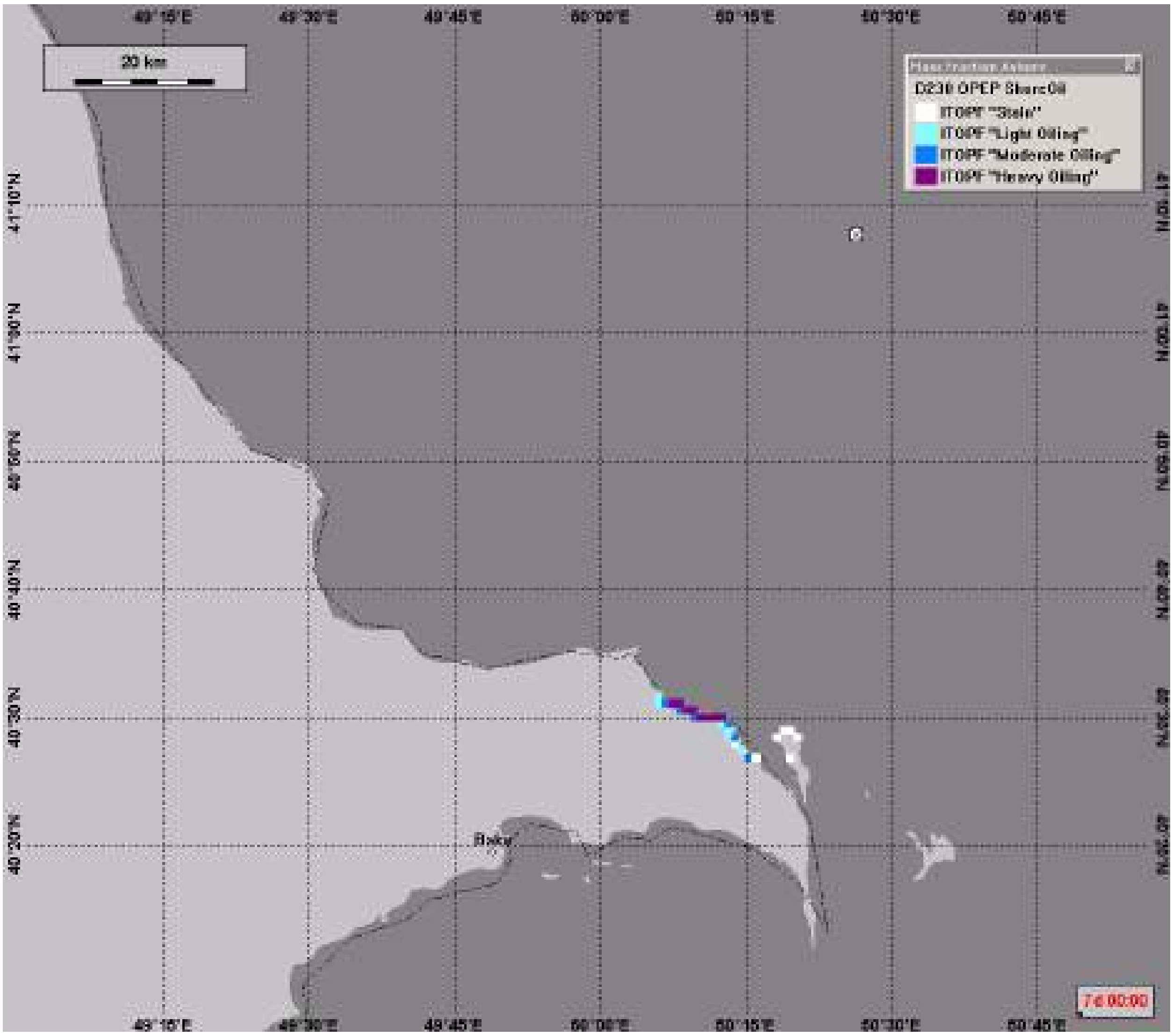
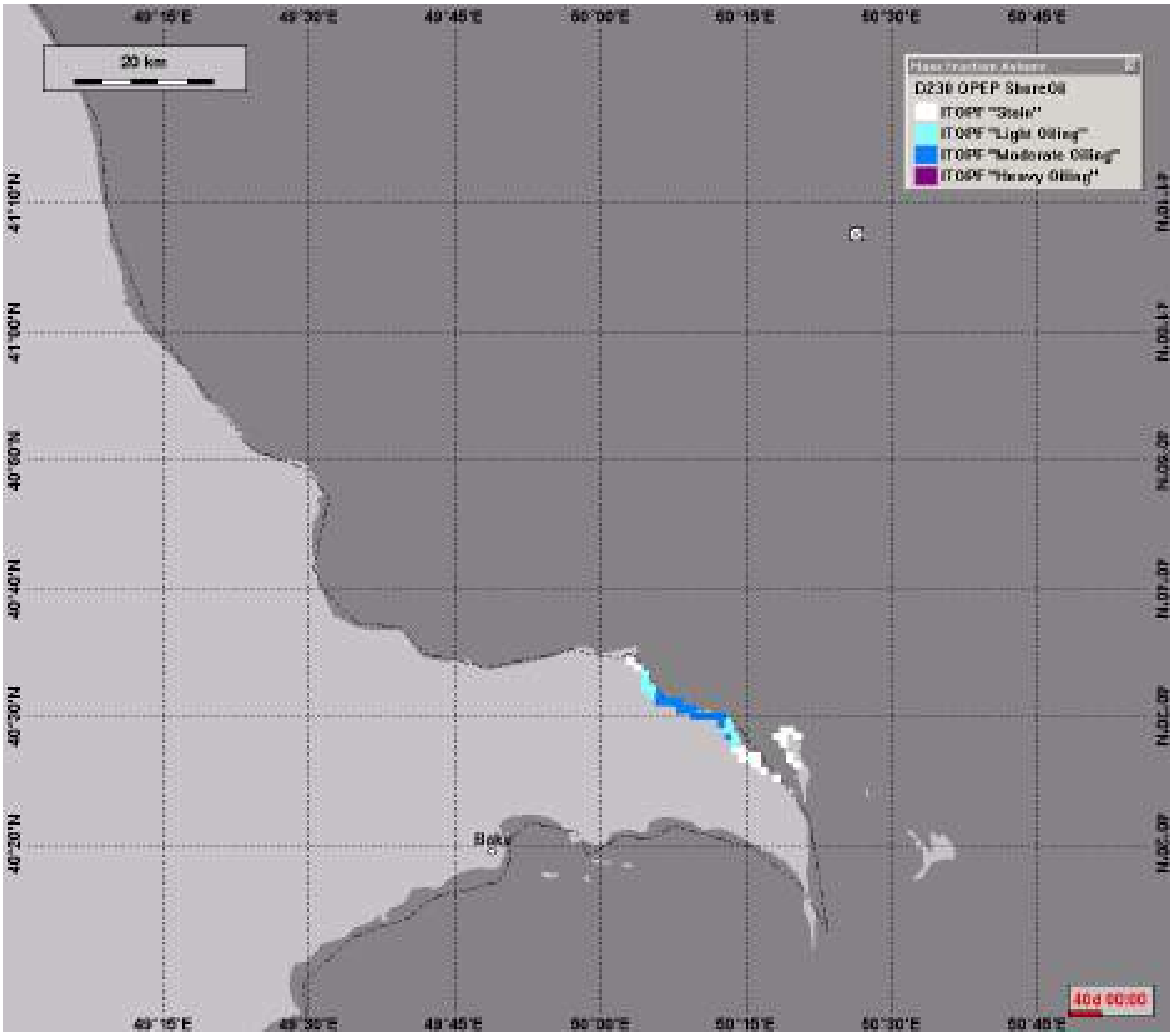


Figure 12: Shoreline oiling 491 te) at 00:00 on Day 40 of the Worst Case Shoreline Oiling (Scenario 3b – NS3 Summer - 12/08/2008) deterministic simulation from section 8.1. Results show evaporation and biodegradation effects in reducing the severity of oiling when compared to Day 7 when the maximum shoreline oiling occurs (see Figure 11).



9 Conclusions

Stochastic modelling has been completed for Spring (March-May), Summer (June-August), and Autumn (September-November) scenarios using ReEMS hydrodynamic data for the period 2006-2009. The results have been used to assess the likelihood of surface and shoreline oiling following a full vessel diesel inventory release at 6 locations within and outside the D230 survey area. In addition, a single lube oil inventory loss scenario was modelled to determine if this would constitute a worse case event over a diesel inventory release. It does not and no further analysis of this scenario is included in this report. Stochastic outputs, involving 100 individual simulations for all three seasons at each release location were used to identify the scenario and simulation therein with the highest amount of shoreline oiling. This single simulation was subsequently modelled deterministically.

Stochastic results showed that the largest amount of shoreline oiling occurs for a marine diesel release from NS3 during summer, even with the warmer sea and higher air temperatures which would induce more evaporation. A single deterministic simulations was run for the worst case shoreline oiling scenario (Scenario 3b: NS3 Summer – 12/08/2008). The maximum mass of stranded oil associated with this worst case simulation was 491 tonnes.

9.1 Surface Oil

9.1.1 Probabilistic Modelling

Results show that the presence of any surface oil (diesel) from a seismic vessel release where probabilities >5% occur tend to be very close to the release location. The extent of surface oil with probabilities >5% were mapped for all three seasons from release site NS3 (Scenario 3) (see section 7.1) and FS1 (Scenario 5) (see Appendix 1). The potential extent of surface oil in summer is more constrained than Winter due to warmer sea temperatures promoting greater evaporation and more benign current and wind conditions. However, during summer month's currents and wind have a greater tendency tend to flow more west and south. As a result the largest shoreline oiling events occur in summer. Generally surface oil is restricted to the economic waters of Azerbaijan, although some surface oil is seen in the economic waters of Russia, Iran, Kazakhstan, and Turkmenistan at probabilities <5%.

The results show that the released diesel tends to migrate parallel to the Azerbaijan coast in either a northerly or southerly direction. In spring and autumn surface oil is shown to travel further than in summer and more surface oiling occurs across the Azerbaijan-Kazakhstan and Azerbaijan-Turkmenistan median lines, although at probabilities <5%.

Surface diesel thicknesses tend to have a visual "metallic" appearance in the regions immediately adjacent to the release. Further away, surface diesel was predicted to exist as "sheen" or "rainbow" thicknesses. In the calmer waters closer to shore there is also a greater chance of surface oil being "rainbow" in appearance.

Modelling shows that diesel does not persist for any great length of time at any given location. This is due in part to the fact it is a single bulk release that is transported away from the release site by currents and winds. Modelling showed that diesel does not persist for longer than 3 days on the sea surface within most areas of the modelling domain, and generally for less than 2 days (see section 7.1).

9.1.2 Deterministic Modelling

The worst case deterministic simulation shows the dynamics of the release associated with the simulation with the most shoreline oiling from Scenario 3. Whilst stochastic results better represent the overall environmental risk, these single deterministic simulations show how spilled diesel at sea might be expected to behave during a worst-case shoreline oiling event.

When the cumulative surface area coverage or "swept" area of diesel oil are compared for the 1 deterministic simulation, it can be seen that the surface coverage (see Figure 9) is not extensive. The diesel is shown to be driven quickly to the shoreline where it is stranded. The diesel does have a large amount of time to disperse into the water column, so the spatial extent where total concentrations of dispersed and dissolved diesel exceeds 58 ppb is only slightly larger than the area where surface oiling occurs (see Figure 9 and Figure 10).

Mass balance analysis (Figure 7) shows that evaporation occurs rapidly when diesel is on the sea surface. When it is stranded onshore biodegradation rates significantly increase. These two process account for 60-70% of all the released diesel mass for the worst case scenario.

9.2 Shoreline Oil

9.2.1 Probabilistic Modelling

Shoreline oiling was shown to occur mainly along the eastern and northern shores of the Absheron Peninsular. This is the same for all seasons, although in Spring and Autumn some shoreline oiling occurs in isolated and more distant locations. Arrival times were shown to increase with distance from the release site. Shoreline diesel accumulation tends to occur within the first 10 days on the Absheron Peninsular, and after 20-25 at more distant and isolated locations like the shoreline close to Machackala in Russia.

9.2.2 Deterministic Modelling

The Worst Case release trajectory was characterised by diesel being driven by currents and winds south from the release site NS3 (see Figure 11 and

Figure 12). The bulk of the released diesel does not mix or disperse much (see Figure 9 and Figure 10) and is stranded onshore in a relatively concentrated mass. Once onshore, the diesel biodegraded and evaporated relatively quickly. Although even after 50 days significant quantities of emulsified diesel were shown to persist on the shoreline (see Figure 7 and Figure 8). Modelling also showed that once onshore there as little remobilisation of oil back into the water column.

9.3 Diesel Dispersion in the Water Column

9.3.1 Probabilistic Modelling

The results showed a more constrained region where diesel exists in the water column at total hydrocarbon concentrations >58 ppb. When considering the >5% probability envelope, the extents are localised to the release location. The regions with <5% probability of total hydrocarbons >58 ppb extend <50 km from the release site in both northwards and southwards directions parallel to the shoreline. The zone is generally also shown to be constrained within the Azerbaijan economic zones (EEZ). Modelling shows that probabilities as high as 20% for total hydrocarbon concentrations in the water column exist within 10 km of the release site. Generally however, probabilities are shown to be <5%. Dispersed and dissolved diesel >58 ppb in the water column generally persists for <1 day at any location.

9.3.2 Deterministic Modelling

Deterministic modelling showed that the spatial extent of the dispersed diesel plumes in the water column were closely associated with the footprint of diesel on the sea surface (see Figure 10). The extents are however slightly less spatially constrained than those for surface diesel.

9.4 Mass Balance

The fates (mass balance by compartment) for diesel releases were determined for the worst case shoreline oiling deterministic scenarios (see Figure 7 and Figure 8). The results showed that for this scenario, shoreline diesel accumulation accounted for the bulk of the release within the first 5-6 days. Rapid evaporation was shown to occur within the first 5 days prior to the diesel stranding onshore. Evaporation rates then slow significantly and biodegradation becomes the most active degradation process when the diesel is stranded. After 50 days biodegradation overtakes evaporation as the most significant fate by mass for the stranded diesel.

9.5 Protected Areas (PAs) and Internationally Protected Areas (IPAs)

The modelling results for sites NS3 and FS1 predicted that a number of Protected Areas and Internationally Protected Areas in Azerbaijan, Russia, may be impacted (albeit at low probability) from shoreline oiling. These locations include the Absheron National Park (IUCN II), Bandovan State Nature Sanctuary (UICN IV), Shirvan National Park (IUCN II), and Gizilaghaj State Nature Reserve (IUCN Ia) in Azerbaijan, and Agrakhansky (IUCN IV) in Russia. Further details can be found in Appendix 2 for Scenario 3 and Appendix 2 for Scenario 5. Surface oiling was also predicted to occur at low probabilities in these PAs and IPAs as well as IPAs in Iran (Location FS1 only)

9.6 Environmentally Sensitive Areas (ESAs)

Intersection analysis between ESAs and OSCAR outputs has not been provided and will be completed by the D230 ESIA contractor. OSCAR output shapefiles are provided as part of this report for this purpose.

10 References

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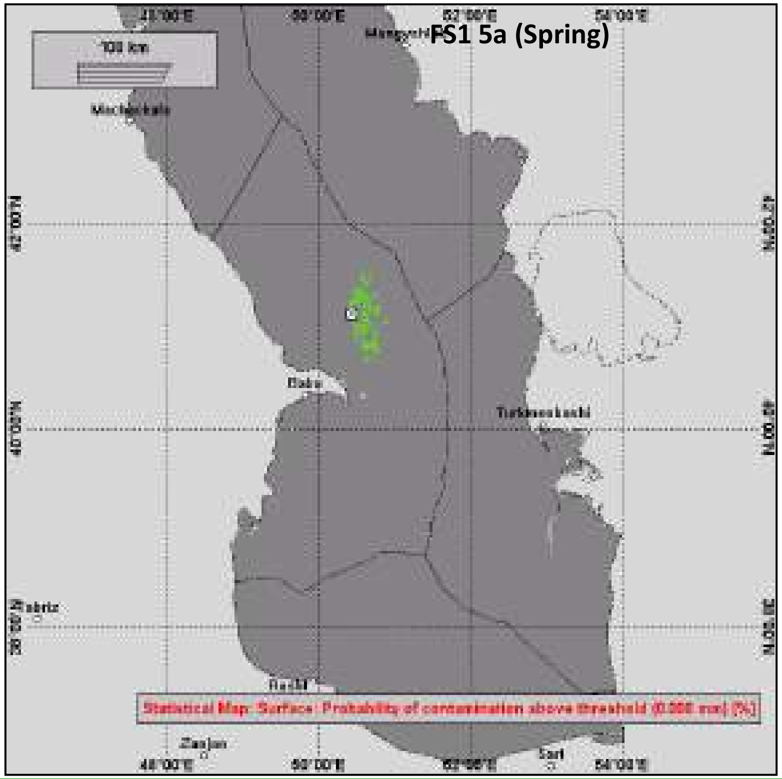
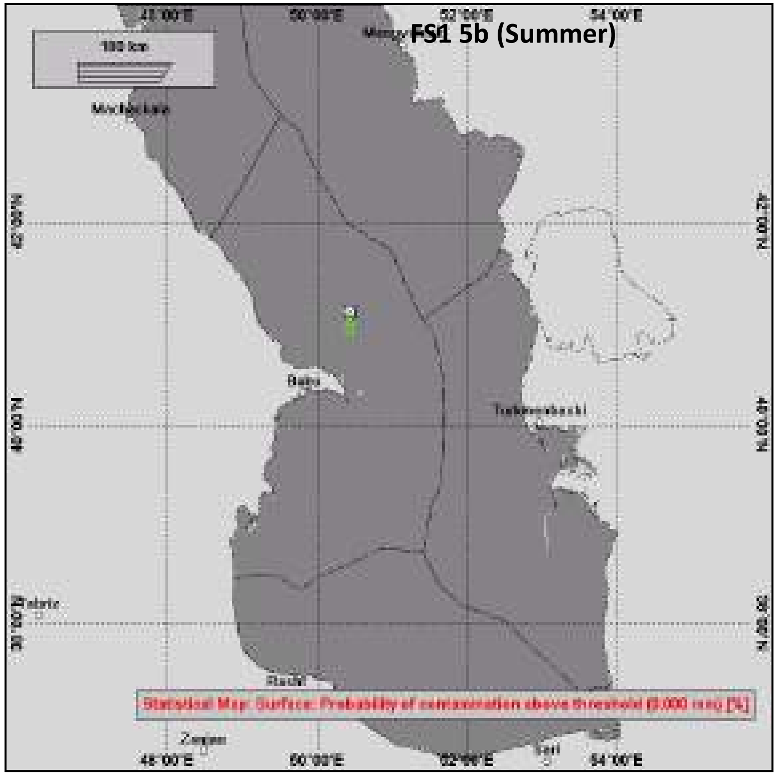
Appendix 1 Scenario 5 Results

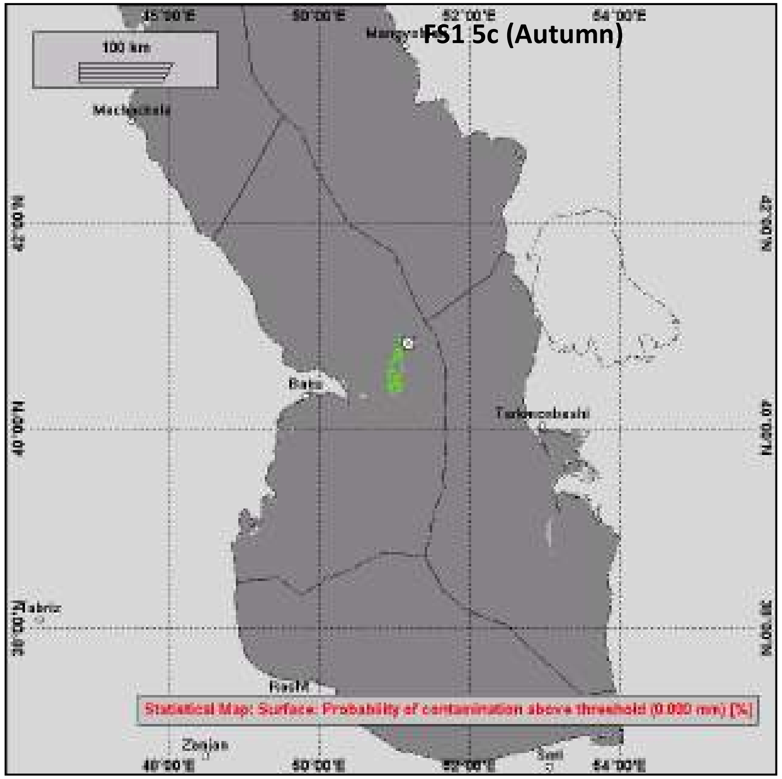
10.1.1 Surface Oiling

12.1.1.15 Surface Oiling Probability

Surface Oil Thicker than 0.04µm (Visible Sheen) (Probability >5%) **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Surface Oiling Probability (> 5%) where surface oil is thicker than 0.04 µm (the minimum visible thickness from the Bonn Agreement Oil Appearance Code system (Lewis, 2007).







Map Key

Probability of Surface Oiling

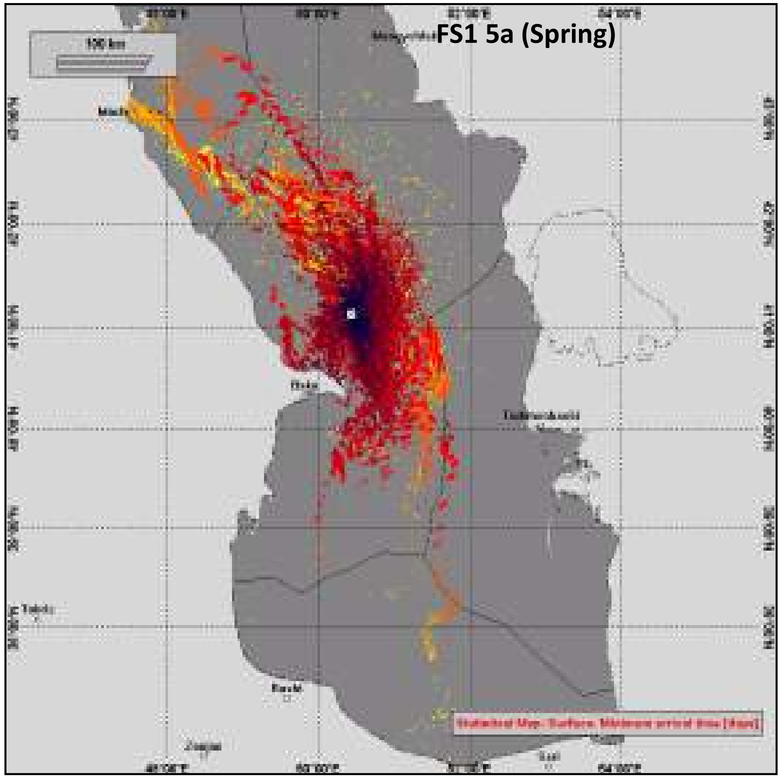
5
10
20
30
40
50
60
70
80
90

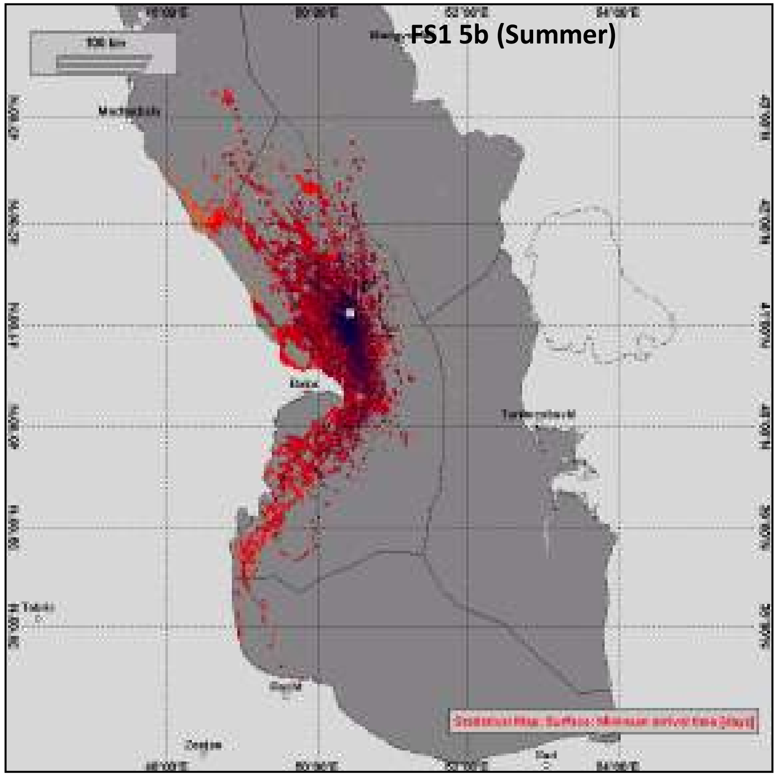
Release Site

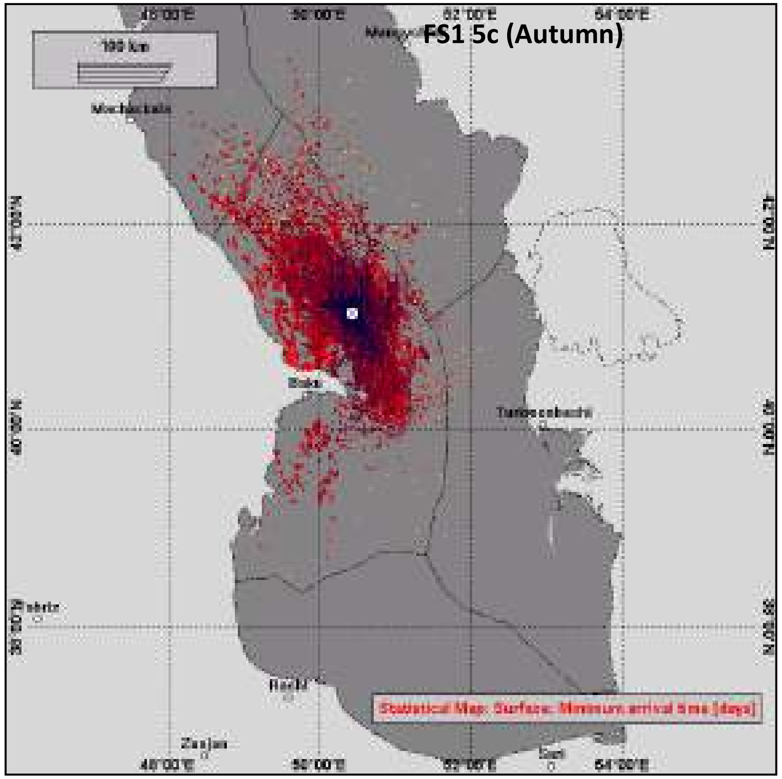
Median Line

12.1.1.16 Surface Oiling Arrival Time

Minimum Arrival Time (Days) of Surface Oil Thicker than 0.04µm (Probability >1%) **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Minimum arrival time of surface oil thicker than 0.04 µm (BAOAC "Sheen"). No probability threshold is applied due to limited functionality in OSCAR so the extents represent locations where the probability of surface oil is >1% rather than the >5% threshold used in the probability extent maps.







Map Key

Arrival Time (days)

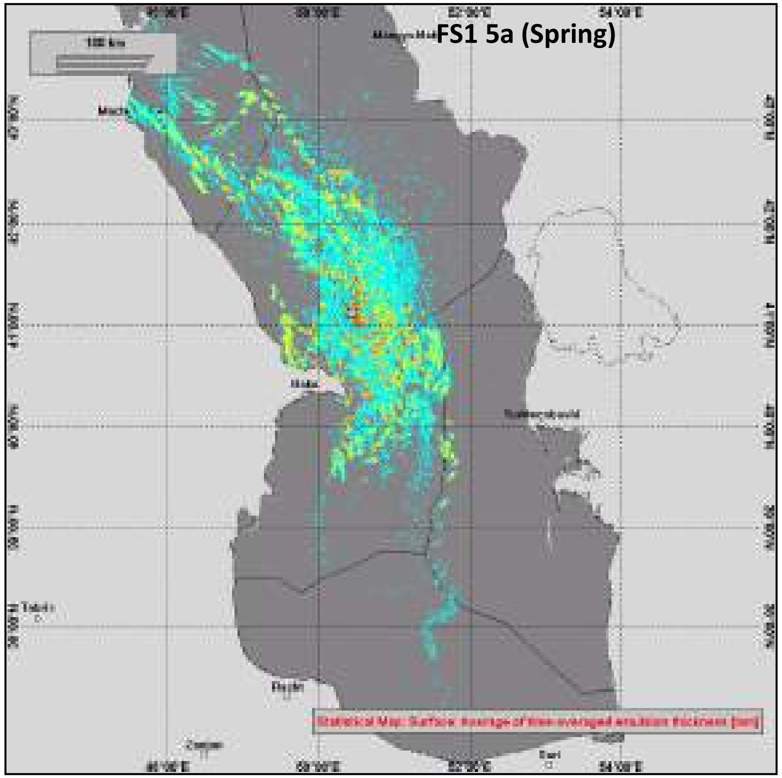
0-1 | 1-2 | 2-4 | 4-7 | 7-10 | 10-14 | 14-17 | 17-20 | 20-25 | 25-30 | 30-45 | 45-60 | 60-90 | >90

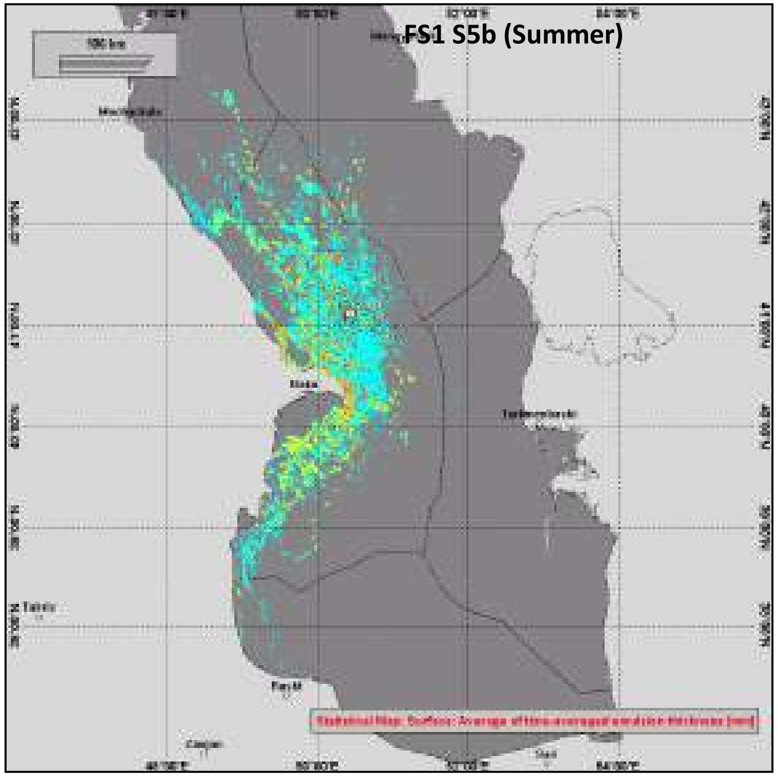
Release Site

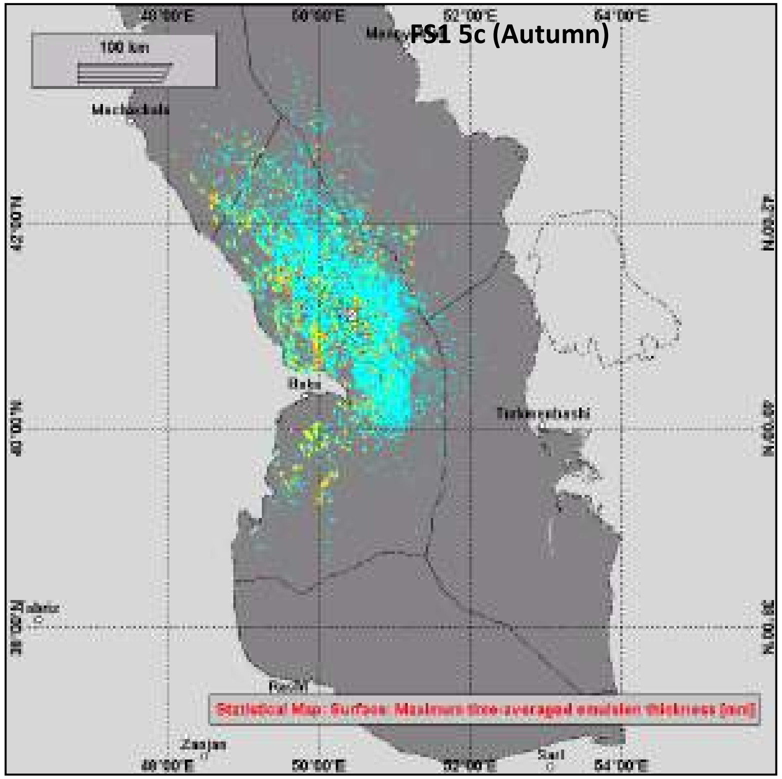
Median Line

12.1.1.17 Surface Oiling Average Thickness (BAOAC)

Surface Oil Thickness (Bonn Agreement Oil Appearance Code) (Probability >1%) **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Surface Oiling Average Thickness based on the BAOAC groups. No probability threshold is applied due to limited functionality in OSCAR so the extents represent locations where the probability of surface oil is >1% rather than the >5% threshold used in the probability extent maps.







Map Key

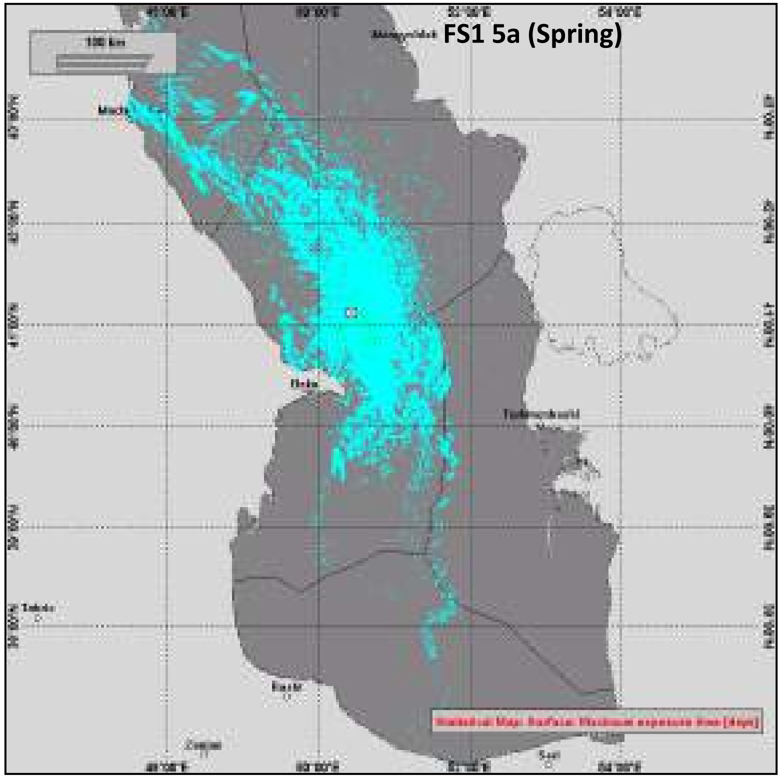
Surface Oil Thickness (Bonn Agreement Oil Appearance Code)

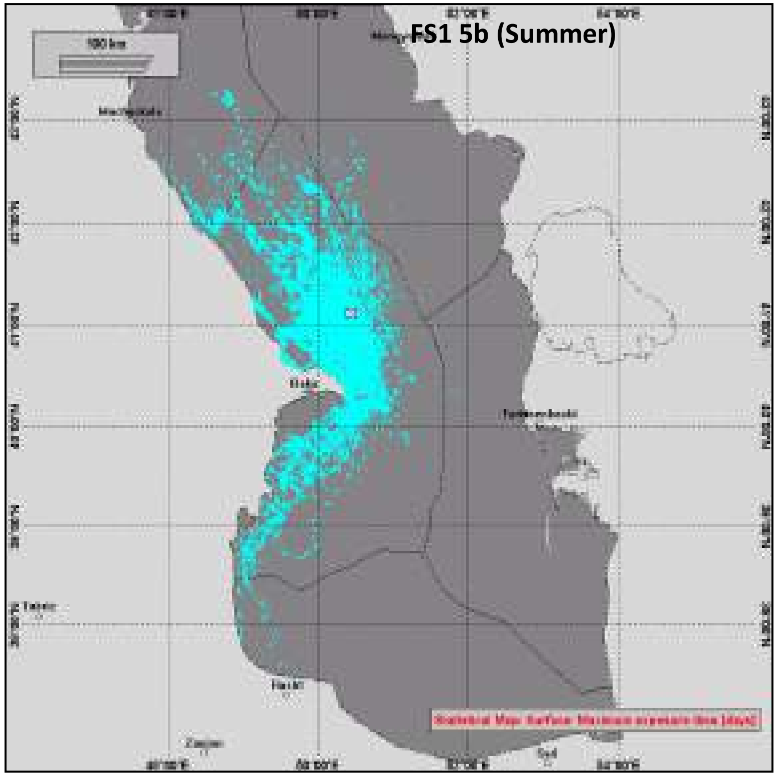
- Sheen (0.04 - 0.3 um)
- Rainbow (0.3 - 5 um)
- Metallic (5 - 50 um)
- DTOC (50 - 200 um)
- CTOC (>200 um)

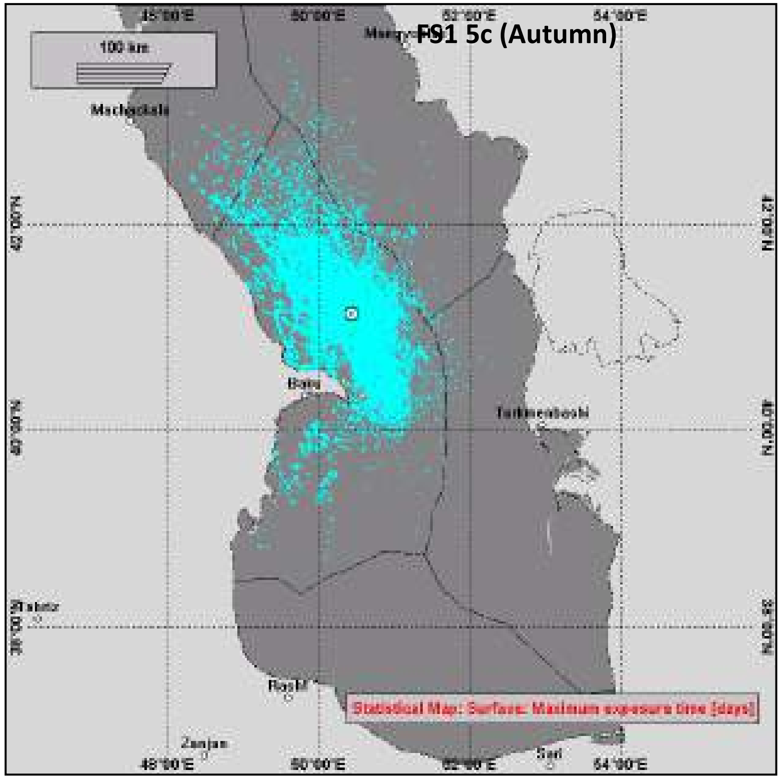
Release Site

12.1.1.18 Surface Oiling Exposure Time (Days)

Maximum Exposure Time (Days) (Probability >1%) **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Maximum surface oil exposure in days. No probability threshold is applied due to limited functionality in OSCAR so the extents represent locations where the probability of surface oil is >1% rather than the >5% threshold used in the probability extent maps.







Map Key

Exposure Time (days)

0 - 1	2 - 4	7 - 10	14 - 17	20 - 25	> 30
1 - 2	4 - 7	10 - 14	14 - 20	25 - 30	

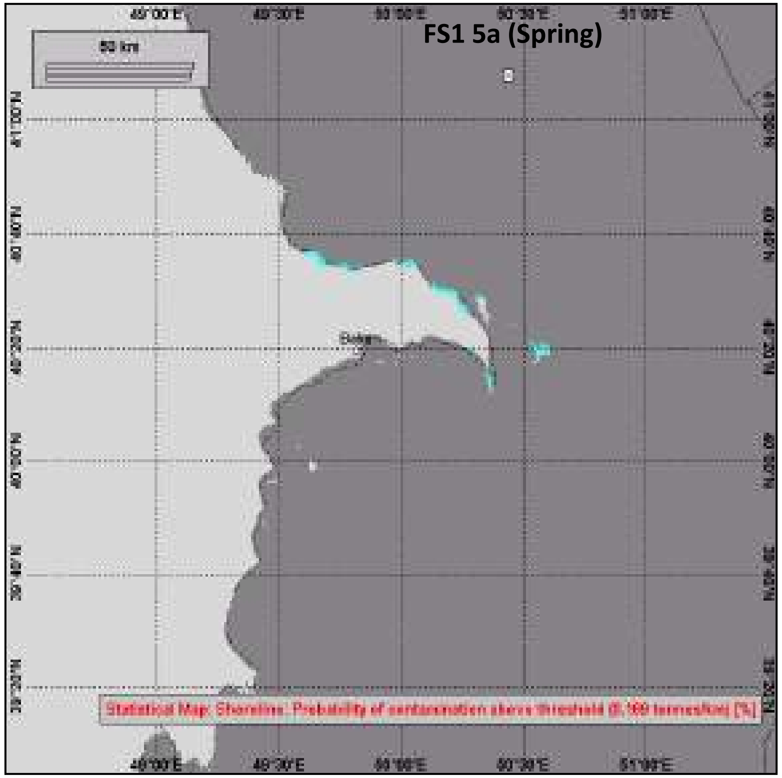
Median Line

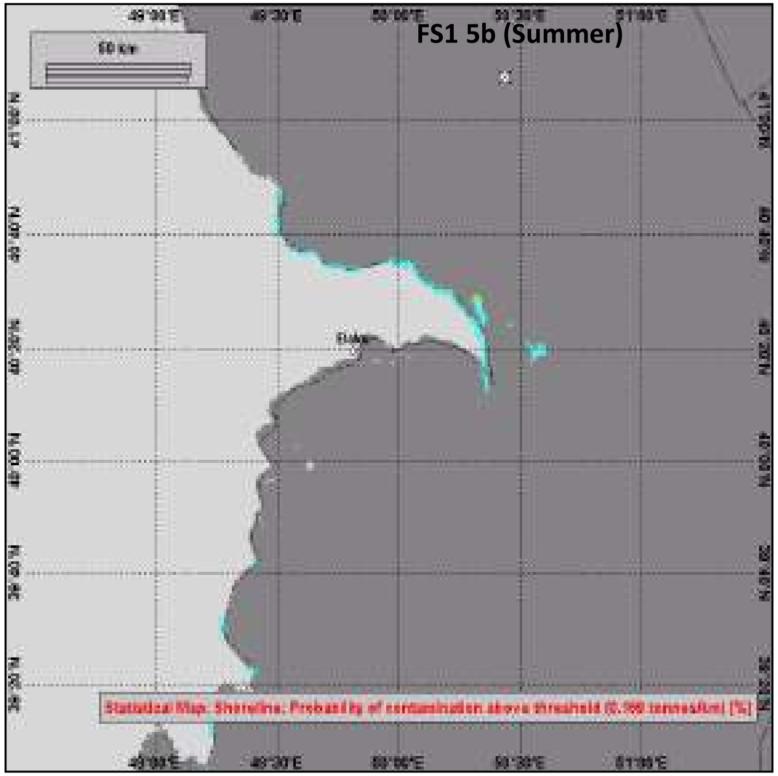
Release Site

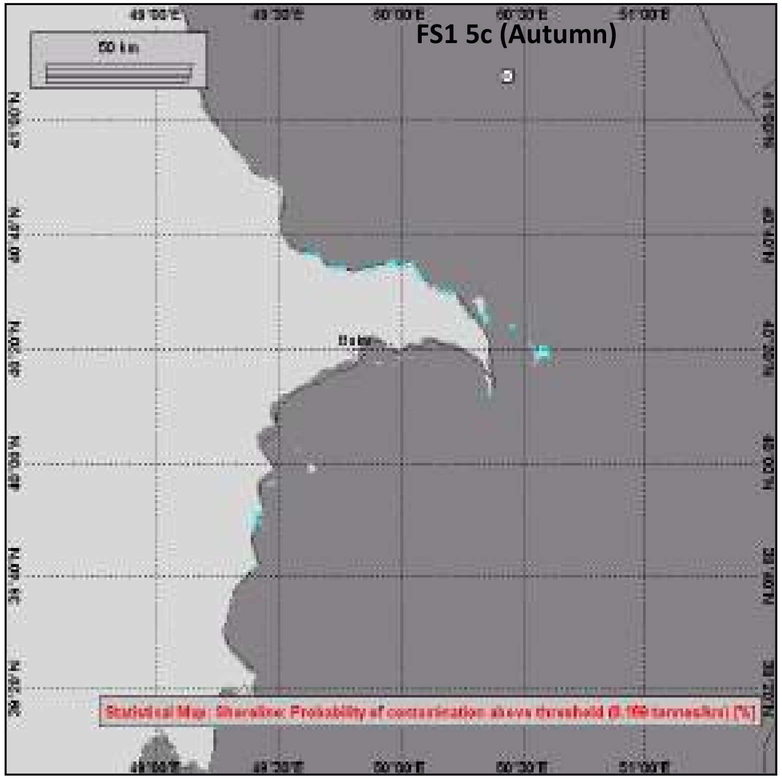
10.1.2 Shoreline Oiling

12.1.1.19 Shoreline Oiling probability

Probability (>1%) of Shoreline Oiling exceeding 0.169tonnes/km (ITOPF "Light Oiling" Threshold) **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Shoreline Oiling Probability (> 1%) where shoreline oil mass exceed 0.169 tonnes/km (the minimum value of the ITOPT "Light Oiling" range (ITOPF, 2011).







Map Key

Oiling Probability (%)

1 - 5
5 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100

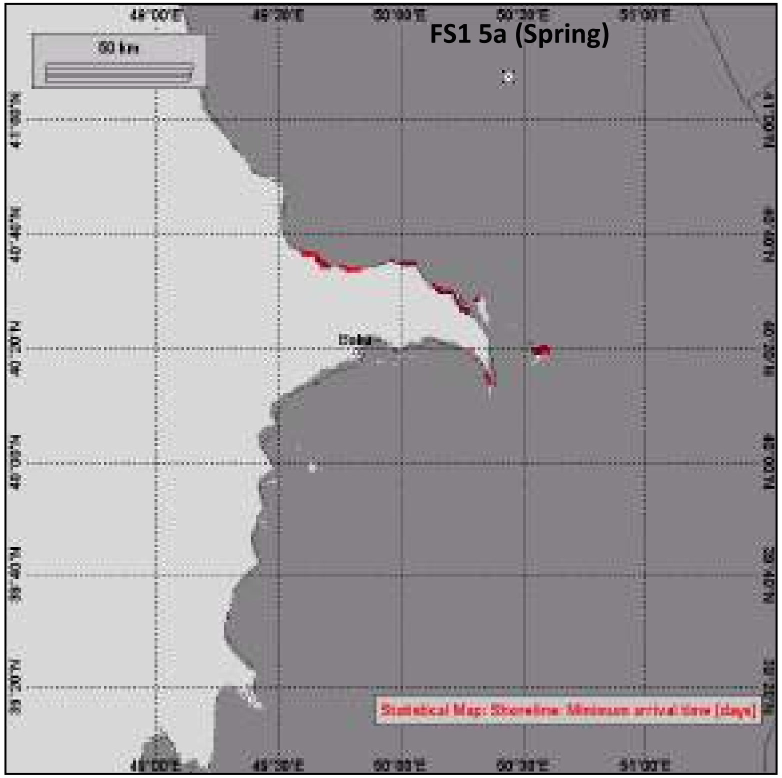
Release Site

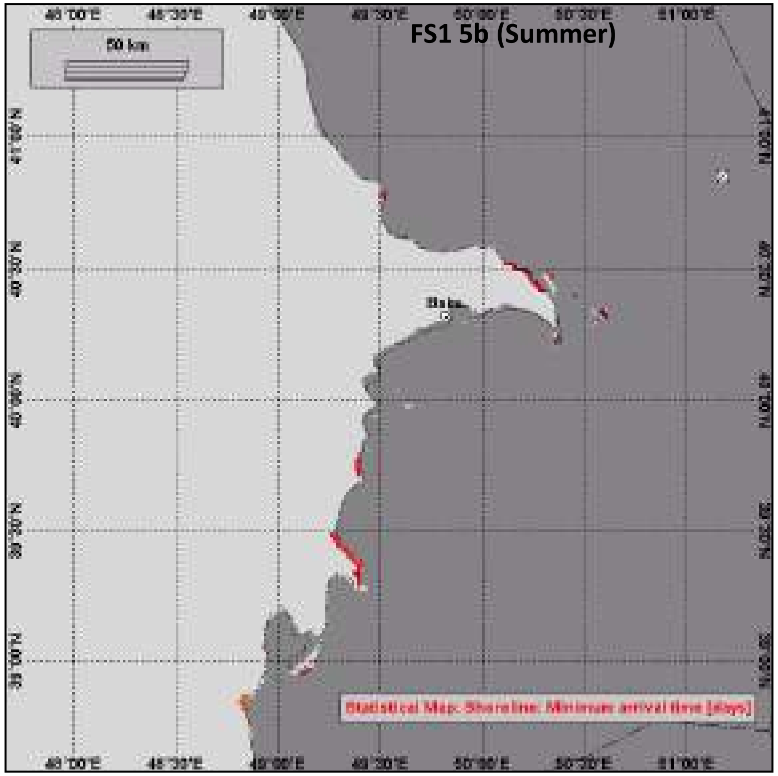
12.1.1.20 Shoreline Oiling Arrival Time

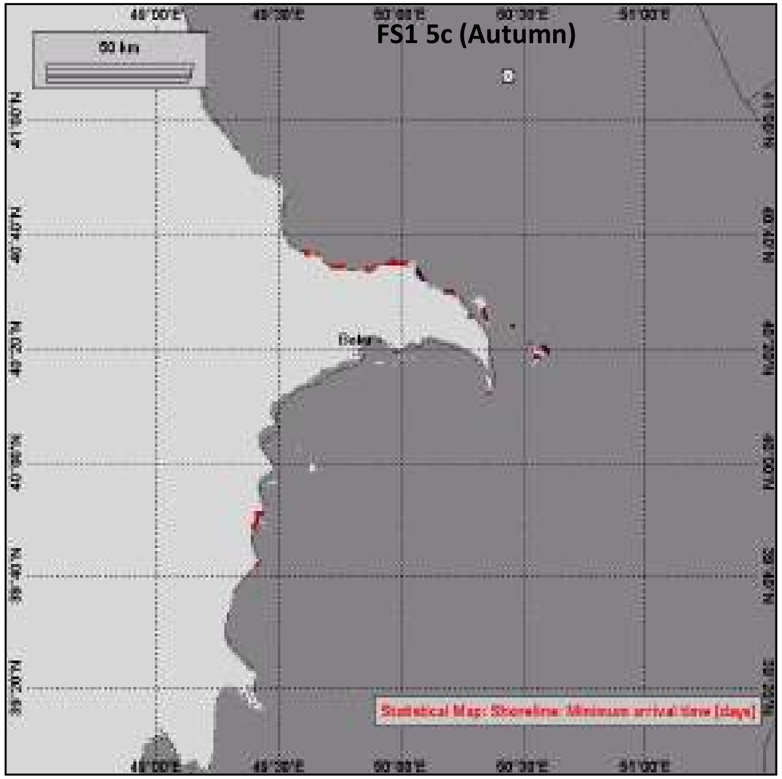
Minimum Arrival Time (Days) of Shoreline Oil exceeding 0.169tonnes/km (ITOPF “Light Oiling” Threshold)

Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes

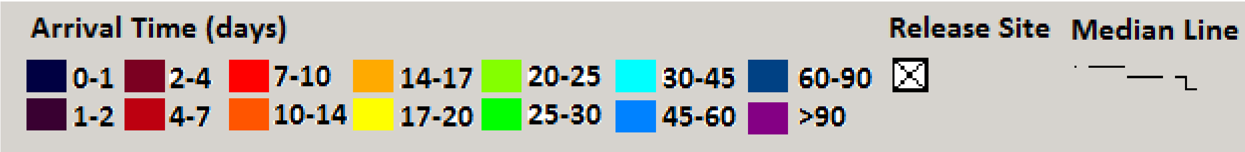
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Minimum arrival time of diesel on the shoreline exceeding 0.169 tonnes/km (Minimum ITOPF “Light Oiling” Threshold). Results show locations where the probability of shoreline diesel >1%.





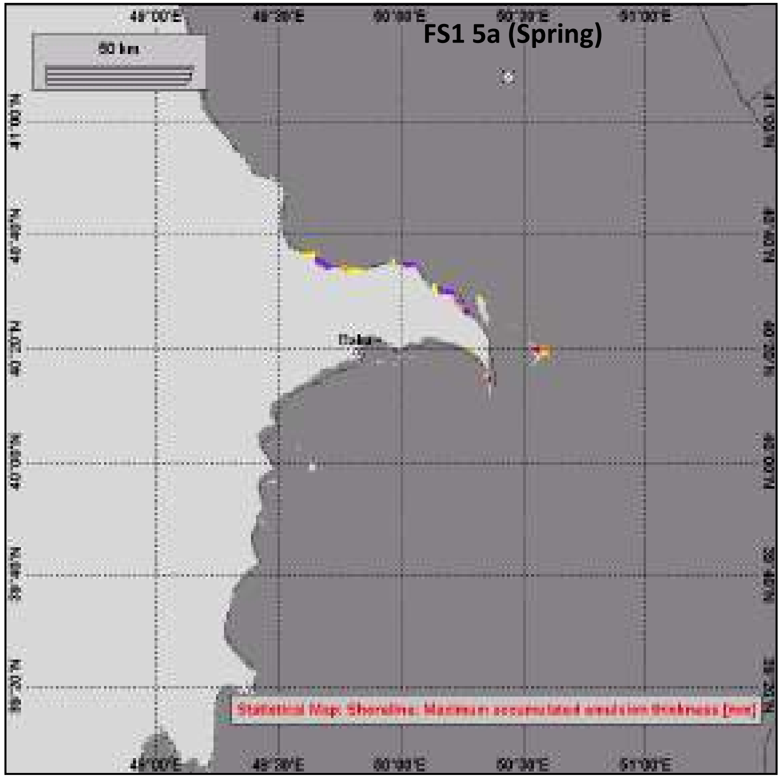

FS1 5c (Autumn)
50 km
Statistical Map: Shoreline: Minimum arrival time [days]

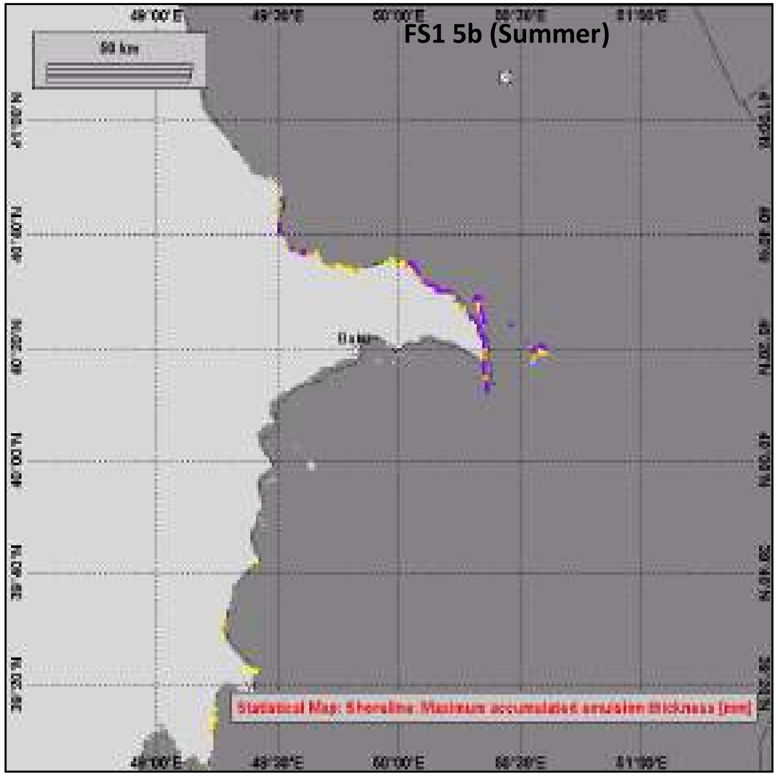
Map Key

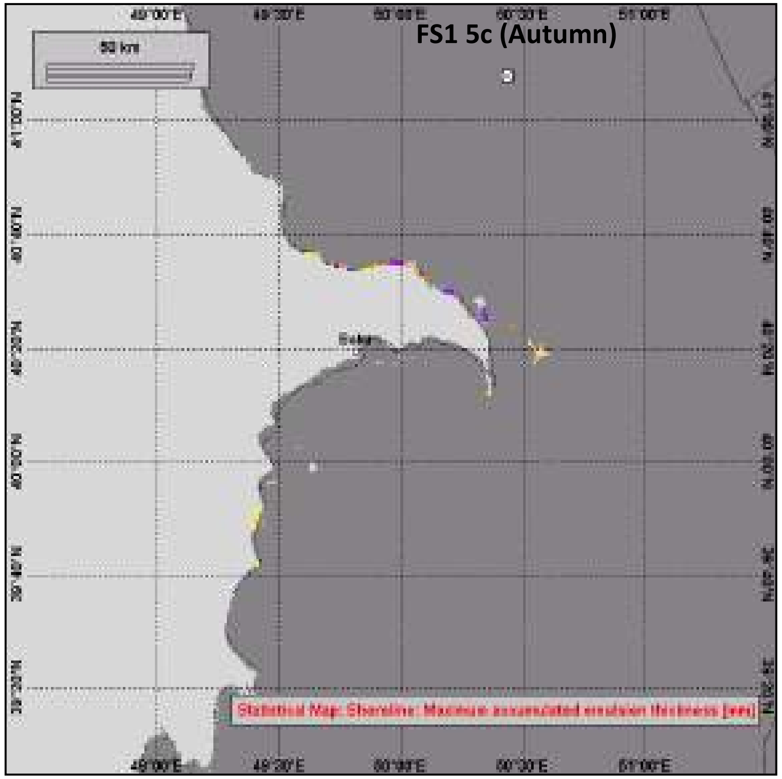

Arrival Time (days)
0-1
1-2
2-4
4-7
7-10
10-14
14-17
17-20
20-25
25-30
30-45
45-60
60-90
>90
Release Site
Median Line

12.1.1.21 Shoreline Oiling Severity

Severity of Shoreline Oiling (ITOPF Classification) **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Severity of shoreline oiling (ITOPF Classification) where it exceeds the ITOPF “Light Oiling” threshold of 0.169 tonnes/km. Results show locations where the probability of shoreline diesel >1%.







Map Key

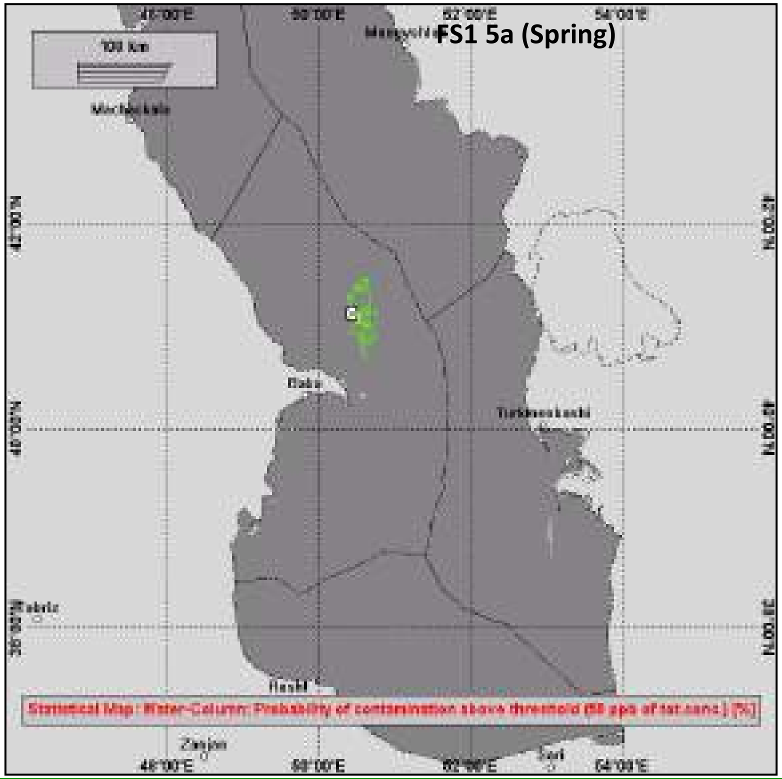
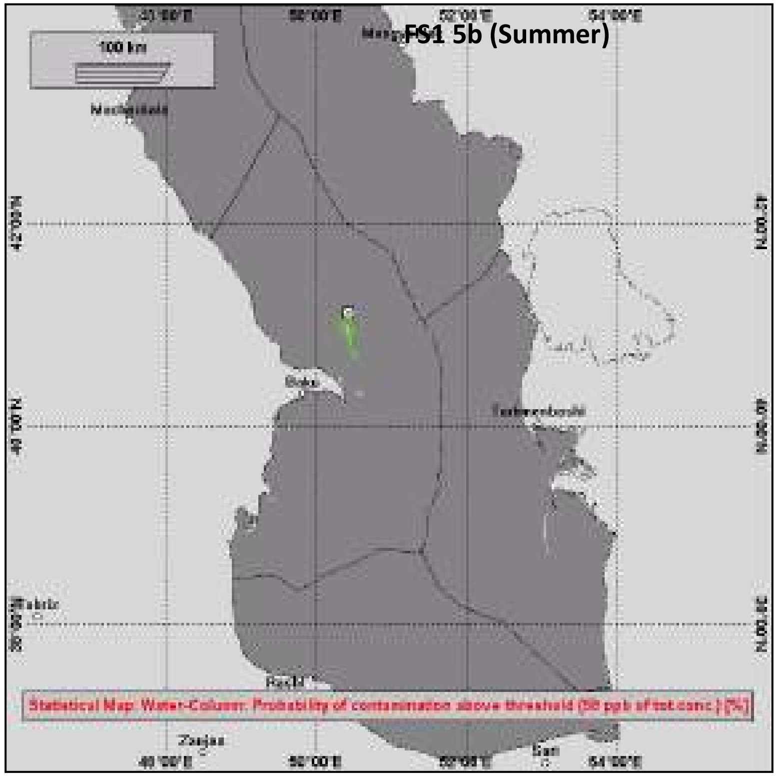
ITOPF Shoreling Oiling Classification

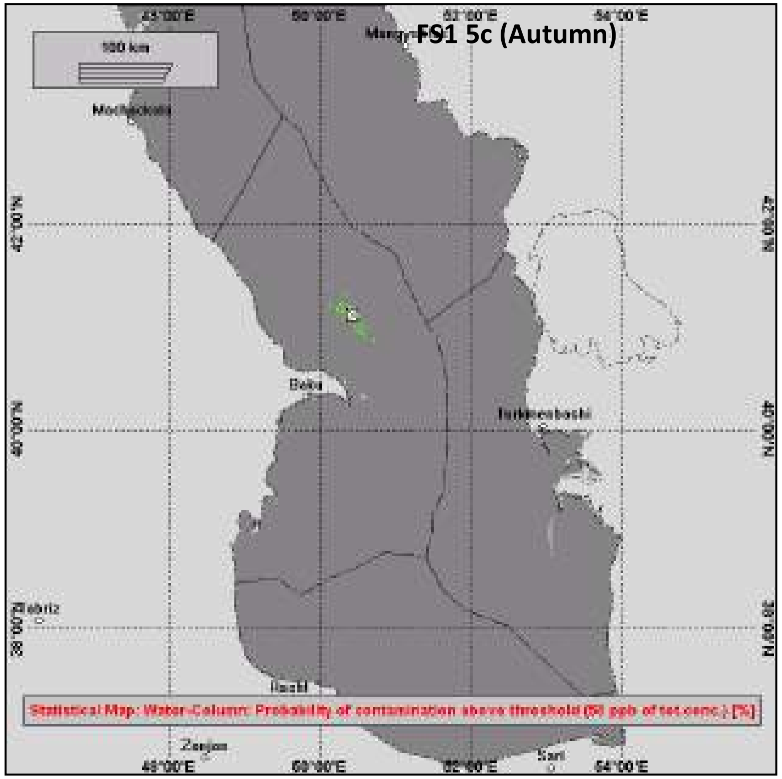
- ITOPF Light Oiling (0.1-1mm Thick)
- ITOPF Moderate Oiling (1-10mm Thick)
- ITOPF Heavy Oiling (>10mm Thick)

Release Site

10.1.3 Water Column Concentrations

12.1.1.22 Probability of water column concentrations of diesel (dispersed and dissolved) exceeding 58 µg/l (ppb)

Probability (>5%) of Water Column Concentrations >58 µg/l (ppb). **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Probability (>5%) of diesel concentrations > 58 ppb being exceeded in the water column. This is the total concentration including dispersed and dissolved diesel.
			

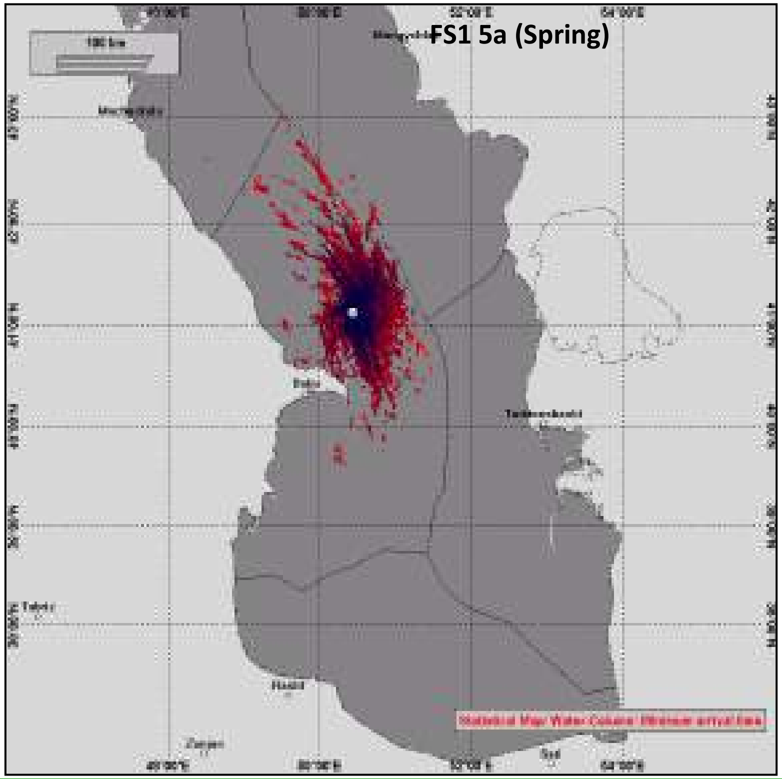

F91 5c (Autumn)
100 km
48°00'E
50°00'E
52°00'E
54°00'E
42°00'N
40°00'N
38°00'N
Baku
Turkmenbashi
Rasht
Zanjan
Sari

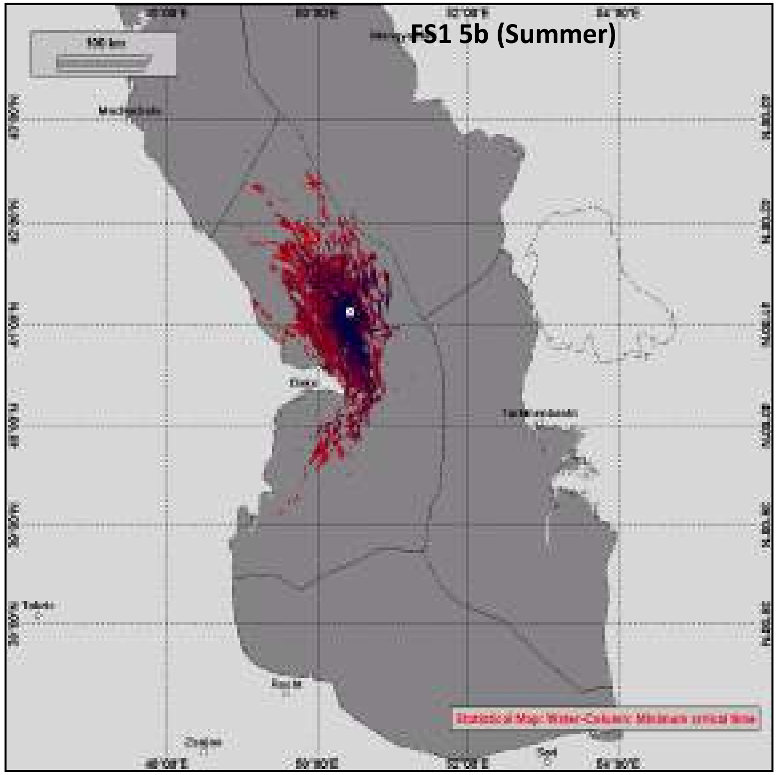
Map Key

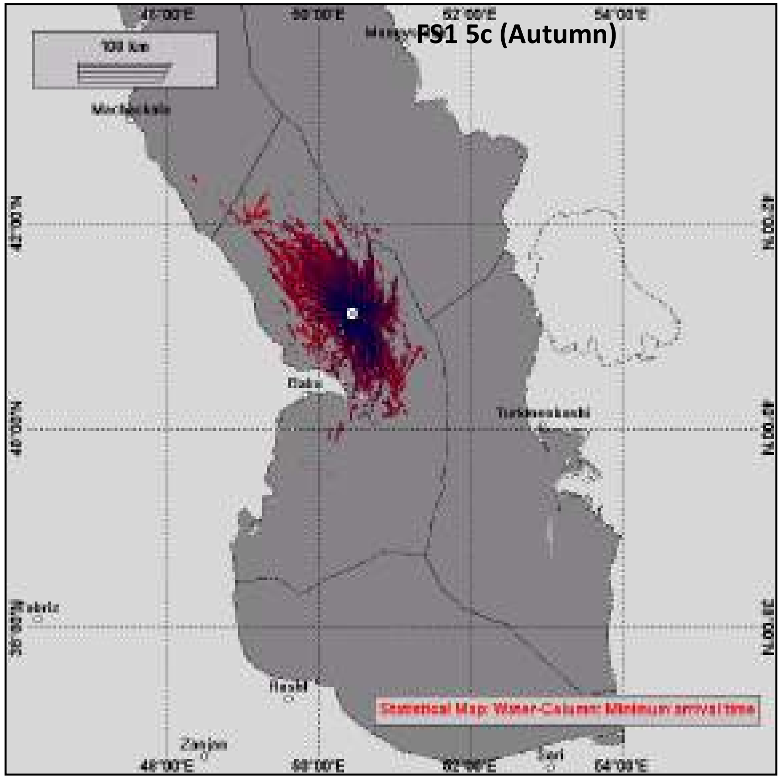

Probability of Dispersed + Dissolved Diesel > 58 ppb
5
10
20
30
40
50
60
70
80
90
Release Site
Median Line

12.1.1.23 Minimum Arrival Time of Water Column Concentrations of Diesel (Dispersed and Dissolved) exceeding 58 µg/l (ppb)

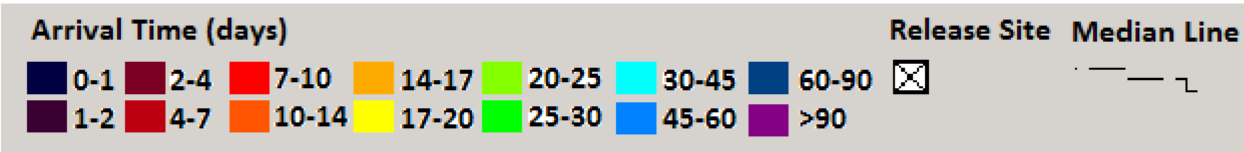
Minimum Arrival Time (Days) of Water Column Diesel Concentrations exceeding 58 ppb **Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes**			
Hydrocarbon Type	Marine Diesel (IKU)	Model output	Minimum arrival time of water column diesel concentrations (dispersed and dissolved) exceeding 58 ppb (Statoil, 2006). No probability threshold is applied due to limited functionality in OSCAR so the extents represent locations where the probability of surface oil is >1% rather than the >5% threshold used in the probability extent maps.






FS1 5c (Autumn)
100 km
Baku
Rasht
Zanjan
Sari
Statistical Map: Water-Column: Minimum arrival time

Map Key

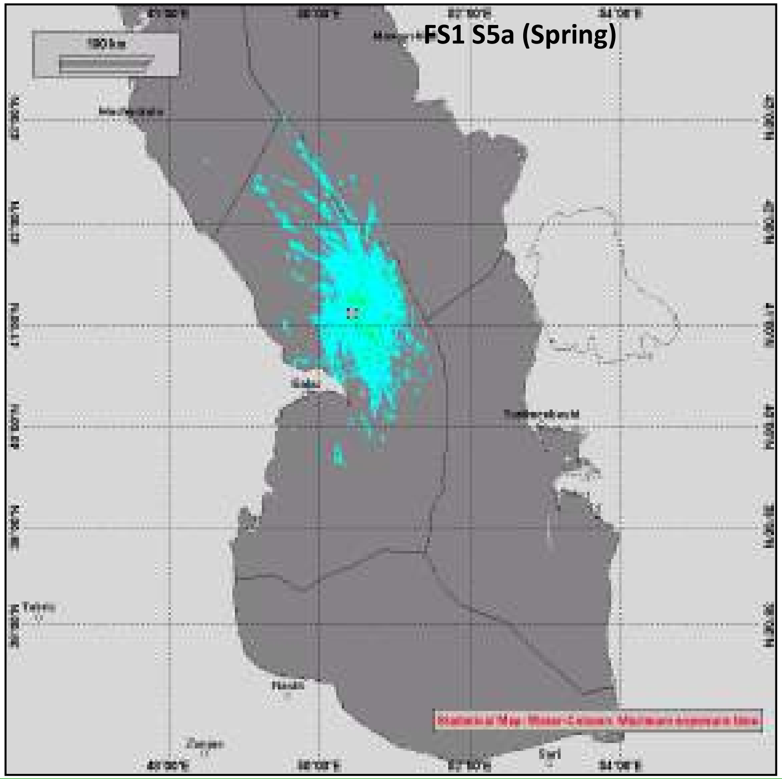

Arrival Time (days)
0-1
1-2
2-4
4-7
7-10
10-14
14-17
17-20
20-25
25-30
30-45
45-60
60-90
>90
Release Site
Median Line

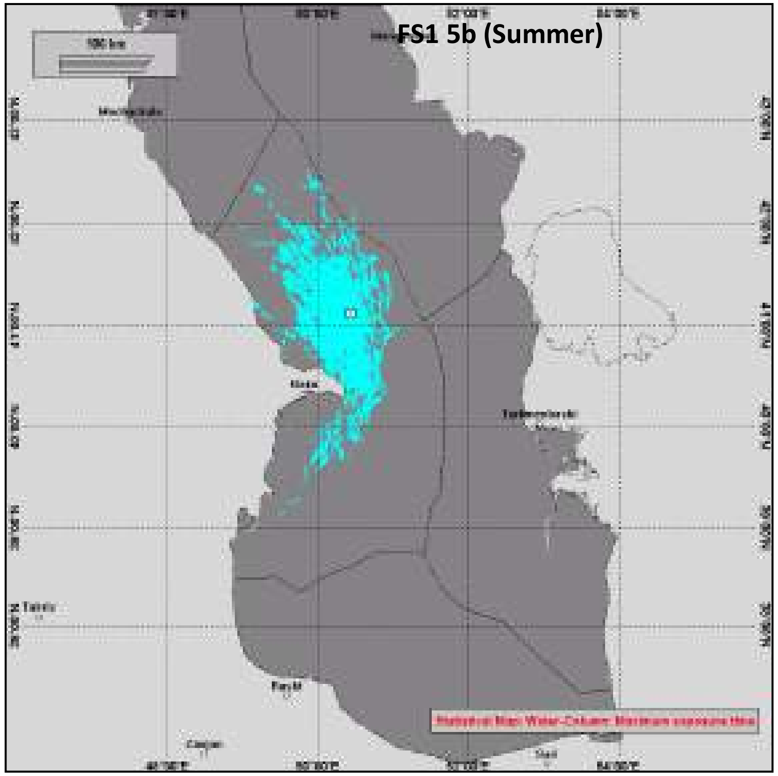
12.1.1.24 Duration of Diesel Concentrations in the Water Column (Dispersed and Dissolved) exceeding 58 µg/l (ppb)

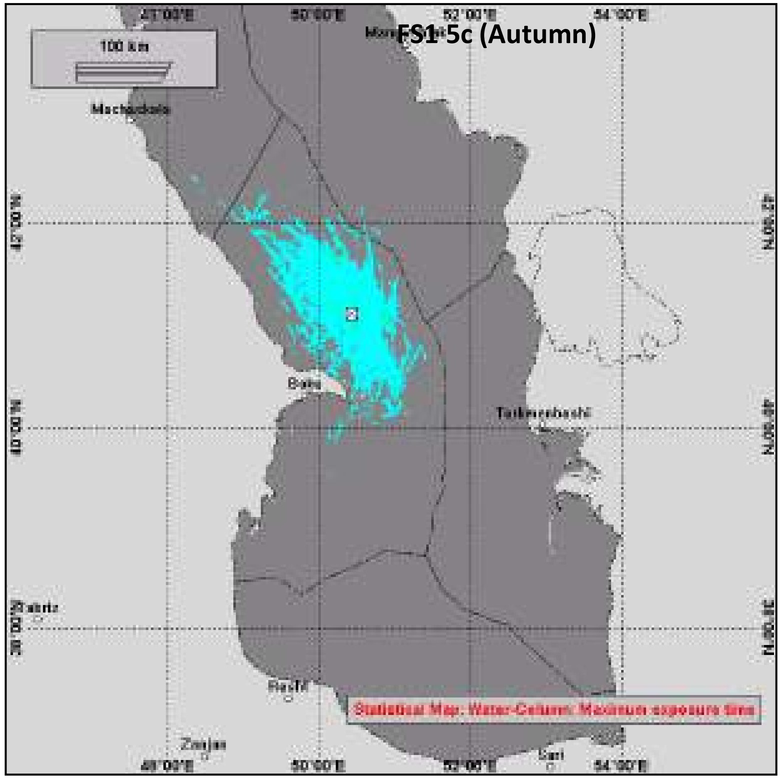
Maximum Exposure Time (Days) of Water Column Diesel Concentrations exceeding 58 ppb

Seismic Vessel Diesel Inventory Release – 800 tonnes over 10 minutes

Hydrocarbon Type	Marine Diesel (IKU)	Model output	Maximum water column exposure in days where diesel concentrations (dispersed and dissolved) exceed 58 ppb. No probability threshold is applied due to limited functionality in OSCAR so the extents represent locations where the probability of surface oil is >1% rather than the >5% threshold used in the probability extent maps.







Map Key

Exposure Time (days)

0 - 1
1 - 2
2 - 4
4 - 7
7 - 10
10 - 14
14 - 17
14 - 20
20 - 25
25 - 30
> 30

Median Line

Release Site

12.1.1.25 Tabulated Stochastic Results

The table below synthesises key outputs from the stochastic modelling. The probability and minimum arrival time of surface diesel at an international economic exclusion zone boundary are shown for each scenario in the section entitled “Median Crossing”.

Oil Spill Modelling Summary						
Spill scenario / descriptor	Seismic Vessel Diesel Release – 800 te over 10 minutes					
Median Crossing						
Identified median line	Probability (> 1%) of crossing and minimum time to reach (hrs)					
	5a (FS1 Spring)		5b (FS1 Summer)		5c (FS1 Autumn)	
	Prob	Days	Prob	Days	Prob	Days
Azerbaijan-Iran	3	15	1	11		
Azerbaijan-Kazakstan	5	1	3	2	2	2
Azerbaijan-Russia	1	26	1	10	1	10
Azerbaijan-Turkmenistan	6	1	2	2	2	2
Kazakstan-Turkmenistan	4	1	2	5	1	3
Turkmenistan-Iran	2	12				
Landfall						
	Probability of beaching and minimum time to beach (hrs)					
Predicted locations	5a (FS1 Spring)		5b (FS1 Summer)		5c (FS1 Autumn)	
	Prob	Days	Prob	Days	Prob	Days
Azerbaijan	5	3	3	2	3	2
Iran			1	15	1	15
Russia			1	18		
Mass beached (worst case)	243 te		240 te		255 te	
Key sensitivities at risk						
Protected Area Potentially Impacted	See Appendix 2					
Surface, Shoreline and Water Column Diesel Shapefiles (Projection – Geographic Coordinate System WGS 84)	**Stochastic Surface OSCAR Results**		**Stochastic Shoreline OSCAR Results**		**Stochastic Water Column OSCAR Results**	
	OSCAR Results Attribute Table Details					
Spring – Scenario 3a						
Summer – Scenario 3b						
Autumn – Scenario 3c						

Appendix 2 Scenario 3 (Release Site NS3) Diesel Release - Protected Area Intersections

The tables below provide a high level analysis of the protected /designated areas affected by oiling. A full analysis is provided in the ESIA report.

12.1.1.26 Shoreline Diesel (>0.169tonnes/km) >1% Probability

Scenario 3						
Shoreline Oil						
Protected Area Name	Shoreline Oiling (>1% Probability)					
	Winter		Spring		Autumn	
	Prob	Arrival	Prob	Arrival	Prob	Arrival
Absheron National Park	**1**	**2**			**1**	**2**
II	**1**	**2**			**1**	**2**
National Park	1	2			1	2
Bandovan State Nature Sanctuary	**1**	**11**			**2**	**9**
IV	**1**	**11**			**2**	**9**
State Nature Sanctuary	1	11			2	9
Gizilaghaj State Nature Reserve	**1**	**9**			**1**	**9**
Ia	**1**	**9**			**1**	**9**

State Nature Reserve	1	9			1	9
Lesser Gizilaghaj State Nature Sanctuary	**1**	**17**			**1**	**16**
IV	**1**	**17**			**1**	**16**
State Nature Sanctuary	1	17			1	16

12.1.1.27 Surface Diesel (>0.04µm thick) >1% Probability

Scenario 3						
Surface Oil						
Protected Area Name	Surface Oiling (>1% Probability)					
	Spring		Summer		Autumn	
	Prob	Arrival	Prob	Arrival	Prob	Arrival
Absheron National Park						
II						
National Park	1	8	3	4		
Absheron National Park					1	6
Agrakhansky						
IV						
Zakaznik (Federal)	1	23				

Gizilaghaj State Nature Reserve

Ia		
State Nature Reserve	1	13

Samurskiy reliktovy les

II		
Nature Park	1	19

Appendix 3 Scenario 5 (Release Site FS1) Diesel Release - Protected Area Intersections

The table below provide a high level analysis of the protected /designated areas affected by oiling. A full analysis is provided in the ESIA report.

12.1.1.28 Surface Diesel (>0.04µm thick) >1% Probability

Scenario 5						
Surface Oil						
Protected Area Name	Surface Oiling (>1% Probability)					
	Winter		Spring		Autumn	
	Prob	Arrival	Prob	Arrival	Prob	Arrival
Absheron National Park						
II						
National Park					1	4
Gizilaghaj State Nature Reserve						
Ia						
State Nature Reserve	1	9.5			1	9.5
Samurskiy reliktovy les						
II						
Nature Park	1	18				

Lisar						
V						
Protected Area	1	38			1	38
Bandovan State Nature Sanctuary						
IV						
State Nature Sanctuary	1	11.5			1	11.5
Amirkelayeh Lake						
Not Reported						
Ramsar Site, Wetland of International Importance			1	32.5		
Gil Island State Nature Sanctuary						
IV						
State Nature Sanctuary			1	30.5		

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