9 Drilling and Completion Environmental Impact Assessment, Mitigation and Monitoring

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9.1 Introduction

For all phases of the Shah Deniz 2 (SD2) Project, Activities and Events have been determined based on the SD2 Base Case as detailed within Chapter 5: Project Description; and the potential for Interactions with the environment identified.

In accordance with the impact assessment methodology (see Chapter 3), ESIA Scoping has been undertaken to identify selected Activities that may be “scoped out” from the full environmental impact assessment process based on Event Magnitude and the likely receptor Interaction. In addition, existing controls and mitigation have been identified. These include:

- Existing procedures that will be used to ensure that activities are consistent with environmental expectations; and
- Feedback from existing operational and ambient monitoring of environmental performance and/or impacts.

Those Activities that have not been scoped out have been assessed on the basis of Event Magnitude and Receptor Sensitivity, taking into account the existing controls and mitigation, and impact significance determined. Monitoring and reporting activities undertaken to confirm that these controls are implemented and effective, as well as additional mitigation and monitoring to further minimise impacts, are provided.

Assessments of socio-economic, cumulative and transboundary impacts and accidental events have also been undertaken and are provided in Chapters 12 and 13 respectively.

The structure of the impact assessment within this ESIA is provided within Table 9.1 below.

Table 9.1 Structure of SD2 Project Impact Assessment

<table>
<tr><th>Chapter</th><th>SD2 Phase</th><th>Content</th></tr>
<tr><td>9</td><td>• Drilling and Well Completion Activities</td><td rowspan="3">Common contents adopted for sections 9,10 and 11:
• Scoping Assessment of SD2 Activities, Events and Interactions.
• Identification of existing controls, mitigation, monitoring and reporting.
• Environmental impact assessment of SD2 activities based on:
o Event Magnitude
o Receptor Sensitivity
• Identification of any additional mitigation measures.</td></tr>
<tr><td>10</td><td>• Onshore Construction and Commissioning of Terminal Facilities
• Onshore Construction and Commissioning of Offshore and Subsea Facilities
• Platform Installation & HUC
• Installation, HUC of Subsea Export & MEG Pipelines
• Subsea Infrastructure Installation & HUC.</td></tr>
<tr><td>11</td><td>• Offshore Operations
• Onshore Operations
• Subsea Operations</td></tr>
<tr><td>12</td><td>All Phases</td><td>Assessment of socio-economic impacts.</td></tr>
<tr><td>13</td><td>All Phases</td><td>Assessment of cumulative and transboundary impacts (including impacts associated with greenhouse gas emissions) and impacts arising from accidental events (including oil spills and spill management).</td></tr>
<tr><td>14</td><td>All Phases</td><td>Description of the SD2 Environmental and Social Management System including waste management plans and procedures.</td></tr>
</table>

9.2 Scoping Assessment

The SD2 Project Drilling and Completion Activities and associated Events that have been scoped out due to their limited potential to result in discernable environmental impacts are presented in Table 9.2 (see Appendix 9A for all SD2 Project Drilling and Completion Activities, Events and Interactions). The scoping process has used judgement based on prior experience of similar Activities and Events, especially with respect to earlier SD or Azeri Chirag Guneshli (ACG) developments. In some instances, scoping level quantification/numerical analysis has been used to justify the decision. Reference is made to relevant quantification, analysis, survey and/or monitoring reports in these instances.

Table 9.2 "Scoped Out" SD2 Project Drilling and Completion Activities

ID	Activity / Event	Ch. 5 Project Description Reference	Justification for "Scoping Out"
Dri-R16	Crew change operations	**N/A**	• Crew changes will be made on a regular basis using crew change vessels (approximately 3 trips per week are estimated). • The low volume of emissions released will be dispersed across the entire vessel route and the wider area. Increases in pollutant concentrations will be very small and indistinguishable from existing background concentrations. • Helicopters will be used infrequently e.g. when vessel transportation is not possible due to bad weather or for emergency crew transportation. Flights will originate from Zabrat heliport. A portion of the flight path will be over residential receptors but at height (>500m). Noise disturbance will be temporary, of short duration and low intensity. • Emissions and noise from crew change operations is expected to result in no discernable impact to human receptors. • **Conclusion:** Emissions and noise from crew change operations is expected to result in no discernable impact to human receptors.
Dri-R17	Waste Management	**5.4.9.3**	• Waste generated during SD2 drilling and completion will be consistent with the type and quantity that have been routinely generated during previous MODU drilling work. • Waste on the MODU will be segregated at source, stored and transported in fit for purpose containers. • The CWAA at the supply base within the BDJF yard will be used as the main reception and consolidation point for solid waste from drilling. • Waste generated during SD2 drilling and completion will be managed in accordance with the existing BP AGT Region management plans and procedures. BP has gained significant operational experience of managing similar waste from 10 years of MODU drilling operations. • Waste management plans have been established for the MODU aligned to the existing BP AGT Region management plans and all waste transfers will be controlled and documented. • **Conclusion:** Waste generated during the SD2 Project will be managed in accordance with the existing BP AGT Region management plans and procedures. No discernable impact to the terrestrial or marine environment expected.
Dri-R18	Fugitive Emissions	**N/A**	• During the transfer dry bulk (primarily cement and barite) from vessel to MODUs silos some losses to the atmosphere of dry bulk may happen through vent lines (the vent lines must be open as part of operational requirements). • The duration of the transfer will be approximately 3-4 hours. • Fugitive emissions resulting from dry bulk transfer are expected to be minimal and will not result in a discernable impact to the marine environment. • **Conclusion:** Fugitive emissions resulting from dry bulk transfer are expected to be minimal and will not result in a discernable impact to the marine environment.
Dri-R19	Seabed Disturbance	**5.4.1.1** **5.4.2.3** **5.4.4.2**	• MODU anchoring will result in disturbance due to positioning of anchors and anchor chains of up to approximately 190,280m^2 in total. • Frames associated with geotechnical holes (up to 4 planned) will be installed and left on the seabed • Wellhead brace will be installed at each well location in order to support the wellhead during installation of the BOP and production tree. The frame will occupy a small area in the vicinity of wellhead • The displacement of sediment will not cause significant levels of mortality in benthic organisms. A small proportion of animals may be buried too deeply to recover to a position near the sediment surface, but the majority of organisms will be able to re-establish themselves once the anchors and chains have been removed and the frame and brace is in position • **Conclusion:** It is considered that impacts are minimised as far as practicable and no discernable impact to the marine environment due to seabed disturbance

The SD2 Project routine and non-routine Drilling and Completion Activities and their associated Events assessed in accordance with the full impact assessment process are presented in Table 9.3.

Table 9.3 "Assessed" SD2 Project Drilling and Completion Activities

ID	Activity / Event	Ch. 5 Project Description Reference	Event	Receptor
Dri-R1	Tow out and positioning of Mobile Offshore Drilling Units (MODU)	**5.4.1.1**	Other discharges to sea	Marine Environment
			Underwater noise and vibration	
			Emissions to atmosphere (non GHG)	Atmosphere
Dri-R2	Vessel support including supply to MODU and backload to shore	**5.4.1.2 Table 5.1**	Other discharges to sea	Marine Environment
			Underwater noise and vibration	
			Emissions to atmosphere (non GHG)	Atmosphere
Dri-R3	Drilling with seawater/PHB sweeps or water based muds (WBM) (42", 32" and 28" hole sections and geotechnical holes)	**5.4.2.4**	Underwater noise and vibration	Marine Environment
			Drilling discharges to sea	
Dri-R4	Discharge of residual WBM (after 28" hole section and geotechnical hole drilling)	**5.4.2.4**	Drilling discharges to sea	Marine Environment
Dri-R5	Discharge from 28" section due to MRS failure	**5.4.2.4**	Drilling discharges to sea	Marine Environment
Dri-R6	Drilling with non WBM (lower hole section drilling)	**5.4.2.4**	Underwater noise and vibration	Marine Environment
Dri-R7	Cementing discharges to seabed (from cementing casings and from installation of wellhead brace) and excess cement discharge to seabed (following cementing casings)	**5.4.2.6 and 5.4.4.2**	Cement discharges to sea	Marine Environment
Dri-R8	Clean up flaring	**5.4.6**	Emissions to atmosphere (non GHG)	Atmosphere
Dri-R9	Well test flaring	**5.4.7**		
Dri-R10	MODU power generation	**5.4.1.2 Table 5.1**	Emissions to atmosphere (non GHG)	Atmosphere
Dri-R11	MODU seawater lift and cooling discharge	**5.4.1.2 Table 5.1**	Water intake/entrainment	Marine Environment
			Cooling water discharge to sea	
Dri-R12	MODU treated black water/grey water/drainage discharges	**5.4.1.2 Table 5.1**	Other discharges to sea	Marine Environment
Dri-R13	Discharge of excess cement and cement system wash out to sea via MODU cuttings caisson	**5.4.2.6 5.4.4.2**	Cement discharges to sea	Marine Environment
Dri-R14	BOP testing discharges	**5.4.4**	Discharges to sea	Marine Environment
Dri-R15	Flaring during interventions	**5.4.8**	Emissions to atmosphere (non GHG)	Atmosphere

9.3 Impacts to the Atmosphere

9.3.1 MODU Power Generation, MODU Flaring and Support Vessel Emissions

Non greenhouse gas (GHG) emissions to the atmosphere from Drilling and Completion activities will be associated with MODU power generation, flaring events and use of support vessels. GHG emissions associated with the SD2 Project are discussed within Chapter 13 of this ESIA. This section focuses on the assessment of potential air quality impacts.

9.3.1.1 Mitigation

Existing controls associated with emissions from MODU power generation, MODU flaring and support vessel operations include:

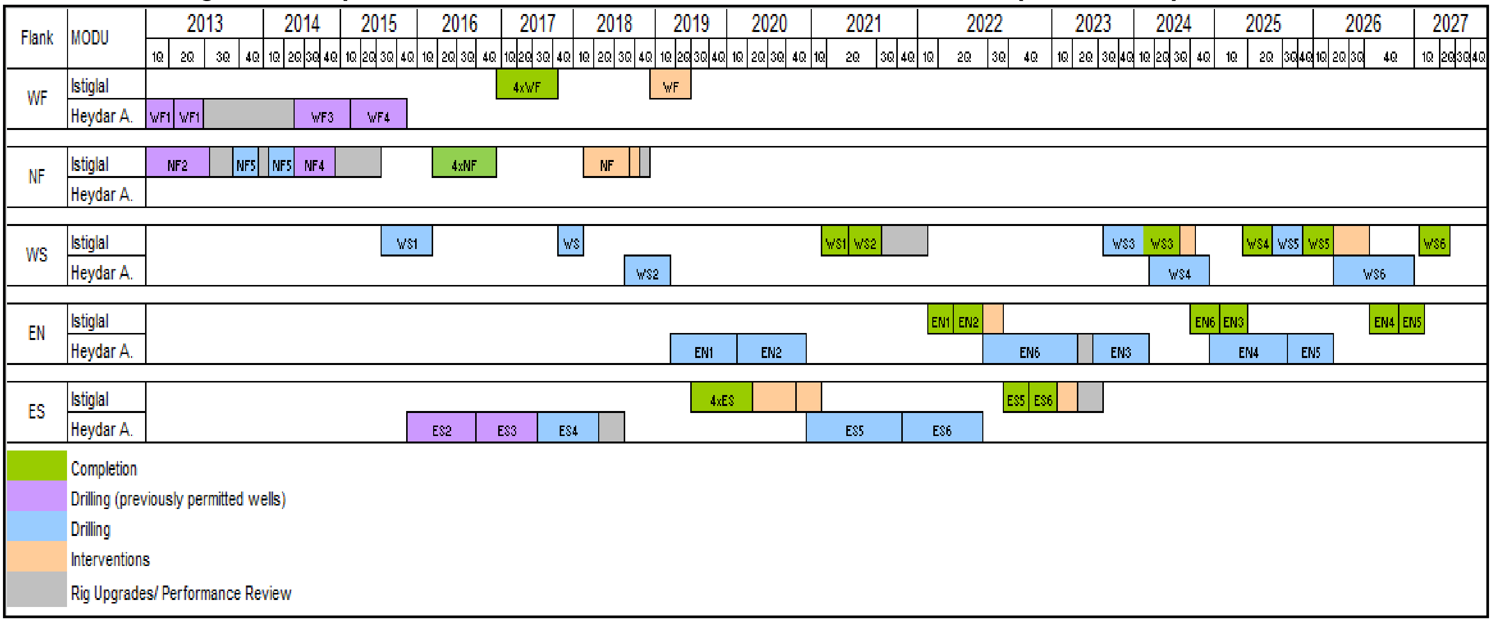
- MODU diesel generators and engines will be maintained in accordance with written procedures based on the manufacturers' guidelines or applicable industry code or engineering standards to ensure efficient and reliable operation;
- Burners will be designed to achieve high burning efficiencies during well testing and well clean up flaring;
- Burners will be operated in accordance with written procedures based on the manufacturers' guidelines or applicable industry code or engineering standard; and
- Well test proposals will be reviewed and challenged through existing BP internal processes.

9.3.1.2 Event Magnitude

Description

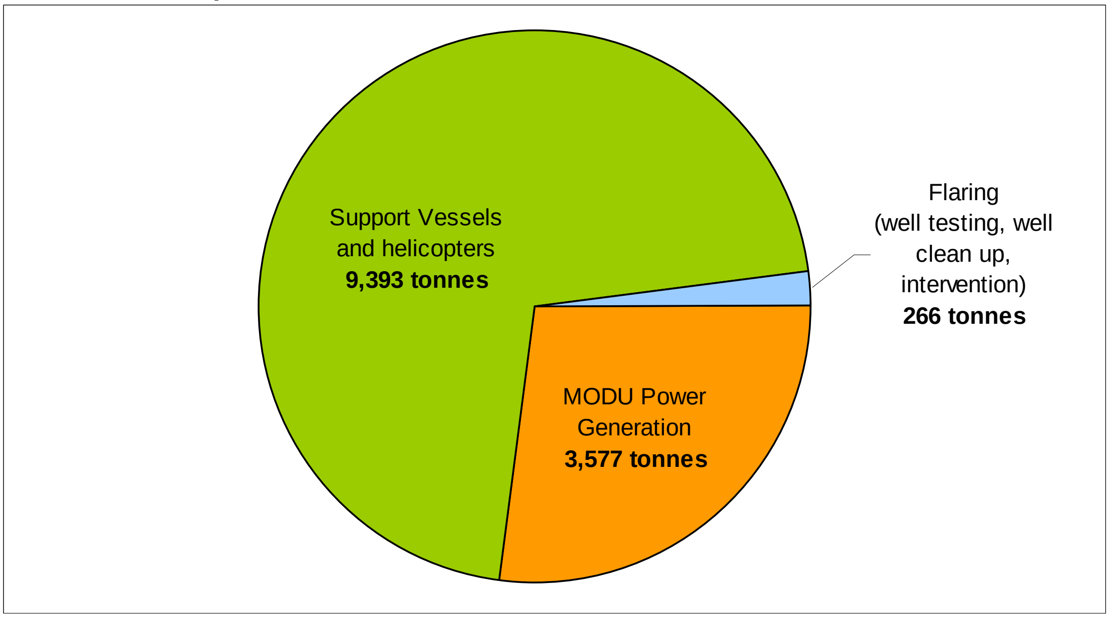
As described within Chapter 5 Section 5.4.1 it is anticipated that two MODU (the Istiglal and Heydar Aliyev rigs) will be used during the SD2 Project drilling and completion programme, resulting in emissions from onboard engines and generators. Figure 9.1 shows the expected use of the two MODU within the five flanks of the SD Contract Area from 2013 to 2027.

Figure 9.1 Expected MODU Activities Within the SD Contract Area (2013 – 2027)



MODU flaring is expected to comprise clean up flaring, well test flaring and flaring associated with well interventions as discussed with Chapter 5 Sections 5.4.63, 5.4.7 and 5.4.8 respectively. In addition emissions will result from the operation of support vessels required throughout the drilling and completion programme as discussed in Chapter 5 Section 5.4.1.2 Figure 9.2 presents the estimated volume of nitrogen dioxide (NO_2) emissions per source during SD2 Project drilling, completion and intervention activities[1].

Figure 9.2 Estimated Volume of NO_2 Emissions per Source During SD2 Project Drilling, Completion and Intervention Activities



Assessment

Modelling undertaken for MODU power generation and MODU flaring is presented in Appendix 9B. The modelling focuses on NO_X (which comprises nitrogen oxide (NO) and nitrogen dioxide (NO_2)) as the main atmospheric pollutant of concern, based on the larger predicted emission volumes as compared to other pollutants (SO_X, CO and non methane hydrocarbons) and its potential to impact upon human health and the environment.

MODU Power Generation

For MODU power generation long term (annual average) NO_2 concentrations were modelled to assess the contribution in the context of the annual EU standard for NO_2 of 40 µg/m^3. This standard is relevant to locations where humans are normally resident (i.e. onshore settlements) and do not apply to commercial locations and workers, which are subject to standards under separate occupational health requirements. The modelling conservatively assumed that, for the long term, all NO_X is converted to NO_2.

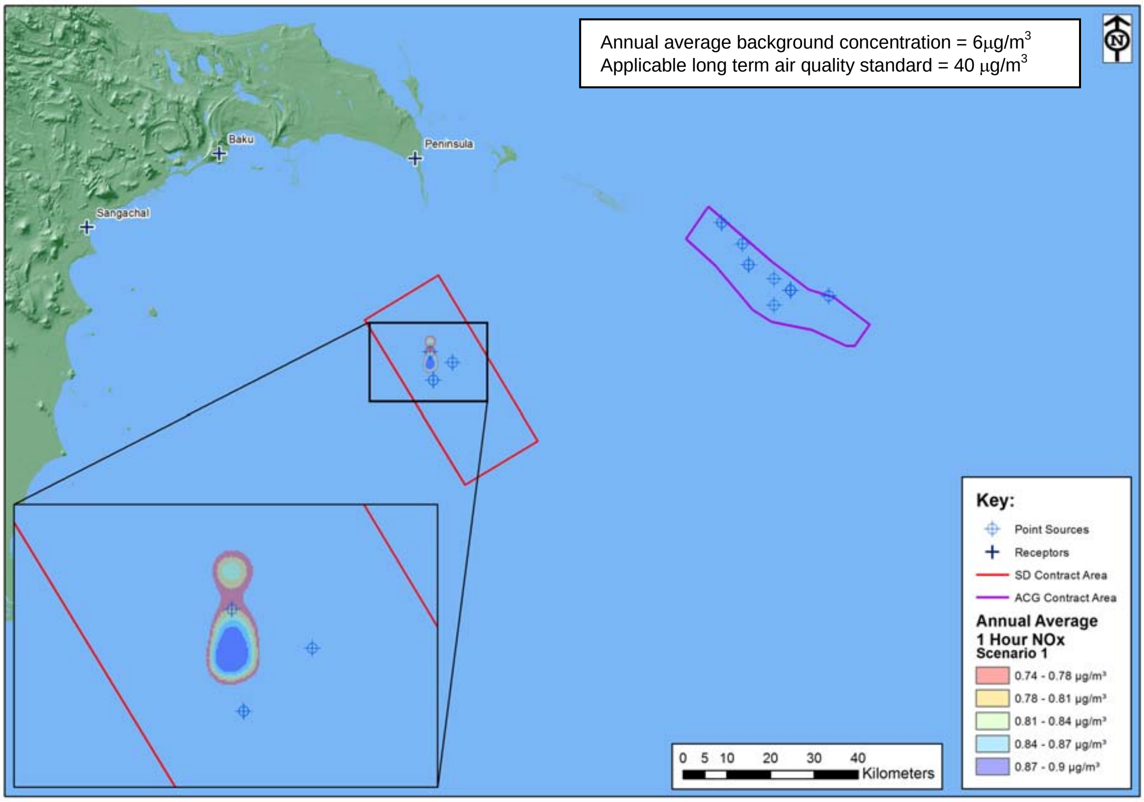
The modelling assessment was carried out assuming a maximum of two wells can be drilled simultaneously using the 'Istiglal' and 'Heydar Aliyev' MODUs as shown in Figure 9.1. The rigs may be located in any of the five well clusters, however based on the prevailing wind conditions, simultaneous operation at flanks NF and WF represent the worst case i.e. the greatest potential for increases in pollutant concentrations onshore.

As shown in Figure 9.3, the results demonstrated that, during routine operation, long term concentrations of NO_2 are predicted to increase by up to 1 µg/m^3 within 10 km of the NF and WF locations. At the coastline of the Absheron Peninsula (at Shahdili Spit) the increase in NO_2 concentrations is expected to be less than 0.1 µg/m^3 onshore. This represents less than

[1] Basis of the estimate is provided within Appendix 5A

0.3% of the air quality standard of 40 µg/m^3 and increase of less than 2% above the existing background concentration of 6 µg/m^3.

Figure 9.3 Predicted Increase in Long Term NO_2 Concentrations Due to MODU Power Generation



No discernable change in pollutant concentrations or exceedances of the long term air quality standards that could impact human health are predicted at any distance from the two MODUs due to the drilling and completion activities[2].

Based on efficient operation, regular maintenance, planned use of good quality, low sulphur fuel (typically less than 0.05%) and previous experience, routine operation of the MODU engines and generators will not result in plumes of visible particulates from the generator exhausts.

MODU Flaring

As described within Chapter 5 Sections 5.4.6 and 5.4.7 MODU flaring is anticipated to comprise:

- Two well test events in the WS and EN flanks, each at a flowrate of 40MMscfd for up to 150 hours; and
- 26 clean up flaring events following the drilling of each SD2 Project well, each at an average rate of 250MMscfd for up to 2 days.

In addition it is expected that flaring will occur during intervention activities at a rate of 80 MMscfd for a day per event. A total of 80 intervention events involving flaring are anticipated between 2018 and the end of the PSA (2036).

[2] Historically in Azerbaijan ambient concentrations of NO_2, SO_2, CO and PM_{10} have also been assessed against specific 24 hour and 1 hour standards. These standards were not derived using the same health based criteria as the IFC, WHO and EU guideline values and the standards derived are not widely recognised. However, Appendix 9B includes an assessment of expected air quality concentrations against these standards for completeness. The modelling demonstrated that none of these standards would be exceeded during drilling and completion activities.

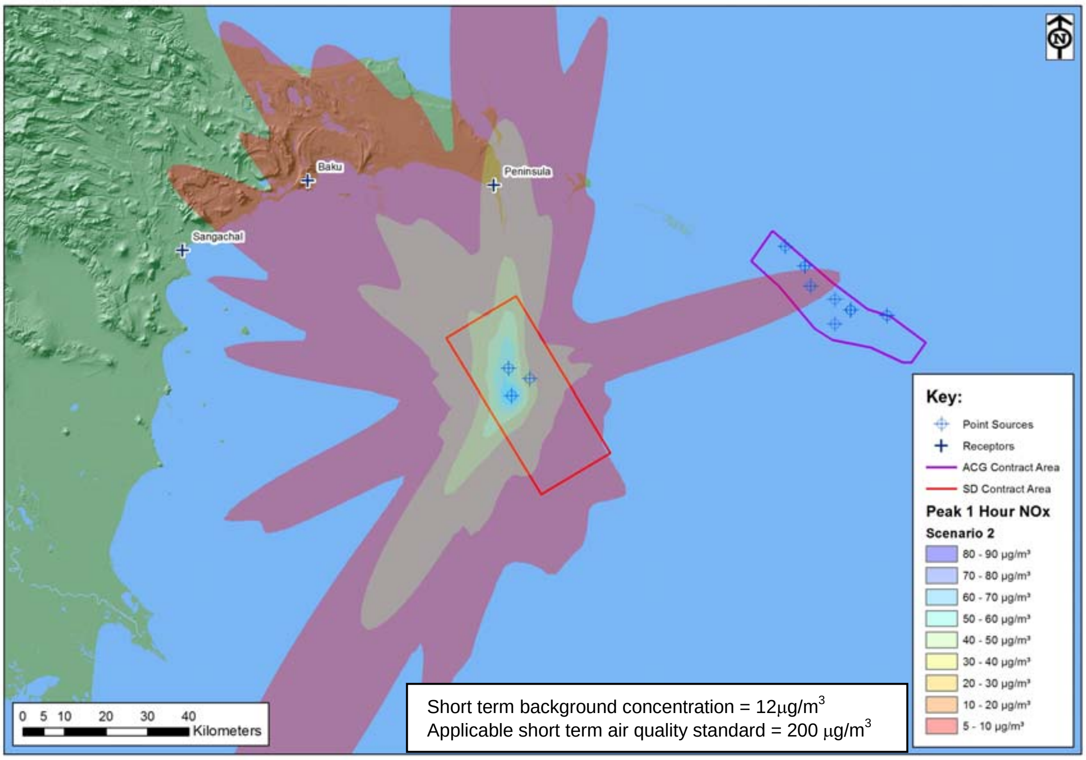
Modelling was undertaken based on the following:

- At any one time a flaring event will only be undertaken on one MODU; the two MODUs will not flare simultaneously;
- The highest flaring rate is for clean up flaring. The assessment for clean up flaring is therefore represents the worst case with regard to MODU flaring events;
- The MODU were located at the NF and WF locations as this represent the worst case in terms of potential air quality impacts to onshore receptors. It was assumed that the MODU flaring event was located at the WF location to represent the worst case scenario; and
- Clean up, well test and intervention flaring events are all short term (i.e. expected to last no more than 7 days per event) and therefore the assessment should focus on assessing the impact relative to short term air quality standards.

Modelling undertaken for MODU clean up flaring is presented in Appendix 9B, focusing on key pollutant species, NO_2. Short term (1 hour peak) NO_2 concentrations were modelled to assess the contribution of emissions from clean up flaring in the context of the EU short term air quality standards for NO_2 of 200 µg/m^3.

The results demonstrated that, during clean up flaring, short term concentrations of NO_2 are predicted to increase by approximately 6.3µg/m^3 onshore, at the Absheron Peninsula and 2.0-2.9 µg/m^3 at Sangachal and Baku (see Figure 9.4). This represents approximately 1-3% of the short term NO_2 standard of 200 µg/m^3 and increase of less than 50% above the existing short term background concentration of 12 µg/m^3.

Figure 9.4 Predicted Increase in Short Term NO_2 Concentrations Due to MODU Clean Up Flaring



No discernable change in pollutant concentrations or exceedances of the short term NO_2 standard are predicted at any distance from either MODU during MODU flaring.

Support Vessels

As stated within Chapter 5 Section 5.4.1.2, vessels will be required throughout drilling, completion and intervention activities to supply consumables (e.g. drilling mud, diesel, chemicals etc) to the two MODU and ship solid and liquid waste to shore for treatment and disposal. The number and type of vessels anticipated to be used are presented in Appendix 5F.

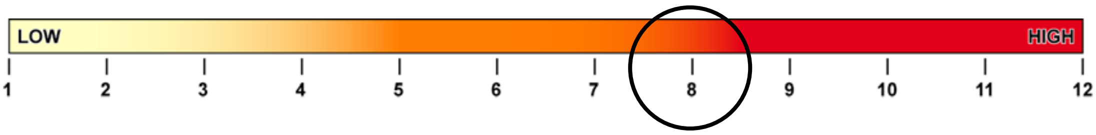
Figure 9.2 shows the total volume of emissions of the key pollutant species relevant to human health, NO_2, for all sources over the entire drilling, completion and intervention programme between 2013 to 2027 (14 years). For the period of drilling activities it is predicted that NO_2 emissions from support vessels will total approximately 9,393 tonnes. This is approximately 2.6 times greater than NO_2 emissions associated with MODU power generation during drilling activities however emissions from vessel movements will occur across a relatively large geographic area and over a long period of time. They are therefore expected to disperse rapidly and are not expected to result in noticeable increases in NO_2 concentrations at onshore locations.

Based on efficient operation, regular maintenance, planned use of good quality, low sulphur fuel and previous experience, routine operation of the support vessels should not result in plumes of visible particulates from the vessel engine exhausts.

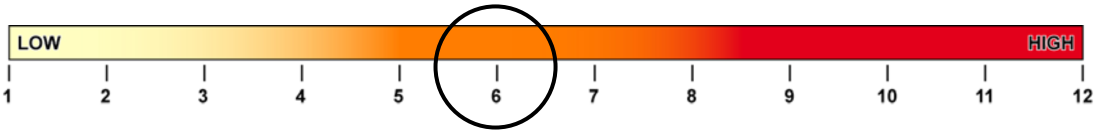
The Event Magnitude associated with emissions from MODU power generation, MODU flaring (during well testing, clean up or intervention flaring) and support vessels is summarised in Table 9.4. In each case a Medium Event Magnitude is predicted.

Table 9.4 Event Magnitude

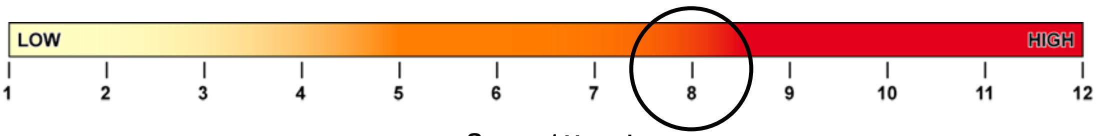
Event Parameter	MODU Power Generation	MODU Flaring	Support Vessels
Extent/Scale	1	1	1
Frequency	3	3	3
Duration	3	1	3
Intensity	1	1	1
Event Magnitude:	**8**	**6**	**8**



MODU Power Generation



MODU Flaring



Support Vessels

9.3.1.3 Receptor Sensitivity

Human Receptors

Table 9.5 presents the justification for assigning a score of 2 to human receptors, which represents Low Receptor Sensitivity.

Table 9.5 Human Receptor Sensitivity

Parameter	Explanation	Rating
Presence	There are no permanently present (i.e. resident) human receptors within 45km of the nearest SD2 well locations to shore.	1
Resilience	Changes in air quality onshore will be indiscernible. Onshore receptors will be unaffected.	1
Total		2

Biological/Ecological Receptors

Table 9.6 presents the justification for assigning a score of 2 to biological/ecological receptors, which represents Low Receptor Sensitivity.

Table 9.6 Biological/Ecological Receptor Sensitivity

Parameter	Explanation	Rating
Presence	Marine/bird species are mobile and will not be present at one location for long periods of time. Birds found in the area will be transient and not resident.	1
Resilience	Volume of emissions released (including visible particulates) will create a very small increase in pollutant concentrations in the atmosphere and in any washout from rainfall, which will not be discernable to biological / ecological receptors[3].	1
Total		2

9.3.1.4 Impact Significance

Table 9.7 summarises impacts on air quality associated with SD2 Project Drilling and Completion activities.

Table 9.7 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
MODU Power Generation	Medium	(Humans) Low	**Minor Negative**
		(Biological/Ecological) Low	**Minor Negative**
MODU Flaring (well testing, clean up or intervention flaring)	Medium	(Humans) Low	**Minor Negative**
		(Biological/Ecological) Low	**Minor Negative**
Support Vessels	Medium	(Humans) Low	**Minor Negative**
		(Biological/Ecological) Low	**Minor Negative**

[3] Note that ambient air quality standards are not relevant to biological/ecological receptors.

Monitoring and reporting requirements associated with emissions to atmosphere during MODU drilling, completion and intervention activities include:

- MODU diesel usage will be recorded on a daily basis;
- Environmental management system audits of drilling operations including MODU drilling will be undertaken periodically ; and
- The following will be provided to the MENR either within the MODU Annual Emissions Report or the End of Well Environmental Report:
    - Volume of fuel used by each MODU (recorded daily in tonnes and reported monthly);
    - Volumes of gas and condensate flared for each well; and
    - Estimated volumes of emissions generated as a result of fuel used and MODU flaring (calculated using emission factors).

These requirements are incorporated into the Environmental Management System (EMS) for each MODU, which is aligned to the AGT Region EMS as described within Chapter 14 Section 14.5 of this ESIA.

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures and no additional mitigation is required.

9.4 Impacts to the Marine Environment

9.4.1 Underwater Noise & Vibration

9.4.1.1 Event Magnitude

Description

Underwater noise, resulting from the drilling of the SD2 geotechnical holes and wells and vessel movements during drilling, completion and intervention activities as described with Section 5.4 of Chapter 5, has the potential to impact biological/ecological receptors (specifically seals and fish) in the marine environment.

Assessment

Propagation of underwater noise due to drilling and vessel activities was modelled and a number of acoustic impact criteria were applied in order to estimate distances at which various acoustic impacts on marine species may occur. The bathymetry of the seabed in the vicinity of the SD2 wells was constructed using bathymetry data contained in the ETOPO1 database[4] and was used to undertake modelling as presented within Appendix 9C.

As described within the modelling assessment, (Appendix 9C), thresholds for fatality and physical injury to marine animals have been developed for different species through experiments based on impulsive sound pressure levels. Based on the data available, the assessment used a conservative approach, assuming the same threshold limits for both seals and fish.

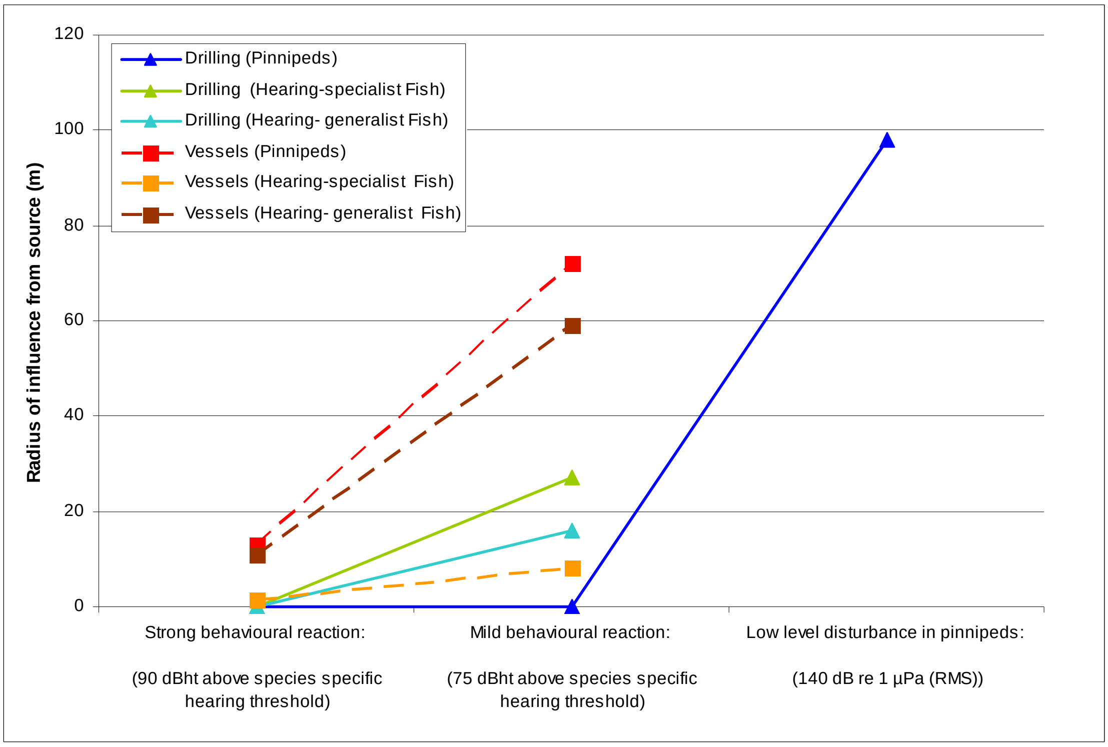
Acoustic impact thresholds are a function of the noise level to which an animal is exposed and vary for different species. Given that data does not exist for many species including Caspian specific species, a generic audiogram approach[5] was adopted to develop representative audiological injury and behavioural thresholds for seals and fish (denoted as either hearing-specialist or hearing-generalist depending on their biology e.g. whether or not they have swim bladders and a physiological connection between the swim bladder and the

[4] Amante, C. and B. W. Eakins,(2009), ETOPO1 1 Arc-Minute Global Relief Model: Procedures, Data Sources and Analysis. NOAA Technical Memorandum NESDIS NGDC-24, 19 pp, March 2009.
[5] Harland E. J., “Measuring Underwater Noise: Perils And Pitfalls”, *Proceedings of the Institute of Acoustics*, Vol 30, Pt 5, 2008.

inner ear) based on proxy species. Fish known to be present within the SD Contract Area and adjacent areas of the Caspian Sea which have swim bladders are listed in Chapter 6, Section 6.7.2.4, Table 6.27. These include sturgeon, kura, kilka, shad and some species of goby. Thresholds for acoustic impact criteria are available for pinnipeds covering lethality; physical injury including deafness; and behavioural reactions while for fish, they cover lethality and behavioural reactions only.

The results of the analysis are summarised within Figure 9.5

Figure 9.5 Summary of Effect of Underwater Drilling and Vessel Noise Relative to Audiological Injury and Behavioural Thresholds



For drilling, the source level is below the levels at which lethal injury, permanent deafness, temporary deafness or auditory injury may occur. As Figure 9.5 taking into account behavioural reactions (based on dB_{ht} impact criteria) mild avoidance to drilling noise may be observed up to 16m for hearing generalist fish and 27m for hearing specialist fish with swim bladders. Pinnipeds are not expected to exhibit behavioural reactions at this threshold level.

For vessel noise the analysis showed that the source level associated with the vessels to be used during MODU drilling activities are below the level at which both lethality and direct physical injury might occur. With regard to behavioural impacts the results indicate that hearing-generalist fish may undergo strong avoidance reactions at a distance of 1.4 m from the vessel. Hearing-specialist fish experience the same reactions at 11 m and pinnipeds at 13 m. Mild avoidance reactions to vessel noise may be observed up to 8m for hearing-generalist fish, 59m for hearing-specialist fish and 72m for pinnipeds.

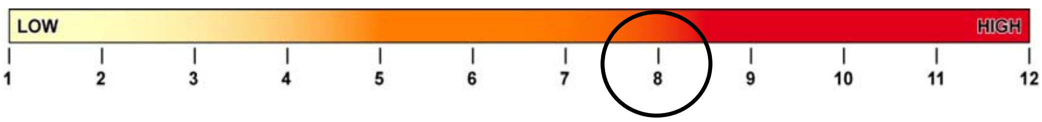
It is common for disturbance distances to vary with season as during the winter months, underwater sound becomes trapped just under the surface within a narrow layer leading to optimal propagation conditions and therefore noise travels further. In summer the noise tends to be directed into the seabed where it undergoes significant losses. Given that the impact ranges extend over relatively short distances, they are, however, insensitive to seasonal variability.

Cumulative impacts due to activities at adjacent well locations are unlikely to arise due to the relatively small acoustic footprint of each noise source.

Table 9.8 presents the justification for assigning a score of 8, which represents a Medium Event Magnitude.

Table 9.8 Event Magnitude

Parameter	Explanation	Rating
Extent / Scale	Underwater sound emissions are unlikely to result in a significant avoidance response from fish/seals beyond 13m from the noise source.	1
Frequency	Underwater sound emissions occur continuously during the drilling programme.	3
Duration	Underwater sound emissions will last for more than one week (estimated average drilling programme of 265 days per well).	3
Intensity	Taking into account concentration, accumulation and persistence of sound energy in the underwater environment, intensity is low.	1
Total		**8**



9.4.1.2 Receptor Sensitivity

The only relevant biological receptors to underwater noise are seals and fish[6]. Recent data indicates that Caspian seals, an endangered species, migrate through the SD Contract Area (refer to Chapter 6 Section 6.7.2.5 and Appendix 6D). The number varies throughout the year with the maximum numbers of up to 4,000 seals migrating through the Contract Area during the spring months which significantly reduces to individual seals during the winter months.

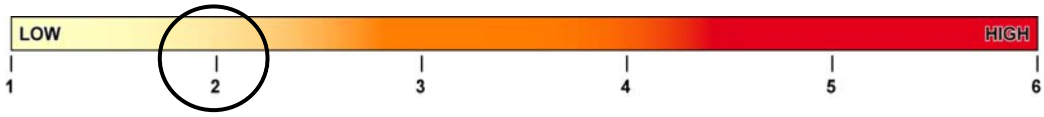
Sturgeon, another endangered species, are known to migrate through the SD Contract Area in March/April and September to November but are not common and do not use the area exclusively (refer to Chapter 6 Section 6.7.2.4 and Appendix 6C). Shad also migrate through the Contract Area in autumn. Goby species are present throughout the year in the Central and Southern Caspian including the Contract Area, however fish such as kilka and mullet are semi migratory primarily present in the Contract Area during the winter months. No fish species is present exclusively within the Contract Area.

Table 9.9 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

[6] Plankton cannot sense the low frequency sound generated because the wavelength is longer than the organism and benthic invertebrates do not have sophisticated sound-sensing apparatus.

Table 9.9 Receptor Sensitivity (Seals and Fish)

Parameter	Explanation	Rating
Resilience	Possibility that species may be temporarily affected by underwater drilling and vessel noise but effect would be short term and limited and ecological functionality will be maintained.	1
Presence	Both the fish and seals are likely to be present for limited periods of time in the SD Contract Area. However, the SD Contract Area is not exclusively used by these species.	1
Total		**2**



9.4.1.3 Impact Significance

Table 9.10 summarises impacts to seals and fish associated with drilling and vessel movements.

Table 9.10 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Drilling and vessel movements	Medium	(Seals & Fish) Low	**Minor Negative**

The assessment above demonstrates that a Minor Negative impact to seals and fish from drilling and vessel movements is predicted. This is considered to be a conservative assessment, as the modelling demonstrates that underwater sound emissions are unlikely to result in an avoidance response from fish/seals beyond 98m from the noise source.

It is considered that impacts are minimised as far as practicable and necessary and no additional mitigation is required.

9.4.2 Drilling Discharges

Discharges of water based mud (WBM) and cuttings are planned to be consistent with existing SD and ACG drilling practices. As discussed within Chapter 5 Section 5.4.1, 12 of the wells will be located within the following flanks:

- WS flank - four wells at approximate depth of 390 - 470m;
- ES flank - four wells at approximate depth of 490 - 530m; and
- EN flank - four wells at approximate depth of 395 – 480m.

The locations of the final four wells have not yet been confirmed and will be within these flanks or within the NF or WF flanks. Figure 9.1 shows the anticipated drilling programme.

9.4.2.1 Mitigation

Existing controls associated with drilling discharges include the following:

- WBM cuttings will be discharged below the sea surface from the Istiglal and Heydar Aliyev in accordance with applicable PSA requirements. WBM cuttings from the MODU can alternatively, be discharged directly to the sea bed using a hose fitted to the MODU cuttings chute;
- LTMOBM and associated cuttings used for lower hole drilling will be returned to the MODU and separated. Separated LTMOBM will be reused where practicable, and the remainder returned to shore for disposal. LTMOBM associated drill cuttings will be

contained in dedicated cuttings skips on the rig deck for subsequent transfer to shore for treatment and final disposal. It is not planned to release any LTMOBM or associated cuttings into the marine environment;

- During MODU drilling activities, WBM will be separated from cuttings as far as practicable and re-used ;
- WBM additives used during MODU drilling activities will be of low toxicity (UK HOCNS "Gold" and "E" category or equivalent toxicity);
- Batches of barite supplied for use in WBM formulations will meet applicable heavy metals concentration standards i.e. Mercury <1 mg/kg and cadmium <3 mg/kg dry weight (total);
- There will be no planned discharge of WBM or associated drilling cuttings from the MODU with chloride concentration greater than four (4) times the ambient concentration of the receiving water; a PSA standard; and
- For the pilot and geotechnical holes and the upper sections of the wells, it is proposed to use PHB sweeps and a WBM of the same specification and environmental performance as used for previous SD wells. If there is a requirement to change the sweeps/drilling mud composition or to select different drilling fluids for commercial or technical reasons, the Management of Change Process (see Section 5.16) will be followed.

9.4.2.2 Event Magnitude

Description

The anticipated drilling activities resulting in discharges to sea are described within Chapter 5 Sections 5.4.2, 5.4.2.4 and 5.4.2.5. The estimated quantities of seawater and PHB sweeps, WBM and cuttings discharged per hole in tonnes are provided in Table 9.11. Two types of discharge events will occur:

- Seabed discharges during routine drilling of the geotechnical hole (planned at four locations) the 42" and 32" holes, and during failure of the Mud Recovery System when drilling the 28" holes; and
- MODU discharges from the cuttings caisson during routine drilling of the the 28" holes and for discharge of residual mud.

Table 9.11 Summary of Drilling Discharges per Hole

Discharge location	Hole Size	Description	Drilling Fluid/ Mud System	Estimated Fluids (Tonnes)	Estimated Cuttings (Tonnes)	Comment
Seabed	12$^{1}/_{4}$"	Pilot hole	WBM	1,015	50	Planned at 4 locations
	9"	Geotechnical hole		1,930	75	
	42"	Conductor and Surface Holes	Seawater & PHB sweeps	1,339	443	16 wells planned
	32"			1,339	442	
MODU cuttings caisson	28"	Surface Hole	WBM	522	729	
	Residual Mud	At the end of geotechnical hole drilling	WBM	495	0	
		At end of 28" hole drilling		943	0	

The anticipated composition and function of the fluids discharged are provided within Table 9.13 below**.**

Seabed levelling work may be required at all drilling location to remove accumulation of drill cuttings and cement, involving either mechanical excavation or jetting with seawater. The potential impacts of remedial work are considered to be comparable or less than those impacts described on Section 9.4.2 and 9.4.3 and are not discussed further.

Assessment

The dispersion and deposition of WBM drilling discharges has been comprehensively modelled for a number of previous Shah Deniz Wells. The modelling covers drilling conditions and water depth ranges appropriate to all of the SD2 Project well locations and have informed the assessment of cuttings deposition within this section.

Seabed Discharges

Cuttings discharged directly to the seabed will be subject to the limited influences of water depth and current. Previous modelling has shown that 90% of the cuttings will accumulate in a primary mound within 15-30m of the well head, and that deposition to a depth of more than 10cm would be limited to a radius of less than 40m from the wellhead.

Based on previous modelling undertaken for a similar volume of discharge it is anticipated that the cuttings piles will result in a maximum deposition thickness ranging from 10.6-11.7m, a primary mound formed within 15m, and a maximum extent to the 1mm contour of approximately 95m.

At each location, the wells will be located within 25m of each other and of the manifold. Deposits arising from seabed discharges of fluids and cuttings from each well will therefore overlap to some extent, although the depth of deposit in areas of overlap will be only a few millimetres.

The volume of cuttings discharged during drilling of the geotechnical holes will be small compared to the discharges associated with the tophole sections, and the cuttings will settle within a very small area. The volume of drilling fluid discharges is larger, and similar in magnitude to that generated during drilling of the 42” and 32” sections; the potential impacts of discharge of WBM direct to seabed are discussed in more detail below.

During failure of the MRS, resultant mud discharges at the seabed will require a dilution of 2 fold to meet the PSA salinity requirement and a dilution of 8 fold to reach ambient chloride concentrations.

MODU Discharges from Cuttings Caisson

The water depths in which cuttings and mud discharges will occur range from 66-88m at the NF location to 530-557m at the ES location. To assess the area over which cuttings and mud would be deposited, discharges at both these extremes of depth were modelled. In each case, this included deposition from a single well, and cumulative deposition from the maximum of 6 wells in each cluster. It should be noted, however, that it is not planned to drill all wells sequentially at any cluster. Some wells will be completed, tied in and producing before subsequent wells are drilled, and the cuttings deposited from earlier wells will, if necessary, be levelled to enable subsea infrastructure to be installed.

Modelling was based on the expected discharges from cuttings caisson during 28” hole drilling (522 tonnes of drilling fluid with 729 tonnes of cuttings) and up to 943 tonnes of drilling fluid at the end of the 28” hole section. The results of the modelling at the NF and ES locations for 1 well and 6 well discharges scenarios are presented in Figures 9.6 to 9.9. The results are summarised within Table 9.12.

Table 9.12 Approximate Extent of Cuttings Deposition to 1mm Depth and Maximum Depth of Deposition for NF and ES MODU Drilling Discharges (1 and 6 Well Scenarios)

Drilling Location	Water Depth	Approximate Extent of Cuttings Deposition to 1mm Depth		Maximum Depth of Deposition	
		1 well	6 wells	1 well	6 wells
NF	66-88m	100x100m	100x250m	775mm	1200mm
ES	530-557m	100x150m	200x400m	375mm	900mm

As Figures 9.6 to 9.9 show while the deposition areas increase with greater water depth, the maximum depth of deposition decreases. This effect is partly offset by weaker currents in the southern part of the Contract Area (where ES is located). The modelling shows that the maximum worst case area of impact (to the 1mm depth) is approximately 80,000m^2.

Figure 9.6 Deposition Thickness from MODU Drilling Discharge in NF Location (1 Well)

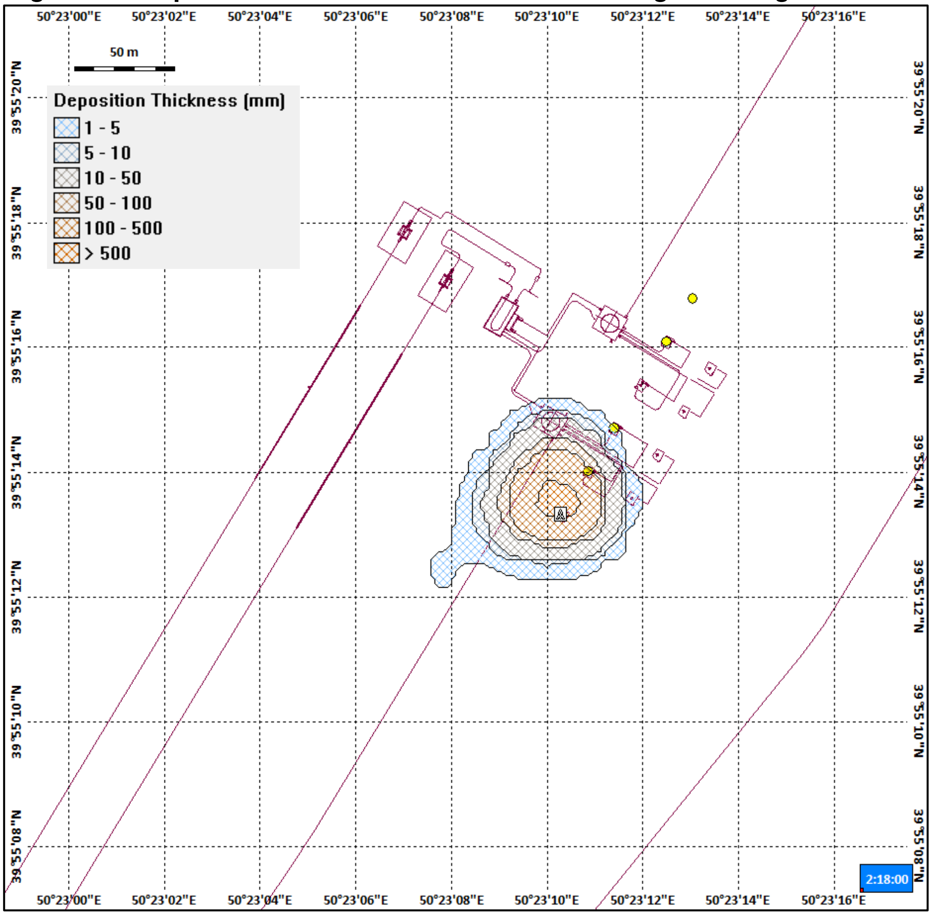


Figure 9.7 Deposition Thickness from MODU Drilling Discharge in NF Location (6 Wells)

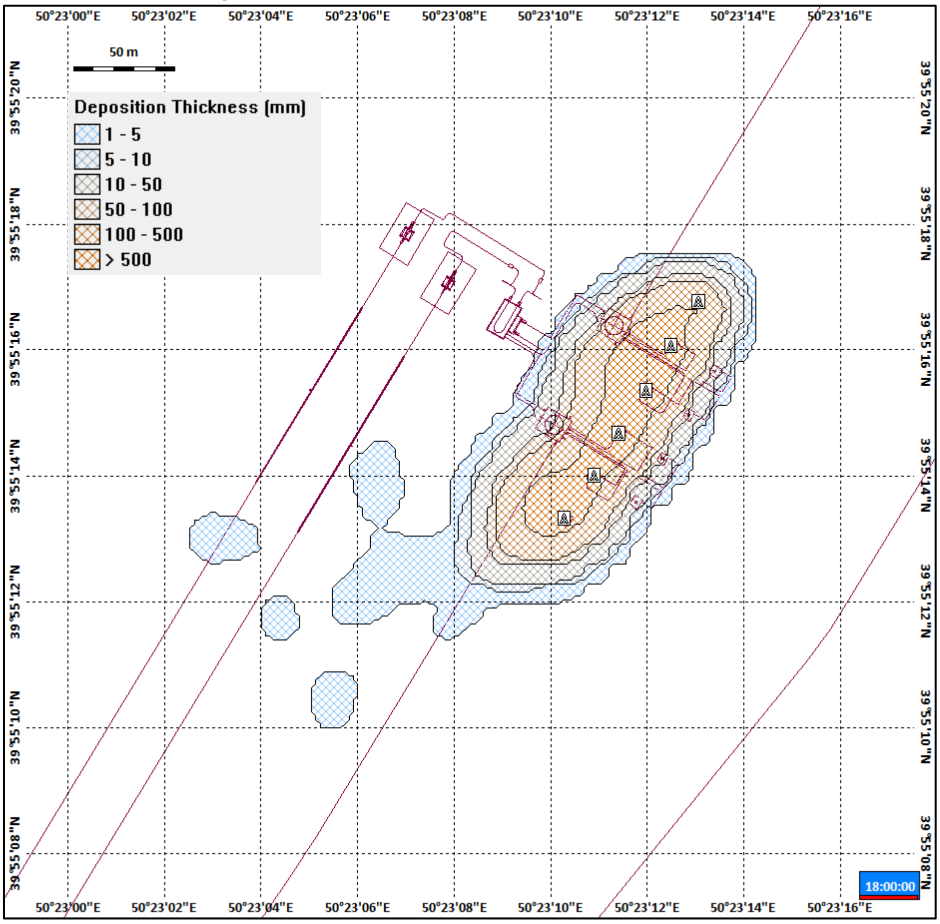


Figure 9.8 Deposition Thickness from MODU Drilling Discharge in ES Location (1 Well)

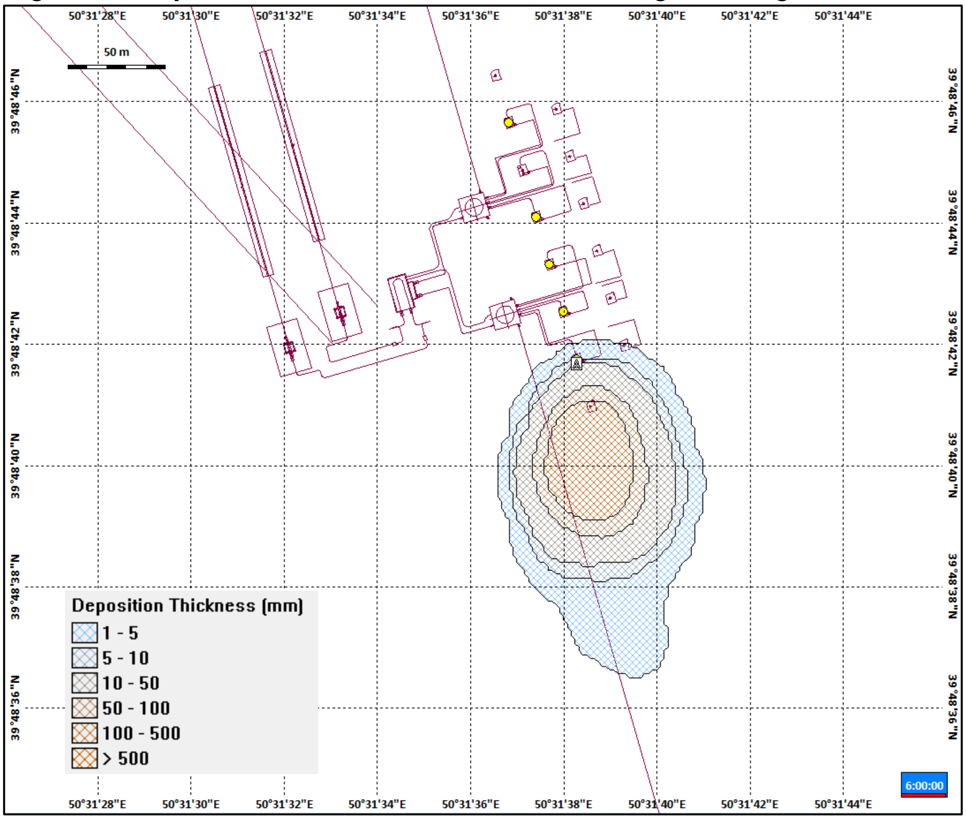
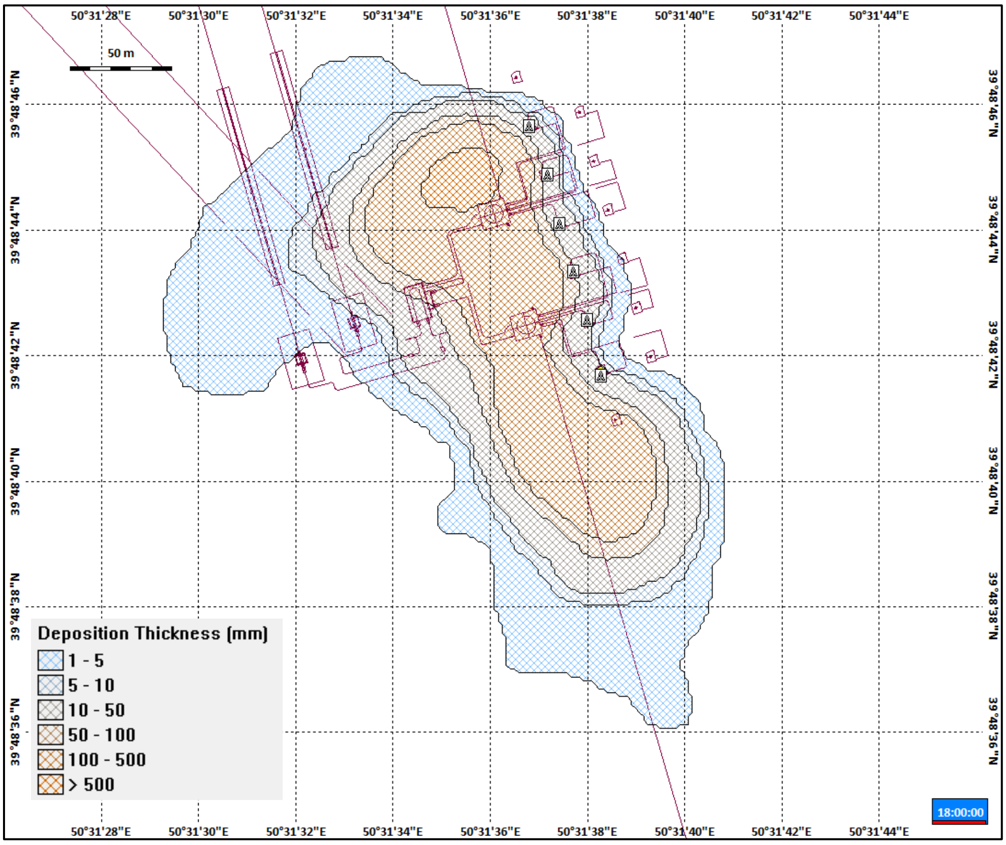


Figure 9.9 Deposition Thickness from MODU Drilling Discharge in ES Location (6 Wells)



Direct Observation and Measurement

BP have accumulated a substantial amount of direct observational data derived from post-drilling environmental surveys conducted around existing operational facilities in both the SD and ACG Contract Areas. These studies provide direct evidence of the environmental effects of discharges arising from the drilling of multiple wells (up to 20 in the case of ACG platforms) at a single location.

In each case, chemical analysis of sediments has shown a detectable barium footprint extending out to approximately 500m from the platforms. This observation is consistent with the modelling predictions which indicated that barite will be transported further than other mud and cuttings components. However, there is no evidence of any ecological effects associated with the barite footprint, and the monitoring evidence available to date indicates that the discharge of WBM-drilled cuttings is not creating any adverse effects on the benthic invertebrate communities at distances of more than 250m from the platforms (for safety reasons, it is not possible to conduct routine environmental surveys within a 250m exclusion radius).

Drilling discharges are assigned an intensity score of 1 for the following reasons:

- A substantial proportion (at least 30%) of the discharges consists of inert geological material (the cuttings);
- The drilling fluid components are inert or of very low toxicity;
- Only the solid, inert components of the drilling mud will settle to the seabed. Low toxicity soluble components, such as potassium chloride and minor additives, will dilute and disperse in the water column and will have neither acute or persistent effects;
- Evidence from monitoring in the vicinity of drilling operations where WBM cuttings have been discharged shows that there is no accumulation of drilling additives and only a

very small effect on the benthos within the 'footprint' of the discharge (up to 500m from the drilling location); and

- The drilling fluids have been the subject of comprehensive testing and assessment and have been approved for use by the MENR for existing operations.

Mud Composition and Toxicity

The approximate composition of the proposed WBM to be used for drilling the SD2 Project wells together with a brief summary of the environmental fate and effects of each component, is summarised in Table 9.13.

Table 9.13 Approximate Composition and Environmental Fate of WBM

Chemical	Function	Hazard Category	Environmental Fate and Effects
Barite	Weighting Agent	E	Dense, fine powder. Will settle to seabed. Not considered environmentally hazardous
Bentonite	Viscosifier	E	Inert clay. Not considered environmentally hazardous
Soda Ash	Alkalinity Control	E	Water soluble. Will disperse in water column. Not considered harmful.
Poly Anionic Cellulose	Water soluble polymer designed to control fluid loss	E	Low toxicity and degradable. Water soluble and will disperse rapidly
Xanthan Gum	Viscosfier	E	Natural substance. Non-toxic and biodegradable. Water-soluble and will disperse in water column.
Nut Shells	LCM/Pipe scouring	E	Natural organic material, not considered environmentally harmful, Will settle slowly to seabed, dispersed over wide area.
Salts (KCl)	Borehole stabiliser / shale inhibitor	E	Natural inorganic substance. Not considered environmentally harmful, will disperse rapidly in water column
Poly Ether Amine/Poly Ether Amine Acetate Blend	Shale Inhibitor	GOLD	UK HOCNS classification of GOLD – low toxicity and low persistence
Aliphatic Terpolymer	Anti-accretion additive	GOLD	UK HOCNS classification of GOLD – low toxicity and low persistence
Ester/Alkenes C15-C18 Blend	Shale Encapsulator	GOLD	UK HOCNS classification of GOLD – low toxicity and low persistence
Polypropylene Fibres	Hole cleaning agent	GOLD	UK HOCNS GOLD classification – low toxicity and inert

Toxicity tests were conducted on the proposed water-based mud formulations in 2007 using Caspian zooplankton, phytoplankton and sediment-dwelling species. Toxicity was assessed in the water column and sediment[7]. The results are summarised in Table 9.14. The estimated acute toxicity levels would require dilution of WBM, discharged from the MODU in accordance with PSA chloride concentration requirements, by a factor of between 31- and 62-fold (depending on the mud composition). The relevant dilution factor would be reached very rapidly following the WBM discharge and the plume of the discharge would be very small, quickly dispersing. The concentrations within Table 9.14 would likely persist only for the duration of each discharge.

[7] The species tested were: Zooplankton: *Calanipeda aquae dulcis;* Phytoplankton: *Chaetoceros tenuissimus* and Sediment: *Pontogammarus maeoticus.*

Table 9.14 Seawater Sweeps and Water Based Mud Toxicity Tests (2007)

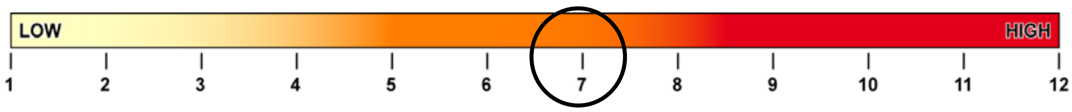
Mud Type	Water Column		Sediment
	ZooPlankton 48h LC_{50} [1] (mg/l)	Phytoplankton 72h EC_{50} [2] (mg/l)	Amphipod 96h LC_{50} [1] (mg/kg)
Seawater sweeps (42" and 32" sections)	>32000	>32000	>32000
KCl mud (28" section)	>10000	>32000	>32000
Ultradril WBM (28" section)	>32000	15591	>32000

Notes
1. LC50 - Lethal Concentration 50 is the estimated concentration of a substance required to cause death in 50% of the test organisms in a specified time period.
2. EC50 - Effective Concentration 50 is the concentration of a substance that has a specified non-lethal effect on half of the test organisms within a specified period of time. Effects measured are often number of young produced, time to reproduction, etc. In the case of phytoplankton, it is the concentration at which growth rate is reduced by 50%.

Table 9.15 presents the justification for assigning a score of 7, which represents a Medium Event Magnitude.

Table 9.15 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Modelling indicates potential for cuttings deposition (from 6 wells in the ES location) over an area of 200 by 400m. Monitoring has shown evidence of cuttings at distances of up to 500m for drilling of other ACG/SD wells.	1
Frequency	Discharges of WBM and associated cuttings will occur once for each hole section.	2
Duration	Total duration of discharge is approximately 800 hours.	3
Intensity	Drilling discharges are considered to be of low intensity due to the composition and evidence from post well surveys of no accumulation of drilling additives and previous toxicity tests.	1
Total		**7**



9.4.2.3 Receptor Sensitivity

Seals and Fish

Drilling discharges will generate turbid plumes of limited duration and dimension, as indicated above. These plumes will not however, generate chemical contamination of the water column and will not occupy a significant proportion of the local water column. It is anticipated that both fish and seals will avoid the plumes.

Table 9.16 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.16 Receptor Sensitivity (Seals and Fish)

Parameter	Explanation	Rating
Resilience	Possibility that species may be temporarily affected by drilling discharges but effect would be short term and limited and ecological functionality will be maintained.	1
Presence	Fish species including kilka and mullet will be present in the Contract Area throughout the year with other species present during migratory periods. However, the Contract Area is not exclusively used by these species and is not considered to be of primary importance for these species.	1
Total		**2**

Plankton

As for fish and seals, the principal potential interaction of drilling discharges with plankton is via the intermittent presence of short-duration turbidity plumes. Discharges from the MODU will normally take place at a depth of 10m, which is within the plankton productive zone present during spring, summer and early autumn. Cuttings will however, sink rapidly and will not impact a large volume of the productive zone. Unlike fish and seals, zooplankton cannot avoid turbidity plumes, but the dimension of the plume is sufficiently small that the “residence time” of individual organisms within the plume will be too short to cause significant harm. None of the plankton species currently present, or historically present, are rare or unique on a regional basis, and there are no observable regional variations across the Contract Area.

Plankton has high reproductive rates during spring, summer and autumn and localised populations tend to develop in patches in response to food availability. The development of patches is limited both by local nutrient availability and by zooplankton grazing. Phytoplankton species are therefore well adapted to rapidly changing conditions. These patches then decline as local food resources are depleted. Consequently, plankton will be highly resilient to the effects of drilling discharges.

Table 9.17 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.17 Receptor Sensitivity (Plankton)

Parameter	Explanation	Rating
Resilience	Species or community unaffected or marginally affected.	1
Presence	Species not rare or unique on a regional basis. Species are assessed at the community level only.	1
Total		**2**

Benthic Invertebrates

The benthic invertebrate communities in the vicinity of the NF and WF manifold locations are very similar to those across the rest of the Contract Area and the Azerbaijan sector of the South Caspian. There are no rare, unique or endangered species present.

The benthic community, at the shallower depth of the NF and WF locations, is dominated by native amphipod, gastropod, polychaete and oligochaete species, most of which have the potential to reproduce several times a year. With the exception of some bivalves, the dominant taxa are deposit feeders which routinely construct burrows to a depth of 10cm or more (this is why field surveys take samples to a depth of 10-15cm). These species are physiologically equipped to construct new burrows through cuttings material deposited in layers of at least similar depth to that which they routinely penetrate during normal burrowing activity. Routine platform monitoring studies undertaken as part of the EMP provides support for the conclusion that burrowing species can penetrate deposited cuttings, by demonstrating the presence of such organisms in samples taken at locations where barite concentrations indicate the presence of significant amounts of cuttings. In addition the cuttings will be of a similar particle size to their natural sediment, and unlike filter feeders, deposit feeders will not suffer from the clogging of feeding appendages.

The benthic invertebrate community at the ES manifold location is, in contrast, very limited in both species diversity and individual abundance. This is, predominantly, a reflection of the water depth at this location (530-557m). The EN and WS locations lie in water depth ranges of 456-480m and 407-420 m respectively. The benthic community at the EN location is, like the ES location, almost abiotic, with only a small number of species and very few individuals. At the slightly shallower WS location, ten taxa were recorded during the baseline survey, but only two species were present throughout the survey area and abundance was extremely low. At the depths at which all three manifold locations are situated, oxygen levels are often much lower than in surface water, and the community is therefore restricted to, and dominated by, oligochaete species which are tolerant of the comparatively stressful conditions.

Table 9.18 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.18 Receptor Sensitivity (Benthic Invertebrates)

Parameter	Explanation	Rating
Resilience	Species or community unaffected or marginally affected.	1
Presence	No rare, unique or endangered species present. Species are assessed at the community level only.	1
Total		**2**

9.4.2.4 Impact Significance

Table 9.19 summarises impacts to biological/ecological receptors associated with drilling discharges to sea.

Table 9.19 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Drilling Discharges to Sea	Medium	(Seals & Fish) Low	**Minor Negative**
		(Plankton) Low	**Minor Negative**
		(Benthic Invertebrates) Low	**Minor Negative**

Based on the findings from the surveys as reported in detail within Chapter 6: Environmental Description, very limited impact on benthic communities has been observed from existing drilling discharges associated with pre-drilling activities and the SD Alpha platform.

Monitoring and reporting requirements associated with drilling discharges to the sea during MODU drilling, completion and intervention activities include followings:

- Should the composition of the mud system be altered during the drilling programme to meet the drilling requirements the Management of Change Process will be followed

(Chapter 5 Section 5.16). As a minimum, tests in accordance with Caspian Specific Ecotoxicity Procedures will be undertaken if the WBM system is changed and the results submitted to the MENR;
- Each batch of barite supplied for use in WBM will be tested by the supplier to confirm cadmium and mercury content;
- When WBM and cuttings are discharged from the MODU the chloride concentrations will be analysed twice a day;
- Volumes and composition of WBM and cuttings discharged at the end of each well section and chloride concentrations will be recorded daily during discharge events;
- Monitoring of potential effects on seabed and benthic communities will be carried out in accordance with the EMP. EMP monitoring results will be submitted to the MENR on an annual basis; and
- The End of Well Environmental Report submitted to the MENR following the completion of activities/well abandonment will include the following relevant to drilling discharges:
    - Volumes of drill cuttings and drilling fluids discharged;
    - Volume of drilling chemicals used;
    - Chloride concentrations of discharged drilling fluids; and
    - Mud type and mud system associated with discharged drilling fluids and associated chemical names and OCNS categories as appropriate.

These requirements are incorporated into the Environmental Management System (EMS) for each MODU, which is aligned to the AGT Region EMS as described within Chapter 14 Section 14.5 of this ESIA.

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures and no additional mitigation is required.

9.4.3 Cement Discharges

As discussed within Chapter 5 Sections 5.4.2.6 and 5.4.9.2 it is expected that cement will be discharged to the marine environment during the cementing of the all hole sections and during plugging of the geotechnical holes. In addition it is expected that excess cement will be discharged from the MODU following the completion of these activities.

9.4.3.1 Mitigation

Existing controls associated with cement during drilling and completion activities include:

- Cementing chemicals used during MODU drilling activities will be of low toxicity (UK HOCNS “Gold” and “E” category or equivalent toxicity);
- Cement is designed to set in a marine environment preventing widespread dispersion;
- The volume of cement used to cement each casing will be calculated prior to the start of the activity. Sufficient cement will be used to ensure that the casing is cemented securely and necessary formations isolated so that this safety and production critical activity is completed effectively while minimising excess cement discharges to the sea; and
- Periodic ROV surveys will be undertaken during drilling activities including cementing; Excess cement at the seabed will be observed and corrective action will be taken, if required, to ensure cement discharges are minimised.

9.4.3.2 Event Magnitude

Description

Cementing discharges will occur during drilling from two types of activity:

- During the cementing of successive well casings, plugging of geotechnical hole and grouting of wellhead brace, although cement discharges from grouting of wellhead brace is expected to be insignificant.

A riserless MRS will be used following the cementing of the 28” hole section which will enable the majority of excess cement to be returned to the MODU. Cement discharged from the 42” and 32” hole sections will discharged directly to the seabed. The event duration will be approximately one hour per casing; and

- Cement discharges will also occur from wash out activities where cement remaining in the cement unit and associated hoses will be slurrified with water (approximately 10:1 dilution), and will be discharged from each MODU via a hose located below the sea surface. The slurry will be discharged at a rate of approximately 8 barrels (1.3 m^3) per minute, for a period not exceeding one hour per discharge. This rate of discharge is equivalent to approximately 250kg of cement per minute.

Assessment

Cement Discharges to Seabed

Cement discharged at the seabed is not expected to disperse (being designed to set in a marine environment) and will therefore set *in-situ*. It is not anticipated that there will be any chemical releases from the cement, which will be effectively chemically inert. The impact of cement discharge will therefore be limited to a small area immediately around the well.

For each well, a total of approximately 200.78 tonnes will be discharged directly to the seabed. Although this will occur in 3 separate events, the largest potential area of impact can be estimated by assuming that this volume forms a uniform shallow layer. If this layer is assumed to be 30cm deep, then the maximum radius to which the cement would extend would be about 9.5m, and the impact of seabed discharge would therefore be minimal, as this area would lie within the area previously impacted by cuttings discharge from the 42” and 32” hole sections.

Cement Discharges from Wash Out

The composition of the cement is described in detail in Table 2 of Appendix 5B; for all wells and hole sections, the principal component (representing between 63 and 95% of the cement by weight) is Class G cement, which is an environmentally inert solid. Other major components by weight are also inert – principally silicate and haematite. The total quantities of excess cement discharge for each well and hole section are summarised in Chapter 5 Table 5.7.

Discharge of slurry at a rate of 1.3m^3/min will generate a downward plume, initially at a velocity of 30-40cm/s. The discharge will consist only of class G cement, mixed with water.

The discharges will occur after any cement job including 28", 18", 16’’, 11 $^1/_4$", 10”x10$^3/_4$” liner & tieback as well as 36”, 22” and 13 $^3/_8$”x13 $^5/_8$” casing. They will last no more than one hour each, and the discharge and dispersion plumes will therefore be completely separated in time. This is assuming 2 plugs and 2 cement squeezes per well, which results in a total of 12 instances of cement clean-up discharges.

The discharges were modelled in order to establish the extent of any turbidity plume. Figure 9.10a and 9.10b illustrate the plan and elevation view of the plume 2 hours after the start of a discharge. At this point, particulate concentrations within the plume are in the 5-50 mg/l range, and therefore too low to have an adverse turbidity effect. The horizontal and vertical extents of the plume are approximately 150m and 10m respectively. Four hours after the start of the discharge, the modelling indicates that the plume will have completely dispersed to particulate concentrations of less than 5 mg/l.

Figure 9.10a Plan View of Cement Dispersion Plume 2 Hours after Start of Discharge

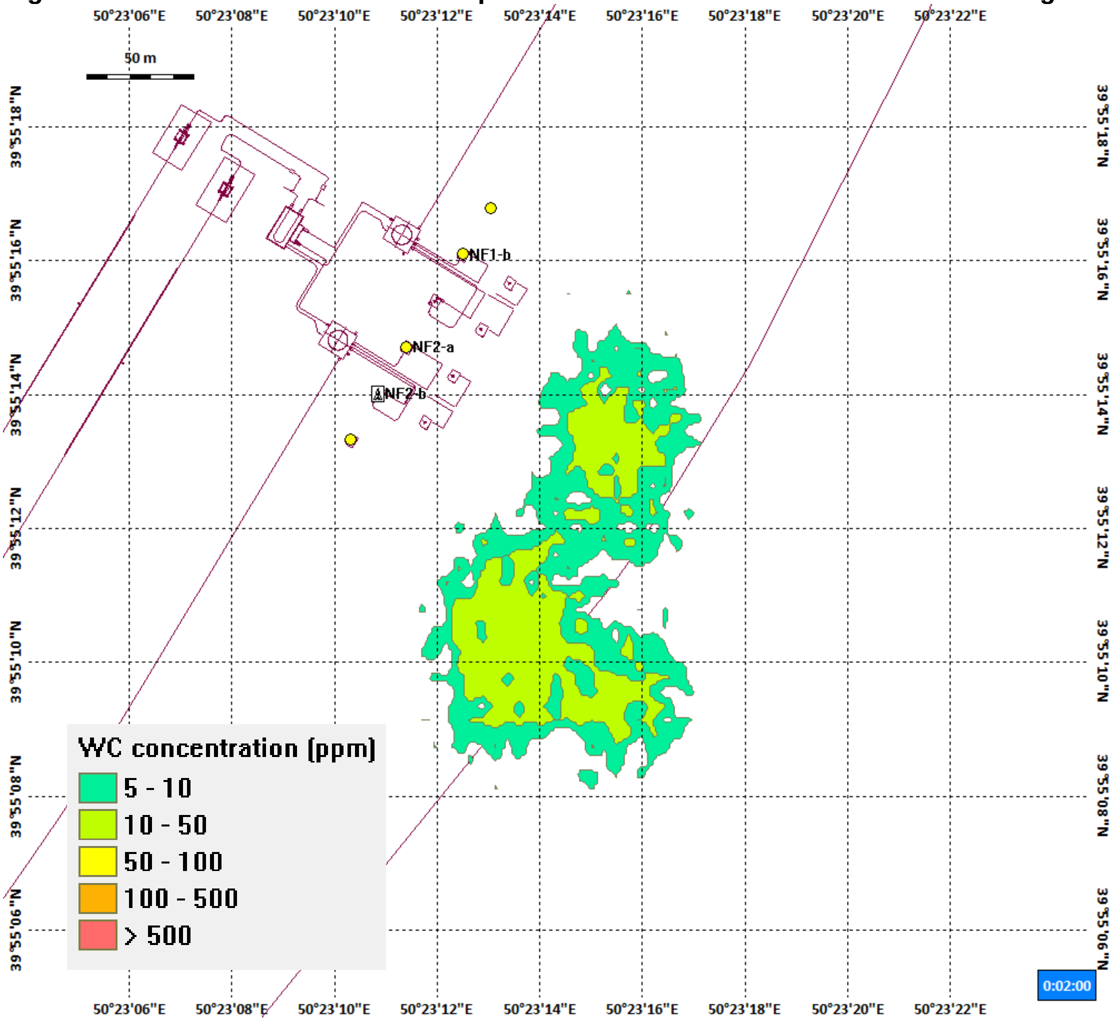
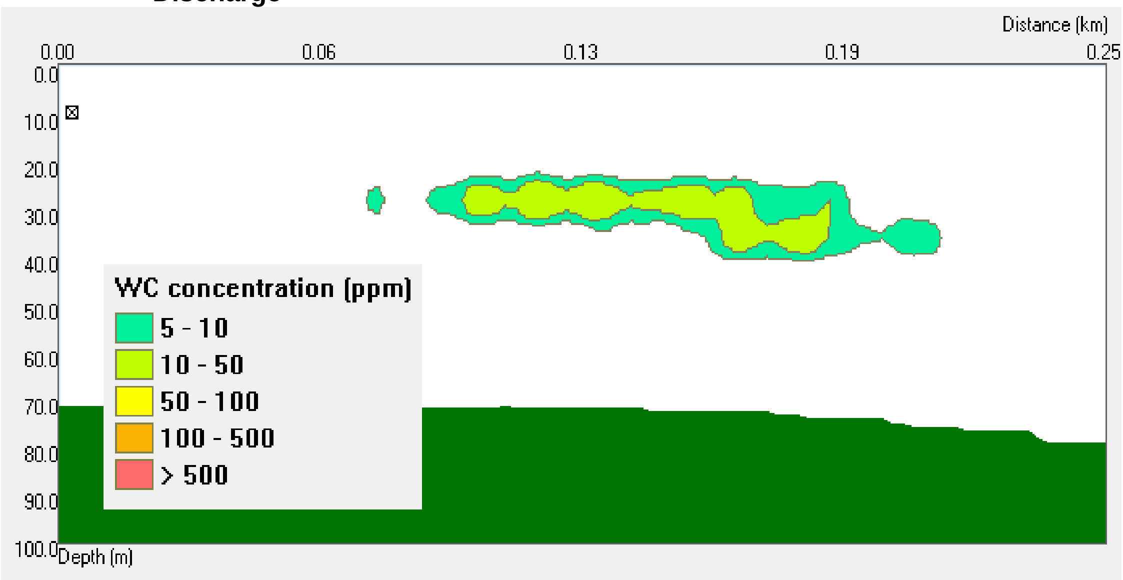


Figure 9.10b Elevation View of Cement Dispersion Plume 2 Hours after Start of Discharge

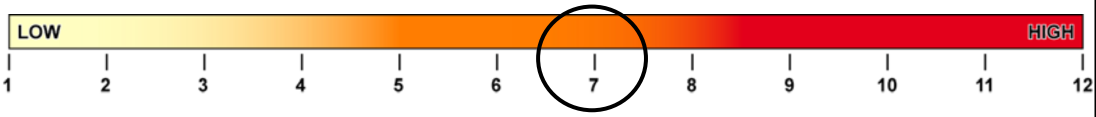


The modelling also indicated that less than 0.1% of the cement solids would be deposited on the seabed within 1.5km of the point of discharge, and that no significant seabed deposition would occur at any location.

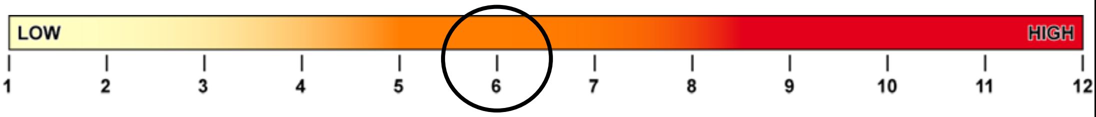
Table 9.20 presents the justification for assigning a score of 7 to cement discharges to seabed and 6 to cement discharges from wash out, which represents Medium Event Magnitudes

Table 9.20 Event Magnitude

Event Parameter	Cement Discharges to Seabed	Cement Discharges from Wash Out
Extent/Scale	1	1
Frequency	3	2
Duration	1	1
Intensity	2	2
Event Magnitude:	**7**	**6**



Cement Discharges to Seabed



Cement Discharges from Wash Out

9.4.3.3 Receptor Sensitivity

With regard to cement discharges to the seabed, these will be confined to a small area of seabed immediately around each well and no chemical releases are anticipated. Consequently, the only biological receptor is the benthic community. The cement deposits will not extend beyond the area occupied by the primary cuttings piles, and will therefore not give rise to any additional impact. The Receptor Sensitivity of all marine organisms to cement discharges is considered to be low and a score of 2 has been assigned in Table 9.21.

Table 9.21 Receptor Sensitivity (Benthic Invertebrates)

Parameter	Explanation	Rating
Resilience	No rare, unique or endangered species at significant risk of exposure, receptor confined to benthic community close to well.	1
Presence	Toxicity and persistence of cement components is low, and cement will set rapidly. Effects will be limited to physical covering of small area of benthos.	1
Total		**2**

With regard to cement discharges associated with wash out, the discharge will form a limited plume extending no more than 150m, comprising settling solids and soluble, low-toxicity chemicals. The quantity of solids is low compared to a WBM discharge, and will not cause significant turbidity or significant deposits on the seabed. The soluble chemical constituents are of low toxicity and low persistence, and will dilute rapidly, with minimal impact on fish and plankton.

Table 9.22 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.22 Receptor Sensitivity (Seals and Fish/ Zooplankton/ Phytoplankton)

Parameter	Explanation	Rating
Resilience	No rare, unique or endangered species at significant risk of exposure.	1
Presence	Toxicity and persistence of cement components is low, and cement will settle (solids) or disperse (soluble components) rapidly. Receptors present only within limited plume which is of limited persistence.	1
Total		**2**

9.4.3.4 Impact Significance

Table 9.23 summarises impacts to benthic invertebrates, seals and fish, zooplankton and phytoplankton associated with cement discharges to seabed and associated with washing of the cement unit.

Table 9.23 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Cement discharges to seabed	Medium	(Benthic Invertebrates) Low	**Minor Negative**
Cement unit washing discharges	Medium	(Seals & Fish/ Zooplankton/ Phytoplankton) Low	**Minor Negative**

The assessment has demonstrated that a Minor Negative impact to benthic invertebrates is predicted from cement discharges to seabed and cement unit washing discharges. Cement chemicals are designed to be of low toxicity, chemically inert and to set in a marine environment. Only the seabed in the immediate vicinity of the well will be affected by cement discharges to seabed.

With regard to cement unit washing discharges, the solids within the discharge will settle over a large area, but the quantities are small compared to drilling mud discharges, and will make no observable difference to existing seabed impacts. Effects in the water column will be minor, and will be restricted to within a short distance (less than 150m) from the point of discharge. Both solids and chemical dispersion plumes will disperse rapidly following cessation of discharge, and therefore:

- No single discharge event will have a marked impact; and
- The successive discharge events at any well will not overlap and will not have cumulative Impact.

Mandatory monitoring and reporting requirements associated with cement discharges to the sea during MODU drilling, completion and intervention activities include:

- Monitoring of potential effects on seabed and benthic communities will be carried out in accordance with the EMP. EMP monitoring results are submitted to the MENR on an annual basis; and
- The volume of cementing chemicals used and discharged will be recorded daily and included within the End of Well Environmental Report submitted to the MENR following well drilling and cementing activities/well abandonment.

These requirements are incorporated into the Environmental Management System (EMS) for each MODU, which is aligned to the AGT Region EMS as described within Chapter 14 Section 14.5 of this ESIA.

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures and no additional mitigation is required.

9.4.4 BOP Testing

9.4.4.1 Event Magnitude

Description

As described with Chapter 5 Section 5.4.4 a blow out preventer (BOP) will be installed on all wells to control pressure in the well prior to installation of the well production facilities. The BOP will be tested weekly for safety reasons, resulting in discharge of control fluids to sea. The anticipated discharges and duration of each event is detailed within Table 5.10. In total a discharge of 2,052 litres of BOP fluid over a period of 13.8 minutes is estimated for each 2 pod test. Single pod testing results in discharges of 1,026 litres. Single and 2 pod tests are undertaken on alternate weeks through the drilling and completion programme.

The BOP fluid comprises a proprietary control fluid (Stack Magic ECO Fv2), propylene glycol and water. The active components of Stack Magic ECO Fv2 and the typical proportions of this product, propylene glycol and water in the BOP fluid as a whole are summarised in Table 5.9. Since the proportions of components can vary, the impact assessment is based on the highest proportions of each (indicated in bold in Table 5.9).

Assessment

An ecotoxicological risk assessment of the discharge has been undertaken. This is based on available data on the aquatic toxicity of the product and of the components of the overall BOP fluid. No data are available for the acute toxicity of either the product or of the whole BOP fluid. Accordingly, two surrogate sources of data have been used:

- Results of chronic tests on the product, conducted to US Environmental Protection Agency (EPA) requirements for the Western Gulf of Mexico; and
- Literature values for the acute toxicity of the individual chemical components.

The US EPA test results (growth tests on mysid shrimp and fish) reported no effect at a whole product concentration of 200 mg/l. These results do not take into account the contribution of propylene glycol to the overall toxicity of the BOP fluid.

In order to estimate overall BOP fluid toxicity, it has been assumed that the product LC_{50} is ten times the chronic no-effect value. This is based on the risk assessment convention of applying a safety factor of 10 to acute toxicity data (for short-duration discharges). Literature data cover a wide range of methodologies and test organisms, and consequently the data used can only be considered to represent the correct order of magnitude. The process of estimating mixture toxicity from individual component values also limits precision, as it is necessary to assume simple additivity of toxicity.

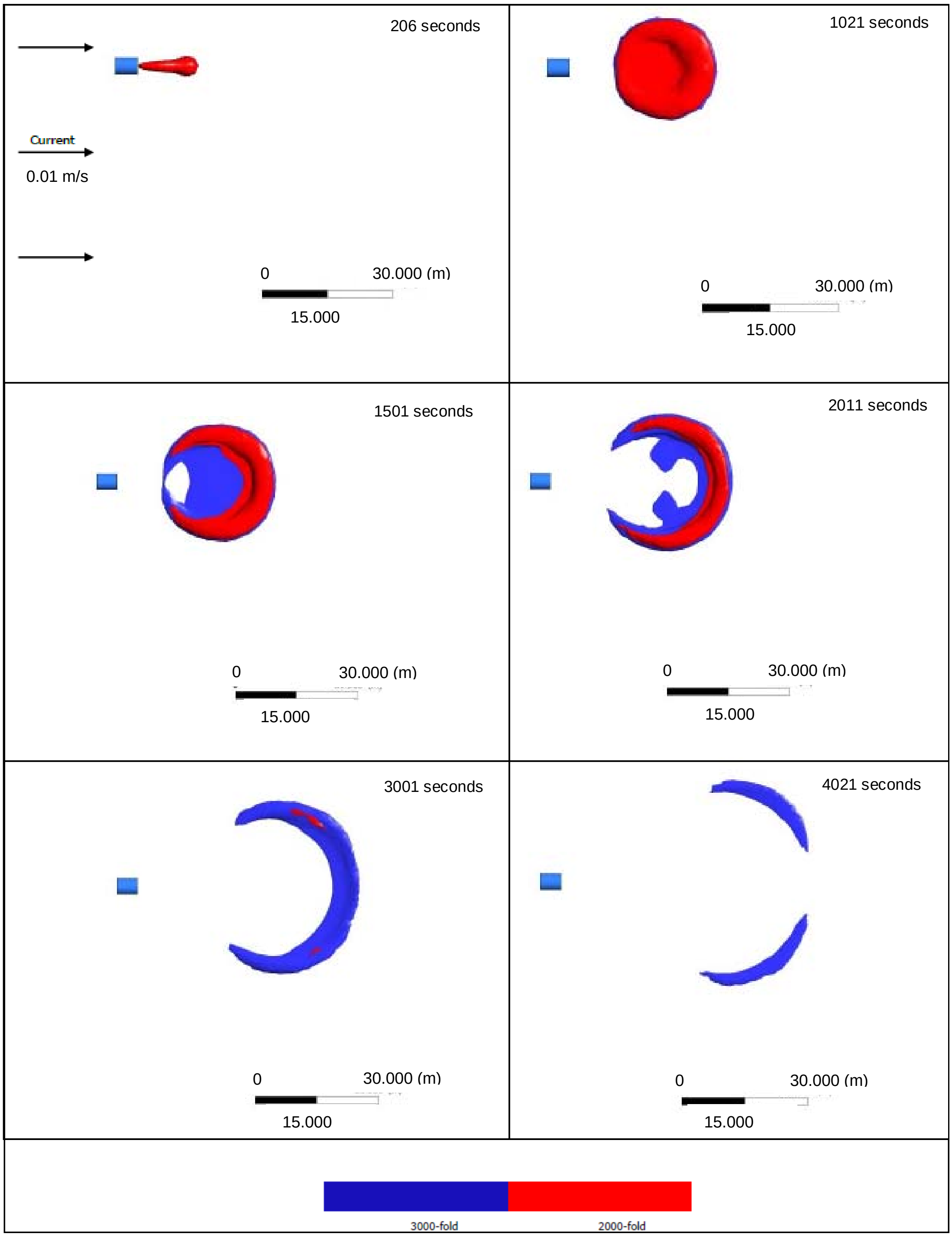
Although propylene glycol is of very low toxicity (LC_{50}s >10,000 mg/l), it can represent a substantial fraction of the BOP fluid (up to 25%, see Table 5.9), and it is estimated that for this reason its contribution to toxicity will be similar to that of Stack Magic ECO Fv2.

Estimated BOP fluid toxicity (LC_{50}) ranged from approximately 18,000 mg/l (based on US EPA and propylene glycol data) to approximately 15,000 mg/l (based on component and propylene glycol data).

For short-duration discharges, the risk assessment convention is to apply a safety factor of 10 to acute toxicity data; consequently, the BOP fluid no-effect concentration is estimated to be between 1,500 and 1,800 mg/l. To reach these concentrations, a discharge would require dilution of between 550 and 650-fold. However, to make allowance for uncertainty in the estimation of toxicity, as a conservative estimate, the required no-effect dilution is assumed to be between 2,000- and 3000-fold.

The dispersion of the discharges in Table 5.10 was modelled, to enable the dimensions and persistence of the dispersion plumes to be quantified and visualised. For the purpose of visualisation, the plumes were modelled and displayed separately. Four scenarios, representing the range of volumes and discharge velocities, were each modelled for two current velocities (0.01 and 0.1 m/s). In practice, the degree of independence of the plumes will depend on the interval between each individual operation; if this interval is less than the persistence time of the plume from the preceding operation, then the plumes will be contiguous. Contiguity of plumes will affect the maximum volume, but will not affect either plume width or maximum displacement from the BOP. Figure 9.11 graphically illustrates the plume development and dissipation for largest discharge i.e. upper annular discharge of 654 litres over 3 minutes.

Figure 9.11 Upper Annular Discharge at Near-Stagnant (0.01m/s) Current Velocity



The assessment concluded:

- For the largest discharge, maximum plume persistence was approximately 77 minutes, with maximum width and length of 51 and 81m respectively, and maximum displacement of 98m;
- For the smallest discharges (20 litres over 0.5 minutes), plume persistence to a dilution of 3000-fold ranged between approximately 3 and 12 minutes, with maximum width and length of 5m and 7m respectively, and maximum displacement of 13m; and

- For the intermediate volume (lower pipe ram discharge of 70 litres over 1.16 minutes), plume persistence was approximately 15 minutes, with maximum width and length of 26m and 37m respectively, and maximum displacement of 37m.

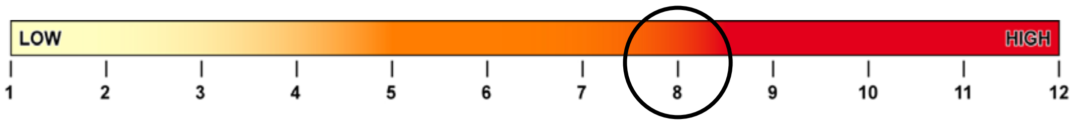
In all cases, plumes were narrower, longer and of shorter persistence at typical (0.1m/s) current velocity than at near-stagnant (0.01m/s) current velocity. For discrete discharges each plume ‘detaches’ from the BOP and disperses as it is displaced down-current. If the discharges were closely spaced in time, a continuous plume would develop which would only detach after the last operation had been completed. Whilst variation in the dimensions of the plume would depend on the order in which the operations took place, the maximum dimensions indicated above would not be affected. For practical purposes, therefore, the maximum area within which the discharge dilution would transiently be less than 3000-fold would be 51m wide and 98m long, and overall persistence would equal the total duration of the flushing operations plus no more than 1.5 hours.

The components of the control fluid and propylene glycol are all readily degradable, and the product has passed US EPA standards and has been assigned a UK Offshore Chemical Notification Scheme (OCNS) category D (rated A-E where E is the least environmental harmful). As this product has an LC_{50} between 10 and 100ppm, it can be assumed that this product is inherently biodegradable (20-60% in 28 days) and is non-bioaccumulative. The area of potential impact has been very conservatively assessed on the basis of information on toxicity tests which are of much longer duration (2 - 7 days) than the duration of the discharges (up to 17 minutes per BOP). Consequently, and taking into account both the limited area of potential impact and the very short duration of the operations, BOP fluid flushing is considered to be a low intensity activity.

Table 9.24 presents the justification for assigning a score of 8, which represents a Medium Event Magnitude.

Table 9.24 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Affects an area less than 500m from source.	1
Frequency	Discharge will occur weekly	3
Duration	Discharge will occur for the duration of the drilling programme (9 months).	3
Intensity	Low intensity.	1
Total		**8**



9.4.4.2 Receptor Sensitivity

The discharges will take place approximately 8m above the seabed. No human receptors are present, and seals are not considered at risk of exposure due to the small size of the area of potential impact and the fact that dermal contact at the dilutions modelled would be very limited. Fish and zooplankton are most likely to be exposed, but neither category of organism is likely to be present in abundance at the discharge location during the very short period of discharge and plume persistence. There are no viable phytoplankton communities or macroalgae present at the discharge location.

For horizontal discharges (depending on the rig used, discharges will either be horizontal or vertical), it is possible that one or more plumes might transiently contact the seabed. However, the contact period and area would be insufficient to promote permeation of the sediment by the fluid components, and the exposure of benthic organisms would, overall, be less than the exposure of fish or zooplankton.

Table 9.25 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.25 Receptor Sensitivity (All Receptors)

Parameter	Explanation	Rating
Resilience	Exposure is low and of short duration, so resilience is, in effect, high.	1
Presence	No significant presence of rare, unique or endangered species.	1
Total		**2**

9.4.4.3 Impact Significance

Table 9.26 summarises the impact of BOP fluid discharge to sea on seals, fish, zooplankton and benthos based on the impact significance criteria presented in Chapter 3: Impact Assessment Methodology.

Table 9.26 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
BOP testing discharges to sea	Medium	(Seals) Low	**Minor Negative**
		(Fish & Zooplankton) Low	**Minor Negative**
		(Phytoplankton & Benthos) Low	**Minor Negative**

The assessment has demonstrated that Minor Negative impacts to seals, fish, zooplankton and benthos are predicted from BOP fluid discharge during the drilling programme.

Monitoring and reporting requirements associated with BOP discharges include:

- A program of BOP fluid sampling every 6 months from each MODU and ecotoxicity testing, involving phytoplankton and zooplankton, will be implemented during the drilling program.

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures and no additional mitigation is required.

9.4.5 Cooling Water Intake and Discharge

Cooling water will be continuously uplifted and discharged during MODU drilling activities onboard both MODU.

9.4.5.1 Mitigation

Existing controls related to MODU cooling water intake and discharge include:

- The design and operation of the cooling water system has been reviewed. The temperature at the edge of the cooling water mixing zone (assumed to be 100m from the discharge point) will be no greater than 3 degrees above ambient water temperature; and
- The MODU seawater intake design will include the use of a screen mesh to prevent fish entrainment.

9.4.5.2 Event Magnitude

Description

The intake/discharge rate on the Istiglal rig will be up to 630m^3 per hour. Water will be lifted from a depth of 9.8 m and discharged via a caisson 12.5m below sea level (depending on draft) and at a maximum temperature of 30^{o}C (during summer). The Istiglal secondary cooling system is protected by a standard anodic corrosion control system.

The Heydar Aliyev normally operates two seawater pumps, each rated at 480m^3 per hour, at 90-100% capacity.

Assessment

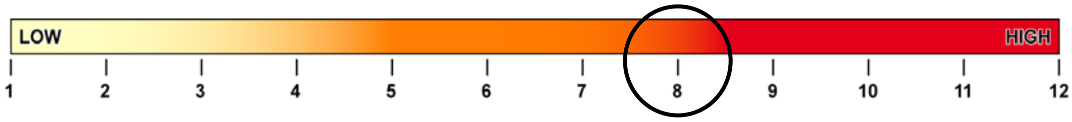
For the Istiglal rig as the intake depth is shallow it is anticipated that the lifted water will be at the same ambient temperature as the receiving water at all times of the year. The discharge temperature will be no more than 4-5^{o}C above ambient temperature. It was concluded that the discharge would require dilution by less than a factor 2 to meet the requirement that the temperature at the edge of a 100m mixing zone does not exceed ambient temperatures by more than 3°C and the requirement would be achieved within 4-5m of the point of discharge.

As a consequence of the higher discharge flowrate associated with the Heydar Aliyev (960m^3/hr in total), the temperature difference between intake and discharge is only anticipated to be approximately 2.8°C and therefore the requirement for the discharge not to exceed ambient temperature by more than 3°C is met at the discharge location.

Table 9.27 presents the justification for assigning a score of 8, which represents a Medium Event Magnitude.

Table 9.27 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Affects an area less than 100m from source.	1
Frequency	Discharge will occur continuously through drilling and completion activities	3
Duration		3
Intensity	Low intensity.	1
Total		**8**



9.4.5.3 Receptor Sensitivity

For both MODU the cooling water intake velocity will be low and screens installed on the cooling water intake will prevent fish entering the cooling water system. Plankton will however, be entrained due to their small size. The volume flowrate is however, small compared to the water volume in the immediate surroundings of the MODU.

As noted above in Section 9.4.5.2, for the Istiglal MODU, the area and volume of water within which any potentially harmful exposure might occur, is limited to within 4-5m from the point of discharge, meaning the discharge plume would be very small in size. The temperature gradient at the edge of the plume is likely to be reasonably abrupt, provoking an avoidance reaction in fish and seals (although the probability of encounter with the plume for either group is very low based on their expected presence and the plume dimensions).

For all plankton, interaction with the plume depends on entrainment from the surrounding water and the process will ensure that individual plankton organisms do not remain in the discharge plume for more than a few tens of seconds.

For the Heydar Aliyev MODU due to the small difference between the intake and discharge temperatures, there will be no measurable thermal impact of the discharge.

The cooling water discharge takes place 12.5m below the sea surface for the Istiglal rig and 10.9-12.9m below the sea surface for the Heydar Aliyev and therefore does not have the potential to interact with benthic invertebrates.

Table 9.28 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.28 Receptor Sensitivity (All Receptors)

Parameter	Explanation	Rating
Resilience	Exposure is negligible, so resilience is, in effect, high.	1
Presence	No significant presence of rare, unique or endangered species.	1
Total		**2**

9.4.5.4 Impact Significance

Table 9.29 summarises the impact of cooling water discharges to sea on seals and fish, zooplankton and phytoplankton based on the impact significance criteria presented in Chapter 3: Impact Assessment Methodology.

Table 9.29 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
MODU Cooling Water Discharges to Sea	Medium	(Seals & Fish) Low	**Minor Negative**
		(Zooplankton) Low	**Minor Negative**
		(Phytoplankton) Low	**Minor Negative**

The assessment has demonstrated that Minor Negative impacts to seals, fish, zooplankton and phytoplankton are predicted from cooling water intake and discharge. In practice, these impacts are more directly related to the Istiglal; lower discharge temperatures result in a lower impact in the case of the Heydar Aliyev. Therefore, no additional mitigation beyond existing control measures is deemed to be necessary.

9.4.6 Other Discharges

These comprise ballast water, treated black water, grey water and drainage.

9.4.6.1 Mitigation

Existing controls related to other MODU discharges include:

- Ballast Water:
    - Ballast Water - The MODU water intake point will be screened to prevent fish entrainment;
    - Ballasting will be undertaken in accordance with existing ballast water management plans, which include measures designed to avoid introduction of nearshore species offshore and vice versa;
    - The MODU Ballast System will be operated so that ballasting, which uses untreated seawater, will be undertaken daily to maintain stability of the MODU for effective drilling; and
    - There will be no planned discharges to sea of treated oily water with an oil content more than 15ppm.

- Treated Black Water:
    - Under routine conditions, black water will be treated within the MODU sewage treatment system to MARPOL 73/78 Annex IV: Prevention of Pollution by Sewage from Ships standards: Five day BOD of less than 50mg/l, suspended solids of less than 50mg/l (in lab) or 100mg/l (on board) and coliform 250MPN (most probable number) per 100ml. Residual chlorine as low as practicable; and
    - Under non routine conditions when the MODU sewage treatment system is not available black water will be managed in accordance with the existing AGT plans and procedures and reported to the MENR as required.
- Drainage:
    - Deck drainage and wash water will be discharged to sea as long as no visible sheen is observable; and
    - Rig floor runoff, including WBM spills, collected via rig floor drains will be recycled to mud system or if not possible for technical reasons, diluted and discharged to sea (>60cm from sea surface) in accordance with applicable PSA requirements i.e. there shall be no discharge of drill cuttings or drilling fluids if the maximum chloride concentration of the drilling fluid system is greater than 4 times the ambient concentration of the receiving water.

9.4.6.2 Event Magnitude

Description and Assessment

Other discharges to sea comprise:

- **Ballast Water** – MODU ballasting activities will consist primarily of:

    - Ballasting the drilling rig for transit to the drilling location – minimum draft configuration for towing, so it may involve near shore discharge of some ballast water if the vessel has been anchored close to shore prior to mobilisation;
    - Taking on ballast water to increase the draft to the drilling configuration once on site;
    - Occasional uptake and discharge of ballast water during drilling operations; and
    - De-ballasting prior to demobilisation once drilling is completed.

Taking into account the existing mitigation uptake and discharge are therefore anticipated to have negligible environmental impact.

- **Treated Black Water –** Based on 120 and 130 POB for the Istiglal and Heydar Aliyev, respectively and a forecasted generation rate of 0.1m^3/person/day, it is expected that approximately 12-13m^3/day of black water will be generated by the Istiglal and Heydar Aliyev rigs respectively during SD2 Project drilling activities. The flow rate is low, so the effluent will be rapidly diluted close to the point of discharge. The discharge of biologically treated black water offshore, including total suspended solids at the proposed treatment level, does not pose any risk of environmental impact.

- **Grey Water –** Grey water will be discharged directly to sea. Grey water (from showers, laundry etc) will contain primarily dilute cleaning agents (soaps and detergents). Daily visual checks will be undertaken during the discharging process in order to confirm that no floating solids are observable.

- **Drainage -** Comprises
  - Deck drainage, washwater and diluted rig floor runoff containing WBM which cannot be returned to the mud system (see Section 9.4.6.1 above) will be routed to sea;
  - In the event of a spill, main deck drainage will be diverted to hazardous drainage tank for spills including LTMOBM, oil/diesel/cement and oily water. Contents of hazardous waste tank will be shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures.

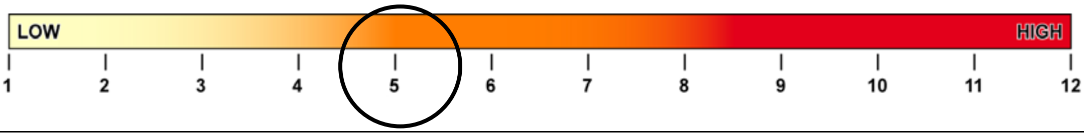
  Heydar Aliyev
  - Waste oil collected from the drainage system will be sent to waste oil tank. The contents of the tank will be incinerated using the rig's incinerator
  - Bilge water will be sent to an oily water separator. Treated bilge water with an oil content less than 15ppm will be discharged to sea; and
  - Drains within the drilling area are connected to the mud system. If it is not possible to send runoff including mud to the mud system it will be directed to a zero discharge centrifuge. Treated water from the centrifuge with an oil content less than 15ppm will be discharged to sea. Separated sludge will be shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures and separated oil sent to the waste oil tank;

Event Magnitude is summarised in Table 9.30.

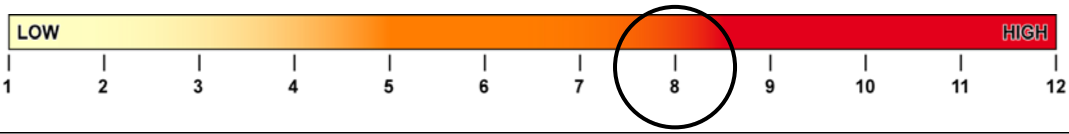
Table 9.30 Event Magnitude

Event Parameter / Discharge	Ballast Water	Treated Black Water	Grey Water	Drainage
Scale	1	1	1	1
Frequency	2	3	3	3
Duration	1	3	3	3
Intensity	1	1	1	1
Event Magnitude	**5**	**8**	**8**	**8**

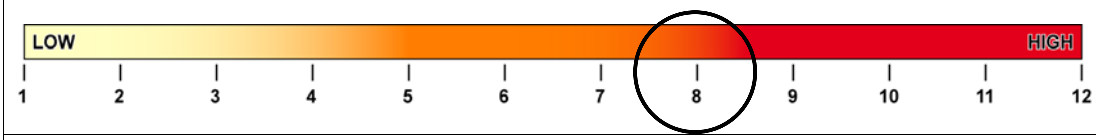
Ballast Water:



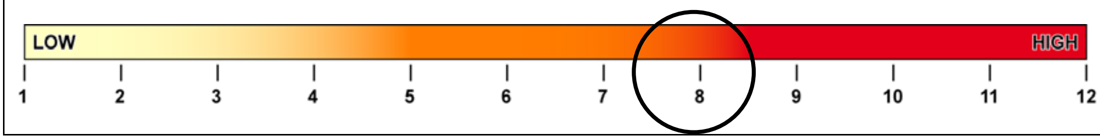
Treated Black Water:



Grey Water:



Drainage:



9.4.6.3 Receptor Sensitivity

All of the discharges are low in volume, do not contain toxic or persistent process chemicals and are considered to pose no threat to the environment or the identified biological/ecological receptors.

Table 9.31 present the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.31 Receptor Sensitivity (All Receptors)

Parameter	Explanation	Rating
Resilience	The extremely low level of exposure is equivalent to high resilience.	1
Presence	There is no significant presence of rare, unique or endangered species (i.e. the risk of exposure for any such species is close to zero).	1
Total		**2**

9.4.6.4 Impact Significance

Table 9.32 summarises the impact of other discharges to sea on seals and fish, zooplankton, phytoplankton and benthic invertebrates based on the impact significance criteria presented in Chapter 3: Impact Assessment Methodology.

Table 9.32 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Other Discharges to Sea **Ballast Water**	Medium	(All Receptors) Low	**Minor Negative**
Other Discharges to Sea **Treated Black Water**	Medium	(All Receptors) Low	**Minor Negative**
Other Discharges to Sea **Grey Water**	Medium	(All Receptors) Low	**Minor Negative**
Other Discharges to Sea **Drainage**	Medium	(All Receptors) Low	**Minor Negative**

Monitoring and reporting requirements associated with discharges of black, grey and drainage water and macerated galley waste (to applicable MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships particle size standards) during MODU drilling, completion and intervention activities include:

Black Water:

- o Samples will be taken from the MODU sewage discharge outlet and analysed monthly for total suspended solids, thermotolerant coliforms and BOD;
- o Daily visual checks will be undertaken when discharging to confirm no floating solids are observable; and
- o Summary of MODU sewage sampling analysis results, recorded floating solids observations and estimated volumes of treated black water discharged daily (based on a generation rate of $0.1m^3$/person/day) will be reported to the MENR on an annual basis for each MODU.

Grey water, Galley Waste and Drainage:

- o Daily visual checks undertaken when discharging to confirm no floating solids are observable ; and
- o Daily estimated volumes of grey water and galley waste from each MODU will be recorded monthly and reported by MODU to the MENR on an annual basis. Estimates will be based on generation rates of $0.018m^3$/person/day (galley waste) and $0.22m^3$/person/day (grey water).

These requirements are incorporated into the Environmental Management System (EMS) for each MODU, which is aligned to the AGT Region EMS as described within Chapter 14 Section 14.5 of this ESIA.

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures and no additional mitigation is required.

9.5 Summary of the SD2 Project Drilling and Completion Activities Residual Environmental Impacts

With regard to the SD2 Project Drilling and Completion Activities, it has been concluded that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures and no additional mitigation is required.

Table 9.33 summarises the residual environmental impacts associated with the SD2 Project Drilling and Completion Activities.

Table 9.33 Summary of SD2 Project Drilling and Completion Activities Environmental Impacts

	Event/ Activity	Magnitude				Sensitivity	Overall Score		
		Extent/ Scale	Frequency	Duration	Intensity		Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Emissions from mobile drilling rig power generation	1	3	3	1	1 1 1 1	Medium	Human: Low Biological/ Ecological: Low	Minor Negative
	Emissions from MODU Flaring (well testing, clean up or intervention flaring)	1	3	1	1	1 1 1 1	Medium	Human: Low Biological/ Ecological: Low	Minor Negative
	Emissions from support vessel engines	1	3	3	1	1 1 1 1	Medium	Human: Low Biological/ Ecological: Low	Minor Negative
Marine Environment	Underwater noise from drilling and vessel movements	1	3	3	1	1 1	Medium	Low	Minor Negative
	Drilling discharges	1	2	3	1	1 1	Medium	Low	Minor Negative
	Cement discharges to seabed	1	3	1	2	1 1	Medium	Low	Minor Negative
	Cement unit washing discharges	1	2	1	2	1 1	Medium	Low	Minor Negative
	BOP testing discharges to sea	1	3	3	1	1 1	Medium	Low	Minor Negative
	MODU cooling water discharges to sea	1	3	3	1	1 1	Medium	Low	Minor Negative
	Vessel and drilling rig ballast water discharge	1	2	1	1	1 1	Medium	Low	Minor Negative
	Vessel and drilling rig treated black water discharge	1	3	3	1	1 1	Medium	Low	Minor Negative
	Vessel and drilling rig grey water discharge	1	3	3	1	1 1	Medium	Low	Minor Negative
	Vessel and drilling rig drainage discharges	1	3	3	1	1 1	Medium	Low	Minor Negative