15 Residual Impacts and Conclusion

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15.1 Introduction

This Chapter of the Environmental and Socio-economic Impact Assessment (ESIA) summarises the residual impacts and conclusions of the Shah Deniz Stage 2 (SD2) Project ESIA.

15.2 Design, Construction, Installation, HUC and Operation

The Shah Deniz Bravo (SDB) platform complex, SD2 onshore facilities, SD2 export and MEG pipelines and the infield subsea infrastructure are based on established and proven designs and will be constructed and installed by experienced contractors using established facilities and a well-trained workforce.

15.3 Environmental Impacts

Environmental impacts have been assessed separately for the following:

- Drilling and Completion Activities (ESIA Chapter 9);
- Onshore Construction and Commissioning Activities, Platform, Export & MEG Pipeline and Subsea System Installation, Hook Up and Commissioning (HUC) (ESIA Chapter 10); and
- Offshore, Onshore and Subsea Operations (ESIA Chapter 11).

Cumulative impacts, transboundary impacts and accidental events have also been assessed.

15.3.1 Drilling and Completion Activities

Table 15.1 summarises the outcome of impact assessment for the Drilling and Completion Activities associated with the SD2 project.

Table 15.1 Summary of Residual Environmental Impacts for SD2 Drilling and Completion Activities

	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

	Event/ Activity	Magnitude				Sensitivity	Overall Score		
		Extent/ Scale	Frequency	Duration	Intensity		Event Magnitude	Receptor Sensitivity	Impact Significance
Marine Environment	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

Emissions associated with mobile drilling rig (MODU) power generation, well test, clean up and intervention flaring and the activity of support vessels will all occur offshore and disperse into the atmosphere. Modelling was undertaken to determine the concentration of key pollutants associated with these activities at receptor locations (i.e. onshore) and hence event magnitude. Based on existing good air quality relative to recognised standards for the protection of health, receptor sensitivity was considered to be low and the impact of atmospheric emissions was considered to be minor.

During Drilling and Completion Activities, the largest discharges to the marine environment by volume are drilling discharges, specifically the discharge of water based mud (WBM) associated drill cuttings and WBM, discharge of control fluid during blow out preventer (BOP) testing and the discharge of cooling water from the MODU. Modelling has been completed to aid the assessment of the extent and scale of mud and cuttings deposition on the seabed during SD2 Project drilling. This was compared to trends observed during post- drilling surveys. These surveys have shown that WBM and cuttings discharges have a very limited ecological impact to marine receptors. Based on the predicted event magnitude, receptor characteristics and observed sensitivities the impact was assessed as minor.

Modelling of the BOP control fluid discharged during BOP testing was undertaken to enable the dimensions and persistence of the dispersion plumes to be assessed. It was concluded that the dispersion plume would have a limited area of potential impact and that BOP testing would have a very short duration; the maximum plume size was predicted to be 51m wide and 98m long, and overall persistence would be less than 2 hours. The BOP fluid is inherently biodegradable and is non-bioaccumulative, thus the impact was assessed as minor.

Small quantities of cement will be discharged to the seabed during the cementing of all hole sections and during plugging of the geotechnical holes. These will remain close to the wellhead in the same area as drill cuttings are deposited. Cement discharges will also occur from wash out activities where cement remaining in the cement unit and associated hoses will be slurrified with water and discharged from each MODU. Modelling of the washed out cement indicated that less than 0.1% of the cement solids would settle within 1.5km of the rig, and no significant deposition will occur at any location. Water column plumes will be limited in size (approximately 150m by 10m), and cement particle concentrations will fall below 5 mg/l within 4 hours of the start of each discharge. Benthic communities will not be impacted, and turbidity effects in the water column will be minor and transient. The impact was assessed as minor.

MODU cooling water discharges are estimated to have a zone of influence (i.e., where the temperature of the discharge is greater than the ambient water temperature) of only a few metres and are also considered to have a minor impact upon biological receptors in the water column (i.e. zooplankton, phytoplankton, seals and fish).

The remaining discharges to sea (ballast water, black water, grey water and deck drainage) are all small in volume (relative to drilling discharges, BOP control fluid and cooling water discharges) and do not contain components of high environmental concern. These discharges, which are monitored in accordance with existing procedures to ensure applicable

project standards are met, will be rapidly diluted and are all assessed as having a minor impact upon biological receptors in the water column.

Underwater noise and vibration associated with the Drilling and Completion Activities was also assessed. Propagation of underwater noise was modelled to estimate distances at which various acoustic impacts on marine species may occur. For drilling, the source level was found to be below the levels at which lethal injury, permanent deafness, temporary deafness or auditory injury to marine species may occur. It was concluded that mild avoidance to drilling noise may be observed for hearing generalist fish and hearing specialist fish up to approximately 27m from the noise source. Pinnipeds are not expected to exhibit behavioural reactions at the noise levels predicted.

For vessel noise the modelling concluded that noise levels will be below the level at which both lethality and direct physical injury might occur to fish and pinnipeds. Hearing-generalist fish, hearing-specialist fish and pinnipeds may undergo strong avoidance reactions at up to 13m from the noise source Mild avoidance reactions are also expected at distances up to 72m. The assessment concluded that marine species in the area may be temporarily affected by noise, however, ecological functionality will be maintained and the impact was therefore assessed as minor.

For all Drilling and Completion Activities environmental impacts assessed 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.

15.3.2 Construction, Installation and HUC Activities

Table 15.2 summarises the outcome of impact assessment for the Construction, Installation and HUC Activities associated with the SD2 Project.

Table 15.2 Summary of Residual Environmental Impacts for SD2 Construction, Installation and HUC Activities

	Event/ Activity	Magnitude				Sensitivity	Overall Score		
		Extent/ Scale	Frequency	Duration	Intensity		Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Emissions from Construction Plant and Vehicles (Terminal, Onshore Pipelay and Pipeline Drying)	1	3	3	1	3 1	Medium	Medium	Moderate Negative
	Emissions from Offsite Vehicles	1	3	3	1	3 1	Medium	Medium	Moderate Negative
	Emissions from Terminal Commissioning	1	3	2	1	3 1	Medium	Medium	Moderate Negative
	Emissions from Construction Yard Plant and Vehicles	1	3	3	1	1 1	Medium	Low	Minor Negative
	Emissions from Onshore Commissioning of Main Platform Generators and Topside Utilities	1	3	3	1	1 1	Medium	Low	Minor Negative
	Vessel Emissions	1	3	3	1	1 1	Medium	Low	Minor Negative
Terrestrial Environment	Terminal Construction Plant and Vehicles (Noise)	3	3	3	2	2 2 1 2	High	Human: Medium Biological / Ecological: Medium	Major Negative - reduced to Moderate Negative following additional mitigation

	Event/ Activity	Magnitude				Sensitivity	Overall Score		
		Extent/ Scale	Frequency	Duration	Intensity		Event Magnitude	Receptor Sensitivity	Impact Significance
	Onshore & Nearshore Pipelay (Noise)	3	1	3	1	2 2 1 2	Medium	Human: Medium Biological / Ecological: Medium	Moderate Negative
Terrestrial Environment	SD2 Export and MEG Pipeline Pre-Commissioning and Drying	1	1	3	1	2 2 1 2	Medium	Human: Medium Biological / Ecological: Medium	Moderate Negative
	Terminal Commissioning (Noise)	1	1	2	1	2 2 1 2	Low	Human: Medium Biological / Ecological: Medium	Minor Negative
	Construction Yard Plant (Noise)	1	3	3	1	3 1 2 1	Medium	Human: Medium Biological / Ecological: Medium	Moderate Negative
	Platform Commissioning and Topside Utilities (Noise)	3	1	1	1	3 1 2 1	Medium	Human: Medium Biological / Ecological: Medium	Moderate Negative
	Onshore SD2 Export Pipeline Installation (Ecology)	1	1	3	1	2 1	Medium	Medium	Moderate Negative
	Onshore Pipeline Installation (soils, groundwater and surface water)	1	3	3	1	2 2	Medium	Medium	Moderate Negative
	SD2 Condensate Tank Area Works (soils, groundwater and surface water)	1	3	3	1	2 2	Medium	Medium	Moderate Negative
	Piling within the SD2 Expansion Area (Cultural Heritage)	1	3	1	1	1 2	Medium	Medium	Moderate Negative
	Onshore Pipeline Installation (Cultural Heritage)	1	1	3	2	1 2	Medium	Medium	Moderate Negative
Marine Environment	Construction Yard Cooling Water Discharge	1	3	3	1	1 1	Medium	Low	Minor Negative
	Pipeline and Flowline Pre-commissioning Discharges	3	3	2	1	1 1	High	Low	Moderate Negative
	MEG Discharge During Subsea Infrastructure Installation	1	1	1	1	1 1	Low	Low	Negligible
	Ballast Water (Vessels)	1	2	1	1	1 1	Medium	Low	Minor Negative
	Treated Black Water (Vessels)	1	3	3	1	1 1	Medium	Low	Minor Negative
	Grey Water (Vessels)	1	3	3	1	1 1	Medium	Low	Minor Negative
	Drainage (Vessels)	1	3	3	1	1 1	Medium	Low	Minor Negative
	Piling – Jackets and SSIVs (underwater noise)	3	2	1	2	1 1	Medium	Low	Minor Negative
	Vessels During Nearshore and Offshore Pipelay (underwater noise)	2	3	3	1	1 1	High	Low	Moderate Negative
	Vessels During Subsea Infrastructure Installation (underwater noise)	1	3	3	1	1 1	Medium	Low	Minor Negative

	Event/ Activity	Magnitude				Sensitivity	Overall Score		
		Extent/ Scale	Frequency	Duration	Intensity		Event Magnitude	Receptor Sensitivity	Impact Significance
Nearshore/ Coastal	Construction of Finger Piers	1	3	3	1	1 1	Medium	Low	Minor Negative
	Nearshore Pipeline Installation Works	1	2	2	1	1 1	Medium	Low	Minor Negative
	Seabed disturbance (cultural heritage)	1	3	1	1	2 2	Medium	Medium	Moderate Negative

In the vicinity of the Sangachal Terminal, emissions to atmosphere will arise from construction plant and vehicles associated with nearshore pipeline installation, SD2 onshore facility construction and commissioning and SD2 onshore pipeline installation and pre-commissioning activities. In addition emissions will arise from offsite vehicles using the Baku-Salyan Highway. The combined impact to air quality (specifically the contribution to NO_2 concentrations) from these sources at sensitive receptors (i.e. Sangachal Town, Umid, Azim Kend and Masiv 3) is considered to be of no more than a moderate negative impact.

Noise associated with the onshore construction activities in the Terminal vicinity was also assessed. Modelling demonstrated that, based on realistic worst case assumptions for all activities assessed, the predicted construction noise levels at Azim Kend, Masiv 3 and Umid would be below relevant noise limits for the duration of the construction programme. At Sangachal it was predicted noise limits would be met for the majority of the construction programme with a slight exceedance of 1dB(A) predicted during peak construction activity. It was considered unlikely that this 1dB(A) increase would be perceptible. Due to the anticipated duration of the works (approximately four years in total) and the distance construction noise is expected to travel as well as the sensitivity of the community receptors to noise (assessed as Medium), construction noise associated with the onsite plant and vehicles was assessed as having Major negative impact. Therefore, in addition to existing control measures regarding appropriate selection, use and maintenance of plant and equipment, to further minimise noise from construction plant and vehicles at the Terminal the following requirements will be included within the Community Engagement and Nuisance Management and Monitoring Plan:

- Prior to construction commencing within the Sangachal Terminal vicinity, a detailed assessment will be undertaken of all plant and vehicles proposed, and the construction programme to specifically identify the activities which result in the highest noise levels and their duration;
- The main construction and installation contractors will complete work plans detailing forecast activities at an agreed frequency. Should very noisy activities be identified the contractor (following procedures set out in the relevant Community Engagement and Nuisance Management and Monitoring Plan) will liaise with the affected communities warning them that a period of high noise will be experienced and the duration of the activity expected; and
- Noise monitoring will be undertaken at community receptors during construction activities implemented in the vicinity of Sangachal Terminal. If noise levels recorded indicate exceedance of the relevant noise limits (65dB Azim Kend, Masiv 3 and Umid and 70dB at Sangachal) the following will be undertaken:
    - The reason for the non-compliance will be established, where possible;
    - Any action that taken immediately following the survey will be recorded; and
    - If necessary recommendations will be made for further actions, which may include:
        - Further surveys to identify the reason for the non-compliance;
        - Noise control recommendations including, for example:
            - Requirement for equipment maintenance;
            - Selection of alternative equipment; and
            - Screening of equipment.

With these additional mitigation measures in place it is expected the impact associated with Terminal construction plant and vehicles will reduce to Moderate Negative.

Emissions and noise associated with onshore construction activities at the construction yards were also assessed. Modelling demonstrated impacts to onshore receptors were considered to be minor and moderate respectively and additional mitigation was required.

During commissioning of the platform topsides at the construction yard(s), temporary cooling water systems will abstract and discharge water at the quayside. The thermal impact of the discharge was modelled, and indicated that the discharged water (at a worst-case temperature of 50ºC) would not exceed ambient temperature by more than 3ºC at a distance of more than 4m from the point of discharge. Thermal impact is therefore considered minimal, with no need for further mitigation. The cooling water will be treated to inhibit marine fouling and neutralised prior to discharge. The discharge will contain no harmful persistent materials.

The impact of onshore pipeline installation activities to soil, groundwater and surface water, cultural heritage and ecology were assessed taking into account the baseline surveys which have been completed in the area affected by the works. In each case, the impact was assessed to be moderate negative. The impact to soil, groundwater and surface water associated with the SD2 condensate tank activities were also assessed to be moderate negative.

The construction of finger piers, and the trenching of pipelines in shallow nearshore water, will follow practices and procedures established during the SD1 project and the ACG Phase 1 and Phase 2 projects. Monitoring of benthic, seagrass and fish communities in the vicinity of the existing pipeline corridors has shown that pier construction and removal, and pipeline trenching, has had no persistent impact on the local marine ecology. The following monitoring will be undertaken for the SD2 Project:

- Fish population surveys will be undertaken one year prior to trenching activities, during trenching and once trenching has been completed; and
- Pre and post trenching seabed surveys will be undertaken. Post trenching seabed surveys will be undertaken one and three years after completion of trenching activities. The surveys will include drop down video work to confirm seabed distribution.

In addition the impact of these activities and activities offshore which may result in seabed disturbance on cultural heritage were assessed. Taking into account existing control measures, which included the requirement for 3D seismic and bathymetry surveys to be reviewed by a marine cultural heritage specialist, a no more than moderate impact was identified.

Underwater noise sources include jacket and SSIV foundation piling activities and movement of vessels used during platform, pipeline and subsea infrastructure installation. Piling activities will generate the greatest sound volume but the sound will occur intermittently and over a short period. Vessel noise will be more persistent but will be at a much lower level than piling noise. Underwater noise modelling, undertaken to determine the extent of the noise impacts, coupled with an assessment of the associated injury and strong avoidance behaviour reactions recorded in fish and seal populations, demonstrated that the activities would result in a moderate to minor impact.

Aqueous discharges from installation vessels (ballast water, grey water, black water and drainage) will also be similar in magnitude and impact to those for the Drilling and Completion programme and were assessed as having a minor impact upon biological receptors.

Following installation of the pipelines and flowlines, they will be filled with seawater containing preservation chemicals (to prevent corrosion and biological growth). Over the lifetime of the project, there will be a number of treated seawater discharges for each line, following initial filling, hydrotesting, leak testing and integrity testing. On completion of these activities, each line will be dewatered, dried and filled with inert nitrogen. Aquatic toxicity tests have been carried out on the preservation chemicals, and no-effect concentrations have been estimated for the treated seawater. Dispersion modelling has been conducted for a representative range of discharges, in order to estimate the point at which the discharges will be diluted to the no-effect concentration. Many of the smaller (hydrotest and leak test) discharges diluted almost

immediately to a no-effect concentration. The largest discharges (associated with gas export line dewatering) generated narrow plumes 3.1 - 4.5km long. In no instance did a plume reach the seabed or the sea surface. The volumes of water occupied by the discharge plumes are small relative to the receiving environment, and the discharge durations are short. The preservation chemicals are non-persistent, and it is considered that there will be no cumulative effects from successive events. Measures to monitor and control hydrotest discharges (i.e. seawater containing preservation chemicals) will comprise:

- Preparation and maintenance of a hydrotest management plan, which will include a regularly updated schedule of hydrotest events together with a detailed set of commissioning procedures;
- The amounts of chemicals used, together with the dosage rates and water flow rates during all pipeline filling, top-up and pressure testing activities will be rigorously recorded;
- The actual volumes of hydrotest water released during each pipeline discharge event will be rigorously recorded; and
- Laboratory samples (seawater dosed with chemicals at the rate recorded during offshore pipeline fill activities) will be prepared and stored onshore under simulated pipeline conditions. These samples will be periodically subject to toxicity testing.

Based on previous experience, these measures are considered to provide effective and practicable monitoring and assurance during hydrotesting and are designed to ensure that the impact to the marine environment is of no more than minor significance.

Overall, the majority of residual impacts were assessed as moderate or minor. The only major impact was noise associated with Terminal construction plant and vehicles which was subsequently revised to moderate following identification of additional mitigation measures. While impacts arising from onshore construction activities will not result in exceedences of applicable air quality or noise standards for the protection of human health, community liaison and engagement, similar to that undertaken for the previous SD and ACG projects, will be a key element throughout the construction phase to ensure these impacts are minimised.

15.3.3 Offshore, Onshore and Subsea Operations

Table 15.3 summarises the outcome of impact assessment for the Offshore, Onshore and Subsea Operations phase of the SD2 Project.

Table 15.3 Summary of Residual Environmental Impacts for the SD2 Offshore, Onshore and Subsea Operations Activities

	Event/ Activity	Magnitude				Sensitivity	Overall Score		
		Extent/ Scale	Frequency	Duration	Intensity		Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Non-GHG Emissions from Routine Offshore Operations	1	3	3	1	1 1	Medium	Low	Minor Negative
	Non-GHG Emissions from Non Routine Offshore Operations (DEH)	1	3	1	1	1 1	Medium	Low	Minor Negative
	Non-GHG Emissions from Non Routine Offshore Operations (Emergency Flaring)	1	3	1	1	1 1	Medium	Low	Minor Negative
	Non-GHG Emissions from Routine Onshore Operations	1	3	3	1	3 1 1 1	Medium	Humans : Medium Biological / Ecological: Low	Moderate Negative Minor Negative
	Non-GHG Emissions from Non Routine Onshore Operations (Emergency Flaring)	1	3	1	1	3 1 1 1	Medium	Humans : Medium Biological / Ecological: Low	Moderate Negative Minor Negative
Terrestrial Environment	Noise associated with Routine Onshore Plant Operations	1	3	3	1	3 1	Medium	Medium	Moderate Negative
	Noise associated with Non Routine Onshore Flaring	3	2	2	1	3 1	Medium	Medium	Moderate Negative
	Odour from non routine pond storage of produced water	2	2	3	2	3 2	High	High	Major Negative - reduced to Moderate Negative following additional mitigation
Marine Environment	Offshore Operations: Cooling Water intake and discharge	1	3	3	1	1 1	Medium	Low	Minor Negative
	Offshore Operation: Other Discharges to Sea: **Treated Black and Grey Water**	1	3	3	1	1 1	Medium	Low	Minor Negative
	Offshore Operation: Other Discharges to Sea: **Galley Waste**	1	3	3	1	1 1	Medium	Low	Minor Negative
	Offshore Operation: Other Discharges to Sea: **Drainage**	1	3	3	1	1 1	Medium	Low	Minor Negative
	Offshore Operation: Other Discharges to Sea: **Freshwater Maker – Saline Effluent**	1	3	3	1	1 1	Medium	Low	Minor Negative
	Subsea Operations: Routine and Non Routine Control Fluid Discharge:	1	3	1	1	1 1	Medium	Biological / Ecological: Low	Minor Negative
	Subsea Operations: Non Routine Discharge of Fluids during Subsea Production System Interventions	1	2	1	1	1 1 1	Medium	Biological / Ecological: Low	Minor Negative

Each operational interaction was assessed based on event magnitude and receptor sensitivity to determine the impact significance.

Events for Offshore Operations include emissions to atmosphere from the SDB platform complex, cooling water discharge and aqueous discharges (i.e. black water, grey water, galley waste, drainage, saline effluent).

The impact of emissions to atmosphere from routine and non routine offshore operations was assessed using dispersion modelling. Sources included the offshore platform generators during routine operations and during Direct Electrical Heating (DEH) (when the power demand increases) and the offshore platform flare during emergency depressurisation. For all scenarios assessed a minor impact to onshore receptors was predicted.

Cooling water intake and discharge associated with the SDB platform complex were assessed. Previous modelling work was used to determine that effects on water velocities in the vicinity of the intake will be such that fish are able to detect and avoid the intake. The cooling water discharge was modelled to determine the extent and travel of the thermal plume. The distance from the discharge to where the water temperature is estimated to be 3°C above ambient temperature is determined to be within 11m of the discharge point. Thus it is concluded that the discharge will have a zone of influence (i.e., where the temperature of the discharge is greater than the ambient water temperature) of a small area. It is considered that this zone of influence will have a minor impact upon biological receptors in the water column (i.e. zooplankton, phytoplankton, seals and fish).

The remaining discharges to sea from Offshore Operations (black water, grey water, galley waste, drainage and saline effluent) are all small in volume (relative to cooling water discharges) and do not contain components of high environmental concern. These discharges, which are monitored in accordance with existing procedures to ensure applicable project standards are met, will be rapidly diluted and are all assessed as having a minor impact upon biological receptors in the water column.

Onshore Operations events assessed include routine and non routine operations at the Terminal resulting in air emissions and noise. To assess the impact of emissions to atmosphere dispersion modelling was undertaken for routine and non routine operations. Sources included the onshore power generator, direct drive export compressors and the SD2 elevated flare (under emergency depressurisation conditions). The modelling predicted no significant change to air quality (in terms of NO_2 concentrations) at nearby receptors and no exceedances of internationally recognised ambient air quality standards for the protection of health at onshore receptors.

Modelling was also undertaken to assess the impact of onshore plant at the Terminal to noise levels at receptors and predicted no exceedances of the most stringent night time noise limit at any receptor. The impact of non routine flaring to noise levels at receptors was also assessed and results compared to limit values which must be met for 95% of the time. The modelling showed that the while there would be exceedances of the night time noise limits the limit would be met for 99.3% at Azim Kend/Masiv 3 and Sangachal 99.77% of the year at Sangachal respectively. Noise impacts associated with both routine and non routine onshore operations were assessed to be moderate negative.

Impacts associated with odour due to the anticipated non routine use of ponds for produced water storage were assessed to be of moderate adverse impact, taking into account existing controls and additional mitigation, which includes use of a treatment package to manage any potential exceedances of air quality thresholds from the produced water stored in the pond and evaluation of odour control techniques to be included in the design, if practicable.

For Subsea Operations there will be discharge of control fluid during routine conditions from continuous control valve discharge and intermittent valve operations. The control fluid discharge was the subject of dispersion modelling for routine operations. The results of these studies have been used to estimate the degree of dilution required to reach a “no effect” level and the size of the dispersion plume within which such dilution would occur. The modelling showed that for the continuous release scenario the plume persistence and maximum total plume volume is negligible.

For intermittent valve operation discharge during routine operations, the worst case showed that a maximum plume length (at the no-effect concentration boundary) of less than 20m was reached 15 minutes after a discharge, and that the plume was diluted to less than one-tenth of the no-effect concentration within one hour.

Based on the sensitivity of the receptors in the water column and the limited magnitude of the subsea discharge events, the discharges from both routine and non routine operation were assessed as having a minor impact upon biological receptors.

Over the PSA period it will be necessary to replace a number of the subsea production system elements. Discharges of approximately $1.3m^3$ are anticipated to result from replacement of each production tree choke (26 in total). This is expected to occur once for each production tree over the PSA period. Based on the modelling completed for larger MEG discharges during subsea production system installation it was concluded that the no-effect concentration would be met within a few metres from the point of discharge (less than 20m). MEG is of very low toxicity and low persistence and thus discharges during subsea interventions were deemed to have a minor negative environmental impact.

Overall, the majority of residual impacts from Offshore, Onshore and Subsea Operations are assessed as minor or moderate.

The expected moderate negative impacts associated with emissions and noise during Onshore Operations at the Sangachal Terminal will also be mitigated through existing community liaison and engagement supported by the EMP ambient monitoring undertaken in and around the Terminal. All activities will be managed in accordance with previously established practice and AGT Region procedures and impacts are considered to be controlled and mitigated to an acceptable level.

15.4 Socio-Economic Impacts

The majority of SD2 Project related Activities (with the exception of the offshore platform and subsea system installation and hook up) occur onshore and use existing operational onshore infrastructure capacities (e.g. Sangachal Terminal, the Baku Deep Water Jacket Factory (BDJF)). With reference to the experience gained on from ACG Phases 1-3 and SD1 projects, the following key socio-economic issues were assessed:

- Disruption or restriction of fishing and commercial shipping operations' access to coastal, nearshore and offshore resources through the enforcement of marine exclusion zones;
- Employment creation and subsequent de-manning of the construction workforce, after peak employment has been reached;
- Training and skills development opportunities provided to the workforce;
- Procurement of goods and services by the main construction and installation contractors through the use of internal supply chains; and
- Community disturbance through the visual impact of the elevated flare.

The assessment concluded that the national workforce to be employed during the SD2 Project construction phase is likely to peak at approximately 8,560. Additional and new employment during the operations phase will be less in terms of new positions. Employment impacts are likely to be distributed within the local area with the majority of employees expected to be recruited from the local Garadagh area.

Although the jobs created during the construction phase will not be required once the SD2 Project construction phases are complete, training and skills development opportunities, similar to those undertaken during the previous ACG Phases 1-3 and SD1 projects, will be provided to the construction workforce by the implementation of an Employee Relations Management Plan. Training programmes to be implemented cover topics including Health, Safely and Environment (HSE), and work task specific language and computer skills, driving and certified courses including painting, lifting, scaffolding and welding. It is expected that the

employment generated by the SD2 Project will result in positive impacts to individuals and their households.

As the construction phase will generate temporary employment opportunities only, planning for the conclusion of construction workforce contracts will be carefully planned from the start of the SD2 Project. Measures to mitigate this will include adequate staff communications between the main construction and installation contractors and their workforce which will inform the workforce of project progress and expected completion dates, so they can start to seek alternative employment positions in advance of their position being made redundant.

The overall socio-economic impacts of the SD2 Project, particularly from employment creation throughout the construction, installation and hook-up and commissioning phases were assessed as positive.

Potential negative impacts to community well being associated with visual impacts from non routine operational flaring were assessed. To reduce the impact associated with changes in community well-being, community engagement activities will be undertaken prior to the operation of the SD2 Project elevated flare, with the aim of providing information about non-routine flaring events to local residents.

15.5 Cumulative, Transboundary and Accidental Events

Discharges to the marine environment are not predicted to have any transboundary consequences. The majority of the discharges are small, and are comparable to discharges associated with previous projects and existing operations. The largest discharges will either be confined to a small area of seabed (drilling discharges) or will be short in duration and have transient impact (discharge of treated seawater pipeline hydrotesting). All of the discharges associated with construction, hook-up and commissioning, and operation, have been assessed, and it is concluded that there will be no cumulative or additive interactions between the impacts.

The most significant air quality pollutant in terms of health impacts is NO_2. It has been demonstrated that emissions associated with SD2 Project activities alone and emissions from worst-case cumulative ACG and SD onshore activities are not expected to result any discernable changes in onshore NO_2 concentrations.

For both Onshore and Offshore activities, the volumes of atmospheric emissions released (including visible particulates) are expected to result in very small increases in pollutant concentrations in the atmosphere and in any washout from rainfall, which will not be discernable to biological/ecological receptors.

Based on the limited geographic scope of pollutant species, which will disperse rapidly in the atmosphere, no transboundary impacts associated with air quality and human health are predicted from the SD2 Project.

The majority (79.8%) of GHG is predicted to result from onshore and offshore activities during the SD2 Project operations phase. Activities associated with well drilling and completion is predicted to contribute 13.0% of the total volume of GHG emissions produced by the SD2 Project. The annual contribution of SD2 Project in the year 2020 to the predicted national Azerbaijan forecast[1] was estimated to be approximately 0.36%.

Energy efficiency and GHG reduction was a key aspect taken into account during the development of the SD2 project design, contributing to the selection of the following:

- Offshore compression vs onshore compression;
- Offshore flare vs vent;
- Direct Drive Gas Turbines onshore vs electric drives;
- Waste Heat Recovery on onshore compression gas turbines; and

[1] First National Communication of Azerbaijan on Climate Change, May 23 2000.

- Onshore Flare Gas Recovery.

These resulted in a saving of approximately 103,700 ktonnes of CO_2 emissions across the SD PSA duration.

To support the assessment of accidental events, modelling of spill behaviour in water column and sea surface was undertaken as well as laboratory weathering analysis of SD2 condensate. The key accidental event scenarios assessed included:

- Well blow-out;
- Flowline rupture;
- Export pipeline rupture; and
- The loss of diesel inventory on the platform.

In the worst case, a blow-out could continue for an estimated 224 days, which is the time which would be required to mobilise a drilling rig and to drill a relief well. During this time, approximately 20,000 barrels of condensate would be released per day. Turbulent mixing driven by gas pressure will give rise to total (dispersed and dissolved) hydrocarbon concentrations in the water column of between 2.5 and 10 ppm, and these will persist for the duration of the blowout. Depending on the water depth at which the blowout occurs, between 0.5% and 3.6% of the condensate is predicted to reach the shoreline; this will be in the form of waxy flakes (the residue after condensate weathering). The magnitude and duration of a blowout event is such that it is likely to have a severe impact on the water column over tens of kilometres from the point of release. The hydrocarbons in the water column will be predominantly BTEX and substituted naphthalenes, and concentrations are predicted to decline rapidly to part-per-billion levels once the release stops.

Flowline and export pipeline ruptures are likely to be of much small magnitude than a blow-out. In the case of a flowline rupture, the control valves can be closed within 5 minutes, limiting the volume released to a range of approximately 65-1000 m^3. Maximum hydrocarbon concentrations in the water column will be of the same order of magnitude as for a blow-out, but will persist for only 1-2 days within less than 1km from the release point. Ecological impact is therefore likely to be limited. Very little condensate is predicted to reach the shoreline, even from a release from the more northerly subsea clusters.

In the event of a rupture of the condensate export pipeline, the amount of condensate released will depend on water depth; a release at 85m depth will result in a total release of about 780 m^3, while a release at a depth of 12m (with less hydrostatic head at the point of rupture) would result in a release of abut 1800 m^3. A nearshore export line rupture would give rise to much higher water column hydrocarbon concentrations than with an offshore rupture, a blow-out or a flowline rupture, and the more protracted loss of inventory (once the pipeline pressure drops to ambient) will mean that these higher concentrations will persist for 6 or 7 days over a distance of up to 10km. The entire water depth within this area could be impacted, and the ecological effects would be substantial. Up to 367 tonnes of wax residue would be likely to come ashore from a shallow-water release.

A loss to sea of 123m^3 of diesel was assessed. This would rapidly spread out to form a thin surface sheen, which would disperse within 24 hours. Total water column hydrocarbon concentrations were predicted to decline to less than 25 ppb within 48 hours. No significant ecological damage would be anticipated from a spill of this magnitude.

An Oil Spill Response Plan has been developed, which provides guidance and actions to be taken during an oil spill incident associated with all Shah Deniz offshore operations, which include mobile offshore drilling units, platforms, subsea pipelines and marine vessels.

15.6 Environmental and Social Management

Each phase of the SD2 Project will be subject to formal environmental and social (E&S) management planning.

The BP Construction Phase Environmental and Social Management System (ESMS) will include the Environmental and Social Management and Monitoring Plan (ESMMP) that describes:

- Conformance requirements;
- Roles and responsibilities of BP and the main construction and installation contractors;
- The actions needed to avoid and/or mitigate environmental and social impacts and to put the commitments in the ESIA into effect; and
- The assurance process that will be adopted to monitoring and report environmental and social performance will include inspection, audit and monitoring programs such as sewage treatment plant performance monitoring.

To support the ESMMP, environmental and social management plans will be developed by BP to present the SD2 Project environmental and social requirements by subject matter. The SD2 Project environmental and social management plans will be finalised during mobilisation of the main construction and installation contractors, and regularly reviewed as construction work proceeds.

The MODUs used to drill the SD2 Project wells will be operated by a rig operator(s) who have their own independent EMS already in place. Alignment of the plans, procedures and reporting requirements of the rig and AGT Region EMS has been achieved through the development of an EMS Interface Document.

BP will operate the SD2 facilities using an Operations Phase ESMS that is certified to ISO 14001 Environmental Management System (EMS) and will be based on the 'plan-do-check-act' cycle. The BP Operations Phase ESMS will be developed prior to commencement of SD2 operations and transition plans will be developed to assist with the movement from the construction to the BP Operations Phase ESMS.

The environmental and social management process during all phases of the SD2 Project will benefit from accumulated experience and 'lessons learned' from executing the previous ACG and SD1 projects. Major benefits of previous project experience include the development of:

- Effective and reliable procedures for on-site segregation and management of waste;
- A non-hazardous landfill site designed and constructed to EU standards; and
- An effective process for identifying and utilising opportunities for waste recovery and recycling.

15.7 Conclusions

Activities associated with the SD2 Project have been assessed for all project phases. Residual environmental and socio economic impacts identified have either been negligible, minor or moderate with positive impacts arising from employment, training and skills development and through procurement of goods and services.

The monitoring and mitigation plans and procedures associated with each impact have been presented and discussed, and it is concluded that these are sufficient to ensure the sound management of impacts throughout the project duration. This conclusion is underpinned by the project philosophy of using only tried and tested technology, and by the substantial experience acquired by BP, its partners, and its contractors in successfully executing previous projects in the ACG and Shah Deniz Contract Areas.