

# ENVIRONMENT PLAN

Beehive Multi-Well Exploration Drilling

## 7.Environmental Impact Assessment - Planned Activities

**WA-488-P**

16 December 2024

Rev 2

# 7. Environmental Impact Assessment – Planned Activities

This chapter presents the EIA for the environmental impacts identified for the activity using the methodology described in Chapter 6, as required under Regulations 21(5)(6) of the OPGGS(E).

This chapter presents the control measures, Environmental Performance Objectives (EPOs), Environmental performance Standards (EPSs) and measurement criteria required to manage (i.e., avoid, minimise or mitigate) the identified impact. The following definitions are used in this section, as defined in Regulation 5 of the OPGGS(E):

- **Control measure** – a system, an item of equipment, a person or a procedure, that is used as a basis for managing environmental impacts and risks;
- **EPO** – a measurable level of performance required for the management of environmental aspects of an activity to ensure that environmental impacts and risks will be of an acceptable level (i.e., the environmental objective);
- **EPS** – a statement of the performance required of a control measure; and
- **Measurement criteria** – defines the measure by which environmental performance will be measured to determine whether the EPO has been met.

A summary of the impact consequence rankings and risk ranking for each hazard identified and assessed in this chapter is presented in Table 7.1.

**Table 7.1. Activity environmental impacts summary**

| Identifier | Hazard | Inherent | Residual |
|---|---|---|---|
| Impacts | | | |
| 1 | Physical presence - seabed disturbance | Negligible | Negligible |
| 2 | Physical presence - displacement of other marine users | Negligible | Negligible |
| 3 | Routine emissions - light | Negligible | Negligible |
| 4 | Routine emissions - atmospheric | Negligible | Negligible |
| 5 | Routine emissions – noise | | |
| | - Plankton | Negligible | Negligible |
| | - Crustaceans (i.e., prawns) | Negligible | Negligible |
| | - Fish (with and without swim bladders) | Negligible | Negligible |
| | - Marine mammals | Negligible | Negligible |
| | - Marine reptiles (i.e., turtles) | Negligible | Negligible |
| | - Avifauna | Negligible | Negligible |
| 6 | Routine discharges - drill cuttings and muds | Negligible | Negligible |
| 7 | Routine discharges - cement | Negligible | Negligible |
| 8 | Routine discharges - putrescible waste | Negligible | Negligible |
| 9 | Routine discharges - sewage and grey water | Negligible | Negligible |
| 10 | Routine discharges - cooling and brine water | Negligible | Negligible |
| 11 | Routine discharges - bilge water and deck drainage | Negligible | Negligible |

The following sections assess environmental impacts (arising from planned events, being events that do or will happen), as listed in Table 7.1 and presented pictorially in Figure 7.1.

In this chapter, reference to support vessels includes any vessel undertaking GVI (see Section 2.8.2).

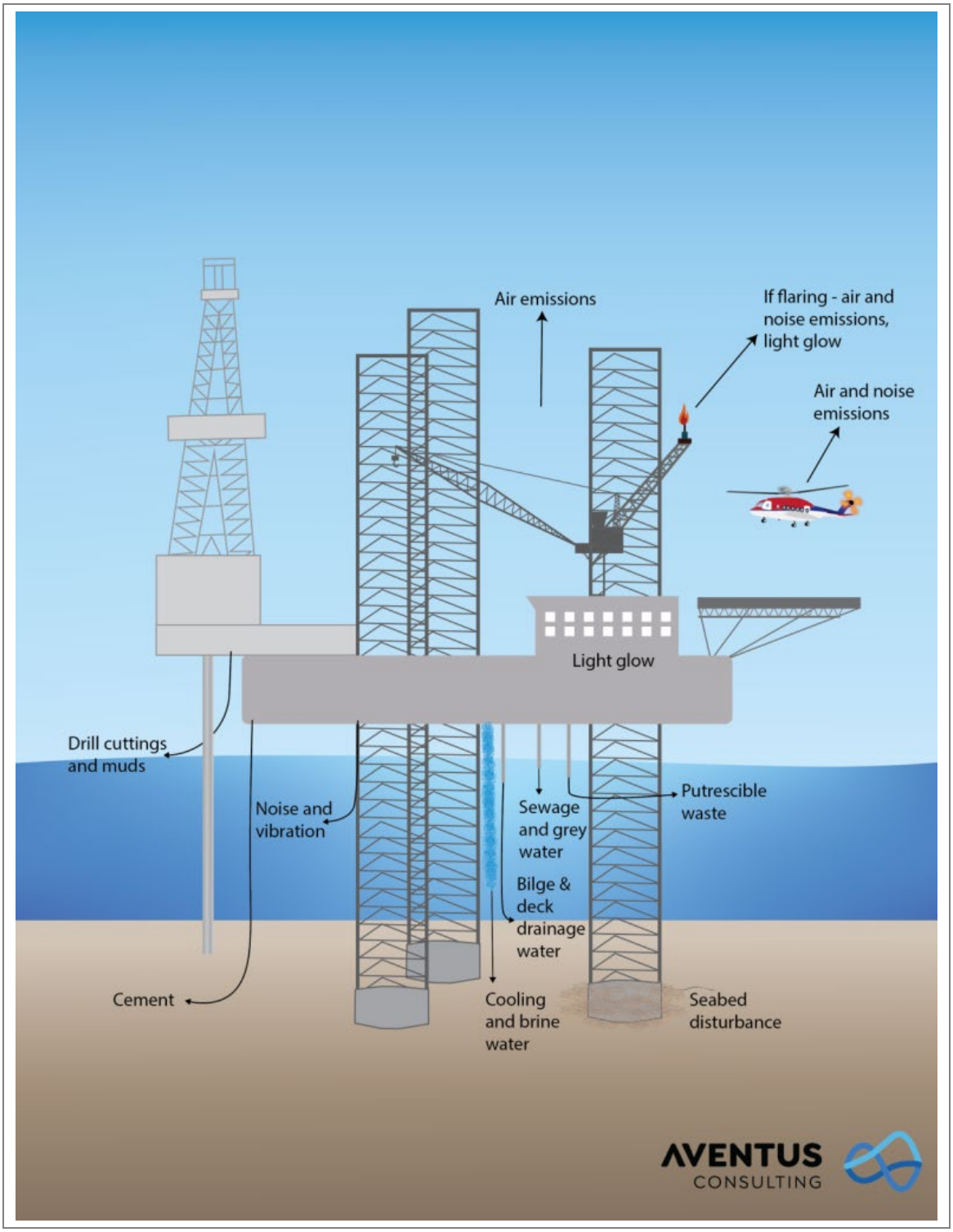



**Figure 7.1. Simplified pictorial representation of impacts arising from the planned activities during Beehive multi-well drilling**

## 7.1. IMPACT 1 – Physical Presence - Seabed Disturbance

### 7.1.1. Hazard

The following elements of the activity will result in seabed disturbance:

- MODU positioning – pinning of the jack-up MODU's legs to the seabed, with the spud cans penetrating the seabed sediments to a depth of about 16 m (based on previous drilling at the nearby Blacktip field).
- Drilling – the drilling activity will result in the generation of drill cuttings and discharge of cement and drilling muds, which will be deposited either directly at the seabed or settle to the seabed when discharged at the sea surface. Seabed disturbance resulting from the discharge of drilling cuttings, muds and cement is addressed in Section 7.6 and Section 7.7, respectively.
- Support vessel anchoring – the use of anchors (when vessels are on standby or in an emergency).

### 7.1.2. Known and Potential Environmental Impacts

Seabed disturbance has the potential to impact on:

- Marine receptors through physical removal or disturbance of seabed sediments an increase in turbidity of the water column near the seabed; and
- UCH, if present.

These impacts will result in localised and temporary disturbance, displacement or smothering of benthic habitats and fauna. At each well site, the area of benthic habitat that will be disturbed is limited to that occupied by the well itself (1 $m^2$), the three spud cans (with a diameter of 18 m each, each one occupies an area of 254 $m^2$) and the support vessel anchors (~5 $m^3$ each). This will result in a total of 769 $m^2$ of seabed disturbance per well, noting that the support vessels are highly unlikely to anchor in the same position each time, so this figure may be slightly higher.

Assuming three wells are drilled, this will result in a total of 2,307 $m^2$ of seabed disturbance, which is equivalent of 0.005% of the activity area (excluding anchoring by support vessels, which is not planned to occur).

There are no listed shipwrecks present within the impacts EMBA (see Section 5.6.2) and nor were any revealed during EOG's geophysical survey in June 2022 (see Section 5.2.3), therefore impacts to shipwrecks are not discussed further.

### 7.1.3. EMBA

The EMBA for seabed disturbance created by MODU positioning is likely to be restricted to tens of metres around each leg ('soft pinning' is usually only required when approaching a platform, and as such, furrows created in this process will not be created for this activity). Receptors that are known to occur or may occur within this EMBA are:

- Benthic species; and
- Demersal fish species.

### 7.1.4. Evaluation of Environmental Impacts

**Physical removal of seabed sediments**

Within the activity area, there are no known sensitive seabed features (such as reef, sponge gardens, seagrass meadows or scallop beds), so MODU positioning will not result in a loss of sensitive or geographically restricted habitats. Surveys of seabed disturbance from anchoring activities indicate that recovery of benthic fauna in soft sediment substrates (such as the sandy seabed that dominates the activity area) occurs between 6 to 12 months after the disturbance was created (URS, 2001). The anchor depression acts as a trap for marine detritus and sand, which will quickly fill and be recolonised by benthic organisms (Currie and Isaac, 2005). The area impacted by spud cans and the well bore is extremely small and will not pose a threat to seabed habitats or fauna communities.

The area that will be disturbed is very small compared with the overall extent of the sandy seabed habitat in the region and consequently, there will be no long-term impacts to the diversity and abundance of benthic fauna, with impacts being extremely localised.

**Water column turbidity**

Turbidity may occur when seabed sediments are stirred up during the drilling process and during jack-up and jack-down of the MODU legs. Any turbidity created is likely to be within the limits of natural variability when considering the turbidity created by tides and storm events in the shallow waters of the activity area. This turbidity would limit light penetration into the water column but given its temporary nature, it would be unlikely to inhibit any macroalgae growth. Benthic fauna living in sediment (endobenthos) or on sediment (epibenthos) may be temporarily displaced by this turbidity.

Given the dominance of soft sediments (sand) in the activity area, it is expected that holes created by coring activities will rapidly collapse in on themselves, leaving only shallow pock marks in the seabed that will be rapidly filled in and colonised, as described above.

**Direct mortality of benthic fauna**

Mortality of benthic fauna may result in areas that are directly disturbed, or disturbed a result of suspended sediments settling back onto the seabed. Assuming 3 wells are drilled, the area that will be disturbed is extremely small compared with the overall extent of the habitat in the region and consequently, there will be no long-term impacts to the diversity and abundance of benthic fauna populations, with impacts being extremely localised and temporary.

**Underwater cultural heritage**

This evaluation of potential impacts to UCH is taken from Cosmos Archaeology (2023) (**Appendix 12).** At each well site, the three spuds and the drill hole will penetrate the recent Holocene sediments and impact the former Late Pleistocene surfaces. There is a remote likelihood that the spud cans or drill will intersect a lithic artefact. Only the drill would destroy such an artefact, while the spud cans would dislocate or modify it. Even with the remote likelihood that an artefact may be impacted in this manner, such an impact will not appreciably alter the existing archaeological integrity of the artefact and as such will not affect its archaeological/scientific cultural heritage values.

Relocating the drill sites will not alter the risk of impact. Any form of retrieval of seabed material from the potential impact areas for the purposes of recovering artefacts will likely cause the same or greater disturbance than the proposed works. Any further remote sensing or geotechnical investigation will not alter the assessment of the identified landform and archaeological potential.

Cosmos Archaeology concludes that the proposed activity will have a remote likelihood of impacting First Nations tangible UCH.

This evaluation aligns with the *Guidelines for Assessing and Managing Impacts to Underwater Cultural Heritage in Australian Waters* (DCCEEW, 2024).

### 7.1.5. Impact Assessment

Table 7.2 presents the impact assessment for seabed disturbance.

**Table 7.2. Impact assessment for seabed disturbance**

| Summary | | |
|---|---|---|
| Summary of impacts | Removal/disturbance of seabed sediments.<br>Turbidity of the water column at the seabed. | |
| Extent of impacts | Localised – around individual points of disturbance. | |
| Duration of impacts | Temporary – returning to pre-impact condition soon after impact. | |
| Level of certainty of impacts | HIGH – the impacts of disturbance to seabed sediments are well known. | |
| Impact decision framework - context | Decision type | A - good industry practice required. |
| | Activity | Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined. |
| | Risk & uncertainty | Risks are well understood, uncertainty is minimal. |
| | Stakeholder influence | No conflict with company values, no partner interest, no significant media interest. |
| Defined acceptable level | Seabed disturbance is limited to the areas required for MODU positioning | |

| Impact Consequence (inherent) | | | |
|---|---|---|---|
| Negligible | | | |
| Assessment of Proposed Control Measures | | | |
| Control measure | Control type | Adopt | Justification |
| Seabed disturbance is kept to the minimum area necessary for safe operations **(IMP-01:EPS-01, -02, -03)**. | Elimination | Yes | **EB:** Reduces the footprint of seabed disturbance.<br>**C:** No additional cost due to the nature of the activity.<br>**Ev:** The environmental benefits outweigh the negligible costs. |
| No anchoring of support vessels. | Elimination | No | **EB:** Reduces the area of seabed disturbance.<br>**C:** Cost of additional diesel fuel will be substantial (tens of thousands of dollars).<br>**Ev:** The featureless seabed of the activity area (verified through the geophysical survey) means there is no environmental benefit in preventing vessels from |

| | | | |
|---|---|---|---|
| | | | anchoring if they need to. Anchoring, if required, will save the volume of fuel consumed and reduce associated atmospheric emissions. |
| Installation of support vessel mooring | Substitution | No | **EB:** Reduces the area of seabed disturbance from vessel anchors<br>**C:** Additional vessel-based activity to install at least one mooring on location.<br>**Ev:** Given the short duration of the activity, and the featureless seabed in the vicinity, the installation of a mooring is not considered necessary. Vessels will be on DP most of the time and therefore the requirement to anchor will be limited. |
| Avoid objects being dropped overboard **(IMP-01:EPS-04, -05, -06, -07)**. | Elimination | Yes | **EB:** Reduces the likelihood of seabed disturbance from dropped objects overboard.<br>**C:** No additional cost due to the nature of the activity.<br>**Ev:** The environmental benefits outweigh the negligible costs. |
| Large objects dropped overboard from the MODU will be retrieved wherever possible | Engineering | No | **EB:** The MODU will not have an inspection class ROV onboard – this is only standard on semi-submersible MODUs. Only an observation class ROV will be available. The retrieval of large objects from the seabed is therefore not possible.<br>**C:** Significant cost (hundreds of thousands of dollars) involved in having an inspection class ROV onboard during the campaign.<br>**Ev:** The environmental benefits are outweighed by the substantial costs. |
| Unexpected finds of potential UCH sites/features are managed in accordance with an UCH unexpected finds procedure.<br>**(IMP-01:EPS-09, -10)**. | Administrative | Yes | **EB:** Finds are managed in accordance with legislative requirements, expert advice and community expectations.<br>**C:** Negligible.<br>**Ev:** The environmental benefits outweigh the negligible costs. |

| Environmental Controls and Performance Measurement | | |
|---|---|---|
| EPO | EPS | Measurement criteria |
| Seabed disturbance is kept to the minimum area necessary for safe operations. | **(IMP-01:EPS-01)** The MODU will be pinned directly at each location and will not undergo a soft-pinning exercise, thereby preventing the creation of scour channels in the seabed. | The MODU positioning report confirms direct pinning occurred. |
| | **(IMP-01:EPS-02)** MODU-specific jack-up procedures are used to ensure compliance with stability criteria, reduce the risk of foundation shift or failure. | The MODU positioning report confirms MODU-specific jack-up procedures were used. |

| | | |
|---|---|---|
| | **(IMP-01:EPS-03)** Vessel anchoring will only occur in locations deemed suitable from the results of the PDSA. | PDSA report identifies suitable seabed for anchoring (i.e., absence of sensitive seabed habitat such as rocky reef). |
| Avoid objects being dropped overboard. | **(IMP-01:EPS-04)** Large bulky items are securely fastened to or stored on the deck to prevent loss to sea. | A completed pre-departure inspection checklist verifies that bulky goods are securely sea-fastened. |
| | **(IMP-01:EPS-05)** The crane/A-frame handling and transfer procedure is in place and implemented by crane operators (and others, such as dogmen) to prevent dropped objects. | Completed handling and transfer procedure checklist, permits to work (PTWs) and/or risk assessments verify that the procedure is implemented prior to each transfer. |
| | **(IMP-01:EPS-06)** The crane/A-frame operators are trained to be competent in the handling and transfer procedure to prevent dropped objects. | Training records verify that crane operators are trained in the loading and unloading procedure. |
| | **(IMP-01:EPS-07)** Visual inspection of lifting gear is undertaken every quarter by a qualified competent person (e.g., maritime officer) and lifting gear is tested regularly in line with the MODU/vessel planned maintenance system (PMS). | Inspection of PMS records and Lifting Register verifies that inspections and testing have been conducted to schedule. |
| Large objects dropped overboard from the MODU will be reported. | **(IMP-01:EPS-08)** Large objects left behind at the end of the activity (that cannot be retrieved) will be reported internally and to NOPSEMA. | Incident report/s verify that the report was issued to NOPSEMA. |
| No adverse impacts to unexpected finds of UCH. | **(IMP-01:EPS-09)** The Unexpected Finds Procedure (available in Section 10.5.4) will be implemented in the event that an UCH site or feature is identified. | Incident report verifies that the Unexpected Finds Procedure was implemented. |
| | **(IMP-01:EPS-10)** MODU and support vessel crew are made aware of the Unexpected Finds Procedure via induction. | Induction presentation contains information on Unexpected Finds Procedure and crew induction records verify they were received. |
| Impact Consequence (residual) | | |
| Negligible | | |
| The consequence of seabed disturbance is assessed as negligible because:<br>• Impacts are extremely localised, thereby reducing temporary turbidity in water column;<br>• Spud can depressions will collapse in on themselves and fill in quickly with sediments and recolonise with benthic fauna; and<br>• There is an absence of sensitive habitats in the activity area. | | |
| Demonstration of ALARP | | |
| A ‘negligible’ residual impact consequence is considered to be ALARP and a ‘lower order’ impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence. | | |

| Demonstration of Acceptability | | |
|---|---|---|
| Policy compliance | EOG's Safety and Environmental Policy objectives are met. | |
| EMS compliance | Chapter 10 describes the EP implementation strategy to be employed for this activity. | |
| Risk matrix standard compliance | The residual consequence is negligible, which is considered acceptable. | |
| External context | There have been no objections or claims made by relevant persons regarding seabed disturbance for this activity. | |
| Legislative context | There is no legislation associated with seabed disturbance.<br>UCH is protected from disturbance or adverse impacts by the *Underwater Cultural Heritage Act* 2018 (Cth). | |
| Industry practice | The consideration and alignment of EPS with the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity. | |
| | Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020) | The EPS developed for this hazard are in line with the management measures listed for offshore marine use (physical disturbance) in Section 4.3.2 of the guidelines. In addition, this EP addresses the point of undertaking an environmental assessment to identify protected areas and local sensitivities.<br>• Reduce footprint (**IMP-01: EPS-01, -02**). |
| | Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019) | Not applicable. There is no guidance in these guidelines regarding seabed disturbance. |
| | Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015) | Section 2.3.13 (marine operations and site assessment) of this guideline states that location-specific seabed assessments are undertaken to assure suitability of the equipment for the operating environment.<br>Section 3.2.3.3 (foundation stability for jack-ups) also states that obtaining and analysing geotechnical data and information from seabed surveys should be undertaken. This will be achieved by conducting the geotechnical investigations (subject to a separate accepted EP) and using the results to guide the placement of the MODU.<br>Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement. |
| | Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015) | Not applicable. There is no guidance regarding seabed disturbance. |

| | | |
|---|---|---|
| | AEP CoEP (APPEA 2008) | The EPS developed for this activity meet the code's following objectives for offshore drilling operations:<br>• To reduce the impacts to benthic communities to acceptable levels and to ALARP. |
| Environmental context | MNES | |
| | AMPs | This hazard will not impact the conservation values of nearby AMPs. |
| | Ramsar wetlands | This hazard will not impact any Ramsar wetlands. |
| | TECs | This hazard will not impact any TECs. |
| | Nationally threatened and migratory species | This hazard will not impact any threated or migratory species. |
| | Other matters | |
| | KEFs | This hazard will not impact any KEFs. |
| | NIWs | This hazard will not impact any NIWs. |
| | State marine parks | This hazard will not impact any state marine parks. |
| | Species Conservation Advice/<br>Recovery Plans/<br>Threat Abatement Plans | None triggered by this hazard. |
| ESD principles | The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant). | |
| Statement of acceptability | EOG considers the impacts from seabed disturbance to be acceptable because:<br>• It will adhere to the company's Safety and Environmental Policy;<br>• The residual consequence rating is negligible;<br>• An Implementation Strategy (described in Chapter 10) is in place to ensure the EPS are achieved.<br>• Relevant legislation and industry best practice will be complied with;<br>• Seabed disturbance will not have long-term or significant impacts on MNES;<br>• The management of seabed disturbance is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species;<br>• The management of seabed disturbance is not inconsistent with the aims of relevant marine reserve management plans; and<br>• The management of seabed disturbance is not inconsistent with ESD principles. | |
| Environmental Monitoring | | |
| • None required. | | |
| Record Keeping | | |
| • MODU positioning report<br>• Daily reports.<br>• PTWs. | • Load ratings and load test certificates.<br>• PMS records.<br>• Training records. | |

| | |
|---|---|
| • Equipment pre-deployment inspection checklist.<br>• Handling and transfer procedure.<br>• Completed handling and transfer checklists.<br>• PMS records and Lifting Register | • Crane/A-frame operator qualification and training records.<br>• Incident reports.<br>• Operations reports.<br>• Induction presentation. |

## 7.2. IMPACT 2 – Physical Presence - Displacement of Other Marine Users

### 7.2.1. Hazard

The physical presence of the MODU and support vessels undertaking the activity, potentially at up to three locations within the activity area, necessitates the temporary displacement of other marine users from around the MODU for the safety of other marine users and the MODU crew. This will result in the temporary displacement of other marine users such as commercial fishing vessels and merchant vessels from areas in which they would normally operate. Displacement of other marine users differs from interference with other marine users, which is addressed in Section 8.4.

### 7.2.2. Known and Potential Environmental Impacts

The known and potential impacts of the displacement of other marine users are:

- Diversion from a planned travel route and additional time to re-join the planned route;
- Increased fuel use (and cost) as a result of this diversion; and
- Temporary exclusion from fishing grounds.

### 7.2.3. EMBA

Other marine users will be excluded from operating within a 500-m radius of the MODU (in line with the PSZ and NTM) so as to avoid potential damage to the MODU. Receptors in the EMBA may include:

- Commercial fishing vessels; and
- Merchant shipping vessels.

### 7.2.4. Evaluation of Environmental Impacts

**Merchant Shipping**

As illustrated in Figure 5.37 and detailed in Table 5.19, the activity area and the immediate surrounds has recorded 74 vessel trips (tankers, cargo chips, fishing vessels, etc) over a 12-month period and therefore overlaps an area of low shipping traffic. This is primarily due to its location south of the major shipping routes travelling to and from the Port of Darwin (Figure 5.49).

The temporary exclusion of other marine users is likely to result in a negligible increase in travel time and fuel cost to individual marine users because of the very small exclusion zone and short-term nature of the activity at each well site. In the context of the marine voyages undertaken by vessels in the region, a negligible increase in travel time and fuel use in order to divert around the path of the MODU undertaking drilling activities will have a negligible consequence.

**Fishing Vessels**

The primary fishery with recent fishing history in the activity area is the NPF. The timing of the activity may fall within the banana prawn fishing season. Under an agreement between AFMA and the NPFI, the JBG will be closed to prawn fishing for from 1st April to 15th June (until 2026).

There will be a PSZ in place during drilling (a 500-m radius around the MODU) that aims to exclude interference with MODU operations. This is an area of 0.7855 km$^2$ at each drill site, which represents 0.000001% of the NPF. As such, if fishing in the NPF is taking place at the time of drilling, impacts are likely to be negligible given the extremely small area of overlap with the fishery. This should eliminate the potential for displacement with license holders of this fishery.

The WA-managed NDSMF and MMF may operate within the activity area. Given the short duration of the activity at each drill site, the small area of potential displacement (0.0005% for the NDSMF (Zone A) and 0.0002% for the MMF (Area 1 - Kimberley)) and the low volume of catch recorded from the activity area (see Section 5.7.1), the consequence of potential temporary displacement to these fisheries will have a negligible consequence.

In the event of one or more wells being TA and that trawl guards are installed over the wellhead(s), this will ensure that fishing gear is protected from the snag risk posed by the wellhead(s). As such, damage to fishing trawl nets is unlikely to occur in this scenario.

### 7.2.5. Impact Assessment

Table 7.3 presents the impact assessment for displacement with other marine users.

**Table 7.3. Impact assessment for displacement of other marine users**

| Summary | | |
|---|---|---|
| Summary of impacts | Presence of the MODU and support vessels will temporarily displace other marine users (i.e., commercial fishing vessels, merchant shipping, etc) resulting in temporary exclusion in the area immediately around the vessel. | |
| Extent of impacts | Highly localised – 500 m around MODU. | |
| Duration of impacts | Short-term – minutes for a third-party vessel detour. | |
| Level of certainty of impacts | HIGH – the impacts associated with displacement of other marine users is well understood. | |
| Impact decision framework context | Decision type | A - good industry practice required. |
| | Activity | Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined. |
| | Risk & uncertainty | Risks are well understood, uncertainty is minimal. |
| | Stakeholder influence | No conflict with company values, no partner interest, no significant media interest. |
| Defined acceptable level | Displacement of other marine users is no greater than the necessary for the reasonable exercise of rights afforded under the OPGGS Act. No unplanned interactions with other marine users. | |

| Impact Consequence (inherent) | |
|---|---|
| Receptor | Consequence |
| Merchant shipping | Negligible |
| Commercial fisheries | Negligible |

| Assessment of Proposed Control Measures | | | |
|---|---|---|---|
| Control measure | Control type | Adopt | Justification |
| Do not conduct the activity in waters available to fisheries. | Eliminate | No | **EB:** Eliminates the potential for displacement of fishers by conducting the activity only in waters that are closed to fishing.<br>**C:** The activity objectives could not be met if confined to areas closed to fishing.<br>**Ev:** There are low numbers of fishers working in the activity area and the area is closed to the NPF during the activity timing. The activity area does not represent critical fishing grounds for any WA-managed fisheries. The cost of implementing this control is grossly disproportionate to the environmental benefit. |
| Conduct the activity during the NPF JBG closure period (1st April to 15th June). | Eliminate | No | **EB:** Eliminates the potential for displacement of NPF fishers by conducting the activity only when JBG waters are closed to prawn fishing.<br>**C:** Extremely high (up to several millions of dollars) if MODU availability aligns with the requested exclusion period. The costs are associated with 'warm-stacking' the MODU, paying a termination fee to the MODU operator for breach of contract and/or lost opportunity costs.<br>**Ev:** The cost of this control measures is grossly disproportionate to low inherent risk to fishers in the NPF. Trawling will not be impacted outside of the 500-m radius PSZ around the MODU. The PSZ represents 0.000001% of the total fishing area of the NPF. |
| Install trawl guard(s) over TA wellhead(s) if there has been trawl fishing in the 5 years pre-drilling and if trawl fishers request it **(IMP-02:EPS-04)**. | Engineering | Yes | **EB:** Prevents displacement from fishing grounds. Protects fishing trawl equipment from damage and therefore prevents potentially costly losses to fishers from snagging. Also presents safety benefits to fishers.<br>**C:** Significant cost to EOG in terms of trawl guard manufacture and MODU time for installation.<br>**Ev:** Preventing displacement and safety risks to trawl fishers outweighs the cost. |
| Reduce the exclusion zone (PSZ) to the | Administrative | Yes | **EB:** The exclusion zone (and thus extent of displacement) is reduced to the lowest possible |

| | | | |
|---|---|---|---|
| smallest area possible for safe operations **(IMP-02:EPS-01).** | | | extent necessary to achieve its aim and is linked to the minimum safe distance from the MODU.<br>**C:** No cost to gazette the PSZ.<br>**Ev:** Reducing the extent of displacement to the smallest area possible for safe operations outweighs the cost. |
| Communicate the required area of displacement for the duration of the activity. **(IMP-02:EPS-02, -03)**. | Administrative | Yes | **EB:** Informed stakeholders allows for planning so as to avoid or minimise displacement.<br>**C:** Minimal cost to communicate with other marine users ahead of the activity through EOG notifications and the NTM.<br>**E:** The benefit of avoiding or minimising displacement outweighs the minimal cost to implement this control measure. |
| Compensate for economic loss due to a spill associated with drilling **(IMP-02:EPS-05, -06)**. | Administrative | Yes | **EB:** Affected third-party marine users are compensated for any economic loss due to displacement, thereby mitigating the potential socio-economic consequences.<br>**C:** Minor costs to prepare the procedure and administer the claims process. Potentially significant costs for a claim or claims.<br>**Ev:** The principal of the control measure is to ensure that other marine users are no worse off as a result of drilling so that all parties maintain their rights to access the ocean. The benefits outweigh the high costs of potential claims. |

| Environmental Controls and Performance Measurement | | |
|---|---|---|
| EPO | EPS | Measurement criteria |
| Displacement is limited to the area necessary for safe operations. | **(IMP-02:EPS-01)** The exclusion zone is limited to a 500-m radius around the MODU, as gazetted through the PSZ. | The PSZ is gazetted by NOPSEMA and available on its website. |
| | **(IMP-02:EPS-02)** EOG provides pre-activity notification to commercial fisheries at least one month prior to activity commencement to ensure they are aware of the activity timing and safety exclusion zone requirements. | Consultation records verify that notifications to fisheries were provides at least one month ahead of the activity starting. |
| | **(IMP-02:EPS-03)** EOG provides pre-activity notification to the AHO at least three weeks prior to activity commencement to enable the promulgation of the NTM. | NTM is issued prior to the commencement of the activity and includes activity MODU/vessel details, location and timing. |
| | **(IMP-02:EPS-04)** Trawl guard(s) will be installed over any TA well if there has been trawl fishing in the activity area in the five years pre-drilling and if trawl fishers request it. | Daily drilling reports (DDR) and end-of-well ROV report confirms installation of trawl guard(s). |

<table>
<tr><td rowspan="3">There is no economic loss to other marine users as a result of the multi-well activity.</td><td rowspan="2">(IMP-02:EPS-05) EOG makes its Fisheries Compensation Procedure (FCP) (summary available in Appendix 9), which will be finalised at least one month prior to the commencement of drilling, available to fishing associations, companies or individuals who have requested it so that they are able to make a claim for losses. The protocol contains:<ul><li>Philosophy of shared ocean access;</li><li>A commitment that EOG consults with fishers and fishing associations who may be impacted by EOG activities;</li><li>A commitment that a fisher should not suffer an economic loss as a direct result of an EOG activity;</li><li>A method for calculating economic loss for direct impact;</li><li>A claims procedure and forms; and</li><li>How to manage disagreements.</li></ul></td><td>Email correspondence verifies the fisheries compensation procedure was provided to those that requested it.</td></tr>
<tr><td>Completed claims forms are available for any lodged claims.</td></tr>
<tr><td>(IMP-02:EPS-06) EOG administers and implements the FCP in a manner such that compensation is provided in a timely manner (within 60 days of receiving a commercial fisher’s signed settlement agreement, per Section 9 of the FCP) in response to any evidence-based claims for compensation that have merit.</td><td>Claims correspondence and payment date verifies that compensation payments are paid within 60 days of receiving a commercial fisher’s signed settlement agreement.</td></tr>
<tr><td colspan="3">Impact Consequence (residual)</td></tr>
<tr><td colspan="2">Receptor</td><td>Consequence</td></tr>
<tr><td colspan="2">Merchant shipping</td><td>Negligible</td></tr>
<tr><td colspan="2">Fisheries</td><td>Negligible</td></tr>
<tr><td colspan="3">The impact of displacement of other marine users is assessed as negligible because:<ul><li>The activity will be of a short duration;</li><li>The area of displacement is extremely small and will not result in negligible increased time and fuel use for third-party vessels to divert around the activity vessel;</li><li>The activity will be conducted during the NPF JBG closure period; and</li><li>Thorough consultation has been undertaken in the development of the activity to minimise the impact of temporary displacement.</li></ul></td></tr>
<tr><td colspan="3">Demonstration of ALARP</td></tr>
<tr><td colspan="3">A ‘negligible’ residual impact consequence is considered to be ALARP and a ‘lower order’ impact. The adopted controls and associated EPS have lowered the risk to the point that any additional or alternative control measures either fail to lower the residual risk rating any further or are grossly disproportionate to the residual risk rating.</td></tr>
<tr><td colspan="3">Demonstration of Acceptability</td></tr>
</table>

| | | |
|---|---|---|
| Policy compliance | EOG's Safety and Environmental Policy objectives are met. | |
| EMS compliance | Chapter 10 describes the EP implementation strategy to be employed for this activity. | |
| Risk matrix standard compliance | The residual impact consequence is negligible, which is considered acceptable. | |
| External context | There have been no objections or claims made by relevant persons regarding displacement of other users for this activity. | |
| Legislative context | The EPS outlined in this table align with the requirements of:<br>• OPGGS Act 2006 (Cth).<br>  ○ Section 280 – requires that a person carrying on activities in an offshore area under the permit, lease, licence, authority or consent must carry on those activities in a manner that does not interfere with navigation or fishing (among others) to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person. | |
| Industry practice | The consideration and alignment of EPS with the mitigation measures outlined in the below-listed guidelines and codes of practice demonstrates that BPEM will be implemented for this activity | |
| | Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020) | The EPS developed for this hazard are in line with the management measures listed for offshore physical presence in Section 4.3.1 of the guidelines, which include:<br>• Develop exclusion zones in consultation with key stakeholders, including local fishing communities; raise awareness of exclusion zones with all stakeholders **(IMP-02:EPS-01)**.<br>• Issue a 'NTM' through the relevant government agencies, detailing the area of operations **(IMP-02:EPS-03)**.<br>• Ensure all vessels adhere to International Regulations for Preventing Collisions at Sea (COLREGS), which set out the navigation rules to be followed to prevent collisions between two or more vessels.<br>• Optimise vessel use to ensure the number of vessels required and length of time that vessels are on site is as low as practicable. |
| | Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019) | There are no guidelines specifically regarding physical presence for offshore activities. |
| | Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015) | There is no specific guidance regarding displacement of other marine users.<br>Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement. |

| | | |
|---|---|---|
| | Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015) | There are no guidelines specifically regarding physical presence for activity vessels. |
| | AEP CoEP (APPEA 2008) | The EPS developed for this activity meet the code's following objectives for offshore drilling operations:<br>• To reduce disturbance to fishing operations or other marine users to ALARP and to an acceptable level.<br>• To reduce the risk of collision with other vessels in accordance with maritime standards. |
| Environmental context | MNES | |
| | AMPs | This hazard will not intersect nearby AMPs. |
| | Ramsar wetlands | This hazard will not intersect any Ramsar wetlands. |
| | TECs | This hazard will not intersect any TECs. |
| | Nationally threatened and migratory species | This hazard will not have any impacts on threatened or migratory species. |
| | Other matters | |
| | KEFs | This hazard will not intersect any KEFs. |
| | NIWs | This hazard will not intersect any NIWs. |
| | State marine parks | This hazard will not intersect any state marine parks. |
| | Species Conservation Advice/<br>Recovery Plans/<br>Threat Abatement Plans | None triggered by this hazard. |
| ESD principles | The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant). | |
| Statement of acceptability | EOG considers the impacts from displacement of other marine users to be acceptable because:<br>• It will adhere to the company's Safety and Environmental Policy;<br>• The residual consequence rating is negligible;<br>• An Implementation Strategy (described in Chapter 10) is in place to ensure the EPS are achieved;<br>• Input from engagement with relevant persons has been considered and incorporated into the design of the activity; and<br>• Relevant legislation and industry best practice will be complied with. | |
| Environmental Monitoring | | |
| • Continuous bridge monitoring from the support vessels. | | |
| Record Keeping | | |

| | |
|---|---|
| • Consultation records.<br>• NTM. | • Operational reports.<br>• Incident reports. |

## 7.3. IMPACT 3 – Routine Emissions – Light

### 7.3.1. Hazard

Light emissions will occur from the MODU and support vessels due to:

- Vessel navigation lighting will be maintained while vessels are on location for maritime safety purposes;
- MODU deck lighting will be maintained for the safety of personnel working on deck;
- Flaring from the MODU (if DST is undertaken); and
- Underwater light from ROV activities.

### 7.3.2. Known and potential environmental impacts

The known and potential impacts of lighting are:

- Light glow may act as an attractant to light-sensitive species (e.g., seabirds, turtles, squid, zooplankton), in turn affecting predator-prey dynamics (due to attraction to or disorientation from light); and
- Continuous lighting may result in localised alterations to normal marine fauna behaviours.

### 7.3.3. EMBA

According to the National Light Pollution Guidelines for Wildlife (DCCEEW, 2023c), if there is important habitat for seabirds (e.g., foraging BIAs) and turtles (e.g., nesting beaches) within 20 km of a project, an EIA should be undertaken. The 20 km buffer is based on the observed grounding of seabirds in response to a light source at least 15 km away and observed disorientation of turtle hatchlings to a light source 18 km away (DCCEEW, 2023c).

Based on a MODU deck height of 20 m above the sea, the MODU (and therefore light) would be visible from 16 km away (calculated based on average human height, not birds in the air or turtles at the sea surface). For vessels, this distance would be slightly less. Although there are no bird BIAs or turtle nesting beaches within 20 km of the multi-well activity area, the 20-km radius light EMBA from drilling activities (not including DST) has been adopted as a very conservative EMBA for light emissions in line with DCCEEW (2023).

Light-sensitive receptors that occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Turtles;
- Pelagic fish; and
- Seabirds.

If DST is undertaken, the light from flaring may be visible over a larger distance for a short period of time (approximately 3 days per well). Light modelling was undertaken for Santos' Dorado development (northwest WA) for flaring from an FPSO (Pendoley Environmental, 2020). This study

indicated that the flare is no longer directly visible at 42.4 km, when the flare drops below the horizon. As the flare drops below the horizon, radiance declines rapidly and is no longer visible.

The flare boom for the DST is slightly elevated above the deck. For the typical MODU being considered, the main deck is 22.8 m above MSL and the EverGreen Burner would be ~2.0 m above the main deck. This is lower than the height of a flare on a typical FPSO and therefore distances that the flare would be visible are considered conservative. Lighting impacts are not only related to the amount of artificial light, but also the types of light and the wavelengths that the different light types emit. Measurements of light emitted from a MODU recorded peak wavelengths between 530 to 620 nm, which is within the range that is visible to marine turtles and seabirds (300 to >700 nm) (Woodside, 2019). Light emitted from a natural gas flare recorded peak wavelengths between 750 to 900 nm (Pendoley, 2000 in Woodside, 2019). While this peak is outside the visible spectrum that is most disruptive to wildlife, including marine turtles and seabirds (DCCEEW, 2023c), light emissions from gas flares tend to be high intensity, which is also an important factor. Therefore, light emissions from gas flares may pose a potential risk to wildlife.

### 7.3.4. Evaluation of Environmental Impacts

The routine lighting levels associated with the MODU and support vessels are not considered to be significantly different from other commercial shipping activity in the impacts EMBA (see vessel types in Section 5.7.7), nor will it be a permanent additional contribution of artificial light in the JBG.

The additional lighting experienced during a DST (if performed) will result in a larger light EMBA, conservatively estimated at 42 km, for short periods of time (i.e., a 3-5 day period per zone with less than 1.5 days continuous flaring during each zone for each well).

**Turtles**

Artificial light can disrupt critical behaviours in turtles such as adult nesting and hatchling orientation, sea finding and dispersal ability and can reduce the reproductive viability of turtle stocks (DCCEEW, 2023c). Female turtles nest on sandy tropical and sub-tropical beaches predominantly at night where they rely on visual cues to select nesting beaches and orient on land. Most turtle hatchlings emerge at night and must rapidly orient for and find the ocean to avoid predation. Hatchlings orient for the ocean using both topographic and brightness cues, whereby they move toward the brighter oceanic horizon and away from the darkened silhouettes of the sand dunes on the beach (DCCEEW, 2023c). This critical sea finding behaviour can be disrupted by artificial lights that disorient or misorient the movement of hatchling in a direction other than the sea, which often leads to mortality from predation, exhaustion or dehydration (DCCEEW, 2023c).

The multi-well activity area is located 46 km from the nearest shoreline, which far exceeds the recommended 20 km buffer for artificial light applied to turtle nesting locations for drilling activities, and is also outside the 42 km EMBA from flaring. Therefore, lighting from the MODU, flaring and support vessels is not predicted to impact turtle hatchlings at any potential nesting locations. Although hatchlings have been found to be attracted to light sources in the nearshore environment (Wilson *et al*., 2018), the offshore waters of the operational area and its long distance from shorelines means that the impact of lighting on hatchling dispersal will be negligible (e.g., the nearest nesting beaches are at Cape Domett for green turtles, 84 km to the southwest of the activity area).

The light EMBA from routine drilling and from flaring (Figure 7.2) has been applied to the entire activity area (due to the unknown location of up to three wells within the activity area) and is therefore considered extremely conservative (i.e., light glow will occur from a single point rather

than an area as large as the activity area) and thus overlaps the following turtle BIAs and habitat critical to the survival of marine turtles:

- Green turtle – foraging BIA;
- Flatback turtle – inter-nesting BIA;
- Olive Ridley turtle – foraging BIA; and
- Flat back turtle – nesting - habitat critical to the survival of marine turtles.

Table 7.4 presents a comparison of the routine light EMBA and flaring EMBA overlaps with the turtle BIAs and habitat critical to the survival of marine turtles. Habitat critical to the survival of turtles is discussed in Section 5.4.6.

**Table 7.4. Comparison of the light EMBAs overlap with turtle BIAs and habitat critical to the survival of marine turtles**

| BIA/Habitat critical to the survival of marine turtles | Light EMBA (20 km radius) | Flaring EMBA (42 km radius) |
|---|---|---|
| BIA | | |
| Loggerhead turtle (see Figure 5.25) | 0% | 0% |
| Green turtle – foraging (see Figure 5.26) | 4.3% | 16% |
| Flatback turtle – reproduction (see Figure 5.27) | 7.8% | 27% |
| Olive Ridley turtle – foraging (see Figure 5.28) | 2.73% | 10% |
| Habitat critical to the survival of marine turtles | | |
| Flat back turtle – nesting (see Figure 5.27) | 0.4% | 19% |

*Note: given the uncertainty of the well locations, the EMBA has been applied to the entirety of the activity area (not a particular drilling location). As such, these figures are significantly greater than they would be in reality and are extremely conservative.*

These BIAs are associated with adult foraging turtles, so light emissions from the multi-well activity are anticipated to have a negligible consequence because lighting will not interfere with the behaviour of their prey and therefore disruption to normal foraging behaviour will not be negatively impacted.

Although the light EMBAs overlap important inter-nesting habitat, the number of individuals likely to be present is expected to be limited. Suitable inter-nesting habitat for flatback turtles is defined as water depths shallower than 16 m (Whittock *et al*., 2016b; Pendoley, 2019). The flaring light EMBA reaches water depths between 25-70 m, so suitable inter-nesting habitat will not be impacted. Inter-nesting olive ridley turtles remain relatively close to nesting beaches during the nesting period (in comparison to post-nesting movements); tagged turtles remained within 48 km of the nesting beach in waters typically <30 m water depth (Hamel *et al*., 2008). Inter-nesting may occur year-round with a peak expected between April and June with increased potential for inter-nesting females to occur during this time.

If individual turtles are present, light emissions are unlikely to be of concern. There is no evidence, published or anecdotal, to suggest inter-nesting turtles are impacted by light from offshore vessels, and nothing in their biology would indicate this as a plausible threat (Pendoley, 2019; Witherington and Martin, 2003). Potential impacts to foraging turtles are limited to local attraction to prey species attracted to light (Kebodeaux, 1994).

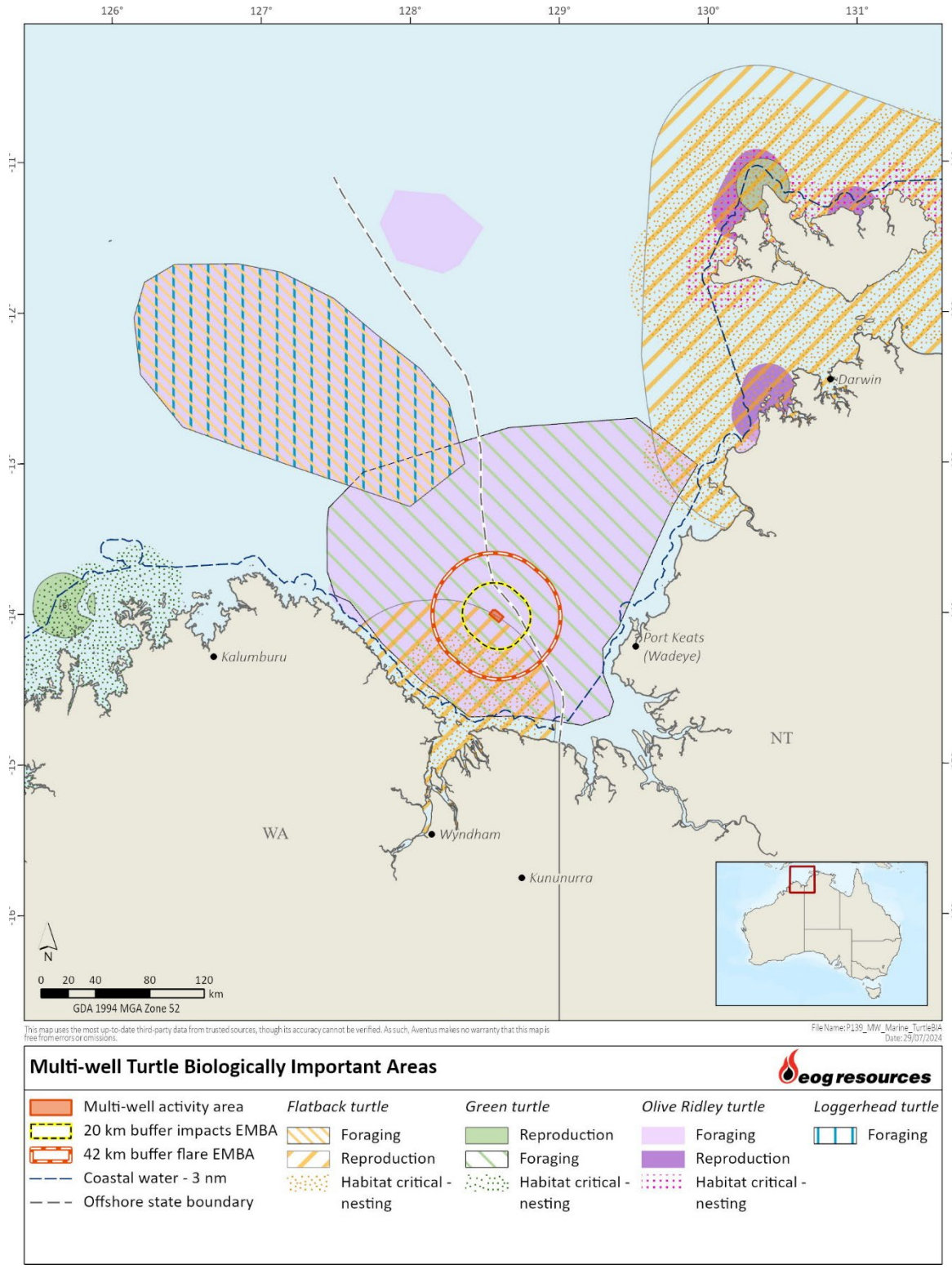



**Figure 7.2. Turtle BIAs and habitat critical to the survival of marine turtles in the light EMBAs**

Marine turtles do not feed during the breeding season (Limpus *et al*., 2013), and light is not a cue to inter-nesting behaviours. Therefore, potential impacts of artificial light to inter-nesting turtles are not considered likely.

Adult turtles have been observed feeding on prey presumed to be attracted by lights of oil production platforms in the Gulf of Mexico (Kebodeaux, 1994). However, illuminating fishing nets has been shown to reduce the bycatch of green turtles as they are thought to alert them to the presence of a net (Ortiz *et al*., 2016). This suggests that, although aggregation of foraging turtles may occur around light sources as a secondary response to effects of light on prey distribution, light does not appear to act as a cue to foraging behaviour. Light pollution is identified as a threat to turtles in the Recovery Plan for Marine Turtles 2017-2027 (DoEE, 2017c). An assessment of relevant interim recovery objectives and targets with the activity is provided in Table 7.5.

**Table 7.5. Assessment of the relevant interim recovery objectives and targets of the Recovery Plan for Marine Turtles 2017-2027 (DoEE, 2017c) with the activity**

| Interim Objective or Target | Assessment |
|---|---|
| *Interim Objective 3: Anthropogenic threats are demonstrably minimised.* | |
| Target 3.1: Robust and adaptive management regimes that lead to a reduction in anthropogenic threats to marine turtles and their habitats are in place. | The EPS listed in Table 7.8 will reduce the impact of light emissions on turtles to ALARP and ensure the activity is conducted in a manner that is not inconsistent with this recovery target. |
| Target 3.2: Threat mitigation strategies are supported by high quality information. | The activity will not have any impacts on this recovery target. |

Based on this impact evaluation, there is no information to suggest that drilling up to three wells in succession (if it were to occur) would result in cumulative impacts to turtle foraging, nesting or inter-nesting behaviours.

**Fish and plankton**

Fish and zooplankton may be directly or indirectly attracted to lights. Experiments using light traps have found that some fish and zooplankton species are attracted to light sources (Meekan *et al*., 2001), with traps drawing catches from up to 90 m (Milicich *et al*., 1992). Lindquist *et al.* (2005) concluded from a study of larval fish populations around an oil and gas platform in the Gulf of Mexico that an enhanced abundance of clupeids (herring and sardines) and engraulids (anchovies), both of which are highly photopositive, was caused by the platforms' light fields. The concentration of organisms attracted to light results in an increase in food source for predatory species and marine predators are known to aggregate at the edges of artificial light halos. Shaw *et al*. (2002), in a similar light trap study, noted that juvenile tunas (Scombridae) and jacks (Carangidae), which are highly predatory, may have been preying upon concentrations of zooplankton attracted to the light field of the platforms. This could potentially lead to increased predation rates compared to unlit areas.

Overall, an increase in fish activity around the MODU and support vessels may occur at night-time, but this is highly localised and short-term and therefore expected to have negligible impacts to the local and regional food web.

Based on this impact evaluation, there is no information to suggest that drilling up to three wells in succession (if it were to occur) would result in cumulative impacts to fish and plankton populations.

**Cetaceans**

There is no evidence to suggest that artificial light sources adversely affect the migratory, feeding or breeding behaviours of cetaceans. Cetaceans predominantly utilise acoustic senses to monitor their environment rather than visual sources (Simmonds *et al.,* 2004), so light is not considered to be a significant factor in cetacean behaviour or survival and will therefore have a negligible impact.

**Seabirds**

Seabirds may be attracted to light glow at night-time. Bright lighting can disorientate birds, thereby increasing the likelihood of seabird injury or mortality through collision with the MODUs and support vessels, or mortality from starvation due to disrupted foraging at sea (Wiese *et al*., 2001 in DSEWPC, 2011b; Rajkhowa, 2014). This disorientation may also result in entrapment, stranding, grounding and interference with navigation (DCCEEW, 2023c). The DCCEW (2023) notes that seabird fledglings may be affected by lights up to 15 km away. Studies conducted between 1992 and 2002 in the North Sea confirmed that artificial light was the reason that birds were attracted to and accumulated around illuminated offshore infrastructure (Marquenie *et al*., 2008) and that lighting can attract birds from large catchment areas (Wiese *et al*., 2001). The light may provide enhanced capability for seabirds to forage at night.

The WCP for seabirds (2020) identifies light pollution as minor threat to seabirds. Vessels are listed as a problematic source of light and offshore oil platforms and flaring have also been identified as impact light sources. Artificial lighting has the potential to interfere with nocturnal breeding behaviours of some seabirds. Fledglings are more vulnerable to artificial light compared to adults, due to their naivety on their first flight (Commonwealth of Australia, 2020).

There are no seabird BIAs that are intersected by the light EMBA from routine activities or during flaring (Figure 7.3). Therefore, impacts to seabird breeding colonies from light emissions are not expected to occur. However, there is potential for foraging seabirds to be present at the time of the activity. Given the short duration of the activity at each drill site and the distance of the multi-well activity area from breeding colonies, the consequence of light emissions on seabird populations will be negligible. This remains the case regardless of whether one, two or three wells are drilled.

**Marine Parks**

Management of the JBG AMP is covered by the North Marine Parks Network Management Plan 2018 (DNP, 2018a). This plan identifies light emissions associated with habitat modification and marine pollution as a pressure on the AMP network. The light EMBA from day-to-day drilling activity does not intersect any AMPs (it is located 10 km from the boundary of the JBG AMP) or other marine protected areas (see Figure 7.3).

The 42 km light EMBA from flaring will overlap parts of the western and southern edges of the JBG AMP during DST (9.8% overlap in total), with no overlap of the North Kimberley Marine Park. The JBG AMP's key values are its submerged features and nearshore ecosystems (outside of the light EMBA). The submerged features are not considered at risk of impacts from flaring lighting emissions. The JBG AMP supports a range of species including marine turtles and the Australian snubfin dolphin. Impacts to turtles from the flaring light EMBA are described earlier in this section, and there is no evidence to suggest that artificial light sources adversely affect the migratory,

feeding or breeding behaviours of cetaceans. Therefore, flaring will not have a significant impact on the values of the JBG AMP.

**Community**

The distance of the closest point of the multi-well activity area from the nearest shoreline (76 km) and nearest town (Wadeye, 100 km) means that MODU and support vessel lighting in the activity area will not be visible from land. Visual impacts to these communities from lighting will not occur.

**National Light Pollution Guidelines for Wildlife**

Table 7.6 provides an assessment of the light management options for seabirds as outlined in Table 8 of the National Light Pollution Guidelines for Wildlife (DCCEEW, 2023c). Where management options have been deemed as feasible, they have been assessed and adopted as a control measure and associated EPS have been developed (Table 7.6).

Table 7.7 provides an assessment of the light management options for turtle nesting beaches as outlined in Table 5 of the National Light Pollution Guidelines for Wildlife (DCCEEW, 2023c) against the activity. Where management options have been deemed as feasible, they have been assessed and adopted as a control measure and associated EPS have been developed (Table 7.7).

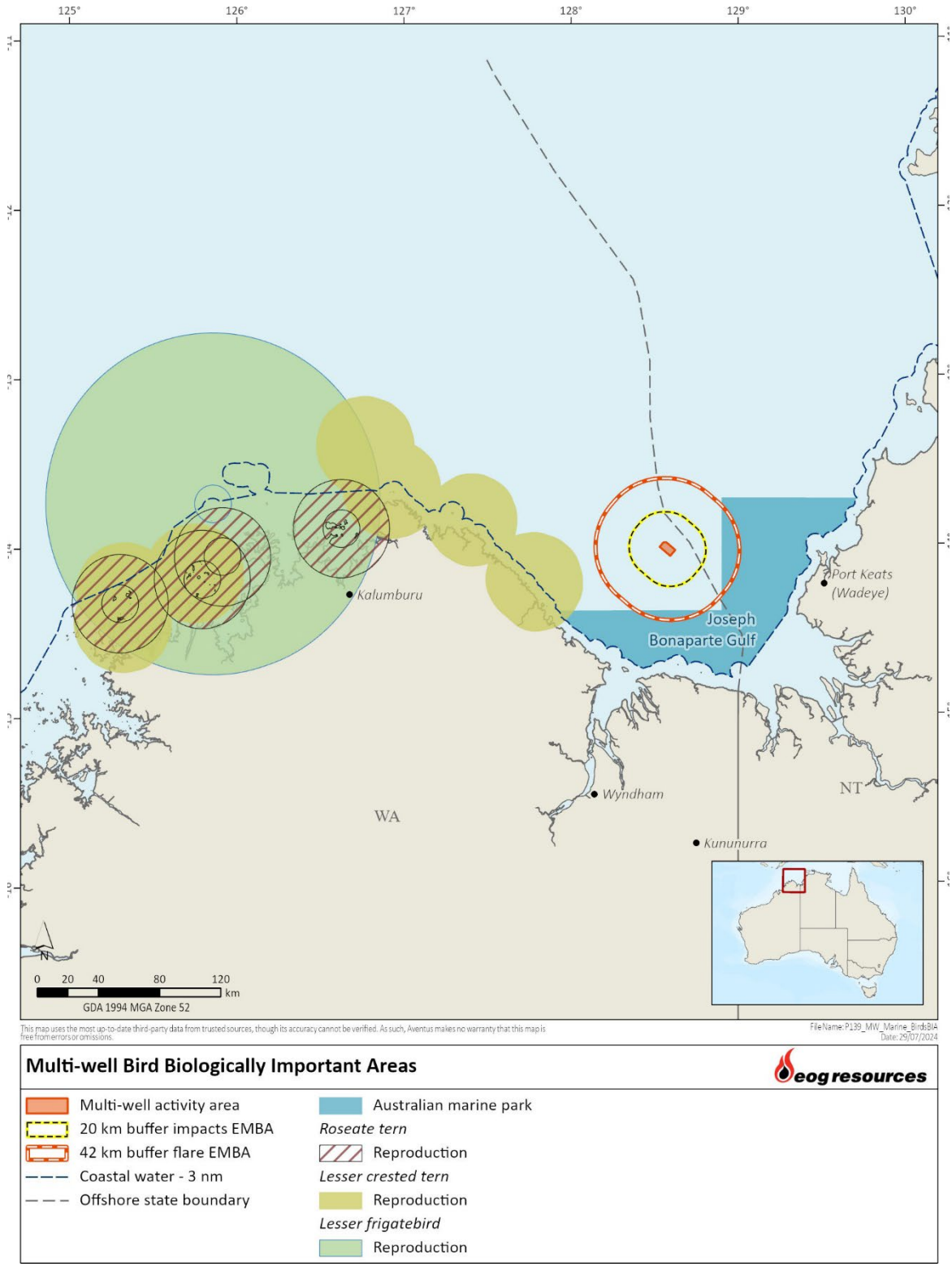



**Figure 7.3. Seabird BIAs closest to the light EMBAs**

**Table 7.6. Assessment of the light management options for seabirds from the National Light Pollution Guidelines for Wildlife (DCCEEW, 2023c)**

| Management option | Achievable? | Justification |
|---|---|---|
| Implement management actions during the breeding season. | Yes | Achievable management actions are identified in this table and in Table 7.8 (adopted control measures and associated EPS). |
| Maintain a dark zone between the rookery and the light sources. | Yes | The nearest shoreline (and thus potential rookery location) is 80 km away on the southern coast of the JBG. As such, there is a large dark zone between the rookery and the activity area. |
| Turn off lights during fledgling season. | No | Drilling operations are conducted 24-hours a day and light is necessary for navigational and personnel safety. Lighting will be reduced to the furthest extent possible for safe operations (see Table 7.8). |
| Use curfews to manage lighting. | No | As above. |
| Aim lights downwards and direct them away from nesting areas. | Yes | Where practicable, lights will be directed towards working areas for the safety of personnel (see Table 7.8). |
| Use flashing/intermittent lights instead of fixed beam. | No | Drilling operations are conducted 24-hours a day and light is necessary for personnel safety. Lighting will be reduced to the furthest extent possible for safe operations (see Table 7.7). |
| Use motion sensors to turn lights on only when needed. | No | As above. |
| Prevent indoor lighting reaching outdoor environment. | Yes | Blinds will be lowered on portholes and windows at night where this does not interfere with safe work practices (see Table 7.8). |
| Manage artificial light on jetties, wharves, marinas, etc. | N/A | Not applicable to this activity. |
| Reduce unnecessary outdoor, deck lighting on all vessels and permanent and floating oil and gas installations in known seabird foraging areas at sea. | Yes | Lighting will be reduced to that required for safe operations and by maritime legislative requirements (see Table 7.8). Flaring (if undertaken), will be undertaken only intermittently over the course of 3-5 days per zone. |
| Night fishing should only occur with minimum deck lighting. | N/A | Not applicable - fishing is not permitted from the MODU or support vessel. |

| Management option | Achievable? | Justification |
|---|---|---|
| Avoid shining light directly onto fishing gear in the water. | N/A | Not applicable - fishing is not permitted from the MODU or support vessel. |
| Ensure lighting enables recording of any incidental catch, including by electronic monitoring systems. | N/A | Not applicable - fishing is not permitted from the MODU or support vessel. |
| Avoid shining light directly onto longlines and/or illuminating baits in the water. | N/A | Not applicable - fishing is not permitted from the MODU or support vessel. |
| Vessels working in seabird foraging areas during breeding season should implement a seabird management plan to prevent seabird landings on the ship, manage birds appropriately and report the interaction. | N/A | The MODU and support vessels are equipped with lighting required under legislation to identify itself to other vessels, reduce the risk of at-sea collision and provide for the safety of its crew.<br>Most seabirds in the region are migratory, with no breeding areas (i.e., islands) within 75 km of the activity area. |
| Use luminaires with spectral content appropriate for the species present. | No | The activity vessel is equipped with lighting required under legislation to identify themselves to other vessels, reduce the risk of at-sea collision and provide for the safety of crews.<br>Most seabirds in the region are migratory, with no breeding areas (i.e., islands) within 78 km of the activity area. See Table 7.8 for adopted control and associated EPS. |
| Avoid high intensity light of any colour. | No | As above. |
| Shield gas flares and locate inland and away from seabird rookeries. | No | The activity may involve flaring, but the flare is not able to be shielded. The multi-well activity area is located a long distance from seabird rookeries, so this management option is not required. |
| Minimise flaring on offshore oil and gas production facilities. | Yes | Flaring (if undertaken), will be undertaken only intermittently over the course of 3-5 days per zone per well. |
| In facilities requiring intermittent night-time inspections, turn on lights only during the time operators are moving around the facility. | N/A | The MODU and support vessels are equipped with lighting required under legislation to identify themselves to other vessels, reduce the risk of at-sea collision and provide for the safety of crews. |
| Ensure industrial site/plant operators use head torches. | No | Drilling operations are conducted 24-hours a day and lighting of all areas is necessary for personnel safety. As such, the use of head torches is not necessary. Lighting will be reduced so far as is practicable and in accordance with maritime requirements and personnel safety. See Table 7.8 for adopted control and associated EPS. |

| Management option | Achievable? | Justification |
|---|---|---|
| Supplement facility perimeter security lighting with computer monitored infrared detection systems. | N/A | Not applicable to this activity. |
| Tourism operations around seabird colonies should manage torch usage so birds are not disturbed. | N/A | Not applicable to this activity. |
| Design and implement a rescue program for grounded birds. | No | Due to the distance between the operational area and seabird rookeries, grounding of birds is unlikely to occur and thus a rescue program is not necessary. |

**Table 7.7. Assessment of the light management options for turtle nesting beaches from the National Light Pollution Guidelines for Wildlife (DCCEEW, 2023c)**

| Management option | Achievable? | Justification |
|---|---|---|
| Implement light management actions during the nesting and hatching season. | Yes | Achievable management actions are identified in this table and in Table 7.8 (adopted control measures and associated EPS). |
| Avoid direct light shining onto a nesting beach or out into the ocean adjacent to a nesting beach. | Yes | The nearest shoreline (and thus potential nesting location) is 76 km away on the southern coast of the JBG. As such, the MODU and support vessel lighting will not shine on to the beach or the ocean adjacent to the beach. |
| Maintain a dune and/or vegetation screen between the nesting habitat and inland sources of light. | N/A | Not applicable to this activity. |
| Maintain a dark zone between turtle nesting beach and industrial infrastructure | Yes | The nearest shoreline (and thus potential nesting location) is 76 km away on the southern coast of the JBG. As such, there is a large dark zone between the coast and the activity area. |
| Install light fixtures as close to the ground as practicable. | No | Drilling operations are conducted 24-hours a day and light is necessary for navigational and personnel safety. Lighting will be reduced to the furthest extent possible for safe operations (see Table 7.8). |
| Use curfews to manage lighting. | No | Drilling operations are conducted 24-hours a day and light is necessary for navigational and personnel safety. Lighting will be reduced to the furthest extent possible for safe operations (see Table 7.8). |
| Aim lights downwards and direct them away from nesting beaches. | Yes | Where practicable, lights will be directed towards working areas for the safety of personnel (see Table 7.8). |
| Use flashing/intermittent lights instead of fixed beam. | No | Drilling operations are conducted 24-hours a day and light is necessary for navigational and personnel safety. Lighting will be reduced to the furthest extent possible for safe operations (see Table 7.8). |
| Use motion sensors to turn on lights only when needed. | No | Drilling operations are conducted 24-hours a day and light is necessary for navigational and personnel safety. Lighting will be reduced to the furthest extent possible for safe operations (see Table 7.8). |

| Management option | Achievable? | Justification |
|---|---|---|
| Prevent indoor lighting reaching beach. | Yes | Blinds will be lowered on portholes and windows at night where this does not interfere with safe work practices (see Table 7.8). |
| Limit the number of beach access areas or construct beach access such that artificial light is not visible through the access point. | N/A | Not applicable to this activity. |
| Work collectively with surrounding industry/private land holders to address the cumulative effect of artificial lights. | N/A | Not applicable to this activity. |
| Manage artificial light at sea, including on vessels, jetties, marinas and offshore infrastructure. | Yes | Achievable management actions are identified in this table and in Table 7.8 (adopted control measures and associated EPS). |
| Reduce unnecessary lighting at sea. | Yes | Flaring (if undertaken), will use a boom that extends past the deck and over the sea. If undertaken, it will be intermittent over the course of 3-5 days per zone per well.<br>Achievable management actions are identified in this table and in Table 7.8 (adopted control measures and associated EPS). |
| Avoid shining light directly onto longlines and/or illuminating baits in the water. | N/A | Not applicable to this activity – no fishing is allowed from the MODU or support vessels. |
| Avoid lights containing short wavelength violet/blue light. | No | The MODU and support vessels are equipped with lighting required under legislation to identify themselves to other vessels, reduce the risk of at-sea collision and provide for the safety of its crew.<br>Most seabirds in the region are migratory, with no breeding areas (i.e., islands) within 80 km of the activity area. See Table 7.8 for adopted control and associated EPS. |
| Avoid white LEDs. | No | As above. |
| Avoid high intensity light of any colour. | No | As above. |
| Shield gas flares and locate inland and away from nesting beach. | No | The activity may involve flaring, but the flare is not able to be shielded. The activity area is located a long distance from seabird rookeries, so this management option is not required. |

| Management option | Achievable? | Justification |
|---|---|---|
| Industrial/port or other facilities requiring intermittent night-time light for inspections should keep the site dark and only light specific areas when required. | No | Drilling operations are conducted 24-hours a day and light is necessary for navigational and personnel safety. Lighting will be reduced to the furthest extent possible for safe operations (see Table 7.8). |
| Industrial site/plant operators to use head torches. | No | Drilling operations are conducted 24-hours a day and lighting of all areas is necessary for personnel safety. As such, the use of head torches is not necessary. Lighting will be reduced so far as is practicable and in accordance with maritime requirements and personnel safety. See Table 7.8 for adopted control and associated EPS. |
| Supplement facility perimeter security lighting with computer monitored infra-red detection systems. | N/A | Not applicable to this activity. |
| No light source should be directly visible from the beach. | Yes | The nearest shoreline (and thus potential nesting location) is 76 km away on the southern coast of the JBG. As such, the MODU and support vessel lighting will not be visible from the beach. |
| Manage light from remote regional sources (up to 20 km away). | Yes | The nearest shoreline (and thus potential nesting location) is 76 km away on the southern coast of the JBG. As such, the MODU and support vessel lighting will not be visible from the beach. |

### 7.3.5. Impact Assessment

Table 7.8 presents the impact assessment for light emissions.

**Table 7.8. Impact assessment for light emissions**

| Summary | | |
|---|---|---|
| Summary of impacts | Light glow may act as an attractant to light-sensitive species (e.g., seabirds, turtles, fish, zooplankton), in turn affecting predator-prey dynamics (due to attraction to or disorientation from light). | |
| Extent of impacts | Localised for most marine fauna, and up to 15 km for turtle hatchlings and 20 km for seabirds during day-to-day drilling activities, and up to 42 km during flaring. | |
| Duration of impacts | Temporary – short-term (duration of activity) (and up to 3-5 days for flaring per well). | |
| Level of certainty of impacts | HIGH – the impacts of light glow on marine fauna are well known. | |
| Impact decision framework context | Decision type | A - good industry practice required. |
| | Activity | Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined. |
| | Risk & uncertainty | Risks are well understood, uncertainty is minimal. |
| | Stakeholder influence | No conflict with company values, no partner interest, no significant media interest. |
| Defined acceptable level | The impacts of light emissions to EPBC Act-listed threatened and migratory bird species and marine turtles are not inconsistent with their in-force recovery plans or wildlife conservation plans/advice. | |
| Impact Consequence (inherent) | | |
| Negligible | | |
| Assessment of Proposed Control Measures | | |
| Control measure | Control type | Adopt | Justification |
| Exclude night-time operations. | Eliminate | No | **EB:** Eliminates impact of night-time light emissions on sensitive species (e.g., seabirds and turtles foraging at night).<br>**C:** Would double the duration of the activity and therefore double activity costs.<br>**Ev:** Increased impacts in other areas due to a longer presence on location, including increase in waste discharges, air emissions, displacement of commercial fishers. The high costs associated with extending the activity are grossly disproportionate to the benefits. Lighting is required by law for navigational and safety purposes. |
| Manage the timing of the activity to avoid sensitive periods. | Eliminate | No | **EB:** Reduces potential for impacts on turtles during critical life stages from light emissions.<br>**C:** Timing of the activity is subject to multiple factors and turtle activity can occur all year round, with breeding from June-August. |

| | | | |
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| | | | **Ev:** Impacts to nesting females, emerging hatchlings and dispersing hatchlings at sea are not expected to result in changes at the individual, population or genetic stock level. A seasonal exclusion would not avoid all turtle nesting, inter-nesting and hatchling activity but may avoid the known peaks. The impact assessment determined the risk to hatchlings from light emissions is low and not inconsistent with the requirements of the Recovery plan for marine turtles in Australia 2017–2027. |
| Do not flare. | Eliminate | No | **EB:** Eliminates impact of artificial light on sensitive species (e.g., seabirds and turtles).<br>**C:** In a success case, not being able to test the well using DST (which involves flaring) compromises the objectives of the drilling program and would it make it extremely difficult to predict future steps. Flaring is a pre-requisite for declaring a discovery (which is the objective of this activity).<br>**Ev:** The high costs associated with not being able to evaluate the well sufficiently are grossly disproportionate to the benefits of temporary additional light. |
| Keep MODU and support vessel external lighting to levels required for navigation, and safety of deck operations **(IMP-03:EPS-01)**. | Engineering | Yes | **EB:** This keeps light to the minimum required to meet legislated navigation requirements whilst reducing the likelihood of impacts to fauna from MODU and support vessel lighting.<br>**C:** No additional activity costs. MODU and support vessel lighting is a legislative requirement for safe navigation and deck operations.<br>**Ev:** Good practice is well defined and established in Marine Orders (Part 30 and Part 59) for MODUs and vessels. Lighting is required to provide navigational safety and meet legislative requirements. Lighting is reduced to the lowest practicable level to allow for safe work practices and legislative compliance. |
| Install lighting shields. | Engineering | No | **EB:** Reduces light spill to the marine environment through physical barriers.<br>**C:** These are not standard fixtures on MODUs and vessels. There will be significant time and cost to install these.<br>**Ev:** External lighting is necessary for safe navigation and deck operations. The cost of this control measure outweighs the minimal benefit this control measure would have. |
| Use of lighting with wavelengths that are less intrusive to marine fauna. | Engineering | No | **EB:** Some marine fauna are less sensitive to particular light wavelengths.<br>**C:** High cost of sourcing specialised globes.<br>**Ev:** Lighting will be managed in accordance with the relevant Australian and international standards to ensure that personnel and vessel safety is not compromised. This control measure is unlikely to result in reduced impact due to the diversity of species present in the region and the significant |

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| | | | distance to sensitive receptors, such as turtle nesting beaches; no single light wavelength can reduce risks for all fauna groups. This control measure would result in negligible benefit at a high cost. |
| Use of dark, matte surfaces on MODU and support vessels. | Engineering | No | **EB:** Would reduce reflection and scattering of light that results in skyglow.<br>**C:** Additional cost to repaint surfaces. Some areas may require lighter surfaces to manage heat conduction for health and safety. Unlikely to result in a material light reduction.<br>**Ev:** The high financial cost would be grossly disproportionate to negligible environmental benefits. May compromise human health and safety in some circumstances. |
| Direct lighting to working areas only on the MODU and support vessels **(IMP-03:EPS-02)**. | Engineering | Yes | **EB:** Reduces light spill to the marine environment.<br>**C:** No additional costs.<br>**Ev:** Good practice and well established in the industry. Environmental benefits can be achieved with no cost. |
| Periodically inspect lighting on-board to confirm it complies with lighting standards **(IMP-03:EPS-03)**. | Administrative | Yes | **EB:** Provides mechanism to inspect the implementation of control measures and their associated environmental benefits.<br>**C:** Cost of time only.<br>**Ev:** Good practice and well established in the industry. Environmental benefits can be achieved with minimal cost. |
| Lower blinds on non-essential portholes and windows at night **(IMP-03:EPS-04)**. | Administrative | Yes | **EB:** Reduces light spill to the marine environment.<br>**C:** No additional cost. Involves only time to discuss this during crew inductions and in undertaking routine inspections.<br>**Ev:** Good practice and well established in the industry. Environmental benefits can be achieved without cost. |
| Implementation of Well Test Plan to minimise flaring overall **(IMP-03:EPS-05)**. | Administrative | Yes | **EB:** Ensures well test crew follow set procedures, thereby ensuring efficient flaring for minimal periods of time.<br>**C:** The preparation of a Well Test Plan is standard practice for well testing contractors, whereby the cost is factored into the contract and not an extra cost per se.<br>**Ev:** Environmental benefits outweigh the low costs. |

| Environmental Controls and Performance Measurement | | |
|---|---|---|
| EPO | EPS | Measurement criteria |
| External lighting conforms to that required by maritime safety standards. | **(IMP-03:EPS-01)** External lighting is managed in accordance with:<br>• AMSA Marine Orders Part 30 (Prevention of Collisions). | Vessel class certifications are current. |

| | | |
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| | • AMSA Marine Orders Part 59 (Offshore Support Vessel Operations). | |
| Lighting is reduced to limit the localised attraction of marine fauna. | **(IMP-03:EPS-02)** Lighting is directed to working areas (rather than overboard) to minimise light spill to the ocean. | Completed environmental checklists and photos verify that lighting standards are inspected, and lighting is directed inboard where practicable. |
| | **(IMP-03:EPS-03)** Lighting is periodically inspected to ensure it complies with lighting standards and relevant control measures. | |
| | **(IMP-03:EPS-04)** Blinds will be lowered on all non-essential portholes and windows at night. | Completed environmental checklists and photos verify that blinds are drawn each night. |
| | **(IMP-03:EPS-05)** In accordance with the Well Test Plan, flaring is limited to the minimum time required to safely undertake the DST and achieve data collection requirements. | DDRs record the duration of flaring. |
| | **(IMP-03:EPS-06)** All crew are informed of the artificial lighting control measures during the environmental awareness induction. | Induction presentation includes requirements to minimise artificial lighting. |
| | | Induction attendance list verify crew are aware of these measures. |
| Impact Consequence (residual) | | |
| Negligible | | |
| The consequence of light emissions is assessed as negligible because:<br>• The activity is short-term;<br>• There are no seabird breeding colonies or turtle nesting beaches within the light EMBA;<br>• Wildlife potentially vulnerable to light (e.g., seabirds and turtles) will not be displaced from foraging habitat; and<br>• The control measures adopted are commensurate with the inherent level of impact consequence. | | |
| Statement of ALARP | | |
| A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence. | | |
| Demonstration of Acceptability | | |
| Policy compliance | EOG's Safety and Environmental Policy objectives are met. | |
| EMS compliance | Chapter 10 describes the EP implementation strategy to be employed for this activity. | |
| Risk matrix standard compliance | The residual impact consequence is negligible, which is considered acceptable. | |
| External context | There have been no objections or claims made by relevant persons regarding light emissions for this activity. | |
| Legislative context | The EPS align with the requirements of:<br>• COLREGS 1972.<br>• *Navigation Act* 2012 (Cth): | |

| | | |
|---|---|---|
| | ○ Part 3 (Prevention of Collisions).<br>○ AMSA Marine Orders Part 21 (Safety of Navigation and Emergency Procedures).<br>○ AMSA Marine Orders Part 27 (Safety of Navigation and Radio Equipment).<br>○ AMSA Marine Orders Part 30 (Prevention of Collisions).<br>○ AMSA Marine Order 58 (Safe Management of Vessels). | |
| Industry practice | The consideration and alignment of EPS with the mitigation measures outlined in the below-listed guidelines and codes of practice demonstrates that BPEM will be implemented for this activity. | |
| | Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020) | The EPS listed in this table meet the relevant mitigation measures listed for offshore activities with regard to:<br>• Light emissions - minimise external lighting to that required for navigation and safety of deck operations **(IMP-03:EPS-02, -03, -04)**. |
| | Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019) | There are no guidelines specifically regarding lighting for offshore activities. |
| | Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015) | There is no specific guidance regarding lighting emissions.<br>Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement. |
| | Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015) | The EPS listed in this table are in accordance with these guidelines with regard to:<br>• Ship collision (item 120). To avoid collisions with third-party vessels, offshore facilities should be equipped with navigational aids that meet national and international requirements, including navigational lights on vessels **(IMP-03:EPS-01)**. |
| | AEP CoEP (APPEA, 2008) | The EPS for this activity meet the code's following objectives for offshore drilling operations:<br>• To reduce the impact of light to ALARP and an acceptable level.<br>• To reduce the risk of collision with other vessels in accordance with maritime standards and to an acceptable level. |
| | Light-specific guidance | |
| | The National Light Pollution Guidelines for Wildlife (DCCEEW, 2023c) | The EPS listed in this table meet the following management actions related to activities associated with the MODU and support vessels: |

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|---|---|---|
| | | • Maintain a dark zone between the rookery and the light sources.<br>• Aim lights downwards and direct them away from nesting areas **(IMP-03:EPS-02)**.<br>• Prevent indoor light reaching outdoor environment **(IMP-03:EPS-04)**.<br>• Reduce unnecessary outdoor, deck lighting on all vessels in known seabird foraging areas at sea **(IMP-03:EPS-02)**.<br>An assessment of the activity against the management actions of these guidelines is included in Table 7.5 for seabirds and Table 7.6 for turtles. |
| Environmental context | MNES | |
| | AMPs | The lighting EMBA from the DST will overlap up to 9.8% of the JBG AMP, which is designated to protect submerged features (these are not affected by lighting), marine turtles and dolphins. Impacts may be limited to behavioural impacts to individual turtles and dolphins and not inconsistent with the objectives of this AMP management plan. |
| | Ramsar wetlands | This hazard will not reach any Ramsar wetlands. |
| | TECs | This hazard will not reach any TECs. |
| | Nationally threatened and migratory species | The activity will be managed in a manner such that nationally threated and migratory species will not be impacted by localised and temporary light emissions. |
| | Other matters | |
| | KEFs | This hazard will not reach any KEFs. |
| | NIWs | This hazard will not reach any NIWs. |
| | State marine parks | This hazard will not reach any state marine parks. |
| | Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans | Table 7.6 demonstrates that light emissions will not be inconsistent with the objectives of the Recovery Plan for Marine Turtles 2017-2027 (DoEE, 2017c).<br>The EPS outlined within this table mitigate the risk of artificial light on seabirds identified as a threat by the WCP for seabirds (Commonwealth of Australia, 2020). |
| ESD principles | The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant). | |
| Statement of Acceptability | EOG considers the impacts from light emissions to be acceptable because:<br>• It will adhere to the company's Safety and Environmental Policy; | |

| | |
|---|---|
| | • The residual consequence rating is negligible;<br>• An Implementation Strategy (described in Chapter 10) is in place to ensure the EPS are achieved.<br>• Relevant legislation and industry best practice will be complied with;<br>• Light emissions will not have long-term or significant impacts on MNES;<br>• The management of lighting is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species;<br>• The management of lighting is not inconsistent with the aims of relevant marine reserve management plans; and<br>• The management of lighting is not inconsistent with ESD principles. |
| Environmental Monitoring | |
| • Periodic lighting inspections. | |
| Record Keeping | |
| • Vessel class certification.<br>• Completed environmental inspections checklists.<br>• Photos. | • Induction presentation.<br>• Induction attendance sheet. |

## 7.4. IMPACT 4 – Routine Emissions – Atmospheric

### 7.4.1. Hazard

The use of fuel to power the MODU and support vessels will result in emissions of GHGs such as carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$), along with non-GHG such as sulphur oxides (SOx) and nitrogen oxides (NOx).

The following activities generate atmospheric emissions from the MODU and support vessels:

- Combustion of marine diesel oil (MDO) from engines, generators, cranes and other fixed and mobile equipment;
- Flaring (if undertaken);
- Painting and paint storage, resulting in the release of fugitive volatile organic compounds (VOCs) as vapours;
- Release of ozone-depleting substances (ODS) from refrigerants (R134a, R407C and R410A) used in the centralised air-conditioning system during maintenance activities; and
- When transferring dry bulk products used for drilling (e.g., barite, bentonite), tank venting is necessary to prevent tank overpressure. The vent air will contain minor quantities of product particles, which will suspend in the air or settle on the sea surface.

Atmospheric emissions from fuel combustion from the helicopter will also be generated, but are considered negligible given the jurisdiction for the helicopter is a 500-m radius from the MODU.

Greenhouse gases comprise a large part of atmospheric emissions and are measured in units called carbon dioxide equivalent ($CO_2$-e). This means that the amount of a GHG that an entity emits is measured as an equivalent amount of carbon dioxide which has a global warming potential of one. For example, one tonne of methane released into the atmosphere will cause the same amount of global warming as 25 tonnes of carbon dioxide. So, the one tonne of methane is expressed as 25 tonnes of carbon dioxide equivalence, or 25 t $CO_2$-e (CER, 2022).

Greenhouse gas emissions from industry and business are reported as Scope 1, 2 and 3, and are defined by the World Business Council for Sustainable Development, the World Resources Institute and the CER (2022) below:

- Scope 1 – direct emissions released to the atmosphere as a result of an activity, or series of activities at a facility level (e.g., burning of diesel in company-owned vehicles or used in on-site plant and equipment, such as a MODU).
- Scope 2 – indirect emissions released to the atmosphere associated with the import of energy from another source (e.g., use of electricity produced by the burning of coal in another facility).
- Scope 3 – other indirect emissions, other than energy imports that are a direct result of the operations of the organisation, but from sources not owned or operated by them and due to upstream or downstream activities (e.g., combustion of hydrocarbons extracted by a future Beehive well and sold to the market).

Only Scope 1 emissions will be generated by the multi-well drilling campaign, as estimated below:

- MODU – combustion emissions will be expelled from exhaust stacks about 22-25 m above deck level to ensure adequate aerial dispersion. For a drilling campaign undertaken in Bass Strait using a jack-up MODU in late 2019 and early 2020, the average daily diesel consumption was 14,500 litres. This would result in the generation of about 39 tonnes of carbon dioxide equivalent ($CO_2$-e) per day. For the estimated duration of drilling each well, this will result in the emissions of 2,145 t $CO_2$-e (55 days) to 5,850 t $CO_2$-e (150 days). If all three wells are drilled, this is 6,425 t $CO_2$-e (55 days) to 17,550 t $CO_2$-e (150 days).
- Support vessels – during the same drilling campaign in Bass Strait, the two support vessels consumed an average of 6,400 litres of diesel per day. This would result in the generation of about 17 tonnes of $CO_2$-e each day. For the estimated duration of drilling for each well, this will result in the emissions of 935 t $CO_2$-e (55 days) to 2,550 t $CO_2$-e (150 days). If all three wells are drilled, this is 2,805 t $CO_2$-e (55 days) to 7,650 t $CO_2$-e (150 days).
- Flaring – if flaring is undertaken, and assuming a worst-case calculation of flowing 37,333 bbl oil (with an associated 67.2 MMscf of gas) for the testing of two zones over a period of 3-5 days, it is estimated that 19,877 t $CO_2$-e would be generated for each well that is tested. If all three wells are tested, this is 59,631 t $CO_2$-e.

### 7.4.2. Known and Potential Environmental Impacts

The known and potential environmental impacts of atmospheric emissions are:

- Localised and temporary decrease in air quality due to gaseous emissions and particulates from MDO combustion; and
- Addition of GHG to the atmosphere (influencing climate change).

### 7.4.3. EMBA

The EMBA for atmospheric emissions associated is the local air shed, likely to be within hundreds of meters of the MODU and support vessels, both horizontally and vertically. Sensitive receptors that may occur within this EMBA, either as residents or migrants, are seabirds. The health of the workforce on the MODU and support vessels, with regard to atmospheric emissions, is considered and assessed in other health and safety project documents.

### 7.4.4. Evaluation of Environmental Impacts

**Localised and temporary decrease in air quality from diesel combustion**

The combustion of MDO fuel can create continuous or discontinuous plumes of particulate matter (soot or black smoke) and the emission of non-GHG, such as $SO_X$ and $NO_X$. Inhaling this particulate matter can cause or exacerbate health impacts to humans exposed to the particulate matter, such as offshore project personnel or residents of nearby towns (e.g., respiratory illnesses such as asthma) depending on the amount of particles inhaled. Similarly, the inhalation of particulate matter may affect the respiratory systems of fauna. In the activity area, this is limited to seabirds overflying the MODU and support vessels.

Particulate matter released from the MODU and support vessels is not likely to impact on the health or amenity of the nearest human coastal settlements (e.g., Port Keats (Wadeye) (NT) or Wyndham (WA)), as offshore winds will rapidly disperse and dilute particulate matter. This rapid dispersion and dilution will also ensure that seabirds are not exposed to concentrated plumes of particulate matter from MODU and support vessel exhaust points and therefore has a negligible impact consequence.

**Contribution to the GHG effect**

The use of fuel to power engines, generators and any mobile/fixed plant will result in gaseous emissions of GHG such as carbon dioxide, methane and nitrous oxide.

The latest state and territory GHG inventory data notes that annual GHG emissions from WA were 91.85 Mt $CO_2$-e (DCCEEW, 2022). The emissions from the operation of the MODU and support vessels, assuming a 150-day campaign, equate to 0.0084 Mt $CO_2$-e for a single well, or 0.0252 Mt $CO_2$-e if all three wells are drilled. This represents 0.009% of WA's 2019 annual GHG emissions for a single well, or 0.02% if all three wells are drilled.

If flaring is undertaken at the volumes noted in Section 7.4.1, an estimated 0.019 Mt $CO_2$-e could be emitted for a single well, or 0.057 Mt $CO_2$-e if all three wells are drilled. This represents 0.020% of WA's 2019 annual GHG emissions for a single well, or 0.06% if all three wells are drilled.

While these emissions add to the GHG load in the atmosphere, which adds to global warming potential, they are tiny on a state, national and global scale, representing an insignificant contribution to overall GHG emissions and therefore has a negligible impact consequence. The activity is similar to other shipping and industrial activities contributing to the accumulation of GHG in the atmosphere.

**Tank venting**

Tank venting is a necessary safety control, and any dust emissions will be negligible and limited to the immediate vicinity of the MODU and support vessels. The quantities of gaseous emissions are relatively small and will quickly dissipate into the surrounding atmosphere. Air emissions will be similar to other MODUs and vessels operating in the region for both petroleum and non-petroleum activities.

### 7.4.5. Impact Assessment

Table 7.9 presents the impact assessment for atmospheric emissions.

**Table 7.9. Impact assessment from atmospheric emissions**

| Summary | | | |
|---|---|---|---|
| Summary of Impacts | Decrease in air quality due to gaseous emissions and particulates from MDO combustion and contribution to the incremental build-up of GHG in the atmosphere (influencing climate change). | | |
| Extent of impacts | Localised (local air shed for air quality), widespread (for GHG). | | |
| Duration of impacts | Temporary (duration of activity) – emissions are rapidly dispersed and diluted. | | |
| Level of certainty of impact | HIGH – the impacts of atmospheric emissions are well known. | | |
| Impact decision framework context | Decision type | A - good industry practice required. | |
| | Activity | Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined. | |
| | Risk & uncertainty | Risks are well understood, uncertainty is minimal. | |
| | Stakeholder influence | No conflict with company values, no partner interest, no significant media interest. | |
| Defined acceptable level | Atmospheric emissions are managed in accordance with legislated requirements. | | |
| Impact Consequence (inherent) | | | |
| Negligible | | | |
| Assessment of Proposed Control Measures | | | |
| Control measure | Control type | Adopt | Justification |
| No incineration of wastes from MODU or support vessels during the activity. | Eliminate | No | **EB:** Eliminates a source of atmospheric emissions.<br>**C:** Increased health risk from long-term onboard storage of wastes. If shore transfers are involved, there is an increase in fuel usage and other routine discharges and emissions.<br>**Ev:** Health and safety risks outweigh the benefit given the high energy offshore locations. The low cost of onboard incinerations outweighs the high cost of transporting waste to shore. |
| Use incinerators and engines with higher environmental efficiency. | Substitution | No | **EB:** Reduces the volume of emissions and improves air quality.<br>**C:** MODU and support vessels are not yet contracted, so it is unreasonable to commit a contractor to potentially swapping out equipment, likely at significant cost.<br>**Ev:** Cost to implement control measure is disproportionate to the low environmental benefit. |
| Use low sulphur (<0.5% m/m) MDO **(IMP-04:EPS-01)**. | Engineering | Yes | **EB:** Reduces SOx emissions to the environment. This has been a MARPOL requirement since the start of 2020. |

| | | | |
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| | | | **C:** Some additional cost, but this is factored into the MODU and support vessel contract costs. This is a legislative requirement.<br>**Ev:** Environmental benefits can be achieved with little additional cost. |
| Implementation of a PMS for combustion equipment **(IMP-04:EPS-02)**. | Engineering | Yes | **EB:** Reduces the volume of emissions through improved equipment efficiency.<br>**C:** Negligible; maintenance is part of routine MODU and support vessel operations.<br>**Ev:** Benefits of ensuring efficient MODU and support vessel combustion processes outweigh the negligible costs. |
| IAPP certification **(IMP-04:EPS-03)**. | Engineering | Yes | **EB:** Reduces the volume of emissions.<br>**C:** Negligible; certification and re-certification costs are factored into routine MODU and support vessel operations.<br>**Ev:** Benefits of ensuring MODU and support vessels comply with emissions reduction standards outweighs the negligible cost. |
| SEEMP **(IMP-04:EPS-04)**. | Engineering | Yes | **EB:** Improved energy efficiency reduces the volume of emissions.<br>**C:** Negligible; certification and re-certification costs are factored into routine MODU and support vessel operations.<br>**Ev:** Benefits of ensuring MODU and support vessels comply with emissions reduction standards outweighs the negligible cost. |
| ODS procedure **(IMP-04:EPS-05)**. | Engineering | Yes | **EB:** Reduces emissions associated with global warming.<br>**C:** Negligible; maintenance of equipment with ODS potential (e.g., HVAC) is part of routine MODU and vessel operations.<br>**Ev:** Benefits of ensuring MODU and support vessels comply with ODS reduction standards outweighs the negligible cost. |
| Waste incineration managed in accordance MARPOL and Marine Orders **(IMP-04:EPS-06, -07, -08)**. | Engineering | Yes | **EB:** Reduced impacts to air quality.<br>**C:** Negligible; waste incineration in accordance with MARPOL requirements is part of routine MODU and support vessel operations.<br>**Ev:** Benefits of ensuring MODU and support vessels comply with MARPOL requirements outweighs the negligible cost. |
| Support vessels have the option to anchor rather than burning fuel to remain on | Engineering | Yes | **EB:** Reduced fuel consumption results in fewer emissions to air.<br>**C:** None. |

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| station **(IMP-04:EPS-09)**. | | | **Ev:** Benefits of allowing the support vessels to anchor in an area free of seabed sensitivities saves considerable fuel and therefore minimises emissions to air. |
| Use a high-efficiency well effluent burner head **(IMP-04:EPS-10)**. | Engineering | Yes | **EB:** Maximises combustion through proper atomisation of oil droplets, which eliminates or significantly reduces smoke and oil fallout.<br>**C:** High-efficiency well effluent burners are an industry standard, so there is little additional cost in specifying this type of burner.<br>**Ev:** Good practice and well established in the industry. Environmental benefits can be achieved with minimal additional cost. |
| Implementation of Well Test Plan **(IMP-04:EPS-10, -11, -12, -13)** | Administrative | Yes | **EB:** Ensures well test crew follow set procedures, thereby minimising the likelihood of liquid dropouts, reducing the risk of poor-quality incineration of hydrocarbons entering the atmosphere and ensuring efficient flaring for minimal periods.<br>**C:** The preparation of a Well Test Plan is standard practice for well test contractors, whereby the cost is factored into the contract and not an extra cost per se.<br>**Ev:** Environmental benefits outweigh the low costs. |
| Monitor fuel use **(IMP-04:EPS-14)**. | Administrative | Yes | **EB:** May minimise excessive fuel use and associated air emissions by rapidly detecting abnormalities with fuel consumption patterns.<br>**C:** Negligible; such monitoring is part of routine MODU and vessel operations.<br>**Ev:** Benefits of avoiding excessive fuel consumption and unnecessary air emissions outweighs the minimal cost. |

| Environmental Controls and Performance Measurement | | |
|---|---|---|
| EPO | EPS | Measurement criteria |
| Combustion systems operate in accordance with MARPOL Annex VI (Prevention of Air Pollution from Ships) requirements. | **(IMP-04:EPS-01)** Only low-sulphur (<0.5% m/m) MDO will be used in order to minimise SOx emissions. | Bunker receipts verify the use of low-sulphur marine grade diesel. |
| | **(IMP-04:EPS-02)** All combustion equipment is maintained in accordance with the PMS (or equivalent). | PMS records verify that combustion equipment is maintained to schedule. |
| | **(IMP-04:EPS-03)** Vessels >400 gross tonnes possess equipment, systems, fittings, arrangements and materials that comply with the applicable requirements of MARPOL Annex VI. | IAPP Certificate is current. |

| | | |
|---|---|---|
| | **(IMP-04:EPS-04)** Vessels >400 gross tonnes and involved in an international voyage implement their SEEMP to monitor and reduce air emissions. | SEEMP records verify energy efficiency records have been adopted. |
| | **(IMP-04:EPS-05)** Vessels >400 gross tonnes must ensure that firefighting and refrigeration systems are managed to minimise ODS. | ODS record book is available and current. |
| Solid combustible waste will only be burned within an incinerator, and only if logistics don't allow for the timely removal of waste from the vessel. | **(IMP-04:EPS-06)** Only a MARPOL VI-approved incinerator is used to incinerate solid combustible waste (food waste, paper, cardboard, rags, plastics). | IMO incinerator certificate verifies the incinerator meets MARPOL requirements. |
| | **(IMP-04:EPS-07)** Incineration is only conducted when the MODU and support vessels are >12 nm from the shore. | Incineration records include geographic coordinates to verify incineration took place >12 nm of the shore. |
| | **(IMP-04:EPS-08)** Oil and other noxious liquid substances will not be incinerated. | The Oil Record Book and Garbage Record Book verify that waste oil and other noxious liquid substances are transferred to shore for disposal. |
| Support vessels anchor in preference to burning fuel to remain on station. | **(IMP-04:EPS-09)** Anchoring occurs in preference to burning fuel when the vessels are required to maintain station. | DDRs note when the support vessels are on anchor. |
| The duration of and emissions from flaring are kept to ALARP. | **(IMP-04:EPS-10)** A high-efficiency well effluent burner head is used during flaring. | DDR verifies the use of a high-efficiency well effluent burner head for flaring. |
| | **(IMP-04:EPS-11)** Well flaring is limited to the minimum time required to safety undertake the DST. | DDRs record the duration of flaring. |
| | (**IMP-04:EPS-12**) Burner pilots remain ignited during the well test to minimise the likelihood of liquid dropouts. | Well test daily report verifies that burner pilot remained ignited during the well test. |
| | (**IMP-04:EPS-13**) Dedicated MODU deck crew are in place to watch for liquid dropouts, who then notify the Well Test Supervisor as soon as liquid dropout is observed so that the well test process can be quickly shut down and corrected before re-commencing. | Well test daily report includes details of flare watch for liquid dropouts. |
| Fuel use will be measured, recorded and reported. | **(IMP-04:EPS-14)** Fuel use will be measured, recorded and reported for abnormal consumption, and in the event of abnormal fuel use, corrective action is taken to minimise air pollution. | Fuel use is recorded in the DDRs. |

| Impact Consequence (residual) | | |
|---|---|---|
| Negligible | | |
| The consequence of atmospheric emissions is assessed as negligible because:<br>• The activity is of a temporary nature;<br>• The activity is located far offshore in a high energy offshore environment and air emissions will not impact on air quality in coastal towns;<br>• The quantities of gaseous emissions are relatively small and will dissipate into the surrounding atmosphere; and<br>• Management of atmospheric emissions will comply with legislated requirements. | | |
| Demonstration of ALARP | | |
| A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence. | | |
| Demonstration of Acceptability | | |
| Policy compliance | EOG's Safety and Environmental Policy objectives are met. | |
| EMS compliance | Chapter 10 describes the EP implementation strategy to be employed for this activity. | |
| Risk matrix standard compliance | The residual impact consequence is negligible, which is considered acceptable. | |
| External context | There have been no objections or claims made by relevant persons regarding atmospheric emissions for this activity. | |
| Legislative context | The EPS align with the requirements of:<br>• *Navigation Act* 2012 (Cth):<br>  ○ Chapter 4 (Prevention of Pollution).<br>  ○ AMSA Marine Order Part 79 (Marine pollution prevention – air pollution).<br>• *Protection of the Sea (Prevention of Pollution by Ships) Act* 1983 (Cth):<br>  ○ Part IIID (Prevention of Air Pollution).<br>  ○ AMSA Marine Orders Part 97 (Air Pollution), enacting MARPOL Annex VI (especially Regulations 6, 14, 16).<br>• *National Greenhouse and Energy Reporting Act* 2007 (Cth). | |
| Industry practice | The consideration and alignment of EPS with the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity. | |
| | Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020) | The EPS listed in this table meet the relevant mitigation measures listed for offshore activities with regard to:<br>• Section 4.4.3 - Combustion emissions;<br>  ○ Use of high efficiency equipment to minimise power demand **(IMP-04: EPS-04)**.<br>  ○ Selection of low sulphur diesel **(IMP-04: EPS-01)**. |

| | | |
|---|---|---|
| | | ○ Regular plant maintenance **(IMP-04: EPS-02)**.<br>○ Regular maintenance and emission control devices on vehicles and machinery **(IMP-04: EPS-02)**. |
| | Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019) | The EPS listed in this table meet these guidelines for offshore activities with regard to management of fugitive emissions (item 22). The BAT are met for the MODU and vessels. |
| | Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015) | No guidance provided regarding the management of atmospheric emissions.<br>Section 2.4.4 specifies that equipment used for monitoring discharges or emissions should be correctly calibrated and operated, and that sampling and analysis procedures are based on sound field practices. |
| | Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015) | Guidelines met with regard to:<br>• Air emissions (item 11). The overall objective to reduce air emissions **(all IMP-07 EPS, except EPS-07)**.<br>• Air emissions (item 12). During equipment selection, air emission specifications should be taken into account, as should the use of very low sulphur content fuels and/or natural gas **(IMP-04: EPS-01)**. |
| | AEP CoEP (APPEA 2008) | The EPS for this activity meet the code's following objectives for offshore drilling operations:<br>• To reduce the impact of air emissions to ALARP and an acceptable level.<br>• To reduce GHG emissions to ALARP and an acceptable level (All **IMP-07 EPS**). |
| Environmental context | MNES | |
| | AMPs | This hazard will not directly affect nearby AMPs. |
| | Ramsar wetlands | This hazard will not directly affect any Ramsar wetlands. |
| | TECs | This hazard will not directly affect any TECs. |
| | Nationally threatened and migratory species | This hazard will not directly affect threated or migratory species. |
| | Other matters | |
| | KEFs | This hazard will not directly affect any KEFs. |
| | NIWs | This hazard will not directly affect any NIWs. |
| | State marine parks | This hazard will not directly affect any state marine parks. |

| | | |
|---|---|---|
| | Species Conservation Advice/<br>Recovery Plans/<br>Threat Abatement Plans | The Recovery Plans and Conservation Advice for the Blue, Sei, Fin and Humpback Whales list climate change as a key threat, though the most pervasive threats are whaling, vessel strike and entanglement.<br>The Recovery Plan for Marine Turtles in Australia lists climate change as a key threat. Atmospheric emissions resulting from the activity are not inconsistent with this recovery plan.<br>The Wildlife Conservation Plan for Seabirds (Commonwealth of Australia, 2020) lists climate variability and change as a threat, though none of the seabirds known to occur in the impacts EMBA are listed as being of high risk from exposure to climate change.<br>The Wildlife Conservation Plan for Migratory Shorebirds (DoE, 2015d) lists climate variability and change as a threat, though coastal habitat loss and habitat modification are the key threats. |
| ESD principles | The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant). | |
| Statement of acceptability | EOG considers the impacts from atmospheric emissions to be acceptable because:<br>• It will adhere to the company's Safety and Environmental Policy;<br>• The residual consequence rating is negligible;<br>• An Implementation Strategy (described in Chapter 10) is in place to ensure the EPS are achieved.<br>• Relevant legislation and industry best practice will be complied with;<br>• Atmospheric emissions from the activity will not have long-term or significant impacts on MNES;<br>• The management of air emissions will ensure it is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species;<br>• The management of air emissions will ensure it is not inconsistent with the aims of relevant marine reserve management plans; and<br>• The management of air emissions will ensure it is not inconsistent with ESD principles. | |
| Environmental Monitoring | | |
| • Fuel use. | | |
| Record Keeping | | |
| • PMS records.<br>• Fuel use records.<br>• Bunkering receipts.<br>• Waste manifests (for incineration). | • ODS record books.<br>• Oil record books.<br>• Garbage record books. | |

## 7.5. IMPACT 5 – Routine Emissions – Underwater Sound

### 7.5.1. Hazard

The following activities will generate underwater sound:

- MODU operations – sound generated by engines, onboard machinery and drilling equipment (principally the mechanical operation of the drill string);
- Placement and installation of the MODU;
- Support vessel operations – engine noise transmitted through the hull, propeller cavitation or dynamic positioning (DP);
- Helicopter operations – movements within the PSZ;
- Flaring; and
- Acoustic downhole profiling operations – VSP.

### 7.5.2. Known and Potential Environmental Impacts

The effects of underwater sound are generally well understood with regard to potential mortality and/or physiological injury for species in the water column, however, uncertainty lies in understanding the spatial and temporal extents of behavioural disturbances and the potential effects on populations and requires the application of context-specific information.

The potential environmental impacts to marine fauna from high levels of underwater sound are:

- Physical injury to auditory tissues or other air-filled organs;
- Hearing impairment, temporary threshold shift (TTS – the temporary loss of hearing sensitivity caused by excessive noise exposure) or permanent threshold shift (PTS – a permanent loss of hearing sensitivity caused by excessive noise exposure, considered an auditory injury);
- Direct behavioural effects through disturbance or displacement, and consequent disruption of natural behaviours or processes (e.g., migration, resting, calving or spawning); and
- Indirect behavioural effects by impairing/masking the ability to navigate, find food or communicate, or by affecting the distribution or abundance of prey species.

The potential impacts on individual animals from exposure to elevated sound levels above ambient sound levels in a given area depends on a number of factors, including the extent of sound propagation underwater, its frequency characteristics and duration, its distribution relative to the location of the organisms, the sensitivity and range of spectral hearing among species (Carroll *et al*., 2017).

**Drilling**

Fixed platforms such as jack-up MODUs have lower radiated sound levels than floating platforms (NCE, 2007) because they do not use thrusters or propellers to maintain station. Equipment operating onboard these facilities can contribute to marine environment sound however, airborne and structure-borne (vibration) pathways are considered more significant on floating platforms where equipment can be located below the water line (NCE, 2007).

Underwater noise produced from platforms standing on metal jack-up supports is relatively low given the small surface areas available for sound transmission and also given the location of machinery above the waterline. It is therefore expected that the dominant pathway for sound

generation is structure-borne (i.e., vibration from machinery passing through the legs) (NCE, 2007).

**Support Vessels**

There will be several support vessel trips per week between the MODU and the supply base for each of the up to three drilling campaigns, with one support vessel 'on station' close to the MODU at all times. The support vessels will generate low levels of sound. This is generated from propeller cavitation (the dominant sound source), hydrodynamic flow around the hull and from onboard machinery (Popper *et al*., 2014). It is unlikely that engine sound levels will be greater than that of any other similarly sized vessel normally operating in the area (such as vessels supporting the nearby Blacktip operations).

The sound levels and frequency characteristics of underwater sound produced by vessels are related to vessel size and speed. When idle or moving at slow speed within the PSZ, vessels generally emit low-level noise. The typical sound levels generated by vessels are:

- Tugboats, crew boats, supply ships and many research vessels in the 50-100 m size class – 165-180 dB re 1µPa range (Gotz *et al*., 2009);
- Vessels up to 20 m size class – 151-156 dB re 1µPa (Richardson *et al*., 1995);
- Trawlers – peak at around 175 dB re 1µPa (Gotz *et al*., 2009); and
- Large ships – levels exceeding 190 dB re 1µPa (Gotz *et al*., 2009).

**Helicopters**

There will be several return helicopter flights each week to transport personnel and equipment to the MODU during drilling operations (see Section 2.6.3). Sound emitted from helicopter operations is typically below 500 Hz (Richardson *et al*., 1995). Sound travelling from a source in the air (e.g., helicopter) to a receiver underwater is affected by both in-air and underwater propagation processes, which are further complicated by processes occurring at the air-seawater surface interface. The received sound level underwater depends on the altitude of the sound source and lateral distance from the receiver, receiver depth, water depth, and other variables.
The angle at which the line from the aircraft and receiver intersects the water surface is important. In calm conditions, at angles above 13° from the vertical much of the sound is reflected and does not penetrate into the water (Richardson *et al*., 1995; NRC, 2003). Therefore, strong underwater sounds are detectable for a period roughly corresponding to the time the helicopter is within a 26° cone above the receiver. This 'zone of ensonification' can be enlarged in rough seas and can also be enlarged in shallow waters (Richardson *et al*., 1995).

Most air traffic supporting offshore installations involves turbine helicopters flying along straight lines. Usually, a helicopter can be heard in air well before and after the brief period it passes overhead and is heard underwater. Sound pressure in the water directly below a helicopter is greatest at the surface and diminishes with increasing receiver depth. The peak received level diminishes with increasing helicopter altitude, but the duration of audibility often increases with increasing altitude. Richardson *et al*. (1995) reports figures for a Bell 214 helicopter (considered to be one of the loudest) being audible in air for four minutes before it passed over underwater hydrophones but detectable underwater for only 38 seconds at 3 m depth and 11 seconds at 18 m depth.

**VSP**

The VSP program for the multi-well activity includes the use of four airguns with a total sound source volume of 600 cui, performing acoustic pulses for a duration of 8 hours (see Section 2.7.4). VSP involves placing a number of receivers in the well bore and transmitting impulsive sound

energy to them from a sound source hung over the MODU just below the sea surface. VSP uses highly directional sound energy that is focussed towards the seabed, but it also ensonifies the surrounding water column.

Each discharge of the sound source generates a short, discrete, low frequency sound impulse, which are much lower than those generated during large-scale 2D or three dimensional (3D) marine seismic surveys (MSS). The underwater sound generated by VSP is loudest directly under the source and rapidly decreases with distance from the source.

Based on VSP modelling undertaken by Jasco Applied Sciences (McPherson *et al*., 2017) for the Gular-1 appraisal well undertaken in a water depth of 26 m for a 600 cui airgun array, it is expected that the sound source is expected to generate a peak sound pressure level (SPL) of 239 dB re 1 µPa pk @ 1 m and per-pulse sound exposure level (SEL) up to 215 dB re 1 $\mu Pa^2$.s @ 1 m.

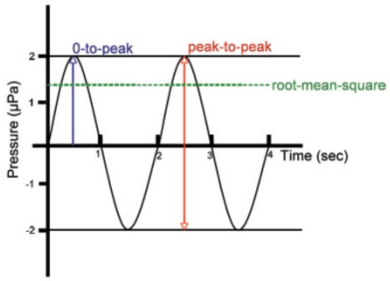
Modelling of VSP undertaken by Chevron Australia and reported in Chevron (2010) using 3 x 250 cui air guns at a source depth of 5 m recorded an amplitude spectrum peak of 190 dB re 1 µPa @ 1 m from the source. The results reported also demonstrated that the received source level did not exceed 160 dB re 1 $\mu Pa^2$.s at a distance of 500 m from the source and 170 dB re 1 $\mu Pa^2$.s at 100 m from the source.

**Terminology**

Activities that generate underwater sound can affect marine fauna by interfering with aural communication, eliciting changes in behaviour and, potentially, causing either acute or chronic physiological damage. Table 7.10 defines the acoustic terms used throughout this section.

**Table 7.10. Acoustic terminology used in this EIA**

| Term | Definition |
|---|---|
| Sound | A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water. |
| Decibel (dB) | Sound is measured on a logarithmic scale that expresses the ratio of two values of a physical quantity. It is used to measure the amplitude or 'loudness' of a sound. As the dB scale is a ratio, it is denoted relative to some reference level, which must be included with dB values if they are to be meaningful. The reference pressure level in underwater acoustics is 1 micropascal (µPa), whereas the reference pressure level used in air is 20 µPa, which was selected to match human hearing sensitivity.<br>As a result of these differences in reference standards, sound levels in air are not equal to underwater levels.<br>There are four main metrics for underwater sound (ISO/DIS 18405.2:2017) – SEL, SPL, PK and PK-PK, all described in this table. |
| Frequency | The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period.<br>**Unit:** hertz (Hz). 1 Hz is equal to 1 cycle per second. |
| Source level | A measure of sound pressure at a nominal distance of 1 m from a theoretical point source that radiates the same total sound power as the actual source. It is a theoretical value for a seismic source because a seismic source is not a point source, but rather, comprises individual elements in a defined area.<br>Source level can be expressed as an SPL, SEL or PK.<br>**Unit:** dB re 1 $\mu Pa^2m^2$ (pressure level) or dB re 1 $\mu Pa^2m^2s$ (exposure level). |
| Impulse/Pulse | The terms used to refer to the discharge of a seismic source are impulse and pulse, therefore the terms used to describe a single discharge are per-impulse or per-pulse. |

| Term | Definition |
|---|---|
| | Impulsive sound is sound that is typically brief and intermittent with rapid (within a few seconds) rise time and decay back to ambient levels (NOAA, 2013). Airguns used for seismic surveys are a good example of impulsive sound. |
| Sound exposure level (SEL) | A measure related to the sound energy in one or more pulses, or the ratio of the time-integrated squared sound pressure to the specified reference value.<br>**Unit:** dB re 1 $\mu Pa^2 \cdot s$ |
| $SEL_{24hr}$ | SEL is specified in terms of either per-impulse (per-pulse) or accumulation period. In this report, the accumulation period applied is 24 hours, and therefore the SEL is referred to as either per-impulse SEL or $SEL_{24h}$. |
| Zero-to-peak sound pressure (PK)<br>*Impulsive sounds* | The greatest magnitude of the sound pressure during a specified time interval. PK levels are modelled to assess mortality and potential mortality to fish larvae and eggs, fish and turtles. A simple sound wave and three common methods to characterise the loudness of sounds, including zero-to-peak sound pressure, are illustrated below in the PK graph.<br>**Unit:** dB re 1 µPa.<br><br> |
| Peak-to-peak sound pressure (PK-PK)<br>*Impulsive sounds* | Sum of the peak compressional pressure (highest pressure variation) and the peak rarefactional pressure (lowest pressure variation) during a specified time interval. PK-PK is the difference between the minimum and maximum instantaneous sound pressure levels in a stated frequency band attained by an impulsive sound.<br>**Unit:** dB re 1 µPa. See also the PK graph. |
| Root-mean-square sound pressure level (SPL) | The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure over the duration of the acoustic event (i.e., the duration of a single seismic pulse).<br>Because the SPL represents the effective sound pressure over the full duration of the acoustic event rather than the maximum instantaneous peak pressure (PK or PK-PK), it is regularly used to represent the effective or perceived loudness of a sound and to assess the potential for a behavioural response from marine fauna.<br>**Unit**: dB re 1 µPa.<br>See also the PK graph. |
| Particle motion | The motion caused by a sound wave of a given infinitesimal part of the medium relative to the medium as a whole, and it is an integral part of any sound field. Particle motion is directional (unlike pressure) and is typically described using three-dimensional vector notation.<br>Particle motion levels can be expressed in a variety of units related to displacement; velocity or acceleration. Acoustic particle velocity is the time derivative of particle displacement, and likewise, acceleration is the time derivative of velocity.<br>• Sound particle velocity (v) - contribution to velocity of a material element caused by the action of sound, in units of metre per second (m/s). It is the physical speed of a particle in a material moving back and forth in the direction of the pressure wave.<br>• Sound particle acceleration (*a*) - the contribution to acceleration of a material element caused by the action of sound, in units of metre per second squared ($m/s^2$). It is the rate of change of the velocity with respect to time.<br>Benthic invertebrates (e.g., scallops) and many types of fish are sensitive only to particle velocity or acceleration rather than pressure, however, limited |

| Term | Definition |
|---|---|
| | measurements of data are available on the levels of particle motion that may result in effects. Some measurements are available from studies on bivalves and therefore modelled particle motion values have been referenced for this EIA. |
| Transmission loss | The decibel reduction in sound level between two stated points that results from sound spreading away from an acoustic source subject to the influence of the surrounding environment. It can also be referred to as propagation loss. |
| TTS in hearing | TTS is the temporary loss of hearing sensitivity caused by excessive noise exposure. Exposure to sufficiently intense sound may lead to an increased hearing threshold in any living animal capable of perceiving acoustic stimuli (Finneran, 2016). If this shift is reversed and the hearing threshold returns to normal, the effect is called a TTS. The onset of TTS is often defined as threshold shift of 6 dB above the normal hearing threshold (Southall *et al*., 2016).<br>Impairment to the hearing apparatus of a marine animal may result from a fatiguing stimulus measured in terms of sound exposure level (SEL), which considers the sound level and duration of the exposure signal. Intense sounds may also damage the hearing apparatus independent of duration, so an additional metric of peak pressure (PK) is needed to assess acoustic exposure impairment risk. |
| PTS in hearing | PTS is the permanent loss of hearing sensitivity caused by excessive noise exposure. It is considered an auditory injury. If a TTS does not return to normal, the residual shift is called a PTS. |
| Behavioural response | The context of sound exposure plays a critical and complex role in behavioural responses in marine mammals (Gomez *et al*., 2016). For example, different species (and different individuals or groups within a species) may respond differently to varying levels of sound depending on their behaviours and motivation at the time (depending on whether they're foraging, socialising, resting or mating) and other factors such as the type of sound, duration of exposure, and the suddenness of the onset of the received sound (Ellison *et al*., 2012; Gomez *et al*., 2016).<br>The national marine fisheries service (NMFS) in the USA uses an impulsive noise criteria threshold of 160 dB re 1 µPa (SPL) for potential behavioural disturbance to marine mammals (NMFS, 2018). The threshold for behavioural response represents the level at which a moderate behavioural response may occur, such as changes in swimming speed, direction and dive profile, localised deviations in migratory patterns, brief to moderate shift in group distribution, short term cessation or modification of vocal behaviour. (McCauley *et al*., 2000a; Southall *et al*., 2007; Tyack, 2008). Avoidance, however, is not directly related to sound level thresholds but also influenced by the state of the individuals (e.g., their reproductive, health and foraging condition) and the context of exposure. It is considered that avoidance behaviour represents only a minor effect on either the individual or the species unless avoidance results in displacement of whales from areas of biological importance such as nursery, resting or feeding areas during an important period for the species.<br>Higher received levels are not always associated with stronger behavioural responses and vice versa, and a clear dose-response relationship has not been identified (Southall *et al*., 2007). In addition, a behavioural response does not necessarily equate to a significant avoidance or deviation in cetacean movements that would actually displace individuals or the population from the wider area. Similarly, proximity of the animal to the sound source, irrespective of received level, has been identified as an influencing factor, with behavioural response in humpback whales being both dependent on the proximity of whale to the vessel source and also the received level (i.e., at the same received level no behavioural response was detected when the source was greater than 3 km away) (Dunlop *et al*., 2018). |
| Masking | Acoustic masking may occur when a noise impedes the ability of an animal to perceive a signal (Wood *et al.,* 2012; Erbe *et al*., 2015). For this to occur the noise must be loud enough, have similar frequency content to the signal, and must happen at the same time (Wood *et al.,* 2012). |

| Term | Definition |
|---|---|
| | Masking and the potential effects of masking on communication and listening space of marine mammals are not fully understood and remain an area of active research (Terhune *et al*., 1979; Cunningham & Mountain, 2014; Tennessen & Parks, 2016; Cholewiak *et al*., 2018; Dunlop, 2017; 2018; Gabriele *et al*., 2018; Putland *et al.,* 2018). Currently, there are no specific received level thresholds for reliably assessing or regulating masking responses to seismic noise (Gomez *et al.,* 2016). |

### 7.5.3. EMBA

The EMBA for underwater sound is unlikely to be beyond several hundred metres at most from the sound source, dependent on the species and associated thresholds, as outlined in this chapter. Receptors that are known to occur or may occur within the underwater sound EMBA, either as residents or migrants, are:

- Plankton;
- Benthic invertebrates (i.e., prawns);
- Pelagic fish;
- Marine mammals;
- Marine reptiles; and
- Seabirds.

The focus of this EIA is on EPBC-listed species that are sensitive to underwater sound, these being pelagic fish, marine mammals (whales) and marine reptiles (turtles).

### 7.5.4. Evaluation of Environmental Impacts

**MODU noise**

The MODU will generate noise from the operation of on-board machinery, including diesel engines, mud pump, ventilation fans (and associated exhaust) and electrical generators, and also (during drilling) from the drill string and bit. In general, fixed platforms such as jack-up MODUs transmit less noise underwater than a semi-submersible platform or a drill vessel due to the smaller surface area in contact with the water column.

Gales (1982) cited in NCE (2007), reports that underwater sound measured from platforms did not exhibit markedly different characteristics from those engaged in production, and that none of the measured sound could be directly related to the mechanical action of the drill bits. It is therefore believed that most sound associated with drilling is created by the operation of the MODU itself (and sound radiated through the MODU structure).

In the same study (Gales, 1982; cited in Richardson *et al.,* 1995) it was identified that platform noise was so weak that it was nearly undetectable even when alongside the platform during sea states ≥ 3. At the near-field measurement locations (ranges 9–61 m), the received sound levels were 119-127 dB re 1µPa (Richardson *et al.,* 1995).

Studies performed on the Spartan 151 jack-up MODU in Alaska's Cook Inlet in shallow waters (18-37 m water depth) verified the underwater acoustic levels as a function of range from the MODU (Marine Acoustics, 2011). Primary sources of MODU-based acoustic energy were identified as originating from the diesel engines, mud pump, ventilation fans and electrical generators. The study identified maximum sound levels were periodic (impulsive <1 second) with received levels at approximately 127 dB re 1µPa to a maximum range of 1.2–1.4km in the frequency range 8.9-

44.7 Hz. Levels in the infrasonic band (i.e., frequencies <20 Hz) between 8.9–11.2 Hz and 11.2–14.1 Hz infrequently exceeded 120 dB re 1µPa at ranges less than 1.7 km and never more than 1 second at a time.

On this basis, emissions predominantly below 120 dB re 1µPa with non-continuous (less than 1 second) levels exceeding this to a range of approximately 1.4 km in the frequency band 8.9 Hz to 44.7 Hz (infrasonic and low frequency) as measured in that study is expected to be indicative of the low frequency sound levels emitted by the jack-up MODU during drilling activities.

In addition, an acoustic monitoring program commissioned by Santos conducted during an exploratory drilling program in 2003, indicated that the drilling operation was not audible between 8 and 28 km from the MODU (McCauley, 2004), with most sound above 120 dB SPL RMS confined within a 2 km to 4 km radius of the MODU.

Sound generation and frequency bands from the operation and drilling activities associated with the MODU would be expected to be similar to the sound levels described above. This sound level is lower than the recorded ambient sound in the activity area (that varies from a minimum of 148 dB re 1µPa2.s SEL to a maximum of 163 dB re 1µPa2.s SEL, see Section 5.2.2 under 'Ambient Ocean Sound' in Section 5.2.2) and is therefore likely to have a negligible impact on marine fauna.

Based on this impact evaluation, there is no information to suggest that drilling up to three wells in succession (if it were to occur) within the activity area would result in cumulative underwater sound impacts that have a consequence higher than negligible.

**Vessel noise**

Noise from vessels acts to increase the sound in the water column above ambient noise levels. For example, noise emissions from idling vessels are low, however noise from thrusters and strong thrusts from the main engines have been recorded at levels of up to 182 dB re 1µPa at 1 m (McCauley, 1998). Under this mode of operation, McCauley (1998) measured underwater broadband noise of approximately 137 dB re 1µPa at 405 m. Levels of 120 dB re 1 µPa extended for a distance of approximately 3-5 km from the source, depending on water depth, seabed composition and other factors.

Under normal operating conditions when the vessel is idling or moving between sites, vessel noise would be detectable over only a short distance. For example, Woodside (2003) found that vessel noise levels rarely (<1% of the time) exceeded a threshold of 120 dB re 1 µPa (i.e., slightly less than ambient underwater sound intensity in the activity area) from an acoustic monitoring site 5.1 km from the source when a drilling support vessel was holding position using dynamic positioning bow thrusters.

Temporary and permanent threshold shifts are very unlikely to occur in any marine species as a result of vessel operations. The sounds produced by the vessels during this activity will not be outside the range of other anthropogenic sound and ambient underwater sound of the activity area (see 'ambient ocean sound' in Section 5.2.2).

**Helicopter noise**

Several helicopter flights each week will transport personnel and equipment to the MODU during drilling operations (see Section 2.5.3). Sound emitted from helicopter operations is typically below 500 Hz (Richardson *et al.,* 1995).

Sound travelling from a source in the air (e.g., helicopter) to a receiver underwater is affected by both in-air and underwater propagation processes, which are further complicated by processes occurring at the air-seawater surface interface. The received sound level underwater depends on

the altitude of the sound source and lateral distance from the receiver, receiver depth, water depth, and other variables.

The angle at which the line from the aircraft and receiver intersects the water surface is important. In calm conditions, at angles above 13 from the vertical much of the sound is reflected and does not penetrate into the water (Richardson *et al*., 1995; NRC, 2003). Therefore, strong underwater sounds are detectable for a period roughly corresponding to the time the helicopter is within a 26° cone above the receiver. This 'zone of ensonification' can be enlarged in rough seas and can also be enlarged in shallow waters (Richardson *et al*., 1995).

Most air traffic supporting offshore installations involves turbine helicopters flying along straight lines. Usually, a helicopter can be heard in air well before and after the brief period it passes overhead and is heard underwater. Sound pressure in the water directly below a helicopter is greatest at the surface and diminishes with increasing receiver depth. The peak received level diminishes with increasing helicopter altitude, but the duration of audibility often increases with increasing altitude.

Richardson *et al*. (1995) reports figures for a Bell 214 helicopter (considered to be one of the loudest) being audible in air for four minutes before it passed over underwater hydrophones but detectable underwater for only 38 seconds (at 3 m depth) and 11 seconds (at 18 m depth). This means that as a conservative case, helicopter sound may be audible underwater for up to two minutes per flight per to and from the MODU. This provides an indication of the low level of received noise that may be expected from a helicopter.

Given the short time of audibility underwater (0.14% of a day) and low frequency of helicopter flights, impacts from helicopter sound to sound-sensitive marine fauna are assessed as negligible.

**VSP**

Noise emissions from VSP operations on marine fauna is considered to be low given its short duration (12 to 24 hours) and small air-gun array (600 cui array) as compared to conventional seismic survey arrays (typically 2,500 to 3,500 cui) that operate continuously for weeks or months. Undertaking three rounds of VSP (should all three wells be drilled) will not result in cumulative impacts to marine fauna because there will be significant time between these VSP events (more than 55-150 days required to drill each well) where ocean sound will be at ambient levels.

**Biological Impacts**

The impacts of impulsive and non-impulsive noise in the operational area are assessed in Section 7.1.4 of the Beehive-1 PDSA EP (available here), which was accepted by NOPSEMA in March 2022. The impacts of MODU and support vessel operations are expected to be similar to these.

For VSP operations, the impact assessment provided here is based on VSP modelling undertaken by Jasco Applied Sciences (McPherson *et al*., 2017) for the Gular-1 appraisal well undertaken in a water depth of 26 m (slightly shallower waters than the activity area) for a 600 cui airgun array. A summary of the results for the VSP modelling is presented in Table 7.11.

**Table 7.11. Summary of the maximum horizontal distances to noise effect criteria from VSP operations for per-pulse (PK) modelled sites in the water column and at the seabed**

| Fauna group | Behavioural | Injury | | | Mortality/ potential mortality |
|---|---|---|---|---|---|
| | | TTS | PTS | Recoverable injury | |
| Water column | | | | | |
| Plankton | - | - | - | - | 84 m |
| Fish (with no swim bladders, including sharks) | (N) High<br>(I) Moderate<br>(F) Low | 922 m | - | 30 m | 30 m |
| Fish (with swim bladders) | (N) High<br>(I) High<br>(F) Moderate | 922 m | - | 84 m | 84 m |
| Fish eggs and larvae | (N) Moderate<br>(I) Low<br>(F) Low | 922 m | - | 84 m | 84 m |
| Low-frequency cetaceans (LFC) | 2,900 m | 20 m | * | - | - |
| Mid-frequency cetaceans (MFC) | | * | * | - | - |
| High-frequency cetaceans (HFC) | | 350 m | 200 m | - | - |
| Turtles | 1,856 m | N/A | N/A | - | 84 m |
| Seabed | | | | | |
| Sponges and corals | - | - | - | - | * |
| Molluscs | - | - | - | 304 m | - |
| Crustaceans | - | - | - | 304 m | - |
| * *Threshold not reached.*<br>- *No exposure criterion is available to model.*<br>N/A *Not assessed.* | | *N (near) = tens of metres.*<br>*I (intermediate) = hundreds of metres.*<br>*F (far) = thousands of metres.* | | | |

The following impact assessment is based on species-specific for underwater sound on the various groups of biological receptors in the activity area. Where available, threshold criteria associated with behavioural and physiological impacts for sensitive receptors have been used to compare measured and predicted sound levels for different sound sources to assess potential impacts.

*Impacts to Plankton*

Plankton (described in Section 5.4.3) is very widely dispersed throughout the ocean and is transported by prevailing wind and tide- driven currents. They cannot take evasive behaviour to avoid anthropogenic sound sources. However, the potential for impacts is limited due to their widespread distribution and rapid population growth rates. This means that only a small percentage of a cohort will be exposed at any one time. Invertebrate plankton species that have gas-filled flotation organs (such as cephalopods) are more likely to be affected by underwater noise.

Impacts to plankton are likely to be insignificant at both a local and population level or compared with natural variability and mortality rates for plankton organisms. The estimated distance for mortality of plankton (84 m) from VSP modelling also indicates a very localized area of impact.

Based on this evaluation, the impact consequence for plankton resulting from underwater noise generated by VSP is negligible at an ecosystem and population level.

*Impacts to Fish and Sharks*

Fish species known to occur within the impacts EMBA are listed and described in Section 5.4.4. All fish studied to date are able to detect sound, with the main auditory organs in teleost (bony) fish being the otolithic organs of the inner ear (Carroll *et al*., 2017). Hearing in fish primarily involved the ability to sense acoustic particle motion via direct inertial stimulation of the otolithic organs or their equivalent. Many species also have the ability to sense sound pressure using an indirect path of sound stimulation involving gas-filled chambers such as the swim bladder (Carroll *et al*., 2017).

Limited research has been conducted on responses from elasmobranchs (sharks and rays, including juveniles) to underwater sound. This may be because sharks and rays differ from bony fish in that they have no accessory organs of hearing (i.e., a swim bladder) and therefore are unlikely to respond to acoustic pressure (Myrberg, 2001). Elasmobranchs sense sound via the inner ear and organs and as they lack a swim bladder it is thought that they are only capable of detecting the particle motion component of acoustic stimuli (Myrberg, 2001).

Based on the VSP modelling results in Table 7.10, it is expected that any impacts to fish and sharks from VSP will be highly localised and have no lasting effect, with the main impact being temporary behavioural changes (avoidance) for those individuals that are close to the VSP array at the time of operations. Impacts to species with BIAs in the operational area (see Section 5.4.4), such as the northern river shark (adults/juveniles may occur), dwarf sawfish (adults known to occur), largetooth sawfish (adults known to occur), green sawfish (adults known to occur) are expected to be the same. Underwater sound is not listed as a threat for these species (see Table 5.7 in Section 5.4.4). As such, the impact consequence from VSP operations are assessed as minor.

The available evidence indicates sharks will generally avoid sound sources, so the likely impacts on sharks are expected to be limited to short-term behavioural responses, such as avoidance of waters around the VSP. For the purposes of this EIA, sharks are included in the same group as fish without swim bladders and for the reasons outlined above, along with the fact that the Recovery Plan for the White Shark (DSEWPC, 2013) does not list anthropogenic sound as a threat to this species, impacts to sharks are considered to be negligible.

The activity will not have a 'significant' impact on endangered or vulnerable fish species (see Section 5.4.4) when assessed against the EPBC Act Significant Impact Guidelines 1.1 (DoE, 2013), as outlined in Table 7.12.

**Table 7.12. Assessment against EPBC Act Significant Impact Guidelines for Fish**

| Significant impact guideline | Assessment |
|---|---|
| Lead to a long-term decrease in the size of a population. | Underwater sound generated from drilling activities will not lead to a long-term decrease in the size of a population given the short duration of the activity and the small size of the VSP array and the short duration of VSP operations. Impacts are localised and temporary. |
| Reduce the area of occupancy of the species. | The area of occupancy may be temporarily reduced given fish primarily respond by avoiding emitted sound from sound sources, however there will be no long-term reduction in the area of occupancy of fish. |
| Fragment an existing population into two or more populations. | Underwater sound generated from drilling activities will not split up a single fish population into two or more populations. |
| Adversely affect habitat critical to the survival of a species. | Underwater sound generated from drilling activities will not affect habitat critical to the survival of a species. is no overlap between underwater noise emissions and critical fish habitat. |
| Disrupt the breeding cycle of a population. | Underwater sound generated from drilling activities will not disrupt the breeding cycle of a population. There is no overlap between underwater noise emissions and fish breeding sites. |

| Significant impact guideline | Assessment |
|---|---|
| Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. | Underwater sound generated from drilling activities will not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Impacts will be localised and temporary. Habitats for site-attached fish, such as rocky reef, do not occur in the activity area or immediate surrounds. |
| Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat. | The activity will not result in the introduction of IMS. |
| Introduce disease that may cause the species to decline. | The activity will not result in the introduction of disease. |
| Interfere with the recovery of the species. | Recovery of threatened fish species will not be interfered with given there is no overlap between underwater sound emissions and areas critical to species recovery (such as breeding or migration). |

*Impacts to Cetaceans*

The impacts of underwater sound on cetaceans are assessed in Section 7.1.4 of the Beehive-1 PDSA EP (available here), which was accepted by NOPSEMA in March 2022.

This VSP modelling results presented in Table 7.10 indicate that mortality to cetaceans from VSP operations is not predicted. The maximum distance at which the NMFS (2018) marine mammal behavioural response criterion of 160 dB re 1µPa could be exceeded was modelled as 2,900 m (2.9 km). TTS and PTS are predicted to only affect HFC (species such as porpoises, that are not known to occur in the impacts EMBA), and even then to only a few hundred metres from the sound source. Given that threatened and other whale species are not likely to occur in the impacts EMBA at the time of drilling (see Figure 5.17), the impacts of VSP on whales are expected to have a negligible impact consequence. Dolphins are classified as MFC, and the VSP modelling results in Table 7.10 indicate that impacts will be limited to behavioural impacts (e.g., avoidance) within a 2,900 m radius of the sound source. Given the short-term nature of VSP, the impacts will be limited to short-term avoidance.

The proposed drilling activity will not have a 'significant' impact on threatened cetacean species (see Section 5.4.5) when assessed against the EPBC Act Significant Impact Guidelines 1.1 (DoE, 2013) as outlined in Table 7.13.

**Table 7.13. Assessment against EPBC Act Significant Impact Guidelines for Cetaceans**

| Significant impact guideline | Assessment |
|---|---|
| Lead to a long-term decrease in the size of a population. | Underwater sound generated from drilling activities will not lead to a long-term decrease in the size of a population. |
| Reduce the area of occupancy of the species. | Underwater sound generated from drilling activities will not lead to a reduction in the area of occupancy of cetaceans. |
| Fragment an existing population into two or more populations. | Underwater sound generated from drilling activities would not be expected to split up a single population into two or more populations. |

| Significant impact guideline | Assessment |
|---|---|
| Adversely affect habitat critical to the survival of a species. | Underwater sound generated from drilling activities will not affect habitat critical to the survival of a species. There is no overlap between underwater noise emissions and critical habitat for cetaceans. |
| Disrupt the breeding cycle of a population. | Underwater sound generated from drilling activities will not disrupt the breeding cycle of a population. There is no overlap between underwater noise emissions and cetacean breeding sites. |
| Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. | Underwater sound generated from drilling activities will not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Impacts will be localised and temporary. |
| Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat. | The activity will not result in the introduction of IMS. |
| Introduce disease that may cause the species to decline. | The activity will not result in the introduction of disease. |
| Interfere with the recovery of the species. | Recovery of threatened cetaceans will not be interfered with given there is no overlap between underwater sound emissions and areas critical to species recovery (such as areas of calving, breeding or migration). |

*Impacts to Turtles*

Turtle BIAs overlapped by the impacts EMBA include that for the green turtle (foraging), flatback turtle (inter-nesting) and olive-ridley turtle (foraging) (see Section 5.4.6).

The impacts of underwater sound on turtles are assessed in Section 7.1.4 of the Beehive-1 PDSA EP (available here), which was accepted by NOPSEMA in March 2022.

This VSP modelling results presented in Table 7.11 indicate that mortality or potential mortality to turtles from VSP operations is only likely within 84 m of the sound source. Based on the limited data in regard to noise levels that illicit a behavioural response in turtles, a level of 166 dB re 1 µPa drawn from NSF (2011) is typically applied, both in Australia and by NMFS, as the threshold level at which behavioural disturbance could occur (Table 7.14).

**Table 7.14. Exposure criteria for seismic sources – turtles**

| Mortality and potential mortal injury | Distance from the source | Impairment | | | Behaviour |
|---|---|---|---|---|---|
| | | Recoverable injury | TTS | Masking | |
| 210 db $24_{hr}$ SEL *or* >207 dB peak | Near | Moderate | Moderate | Low | Moderate |
| | Intermediate | Low | Low | Low | Low |
| | Far | Low | Low | Low | Low |

*Distance from the source*
*Near = tens of metres.*
*Intermediate = within hundreds of metres.*
*Far = thousands of metres.*

In the worst-case, recoverable injury and TTS for any turtles present near the VSP operations could occur within tens of metres (per Table 7.13). Behavioural changes, such as avoidance and diving, may occur for individuals within tens of metres of the sound source. This will not result in short- or long-term population impacts to turtles. The impact consequence level is assessed as negligible.

*Impacts to Crustaceans*

Although there are no threatened crustacean species in the impacts EMBA, crustaceans are assessed here given the presence of the commercially important NPF (see Section 5.7.1). Crustaceans such as banana and tiger prawns that are present in the impacts EMBA are described in Section 5.4.1.

The impacts of underwater sound on crustaceans are assessed in Section 7.1.4 of the Beehive-1 PDSA EP (available here), which was accepted by NOPSEMA in March 2022.

There are no established criteria to model for the effects of underwater sound on crustaceans, so comparisons can only be made to results from acoustic studies. This VSP modelling results presented in Table 7.10 indicate that the distance to effects for recoverable injury (based on a PK-PK of 202 dB re 1µPa from Payne *et al*. (2008)) is 304 m (noting there are no comparison criteria for behaviour, TTS, PTS or mortality).

Based on a Q1 start for the drilling activity, VSP operations may overlap with the spawning period for grooved tiger prawn and blue endeavour prawn, along with migration of juvenile banana prawns (see Figure 5.12 in Section 5.4.1).

Impacts to crustaceans (prawns) will have a negligible impact consequence at both an individual level and local population level based on the following:

- The sound will be temporary (several hours) and localised;
- The activity is 80 km from inshore habitats favoured as nursery grounds for juveniles and therefore will not be impacted by underwater sound generated from VSP; and
- Lethal effects to crustaceans have not been observed (Christian *et al*., 2003; Parry and Gason 2006; Payne *et al*., 2008; Day *et al.,* 2016a).

*Impacts to Avifauna*

There are no threatened seabird species or seabird BIAs in the impacts EMBA.

In the event that individual birds or flocks are present in the impacts EMBA area during VSP operations, an indirect impact may occur if sound pulses cause changes to the abundance or behaviour of prey species (fish). However, the extent to which temporary 'descending' or 'tightening' responses of schooling prey fish such as pilchards (if it occurs) affects availability to birds either positively or negatively, is not known. As described in the previously, the effects to fish from VSP will be very localised and short-term, and it is not likely that measurable impacts to predatory seabirds will be therefore occur.

Seabird species that may forage in the activity area (see Section 5.4.7) all have considerable foraging habitat present throughout JBG, and will all be listed as migratory. The short distance to behavioural effects for fish (tens to hundreds of metres for behavioural impacts) means that any temporary dispersal of fish due to VSP would not result in any significant decrease in availability of prey species that is of biological significance for seabird populations.

There are no thresholds or assessment criteria for noise impacts to birds. As most seabirds spend very little time under the water surface, and when they do it is for several seconds at a time, impacts to seabirds are predicted to be negligible. The operational area does not contain spatially limiting food sources, with JBG providing abundant foraging grounds.

### 7.5.5. Impact Assessment

Table 7.15 presents the impact assessment of underwater sound generated from the activity on biological receptors.

**Table 7.15. Impact assessment for noise emissions on biological receptors**

| Summary | | |
|---|---|---|
| Summary of impacts | Physiological or pathological impacts to local populations of marine fauna and avifauna from noise emissions generated during the drilling activity. | |
| Extent of Impact | Ten of metres and/or up to several hundred metres (due to VSP operations) depending on the source of sound. | |
| Duration of Impact | Very short-term (several minutes for helicopters) to the duration of drilling (support vessel movements, drilling sound). | |
| Level of certainty of impacts | Moderate to high. | |
| Impact decision framework context | Decision type | A – good industry practice required. |
| | Activity | Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined. |
| | Risk and uncertainty | Risks are well understood, uncertainty is minimal. |
| | Stakeholder influence | No conflict with company values, no partner interest, no significant media interest. |
| Defined acceptable level | • No population level impacts to marine fauna and avifauna from the activity.<br>• Anthropogenic noise in BIAs will be managed such that turtles will continue to utilise the area without injury or displacement from foraging, migration and interesting areas. | |

| Impact consequence (inherent) | |
|---|---|
| Receptor | Consequence rating |
| Plankton | Negligible |
| Fish – with swim bladders | Negligible |
| Fish – without swim bladders | Negligible |
| Marine mammals | Negligible |
| Turtles | Negligible |
| Marine invertebrates (crustaceans) | Negligible |
| Avifauna | Negligible |

| Assessment of Proposed Control Measures | | | |
|---|---|---|---|
| Control measure | Control type | Adopt | Justification |
| EPBC Policy Statement 2.1 – Part A (Standard management procedures) for VSP operations **(IMP-05: EPS-01, -03 & -04)** | Engineering & administrative | Yes | **EB:** Improved ability to spot and identify marine fauna at risk of impact from underwater sound generated by VSP equipment.<br>**C:** Little additional cost – time to induct VSP and deck crew and ensure compliance.<br>**Ev:** Standard management procedures in Part A of the policy statement must be followed by all vessels conducting seismic surveys irrespective of location and time of year. The policy statement notes that these procedures should be sufficient in areas where there is a low likelihood of encountering whales, as is the case in the JBG. |
| EPBC Policy Statement 2.1 – Part A (Standard management procedures) – soft-start procedures for VSP. | Engineering | No | **EB:** Improved ability to avoid or minimise impacts of underwater sound to marine fauna.<br>**C:** Cost associated with the extra time to undertake VSP, likely to be several hours. This would be in the order of $100,000 for the MODU time alone.<br>**Ev:** The airguns used for VSP have a much lower sound source volume (600 cui) compared to traditional seismic surveys (up to 3,500 cui) that the Policy Statement 2.1 has been prepared for. Sound will also be generated by the support vessels, acting as a 'warning' to sound-sensitive species. This, the short duration of VSP and with the low likelihood of whales being in the activity area at the time of drilling means the high cost of implementing this control is disproportionate to the low risk. |
| Environmental awareness induction **(IMP-05: EPS-02)**. | Administrative | Yes | **EB:** Ensures VSP and deck crew are aware of their obligations regarding implementation of EPBC Policy Statement 2.1 when conducting VSP operations, thereby minimising impacts to megafauna.<br>**C:** Minimal additional cost to prepare and present induction.<br>**Ev:** Presenting inductions to ensure VSP and deck crew are aware of their obligations is an industry standard. The environmental benefits outweigh the minor costs. |

| | | | |
|---|---|---|---|
| EPBC Policy Statement 2.1 – Part B (Additional management measures) – use of a Marine Mammal Observer (MMO) during VSP operations) | Administrative | No | **EB:** Improved ability to spot and identify marine fauna at risk of impact from underwater sound generated by activity equipment.<br>**C:** About $20-30,000 to contract two MMOs (back-to-back operations, based on day rate, travel and accommodation) for the duration of VSP operations plus standby time.<br>**Ev**: The use of MMOs is covered by Part B (Additional Management Procedures) of the policy statement. Adoption of Part B (either all or parts thereof) is recommended in areas and/or seasons that have a moderate to high likelihood of encountering whales. The likelihood of encountering whales in the activity area during the activity window is low, so the use of an MMO is not considered necessary. Crew on the MODU can implement EPBC Policy Statement 2.1 with support of constant bridge observations from crew on the support vessels. |
| Undertake site-specific acoustic modelling and develop a noise management plan as per the Approved Conservation Advice for *Megaptera noveangliae* (humpback whale). | Administrative | No | **EB:** Increase the knowledge of potential impacts and potential reduction in impacts to whales.<br>**C:** Several thousand dollars to undertake site-specific acoustic modelling and prepare the management plan.<br>**Ev:** There is no environmental benefit with this control measure as there are no humpback whale BIAs in or near the activity area and the timing of the activity is outside the humpback whale migration period on the North West Shelf. |
| Vessels and helicopters will comply with EPBC Regulations 2000 – Part 8 Division 8.1 **(IMP-05: EPS-03)**. | Administrative | Yes | **EB:** Reduces the risk of physical and behavioural impacts to cetaceans from vessels and helicopters.<br>**C:** Operational costs to adhere to marine fauna interaction restrictions, such as vessel speed and direction, are based on legislated requirements.<br>**Ev:** Standard management procedures in Regulations 8.07 must be followed. |
| MODU machinery and support vessel engines and thrusters/DP are well maintained **(IMP-05: EPS-05)**. | Engineering | Yes | **EB:** Efficient engines, thrusters and other rotating equipment are likely to result in lower sound and vibration, thereby minimising impacts to sound-sensitive marine fauna.<br>**C:** Maintenance costs can be significant.<br>**Ev:** Planned maintenance is necessary to maintain MODUs and support vessels in sea-worthy condition. EOG would not hire a MODU or vessel that is not sea-worthy, so there are no alternative to implementing this control measure. |

| Environmental Controls and Performance Measurement | | |
|---|---|---|
| Performance outcome | Performance standard (control) | Measurement criteria |
| VSP and pre-drilling geophysical operations | | |
| No displacement or injury to threatened marine fauna from drilling or pre-drilling activities | **(IMP-05:EPS-01)** Geophysical and VSP team members, with the support of dedicated MODU deck crew and support vessel bridge crew, will implement parts of Part A of EPBC Policy Statement 2.1 during VSP and any pre-drill geophysical activities. Specifically: | |
| | *A.3.1: Pre Start-Up Visual Observations*<br>• Pre-start visual observations out to 3 km for 30 minutes.<br>• If a whale or turtle is observed during the pre-start observations, delay soft start for 30 minutes.<br>• If no whales or turtles are observed, activate acoustic equipment. | Daily operations reports verify procedure was followed as required. |
| | *A.3.4: Operations procedure*<br>• If a whale or turtle is observed within the shutdown zone of the source (500 m), the airguns will be shut down.<br>• VSP can recommence after the whale or turtle has been observed to move outside the shutdown zone or if the whale has not been sighted for 30 minutes. | Daily operations reports verify procedure was followed as required. |
| | *A.3.6 Night-time and low visibility procedure*<br>• Wherever practicable, commence VSP operations during daylight hours.<br>• Night-time and low visibility operations will not commence if there have been 3 or more whale-instigated shutdown in the preceding daylight hours. | Daily operations reports verify procedure was followed as required. |

| Environmental Controls and Performance Measurement | | |
|---|---|---|
| Performance outcome | Performance standard (control) | Measurement criteria |
| | **(IMP-05: EPS-02)** Environmental awareness induction will be provided to MODU, geophysical, VSP and support vessel crew prior to start of the activity. This includes:<br>• Providing the policy statement to the Vessel Masters and Drilling Supervisor (DSV).<br>• Providing photos/pictures of the different megafauna expected in the area at the time of the activity, including in the form of posters for display.<br>• Instructions on the pre-start, shut-down and re-start requirements (as listed in **IMP-05:EPS-01**).<br>• Instructions on distance estimation, including the specification that marine binoculars with reticles are used.<br>• Instructions on how to detect marine megafauna based on observations on the water surface and surrounds.<br>• Instructions on data to be recorded for marine megafauna sightings, including time of observation, type and number of species observed and estimated location coordinates. | Induction presentation and signed attendance sheet. |
| | **(IMP-05: EPS-03)** Support vessel and helicopter activities will be undertaken in accordance with EPBC Regulations 2000 – Part 8, Division 8.1. Specifically:<br>• Vessels will not knowingly travel faster than 6 knots within 300 m of a whale or 150 m of a dolphin;<br>• Vessels will not knowingly get closer than 100 m of a whale or 50 m of a dolphin;<br>• If a cetacean approaches, the vessel within the above zones, the vessel will avoid rapid changes in engine speed or direction;<br>• Helicopters will not fly lower than 1650 ft when within 500 m horizontal distance of a cetacean except when landing or taking off and will not approach a cetacean from head on. | Flight reports verify in the event of a cetacean sighting, that caution zone and interaction management actions were implemented. |

| Environmental Controls and Performance Measurement | | |
|---|---|---|
| Performance outcome | Performance standard (control) | Measurement criteria |
| Cetacean sightings are reported to the DCCEEW. | **(IMP-05:EPS-04)** *EPBC Act Policy 2.1 – Part A.4*<br>EOG will report cetacean sightings online to the DCCEEW within 2 months of activity completion (through the online Cetacean Sightings Application where possible or via email). | Transmittal of sighting records are available to verify reports were made. |
| MODU and support vessel operations | | |
| MODU engines and support vessel engines and thrusters/DP are well maintained. | **(IMP-05: EPS-05)** Engines and thrusters are maintained in accordance with manufacturer's instructions via the PMS to ensure they are operating efficiently. | PMS records verify that engines and thrusters are maintained to schedule. |

| Impact consequence (residual) | |
|---|---|
| Receptor | Consequence rating |
| Plankton | Negligible |
| Fish – with swim bladders | Negligible |
| Fish – without swim bladders | Negligible |
| Marine mammals | Negligible |
| Turtles | Negligible |
| Marine invertebrates (crustaceans) | Negligible |
| Avifauna | Negligible |

The consequence of underwater sound emissions is assessed as negligible because:

- Underwater sound emissions are localised and temporary;
- BIAs for cetaceans (as one of the more sound-sensitive fauna groups) do not occur in the impacts EMBA;
- The activity avoids temporal overlap with whales that may migrate through the region; and
- Distances to effect for underwater sound are very low.

| Demonstration of ALARP |
|---|
| A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence. |

| Demonstration of Acceptability | |
|---|---|
| Policy compliance | EOG's Safety and Environmental Policy objectives are met. |
| Management system compliance | Chapter 10 describes the EP implementation strategy to be employed for this activity. |
| Risk matrix standard | The residual impact consequence is negligible, which is considered acceptable. |

| Environmental Controls and Performance Measurement | | |
|---|---|---|
| Performance outcome | Performance standard (control) | Measurement criteria |
| External context | There have been no objections or claims raised by relevant persons regarding underwater sound emissions for this activity. | |
| Legislative context | The performance standards outlined in this EP align with the requirements of:<br>• EPBC Act 1999 (Cth):<br>  ○ Section 229, 229A – all cetaceans protected in Australian waters, and it is an offence to kill, injure or interfere with a cetacean.<br>• EPBC Act Policy Statement 2.1 (Interaction between offshore seismic exploration and whales) management procedures. | |
| Industry practice | The consideration and adoption of the controls outlined in the below-listed codes of practice and guidelines demonstrates that BPEM is being implemented for this activity. | |
| | Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020) | The EPS developed for this activity take into account the management measures listed for exploration in Section 4.4.1 of the guidelines, which include:<br>• Considering sensitive locations and times of year for critical activities of species that are present. |
| | Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019) | There are no guidelines specifically regarding underwater sound for offshore activities. |
| | Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015) | There is no guidance specific regarding underwater sound. |
| | Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015) | Guidelines met with regard to:<br>• Noise (item 74). The preparation of this EP meets the objectives of these guidelines, whereby sensitive areas for marine life are identified, and stop procedures are in place when marine mammals are sighted within 500 m of the activity **(IMP-05: EPS-01)**. |
| | AEP CoEP (APPEA 2008) | The EPS developed for this activity meet the code's following objectives:<br>• Reduce the impact on cetaceans and other marine life to ALARP and an acceptable level **(IMP-05: EPS-01, -02 & -03)**.<br>• To reduce the impacts to benthic communities to ALARP and an acceptable level. |
| | Underwater sound-specific | |

| Environmental Controls and Performance Measurement | | |
|---|---|---|
| Performance outcome | Performance standard (control) | Measurement criteria |
| | EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (2008a) | The standard management procedures in Part A of the guidelines have been adopted **(IMP-05: EPS-01 & -03)**. |
| | EPBC Regulations 2000 – Part 8, Division 8.1 | The standard management procedures in Part 8, Division 8.1, Regulation 8.07 have been adopted **(IMP-05: EPS-04)**. |
| Environmental context | MNES | |
| | AMPs | This hazard will not reach levels above ambient sound at AMPs. |
| | Ramsar wetlands | This hazard will not reach levels above ambient sound at any wetlands. |
| | TECs | This hazard will not reach levels above ambient sound at TECs. |
| | Nationally threatened and migratory species | This hazard will not reach levels above ambient sound for threatened and migratory species. |
| | Other matters | |
| | KEFs | This hazard will not reach levels above ambient sound at KEFs. |
| | NIWs | This hazard will not reach levels above ambient sound at NIWs. |
| | State marine parks | This hazard will not reach levels above ambient sound at state marine parks, which are located around islands and along mainland coastlines. |
| | Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans | The Conservation Management Plan for the Blue Whale (DoE, 2015b) and the Conservation Advice for the Humpback Whale (TSSC, 2015a); Sei Whale (TSSC, 2015b) and Fin Whale (TSSC, 2015c) identify noise interference as a threat to these species. The plans state that the risk of physical impacts is minimised by the implementation of EPBC Act policy Statement 2.1, which this activity is implementing.<br>The Recovery Plan for the White Shark (DSEWPC, 2013) does not list anthropogenic sound as a threat to this species.<br>The Recovery Plan for the Sawfish and River Sharks (DoE, 2015) does not list anthropogenic sound as a threat to this species.<br>The Conservation Advice of the Whale Shark (TSSC, 2015d) does not list anthropogenic sound as a threat to this species. |

| Environmental Controls and Performance Measurement | | |
|---|---|---|
| Performance outcome | Performance standard (control) | Measurement criteria |
| | The Recovery Plan for Marine Turtles in Australia (DoEE, 2017c) identifies noise interference as a threat to turtles, and for acute noise such as seismic surveys, states that surveys planned to occur inside important inter-nesting habitat should be scheduled outside the nesting season. This is not triggered by this activity given the absence of turtle BIAs in the EMBA. | |
| ESD principles | The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant). | |
| Statement of acceptability | EOG considers the impacts from underwater sound to be acceptable because:<br>• It will adhere to the company's Safety and Environmental Policy;<br>• The residual consequence rating is negligible;<br>• An Implementation Strategy (described in Chapter 10) is in place to ensure the EPS are achieved.<br>• Relevant legislation and industry best practice will be complied with;<br>• Underwater sound emissions from the activity will not have long-term or significant impacts on MNES;<br>• The management of underwater sound emissions will ensure it is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species;<br>• The management of underwater sound emissions will ensure it is not inconsistent with the aims of relevant marine reserve management plans; and<br>• The management of underwater sound emissions will ensure it is not inconsistent with ESD principles. | |
| Environmental Monitoring | | |
| • Monitoring for megafauna. | | |
| Record Keeping | | |
| • Daily operations reports.<br>• VSP operations reports.<br>• Transmittal of sighting records to DCCEEW.<br>• Induction presentation and attendance sheets.<br>• PMS records. | | |

## 7.6. IMPACT 6 – Discharge of Drill Cuttings and Muds

### 7.6.1. Hazard

Cuttings (and adhered fluids) are discharged directly to the seabed during riserless drilling and discharged from the MODU to the sea surface while drilling with the riser connected. Cuttings and adhered muds disposed from the MODU form a turbid plume, within which the larger particles (90-95%) fall to the seabed close to the discharge point, while the finer particles form an upper plume before dispersing, with a dilution factor of at least 10,000 within 100 m of the discharge point (Hinwood *et al*., 1994).

Drill cuttings from upper well sections generally accumulate in an approximate 80 x 80 m area around the well, commonly an ellipsoid shape according to tide and current behaviour (Hinwood *et al*., 1994). When cuttings from the lower sections of the well are discharged at the sea surface, the larger sediment particles settle rapidly to the seabed, generally with 90% of the discharge volume falling within 100 m of the discharge point (Hinwood *et al*., 1994).

The physical deposition of these cuttings, combined with the properties of the adhered fluids, may have an impact on flora and fauna and benthic habitat, depending on the discharge volumes, exposure levels and the sensitivity of the species themselves.

After drilling the riserless sections of the wells, muds will be circulated and continuously recycled to the surface. The mud is circulated to surface to separate cuttings from the fluid and in turn allows the mud to be pumped back down into the well. Cuttings are separated from the mud system using shale shakers to remove as much mud for reuse as possible. The cuttings with residual mud are intermittently discharged from the MODU from a discharge hose above sea level. Periodically, different solids control devices within the mud treatment system may also discharge to sea. The mud treatment system is continuously monitored for operability by the mud engineer and drilling fluid properties assessed at least twice daily by the DSV and Drilling Fluids Engineer to optimise separation efficiency. A bulk discharge of waste WBM will occur at the end of the drilling campaign.

At the completion of drilling, each well will be either P&A or TA (see Section 2.8), with either completion brine or WBM left in the wellbore.

**Drill Cuttings and Fluid Solids Discharge Modelling**

EOG commissioned RPS to undertake dispersion modelling of drill cuttings and muds based on the multi-well design described in Section 2.7 using the following three scenarios:

- Scenario 1 – WBM for all well sections in Table 2.5;
- Scenario 2 – WBM for all well sections, except for SBM in the 12”.25”, 8.5”and 8.5” sidetrack sections; and
- Scenario 3 – WBM for all well sections, except for SBM in the 12.25” section.

The modelling results apply to the drilling of a single well. Table 2.5 in Section 2.7 lists the estimated volume of drill cuttings, WBM, SBM and unrecoverable mud solids for each well interval and the end-of-well mud discharge.

<u>Modelling Methodology</u>

The following information is taken from the RPS modelling report (2024). MUDMAP is a three-dimensional plume model used to aid in assessing the potential environmental effects from operational discharges such as drill cuttings, drilling fluids and produced water. The model has been applied to hundreds of assessments in over 35 countries, including Australia.

The model itself is an enhancement of the Offshore Operators Committee (OOC) model and calculates the fates of discharges through three distinct stages, as defined by laboratory and field studies:

- Stage 1, Convective descent – free fall of the combined mass of fluids and cuttings;

- Stage 2, Dynamic collapse stage – the collapse of the combined mass as it meets the seabed (or water surface); and
- Stage 3, Dispersion stage – the transport and dispersion of discharged fluids and particles by the local currents. For cuttings and drilling mud particles that have higher density than seawater, this phase also calculates sinking and settlement to the seabed.

Each stage plays an integral role on different time and distance scales. Settling under currents is selective for particle size, with the larger particles (rock chips to sand) tending to settle quickly, forming a pile that aligns with the predominant water current axis. Smaller particles (especially silts and clays) will remain suspended for longer periods and will therefore be dispersed more widely by the ambient current conditions. Dispersion of the finer discharged material tend to be enhanced with increased current speeds and water depth and with greater variation in current direction over time and depth. Along with the advanced analyses tools, MUDMAP can simulate six classes of material (or 36 subcategories), each with unique density and particle-size distribution. During the dispersion stage, the model particles are transported in three dimensions according to the current data and horizontal and vertical mixing coefficients at each time step according to the governing equations.

MUDMAP has been extensively validated and applied for discharge operations in Australian coastal waters. The input data used to setup the dispersion model included:

- Volume and discharge duration of the cuttings and unrecovered muds;
- Particle size distributions and associated settling velocities of discharged cuttings and unrecoverable muds;
- Bulk density of the discharged cuttings and unrecoverable muds;
- Temperature and salinity profile of the receiving waters;
- The orientation of the discharge pipe;
- The height/depth of the discharge point relative to mean sea level; and
- Depth-varying current data to represent local physical forcing.

Table 7.17 provides a summary of the discharge configuration and the estimated volume of cuttings and muds used as input into the discharge model for a single well. Each simulation represented the sequential completion of each discharge operation with the sequence and rate of discharges set to represent the proposed drilling and discharge plan. Simulations were run for a longer period than the discharge duration to allow finer sediments to settle out of suspension or to disperse.

**Table 7.17. Input data used for the drill cuttings and dispersion modelling**

| Parameter/description | Values/configuration |
|---|---|
| Volume of cuttings discharged near the seabed | 88.4 $m^3$ |
| Volume of mud solids discharged near the seabed | 30.0 $m^3$ |
| Volume of cuttings discharged near the sea surface | 1,152 $m^3$ |
| Volume of mud solids discharged near the sea surface | 397.4 $m^3$ |
| Total volume of cuttings discharged | 1,240.8 $m^3$ |
| Total volume of mud solids discharged | 427.4 $m^3$ |
| Density of drill cuttings | 2,600 $kg/m^3$ |
| Density of drilling mud solids | 4,200 $kg/m^3$ |
| Duration of discharge | 34.25 days |
| Depth of near – seabed discharge | 2 m above seabed |
| Depth of near – sea surface discharge | 0 m (sea surface) |
| Water depth | 40 m |
| Orientation of discharge pipe | Vertically downwards |
| Stochastic modelling approach and conditions | Randomly selected start simulation dates between January–December (2010–2019).<br>25 simulations per quarter (Q1: January–March, Q2: April–June, Q3: July–September and Q4: November–December). |

As the well will be drilled using a conventional drilling approach, the particle sizes for cuttings and drilling muds were represented by literature data for conventional drilling (Table 7.18). It is important to note that grain size has a greater influence on the rate of settling than density (Neff, 2005), and grain sizes are expected to vary between 0.016 mm and 6 mm in diameter. The model was set up with four main particle classes to represent large, medium and light cuttings, and drilling fluid solids (i.e., mud particles). The fall velocities for the various size classes were derived from empirical data provided by Dyer (1986).

A stochastic modelling approach was followed with one hundred simulations (or 25 per quarter of the year) modelled for each of the three scenarios. Each discharge simulation for the respective well had the same information but different commencement times, and thus, prevailing current conditions were different. This approach ensured that the cuttings and muds experienced a wide range of current conditions (speeds and directions). The results from all 100 simulations per scenario, were integrated to identify the overall area of exposure on the seabed and in water. The outputs are presented as contours relative to the maximum predicted bottom thickness of deposited material on the seabed or total suspended solids (TSS) concentrations.

**Table 7.18. Discharged grain sizes, settling velocities and percentage distributions for the cuttings and drilling muds, based on conventional hole drilling using WBM and SBM**

| Class | Grain size (mm) | Settling velocity (cm/s) | Well section consisting of drilling with WBM (composition %) | WBM class proportion (composition %) | Well section consisting of drilling with SBM (composition %) | SBM class proportion (composition %) |
|---|---|---|---|---|---|---|
| Large cuttings | 6 | 53.62 | 8.6 | 40.3 | 8.2 | 38.5 |
| | 5 | 49.46 | 8.6 | | 8.2 | |
| | 2 | 28.55 | 8.6 | | 8.2 | |
| | 1 | 12.73 | 5.8 | | 5.5 | |
| | 0.5 | 7.5 | 5.8 | | 5.5 | |
| | 0.45 | 6.6 | 2.9 | | 2.7 | |
| Medium cuttings | 0.4 | 6 | 2.9 | 16.9 | 2.7 | 16.3 |
| | 0.35 | 5 | 2.8 | | 2.7 | |
| | 0.3 | 4 | 2.8 | | 2.7 | |
| | 0.25 | 3.1 | 2.8 | | 2.7 | |
| | 0.2 | 2.3 | 2.8 | | 2.7 | |
| | 0.15 | 1.6 | 2.8 | | 2.7 | |
| Light cuttings | 0.1 | 0.8 | 2.8 | 14.3 | 2.7 | 13.7 |
| | 0.05 | 0.22 | 2.8 | | 2.7 | |
| | 0.04 | 0.15 | 2.9 | | 2.7 | |
| | 0.03 | 0.08 | 2.9 | | 5.4 | |
| | 0.02 | 0.04 | 2.9 | | 0.0 | |

| Class | Grain size (mm) | Settling velocity (cm/s) | Well section consisting of drilling with WBM (composition %) | WBM class proportion (composition %) | Well section consisting of drilling with SBM (composition %) | SBM class proportion (composition %) |
|---|---|---|---|---|---|---|
| Drilling fluids solids | 0.063 | 0.34 | 0.4 | 28.5 | 0.0 | 31.5 |
| | 0.05 | 0.22 | 1.6 | | 1.7 | |
| | 0.035 | 0.11 | 3.7 | | 4.1 | |
| | 0.026 | 0.06 | 6 | | 25.3 | |
| | 0.02 | 0.038 | 7.4 | | 0.0 | |
| | 0.016 | 0.026 | 9.4 | | 0.0 | |
| **Total composition (%)** | | | **100** | **100** | **100** | **100** |

*Settling velocities per grain size sourced from Dyer (1986).*

### Reporting Thresholds

The following information on thresholds is taken from RPS (2024). The MUDMAP model can predict sediment concentrations and thickness to very low levels that may not be practical or ecologically significant; therefore, thresholds were carefully selected for reporting the model-predicted outcomes.

Based on available literature, thresholds of 1-10 mm and above 10 mm were used to define low and high exposure levels for this study, respectively (Table 7.19). In addition, Trannum *et al*. (2009) reports a significant decrease in species count, abundance of individuals, Shannon-Wiener diversity, and biomass of marine animals with increasing depth of deposited cuttings (3-24 mm). Furthermore, a study by Kjeilen-Eilertsen *et al*. (2004) reports that depositional thicknesses greater than 9.6 mm are likely to cause smothering impacts on benthic ecosystems, including corals. A study by Smit *et al*. (2008) established that a thickness threshold of greater than 6.5 mm would be needed before potential harm to benthic macrofauna occur.

As a conservative measure, a thickness of 0.05 mm was adopted as a minimum reporting threshold for modelling (Table 7.19). Assuming newly settled cuttings and drilling muds will be less compact due to incorporation of water between grains of sediment deposits, a bulking factor of 2.5 was applied to predicted bottom thicknesses to account for porosity.

The minimum reporting threshold for TSS concentrations used for this study is 5 mg/L. Nelson *et al*. (2016) reports <10 mg/L as a minimal or no effect, whilst concentrations above 10 mg/L have a sublethal effect to pelagic biota. Furthermore, IOGP (2016) cite that very high concentrations (>1,830 mg/L) of TSS has been shown to result in mortality of pelagic biota. Hence, a threshold range of 10-1,830 mg/L and greater than 1,830 mg/L were used to define low and high exposure, respectively (see Table 7.19).

**Table 7.19. Reporting thresholds for sediment thickness and TSS concentrations for the drill cuttings and muds discharge modelling**

| Reporting criteria | Total sediment thickness (mm) | TSS concentration (mg/L) |
|---|---|---|
| Minimum reporting threshold | 0.05 | 5 |
| Low exposure | 1 – 10 | 10 – 1,830 |
| High exposure | > 10 | > 1,830 |

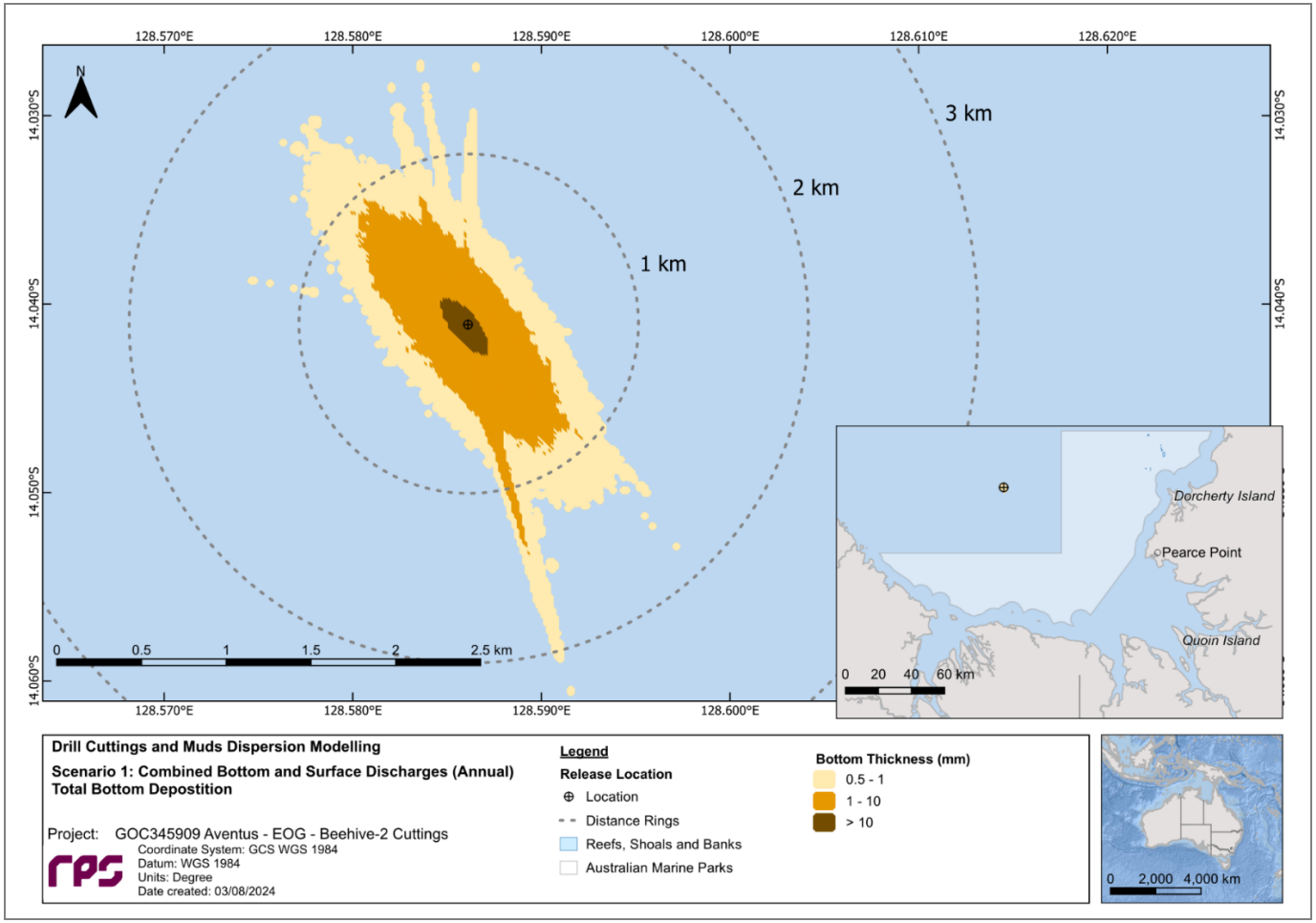
### Stochastic Modelling Results – Sediment Thickness

Figure 7.4, Figure 7.5 and Figure 7.6 illustrate the predicted coverage and sediment thickness from the combined near-seabed and sea surface drill cuttings and unrecoverable muds discharges from all 100 simulations for each of the three scenarios for a single well. Table 7.20 presents the same results.

The total area of coverage on the seafloor above the minimum reporting threshold (0.5 mm) ranged between 1.70 km$^2$ (scenario 3) and 1.80 km$^2$ (scenario 2) for a single well. Assuming three wells are drilled, the total area of coverage increases to a range between 5.1 km$^2$ (scenario 3) and 5.4 km$^2$ (scenario 2). The predicted maximum distances of excursion of the minimum reporting thickness reporting threshold from the release location ranged between 1.99 km (scenario 2) to 2.03 km (scenario 1).

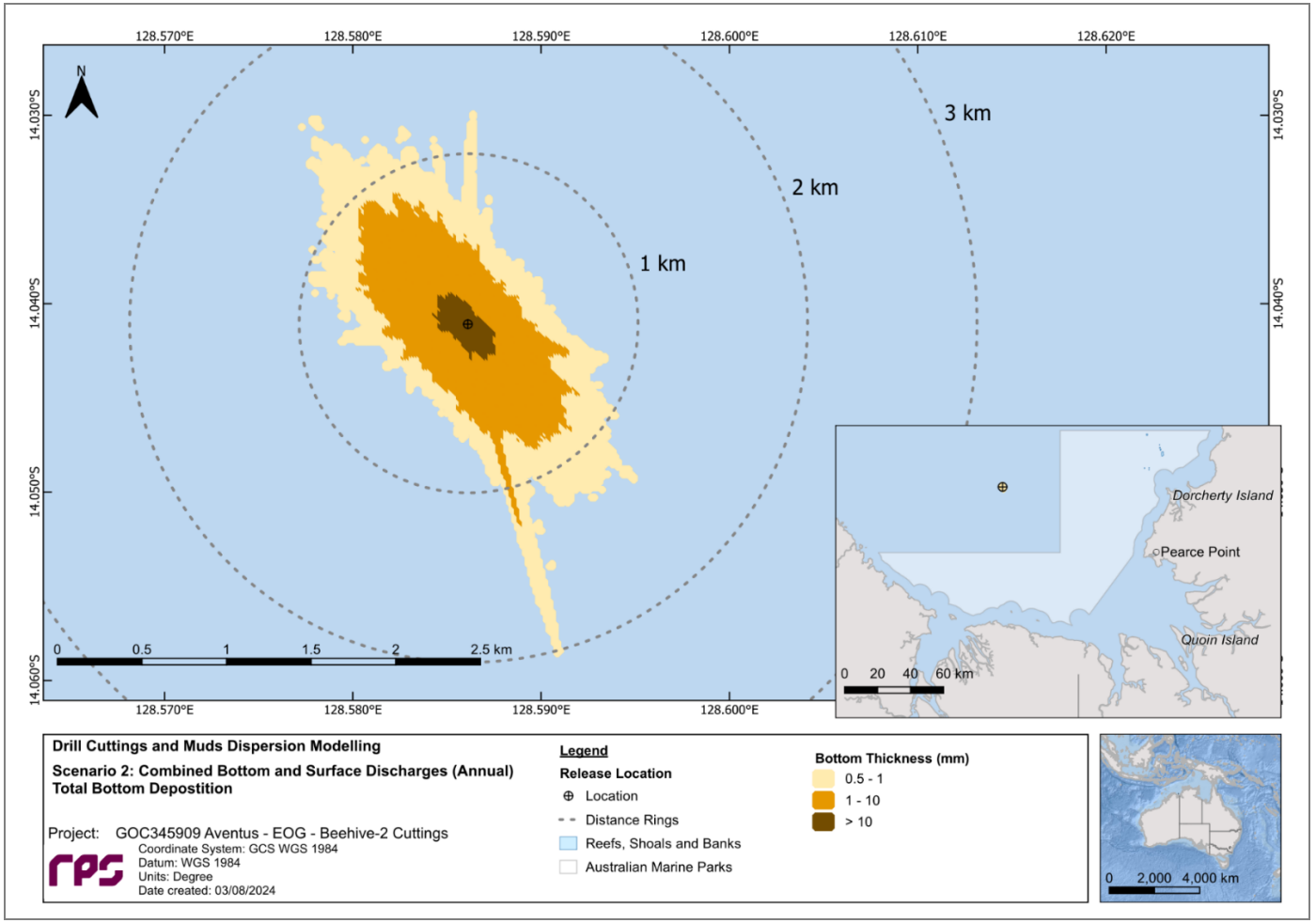
The area of coverage based on the low (1-10 mm) and high (>10 mm) exposure threshold criteria ranged from 0.77 km$^2$ (scenario 1) to 0.86 km$^2$ (scenario 2) and 0.05 km$^2$ (scenarios 1 and 3) to 0.07 km$^2$ (scenario 2), respectively, for a single well. Assuming three wells are drilled, the total area

of coverage increases to a range between 2.3 $km^2$ (scenario 1) and 2.6 $km^2$ (scenario 2) and 0.15 $km^2$ (scenarios 1 and 3) to 0.21 $km^2$ (scenario 2), respectively. The maximum distance from the release location to the low and high exposure thresholds ranged from 1.21 km (scenario 3) to 1.33 km (scenario 1) and 0.21 km (scenarios 1 and 3) to 0.24 km (scenario 2), respectively.



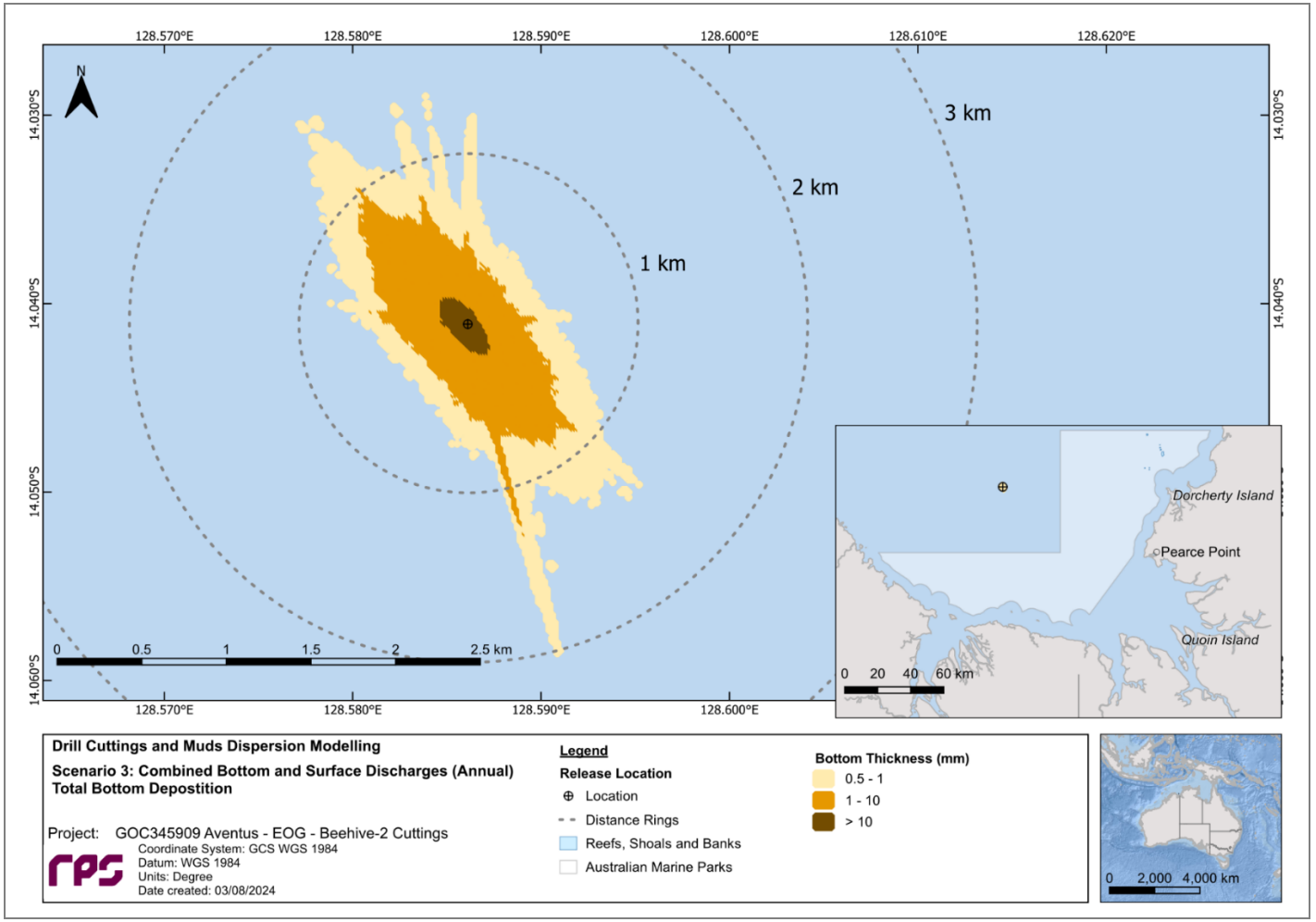

*Source: RPS (2024).*

**Figure 7.4. Predicted distribution and sediment thickness of cuttings and muds discharges for scenario 1 (WBM for all well sections) based on 100 simulations with a 34.25-day modelled discharge period**




*Source: RPS (2024).*

**Figure 7.5. Predicted distribution and sediment thickness of cuttings and muds discharges for scenario 2 (WBM for all well sections, except for SBM in the 12.25”, 8.5” and 8.5” sidetrack sections) based on 100 simulations with a 34.25-day modelled discharge period**




*Source: RPS (2024).*

**Figure 7.6. Predicted distribution and sediment thickness of cuttings and muds discharges for scenario 3 (WBM for all well sections, except for SBM in the 12.25” section) based on 100 simulations with a 34.25-day modelled discharge period**

**Table 7.20. Predicted annual area of coverage and maximum distance for each bottom thickness reporting threshold for each scenario based on 100 simulations with a 34.25-day modelled discharge period for a single well**

| Sediment reporting thickness (mm) | Reporting criteria | Collective assessment of all combined simulations | | |
|---|---|---|---|---|
| | | Area of coverage of cuttings and muds ≥0.05 mm thickness ($km^2$) | Percentage of modelled area covered by sediment | Maximum distance from the release location (km) |
| Scenario 1 – WBM for all sections | | | | |
| 0.05 – 0.1 | Minimum reporting threshold | 0.97 | 54.4 | 2.03 |
| 1 – 10 | Low exposure | 0.77 | 43.0 | 1.33 |
| > 10 | High exposure | 0.05 | 2.6 | 0.21 |
| | **Total** | **1.79** | | |
| Scenario 2 – WBM for all sections, except for SBM in the 12.25”, 8.5” and 8.5” sidetrack sections | | | | |
| 0.05 – 0.1 | Minimum reporting threshold | 0.87 | 48.3 | 1.99 |
| 1 – 10 | Low exposure | 0.86 | 47.8 | 1.22 |
| > 10 | High exposure | 0.07 | 4.0 | 0.24 |
| | **Total** | **1.80** | | |
| Scenario 3 – WBM for all sections, except for SBM in the 12.25” section | | | | |
| 0.05 – 0.1 | Minimum reporting threshold | 0.87 | 51.0 | 2.01 |
| 1 – 10 | Low exposure | 0.78 | 45.8 | 1.21 |
| > 10 | High exposure | 0.05 | 3.1 | 0.21 |
| | **Total** | **1.70** | | |

The modelling results demonstrate that the settlement of the cuttings and drilling muds occur predominantly along a northwest–southeast axis, coinciding with the dominant current directions at the release location. Given the similarity in the seasonal current speeds and directions, there was no discernible differences to the predicted areas of exposure between quarters of the year. However, the modelling results indicate that the maximum bottom thicknesses and area of coverage(s) of the exposure thresholds is directly attributable to the height of discharge. When the cuttings and muds were discharged from the surface, the sediments travelled further spread over a larger area forming a thinner pile on the seabed. While the cuttings and muds discharged near the seabed were unable to travel as far, this resulted in settling closer to the well location and a larger localised mound. Three such cuttings mounds would be created if all three wells are drilled.

**Stochastic Modelling Results – TSS Concentrations**

Figure 7.7, Figure 7.8 and Figure 7.9 illustrate the predicted maximum TSS concentrations (within any depth layer) from all 100 individual simulations (near-seabed and sea surface discharges) for

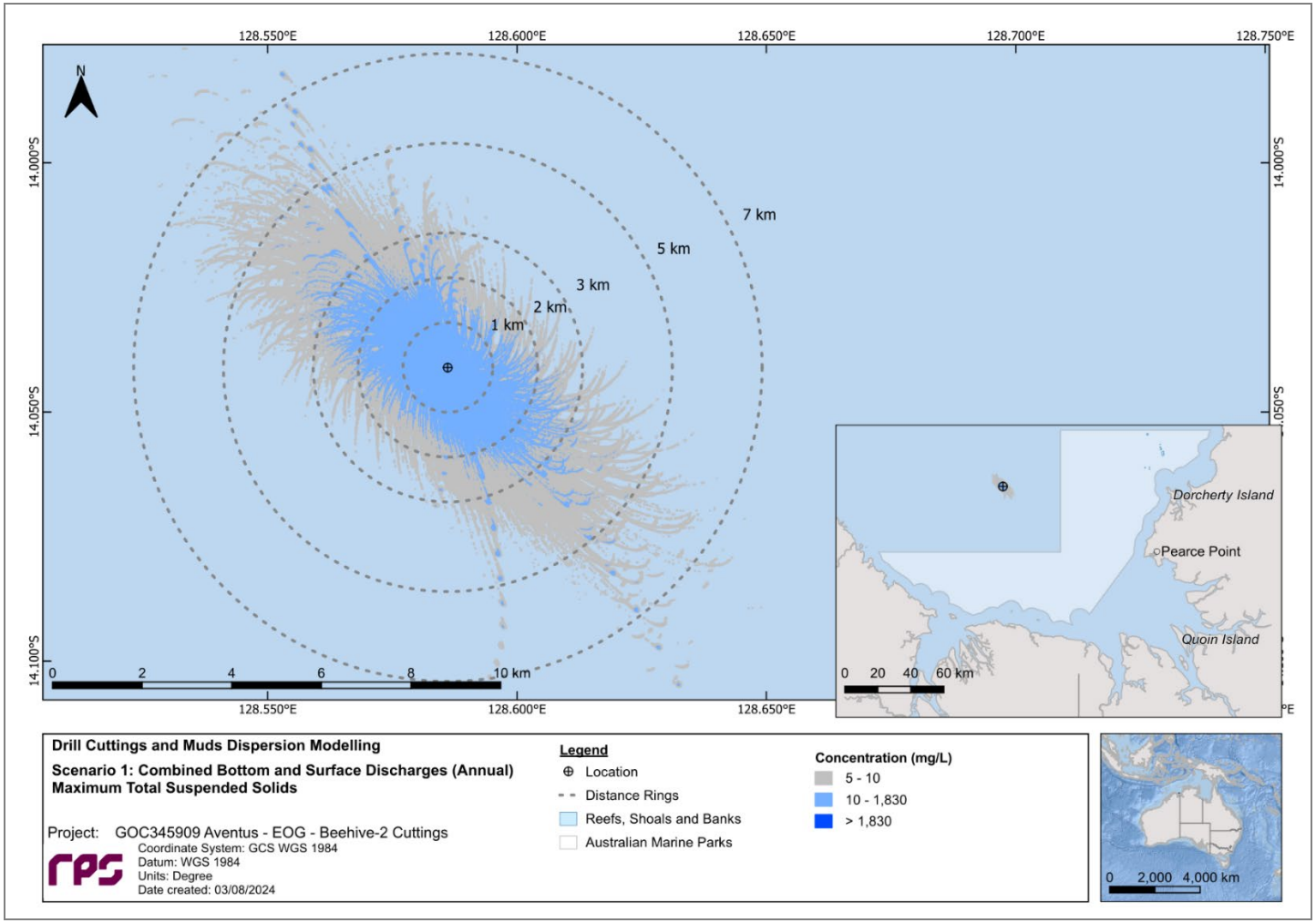
each scenario used to define the area of greatest extent from the discharge of drilling muds (at the completion of drilling) on an annualised basis for a single well.

The total area of coverage above the minimum reporting TSS threshold was 32.6 $km^2$, which was predicted to occur up to a maximum distance of 9.13 km from the drilling site. In comparison, the area of coverage based on the low (10-1,830 mg/L) exposure thresholds was 12.48 $km^2$, which was predicted to occur up to a maximum distance of 6.38 km from the drilling site (Table 7.22). No high exposure concentrations (>1,830 mg/L) were predicted for any modelled scenario. In the case where three wells are drilled, the area of coverage based on the low exposure thresholds would be 37.44 $km^2$.

The modelling results demonstrate the predicted TSS concentrations resulting from the cuttings and drilling muds discharges occurred predominantly along the northwest–southeast axis, coinciding with the dominant current directions at the release locations. Given the similarity in the seasonal current directions and speeds, no discernible differences to the predicted areas of exposure between quarters of the year was observed. For all the scenarios, the discharge of 60.6 $m^3$ of waste muds solids at sea surface following well drilling completion over the anticipated duration of 0.17 days (~4 hrs) resulted in a large contribution of the predicted TSS and was responsible for the overall outer predicted extents (i.e., area of coverage).

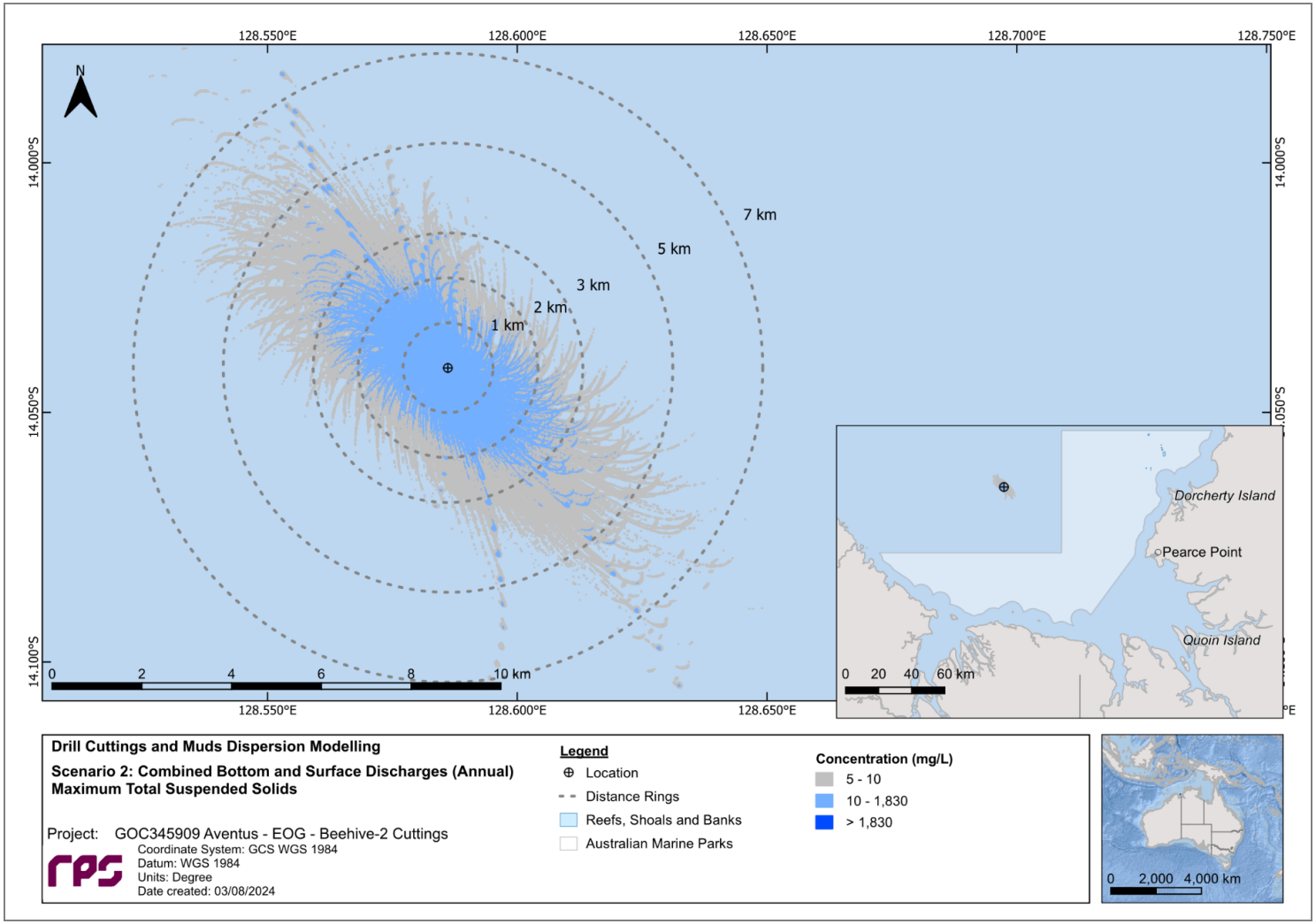
**Table 7.22. Predicted annual area of coverage and maximum distance for each TSS reporting threshold for each scenario based on 100 simulations with a 34.25-day modelled discharge period for a single well**

| Maximum instantaneous TSS concentration (mg/L) | Reporting criteria | Collective assessment of all combined simulations | | |
|---|---|---|---|---|
| | | Area of coverage of maximum instantaneous TSS concentrations ($km^2$) | Percentage of area covered (%) | Maximum distance from release location (km) |
| Scenario 1 – WBM for all sections | | | | |
| 5 – 10 | Minimum reporting threshold | 20.11 | 61.72 | 9.13 |
| 10 – 1,830 | Low exposure | 12.48 | 38.28 | 8.67 |
| > 1,830 | High exposure | 0.0 | 0.0 | 0.0 |
| | **Total** | **32.59** | | |
| Scenario 2 – WBM for all sections, except for SBM in the 12.25”, 8.5” and 8.5” sidetrack sections | | | | |
| 5 – 10 | Minimum reporting threshold | 20.11 | 61.72 | 9.13 |
| 10 – 1,830 | Low exposure | 12.48 | 38.28 | 8.67 |
| > 1,830 | High exposure | 0.0 | 0.0 | 0.0 |
| | **Total** | **32.59** | | |
| Scenario 3 – WBM for all sections, except for SBM in the 12.25” section | | | | |
| 5 – 10 | Minimum reporting threshold | 20.11 | 61.72 | 9.13 |
| 10 – 1,830 | Low exposure | 12.48 | 38.28 | 8.67 |
| > 1,830 | High exposure | 0.0 | 0.0 | 0.0 |
| | **Total** | **32.59** | | |



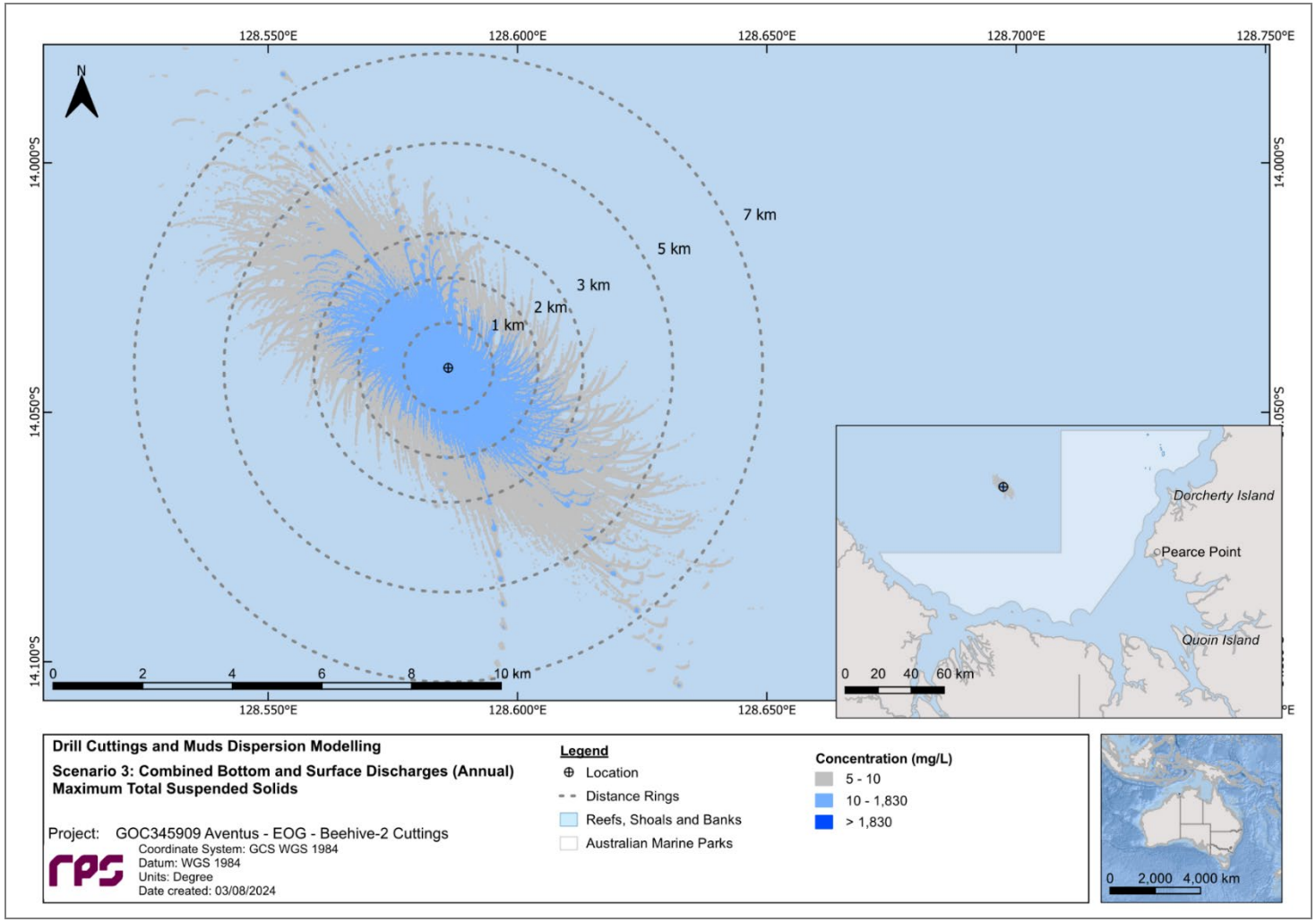

*Source: RPS (2024).*

**Figure 7.7. Predicted maximum TSS concentrations for scenario 1 based on 100 simulations (near-seabed and sea surface discharges) with a 34.25-day modelled discharge period**




*Source: RPS (2024).*

**Figure 7.8. Predicted maximum TSS concentrations for scenario 2 based on 100 simulations (near-seabed and sea surface discharges) with a 34.25-day modelled discharge period**




*Source: RPS (2024).*

**Figure 7.9. Predicted maximum TSS concentrations for scenario 3 based on 100 simulations (near-seabed and sea surface discharges) with a 34.25-day modelled discharge period**

### 7.6.2. Known and Potential Environmental Impacts

The known and potential environmental impacts of the discharge of drill cuttings and fluids discharges are:

- Localised and temporary increase in total suspended solids (TSS) (i.e., turbidity) of the water column;
- Smothering of benthic habitat and fauna; and
- Alteration of benthic substrate.

### 7.6.3. EMBA

The EMBA for drill cuttings and unrecovered muds discharges is up to 1.8 km from the well for sediment deposition and 9.1 km in a in a northwest to southeast direction from the well for TSS, as outlined in Section 7.6.1. Receptors known to occur or may occur within this EMBA are:

- Plankton;
- Benthic habitat and fauna; and
- Pelagic marine fauna.

### 7.6.4. Evaluation of Environmental Impacts

**Increased Turbidity of the Water Column**

During riserless drilling, the larger particles of the drill cuttings will settle in the immediate vicinity of the well, with smaller particles spreading further from the source aided by ocean currents. Once the riser is installed, drill cuttings are discharged just below the sea surface resulting in dissipation of the cuttings over a larger area. Hinwood *et al*. (1994) and Neff (2005) note that within 100 m of the discharge point, a drilling cuttings and fluid plume will have diluted by a factor of at least 10,000, while Neff (2005) states that in well-mixed oceans waters (noting the activity area is considered a moderate-energy environment except when influenced by tropical cyclones), drilling mud is diluted by more than 100-fold within 10 m of the discharge.

When muds and mud-coated cuttings are discharged to the ocean, the larger particles, representing about 90% of the mass of the mud solids, form a plume that settles quickly to the bottom (or until the plume entrains enough seawater to reach neutral buoyancy). About 10% of the mass of the mud solids form another plume in the upper water column that drifts with prevailing currents away from the platform and is diluted rapidly in the receiving waters (Neff, 2005; 2010). Neff (2005) states that although the total volumes of muds and cuttings discharged to the ocean during drilling a well are large, the impacts in the water column environment are minimal, because discharges of small amounts of materials are intermittent. Drilling mud solids do not increase to high concentrations in the water column and affect only small parcels of water.

Periodic, minor increases in the turbidity and suspended particulate material concentrations in the upper water column during cuttings and mud discharges are unlikely to have an environmentally significant effect on phytoplankton, zooplankton and pelagic animal communities in the vicinity of the drill site (Neff, 2005).

Water column turbidity increases as a result from the suspended solids, with a subsequent minor decrease in available light in the water column, which may temporarily reduce primary production. Impacts to fauna may include obstructions to respiratory processes and other physiological

processes as well as behavioural changes due to a reduction in visibility and available oxygen (due to reduction in primary production).

The impacts from cuttings discharges are expected to be restricted to a small area around each drill site. The quantity of material discharged is extremely small compared with the water volume in which the material is dispersing, thus water quality is expected to quickly return to background levels close to the source of the discharge once the discharge ceases.

Bathymetry mapping in the activity area indicates there are no known water column sensitivities (e.g., emergent features such as shoals, banks, reefs) located within the TSS EMBA (9.1 km), so impacts to site-dependent species are not predicted. TSS concentrations above the minimum reporting threshold are not predicted to reach the JBG AMP (located 30 km east of the activity area). Given the relatively low productivity of the TSS EMBA, the absence of features that might lead to aggregations (e.g., shoals, banks, reefs) and the localised nature of discharge plumes, only low densities of marine fauna are expected to be exposed to the discharge plume. As such, the impact consequence of TSS associated with muds and cuttings discharges is considered negligible.

**Smothering of Benthic Habitat and Fauna**

In high energy environments, such as that of the activity area, drill cuttings and muds do not tend to accumulate on the seabed because they are redistributed by bottom currents soon after deposition (Neff, 2010). This is expected to be the case in the sediment deposition EMBA because it is strongly influenced by large tidal ranges that contribute to the vertical mixing of surface layers and sediments (see Section 5.2.3).

A review undertaken by the OGP (2003) of the findings of 75 studies relating to the discharge of SBM concluded that benthic community disturbance is in general very localised and temporary. The effects on soft bottom communities from SBM cuttings discharges are rarely seen beyond 250 to 500 m from the discharge point (Jensen *et al*., 1999).

Once particulate material has settled onto the seabed it requires energy to re-suspend similar to existing sediments present on the seabed. Re-suspension volumes are a function of the surface area available to re-distributing currents, tides and storm events (i.e., induced wave stress). Redistribution is expected in areas of shallow water (<50 m) and strong seabed currents (Breuer *et al.,* 2004). Because the activity area has a water depth of 40 m, the surface layer of deposited sediment is expected to re-suspend during strong currents (e.g., during storms and cyclones), however the magnitude of re-suspension is expected to be of a similar order to re-suspension of existing seabed sediments and should not result in a material impact to benthic habitats/fauna.

The main disturbance to the seabed is smothering and burial of sessile benthic and epibenthic fauna (Hinwood *et al*., 1994). Studies undertaken on faunal counts/diversity have shown no significant effects of drill cuttings as a function of thickness with respect to settling communities (i.e., recolonization) (Setvik, 2010). This is consistent with the findings of Daan & Muldur (1996) that identified no adverse impacts on benthic communities from WBM cuttings one year after deposition, even as close as 25 m from a former discharge site. Field and laboratory studies support that benthic fauna are not significantly harmed from WBM if the exposure is of short duration and the cuttings are rapidly diluted. Impacts of WBM are generally limited to within 100 m of the discharge point and recovery is well within one year (Setvik, 2010). Studies indicate that benthic infauna and epifauna recover relatively quickly, with substantial recovery within 3-10 years (Jones *et al*., 2012).

Santos (2022) reports that benthic monitoring at the Van Gogh-3 well (located 44 km north-northwest of Cape Range near Exmouth in a water depth of 350 m), conducted in 2008 by the Sea Serpent research program (run by the Sydney University of Technology), reported sediment deposition one month following drilling extended up to 180 m from the well location along the longest axis and 70 m along the shortest axis. Two months later, monitoring confirmed that the extent of deposition had decreased to a uniform distance of 55 m around the well with a total area reduction of approximately one third. The monitoring revealed that burrow-forming worms and crabs still persisted within the area of sediment deposition.

There are no areas of seabed sensitivity likely to be impacted by cuttings deposition (such as KEFs or coral reefs), with areas of low and high exposure limited to soft substrate seabed. The modelling results predict that drill cuttings will not reach the JBG AMP.

Impacts to the dominant seabed habitat of infaunal plains (flat, soft substrate with occasional rocky outcrops supporting sponge gardens) and barren sand banks (supporting limited biota) (see Section 5.4.1) within the sediment deposition EMBA will be temporary, with rapid re-colonisation of benthic infauna within the deposited cuttings soon after the cessation of drilling. Infaunal communities (dominated by polychaetes and other crustaceans) and epifauna (i.e., prawns) potentially occur in and around the activity area will not be impacted by sedimentation due to the very small area of exposure (0.05 – 0.07 km2) to high sedimentation deposits (>10 mm).

On the basis of the modelling results, it is possible that smothering of benthic habitat (1-10 mm) may occur in an area of 0.77-0.86 $km^2$ for a single well, extending a maximum distance of 1.21-1.33 km from the drilling site. Assuming all three wells are drilled, this smothering at the 1-10 mm threshold would cover a cumulative area of 2.3-2.6 $km^2$. For sediment thickness >10 mm (that may cause harm to benthic macrofauna), the area of impact is limited to 0.05-0.07 $km^2$ extending a maximum distance of 210-240 m from each drill site. Assuming all three wells are drilled, this smothering at the 1-10 mm threshold would cover a cumulative area of 0.15-0.21 $km^2$.

Taking into account that the activity area is located entirely within the ‘shelf’ geomorphic feature of the JBG, typically characterised by extensive sediment plains and high sediment deposition and influenced by strong tidal movement, the impact of smothering of benthic habitat is expected to be short term (months up to a year). Species re-settlement within one year of the drilling campaign would be expected as per quoted studies of cuttings distribution offshore Australia. This impact area is miniscule compared with the available benthic habitat available throughout the JBG.

Modelling indicates that the maximum height of a sediment mound forming in the immediate vicinity (within 15 m) of any one of the wells is predicted to range between 39 cm (scenario 1) to 84 cm (scenario 2). If all three wells are drilled, three such mounds would form. This will alter the nature of the seabed in this localised area for up to a year. A cuttings mound will result in complete smothering of benthic fauna, though the mounds themselves (if they don’t become quickly redistributed with ocean currents) will provide new habitat for benthic fauna to colonise. The cuttings mound may be readily and rapidly reworked into existing seabed sediments by natural process including movement through bottom currents and infauna burrowing.

Ecotoxicological effects may occur if cuttings and muds contain high concentrations of low-toxicity chemicals or organic matter. Chemical concentrations exceeding 1,000 ppm may occur in sediments immediately adjacent the wellhead and may affect infauna and epifauna colonising the cuttings mound. Microbes biodegrading organic matter in drilling muds may deplete sediment oxygen faster than can be replaced from the overlying water column, causing localised anoxia effects in the sediments (CSA, 2006).

Mobile benthic fauna such as crabs, shrimps and demersal fish in the area of the cuttings mound are expected to be able to avoid impacts from cuttings deposition (IOGP, 2016). Studies have shown increases in populations of some opportunistic species with a resultant decrease in local species diversity but Balcom *et al*. (2012) concluded such impacts are minimal and highly localised.

The Carbonate bank and terrace system of the Sahul Shelf KEF (described in Section 11.4.7 of **Appendix 11**) is located 21 km west of the drill site and therefore outside the EMBA for sediment deposition. For these reasons, the impact consequence of smothering of benthic habitat is negligible.

**Impacts to Fisheries**

There is little commercial fishing in the EMBAs for TSS and sediment deposition. The only fishery that may operate in or immediately around the activity area is the Commonwealth-managed NPF (see Section 5.7.1). Fish species known to occur in the region are common and widely distributed and there is no spatially limiting habitat for the fin fish and benthic species known to occur in the EMBAs for TSS and sediment deposition.

The modelling indicates cuttings and mud plumes will not impact a significant area of muddy and sandy substrates of coastal waters and estuaries (habitat for banana and tiger prawns) given the very small area of exposure (0.05-0.07 $km^2$) to high sedimentation (>10 mm) for each well. In addition, there are no known sensitive benthic ecosystems in the EMBAs such as shoals, banks, reefs, seagrass meadows or mangroves (relevant to juvenile prawns).

The temporary nature of the drilling mud plumes, the rapid settling of cuttings and exclusion of fishing activities within the 500-m PSZ around the MODU at each drill site means that there will be few if any impacts to the NPF from cuttings and muds discharges. Therefore, the impact consequence to the NPF is considered to be negligible.

**Potential Toxicity Impacts to Marine Fauna**

The non-toxic nature of the WBM and low-toxicity nature of the SBM means that acute or chronic toxicity impacts to fauna, especially immobile benthic fauna smothered by the cuttings, are unlikely to occur. The lack of toxicity and low bioaccumulation potential of the drilling muds means that the effects of the discharges are highly localised and are not expected to spread through the food web (Neff, 2010).

Generally, SBM has a high n-octanol/water partition coefficient and is not expected to bioaccumulate in aquatic life, which has been supported by testing on SBM products entering the market. The American Chemistry Council (2006) evaluated the environmental fate and effects of olefin and paraffin SBM. Toxicity test results show that olefin and paraffin SBM are non-toxic to the water-dwelling organisms studied. It also concluded that all olefin and paraffin SBM base fluids biodegrade in the presence of oxygen (aerobic). In the absence of oxygen, SBM prepared from linear alpha olefins (LAO) and internal olefins (IO) biodegrade much more extensively (>50%) than base fluids prepared from paraffins and diesel oil (<5%).

Most minerals in cuttings are stable and have low solubility in sea water, and in particular barite (the most abundant particulate solid in WBM and SBM) has very low solubility in sea water. A study investigating barite solubility and the release of trace metal compounds to the marine environment recorded that <1% of the mercury and 15% cadmium dissolved from barite after one-week exposure in sea water (Crecelius *et al.,* 2007).

A high proportion of the chemicals associated with the coarser cuttings and retained in flocculated clay/barite deposits will settle directly to the seabed (IOGP, 2016) and be less available to water column biota, but more available to sediment biota.

Hinwood et al. (1994) and Neff (2005) note that within 100 m of the discharge point, a drilling cuttings and fluid plume will have diluted by a factor of at least 10,000. Neff (2005) states that in well-mixed oceanic waters (as is the case in the activity area), drilling mud is diluted by more than 100-fold within 10 m of the discharge. Fluids will only comprise a small percentage of the discharge and prior to discharge they will be treated to reduce residual SBM on cuttings to a maximum of 10% by weight, and likely lower than this. Based on Neff (2005), this means that after release, any SBM fluids will be diluted approximately 100-fold within 10 m and 10,000-fold within 100 m of the discharge such that concentrations of chemicals in the SBM (and WBM) are expected to be reduced to 1,000 ppm within 10 m of the release location and 10 ppm within 100 m of the release location.

Metals present in drilling fluid generally resemble that of marine sediments, albeit with concentrations of some metals higher than clean marine sediments (Neff, 2005).

Barite is one of the main constituents used in drilling muds, and its use results in elevated levels of barium (Ba) in cuttings. Other chemicals of concern in cuttings, either because of their potential toxicity and/or abundance are arsenic (As), chromium (Cr), cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), mercury (Hg), nickel (Ni) and zinc (Zn), (Breuer *et al*., 2004).

Dissolved barium and any heavy metal contaminants present in the barite may slowly leach out of an anoxic cuttings pile (Neff, 2005). Breuer *et al*. (2008) has also observed that metals in cuttings migrate either upward to the overlying water (Ba, Mn, and Fe) or diffuse downward (Cr, Cu and Pb), where they become incorporated into iron monosulfides. The exposure of these iron monosulfides to oxygen as a result of transport of oxygen into the cuttings via bioturbation or advection and/or pile resuspension may then lead to the release of the associated metals into the water column (Saulnier and Mucci, 2000; Huerta-Diaz *et al*., 1998).

In a stable cuttings pile with little physical disturbance or bioturbation, it is probable that the fraction of the total cuttings pile metals that is in the dissolved, bioavailable fraction remains low. It is probable that some dissolved metals diffuse into the overlying water column and escape from the pile, as identified by Neff *et al*. (2005). However, this efflux is not sufficient to raise the concentration of metals above natural background levels to an ecologically significant extent (Hartley *et al*., 2003). There is no indication that the levels of trace metals in fish and shellfish collected close to offshore installations are significantly above natural background concentrations (Bakke *et al*., 2013).

Marine fauna that are exposed in the laboratory or field to cuttings in sediments do not bioaccumulate significant quantities of metals (Hartley *et al*., 2003). There is some evidence of a limited bioavailability of a few metals, such as Pb and Zn, which are present in cuttings piles; however, doubt remains that metal bioaccumulation in marine fauna from cuttings piles is sufficient to cause harmful effects in marine fauna living on or near cuttings piles (OSPAR, 2019). Modelling of cuttings pile relocation (disturbance and re-deposition) has confirmed that potential impacts of metals are minimal and disturbance of cuttings drilled with WBM is not expected to result in any significant impact (OSPAR, 2019).

With regard to SBM, the rapid depletion of oxygen through the microbial breakdown to organic matter in the SBM can cause anoxic conditions within and around the cuttings pile. Studies have shown that exposure of fish to low toxicity oil-based mud (OBM) resulted in limited leaching of hydrocarbons and no leaching of metals. The American Chemistry Council (2006) evaluated the environmental fate and effects of olefin and paraffin SBM. Toxicity test results show that olefin and paraffin SBF are non-toxic to the water-dwelling organisms studied. It also concluded that all olefin and paraffin SBM base fluids biodegrade in the presence of oxygen (aerobic). In the absence of oxygen (anaerobic), SBM prepared from LAO and IO biodegrade much more extensively (> 50%) than base fluids prepared from paraffins and diesel oil (<5%). The American Chemistry Council (2006) also found that because SBM adhered to discharged cuttings tend to clump together in particles that rapidly settle to the ocean floor, SBM-coated cuttings tend not to increase water column turbidity. Water column impacts are also minimised due to the low water solubility of the SBM and the short residence time of the solid cuttings as they settle to the sea floor.

APPEA (1998) reports that the conclusions from various studies into SBM discharges are:

- Major community effects are limited to within 500 m of the point of discharge.
- Community changes with varying degree of severity have been reported up to 2 km.
- The biota is not affected beyond 2 km.
- Elevated concentrations of heavy metals and/or hydrocarbons associated with drilling muds are generally contained with 2 km of the point of discharge; however, traces of contaminants below community effect levels have been reported up to 10 km from the point of discharge.

Case studies reported in APPEA (1998) from drilling activities on the North West Shelf regarding impacts of SBM discharge on the marine environment are outlined below:

- Wannea-3/6 – drilled by Woodside in 1994 found that 11 months after the cessation of drilling, low residual concentrations of hydrocarbons were detected (<200 ppm), reducing to less than 1 ppm within 200 m of the cuttings discharge point.
- North Rankin-A platform – drilled by Woodside in 1983 and completed in 1991 in a water depth of 125 m, with 11 of the 23 wells drilled using low-toxicity oil-based mud (OBM). Concentrations of hydrocarbons rapidly decreased from 75,000 ppm beside the platform to 40 ppm at 800 m and 2 ppm at 2 km from the platform in the direction of the prevailing current. Further monitoring conducted in the following years indicated that away from the cuttings pile, the degradation of residual hydrocarbons was occurring successfully with an annual half-life of one year.
- Mydas-1 and Hawksbill-1 – drilled in 1993 and 1994. Results from studies conducted indicated that impacts to seabed fauna were limited in extent and duration, the extent of contamination was approximately 100 m from the well head in the direction of the prevailing currents, the biomass and densities of some of the common and numerous taxa had decreased by 1-2 months after drilling and were limited to 100 m from the well, and in most cases, biomasses and densities of these taxa had recovered 6-8 months after drilling.
- In Bass Strait, studies conducted by Esso Australia Pty Ltd at the Fortescue platform, located in a water depth of 70 m, found that sediment concentrations of non-aquatic based fluids (OBM or SBM) were highest (average of 9,600 ppm) at the site closest to the platform, but not detectable (<0.2 ppm) at any site beyond 100 m from the platform. Four months after the end of drilling, the non-aquatic based fluids concentration had decreased to an average of 230 ppm at the sites closest to the platform, and was not detected at any monitoring station 11 months after drilling. It was concluded that the risks for long-term alteration of benthic infauna from the use of non-aquatic based fluids were low.

Neff (2010) identifies that field and laboratory studies performed in temperate and cold-water environments have shown that any metals present in drill cuttings are not bio-accumulated by marine organisms, primarily because they exist as extremely insoluble inclusions in cuttings minerals. Many field surveys investigating the concentrations of metals and hydrocarbons in tissues of marine animals in the vicinity of offshore WBM and cuttings discharges have shown that metals and hydrocarbon concentrations in tissues of marine animals near drilling platforms are similar to concentrations in tissues of the same or similar species well away from and out of the influence of the drilling platforms (Neff, 2010).

Numerous studies have been carried out in the Gulf of Mexico to test and evaluate a range of biological, biochemical and chemical methodologies to detect and assess chronic sub-lethal biological impacts near long-duration activities associated with oil and gas exploration and production. Contaminant concentrations at most locations studied were below levels thought to induce biological responses (Kennicutt *et al.*, 1996). Therefore, discharges associated with this activity are not expected to have long-term effects due to bioaccumulation.

Based on this information, the bioavailability of metals within cuttings generated from drilling activities is low and thus the impacts from disturbed cuttings to marine fauna and habitats are expected to be minor, whether one, two or three wells are drilled.

### 7.6.5. Impact Assessment

Table 7.24 presents the impact assessment for discharge of drill cuttings and muds.

**Table 7.24. Impact assessment for discharge of drill cuttings and muds**

| Summary | | |
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| Summary of impacts | Increased water column turbidity and smothering of benthic habitat. | |
| Extent of impacts | Localised (up to several kilometres), in the direction of the dominant water currents (northwest to southeast direction). | |
| Duration of impacts | Temporary (days for TSS plumes, months for deposited cuttings). | |
| Level of certainty of impacts | HIGH – the impacts of drill cuttings and fluids discharges are well studied and understood. | |
| Impact decision framework context | Decision type | A - good industry practice required. |
| | Activity | Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined. |
| | Risk & uncertainty | Risks are well understood, uncertainty is minimal. |
| | Stakeholder influence | No conflict with company values, no partner interest, no significant media interest. |
| Defined acceptable level | Discharges of drill cuttings and muds are managed to reduce volume and toxicity impacts to biodiversity or ecological integrity. | |
| Impact Consequence (inherent) | | |
| Receptor | | Consequence |

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| Water column | | | Negligible |
| Seabed habitats | | | Negligible |
| Assessment of Proposed Control Measures | | | |
| Control measure | Control type | Adopt | Justification |
| Recover drill cuttings from the seabed | Elimination | No | **EB:** Eliminates potential for benthic habitat smothering from cuttings deposition on the seabed.<br>**C:** Significant additional cost (potentially hundreds of thousands of dollars)<br>**Ev:** Additional cost and longer MODU time on location required to implement this control is not commensurate with the negligible consequences associated with the discharge of drill cuttings. |
| Cuttings reinjection | Elimination | No | **EB:** Avoids all impacts associated with the discharge of cuttings and muds overboard by reinjecting them down the well annulus.<br>**C:** This would compromise the integrity of the well and is not justified for a single well program. An additional injection well would need to be drilled to implement this control measure, which would cost millions of dollars and add to the routine impacts and risks associated with drilling.<br>**Ev:** Costs are considered grossly disproportionate given the negligible impact consequences of overboard discharges at this location. |
| Onshore disposal of WBM- and SBM-coated cuttings ('skip and ship') | Elimination | Possible | **EB:** Avoids all impacts associated with the discharge of cuttings and muds overboard.<br>**C:** Significant storage space is required on the MODU before cuttings and adhered muds can be "skipped and shipped" to a vessel. There are the usual safety and environmental emissions and discharges impacts and risks associated with numerous vessel movements between the MODU and shore bases. It would cost hundreds of thousands of dollars to implement this control measure.<br>**Ev:** The 'skip and ship' disposal option simply moves disposal from an offshore to an onshore issue. Costs are considered grossly disproportionate given the negligible impact consequences of overboard discharges at this location. |
| Do not use drilling muds | Elimination | No | **EB:** Elimination of impacts associated with TSS and smothering of benthic habitats.<br>**C:** Drilling muds are required to enable the hole to be drilled. Mud prevents the wellbore from collapsing and enables the well objectives to be met. |

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| | | | **Ev:** Costs to the program outweighs the benefits. |
| No discharge of bulk powders overboard | Elimination | Possible | **EB:** At the end of the drilling program, any dry chemicals left over will be left on board/sold to the next operator for use, or transferred to another MODU, or returned to shore. Discharge to the marine environment (as a slurry) will only occur when there are no other safe or technically feasible options (see Table 2.6).<br>**C:** The design of the piping and the tanks on the MODU is such that the reverse pumping of dry bulks back to marine vessels or to shore is not possible. Therefore, return of excess open dry bulk powders to shore is not a feasible option.<br>**Ev:** The potential environmental impacts are negligible due to the chemical selection process and therefore the benefit is negligible. Disposal volumes are minimal due to careful stock management. |
| Use of riserless mud recovery (RMR) | Engineering | No | **EB:** RMR has the advantage of potentially reducing the volume of WBM discharged to the environment as well as preventing cuttings accumulation at the seabed and provides an opportunity to recover and re-use the WBM drilling fluids.<br>**C:** Cost associated with changes to equipment and change to the well design with installation estimated at several million dollars including rig-up and rig-down, rental and interfacing of the package.<br>RMR equipment requires additional space on the MODU and additional crew and introduces additional operational and maintenance and risks. RMR is traditionally used on subsea wellhead systems to enable a closed mud system (weighted and/or inhibited) before the subsea BOP and marine riser is installed. In this case, WBM and cuttings go through the MODU's solids control system and cuttings are discharged at sea surface.<br>There are some examples of RMR being used on jack-up MODUs where a closed system is required before the BOP is installed. Implementing RMR on a jack-up MODU would require a bespoke system to connect to the 30" conductor at the tension deck level of the MODU and divert the returns back to the solids control system.<br>**Ev:** The cost outweighs the minimal environmental benefit given that WBM is being used. Cuttings discharge would be no different as |

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| | | | cuttings would both be released at sea level. In the RMR case, cuttings passing through the solids control system would have less WBM entrained on them, but the residual mud recovered in this process would be discharged anyway. |
| Extended cuttings dump chute to below sea surface | Engineering | No | **EB:** Releases drilled solids (cuttings) deeper in the water column, thereby potentially reducing the spatial extent and turbidity plume.<br>**C:** Costs associated with re-design, engineering, fabrication, installation and the risk of issues during the activity whereby the chute is blocked. May inhibit the distribution of cuttings in the upper sections of the water column, leading to a smaller area of concentrated deposition.<br>**Ev:** Chute does not reduce the volume of cuttings discharged and increases costs and risks to operational activities. The low environmental impact of the muds discharges and the short duration of discharge in a low sensitivity environment, results in no significant increased environmental benefit. |
| Implement a slim well design | Engineering | No | **EB:** A slim well design would result in a reduction in diameter of the well and reduce the overall volume of cuttings discharged to sea.<br>**C:** Cost of ~$2 million for additional engineering and equipment rental. Risks to well objectives whereby the equipment required for well evaluation (sidewall coring, LWD tools) may not fit in a narrower hole which could result in a requirement for side-tracking (an additional cost and additional time on location and increase in discharges to sea). In the event of hole problems or the technical requirement to set a drilling liner, there is no smaller hole size available, which would result in the well being completed and a change in well design or re-drill required.<br>**Ev:** Disproportionate cost compared to the small benefit gained in reducing the volume of cuttings, but also presents a high risk of not achieving the objectives of drilling the well in the first instance, as it may require the well to be re-drilled to reach the target. |
| Establish a closed circulating system early in the program | Engineering | No | **EB:** Provides an opportunity to re-use drilling fluids, thereby reducing environmental discharges. Does not reduce the overall volume of drilled cuttings discharged to sea.<br>**C:** Additional monetary costs, but can also lead to an increase in well design risk due to additional back pressure applied by use of a conductor (to |

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| | | | bring the drilling fluid up to the rotary table) and can lead to stuck pipe and lost circulation.<br>**Ev:** Significant costs and increased risks to well design outweigh the benefits given the low sensitivity of the seabed in the area. |
| Use a centrifuge and dryer while drilling with WBM | Engineering | No | **EB:** Reduces the volume of WBM adhered to cuttings more than the use of shakers alone. This is typically only used when drilling with SBM.<br>**C:** Centrifuges and driers are prone to mechanical failure. Most MODUs do not have this as part of their standard fit out, so there would be significant cost to mobilise this equipment to the MODU. The zero or low toxicity nature of WBM means the use of this equipment is not warranted.<br>**Ev:** Costs to the program outweighs the benefits. |
| Use a centrifuge and dryer while drilling with SBM **(IMP-06: EPS-09)** | Engineering | Yes | **EB:** Reduces the volume of SBM adhered to cuttings more than the use of shakers alone.<br>**C:** Centrifuges and driers are prone to mechanical failure. Most MODUs do not have this as part of their standard fit out, so there is a significant cost to mobilise this equipment to the MODU.<br>**Ev:** Environmental benefits outweigh the costs. |
| Eliminate the use of SBM | Engineering | No | **EB:** Eliminates potential ecotoxicity impacts to benthic fauna.<br>**C:** Deviated sections of the well are most safely drilled using SBM in order to keep the wellbore stable, open and prevent collapse. SBM is a more expensive product than WBM.<br>**Ev:** The safety benefits outweigh the environmental benefit in this case, noting that the environmental impacts of discharging SBM-coated cuttings have a negligible consequence. |
| Use WBM fluids for vertical sections of the wellbore rather than SBM **(IMP-06: EPS-01, -02)** | Engineering | Yes | **EB:** Eliminates potential ecotoxicity impacts to benthic fauna.<br>**C:** Minor cost in selection of WBM rather than SBM. It is safe to drill vertical sections of offshore wells with WBM.<br>**Ev:** Environmental benefit outweighs the cost to implement the measure. |
| Chemical selection procedure specifies the use of low-toxicity mud system and additives **(IMP-06: EPS-01, -02)** | Engineering | Yes | **EB:** Eliminates potential ecotoxicity impacts to benthic fauna.<br>**C:** Minor cost differential in selecting low-toxicity mud system and additives compared to the alternative.<br>**Ev:** Environmental benefit outweighs the cost to implement the measure. |

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| Implement quality control limits for barite (concentration of mercury and cadmium) **(IMP-06: EPS-03)**. | Engineering | Yes | **EB:** Eliminates seabed contamination and ecotoxicity impacts to benthic fauna and ensures compliance with the Minimata Convention.<br>**C:** Minor cost in selection of barite with low mercury and cadmium concentrations.<br>**Ev:** Environmental benefit outweighs the cost to implement the measure. |
| Reduce SBM ROC to less than 10% average per well **(IMP-06: EPS-07, -08, -09, -10, -11, -12)** | Engineering | No | **EB:** Reduces the amount of residual SBM being discharged to the environment and potential ecotoxicity impacts.<br>**C:** The equipment will be in place to manage SBM such that the ROC is <10%, and likely to be a few percentage points lower than this. However, in the event of unplanned downtime of the cuttings management equipment (shakers, dryer and/or centrifuge), the 10% ROC target provides some contingency such that drilling operations don't need to be suspended. The suspension of drilling increases the risk of stuck pipe events associated with wellbore destabilisation over time, which may lead to the need to drill a side-track interval, which in turn increases time spent on location (and associated costs) and routine drilling discharges and emissions.<br>**Ev:** The environmental benefits of reducing the SBM ROC to <10% is disproportionate to the safety and cost considerations of this control measure when considering the negligible consequence of SBM discharges and the nature of the receiving environment. |
| Pre- and post-drilling seabed ROV survey **(IMP-06: EPS-18)** | Engineering | Yes | **EB:** The surveys provide a visual record of seabed conditions pre- and post-drilling and therefore act as a tool for verifying some of the predicted impacts outlined in this EP (e.g., cuttings mound).<br>**C:** Cost is negligible, given that an ROV contractor will be deployed to the MODU for the program. The time (and therefore cost) to undertake the surveys, analyse footage and prepare the associated report is negligible and part of the overall ROV contract<br>**Ev:** The environmental benefits outweigh the minor costs to implement the measure. |
| Employ the services of an SBM Specialist ('Mud Cop') to implement the SBM control measures **(IMP-06: EPS-14)**. | Engineering/ Administrative | Yes | **EB:** By ensuring the control measures are effectively implemented, the environmental impacts (as well as potential delays to the drilling program) associated with non-compliance are avoided.<br>**C:** Cost is significant to employ a specialist full-time for the duration of up to three wells. |

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| | | | **Ev:** The benefits of employing an SBM Specialist outweigh the significant costs to implement the measure. |
| Fluids Program **(IMP-06: EPS-03, -04, -05, -06, -13, -15, -16, -17)** | Administrative | Yes | **EB:** Ensures drill fluids are managed in accordance with well-established industry processes.<br>**C:** No additional cost.<br>**Ev:** The environmental benefits outweigh the costs to implement the measure. |
| Minimum mud release duration | Administrative | No | **EB:** Extends the release duration for muds, thereby reducing concentration of muds in the water column.<br>**C:** Cost of additional MODU time.<br>**Ev:** The environmental benefits are outweighed by the costs to implement the measure in light of the absence of sensitive environmental receptors around the drilling location. |

| Environmental Controls and Performance Measurement | | |
|---|---|---|
| EPO | EPS | Measurement criteria |
| Only low toxicity, readily biodegradable and non-bioaccumulating WBM and SBM and additives will be used. | **(IMP-06: EPS-01)** The contractor ensures that, wherever feasible, only PLONOR, 'D'/'E' (non-CHARM) or 'Gold'/'Silver' (CHARM) OCNS-rated base fluids and additives (that do not have a substitution warning) are used in the drilling fluid system to minimise ecotoxicity impacts to marine fauna. | The Mud Chemical Inventory verifies that all chemicals are PLONOR, 'D'/'E' (non-CHARM) or 'Gold'/'Silver' (CHARM) OCNS-rated. |
| | **(IMP-06: EPS-02)** Where for technical reasons an additive is required that:<br>• Is not rated as PLONOR, 'D'/'E' (non-CHARM) or 'Gold'/'Silver' (CHARM); or<br>• Has a substitution warning; or<br>• Has not been registered with CEFAS (and therefore does not have a rating),<br>Then a risk assessment will be completed to understand the environmental risk of discharge to sea. This will include:<br>• A pseudo-ranking using the OCNS process (where possible);<br>• Consideration of end fate, volumes and concentrations; and<br>• Final approval by EOG of the use of the chemical. | MoC documentation verifies that, for products that do not meet IMP-06:EPS-01, a risk assessment is completed and approved by EOG prior to discharge of the chemical. |
| | **(IMP-06: EPS-03)** When selecting barite, EOG will ensure that the contaminant limit concentrations are at or below the following: | Mud inventory demonstrates containment limits are not breached. |

| | | |
|---|---|---|
| | • Mercury (Hg) – 1 mg/kg (1 ppm) dry weight in stock barite.<br>• Cadmium (Cd) – 3 mg/kg (3 ppm) dry weight in stock barite. | |
| WBM and SBM operations are managed to ensure cuttings discharges are optimised to minimise adhered muds. | **(IMP-06: EPS-04)** In accordance with the Fluid Program, the shaker screens are used during drilling to maximise fluid separation from cuttings prior to overboard disposal. | Daily Mud Report verifies shaker screens are used. |
| | **(IMP-06: EPS-05)** Operation of the separation treatment system is monitored on a full-time basis by the Derrickman/Shaker-Hand to ensure efficient system performance. | Performance of the system is logged by the Mud Engineer in Daily Fluids Reports. |
| | **(IMP-06: EPS-06)** Drilling fluid testing is performed by the Mud Engineer working under the direction of the DSV. The EOG subject matter expert will monitor the fluid testing on a daily basis. | Mud Engineer verifies through Daily Fluids Report that fluids properties have been tested and system optimisation activities actioned. |
| SBM operations are managed to ensure ROC of <10%. | **(IMP-06: EPS-07)** Cuttings samples will be collected at least once per day or every 500 ft (152 m) drilled formation (to a maximum of three measurements per day) and tested to determine the ROC%. | Daily Mud Report verifies that cuttings samples are collected every 12 hours and show the ROC%. |
| | **(IMP-06: EPS-08)** The ROC averages <10% SBM w/w dry weight across the entire length of well drilled with SBM. | End of Well Report verifies <10% average ROC for the SBM sections of the well. |
| | **(IMP-06: EPS-09)** In addition to the shaker screens, a cuttings dryer is used when drilling with SBM to maximise fluid separation from cuttings prior to overboard disposal. | Daily Mud Report verifies cuttings dryer is in use while drilling with SBM. |
| | **(IMP-06: EPS-10)** When an average of <10% ROC for SBM use for the well cannot or is not being achieved:<br>• The rate of penetration will be reduced to allow a wider margin of cuttings per hour through the dryer; or<br>• Halt drilling operations while optimising the solids control equipment. | Daily Mud Report and End of Well Report verify <10% average ROC for the SBM sections of the well. |
| | **(IMP-06: EPS-11)** Preventative maintenance of solids control equipment (shakers, cuttings dryer) is undertaken in line with the PMS. | PMS records verify solids control equipment is appropriately maintained. |
| | **(IMP-06: EPS-12)** Retort equipment that measures ROC is calibrated in line with manufacturer's specifications. | PMS records verify that the retort equipment is calibrated in line with manufacturer specifications. |
| | **(IMP-06: EPS-13)** The SBM tank/s dump valves are locked to prevent unplanned dumping of whole muds, with the keys remaining secure in a key locker. A Permit to Work (PTW) will be required to unlock the dump valve/s, which involves an assessment | Key register and visual inspection verify SBM tank dump valves are locked. |
| | | Daily Fluids Report allow for material balance assessment to determine discharge volume of weighted brine. |

| | | |
|---|---|---|
| | by the OIM regarding the need for a specific operation. | PTW records verify that a PTW was prepared prior to unlocking the dump valve/s. |
| | **(IMP-0: EPS-14)** An SBM specialist (known as a 'mud cop' in the industry) will be onboard the MODU to ensure that all EPS related to SBM operations are implemented. | SBM specialist listed in the POB. |
| | | SBM Management Plan in place outlining how the EPS will be implemented. |
| Fluids discharged overboard from SBM tank cleaning will contain <1% by volume of oil in the fluid sample (<1% v/v) | **(IMP-06: EPS-15)** If SBM has been displaced out of the well bore, only interface fluids with residual synthetic-based oil content of <1% will be discharged overboard if no longer required. | Daily Mud Report verifies interface fluids <1% with residual synthetic-based oil content discharged overboard. |
| | **(IMP-06: EPS-16)** Mud residues from mud tank cleaning will be monitored to ensure there is <1% v/v oil prior to overboard discharge. | Daily Mud Report verifies the 1% v/v target is achieved. |
| | **(IMP-06: EPS-17)** If the mud residue cannot meet the 1% v/v oil limit, it will be transferred to a holding ('slops') tank for further settling and measurement prior to overboard disposal, or transferred to a support vessel for onshore disposal where slops cannot be processed. | Daily Mud Report verifies non-specification mud residues were not discharged overboard. |
| The extent of impacts to the seabed from cuttings will be recorded. | **(IMP-06: EPS-18)** A pre-spud and post-drilling ROV transect-based survey will be undertaken at each well location to verify the condition of the seabed prior to drilling and the nature of cuttings deposition/cuttings mound post-drilling. | Video footage and associated written records verifies that pre-drill and post-drill ROV seabed surveys were conducted. |

| Impact Consequence (residual) | |
|---|---|
| Receptor | Consequence |
| Water column | Negligible |
| Seabed habitats | Negligible |

The impact of drill cuttings and mud discharges is assessed as negligible because:

- The activity will be of a short duration;
- The area of impact on the seabed is extremely small;
- There is an absence of site-attached fauna in the water column and absence of sensitive benthic habitats in the impacts EMBA;
- The impacts EMBA is distant from the Carbonate bank and terrace system of the Sahul Shelf KEF;
- The seabed is widely represented in the region and pre-impact conditions will be rapidly re-established.

**Demonstration of ALARP**

A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the risk to the point that any additional or alternative control measures either fail to lower the residual risk rating any further or are grossly disproportionate to the residual risk rating.

**Demonstration of Acceptability**

| | | |
|---|---|---|
| Policy compliance | EOG's Safety and Environmental Policy objectives are met. | |
| EMS compliance | Chapter 10 describes the EP implementation strategy to be employed for this activity. | |
| Risk matrix standard compliance | The residual impact consequence is negligible, which is considered acceptable. | |
| External context | There have been no objections or claims raised by relevant persons regarding the discharge of drill cuttings or muds for this activity. | |
| Legislative context | The EPS outlined in this table align with the requirements of:<br>• OPGGS Act 2006 (Cth).<br>  ○ Section 460(2) – a person carrying on activities in an offshore area under the permit must carry on those activities in a manner that does not interfere with the conservation of the resources of the sea and seabed to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person. | |
| Industry practice | The consideration and alignment of EPS with the mitigation measures outlined in the below-listed guidelines and codes of practice demonstrates that BPEM will be implemented for this activity | |
| | Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020) | The EPS developed for this hazard are in line with the management measures listed for drilling wastes (cuttings and muds) in Section 4.5.8 of the guidelines, which include:<br>• Select drilling fluid components to include the least ecotoxic options available that are suitable for the project **(IMP-06: EPS-01, -02)**.<br>• Solids control equipment available onboard the drill rig to reduce the amount of residual drill fluids on cuttings prior to discharge **(IMP-06: EPS-04, -05, -06)**. |
| | Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019) | The EPS developed for this hazard reflect the BAT in Section 17.2 of the guidance document, being:<br>• Ensure engineering design for handling of drill cuttings/muds accounts for the minimisation of potential for environmental impact and exposure to hazardous materials in the event of a planned discharge or unplanned release **(IMP-06: EPS-01, -02)**.<br>• For geographical areas where no previous environmental baseline survey has been performed, carry out an environmental baseline survey prior to drilling **(geophysical survey undertaken)**.<br>• Ensure that the handling of drill cuttings and drilling muds is addressed as part of management measures detailed in an EIA **(IMP-06: All EPS)**.<br>• Where it is planned to discharge drill cuttings into the marine environment, perform analysis as part of a specialist technical study **(specialist study conducted)**.<br>• Implement additional approaches as considered necessary to manage risks for specific operations, including but not limited to avoiding the use of oil-based muds, avoid cuttings and mud discharges in sensitive environments, discharge to achieve maximum dispersion of solids on the seabed **(IMP-06: EPS-01)**. |

| | | |
|---|---|---|
| | Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015) | No specific environmental guidance regarding cuttings and mud management (Section 3.3.2).<br>One of the key objectives is to describe the details of the mud treatment equipment/systems that discharge to the environment, which has been outlined in this section. |
| | Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015) | Guidelines met with regard to:<br>• 51 - The selection of a drilling fluid should be made after evaluating its technical suitability and environmental impact. The use of fluids that contain diesel as the principal component of the drilling mud liquid phase is not good practice for offshore drilling programs and should be avoided **(IMP-06: EPS-01, -02, -03)**.<br>• 56 - Feasible alternatives for the disposal of spent WBM and cuttings from well sections drilled with either WBM or non-aqueous drilling fluids (e.g., SBM) should be evaluated. Options include injection into a dedicated disposal well offshore, injection into the annular space of a well, and containment and transfer to shore for treatment and disposal. When no alternative options are available, residual WBM might be discharged to sea at the end of a drilling program, provided that the overall EIA conducted for the site has considered this scenario, demonstrating the environmental acceptability of this practice.<br>• 57 - When discharge to sea is the only alternative, a drilled cuttings and fluid disposal plan should be prepared, taking into account cuttings and fluid dispersion, chemical use, environmental risk and necessary monitoring. Discharge of cuttings to sea from wells drilled with non-aqueous drilling fluids should be avoided. If discharge is necessary, cuttings should be treated before discharge **(IMP-06: All EPS)**. |
| | AEP CoEP (APPEA 2008) | The EPS developed for this activity meet the code's following objectives for drilling:<br>• To reduce the impact on other marine resource users to ALARP and to an acceptable level.<br>• To reduce risks to public safety to ALARP and an acceptable level. |
| Environmental context | MNES | |
| | AMPs | This hazard will not intersect nearby AMPs. |
| | Ramsar wetlands | This hazard will not intersect any Ramsar wetlands. |
| | TECs | This hazard will not intersect any TECs. |
| | Nationally threatened and migratory species | This hazard will not have any impacts on threatened or migratory species. |
| | Other matters | |

| | | |
|---|---|---|
| | KEFs | This hazard will not intersect any KEFs. |
| | NIWs | This hazard will not intersect any NIWs. |
| | State marine parks | This hazard will not intersect any state marine parks. |
| | Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans | None triggered by this hazard. |
| ESD principles | The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant). | |
| Statement of acceptability | EOG considers the impacts from discharge of drill cuttings and muds to be acceptable because:<br>• It will adhere to the company's Safety and Environmental Policy;<br>• The residual consequence rating is negligible;<br>• An Implementation Strategy (described in Chapter 10) is in place to ensure the EPS are achieved.<br>• Relevant legislation and industry best practice will be complied with;<br>• Discharge of drill cuttings and muds will not have long-term or significant impacts on MNES;<br>• The management of drill cuttings and mud discharges will ensure it is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species;<br>• The management of drill cuttings and mud discharges will ensure it is not inconsistent with the aims of relevant marine reserve management plans; and<br>• The management of underwater sound emissions will ensure it is not inconsistent with ESD principles. | |
| Environmental Monitoring | | |
| • Mud chemical inventory.<br>• Mud volumes discharged overboard.<br>• Separation treatment system monitoring. | | |
| Record Keeping | | |
| • DDRs<br>• Daily mud report (including chemical inventory).<br>• End-of-well fluids report.<br>• MoC documents.<br>• Incident reports. | | |

## 7.7. IMPACT 7 – Discharge of Cement

### 7.7.1. Hazard

Activities that use cement are:

- Drilling – cement is used on board the MODU to cement the drill casing in place (sealing the annulus); and

- P&A – cement is used for setting abandonment plugs.

Cement is usually mixed as required ('on-the-fly') and hence waste is minimal. See Table 2.7 for the discharge volumes expected during the activity. As per Table 2.6, bulk dry cement remaining onboard the MODU at the completion of drilling one well will be left on the MODU for use on the next Beehive well or by the next operator. If the excess cement cannot be left for the next operator, options for transferring the remaining cement to another MODU or onshore for disposal will be assessed. Discharge to the marine environment will only occur when there are no other safe or technically feasible options; the cement will be mixed with seawater and discharged overboard as a slurry. The volume of cement is expected to be < 100m$^3$ as outlined in Table 2.6.

*Note: It has been noted that trace amounts of mercury can be present in cement originating from the raw materials used in the process. Research indicates that the mean concentration expected in Portland cement is 0.01ppm (Krzysztof, Gorecki, & Burmistrz, 2021), significantly below the 1ppm criteria as outlined by the Minimata Convention (see Section 2.7.3).*

### 7.7.2. Known and Potential Environmental Impacts

Cement discharges, like drill cuttings, can impact the environment through:

- Localised and temporary increased turbidity of the water column;
- Smothering of benthic habitat and fauna; and
- Alteration of benthic substrate.

### 7.7.3. EMBA

The EMBA for cement discharges is likely to be within the immediate vicinity of the discharge points (e.g., tens of metres to several hundred metres). Receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Benthic fauna;
- Benthic habitat (sand substrates);
- Demersal fish; and
- Pelagic fish.

### 7.7.4. Evaluation of Environmental Impacts

**Water column turbidity**

Similar to drill cuttings dispersion and settling (see Section 7.6.4), cement discharges from the MODU (i.e., cement hose and equipment flushing) will form a turbid surface plume, where the larger, coarser components of the cement will precipitate. This would be expected to settle on the seabed within a radius of 100-200 m from the MODU for each of the wells drilled. The remaining finer components are rapidly dispersed by ocean currents, aiding dispersion and dilution, and minimising water column turbidity. Although turbidity can decrease the available oxygen and light at the water surface (thereby reducing planktonic photosynthetic activity), the brief discharge periods and small volumes discharges result in only localised and temporary impacts.

**Smothering of benthic habitat and fauna/alteration of seabed substrate**

The minor volumes of cement that will be discharged at the seabed during cementing of the top hole section will result in localised smothering of benthic habitat and fauna. The discharge of cement on sandy seabed habitat will not result in impacts to sensitive benthic communities and this seabed type is widely represented in the region. A small area of hardened cement around the drill site will provide a surface for colonisation by epifauna that is not readily available in or around the activity area, so there will be no net loss of seabed habitat.

Given the mobile nature of the sandy seabed sediments (see Section 5.2.3), any unconsolidated cement on the seabed will rapidly shift and disperse. Should colonising benthic species be present, impacts to them and their habitats will therefore be insignificant.

**Toxicity impacts to marine fauna**

Cement is considered inert (with the key component Portland cement being mostly calcium silicates, and aluminate and aluminoferrite). Portland cement is classified as non-CHARMable 'E' PLONOR under the OCNS.

While the cementing program has not yet been finalised, cement additives will be of low toxicity (according to OSPAR rankings, in line with drill fluids). As such, these constituents of the cement will have negligible chronic or acute toxicity impacts to benthic fauna or other fauna exposed to the cement.

In summary, cement discharges are small in volume, inert, unlikely to result in permanent smothering of benthic impact and are generally restricted to a highly localised area around each drill site (other than cement fines that rapidly disperse through the water column).

The impact consequence for cement discharges remains negligible even in the event that all three wells are drilled.

### 7.7.5. Impact Assessment

Table 7.25 presents the impact assessment for cement discharges.

**Table 7.25. Impact assessment for cement discharges**

| Summary | | |
|---|---|---|
| Summary of impacts | Localised and temporary turbidity of the water column, smothering of benthic habitat. | |
| Extent of impacts | Localised – tens to hundreds of metres from the discharge point in the direction of dominant water currents. | |
| Duration of impacts | Short-term – intermittently during drilling. | |
| Level of certainty of impacts | HIGH – the impacts associated with cement discharges are well understood. | |
| Impact decision framework context | Decision type | A - good industry practice required. |
| | Activity | Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined. |

| | | |
|---|---|---|
| | Risk & uncertainty | Risks are well understood, uncertainty is minimal. |
| | Stakeholder influence | No conflict with company values, no partner interest, no significant media interest. |
| Defined acceptable level | Cement discharges are limited to the necessary amount to safely complete the well. | |

| Impact Consequence (inherent) | | | |
|---|---|---|---|
| Negligible | | | |
| Assessment of Proposed Control Measures | | | |
| Control measure | Control type | Adopt | Justification |
| No cement discharges | Eliminate | No | **EB:** Eliminates impacts to benthic communities and the water column.<br>**C:** Cementing is essential to maintain well integrity and the well cannot be drilled without cement. This is not an option.<br>**Ev:** Cement discharges are a necessary component of safely completing the well casing. Adopting this measure would pose significant risks to the project. |
| Skip-and-ship (take cement discharges to shore) (see Section 2.7.3) | Eliminate | Possible | **EB:** No cement discharges to the marine environment.<br>**C:** Very high cost associated with vessel movements between the MODU and port, and onshore disposal costs. Increased vessel movements result in increased fuel use and associated GHG emissions.<br>Transferring excess cement onshore requires the product to be sent from the rig back to a vessel. This process increases the risk of moisture contamination of the product within the lines and tanks of the vessel.<br>This risk is different to when the cement is transported to the rig as the cement has not yet been exposed.<br>Any moisture contamination of dry cement product within the vessel has the potential for costly impact to the operator of the vessel and therefore is not common in industry. More importantly, moisture contaminated cement increases the likelihood of a blockage in the lines and tanks of the MODU or vessel which significantly increases the risk to personnel attending to transfers of excess cement back to the vessel. Hazards include sudden releases of pressure due to blockage clearing, uncontrolled movement of hoses during clearing, and elevated levels of dust posing respiratory concerns.<br>In the event that cement was to be transferred from the rig back to shore, it would be via pneumatic processes from the vessel into a cement bulk trailer. Disposal of cement from this trailer at an appropriate landfill facility will also require a pneumatic transfer |

| | | | |
|---|---|---|---|
| | | | process to get the bulk product out of the tanker. Land fill sites are typically not set up with facilities to handle pressurized delivery of bulk products further complicating the onshore disposal process.<br>This combined with the additional time, vessel logistics and associated GHG emissions required to transfer the cement back to the vessel and then onshore is considered to outweigh the benefit gained. The activity does not intentionally carry excess cement and good management of bulk cement volumes on the MODU will minimize excess cement at the end of the activities.<br>**Ev:** Environmental benefit is outweighed by the significant cost and safety implications associated with this measure, especially given the negligible impact. |
| No discharge of excess cement powder as a slurry at end of well | Elimination | No | **EB:** At the end of the drilling program, any dry, unopened cement left over will be left on board for the next operator to use or returned to shore. Open sacks however, cannot be transferred back to vessels for transport, and therefore are mixed into a slurry and discharged overboard if the stock cannot be used, sold or returned to shore (see Table 2.6).<br>**C:** The design of the piping and the tanks on the MODU is such that the reverse pumping of dry bulks back to marine vessels or to shore is not possible. Therefore, return of excess open dry bulk powders to shore is not usually a feasible option,<br>**Ev:** The potential environmental impacts are negligible due to the chemical selection process and therefore implementing this measure has negligible benefit. Disposal volumes are minimal due to careful stock management. |
| Chemical selection process **(IMP-07: EPS-01, -02)** | Engineering | Yes | **EB:** Ensures only low-toxicity chemicals are used in the cement system.<br>**C:** Minor cost.<br>**Ev:** Environmental benefit outweighs the minor cost to implement this measure. |
| Cement program **(IMP-07: EPS-03, -04, -05)** | Administrative | Yes | **EB:** Ensures cement jobs are conducted in accordance with procedures and processes in order to minimise losses.<br>**C:** No additional cost.<br>**Ev:** Environmental benefit outweighs the cost to implement this measure. |

| Environmental Controls and Performance Measurement | | |
|---|---|---|
| EPO | EPS | Measurement criteria |
| | **(IMP-07: EPS-01)** The Cement Engineer ensures that only PLONOR, 'D'/'E' (non- | The Cement Chemical Inventory verifies that all additives are PLONOR, |

| | | |
|---|---|---|
| Only low toxicity cement additives will be used. | CHARM) or 'Gold'/'Silver' (CHARM) OCNS-rated cement additives are used to minimise ecotoxicity impacts to marine fauna. | 'D'/'E' (non-CHARM) or 'Gold'/'Silver' (CHARM) OCNS-rated. |
| | **(IMP-07: EPS-02)** Where for technical reasons a cement additive is required that:<br>• Is not rated as PLONOR, 'D'/'E' (non-CHARM) or 'Gold'/'Silver' (CHARM); or<br>• Has a substitution warning; or<br>• has not been registered with CEFAS (and therefore does not have a rating),<br>A risk assessment will be completed to understand the environmental risk of discharge to sea. This will include:<br>• A pseudo-ranking using the OCNS process (where possible);<br>• Consideration of end fate, volumes and concentrations; and<br>• Final approval by EOG of the use of the chemical. | MoC documentation verifies that, for products that do not meet **IMP-07:EPS-01**, a risk assessment is completed and approved by EOG prior to discharge of the chemical. |
| Cement losses to the seabed during top hole cementing operations are minimised. | **(IMP-07: EPS-03)** Cementing will take place in accordance with the Cement Plan. | The Cement Job Report notes details the pumping schedule. |
| Cement remaining at the completion of drilling is managed so as to avoid or minimise its discharge overboard. | **(IMP-07: EPS-04)** As far as is practicably reasonable, all remaining dry bulk cement will be used in the casing job.<br>Where cement cannot be transferred to the next operator at the completion of drilling, or transferred and disposed of onshore, it will be mixed with seawater and discharged overboard. | Records are available to verify that, in order of preference:<br>• Effort was made to minimise the inventory of cement on board, and if that was not possible then;<br>• Any leftover cement slurry was used in well plugs, and if that was not possible, then;<br>• Effort was made to transfer cement to the next operator, and if that was not possible, then;<br>• Effort was made to determine if the cement could be transferred onshore for disposal. |
| | **(IMP-07: EPS-05)** Bulk dry cement will not be discharged overboard (unless in an emergency situation). | |
| Impact Consequence (residual) | | |
| Negligible | | |
| The impact of cement discharges is assessed as negligible because:<br>• The discharges will be small in volume and intermittent; and<br>• The area of impact extremely small;<br>• There is an absence of known sensitive seabed features in the activity area (e.g., shoals, reefs); and<br>• The sandy seabed is well represented in the region. | | |

| Demonstration of ALARP | | |
|---|---|---|
| A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the risk to the point that any additional or alternative control measures either fail to lower the residual risk rating any further or are grossly disproportionate to the residual risk rating. | | |
| **Demonstration of Acceptability** | | |
| Policy compliance | EOG's Safety and Environmental Policy objectives are met. | |
| EMS compliance | Chapter 10 describes the EP implementation strategy to be employed for this activity. | |
| Risk matrix standard compliance | The residual impact consequence is negligible, which is considered acceptable. | |
| External context | There have been no objections or claims raised by relevant persons regarding the discharge of cement for this activity. | |
| Legislative context | There are no legislative controls regarding offshore cement discharges.<br>In the absence of Australian regulations or guidelines, cement additive selection complies with the North Sea OCNS, which implements the OSPAR Convention. | |
| Industry practice | The consideration and alignment of EPS with the mitigation measures outlined in the below-listed guidelines and codes of practice demonstrates that BPEM will be implemented for this activity | |
| | Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020) | The EPS developed for this hazard are in line with the management measures listed for offshore cement management Section 4.5.8 of the guidelines, which include:<br>• Volume of cement to be used for each well to be planned to minimise excess bulk at the end of campaign and volumes discharged into the ocean **(IMP-07: EPS-04)**. |
| | Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019) | No guidance is provided regarding cement management. |
| | Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015) | No guidance is provided regarding cement management. |
| | Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015) | No guidance is provided regarding cement management. |
| | AEP CoEP (APPEA 2008) | The EPS developed for this activity meet the code's following objectives for offshore drilling: |

| | | |
|---|---|---|
| | | • To reduce the risk of release of material into the marine environment to ALARP and to an acceptable level.<br>• To reduce the impacts to benthic communities to acceptable levels and to ALARP. |
| Environmental context | MNES | |
| | AMPs | This hazard will not intersect nearby AMPs. |
| | Ramsar wetlands | This hazard will not intersect any Ramsar wetlands. |
| | TECs | This hazard will not intersect any TECs. |
| | Nationally threatened and migratory species | This hazard will not have any impacts on threatened or migratory species. |
| | Other matters | |
| | KEFs | This hazard will not intersect any KEFs. |
| | NIWs | This hazard will not intersect any NIWs. |
| | State marine parks | This hazard will not intersect any state marine parks. |
| | Species Conservation Advice/<br>Recovery Plans/<br>Threat Abatement Plans | None triggered by this hazard. |
| ESD principles | The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant). | |
| Statement of acceptability | EOG considers the impacts from discharge of cement to be acceptable because:<br>• It will adhere to the company's Safety and Environmental Policy;<br>• The residual consequence rating is negligible;<br>• An Implementation Strategy (described in Chapter 10) is in place to ensure the EPS are achieved.<br>• Relevant legislation and industry best practice will be complied with;<br>• Discharge of cement will not have long-term or significant impacts on MNES;<br>• The management of cement discharges will ensure it is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species;<br>• The management of cement discharges will ensure it is not inconsistent with the aims of relevant marine reserve management plans; and<br>• The management of cement discharges will not be inconsistent with ESD principles. | |
| Environmental Monitoring | | |
| • Real-time ROV observations during conductor cementing operations.<br>• Tracking of cement volumes and chemical additives. | | |
| Record Keeping | | |
| • Cement chemical inventory.<br>• Cement job report (and DDRs).<br>• MoC documents. | | • End-of-well cement report.<br>• ROV footage and/or report. |

## 7.8. IMPACT 8 – Routine Discharges – Putrescible Waste

### 7.8.1. Hazard

The generation of food waste (putrescible waste) from the MODU and support vessel galleys will result in the overboard discharge of this waste. The average volume of putrescible waste discharged overboard depends on the number of Persons on Board (POB) at any time, and the types of meals prepared.

Based on the monitoring data from a MODU that has regularly worked in Australian waters, the typical volume of macerated waste discharged overboard is about 50 grams per person. Based on an assumed maximum POB of:

- MODU – assumed maximum POB for 120, equating to a discharge of ~7 kg/day.
- Support vessels – assumed POB of 30 for two vessels, equating to a discharge of 1.5 kg/day.

This waste is likely to float for a short time and if not consumed by fauna (such as pelagic fish and seabirds) quickly at the sea surface, it will become water-logged and sink through the water column.

NERA (2017) estimates the volume of putrescible waste to be in the order of 1-2 kg (0.001-0.002 $m^3$) per person per day. While this is likely to be an over-estimate, based on the same POB numbers listed above, an estimated 150-300 kg (0.15 – 0.3 $m^3$) of putrescible waste may be generated and discharged overboard daily using the NERA estimates. Assuming all three wells are drilled, this equates to an estimated total of 25-50 $m^3$ of putrescible waste discharges (for 55 days of drilling per well) or 67.5-135 $m^3$ of putrescible waste discharges (for 150 days of drilling per well).

### 7.8.2. Known and Potential Environmental Impacts

The known and potential environmental impacts of putrescible waste discharges are:

- Temporary and localised increase in the nutrient content of waters surrounding the discharge point; and
- An associated increase in scavenging behaviour of marine fauna and seabirds (at the sea surface or within the water column).

### 7.8.3. EMBA

The EMBA for putrescible waste discharges is likely to be the top 10 m of the water column and a 100 m radius from the discharge point. This is based on modelling of continuous wastewater discharges undertaken by Woodside for its Torosa South-1 drilling program (in the Scott Reef complex, WA).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Marine mammals;
- Marine reptiles; and

- Seabirds.

### 7.8.4. Evaluation of Environmental Impacts

The overboard discharge of macerated food wastes creates a localised and temporary increase in the nutrient load of near-surface waters. This in turn acts as a food source for scavenging marine fauna and/or seabirds, whose numbers may temporarily increase as a result. The rapid consumption of putrescible waste by scavenging fauna, its physical and microbial breakdown, together with the absence of habitats nearby sensitive to increased nutrients, ensures that the impacts of such discharges are insignificant and therefore have a negligible impact consequence.

The impact consequence for putrescible waste discharges remains negligible even in the event that all three wells are drilled.

### 7.8.5. Impact Assessment

Table 7.26 presents the impact assessment for putrescible waste discharges.

**Table 7.26. Impact assessment for putrescible waste discharges**

| Summary | | | |
|---|---|---|---|
| Summary of impacts | Increase in nutrient content of near-surface waters around the discharge point, which may lead to an increase of scavenging behaviour of pelagic fish and seabirds. | | |
| Extent of impacts | Localised – up to 100 m horizontally and 10 m vertically from the discharge point. | | |
| Duration of impacts | Intermittent and temporary – until the discharge is completely consumed (likely to be several hours). | | |
| Level of certainty of impacts | HIGH – the impacts of putrescible waste discharges on marine fauna are well known. | | |
| Impact decision framework context | Decision type | A - good industry practice required. | |
| | Activity | Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined. | |
| | Risk & uncertainty | Risks are well understood, uncertainty is minimal. | |
| | Stakeholder influence | No conflict with company values, no partner interest, no significant media interest. | |
| Defined acceptable level | Putrescible waste discharges to sea meet legislated requirements such that there are no adverse impacts to biodiversity, ecological integrity or human health. | | |
| Impact Consequence (inherent) | | | |
| Negligible | | | |
| Assessment of Proposed Control Measures | | | |
| Control measure | Control type | Adopt | Justification |
| Store all putrescible waste onboard for onshore disposal. | Eliminate | No | **EB:** Eliminates impacts to water quality and scavenging behaviour by marine fauna.<br>**C:** Additional cost due to onshore disposal, additional fuel usage required to transfer wastes to shore, increased health and safety risk involved with storing organic wastes onboard in a tropical |

| | | | |
|---|---|---|---|
| | | | environment. The discharge of macerated putrescible waste (and unmacerated putrescible waste when >12 nm from shore) is permitted by legislation.<br>**Ev:** Cost of this control measure is grossly disproportionate to the negligible consequence. |
| GMP **(IMP-08: EPS-01)**. | Engineering | Yes | **EB:** Reduces probability of garbage being inappropriately discharged to sea, reducing potential impacts to fauna.<br>**C:** Negligible; part of routine MODU and vessel operations.<br>**Ev:** Benefits of ensuring responsible and compliant garbage handling outweighs negligible cost. |
| Putrescible waste is treated as per MARPOL Annex V requirements prior to discharge **(IMP-08: EPS-02, -03, -04).** | Engineering | Yes | **EB:** Reduces probability of putrescible waste being inappropriately discharged to sea, reducing impacts to water quality and marine fauna.<br>**C:** Negligible; part of routine MODU and vessel operations. Occasional high costs of replacing the macerator.<br>**Ev:** Benefits of ensuring responsible and compliant putrescible waste handling outweighs minimal costs. |
| Environmental induction for MODU and vessel crews **(IMP-08: EPS-05)**. | Administrative | Yes | **EB:** Reduced likelihood of inappropriate waste disposal to the sea.<br>**C:** Negligible; part of routine MODU and vessel operations.<br>**Ev:** Environmental benefits can be achieved with little additional cost. |

| Environmental Performance Objectives and Measurement | | |
|---|---|---|
| EPO | EPS | Measurement criteria |
| Putrescible waste discharges meet MARPOL Annex V requirements. | **(IMP-08: EPS-01)** A MARPOL Annex V-compliant GMP is in place (for vessels >100 GRT tonnes or certified to carry 15 persons or more) that sets out the procedures for minimising, collecting, storing, processing and discharging garbage. | A GMP is in place, readily available onboard and kept current. |
| | **(IMP-08: EPS-02)** A macerator is on board the MODU and vessels, functional, in use and set to macerate putrescible waste to a particle size ≤25 mm using to ensure rapid breakdown upon discharge. | PMS records verify that the macerator is functional and regularly maintained or replaced. |
| | **(IMP-08: EPS-03)** Records of food waste disposal to be maintained in a Garbage Record Book. | A Garbage Record Book is in place and verifies waste discharge locations and volumes. |
| | **(IMP-08: EPS-04)** Only macerated putrescible waste (≤25 mm) is discharged overboard (noting that un-macerated putrescible waste is permitted to be discharged as the MODU and support vessels will be >12 nm from shore). Un-macerated putrescible waste is | |

| | | |
|---|---|---|
| | only discharged overboard in the event of macerator malfunction or other emergency. | |
| | **(IMP-08: EPS-05)** Waste management and housekeeping requirements are communicated to all MODU and vessel crews to ensure discharges are in accordance with MARPOL Annex V. | MODU and vessel induction includes waste management requirements. |

| Impact Consequence (residual) |
|---|
| Negligible |
| The consequence of putrescible waste discharges is assessed as negligible because of:<br>• The temporary duration of the activity;<br>• The intermittent nature of the discharge;<br>• The small discharge volumes;<br>• Maceration of the waste prior to discharge;<br>• High dilution and dispersal factor in open waters;<br>• The long distance from shore;<br>• Rapid consumption by fauna;<br>• High biodegradability and low persistence of the waste; and<br>• The absence of sensitive habitats in the activity area. |
| Demonstration of ALARP |
| A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence. |
| Demonstration of Acceptability |

| | | |
|---|---|---|
| Policy compliance | EOG's Safety and Environmental Policy objectives are met. | |
| EMS compliance | Chapter 10 describes the EP implementation strategy to be employed for this activity. | |
| Risk matrix standard compliance | The residual impact consequence is negligible, which is considered acceptable. | |
| External context | No objections or claims have been made by relevant persons with regard to putrescible waste discharges for this activity. | |
| Legislative context | The EPS align with the requirements of:<br>• *Navigation Act* 2012 (Cth):<br>  ○ Chapter 4 (Prevention of Pollution).<br>  ○ AMSA Marine Order 95 (Marine Pollution Prevention - garbage).<br>• *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 (Cth):<br>  ○ Section 26F (which implements MARPOL Annex V). | |
| Industry practice | The consideration and alignment of EPS with the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity. | |
| | Environmental management in the upstream oil and gas | The EPS listed in this table meet the relevant mitigation measures listed for offshore activities with regard to: |

| | | |
|---|---|---|
| | industry (IOGP-IPIECA, 2020) | • Section 4.5.1 - organic (food) waste from the kitchen should, at a minimum, be macerated to <25 mm prior to discharge to sea, in compliance with MARPOL Annex V requirements **(IMP-08: EPS-02 and -04)**. |
| | Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019) | The EPS listed in this table meet these guidelines for offshore activities with regard to:<br>• Environmental monitoring (item 26). The BAT guidelines are met for the activity with regard to monitoring waste streams. |
| | Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015) | There is no specific guidance regarding putrescible waste discharges.<br>Section 2.3.6.2 (management of waste) of the guideline states that, among other things, waste management and disposal options should be evaluated.<br>Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement. |
| | Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015) | Guidelines met with regard to:<br>• Other waste waters (item 44). Food waste from the kitchen should, at a minimum, be macerated to acceptable levels and discharged to sea, in compliance with MARPOL requirements **(IMP-08: EPS-04)**. |
| | AEP CoEP (APPEA 2008) | The EPS for this activity meet the code's following objectives for offshore drilling operations:<br>• To reduce the volume of wastes produced to ALARP and to an acceptable level. |
| Environmental context | MNES | |
| | AMPs | This hazard will not impact the conservation values of nearby AMPs. |
| | Ramsar wetlands | This hazard will not intersect any Ramsar wetlands. |
| | TECs | This hazard will not intersect any TECs. |
| | Nationally threatened and migratory species | This hazard will not have any significant impacts on threated or migratory species. |
| | Other matters | |
| | KEFs | This hazard will not intersect any KEFs. |
| | NIWs | This hazard will not intersect any NIWs. |
| | State marine parks | This hazard will not intersect any state marine parks. |
| | Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans | This hazard will not compromise the specific objectives or actions (regarding marine pollution) of any of the species Recovery Plans, Conservation |

| | | |
|---|---|---|
| | | Management Plans or Conservation Advice referenced in this EP. |
| ESD principles | The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant). | |
| Statement of acceptability | EOG considers the impacts from putrescible waste discharges to be acceptable because:<br>• It will adhere to the company's Safety and Environmental Policy;<br>• The residual consequence rating is negligible;<br>• An Implementation Strategy (described in Chapter 10) is in place to ensure the EPS are achieved.<br>• Relevant legislation and industry best practice will be complied with;<br>• Putrescible waste discharges will not have long-term or significant impacts on MNES;<br>• Putrescible waste discharges are not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species;<br>• Putrescible waste discharges are not inconsistent with the aims of relevant marine reserve management plans; and<br>• The management of putrescible waste discharges is not inconsistent with ESD principles. | |
| Environmental Monitoring | | |
| • Volume/weight of non-macerated waste sent ashore. | | |
| Record Keeping | | |
| • GMP.<br>• PMS records.<br>• Garbage Record Book. | • Training matrix.<br>• Induction records. | |

## 7.9. IMPACT 9 - Routine Discharges – Sewage and Grey Water

### 7.9.1. Hazard

The use of ablution, laundry and galley facilities by MODU and support vessel crew will result in the discharge of sewage and grey water. The composition of sewage and grey water (when untreated) may include:

- Particulate matter – such as solids composed of floating, settleable, colloidal and dissolved matter, substances that affect aspects of aesthetics such as ambient water colour, the presence of surface slicks/sheens and odour.
- Chemical contaminants – including:
  - Nutrients (e.g., ammonia, nitrite, nitrate and orthophosphate);
  - Organics (e.g., volatile and semi-volatile organic compounds, oil and grease, phenols, endocrine disrupting compounds); and
  - Inorganics (e.g., hydrogen sulphide, metals and metalloids, surfactants, phthalates, residual chlorine);
- Biological pathogens – including bacteria, viruses, protozoa and parasites.

Total volumes of sewage and grey water typically generated at offshore facilities range between 0.04 and 0.45 $m^3$ per person per day (NERA, 2017). Assuming a POB of 120 on the MODU and 30

on both support vessels (a total of 150 people), this equates to between 6 and 68 $m^3$ of sewage and grey water generated daily using the NERA estimates. Assuming all three wells are drilled, this equates to a total of 990 – 11,220 $m^3$ of sewage and grey water discharges (for 55 days of drilling per well) or 8,100 – 30,600 $m^3$ of sewage and grey water discharges (for 150 days of drilling per well).

NERA (2017) states that most large vessels generate 5-15 $m^3$ wastewater per day, the majority of which is grey water (wastewater from showers, laundry, galley and wash basins). Assuming all three wells are drilled, this equates to a total of 825 – 2,475 $m^3$ of grey water discharges (55 days of drilling per well) or 2,250 – 6,750 $m^3$ of sewage and grey water (for 150 days of drilling per well).

### 7.9.2. Known and Potential Environmental Impacts

The known and potential environmental impact of treated sewage and grey water discharges is:

- Temporary and localised increase in the nutrient content of surface waters around the MODU and support vessels; and
- An associated increase in scavenging behaviour of marine fauna and seabirds (at the sea surface or in the water column).

### 7.9.3. EMBA

The EMBA for sewage and grey water discharges associated with MODU and support vessel activities is likely to be the top 10 m of the water column and a 50 m radius from the discharge point. This is based on modelling of continuous wastewater discharges (including treated sewage and greywater) undertaken by Woodside for its Torosa South-1 drilling program (in the Scott Reef complex), which found:

- Rapid horizontal dispersion of discharges occurs due to wind-driven surface water currents;
- Vertical discharge is limited to about the top 10 m of the water column due to the neutrally buoyant nature of the discharge; and
- A concentration of a component within the discharge stream is reduced to 1% of its original concentration at no less than 50 m from the discharge point under any condition (Woodside, 2008).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Marine mammals;
- Marine reptiles; and
- Seabirds.

### 7.9.4. Evaluation of Environmental Impacts

**Water quality**

Nutrients in sewage, such as phosphorus and nitrogen, may contribute to eutrophication of receiving waters (although usually only still, calm, inland waters), causing algal blooms, which can degrade aquatic habitats by reducing light levels and producing certain toxins, some of which are

harmful to marine life and humans. Given the tidal movements and currents in the open oceanic waters of the JBG, eutrophication of receiving waters will not occur. Sewage will be treated through a sewage treatment plant (STP) to a tertiary level, so there are no impacts relating to the release of chemicals and pathogens in untreated sewage.

Grey water can contain a wide variety of pollutant substances at different strengths, including oil and some organic compounds, hydrocarbons, detergents and grease, metals, suspended solids, chemical nutrients, food waste, coliform bacteria and some medical waste. Grey water is treated through the STP, so pollutants will be largely removed from the discharge stream.

The effects of sewage and sullage discharges on the water quality at Scott Reef were monitored for a drill rig operating near the edge of the deep-water lagoon area at South Reef. Monitoring at stations 50 m, 100 m and 200 m downstream of the rig and at five different water depths confirmed that the discharges were rapidly diluted in the upper 10 m water layer and no elevations in water quality monitoring parameters (e.g., total nitrogen, total phosphorous and selected metals) were recorded above background levels at any station (Woodside, 2011).

Treated sewage and grey water discharges will be rapidly diluted in the surface layers of the water column and dispersed by currents. The biological oxygen demand of the treated effluent is unlikely to lead to oxygen depletion of the receiving waters (Black *et al*., 1994), as it will be treated prior to release. On release, surface water currents will assist with oxygenation of the discharge.

**Biological receptors**

Plankton forms the basis of all marine ecosystems, and plankton communities have a naturally patchy distribution in both space and time (ITOPF, 2011a). They are known to have naturally high mortality rates (primarily through predation), however in favourable conditions (e.g., supply of nutrients), plankton populations can rapidly increase. Once the favourable conditions cease, plankton populations will collapse and/or return to previous conditions. Plankton populations have evolved to respond to these environmental perturbations by copious production within short generation times (ITOPF, 2011a).

Any potential change in plankton diversity, abundance and composition as a result of treated sewage and grey water discharges is expected to be very low (given the waste stream is treated) and localised (as outlined in the EMBA) and is likely to return to background conditions within tens to a few hundred metres of the discharge location (NERA, 2017). Accordingly, impacts higher up the food chain (e.g., fish, reptiles, birds and cetaceans) are expected to be negligible.

The impact consequence for sewage and grey water discharges remains negligible even in the event that all three wells are drilled.

### 7.9.5. Impact Assessment

Table 7.27 presents the impact assessment for the discharge of treated sewage and grey water.

**Table 7.27. Impact assessment for the discharge of treated sewage and grey water**

| Summary | |
|---|---|
| Summary of impacts | Reduction in water quality around the discharge point, increase in nutrients. |
| Extent of impacts | Localised – up to 50 m horizontally and 10 m vertically from the discharge point. |

| | | | |
|---|---|---|---|
| Duration of impacts | Temporary – until the discharge is completely diluted (likely to be minutes to hours). | | |
| Level of certainty of impact | HIGH – the impacts of sewage and grey water discharges to water quality are well known. | | |
| Impact decision framework context | Decision type | A - good industry practice required. | |
| | Activity | Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined. | |
| | Risk & uncertainty | Risks are well understood, uncertainty is minimal. | |
| | Stakeholder influence | No conflict with company values, no partner interest, no significant media interest. | |
| Defined acceptable level | Sewage and grey water discharges to sea meet legislated requirements such that there are no adverse impacts to biodiversity, ecological integrity or human health. | | |
| Impact Consequence (inherent) | | | |
| Negligible | | | |
| Assessment of Proposed Control Measures | | | |
| Control measure | Control type | Adopt | Justification |
| No discharge of treated sewage and grey water at sea. | Eliminate | No | **EB:** Eliminates biodegradable waste stream that may result in decreased water quality and scavenging behaviour by marine fauna.<br>**C:** Additional cost of transport to port for onshore disposal, associated increase in emissions (such as GHG) and increased health and safety risk involved with storing organic wastes onboard, particularly in a tropical environment. Discharges are permitted by legislation.<br>**Ev:** Cost is grossly disproportionate to the negligible consequence associated with the discharges. |
| Sewage and grey water treatment and discharges are managed in accordance with MARPOL Annex IV **(IMP-09: EPS-01, -02, -03, -04)** | Engineering | Yes | **EB:** Reduces potential impacts of inappropriate discharge and ensures compliance with Marine Order 96 and MARPOL requirements as appropriate for vessel class.<br>**C:** Cost of installing and maintaining STPs can be high but are part of routine MODU and support vessel operations.<br>**Ev:** Environmental benefits outweigh the costs. |
| Environmental Controls and Performance Measurement | | | |
| EPO | EPS | | Measurement criteria |
| Water pollution is avoided by treating sewage and grey water prior to discharge. | **(IMP-09: EPS-01)** The STPs meet MARPOL standards. | | ISPP certificates are valid and verify the installation of MARPOL-approved STPs. |
| | **(IMP-09: EPS-02)** The STPs are maintained in accordance with the MODU and support vessels' PMS. | | PMS records confirm that the STPs are maintained to schedule. |

| | | |
|---|---|---|
| | **(IMP-09: EPS-03)** All sewage and grey water is treated in the STPs prior to overboard discharge. | No reports of discharge being diverted around the STP in DDRs. |
| | **(IMP-09: EPS-04)** In accordance with Regulation 11 of MARPOL Annex IV (as enacted by Marine Order 96), sewage is comminuted, disinfected and discharged from the support vessels:<br>• When they are >3 nm from the nearest shore.<br>• At a moderate rate while proceeding en route at a speed not less than 4 knots.<br>In the event of a STP malfunction or other emergency, untreated sewage and grey water can be discharged (because they are >12 nm from shore when in the operational area). | Records verify that treated sewage is only discharged when the support vessel is >3 nm from shore and at a speed not less than 4 knots (unless the STP has malfunctioned or in an emergency). |
| Impact Consequence (residual) | | |
| Negligible | | |
| The consequence of treated sewage and grey water discharges is assessed as negligible because of:<br>• The temporary and intermittent nature of the discharges;<br>• The consistent movement of the support vessels;<br>• Low discharge volumes;<br>• Treatment of the waste stream prior to discharge;<br>• High dilution and dispersal factor in open waters;<br>• The long distance from shore;<br>• High biodegradability and low persistence of the waste; and<br>• Absence of sensitive habitats in the activity area. | | |
| Demonstration of ALARP | | |
| A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence. | | |
| Demonstration of Acceptability | | |
| Policy compliance | EOG's Safety and Environmental Policy objectives are met. | |
| EMS compliance | Chapter 10 describes the EP implementation strategy to be employed for this activity. | |
| Risk matrix standard compliance | The residual impact consequence is negligible, which is considered acceptable. | |
| External context | No objections or claims have been made by relevant persons regarding treated sewage and grey water discharges for this activity. | |
| Legislative context | The EPS align with the requirements of:<br>• *Navigation Act* 2012 (Cth):<br>  ○ Chapter 4 (Prevention of Pollution).<br>  ○ AMSA Marine Order 95 (Marine Pollution Prevention – sewage).<br>• *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 (Cth): | |

| | | |
|---|---|---|
| | ○ Section 26D (which implements MARPOL Annex IV). | |
| Industry practice | The consideration and alignment of EPS with the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity | |
| | Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020) | The EPS developed for this hazard are in line with the management measures listed in Section 4.5.1 – offshore discharges (sewage and grey water):<br>• Grey and sewage water from showers, toilets, and kitchen facilities should be treated in an appropriate on-site marine sanitary treatment unit **(IMP-09: EPS-03)**.<br>• Sewage units to be in compliance with MARPOL Annex V requirements **(IMP-09: EPS-01)**. |
| | Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019) | There are no guidelines for offshore activities with regard to managing sewage and grey water discharges. |
| | Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015) | While Section 3.4.5 of the guideline states that the arrangements for sewage and grey water discharges are to be described, there is no specific guidance regarding sewage and grey water discharges.<br>Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement. |
| | Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015) | Guidelines met with regard to:<br>• Other waste waters (item 44). Grey and black water should be treated in an appropriate on-site marine sanitary treatment unit in compliance with MARPOL **(IMP-09: EPS-01, -03)**. |
| | AEP CoEP (APPEA 2008) | The EPS for this activity meet the code's following objectives for offshore drilling operations:<br>• To reduce the volume of wastes produced to ALARP and to an acceptable level. |
| Environmental context | MNES | |
| | AMPs | This hazard will not impact the conservation values of the JBG AMP. |
| | Ramsar wetlands | This hazard will not intersect any Ramsar wetlands. |
| | TECs | This hazard will not intersect any TECs. |
| | Nationally threatened and migratory species | This hazard will not have any significant impacts on threated or migratory species. |
| | Other matters | |
| | KEFs | This hazard will not intersect any KEFs. |

| | | |
|---|---|---|
| | NIWs | This hazard will not intersect any NIWs. |
| | State marine parks | This hazard will not intersect any state marine parks. |
| | Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans | None triggered by this hazard. |
| ESD principles | The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle I is not relevant). | |
| Statement of Acceptability | EOG considers the impacts from treated sewage discharges to be acceptable because:<br>• It will adhere to the company's Safety and Environmental Policy;<br>• The residual consequence rating is negligible;<br>• An Implementation Strategy (described in Chapter 10) is in place to ensure the EPS are achieved.<br>• Relevant legislation and industry best practice will be complied with;<br>• Sewage and grey water discharges will not have long-term or significant impacts on MNES;<br>• The management of sewage and grey water discharges is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species;<br>• The management of sewage and grey water discharges is not inconsistent with the aims of relevant marine reserve management plans; and<br>• The management of sewage and grey water discharges is not inconsistent with ESD principles. | |
| Environmental Monitoring | | |
| • None required. | | |
| Record Keeping | | |
| • ISPP certificate.<br>• STP PMS records.<br>• DDRs | | |

## 7.10. IMPACT 10 - Routine Discharges – Cooling and Brine Water

### 7.10.1. Hazard

Seawater is used as a heat exchange medium for cooling machinery engines and other equipment on the MODU and support vessels. Seawater is drawn up from the ocean, where it is de-oxygenated and sterilised by electrolysis (by release of chlorine from the salt solution) and then circulated as coolant for various equipment through the heat exchangers (in the process transferring heat from the machinery) and is then discharged to the ocean at depth (not at surface). Upon discharge, it will be warmer than the ambient water temperature and may contain low concentrations of residual biocide and scale inhibitors if they are used to control biofouling and scale formation.

The maximum cooling water discharge rate for the MODU and support vessels that may be used is unknown. Also unknown is the temperature at which the heat exchangers are designed to discharge the cooling water at (though this is generally several degrees Celsius above ambient sea temperature). The volume depends on the equipment being cooled, but for this activity, it is likely to be tens of cubic meters each day.

Brine water (hypersaline water) is created through the desalination process that creates freshwater for drinking, showers, cooking etc. This is achieved through reverse osmosis (RO) or distillation resulting in the discharge of seawater with a slightly elevated salinity (~10-15% higher than seawater). The freshwater produced is then stored in tanks on board. Upon discharge, the concentration of the brine is (based on other modern vessels) likely to range from 44-61 ppm, which is 9-26 ppm higher than seawater salt concentration (35 ppm). Brine concentration is dependent on throughput and plant efficiency.

### 7.10.2. Known and potential environmental impacts

The known and potential environmental impacts of cooling water and brine discharges are:

- Temporary and very localised increase in sea water temperature, causing thermal stress to marine fauna;
- Temporary and very localised increase in sea surface salinity, potentially causing harm to fauna unable to tolerate higher salinity; and
- Potential toxicity impacts to marine fauna from the ingestion of residual biocide and scale inhibitors.

### 7.10.3. EMBA

The EMBA for cooling water and brine discharges associated with MODU and vessel activities is likely to be the top 10 m of the water column and a 100 m radius from the discharge point. This is based on modelling of continuous wastewater discharges undertaken by Woodside for its Torosa South-1 drilling program (in the Scott Reef complex) (Woodside, 2008).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Marine mammals;
- Marine reptiles; and
- Seabirds.

### 7.10.4. Evaluation of Environmental Impacts

**Temporary and localised increase in seawater temperature**

Once in the water column, cooling water will remain in the surface layer, where turbulent mixing and heat transfer with surrounding waters will occur. Prior to reaching background temperatures, the impact of increased seawater temperatures down current of the discharge may result in changes to the physiological processes of marine organisms, such as attraction or avoidance behaviour, stress or potential mortality.

Modelling of continuous waste water discharges (including cooling water) undertaken by Woodside for its Torosa South-1 drilling program in the Scott Reef complex found that discharge water temperature decreases quickly as it mixes with the receiving waters, with the discharge water temperature being less than 1°C above background levels within 100 m (horizontally) of the

discharge point, and will be within background levels within 10 m vertically (Woodside, 2008). As such, impacts to most receptors are expected to be negligible even within this mixing zone.

**Temporary and localised increase in sea surface salinity**

Brine water will sink through the water column where it will be rapidly mixed with receiving waters and be dispersed by ocean currents. Walker and MacComb (1990) found that most marine species are able to tolerate short-term fluctuations in water salinity in the order of 20-30%, and it is expected that most pelagic species passing through a denser saline plume would not suffer adverse impacts. Other than plankton, pelagic species are mobile and would be subject to slightly elevated salinity levels for a very short time as they swim through the 'plume.' As such, impacts to receptors are expected to be negligible.

**Potential toxicity impacts**

Scale inhibitors and biocide are likely to be used in the heat exchange and desalination process to avoid fouling of pipework. Scale inhibitors are low molecular weight phosphorous compounds that are water-soluble, and only have acute toxicity to marine organisms about two orders of magnitude higher than typically used in the water phase (Black *et al*., 1994). The biocides typically used in the industry are highly reactive and degrade rapidly and are very soluble in water (Black *et al*., 1994).

These chemicals are inherently safe at the low dosages used, as they are usually 'consumed' in the inhibition process, ensuring there is little or no residual chemical concentration remaining upon discharge and thus have a negligible impact consequence.

The impact consequence for cooling and brine water discharges remains negligible even in the event that all three wells are drilled.

### 7.10.5. Impact Assessment

Table 7.28 presents the impact assessment for the discharge of cooling and brine water.

**Table 7.28. Impact assessment for the discharge of cooling and brine water**

| Summary | | |
|---|---|---|
| Summary of impacts | Increased sea surface temperature and salinity around the discharge point.<br>Potential toxicity impacts to marine fauna from residual biocide and scale inhibitors. | |
| Extent of impacts | Localised – up to 100 m horizontally and 10 m vertically from the discharge point. | |
| Duration of impacts | Temporary – duration of the activity. | |
| Level of certainty of impact | HIGH – the impacts of sea surface temperature and salinity increases on marine fauna are well known. | |
| Impact decision framework context | Decision type | A - good industry practice required. |
| | Activity | Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined. |
| | Risk & uncertainty | Risks are well understood, uncertainty is minimal. |

| | | |
|---|---|---|
| | Stakeholder influence | No conflict with company values, no partner interest, no significant media interest. |
| Defined acceptable level | Cooling water and brine discharges to sea meet legislated requirements such that there are no adverse impacts to biodiversity, ecological integrity or human health. | |

| Impact Consequence (inherent) | | | |
|---|---|---|---|
| Negligible | | | |
| Assessment of Proposed Control Measures | | | |
| Control measure | Control type | Adopt | Justification |
| Store brine onboard prior to discharge onshore. | Elimination | No | **EB:** Eliminates impacts to the marine environment.<br>**C:** Very high costs associated with MODU and vessel modifications to enable onboard storage.<br>**Ev:** Cost outweighs the environmental benefit given the minor inherent consequence. |
| Low toxicity chemicals **(IMP-10: EPS-01)**. | Substitution | Yes | **EB:** Reduces potential water quality impacts through use of environmentally suitable chemicals.<br>**C:** Low toxicity chemicals are generally more expensive than higher toxicity chemicals, but not by high margins.<br>**Ev:** The minimal additional cost is outweighed by the environmental benefits. |
| Biocide dosing **(IMP-10: EPS-02)**. | Engineering | Yes | **EB:** Minimises the likelihood of out-of-specification discharges.<br>**C:** Negligible; part of routine MODU and support vessel operations.<br>**E:** Environmental benefits can be achieved with negligible additional cost. |
| Freshwater generation volumes **(IMP-10: EPS-03)**. | Engineering | Yes | **EB:** Minimises the volume of brine discharges.<br>**C:** Negligible; part of routine MODU and support vessel operations.<br>**E:** Environmental benefits can be achieved with negligible additional cost. |
| PMS **(IMP-10: EPS-04)**. | Engineering | Yes | **EB:** Minimises the likelihood of out-of-specification discharges.<br>**C:** Negligible; part of routine MODU and vessel operations.<br>**E:** Environmental benefits can be achieved with little additional cost. |

| Environmental Controls and Performance Measurement | | |
|---|---|---|
| EPO | EPS | Measurement criteria |

| | | |
|---|---|---|
| Only the minimum required low-toxicity chemicals are used in the cooling and brine water systems. | **(IMP-10: EPS-01)** Only OCNS 'Gold'/'Silver' (CHARM) or 'D'/'E' (non-CHARM)-rated chemicals (i.e., low toxicity) are used in the cooling and brine water systems. | Chemical inventories records verify that biocides and scale inhibitors are of low toxicity. |
| | **(IMP-10: EPS-02)** Biocide dosing is kept to a minimum in accordance with the equipment manufacturer's specifications. | PMS data verifies minimum biocide dosage. |
| The RO plant and equipment that requires cooling by water is well maintained. | **(IMP-10: EPS-03)** Freshwater generation is limited to volumes necessary for operational requirements. | Tank volumes verify minimum requirement for freshwater generation. |
| | **(IMP-10: EPS-04)** Plant and equipment that requires cooling by water is maintained in good working order in accordance with the PMS. | PMS records verify that equipment that requires cooling is well maintained. |

| Impact Consequence (residual) |
|---|
| Negligible |
| The consequence of cooling and brine water discharges is assessed as negligible because of the:<br>• Temporary nature of the activity;<br>• Support vessels will be constantly moving;<br>• Low discharge volumes;<br>• Intermittent nature of the discharge;<br>• 'Consumption' of the chemicals prior to discharge;<br>• High dilution and dispersal factor in the open waters of the JBG; and<br>• Absence of sensitive habitats in the activity area. |
| Demonstration of ALARP |
| A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence. |

| Demonstration of Acceptability | |
|---|---|
| Policy compliance | EOG's Safety and Environmental Policy objectives are met through implementation of this EP. |
| EMS compliance | Chapter 10 describes the EP implementation strategy to be employed for this activity. |
| Risk matrix standard compliance | The residual impact consequence is negligible, which is considered acceptable. |
| External context | No objections or claims have been made by relevant persons regarding cooling and brine discharges for this activity. |
| Legislative context | There are no legislative controls regarding cooling and brine water discharges. |
| Industry practice | The consideration of the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity. |

| | | |
|---|---|---|
| | Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020) | The EPS developed for this hazard are in line with the management measures listed for offshore discharges (cooling water and desalination brine) in Section 4.5.3 of the guidelines:<br>• Biocide dosing kept to a minimum in accordance with the equipment manufacturer's specifications **(IMP-10: EPS-02)**.<br>• Freshwater generation to be limited to volumes necessary for operational requirements **(IMP-10: EPS-03)**. |
| | Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019) | There are no guidelines for offshore activities with regard to managing cooling and brine water discharges. |
| | Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015) | There is no specific guidance regarding cooling and brine water discharges.<br>Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement. |
| | Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015) | Guidelines met with regard to:<br>• Cooling water (items 41 & 42). Antifouling chemical dosing to prevent marine fouling of cooling water systems should be carefully considered and appropriate screens to be fitted to the seawater intake to avoid entrainment and impingement of marine flora and fauna **(IMP-10:EPS-02)**. The cooling water discharge depth should be selected to maximise mixing and cooling of the thermal plume to ensure it is within 3°C of ambient seawater temperature within 100 m of the discharge point.<br>• Desalination brine (item 43). Consider mixing desalination brine from the potable water system with cooling water or other effluent streams. |
| | AEP CoEP (APPEA 2008) | The EPS for this activity meet the code's following objectives for offshore drilling operations:<br>• To reduce the volume of wastes produced to ALARP and to an acceptable level. |
| Environmental context | MNES | |
| | AMPs | This hazard will not impact the conservation values of nearby AMPs. |
| | Ramsar wetlands | This hazard will not intersect any Ramsar wetlands. |
| | TECs | This hazard will not intersect any TECs. |
| | Nationally threatened and migratory species | This hazard will not have any significant impacts on threated or migratory species. |

| | | |
|---|---|---|
| | Other matters | |
| | KEFs | This hazard will not intersect any KEFs. |
| | NIWs | This hazard will not intersect any NIWs. |
| | State marine parks | This hazard will not impact the conservation values of nearby AMPs. |
| | Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans | None triggered by this hazard. |
| ESD principles | The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant). | |
| Statement of Acceptability | EOG considers the impacts from cooling water and brine discharges to be acceptable because:<br>• It will adhere to the company's Safety and Environmental Policy;<br>• The residual consequence rating is negligible;<br>• An Implementation Strategy (described in Chapter 10) is in place to ensure the EPS are achieved.<br>• Relevant legislation and industry best practice will be complied with;<br>• Cooling water and brine discharges will not have long-term or significant impacts on MNES;<br>• The management of cooling water and brine discharges is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species;<br>• The management of cooling water and brine discharges is not inconsistent with the aims of relevant marine reserve management plans; and<br>• The management of cooling water and brine discharges is not inconsistent with ESD principles. | |
| Environmental Monitoring | | |
| • None required. | | |
| Record Keeping | | |
| • PMS records.<br>• Potable water tank volumes.<br>• Chemical inventories. | | |

## 7.11. IMPACT 11 – Routine Discharges – Bilge Water and Deck Drainage

### 7.11.1. Hazard

Bilge tanks on the MODU and support vessels receive fluids from closed deck drainage and machinery spaces that may contain contaminants such as oil, detergents, solvents, chemicals and solid waste. An oily water separator (OWS) then treats this water prior to discharge overboard in order to meet the MARPOL requirement that no greater than 15 ppm oil-in-water (OIW) is discharged overboard. The volume of these discharges is small and intermittent (as required, based on bilge tank storage levels). Where no OWS is present, these fluids are retained in tanks for onshore disposal.

MODU and support vessel decks that are not bunded and drain directly to the sea may lead to the discharge of contaminated water, caused by ocean spray and rain ('green water') or deck washing activities capturing trace quantities of contaminants such as oil, grease and detergents, or a chemical (e.g., hydraulic fluids, lubricating oils) or hydrocarbon spill or leak washed overboard.

### 7.11.2. Known and Potential Environmental Impacts

The known and potential environmental impacts of the discharge of bilge water and deck drainage are:

- Temporary and localised reduction of surface water quality around the discharge point; and
- Acute toxicity to marine fauna through ingestion of contaminated water in a small mixing zone.

### 7.11.3. EMBA

The EMBA for bilge and deck water discharges is likely to be the top 10 m of the water column and less than a 100 m radius from the discharge point. This is based on modelling of continuous wastewater discharges undertaken by Woodside for its Torosa South-1 drilling program in the Scott Reef complex (Woodside, 2008).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Marine mammals;
- Marine reptiles; and
- Seabirds.

### 7.11.4. Evaluation of Environmental Impacts

**Temporary and localised reduction of surface water quality**

Small volumes and low concentrations of oily water (<15 ppm) from bilge discharges and traces of chemicals or hydrocarbons discharged to the ocean through open deck drainage may temporarily reduce water quality.

Given the absence of sensitive habitat types in the water column of the EMBA for these discharges, the greatest risk will be to plankton and pelagic fish. These discharges will be rapidly diluted, dispersed and biodegraded to undetectable levels within a very small mixing zone (as per the EMBA) and thus have a negligible impact consequence.

**Potential toxicity impacts**

While small volumes and low concentrations of oily water from bilge discharges may temporarily reduce water quality, such discharges are not expected to induce acute or chronic toxicity impacts to marine fauna or plankton through ingestion or absorption through the skin.

In the event a OWS malfunction and discharge of off-specification water, toxicity impacts may occur to marine fauna swimming through the discharge, though this is only likely in a highly

localised mixing zone (meaning that few individuals would be exposed), meaning it will have a negligible impact consequence.

The impact consequence for bilge water and deck drainage discharges remains negligible even in the event that all three wells are drilled.

### 7.11.5. Impact Assessment

Table 7.29 presents the impact assessment for the discharge of bilge water and deck drainage.

**Table 7.29. Impact assessment for the discharge of bilge water and deck drainage**

| Summary | | |
|---|---|---|
| Summary of impacts | Increased sea surface temperature and salinity around the discharge point.<br>Potential toxicity impacts to marine fauna from residual biocide and scale inhibitors. | |
| Extent of impacts | Localised – up to 100 m horizontally and 10 m vertically from the discharge point. | |
| Duration of impacts | Intermittent during MODU and vessel operations. | |
| Level of certainty of impacts | HIGH – the impacts of oily water discharges to the ocean are well known. | |
| Impact decision framework context | Decision type | A - good industry practice required. |
| | Activity | Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined. |
| | Risk & uncertainty | Risks are well understood, uncertainty is minimal. |
| | Stakeholder influence | No conflict with company values, no partner interest, no significant media interest. |
| Defined acceptable level | Bilge water discharges and deck drainage meet legislated discharge requirements such that there are no adverse impacts to biodiversity, ecological integrity or human health. | |
| Impact Consequence (inherent) | | |
| Negligible | | |
| Assessment of Proposed Control Measures | | |

| Control measure | Control type | Adopt | Justification |
|---|---|---|---|
| Store treated bilge onboard for disposal onshore. | Eliminate | No | **EB:** Eliminates oily water discharge, thereby eliminating potential impacts to water quality and marine fauna.<br>**C:** Significant cost of re-designing and configuring storage space on the MODU and vessels.<br>**Ev:** Cost to implement control measures outweighs the benefit given the negligible inherent consequence. |

| | | | |
|---|---|---|---|
| Oily water treatment system **(IMP-11: EPS-01, -03, -04).** | Engineering | Yes | **EB:** Oily water is treated prior to discharge, thereby reducing impacts to water quality and marine fauna. Complies with Marine Order 91 and MARPOL requirements.<br>**C:** Significant cost to install, but it is legislated requirement and part of routine MODU and support vessel operations.<br>**Ev:** Benefits to the marine environment outweigh the costs. |
| Maintain bilge water systems **(IMP-11: EPS-02).** | Engineering | Yes | **EB:** Efficient OWS ensures MARPOL requirements are met and impacts to water quality and marine fauna are minimised.<br>**C:** Minor costs to maintain the OWS and part of routine MODU and support vessel operations.<br>**Ev:** Benefits to the marine environment outweigh the costs. |
| Bunding of hydrocarbons and chemical storage areas **(IMP-11: EPS-07, -08)** | Engineering | Yes | **EB:** Reduces the likelihood that a spill will be discharged overboard.<br>**C:** Minor equipment installation and maintenance costs.<br>**Ev:** Environmental benefit outweighs the costs. |
| SMPEP **(IMP-11: EPS-05, -09, -10).** | Administrative | Yes | **EB:** Documented and coordinated response to a spill reduces the area of impact to the marine environment.<br>**C:** Minor equipment installation cost and maintenance costs, minor costs in time of training crew.<br>**Ev:** Environmental benefit outweighs the costs. |
| Use of non-toxic, biodegradable deck cleaning product selection **(IMP-11: EPS-06).** | Administrative | Yes | **EB:** Avoids toxic water discharges.<br>**C:** Minor additional cost of environmentally acceptable deck cleaning products.<br>**Ev:** Environmental benefits outweigh the minimal cost. |

| Environmental Controls and Performance Measurement | | |
|---|---|---|
| EPO | EPS | Measurement criteria |
| No discharge of bilge water unless compliant with MARPOL Annex I requirements. | **(IMP-11: EPS-01)** For vessels >400 gross tonnes, all bilge water passes through a MARPOL-compliant OWS set to limit OIW to <15 ppm prior to overboard discharge. | IOPP certificate is current. |
| | **(IMP-11: EPS-02)** The OWS is maintained in accordance with the PMS. | PMS records verify that the OWS is maintained to schedule. |
| | **(IMP-11: EPS-03)** The OWS is calibrated in accordance with the PMS to ensure the 15 ppm OIW limit is met. | PMS records verify that the OWS is calibrated to schedule. |

| | | |
|---|---|---|
| | **(IMP-11: EPS-04)** The residual oil from the OWS is pumped to tanks and disposed of onshore. | The Oil Record Book verifies that waste oil is transferred to shore. |
| Level 1 spills (<10 $m^3$) of oil or oily water overboard are rapidly responded to by the MODU and support vessel contractor. | **(IMP-11: EPS-05)** The MODU or vessel-specific SMPEPs are implemented in the event of an overboard spill of hydrocarbons or chemicals. | Incident report verifies that the SMPEP was implemented. |
| Planned open deck discharges are non-toxic. | **(IMP-11: EPS-06)** Deck cleaning detergents are biodegradable. | Safety Data Sheets (SDS) verify that deck cleaning agents are biodegradable. |
| Hydrocarbon or chemical spills to deck are prevented from being discharged overboard. | **(IMP-11: EPS-07)** Hydrocarbon and chemical storage areas (process areas) are bunded and drain to the bilge tank. | Site inspections (and associated completed checklists) verify that bunding is in place and piping and instrumentation diagrams (P&IDs) verify that they drain to the bilge tank. |
| | **(IMP-11: EPS-08)** Portable bunds and/or drip trays are used to collect spills or leaks from equipment that is not contained within a permanently bunded area (non-process areas). | Site inspections (and associated completed checklists) verify that portable bunds and/or drip trays are used in non-process areas as required. |
| Personnel are competent in spill response and have appropriate resources to respond to a spill. | **(IMP-11: EPS-09)** The MODU and support vessel crews are competent in spill response and have appropriate response resources in order to prevent or minimise hydrocarbon or chemical spills discharging overboard. | Training records verify that MODU and support vessel crews receive spill response training. |
| | **(IMP-11: EPS-10)** Fully stocked SMPEP response kits and scupper plugs or equivalent drainage control measures are readily available and used in the event of a spill to deck to prevent or minimise discharge overboard. | Site inspections (and associated completed checklists) verify that fully stocked spill response kits and scupper plugs (or equivalent) are available on deck in high-risk locations. |
| | | Review of incident reports indicate that the spills of hydrocarbons or chemicals to deck are cleaned up. |
| Impact Consequence (residual) | | |
| Negligible | | |

The consequence of bilge water discharges and deck drainage is assessed as negligible because the:

- Activity is of a temporary nature;
- Support vessels will be constantly moving;
- Discharges will be low volume and intermittent;
- High energy offshore waters of the JBG will aid in dilution of discharges; and
- EMBA does not contain sensitive habitats.

| Demonstration of ALARP |
|---|
| A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence. |

| Demonstration of Acceptability | | |
|---|---|---|
| Policy compliance | EOG's Safety and Environmental Policy objectives are met. | |
| EMS compliance | Chapter 10 describes the EP implementation strategy to be employed for this activity. | |
| Risk matrix standard compliance | The residual impact consequence is negligible, which is considered acceptable. | |
| External context | There have been no objections or claims raised by relevant persons regarding bilge water discharges and deck drainage for this activity. | |
| Legislative context | The EPS align with the requirements of:<br>• *Navigation Act* 2012 (Cth):<br>  ○ Chapter 4 (Prevention of Pollution).<br>  ○ AMSA Marine Order 91 (Marine Pollution Prevention - oil).<br>• *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 (Cth):<br>  ○ Part II (Prevention of pollution by oil).<br>  ○ Part III (Prevention of pollution by noxious substances). | |
| Industry practice | The consideration and alignment of EPS with the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity. | |
| | Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020) | The EPS developed for this hazard are in line with the management measures listed for offshore discharges (deck drainage and bilge water) in Section 4.5.2 of the guidelines:<br>• MODU and vessels must have an IOPP Certificate (for vessels >400 gross tonnes) and equipped with MARPOL/IMO-compliant oil/water treatment system (as appropriate to vessel class) **(IMP-11: EPS-01)**.<br>• Hydrocarbon and chemical storage areas are to be bunded with no residues/spills permitted to enter the overboard drainage system unless it first goes through a closed drainage treatment system **(IMP-11: EPS-07, -08)**. |

| | | |
|---|---|---|
| | | • MODU and vessels to maintain an Oil Record Book (applicable to vessels >400 gross tonnes), including the discharge of dirty ballast or cleaning water **(IMP-11: EPS-04)**.<br>• Discharge into the sea of oil or oily mixtures is prohibited except when the OIW of the discharge without dilution does not exceed 15 ppm **(IMP-11:EPS-01, -03)**.<br>• Contaminated deck drainage and bilge water to be contained and treated prior to discharge. If treatment is not possible, these waters should be contained and shipped to shore for disposal.<br>• Extracted hydrocarbons from OWS to be stored in suitable containers and transported to shore for treatment and/or disposal by a certified waste oil disposal contractor **(IMP-11: EPS-04)**. |
| | Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019) | The EPS listed in this table meet these guidelines for offshore activities with regard to:<br>• Management of drain water (item 24). The BAT are met for MODU and vessel operations with regard to ensuring deck coaming is in place, maintaining a chemical inventory, implementing an inspection, maintenance and repair schedule and ensuring that personnel are trained in the use of spill kits **(IMP-11: EPS-09)**. |
| | Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015) | While Section 3.2.3.2 (ballast and bilge systems for jack-ups) of the guideline states that bilges be kept clean, there is no specific guidance regarding discharges.<br>Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement. |
| | Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015) | Guidelines met with regard to:<br>• Other waste waters (item 44). Bilge waters from machinery spaces in the MODU and vessels should be routed to the closed drain system or contained and treated before discharge to meet MARPOL requirements **(IMP-11: EPS-01)**. Deck drainage water should be routed to separate drainage systems. This includes drainage water from process and non-process areas. All process areas should be bunded to ensure that drainage water flows into the closed drainage system **(IMP-11: EPS-07)**. |
| | AEP CoEP (APPEA 2008) | The EPS for this activity meet the code's following objectives for offshore drilling operations: |

| | | |
|---|---|---|
| | | • To reduce the risk of release of substances into the marine environment to ALARP and to an acceptable level. |
| Environmental context | MNES | |
| | AMPs | This hazard will not impact the conservation values of nearby AMPs. |
| | Ramsar wetlands | This hazard will not intersect any Ramsar wetlands. |
| | TECs | This hazard will not intersect any TECs. |
| | Nationally threatened and migratory species | This hazard will not have any significant impacts on threated or migratory species. |
| | Other matters | |
| | KEFs | This hazard will not intersect any KEFs. |
| | NIW | This hazard will not intersect any NIWs. |
| | State marine parks | This hazard will not intersect any state marine parks. |
| | Species Conservation Advice/<br>Recovery Plans/<br>Threat Abatement Plans | None triggered by this hazard. |
| ESD principles | The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant). | |
| Statement of Acceptability | EOG considers the impact from bilge water discharges and deck drainage to be acceptable because:<br>• It will adhere to the company's Safety and Environmental Policy;<br>• The residual consequence rating is negligible;<br>• An Implementation Strategy (described in Chapter 10) is in place to ensure the EPS are achieved.<br>• Relevant legislation and industry best practice will be complied with;<br>• Bilge water discharges and deck drainage will not have long-term or significant impacts on MNES;<br>• The management of bilge water discharges and deck drainage is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species;<br>• The management of bilge water discharges and deck drainage is not inconsistent with the aims of relevant marine reserve management plans; and<br>• The management of bilge water discharges and deck drainage is not inconsistent with ESD principles. | |
| Environmental Monitoring | | |
| • None required | | |
| Record Keeping | | |
| • PMS records.<br>• IOPP certificate. | • P&IDs.<br>• SDS (for deck cleaning agents). | |

- Oil Record Book.
- Crew training records.
- Inspection and checklist records.
- Incident reports.
- SMPEP.