8 ENVIRONMENTAL RISK ASSESSMENT – UNPLANNED EVENTS

8.1 Summary of risk ranking from unplanned events

This section of the EP presents the results of the risk assessment for unplanned (accidental) events that could occur during the Eureka 3D MSS. As required by Section 21 of the OPGGS (E) Regulations, this assessment demonstrates that with appropriate treatment the risks associated with the activity will be reduced to ALARP and will be of an acceptable level. A summary of the risks and acceptability for the Eureka 3D MSS is presented in Table 8-1.

Table 8-1: Summary of risk ranking for potential risks during the Eureka 3D MSS

Potential risks	Residual risk ranking
Risks (not expected to occur during routine operations)	
Physical interaction – vessel collision with marine fauna or entrapment by equipment	Low
Introduction and establishment of invasive marine species	Low
Seabed disturbance – loss of solid objects and unplanned anchoring	Low
Accidental release – hazardous and non-hazardous materials	Low
Accidental oil spill - vessel collision/grounding	Low - Moderate
Oil spill response	Low

8.2 Risk 1: Physical interaction – vessel collision with marine fauna or entrapment by equipment

In accordance with the Pilot Energy risk assessment methodology (Section 6) this risk is classified as lower order.

8.2.1 Identification of hazard and extent

Hazard	The survey and supply/chase vessels working within the OA may present a potential physical hazard (risk of collision) to large marine fauna such as cetaceans, pinnipeds, marine turtles and sharks that may be transiting through the area at or close to near the sea surface. Vessel movements can result in collisions between the vessel (hull and propellers) and marine fauna, potentially resulting in superficial injury, serious injury that may affect life functions (e.g., movement and reproduction) and mortality. The factors that contribute to the frequency and severity of impacts due to collisions vary greatly due to vessel type, vessel operation (specific activity, speed), physical environment (e.g., water depth) and the type of animal potentially present and their behaviours. The survey vessel will be transiting at low speeds (4 to 5 knots) during seismic acquisition. Th support/chase vessels generally travel at higher speeds. The physical presence of header and tail buoys on the streamers may present a potential risk of entrapment for marine fauna, particularly turtles and pinnipeds.
Extent	OA
Duration	Duration of survey – up to 40 days in early February to the end of March

8.2.2 Defined acceptable level

For lower-order impacts and risks, Pilot Energy defines the acceptable level as the point at which the residual impact or risk has been reduced to as low as reasonably practicable (ALARP). This means that all relevant control measures have been identified and implemented to the extent that no additional practicable measures are available without costs being grossly disproportionate to the environmental benefit gained. In this context, the acceptable level is inherently linked to the ALARP outcome, recognising that residual impacts and risks for this lower order risk are tolerable, consistent with legislative requirements, and aligned with relevant environmental and stakeholder expectations.

8.2.3 Risk analysis and evaluation

This section describes the impacts that may occur on marine environmental receptors identified in Section 4 that may be at risk of collision with vessels or entrapment by equipment in the towed array (header and tail buoys). This part of the risk and impact assessment method is described in Section 6.4. Each of the subsequent sections then undertake the risk and impact analysis as defined in Section 6.4.2.

Potential risks	Vessel collisions are a cause of mortality of marine fauna and large cetaceans. Fauna at highest risk of collision is those that spend a high percentage of time in surface waters, are slow moving and/or large. The risks associated with vessel/equipment interactions with marine fauna are as follows and can range from minimal (e.g., behavioural changes) to severe (i.e., serious injury or mortality): Vessel collision with marine fauna such as cetaceans, pinnipeds and marine turtles Entrapment of turtles and pinnipeds by equipment in the towed array (header and tail buoys). The fauna that could occur in the OA during the timing of the Eureka 3D MSS include baleen and toothed whales (particularly during periods of migration), the ASL, white shark and transiting marine turtles. These faunae are mobile and would be expected to actively avoid the survey vessels where possible.

Predicted effects	The survey vessel will maintain a cruising speed of 4.5 knots (8 km/h) during data acquisition and turning. Vessel speed has been identified as a contributing factor in the occurrence and severity of vessel collisions with various marine fauna (Laist & Shaw 2006; Hazel et al. 2007) and for large whale species (Laist et al. 2001; Jensen & Silber 2003; Pace & Silber 2005; Vanderlaan & Taggart 2007). Damage and risk of injury is greatly increased at higher speeds and is a higher risk for vessels travelling at 14 knots (25 km/h) or faster because the fauna have less time to take evasive action (Laist et al. 2001). However, an actively acquiring seismic vessel will acoustically announce its approach from distance and fauna are more likely to be aware and able to evade the slow-moving vessel. Vulnerability of cetaceans to vessel collision will vary according to behaviour (e.g., surfacing habits, direction of travel in relation to shipping routes); morphology; the function of preferred habitat (e.g., breeding, feeding) in areas of vessel activity; and aspects of shipping such as vessel type, speed, density and location. Slow moving species that occur frequently at the surface in areas that overlap with shipping activity are the most vulnerable (Clapham et al. 1999). The likelihood of vessel/cetacean collision being lethal is influenced by vessel speed: the greater the speed at impact, the greater the risk of mortality (Laist et al. 2001; Jensen & Silber 2003). Vanderlaan & Taggart (2007) found that the chance of lethal injury to a large whale because of a vessel strike increases from less than 10% at 4.5 knots, to about 20% at 8.6 knots and 80% at 15 knots. During seismic data acquisition, the survey vessel will be moving at a speed of approximately 4.5 knots, so the risk of lethal injury is lower than for most of the freighters transiting the area. Vessel-whale collisions at this speed are uncommon and, based on reported data contained in the US National Ocean and Atmospheric Administration database (Jensen & Silber 2003) there are only two known instances of collisions when the vessel was travelling at less than six knots, both were from whale watching vessels that were deliberately placed amongst whales. There is no published literature on marine turtle entanglement with seismic equipment during seismic surveys; however, Nelms et al. (2016) state that they received anecdotal reports of turtle entrapments in tail buoys and airgun strings during several offshore seismic surveys off the west coast of Africa. Additionally, there is a report of a marine turtle becoming entangled in a discarded seismic cable (Duncan et al. 2018). Humpback, pygmy blue, southern right, Bryde's, fin and sei whales, as well as toothed whales (sperm and killer whales), may be encountered in the OA, with the humpback and pygmy blue whale migration BIA overlapping the OA, while the southern right whale migration and pygmy blue whale foraging BIAs are immediately adjacent to the OA. It is also possible that other species of whale and dolphin could be encountered while traversing the OA. The timing of the survey (early February to end of March) is prior to the period of known presence of migratory whales in the OA (as acquisition will not overlap the migration periods for pygmy blue, southern right and humpback whales), and therefore the presence of whales during this time is expected to be limited to occasional, transient individuals. The closest ASL haul-out site and breeding colony is located ~9 km south of the OA at the Beagle Islands. However, the OA overlaps with foraging BIAs for both male and female sea lions, and so it is possible that vessels may encounter individuals. The OA is also overlapped by a white shark foraging BIA, but white sharks do not tend to spend significant periods of time swimming at or close to the sea surface at slow speeds (behaviours typically exhibited by whale sharks when foraging). There are no BIAs or Habitat Critical for marine turtle species in the OA, and just three anecdotal sightings of marine turtles documented in the ALA database in the region of the Eureka 3D MSS: two records of leatherback turtles and one record of a loggerhead turtle (all deceased). Therefore, it is highly unlikely that marine turtles would be encountered by the survey and supply/chase vessels in the OA. In summary, these faunae are mobile and would be expected to actively avoid the survey vessels, especially during data acquisition. Few encounters with large marine fauna are expected and the survey and associated vessels will acquire data at a speed of typically 4.5 knots. However, in the event of a collision it is possible that injury or death of an individual of a protected species could occur.; No effects at an ecosystem function level or population level are predicted. Entrapment with header or tail buoys could result in injury or mortality of turtles or pinnipeds; however, no effects at a population level are predicted to occur.		
Inherent risk	Consequence	Likelihood	Risk ranking

	Moderate – collision Moderate – entrapment	Unlikely – collision Unlikely– entrapment	Moderate – collision Moderate – entrapment

8.2.4 Risk treatment

Taking the above evaluations, treatments for each of the impacts deemed to be Moderate or higher are identified in the following as described in Section 0 as part of the risk and impact assessment method.

8.2.4.1 Demonstration of ALARP

The risks from vessel collision / equipment entrapment with marine fauna are relatively well understood, regarding the potential for injury and/or mortality from high-speed collisions. In general, the application of recognised good practice is considered appropriate to manage the risks. In addition, this assessment considers the risk to the location specific environmental values and sensitivities (e.g., likely encounters with large, slow moving marine fauna). To augment decision making further, a precautionary approach is applied where uncertainty continues to exist.

Pilot is committed to ensuring continual risk reduction and identifying if additional control measures may be applied that are not disproportionate to the sacrifice (e.g., cost) of implementation. Where the cost of implementing the additional control measures is disproportionate to the benefit gained, they have not been adopted. Pilot has applied a precautionary approach in managing potential encounters with cetaceans, pinnipeds and turtles with the application of additional control measures. These are also referred to below.

Pilot considers the adopted controls to be appropriate in reducing the environmental risks associated with collision / equipment entrapment with marine fauna to ALARP. There are no other controls measures that may practicably or feasibly be adopted to further reduce the risks of impacts without disproportionate costs (Table 8-2).

Table 8-2: Cost benefit analysis and residual risk evaluation – vessel collision with marine fauna or entrapment by equipment

Control measures	Cost benefit analysis	Risk reduction	Control adopted
ALARP assessment technique – good practice, legislative requirements			
The interaction of support/chase vessels and the survey vessel with cetaceans, pinnipeds and turtles during the survey will be managed consistently with the Part 8 of the EPBC Regulations (2000): • Project vessels will not travel at greater than 6 knots within 300 m of a cetacean, pinniped or turtle (caution zone) • Project vessels will not approach closer than 50 m for a dolphin, pinniped or turtle, and/or 100 m for a whale (except for animals bow riding) • If the cetacean, pinniped or turtle shows signs of being disturbed, project vessels will immediately withdraw from the caution zone at a constant speed of less than six knots.	Benefits outweigh costs; Legislative requirement.	Yes	Yes
MFO to maintain watch for marine fauna during the day when the seismic source is active, with observed fauna to be avoided if possible.	Benefits outweigh costs.	Yes	Yes
Use of streamer header and tail buoys fitted with appropriate turtle guards or use of buoys that are of a design that does not represent an entrapment risk to turtles and pinnipeds.	Benefit outweighs cost (increased downtime)	Yes	Yes
Slow speed of survey vessel during seismic acquisition (4.5 knots) will reduce collision risk	Benefits outweigh costs.	Yes	Yes
All vessel crew are inducted in their responsibilities as required regarding marine fauna interactions.	Benefits outweigh costs.	Yes	Yes
All vessels strike incidents are reported, within seven days, to the Secretary of DCCEW via EPBC.Permits@dcceew.gov.au or 1800 920 528	Benefits outweigh costs; aligns with relevant actions for cetacean recovery plans.	Yes	Yes
ALARP assessment technique – EIA			

Control measures	Cost benefit analysis			Risk reduction	Control adopted
Two trained marine fauna observers (MFOs) on the survey vessel will watch for cetaceans, pinnipeds and turtles during daylight hours; throughout the duration of the survey.	Benefit outweighs costs.			Yes	Yes
Two trained MFOs on the support vessel during acquisition within the western section of the ASA	Benefit outweighs cost			Yes	Yes
Use of trained MFOs aboard the support/chase vessels in the eastern section of the ASA.	Given support/chase vessel bridge crews already maintain a constant watch during operations, additional MFOs would not significantly further reduce the risk. Sightings of threatened marine megafauna are unlikely at this time of year in this area of the OA. Costs disproportionately higher than benefits.			Limited	No
Reduce number of vessels in the OA by not using support/chase vessels	Reducing vessels numbers used increases safety risk and reduces ability to manage interactions with other marine users, potential risks are higher than the benefits gained by implementing this control measure.			No	No
No night-time operations	Limiting seismic activities to daylight hours only would significantly extend the time required to acquire data for individual activities. This would at least double the survey time and, therefore, increase the likelihood of interactions with diurnal fauna, the overall duration of seismic impacts, and interaction with commercial fisheries and other marine users and extend the survey into migratory seasons where fauna is more abundant. Costs disproportionately higher than benefits.			Minimal environmental benefit from avoiding night-time operations.	No
Do not acquire the survey	Complete elimination of the risk is not possible as there is no practical alternative to the use of vessels that allows Pilot to undertake the activity. Costs disproportionately higher than benefits.			No	No
Residual risk evaluation					
Residual risk	Consequence	Likelihood	Risk ranking	Decision type	
	Moderate – collision	Very unlikely	Low – collision	A	
	Low – entrapment	Unlikely	Low – entrapment	A	

8.2.4.2 Demonstration of acceptability

The impact assessment has concluded that, with the implemented control measures, the potential for collision or entrapment of marine species represents a low residual risk to marine fauna.

Pilot has thoroughly explored additional opportunities to further mitigate impacts and risks associated with collision and entrapment of marine fauna, as discussed in previous sections. The adopted control measures are in line with good industry practice and fully comply with relevant legislative requirements and recovery plans. Furthermore, these measures align with the principles of ESD.

No specific concerns regarding the potential for collision or entrapment of marine fauna have been raised by relevant stakeholders. Given these factors, Pilot believes the adopted control measures are appropriate and sufficient to manage the impacts and risks from seabed disturbance caused by potential loss of equipment and unplanned anchoring to a level that is broadly acceptable.

8.2.4.3 Environmental performance outcomes, standards and measurement criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for collision with marine fauna and entrapment by equipment are presented below in Table 8-3 in Section 7.3.4.1.

Table 8-3: Environmental performance outcomes, standards and measurement criteria – vessel collision with marine fauna or entrapment by equipment

Environmental performance outcomes	Environmental performance standards	Measurement criteria
EPO 16 No injury or mortality of cetaceans, pinnipeds or turtles due to a vessel collision or entrapment by equipment	PS 15 The interaction of support/chase vessels and the survey vessel with cetaceans, pinnipeds and turtles during the survey will be managed consistently with the Part 8 of the EPBC Regulations (2000): Project vessels will not travel at greater than 6 knots within 300 m of a cetacean, pinniped or turtle (caution zone) Project vessels will not approach closer than 50 m for a dolphin, pinniped or turtle, and/or 100 m for a whale (except for animals bow riding) If the cetacean, pinniped or turtle shows signs of being disturbed, project vessels will immediately withdraw from the caution zone at a constant speed of less than six knots.	MC 86 MFOs reports document appropriate responses to cetacean, pinniped and turtle interactions. MC 18 MFO report demonstrates no breaches of EPBC Regulations 2000 Part 8. MC 87 Records indicate crew inductions include requirements for implementing the guidelines
	PS 105 Two trained marine fauna observers (MFOs) on the survey vessel will watch for cetaceans, pinnipeds and turtles during daylight hours, throughout the duration of the survey. Two MFO's on the support vessel will watch for cetaceans, pinnipeds and turtles during acquisition within the western section of the ASA.	MC 4 MFO data sheets/report demonstrates watch maintained during daylight acquisition MC 5 CVs for MFOs demonstrates competency and experience
	PS 68 Use of streamer header and tail buoys fitted with appropriate turtle guards, or use of buoys that are of a design that does not represent an entrapment risk to turtles and pinnipeds.	MC 88 Records show that turtle guards are fitted to header and tail buoys, or that buoys used are of a design that does not represent an entrapment risk to turtles and pinnipeds.
	PS 69 Survey vessel will not travel at greater than 4.5 knots during seismic acquisition.	MC 89 Vessel log confirms vessels speed did not exceed 5 knots during acquisition.
	PS 70 Survey and support/chase vessels crews are inducted in their responsibilities as required regarding marine fauna interactions.	MC 90 Records show that the survey and support/chase vessel crew inductions include responsibilities regarding marine fauna interactions
	PS 71 All vessel strike incidents are reported, within 7 days, to the Secretary of DCCEW via EPBC.Permits@dcceew.gov.au or 1800 920 528	MC 91 MFO report confirms that all vessel strike incidents are reported in the National Ship Strike Database.

8.3 Risk 2: Introduction and establishment of invasive marine species

In accordance with the Pilot Energy risk assessment methodology (Section 6) this risk is classified as lower order.

8.3.1 Identification of hazard and extent

Hazard	The Convention on Biological Diversity (1992) defines a non-native species as "a species introduced outside its natural past or present distribution; includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce". Non-native species are known from all parts of the world and have been transported by several different anthropogenic means (Carlton & Geller 1993). Australia has over 250 invasive marine species (IMS) and although most do not cause a problem, some may become aggressive pests with detrimental effects on biodiversity and ecology (www.marinepests.gov.au). The following activities have the potential to lead to the introduction and transfer of IMS during a marine seismic survey: Discharge of ballast water from the survey and support vessels Biofouling on vessel hulls and other external niches (e.g., propulsion units, steering gear and thruster tunnels) Biofouling of vessel internal niches (e.g., sea chests, strainers, seawater pipe work, anchor cable lockers and bilge spaces) Marine biofouling of in-water (submersible) equipment (e.g., streamers, tail buoys, OBNs). The potential biofouling risk posed by a vessel relates to its history prior to entering the OA. The main risk factors for marine biofouling are: Time spent in foreign ports, especially those with known IMS infestations Transit from similar bioregion Suitability of OA benthic habitats for IMS establishment Time since hull cleaning Condition and age of anti-fouling Type of ballast water. In-water equipment required for the activity (e.g., airgun array, streamers, header/tail buoys, paravanes, nodes) is transported to and used within the OA. There is the potential that this equipment may be used for other activities prior to being used on this activity. Therefore, there is potential for transfer and establishment of IMS.
Extent	OA
Duration	Duration of survey – up to 40 days in early February to the end of March

8.3.2 Defined acceptable level

For lower-order impacts and risks, Pilot Energy defines the acceptable level as the point at which the residual impact or risk has been reduced to as low as reasonably practicable (ALARP). This means that all relevant control measures have been identified and implemented to the extent that no additional practicable measures are available without costs being grossly disproportionate to the environmental benefit gained. In this context, the acceptable level is inherently linked to the ALARP outcome, recognising that residual impacts and risks for this lower order risk are tolerable, consistent with legislative requirements, and aligned with relevant environmental and stakeholder expectations.

8.3.3 Risk analysis and evaluation

Potential risks	Introduction and establishment of IMS through biofouling or ballast water discharge has the potential to result in effects to seabed habitat and marine ecosystems due to: Competition with native species for resources, reducing native species diversity and abundance Predation on local species.		
Predicted effects	Ballast water exchanges have been implicated in the introduction of marine pest species (DAWR 2017) with impacts including significant eradication and potential cost impacts to commercial fishing. Most introduced marine species in WA occur in temperate waters from Geraldton south, encompassing the OA (Wells et al. 2010). The greatest concentrations of IMS are found in areas with large numbers of vessel movements, vessels are stationary for an extended period and a diverse marine environment e.g., Cockburn Sound and the lower Swan River, and Fremantle in Perth, and Albany, Bunbury and Esperance south of Perth (Wells et al. 2010). These conditions will not be found in the OA during the timeframe of the activity. Seven introduced species, none of which are pest species, that may be found in the vicinity of the OA include four species of bryozoans, the acorn barnacle, a colonial ascidian and a solitary ascidian (Wells et al. 2010). In the unlikely event that a species is introduced, and it survives in the new environment, it has the potential to colonise a new region and establish a new population. Over time the population may increase, and the species become established in the area. This can cause a range of ecological effects, including increased competition with native species. However, the probability of successful establishment of IMS is dependent on several factors including survival of the propagules during their transfer to the area, the suitability of the environmental conditions at the recipient site (water temperature, salinity, depth, habitat types, competitors, and predators), the survival of the propagules to reproductive state and the continued success of the introduced population. If established, IMS can compete with native species, modify habitats and can threaten endemic diversity and abundance. The shallow water depths of the OA may be conducive to IMS survival; however, establishment of IMS is most likely to occur in areas where large numbers of vessels are present and are stationary for an extended period. During the survey, vessels will be continuously moving, albeit at slow speeds.		
Inherent risk	Consequence	Likelihood	Risk ranking
	Moderate	Unlikely	Moderate

8.3.4 Risk treatment

8.3.4.1 Demonstration of ALARP

The risks and potential effects of the introduction and establishment of IMS during seismic surveys are well understood with legislative requirements and industry agreed good practices to manage risks. The application of recognised good practice is generally considered appropriate to manage the risk.

The Commonwealth Department of Agriculture, Fisheries and Forestry (DAFF) is the lead agency for management of ballast water and sediments on international vessels and administers the mandatory Australian Ballast Water Management Requirements (DAWE 2020) under the *Biosecurity Act 2015*. For the petroleum industry, it regulates the condition of vessels and drill rigs entering Australian waters regarding ballast water and hull fouling. The regulations stipulate that all information regarding the voyage of the vessel and the ballast water is declared correctly to the biosecurity officers.

Under these arrangements, all vessels that have travelled from international waters are obliged to assess and manage their ballast water in accordance with the DAFF requirements. These arrangements prohibit the discharge of high-risk ballast water within Australian territorial seas (within 12 nm of Australian territories) including Australian ports. It is also recommended by DAFF that ballast exchanges be conducted as far as possible away from shore and in water at least 200 m deep.

Pilot is committed to ensuring continual risk reduction and identifying if additional control measures may be applied that are not disproportionate to the sacrifice (e.g., cost) of implementation. Where the cost of implementing the additional control measures is disproportionate to the benefit gained, they have not been adopted. Pilot will undertake a biofouling risk assessment of the project vessels and equipment to determine whether the vessels should be either cleaned (hull, niches, workboats and in-water equipment) or can be cleared as a low risk of introducing marine pest species. The risk assessment will follow the recommended approach of the Australian Biofouling Management Requirements (version 2, 2023). The risk assessment will be conducted prior to vessel entry into Australian waters, or mobilisation to the OA if the vessel is sourced from within Australian waters. If the risk assessment indicates an unacceptable risk of introducing marine species, Pilot will require an inspection and clearance to be conducted.

In-water (submersible) equipment (e.g., airgun array, streamers, header/tail buoys, paravanes, nodes) will be cleaned and maintained regularly and will undergo routine inspection prior to, and during, the activity. Submersible equipment that has been dry for more than three days will be considered low risk as attached organisms will die through desiccation and exposure. Any biofouling observed during the survey that could be considered a potential IMS will be reported to the DAFF and treated in accordance with DAFF instructions (e.g., killed with a biocide).

Pilot considers the adopted controls to be appropriate in reducing the environmental risks associated with introduction and establishment of IMS to ALARP. There are no other controls measures that may practicably or feasibly be adopted to further reduce the risks of impacts without disproportionate costs compared to the benefit of the potential risk reduction (Table 8-4).

Table 8-4: Cost benefit analysis and residual risk evaluation – introduction and establishment of IMS

Control measures	Cost benefit analysis	Risk reduction	Control adopted
ALARP assessment technique –legislative requirement, good practice			
No planned ballast water exchanges, but if required, ballast water exchange will occur >12 nm from land No discharge of ballast water from survey and support vessels within 12 nm of land without prior authorisation from the DAFF. Ballast water discharges recorded as >12 nm from land in Ballast Water Management Summary Sheet. Adherence to Australian Ballast Water Management Requirements (DAWE 2020).	Benefits outweigh costs, legal requirement	Yes	Yes
Adherence with the Australian Biofouling Management Requirements Biofouling risk assessment shows low risk of IMS presence prior to entry to the Operational Area. 'Low risk' result is achieved when the following criteria are met: • Vessel Biofouling Management Plan is implemented and is consistent with IMO Guidelines • Biofouling record book is kept and must demonstrate implementation of the vessels Biofouling Management Plan • If the Biofouling record book does not demonstrate implementation of the vessels Biofouling Management Plan, relevant information such as recent inspection, dry dock / clean, operational history, and functional MGPS, should be sought to inform/manage marine pest risk. • If this information is not available, an inspection should be undertaken by suitably experienced marine pest inspector and / or appropriately manage biofouling risk. Survey vessel has a certified anti-fouling coating on the hull and coating is in sound condition. The risk assessment procedure will comply with Biosecurity Regulation 2016 48(2)(o).	Benefits outweigh costs; legal requirement	Yes	Yes
Routine cleaning and inspection of all submersible equipment (e.g., airgun array, streamers, header/tail buoys, paravanes, nodes), consistent with the requirements of the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (MPSC 2018).	Benefits outweigh costs.	Yes	Yes
ALARP assessment technique – EIA			

Control measures	Cost benefit analysis	Risk reduction	Control adopted
Use of freshwater ballast on-board the survey vessel to inhibit survival of marine species.	Costs associated with this measure are high, and disproportionate to the benefit.	No	No
Do not discharge ballast water during the survey.	Ballast water discharges are critical for maintain vessel stability. Given the nature of the survey, the use of ballast (including the potential discharge of ballast water) is a safety-critical requirement.	Control not feasible Not assessed	No
Eliminate use of vessels including the survey vessel and support vessels.	Given that vessels must be used to complete the survey, there is no feasible means to eliminate the source of risk.	Control not feasible Not assessed	No
Source project vessels based in Australia only.	Limiting activities to only use local project vessels could potentially pose a significant risk in terms of the time and duration of sourcing a vessel, as well as the ability of the local vessel to perform the tasks. While the project will attempt to source support vessels locally, it is not always possible. Availability cannot always be guaranteed. There is limited project vessels based in Australian waters and sourcing Australian-based vessels only will cause increases in cost due to pressures of vessel availability. Sourcing vessels from within Australia will reduce the likelihood of IMS introduction from outside Australian waters; however, it does not reduce the likelihood of introducing species native to Australia but alien to the Operational Area. It also does not prevent the translocation of IMS that have established elsewhere in Australia. Therefore, the consequence is unchanged.	No	No

Residual risk evaluation				
Residual risk	Consequence	Likelihood	Risk ranking	Decision type
	Moderate	Unlikely	Moderate	A

8.3.4.2 Demonstration of acceptability

The impact assessment has concluded that, with the implemented control measures, the introduction of IMS to the OA through ballast water or biofouling on vessels or in-water equipment represents a risk that is unlikely to result in a potential impact greater than moderate to species in the benthic community.

The adopted control measures are in line with good industry practice and fully comply with relevant biosecurity legislative requirements. Furthermore, these measures align with the principles of ESD.

Pilot has implemented all practicable control measures to mitigate the risks associated with IMS introduction. These measures encompass comprehensive management of both ballast water and biofouling, in accordance with current best practices and regulatory standards.

No specific concerns regarding the potential introduction of IMS have been raised by relevant stakeholders.

Given these factors, Pilot believes the adopted control measures are appropriate and sufficient to manage the risks of IMS introduction to a level that is acceptable.

8.3.4.3 Environmental performance outcomes, standards and measurement criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for introduction and establishment of IMS are presented below in Table 8-5. Environmental performance standards and relevant measurement criteria have been developed for each control measure adopted in Section 7.3.4.1.

Table 8-5: Environmental performance outcomes, standards and measurement criteria – introduction and establishment of IMS

Environmental performance outcomes	Environmental performance standards	Measurement criteria
EPO 17 No introduction and/or establishment of IMS into the OA and adjacent waters	PS 72 No planned ballast water exchanges to take place during the activity, but if required, ballast water exchange will occur >12 nm from land (except for an exchange to maintain the stability of the vessel in an emergency) No discharge of ballast water from survey and support vessels within 12 nm of land without prior authorisation from the DAFF. Ballast water discharges recorded as >12 nm from land in Ballast Water Management Summary Sheet. Ballast water will be managed in full compliance with Australian Ballast Water Management Requirements – no high-risk ballast water discharge will occur in Australian waters. If any ballast exchange is necessary, it will only be conducted in mid-ocean, >12 nm from land and in water >200 m deep, per the Biosecurity Act standards.	MC 92 Ballast water exchange records show No recorded occurrence of a ballast water exchange during the survey (except for an exchange to maintain the stability of the vessel in an emergency) without prior authorisation from the DAFF. Ballast water discharges recorded as >12 nm from land in Ballast Water Management Summary Sheet Adherence to Australian Ballast Water Management Requirements (DAWE 2020): Maritime Arrivals Reporting Systems (MARS) is available and approved by the Director of Biosecurity Approved ballast water management options are in place.
	PS 73 Survey and supply vessels comply with the Australian Biofouling Management Guidelines Biofouling Record Book kept A vessel specific Biofouling management plan outlining marine fouling management actions Biofouling risk assessment shows low risk of IMS presence prior to entry if outside Australian waters Recent hull inspections (if required based on biofouling risk assessment) Each project vessel will undergo a biofouling risk assessment consistent with Biosecurity Regulation 2016, Reg 48(2), prior to commencing the activity. Any vessel that does not meet the 'low risk' criteria (clean hull, recent anti-fouling, etc.) will be cleaned or treated as required before entry to the Operational Area. The following key factors will be considered in the determination of whether the project vessels present the 'low risk' criteria for the introduction of IMS: • Timing of marine pest risk assessment relative to vessel selection and movement to the offshore activity area to ensure there is sufficient time to implement necessary control measures in cases where management is warranted to reduce the risk.	MC 93 Prior to survey sight operational history since last dry-docking, cleaning, anti-fouling renewal. Biofouling risk assessment report confirming survey vessel poses low risk of introducing IMS. Biofouling risk assessment report confirming risk assessment completion date as being ≥30 days before vessel mobilisation into the Operational Area. Prior to survey a copy of the International Anti-fouling System Certificate is sighted and is in date.

Environmental performance outcomes	Environmental performance standards	Measurement criteria
	• History of the vessel, including time spent in ports of call since last dry dock, cleaning regime or marine pest inspection results. • Time between a biofouling inspection and mobilisation to an offshore activity to inform exposure risk following the last inspection and justify the relevance of biofouling inspection findings. • Presence of an appropriate biofouling management plan and effective implementation of the plan (e.g. demonstrated implementation of external and internal marine growth prevention systems, an understanding of the effectiveness of antifouling coatings and functionality of internal treatment systems). • Level of existing biofouling and the presence of species of concern (in particular the presence of marine pests) within biofouling communities on the vessel associated with the activity (often informed by biofouling record books, maintenance records, cleaning results or inspection programs). • Operational profile relevant to biosecurity risk such as operating speed, time alongside a facility and the need for ballast exchanges while engaged in an offshore activity. • Receiving environment including temperature, salinity and the presence of shallow water sensitivities within proximity to the offshore activity. • Qualifications and competency of personnel undertaking biofouling inspections associated risk assessments and making management decisions. The IMS risk assessment process must be applied to determine residual risk of introducing or spreading marine pests at least 30 days before the start of the activity. Survey and support vessels have a certified anti-fouling coating on the hull and coating is in sound condition. Anti-fouling system certification is in place in accordance with Marine Order 98 –anti-fouling systems.	
	PS 74 Routine cleaning and inspection of submersible equipment (airgun array, streamers, header/tail buoys, paravanes, nodes), consistent with the requirements of the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (MPSC 2018).	MC 94 Evidence / records confirm submersible equipment inspected and found free of biofouling prior to commencing the activity. If biofouling is observed on equipment, it is cleaning and a record of the type of cleaning is kept.

8.4 Risk 3: Seabed disturbance – accidental loss of solid objects and unplanned anchoring

In accordance with the Pilot Energy risk assessment methodology (Section 6) this risk is classified as lower order.

8.4.1 Identification of hazard and extent

Hazard	During normal operations, the survey vessel will tow an underwater seismic source and a series of streamers (minimum of six) with a maximum length of ~7 km, at approximately 4.5 knots (8 km/h). The seismic source will be towed at a depth of 6 m beneath the sea surface, and streamers will be towed at a depth of ~7 m below the sea surface. Should a seismic streamer become detached from the survey vessel or drag on the seabed it has the potential to cause minor physical damage to benthic habitats. However, the streamers are fitted with streamer recovery devices (SRDs) (i.e., pressure-activated, self-inflating buoys) that are designed to bring the equipment to the surface if lost accidentally. As the equipment sinks, it passes a certain water depth at which point the buoys inflate and bring the equipment back to the surface. Once at the surface the survey or support vessel will recover the streamer where practicable and safe to do so. Shallower survey areas in the nodal area will be acquired using OBN technology. Planned impacts to benthic habitats from deployment of ocean bottom nodes are described in Section 7.7. Non-hazardous solid materials (i.e., dropped objects) may be released by accidentally dropping objects overboard (e.g., tools, streamer depth controllers) due to human error, equipment failure or adverse weather. Under normal operations, no anchoring will be undertaken by the survey and support/chase vessels within the OA. Unplanned anchoring could occur in the event of an emergency to maintain the safety of the vessel and crew. Anchoring may result in localised disturbance to the benthic environment in contact with the anchor and anchor chain or inadvertently anchoring over shipwrecks, pipelines, other oil and gas subsea infrastructure, or set fishing gear (i.e., rock lobster pots, octopus traps). The extent of disturbance will depend on the nature of the seabed and the area disturbed.
Extent	OA
Duration	Duration of survey – up to 40 days in early February to the end of March

8.4.2 Defined acceptable level

For lower-order impacts and risks, Pilot Energy defines the acceptable level as the point at which the residual impact or risk has been reduced to as low as reasonably practicable (ALARP). This means that all relevant control measures have been identified and implemented to the extent that no additional practicable measures are available without costs being grossly disproportionate to the environmental benefit gained. In this context, the acceptable level is inherently linked to the ALARP outcome, recognising that residual impacts and risks for this lower order risk are tolerable, consistent with legislative requirements, and aligned with relevant environmental and stakeholder expectations.

8.4.3 Risk analysis and evaluation

Potential risks	The known and potential environmental impact of seabed disturbance due to accidental loss of solid objects and unplanned anchoring are: Temporary smothering / displacement of a small area of seabed habitat Physical damage to benthic habitats and communities Disturbance/damage to shipwrecks, pipelines, other subsea infrastructure and fishing gear.
Predicted effects	Dragging of streamers along the seabed may occur if a streamer becomes damaged and sinks to the seabed while the vessel is in motion. However, streamers will be towed at a depth of ~7 m and fitted with SRDs that are designed to bring the equipment to the surface if lost, and therefore it is unlikely that this would occur. The geophysical

	contractor's operating procedures usually require a minimum clearance requirement of approximately 10 m between the seabed and the deepest point on the streamer. Water depths of the OA range from approximately 10 m (potentially <10m near reefs at low tide) on the eastern perimeter to approximately 60 m in the south-west corner, with most of the OA between 25 and 50 m deep. Seismic data within the Node Survey Area will be acquired using OBNs, removing the need to use the towed streamer array within the shallower waters of the ASA. The shallow waters of the OA partially overlap with the Commonwealth marine environment within and adjacent to the west coast inshore lagoons KEF and the OA is entirely within the Western rock lobster KEF. The Commonwealth marine environment within and adjacent to the west coast inshore lagoons KEF is a chain of inshore lagoons containing extensive seabeds of macroalgae and seagrass with a unique diversity of marine species. The seagrass habitats provide valuable feeding grounds for protected species such as ASLs and are important nursery areas for many recreational and commercial fish species. There are two known historic shipwrecks that may be located within the OA; the *Leander* (potentially located within the Node Survey Area but exact location is unknown) and the *Era*, located in ~45 m water depth in the north-western part of the ASA (Figure 4-41). Loss of a streamer may result in localised physical disturbance of substrates, benthic habitats and communities. However, given the size of seismic equipment, only a small area of the seabed would be disturbed and the risk of anything more than short-term effects are unlikely. The survey and supply vessels will use thrusters to maintain position and will not need to anchor unless in an emergency. Should the survey vessel lose propulsion power or steering, the likely course of action will be for the seismic vessel to immediately drop anchor, quickly followed by the supply vessel towing it to safety. Should a support/chase vessel lose power or steering, it will be towed to safety by the second support/chase vessel. In the event of emergency anchoring, seabed disturbance will be created at the anchor location and there is likely to be some associated anchor chain drag. In the event of loss of a seismic streamer / unplanned anchoring, potential effects will be limited to physical disturbance of substrates, benthic habitats and communities in a localised area (i.e., immediate footprint of the disturbance), with only short-term effects on communities in the disturbance footprint and no effects on ecosystem function. Additionally, there is the potential for physical disturbance / damage to shipwrecks, pipelines, other subsea infrastructure and fishing gear.		
Inherent risk	Consequence	Likelihood	Risk ranking
	Minor	Possible	Moderate

8.4.4 Risk treatment

8.4.4.1 Demonstration of ALARP

The risks relating to seabed disturbance from accidental loss of solid objects and unplanned anchoring are relatively well understood. In general, the application of recognised good practice is considered appropriate to manage the risks. However, the assessment has also specifically considered the site-specific nature and scale of the risk on sensitive receptors such as the Commonwealth marine environment within and adjacent to the west coast inshore lagoons KEF and Western rock lobster KEF.

Pilot is committed to ensuring continual risk reduction and identifying if additional control measures may be applied that are not disproportionate to the sacrifice (e.g., cost) of implementation. Pilot considers the adopted controls to be appropriate in reducing the environmental risks associated with seabed disturbance from accidental loss of solid objects and unplanned anchoring to ALARP. There are no other controls measures that may practicably or feasibly be adopted to further reduce the risks of impacts without disproportionate costs compared to the benefit of the potential risk reduction (Table 8-6).

Table 8-6: Cost benefit analysis and residual evaluation – seabed disturbance – accidental loss of solid objects and unplanned anchoring

Control measures	Cost benefit analysis	Risk reduction	Control adopted
ALARP assessment technique – legislative requirements, good practice			
Operational procedures will be in place aboard the survey vessel for deployment and retrieval of towed equipment, to reduce potential for steamer loss.	Benefits outweigh costs	Yes	Yes
Vessels will be fitted with sonar and depth sounders to assess depth of water when in the nodal area or areas <12m deep	Industry standard	Yes	Yes
No planned anchoring during the survey unless in the event of an emergency.	Benefits outweigh costs	Yes	Yes
Streamers equipped with streamer recovery devices (SRDs) designed to bring the equipment to the surface if lost accidentally and facilitate recovery. Streamer tail buoys equipped with RGPS units.	Benefits outweigh costs	Yes	Yes
Any lost equipment will be recovered where safe and practicable to do so.	Benefits outweigh costs	Yes	Yes
The approximate locations of the *Leander* and *Era* wreck sites, and the known location of the Cliff Head Development offshore pipeline, will be included on project vessel navigational aids.	Benefits outweigh costs	Yes	Yes
Project vessels will not enter the 500 m radius PSZ around the Cliff Head Development wellhead platform.	Benefits outweigh costs	Yes	Yes
ALARP assessment technique – EIA			
In the event of unplanned anchoring all measures will be taken to avoid any shipwreck sites, pipelines, other subsea infrastructure and fishing gear, without compromising vessel or personnel safety	Benefits outweigh costs	Yes	Yes
Residual risk evaluation			

Residual risk	Consequence	Likelihood	Risk ranking	Decision type
	Minor	Unlikely	Low	A

8.4.4.2 Demonstration of acceptability

The impact assessment has concluded that, with the implemented control measures, the potential loss of seismic equipment to the seabed represents a minor consequence to benthic communities and habitats, with no lasting effects anticipated. These impacts, should they occur, are expected to be limited in both extent and duration.

Pilot has thoroughly explored additional opportunities to further mitigate impacts and risks associated with potential equipment loss and unplanned anchoring, as discussed in previous sections. The adopted control measures are in line with good industry practice and fully comply with relevant legislative requirements. Furthermore, these measures align with the principles of ESD.

No specific concerns regarding the potential loss of seismic equipment or unplanned anchoring have been raised by relevant stakeholders. Given these factors, Pilot believes the adopted control measures are appropriate and sufficient to manage the impacts and risks from seabed disturbance caused by potential loss of equipment and unplanned anchoring to a level that is broadly acceptable.

8.4.4.3 Environmental performance outcomes, standards and measurement criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for seabed disturbance from accidental loss of solid objects and unplanned anchoring

are presented below in Table 8-7. Environmental performance standards and relevant measurement criteria have been developed for each control measure adopted in Section 7.4.4.1.

Table 8-7: Environmental performance outcomes, standards and measurement criteria – seabed disturbance – accidental loss of solid objects and unplanned anchoring

Environmental performance outcomes	Environmental performance standards	Measurement criteria
EPO 18 No disturbance or damage to benthic habitats/communities, shipwrecks, pipelines, other subsea infrastructure and fishing gear due loss of equipment or unplanned anchoring	PS 75 Operational procedures will be in place aboard the survey vessel for deployment and retrieval of towed equipment, to reduce potential for steamer loss.	MC 82 Vessel inspections show evidence of implementing geophysical contractor's procedures for streamer retrieval and recovery.
	PS 107 Compliance of Marine Order 27 (Safety of navigation and radio equipment) 2023	MC 105 Records demonstrate that the survey and support/chase vessels are compliant with Marine Orders 27.
	PS 76 No planned anchoring during the survey unless in the event of an emergency.	MC 95 Vessel logs indicate vessel did not anchor in the OA.
	PS 77 Streamers equipped with streamer recovery devices (SRDs) designed to bring the equipment to the surface if lost accidentally and facilitate recovery. Streamer tail buoys equipped with RGPS units.	MC 96 Records demonstrate that streamers are equipped with SRDs set to auto-inflate at less than actual water depth and in good working order. Records show that streamer tail buoys are equipped with RGPS units.
	PS 78 Lost streamer recovery procedure (including shallow water recovery e.g., by grappling) carried aboard survey vessel.	MC 97 Records of streamer loss and recovery by support/chase vessels.
	PS 67 The approximate locations of the *Leander* and *Era* wreck sites, and the known location of the Cliff Head Development offshore pipeline, will be included on project vessel navigational aids.	MC 85 Vessel logs show areas around shipwrecks and pipelines avoided during unplanned anchoring
	PS 112 Any lost equipment will be recovered where safe and practicable to do so.	MC 98 Records of streamer loss will be documented
		MC 33 Records show equipment lost to the marine environment and attempts to recover lost towed equipment
EPO 19	PS 79	MC 99

Environmental performance outcomes	Environmental performance standards	Measurement criteria
Avoid objects being dropped overboard	The crane 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, PTWs and/or risk assessments verify that the procedure is implemented prior to each transfer.
	PS 80	MC 100
	The crane 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.
	PS 81	MC 101
	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 vessel PMS.	Inspection of PMS records and Lifting Register verifies that inspections and testing have been conducted to schedule.

8.5 Risk 4: Accidental release – hazardous and non-hazardous materials

In accordance with the Pilot Energy risk assessment methodology (Section 6) this risk is classified as lower order.

8.5.1 Identification of hazard and extent

Hazard	As part of normal seismic survey vessel operations, a range of chemicals and oily substances (such as lubricating oils, wastes and hydraulic fluid) will be stored on the deck of the survey and support vessels. Hydraulic fluid is also contained in reservoirs, hoses and lines on hydraulic equipment, such as cranes or winches. There is potential for accidental loss of these fluids through operator error or machinery malfunction. In the event of an accidental on-board spill of oily substances or chemicals (such as a containment leak), there is potential for the spill to be washed overboard and released into the marine environment. Chemicals (e.g., solvents and detergents) will typically be stored in small containers of 5 to 25 L capacity with a secondary containment measure (e.g., bunds) in place to contain leaks or spills. Chemicals are stored in internal areas where any leak or spill would be retained on-board and cleaned up in accordance with the SOPEP and associated spill clean-up procedures. For a spill on deck to result in a release to the marine environment, there would need to be an un-confined spill that flowed overboard. Given that the use of oils or other chemicals on deck would be largely confined to bunded areas, this is highly unlikely to occur and would require the failure of a bund or extreme weather conditions. The realistic worst-case spill volume would be typically 25 L (largest capacity container) should a chemical spill in an unconfined area eventuate in release to the marine environment, or a drum is compromised during handling. The project vessels will generate a variety of solid wastes including packaging and domestic wastes such as aluminium cans, bottles, paper and cardboard. Hence, there is the potential for solid wastes to be lost overboard to the marine environment. Wastes on-board are managed in accordance with the on-board waste management plan. Some wastes may be incinerated. Based on industry experience, waste items lost overboard are typically wind-blown rubbish such as container lids, cardboard etc. Such losses typically have occurred during back loading activities, periods of adverse weather and incorrect waste storage.
Extent	OA
Duration	Duration of survey – up to 40 days in early February to the end of March

8.5.2 Defined acceptable levels

For lower-order impacts and risks, Pilot Energy defines the acceptable level as the point at which the residual impact or risk has been reduced to as low as reasonably practicable (ALARP). This means that all relevant control measures have been identified and implemented to the extent that no additional practicable measures are available without costs being grossly disproportionate to the environmental benefit gained. In this context, the acceptable level is inherently linked to the ALARP outcome, recognising that residual impacts and risks for this lower order risk are tolerable, consistent with legislative requirements, and aligned with relevant environmental and stakeholder expectations.

8.5.3 Risk analysis and evaluation

8.5.3.1 Potential Risks

The known and potential environmental risks from the loss of hazardous and non-hazardous materials (oily wastes and chemicals, solid wastes) include:

- Temporary localised decline in water and sediment quality
- Temporary toxicity to marine fauna
- Providing “rafting” opportunities for marine species (including potential IMS).

The potential impacts of solid wastes accidentally discharged to the marine environment include direct pollution and contamination of the environment and secondary impacts relating to potential contact of marine fauna with wastes, resulting in entanglement or ingestion and leading to injury and death of individual animals. Several Threatened and Migratory species were identified as occurring within the OA, including cetaceans, pinnipeds, turtles and seabirds. However, these species are expected to be transient as there are no known key aggregation areas. However, the temporary or permanent loss of waste materials into the marine environment is highly unlikely to have a significant environmental impact, based on the types, size and frequency of wastes that could occur during the limited time the vessels will be in the OA and the transient nature of the species present. Given this, impacts will have no lasting effect on any species or water and sediment quality.

8.5.3.2 Predicted Effects

8.5.3.2.1 Water quality, and marine habitats and communities

Should accidental disposal of such wastes occur, the effects will be dependent upon the receiving environment and the nature of the hazardous material. There is the potential for fluid storage containers to leak and release their contents on the deck of the vessel. The spilled liquids may be washed overboard or spill overboard in adverse weather.

The seabed of the Central West Coast marine region is expected to be broadly characterised by calcareous gravel, sand and silt, and known to support relatively little seabed structure or sessile epibenthos. The area is likely sparsely covered by sessile filter feeding organisms and mobile invertebrates such as echinoderms, prawns and detritus-feeding crabs (DEWHA 2008b). Habitat closer to the shore is categorised as sand and reef, with some small areas of exposed reef and macroalgae meadow, with greater biodiversity and complexity of marine organisms.

The shallow waters of the OA partially overlap with the Commonwealth marine environment within and adjacent to the west coast inshore lagoons KEF and the OA is entirely within the Western rock lobster KEF. The Commonwealth marine environment within and adjacent to the west coast inshore lagoons KEF is a chain of inshore lagoons containing extensive seabeds of macroalgae and seagrass with a unique diversity of marine species. The seagrass habitats provide valuable feeding grounds for protected species such as ASLs and are important nursery areas for many recreational and commercial fish species.

Accidental releases of oily wastes and chemical could; however, cause localised decreases in water quality if accidentally released in significant quantities, which could indirectly affect marine flora and fauna. In the event a loss to sea does occur, impacts to the marine environment would be minimal, due to the small potential volumes released, and the fact that spilt oil and chemicals will rapidly evaporate, disperse and weather.

Water circulation in the vicinity of the OA is well mixed by winds and tides, and any spilled liquids would be rapidly dispersed and diluted. Release of small volumes of oily waste or chemicals would result in a localised adverse effect on water quality. Any effects to pelagic species would be extremely localised and temporary (short-term) and is unlikely to have any impact on species diversity or abundance within these areas.

Given the small volumes involved (maximum container size of typically 25 L) any impacts on the marine environment are likely to be limited to short-term toxicity effects on biota and reduced water quality. The high energy nature of the receiving environment will facilitate rapid dispersion and dilution to non-toxic concentrations.

Smaller items lost overboard, or larger items as they break down, may be ingested by marine fauna such as cetaceans, pinnipeds and turtles. However, the probability of this material being accidentally released is rare if the vessel Garbage Management Plan (GMP) is followed correctly.

8.5.3.2.2 Protected species

The OA overlaps with pygmy blue whale foraging BIA, and the southern right whale and humpback whale migration BIAs and is immediately adjacent to the pygmy blue whale migration BIA. It is also possible that other species of cetacean could be encountered while traversing the OA. The OA overlaps foraging BIAs for male and female ASLs, and the closest haul-out site and breeding colony is located ~9 km away at the Beagle Islands.

The timing of the survey (early February to end of March) is prior to the period of known presence of high densities of whales in the OA, as the acquisition window does not overlap the migration periods for pygmy blue, southern right and humpback whales in the region. Therefore, the presence of whales during this time is expected to be limited to occasional, transient individuals.

There are no BIAs or Habitat Critical for marine turtle species in the OA, and therefore marine turtle presence is likely to be limited to occasional transient individuals. White sharks may forage in the OA, with a BIA extending northwards along the 200 m isobath.

There are up to 13 species of seabirds that may forage within or transit through the Eureka 3D MSS OA. Eight species have foraging BIAs that overlap the OA—the Caspian tern, bridled tern, roseate tern, Australian fairy tern, white-faced storm petrel, Pacific gull, wedge-tailed shearwater and little shearwater (described in Section 4.3.10). The nearest breeding colonies for these species occur within the Turquoise Coast Island Nature Reserve, including the Beagle Islands, located between Leeman and Dongara, and further south within the Jurien Bay Marine Park.

Hazardous items may be mistakenly ingested and cause discomfort or adverse health effects for individuals. However, this would be limited to a small number of individual animals and ingesting small volumes of hazardous material; no lethal effects and no population effects would be expected.

Vessel operations will be compliant with legislative requirements relating to hazardous and non-hazardous materials management.

There are no predicted effects on EBPC Act listed Threatened and Migratory species at a population level.

Relevant person concerns/objections received have been assessed for merit and control measures developed to address merited concerns/objections, where required. No outstanding merited concerns.

Inherent risk	Consequence	Likelihood	Risk ranking
	Minor	Unlikely	Low

8.5.4 Risk treatment

8.5.4.1 Demonstration of ALARP

The risks and potential effects to due to accidental release of hazardous materials are well understood, with legislative requirements and industry agreed good practices to manage risks. In general, the application of recognised good practice is considered appropriate to manage the risk. In addition, the assessment has also considered the site-specific nature and scale of the risk (e.g., to sensitive receptors such migrating pygmy blue whales and humpback whales, and foraging ASLs and white sharks).

Pilot Energy is committed to ensuring continual risk reduction and identifying if additional control measures may be applied that are not disproportionate to the sacrifice (e.g., cost) of implementation. Pilot Energy considers the adopted controls to be appropriate in reducing the environmental risks associated with seabed disturbance from loss of solid objects to ALARP. There are no other controls measures that may practicably or feasibly be adopted to further reduce the risks of impacts without disproportionate costs compared to the benefit of the potential risk reduction (Table 8-8).

Table 8-8: Cost benefit analysis and residual risk evaluation – loss of hazardous and non-hazardous materials

Control measures	Cost benefit analysis	Risk reduction	Control adopted
ALARP assessment technique – good practice, legislative requirements			
Solid (no fluid-filled) streamers to be used, reducing potential for toxicity from lost streamer.	Benefits outweigh costs. Solid streamers used	Yes	Yes
Survey vessel crew will be inducted in waste management and made familiar with the vessel Garbage Management Plan (GMP).	Benefits outweigh costs	Yes	Yes
Compliance with MARPOL 73/78 Annex I and Annex V, the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, and relevant Marine Orders: Marine Order 91–Marine pollution prevention–oil Marine Order 95–Marine pollution prevention–garbage.	Benefits outweigh costs, legal requirement.	Yes	Yes
Vessel provides direction and specifications for waste storage/handling equipment, and waste storage containers	Benefits outweigh costs	Yes	Yes
Activity is not inconsistent with any relevant objectives of the recovery plan for relevant species and the Threat Abatement Plan for the impact of marine debris on the vertebrate wildlife of Australia's coasts and oceans (2018)	Legislative requirement	Yes	Yes
All waste receptacles in locations with potential for overboard waste loss, covered with tightly fitting, secure lids or netting to prevent any solid wastes from blowing overboard	Benefits outweigh costs	Yes	Yes
Hazardous materials will be stored with a form of secondary containment to contain leaks or spills in accordance with their MSDS.	Benefits outweigh costs	Yes	Yes
Deck scupper plugs on-board vessel.	Benefits outweigh costs	Yes	Yes
Equipment located on deck utilising hydrocarbons (e.g., cranes, winches or other hydraulic equipment) will have as a minimum primary bunding (e.g., deck edge lips or up-stands)	Benefits outweigh costs	Yes	Yes
Spill response bins/kits are maintained and located near hydrocarbon storage areas and deck areas for spill recovery / containment	Benefits outweigh costs	Yes	Yes
Spills from fixed internal equipment, such as engines and generators, are enclosed and spills captured via bilges that drain via the OIW separator.	Benefits outweigh costs	Yes	Yes
Minor oil/lubricant spills will be mopped up immediately with absorbent materials that will be stored in covered containers and disposed of onshore as hazardous waste in accordance with the vessel SOPEP	Benefits outweigh costs	Yes	Yes
Survey vessel crew are inducted in their responsibilities for chemical storage and handling and under the SOPEP	Benefits outweigh costs	Yes	Yes
Loose objects on deck will be secured to prevent loss overboard	Benefits outweigh costs	Yes	Yes

Control measures	Cost benefit analysis	Risk reduction	Control adopted
ALARP assessment technique – EIA			
Below-deck storage of all hydrocarbons and chemicals	Access to chemicals and oils on deck is required during operations Chemicals would still need to be brought onto deck when required during operations. This measure would inhibit operations; costs outweigh benefits.	Limited)	No
A reduction in the volumes of chemicals and hydrocarbons stored on-board the vessel	Chemical transfer during operations would be required, which has associated risks. Could also result in delays to operations Costs outweigh benefits due to additional risks associated with transfer of chemicals during the survey.	No	No

Residual risk evaluation				
Residual risk	Consequence	Likelihood	Risk ranking	Decision type
	Low	Unlikely	Low	A

8.5.4.2 Demonstration of acceptability

The impact assessment has concluded that, with the implemented control measures, the accidental release of hazardous and non-hazardous materials represents a low-risk rating that is unlikely to result in potential impacts beyond localised effects with no lasting consequences. These impacts, should they occur, are expected to be limited in both extent and duration.

Pilot has thoroughly explored additional opportunities to further mitigate impacts and risks associated with accidental releases, as discussed in previous sections. The adopted control measures are in line with good industry practice and fully comply with relevant legislative requirements. Furthermore, these measures align with the principles of ESD.

The control measures implemented by Pilot address both the prevention of accidental releases and the management of any potential impacts should such an event occur. These measures are designed to minimize the risk of releases and to ensure prompt and effective response in the unlikely event of an incident.

No specific concerns regarding the potential accidental release of hazardous and non-hazardous materials have been raised by relevant stakeholders. Given these factors, Pilot believes the adopted control measures are appropriate and sufficient to manage the impacts and risks from accidental release of hazardous and non-hazardous materials to a level that is broadly acceptable.

8.5.4.3 Environmental performance outcomes, standards and measurement criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for accidental release of hazardous and non-hazardous materials are presented below in Table 8-9. Environmental performance standards and relevant measurement criteria have been developed for each control measure adopted in Section 7.5.4.1.

Table 8-9: Environmental performance outcomes, standards and measurement criteria for accidental release of hazardous and non-hazardous materials

Environmental performance outcomes	Environmental performance standards	Measurement criteria
EPO 20 Hazardous and non-hazardous wastes are stored, handled, disposed of in a manner that prevents marine pollution. EPO 20A No release of hazardous and non-hazardous wastes to the marine environment.	PS 82 Compliance with MARPOL 73/78 Annex V, the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, and Marine Order 95–Marine pollution prevention–garbage. Survey and support vessels have a Garbage Management Plan (GMP) that must contain as a minimum: Waste handling equipment, waste storage containers, and closed bins appropriate to the type and volume of waste will be provided at waste storage areas.	MC 102 Vessel Garbage Management Plan (GMP) is carried on-board and complies with MARPOL requirements. Vessel audit/inspection confirms waste is managed in accordance with the Garbage Management Plan (GMP).
	PS 83 Hazardous wastes materials will be handled and stored in accordance with the corresponding MSDS.	MC 103 Vessel audit/inspection confirms relevant MSDS' for hazardous waste types are on-board the vessel and are being followed.
	PS 49 Vessel survey crew will be inducted in waste management procedures and made familiar with the vessel GMP.	MC 60 Records show that the project induction includes information on waste management requirements and Garbage Management Plan, and sign-off register indicates all personnel on-board have received the induction.
	PS 84 Solid streamers to be used	MC 127 Inspection prior to commencement of survey confirms solid streamers used.
EPO 21 Oily wastes and chemicals are stored, handled, disposed of and cleaned up in a manner	PS 50 / PS 85 Compliance with MARPOL 73/78 Annex I, the P*rotection of the Sea (Prevention of Pollution from Ships) Act 1983*); and Marine Order 91–Marine pollution prevention–oil: Current Shipboard Oil Pollution Emergency Plan (SOPEP) in place	MC 106 Vessel audit/inspection confirms SOPEP on-board survey vessel MC 62 Vessel audit/inspection demonstrate the survey vessel holds an IOPP certificate, if required under vessel class

Environmental performance outcomes	Environmental performance standards	Measurement criteria
that prevents marine pollution.	Survey vessel holds a valid IOPP certificate, where required, under vessel class	MC 107 Vessel audit/inspection demonstrate that SOPEP drills have taken place
	PS 86 Chemicals and/or hydrocarbons on deck will be stored with a form of secondary containment measure to contain leaks or spills in accordance with their MSDS.	MC 108 Inspection during survey records demonstrate that hydrocarbon storage is designed and maintained to prevent and contain deck spills entering the marine environment.
	PS 87 Hydrocarbon and chemical storage areas (e.g., engine room) are bunded and/or stored safely to prevent spills overboard and drain to the bilge water tank.	MC 109 Vessel audit/inspection verifies that the main deck and hydrocarbon and chemical storage areas are bunded and/or stored safely to prevent spills overboard.
	PS 88 Hazardous wastes materials will be handled and stored in accordance with the corresponding MSDS.	MC 110 Vessel audit/inspection indicates that hazardous wastes materials are stored in accordance with the corresponding MSDS.
	PS 89 All hazardous substances will be included in the Material Safety Data Sheet (MSDS) registers. These registers are available in key locations of the vessels (e.g., bridge, chemical locker) and kept up to date so that chemical spills to deck can be safely managed.	MC 103 Vessel audit/inspection shows that MSDS' for all hazardous waste types are available on-board. MC 111 Vessel audit/inspection shows that MSDS registers are in key locations (i.e., where chemicals are stored) and a relevant crew member is responsible for ensuring they are kept up to date.
	PS 90 Equipment located on deck utilising hydrocarbons (e.g., cranes, winches or other hydraulic equipment) will have as a minimum primary bunding (i.e., deck edge lips or up-stands)	MC 112 Vessel audit/inspection demonstrates that all equipment located on deck utilising hydraulic fluids have primary bunding

Environmental performance outcomes	Environmental performance standards	Measurement criteria
	PS 91 Spills from fixed equipment, such as engines and generators, are enclosed and spills captured via bilges that drain via the oily water separator (OWS).	MC 113 Vessel audit/inspection confirms oily water from machinery spaces collects in bilges for treating in the OWS to MARPOL requirements.
	PS 53 Minor oil/lubricant spills will be mopped up immediately with absorbent materials that will be disposed of onshore as hazardous waste in accordance with the vessel SOPEP	MC 67 / MC 68 Vessel audit/inspection shows that response measures for minor oil/lubricant spills were carried out in accordance with the SOPEP, and contaminated clean-up wastes stored on-board in covered bins prior to onshore disposal at a licensed waste management facility.
		MC 73 Vessel audit/inspection of incident reports for minor spills to the marine environment.
	PS 114 Survey vessel crew are inducted in their responsibilities under the SOPEP and is competent in spill response and has appropriate response resources to prevent hydrocarbon or chemical spills discharging overboard.	MC 114 Vessel audit/inspection show that the project induction includes responsibilities of survey crew under the SOPEP and that regular spill drills are being carried out.
		MC 69 Incident reports record lessons learnt, and corrective measures are being implemented on-board.
	PS 54 Scupper plugs or equivalent drainage control measures are readily available to the deck crew so that deck drains can be blocked in the event of a hydrocarbon or chemical spill on deck to prevent or minimise discharge to the sea.	MC 70 Vessel audit/inspection verifies that scupper plugs (or equivalent) are available on the main deck.
	PS 92 Spill response kits are available in relevant locations around each vessel, are fully stocked and used in the event of a spill to deck to prevent or minimise discharge overboard.	MC 115 Vessel audit/inspection verifies that spill response kits are available in relevant locations in accordance with vessel plans.

8.6 Risk 5: Accidental oil spill – vessel collision/grounding

In accordance with the Pilot Energy risk assessment methodology (Section 6) this risk is classified as higher order. Therefore, an additional assessment and detail is required to demonstrate this risk is of an acceptable level.

8.6.1 Identification of hazard and extent

Hazard	The survey vessels (and supply/chase vessels) will be fuelled with marine gas oil (MGO), carried in separate fuel tanks that are inter-connected and isolatable. In the event of an incident such as a catastrophic vessel collision/grounding that ruptured a fuel tank, a significant volume of fuel may be released to the ocean. The total loss of fuel would be reduced by isolating the compromised fuel tank and transferring fuel to adjacent tanks. Support and chase vessels will typically have similar or smaller fuel tanks. AMSA's Technical Guidelines for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities (AMSA 2015) recommends that the maximum realistic spill scenario for vessel collisions or grounding is the loss of the entire volume of the single largest fuel tank (AMSA 2015). The vessel to be used for the Eureka 3D MSS has not yet been selected, and so the largest tank in the vessel fleet was used for the purposes of assessing spill risk and identifying appropriate spill response strategies. Consequently, the maximum realistic spill scenario herein is based on the rupture of the largest fuel tank in the fleet with a capacity of 320 m^3 (a Level 2 spill scenario). Modelling allowed for a 6-hour surface release and a modelling duration of 28 days. Such a fuel spill has been used to set the worst-case EMBA (Section 4.1) Although this scenario is considered a realistic worst case, it is also an unlikely occurrence given the control measures in place to manage interactions with other users (Section 7.3) and the controls in place to mitigate the loss of fuel in the event of a tank rupture. It is, however, credible that a vessel collision could occur control measures due to the vessel traffic in the shipping routes and fishing in the area. Vessel collision spills make up 11.6% of the marine spills over one tonne, with most of these occurring in ports or other areas where vessels work in proximity (DNV 2011). Based on a review of the Australian Transport Safety Bureau's marine safety database there are no recorded instances of collisions, grounding or sinking of a seismic vessel or its support vessels in Australian waters in at least the last 30 years (ATSB 2018). The Australian registered research vessel *Rig Seismic* grounded on an uncharted reef while engaged in seismic operations in the Philippines in 1992. The vessel suffered only minor damage, and it was re-floated without assistance, and no pollution occurred. Spill response risks are addressed in Section 8.7. The vessel(s) might be anywhere within the ASA and buffer zones so an accidental release could occur anywhere within the OA.
Extent	Spill originates in OA, potential to spread to EMBA
Duration	Duration of survey – up to 40 days in early February to the end of March.

8.6.2 Defined acceptable level

Pilot Energy's risk assessment methodology for demonstrating that impacts and risks are at an acceptable level distinguishes between higher-order and lower-order impacts and risks. For lower-order impacts and risks, acceptability is demonstrated when the impact or risk has been shown to be reduced to as low as reasonably practicable (ALARP). However, for accidental oil spills from vessel collision or grounding, an additional demonstration is required. Before the assessment, acceptable levels of impact are defined (below). Once the assessment is complete, the predicted impact levels are compared with these predefined acceptable levels. If the predicted levels are lower than the defined thresholds, the impact is at an acceptable level.

•

AL 48. There will be no predicted long-term unrecoverable effects on EPBC Act listed MNES, Marine Reserve Management Plan Values and Threatened Species Recovery Plans / Conservation Advice

AL 49. There will be no predicted long-term unrecoverable effects on fish stocks or commercial fishing

AL 50. No specific relevant person claims or objectives have been raised that have not been addressed. There are no outstanding merited claims or objections.

AL 51. Operations are compliant with maritime law, OPGGS Act relating to preventing pollution / collisions at sea reporting and responding effectively to spills.

8.6.3 Risk analysis and evaluation

8.6.3.1 Potential risks

The risks and potential effects of a fuel spill from vessels associated with the oil and gas industry have been the subject of much investigation, and it is accepted that the risks are much less than those associated with spills from, for example, exploratory and operational oil wells. In general, the risks are well understood, with legislative requirements and industry agreed good practices to manage risks. The application of recognised good practice is considered appropriate to manage the risk; particularly due to the well-mixed open ocean waters of the OA that would hasten the natural weathering and dispersion of the plume. In addition, the assessment has considered the site-specific nature and scale of the risk and the environmental values and sensitivities (e.g., presence of habitats susceptible to medium- to long-term effects and likely encounters with marine fauna).

A precautionary approach has also been taken in the decision-making process, where the oil spill risk assessment is based upon a worst-case spill scenario of complete loss of the contents of one fuel tank in the event of vessel collision/grounding. Given the extremely low likelihood of two very unlikely events occurring (catastrophic collision/vessel grounding and complete loss of the contents of one fuel tank) as the defined realistic worst-case spill scenario, the assessment is considered inherently conservative.

8.6.3.2 Predicted effects

In the event of a fuel spill, surface slicks and plumes of entrained hydrocarbons can cause a localised reduction in water quality in surface waters, which at specific thresholds and exposure hours may have toxic effects on marine fauna and flora. Potentially affected biota includes plankton, fishes and invertebrates (including commercial stocks such as demersal scalefish, rock lobster and octopus), seabirds, marine mammals (cetaceans and pinnipeds), and turtles that may encounter a surface hydrocarbon slick. If surface slicks or entrained fuel were to contact shallow waters or emergent features adjacent to the OA, then a range of benthic habitats and communities could be at risk of impacts depending on the location of the spill and tide/weather conditions. Stranded oil can impact coastal parks and reserves, shorelines and public amenities.

Fuel properties may vary according to the blend of gasoil with heavier feedstocks. A spill of a marine gasoil (MGO) typically used by marine seismic survey vessels and supply/chase vessels has been modelled, albeit at a greater volume than the biggest fuel tank onboard. The low dynamic viscosity (4.0 cP at 25°C) (Table 8-10), means the fuel will spread quickly and will thin out to a film; increasing the initial rate of evaporation.

Table 8-10: Physical characteristics of marine fuel

Parameter	Marine gas oil (MDA blend)			
Density (kg/m^3)	829 (at 25 °C)			
Dynamic viscosity (cP)	4 (at 25 °C)			
Characteristic	**Volatiles (%)**	**Semi-volatiles (%)**	**Low volatiles (%)**	**Residual (%)**
	Non-persistent			Persistent
Boiling point (˚C)	<180	180–265	265–380	>380

% of total	6.0	34.6	54.4	5
% of aromatics	1.8	1.0	0.2	-

The components listed above suggest around 41% of the spilled volume will evaporate within the first day and about 54% of the volume may persist for over a week on the surface under calm conditions. Of the less volatile 54%, about 40% will resist evaporation for 1-3 weeks and thus can contribute to the exposure's opportunities considered over the timescale that is the subject of this assessment. Approximately 5% (by mass) of the oil will not evaporate over the longer term (several weeks). MGOs (and MDOs) are categorised as a Group 2, non-persistent oil according to the International Tanker Owners Pollution Federation (ITOPF 2011). Given that a source vessel has yet to be contracted, the exact blend and characteristics of the fuel to be used are unknown and the characteristics of a typical marine MDA blend have been used in the modelling (Table 8-11).

Table 8-11: Fates of spilled MGO in the marine environment relevant to the Eureka 3D MSS OA

Fate	Description
Spreading	MGO is a relatively low viscosity fuel oil and spreads rapidly, influenced by metocean conditions (waves, wind, tides and currents); faster surface currents result in faster spreading.
Evaporation	Volatile components evaporate to the atmosphere, with increased wind speeds and ambient temperatures resulting in a higher evaporation rate. Lighter hydrocarbon fractions (boiling point <200°C) will typically evaporate almost entirely within 24-hours in temperate conditions. The larger the surface area of a slick increases the rate at which it will evaporate. Remaining hydrocarbons will have a higher density and viscosity, which slows the spread and evaporation of the remaining spill.
Dispersion/ entrainment	A large proportion of the spilled MGO will become entrained (or dispersed) in the upper water column; droplets of oil become suspended in the upper layer of the water column assisted by winds and waves. Dispersion occurs more readily with relatively low viscosity MGO in the presence of breaking waves and when wind speeds exceed 5–7 knots (~2.6 to 3.6 m/s). Once dispersed into smaller droplets, the oil is prone to faster biodegradation and photo-oxidation. When metocean conditions are no longer suitable to sustain entrainment, the remaining droplets of oil may return to the sea surface, with the rate of return influenced by the buoyancy of the oil particles. On the sea surface, the droplets may form a slick that is subject to further evaporation. Entrained oil is generally more persistent as it is no longer subjected to evaporation at the surface, and it may travel further in subsurface currents than the surface slick.
Dissolution	While most of components within an MGO spill are not water soluble, some components may dissolve in sea water. The lighter fractions of the oil are typically more soluble (e.g., aromatic hydrocarbons), and these are generally also more toxic than the heavier fractions. Given the relatively small portion of soluble hydrocarbons present in MGO, along with their rapid decomposition, the percentage of spilled oil that will become dissolved in the event of a fuel spill is expected to be small.

Weathering rates and the distribution of MGO over time between the water surface, water column and atmosphere will vary with the wind and sea conditions as shown in Figure 8-1, Figure 8-2 and Figure 8-3.

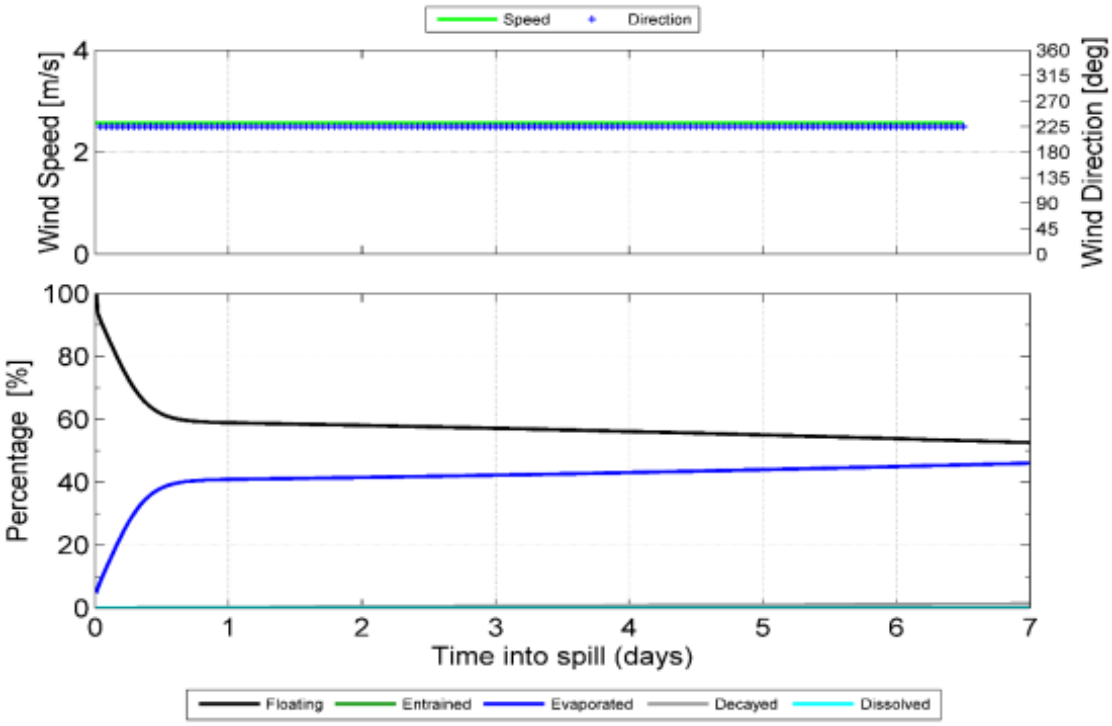


Figure 8-1: Proportional mass balance plot representing weathering of a surface release of 320 m3 of MGO under theoretical conditions

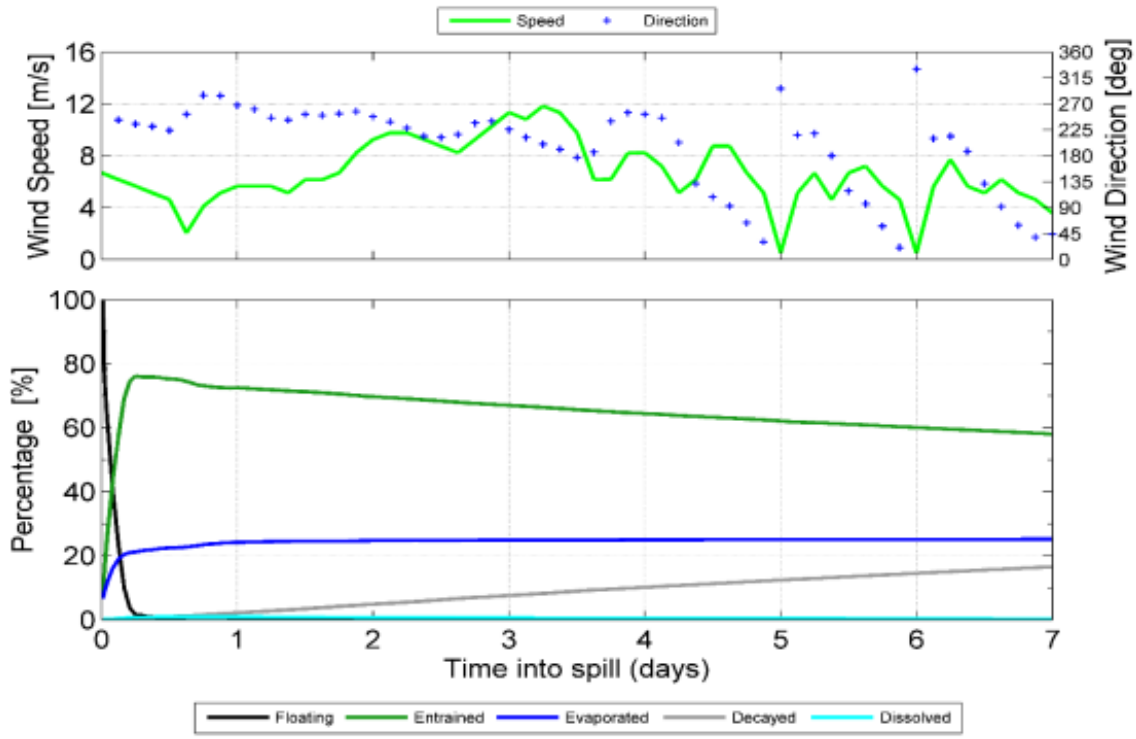
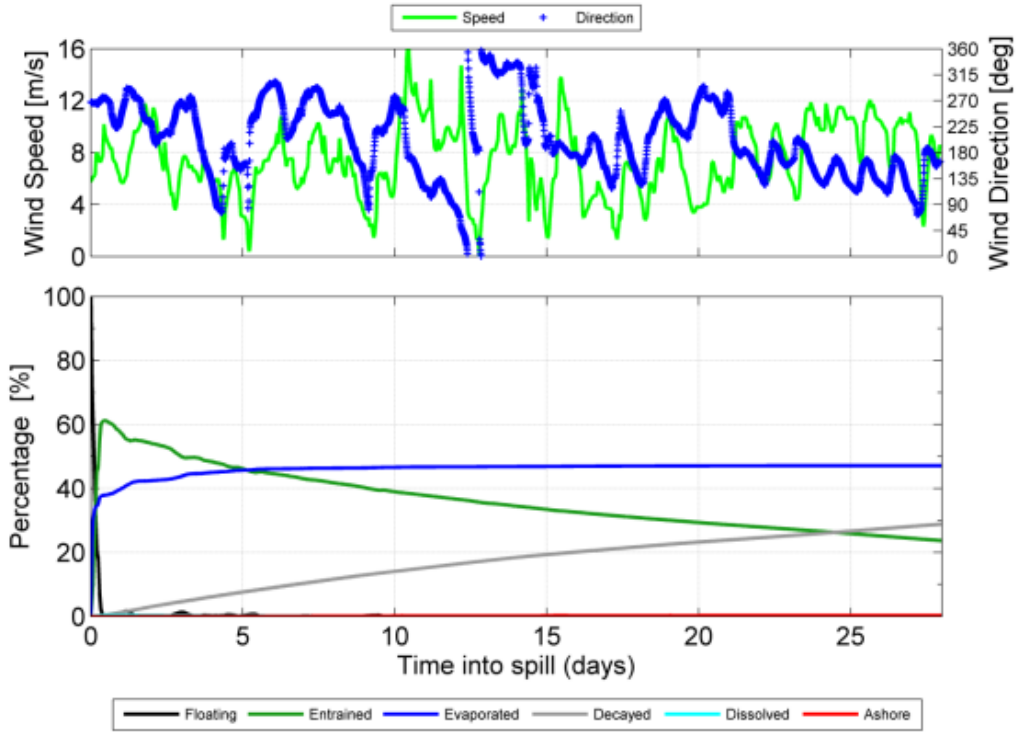


Figure 8-2: Proportional mass balance plot representing weathering of a surface release of 320 m3 of MGO weathering and fates graph, as a function of volume, under 5, 10 and 15 knot static wind conditions



Note: The August to September period was selected as an example due to weather and temperature conditions resulting in less evaporation and more entrainment and therefore showing the worst-case proportional mass balance.

Figure 8-3: Proportional mass balance plot representing weathering of a surface release of 320 m^3 of MGO short-term release under an example set of metocean conditions during August to September

8.6.3.2.1 Spill modelling study

The modelling study (RPS 2023) used the Spill Impact Mapping and Planning (SIMAP) model to determine the trajectory, spread and weathering of spilled oil as influenced predominantly by the current, wind, wind-generated waves and sea temperature. The modelling and analysis methods undertaken, meet and exceed the ASTM Standard F2067-13 "*Standard Practice for Development and Use of Oil Spill Models*".

To account for trends and variability in these conditions, a 5-year database of wind and current data for the area, spanning the years 1994–2016 was sampled as input to multiple simulations. To improve accuracy, this data was derived from measurements and hindcasting of metocean conditions for the region, carried out by linking meteorological and hydrodynamic models.

Modelled data that integrated real measurements is used in lieu of measurement alone because measurements are made at fixed locations and cannot represent spatial variation over the potential trajectories of oil spills.

Modelling was conducted during two different scenario periods of February to March and August to September over a 28-day duration. The modelling results for both these periods were combined to present annualised results that are a maximum worst-case scenario. After consultation it was decided that the survey would be restricted to the February to March period but the larger EMBA with annualised results over both periods would be retained.

A HYDROMAP model was established over a domain that extended approximately 3300 km east-west by 3100 km north–south over the eastern Indian Ocean. The grid extends into the Southern Ocean to the south and the waters of Indonesia to the north. Approximately 98,600 cells were used to define the region, with four layers of sub-gridding applied to provide variable resolution throughout the domain. The resolution at the primary level was 15 km. The finer levels were defined by subdividing these cells into 4, 16 and 64 cells, resulting in resolutions of 7.5 km, 3.75 km, and 1.88 km.

Bathymetric data used to define the three-dimensional shape of the study domain was extracted from the Geoscience Australia 250 m resolution bathymetry database (Falkner 2009) and the CMAP electronic chart database, supplemented where necessary with manual digitisation of chart data supplied by the Australian Hydrographic Office (AHO). Depths in the domain ranged from shallow intertidal areas through to approximately 7200 m.

Exposure potential was assessed for defined geographic areas, referred to as Sensitive Receptors. Sensitive Receptors defined subsections of the coastline, shorelines of islands, State waters, economic zones, marine parks, sanctuary zones, habitat protection zones, foraging areas and other sensitive areas. Geographic bounds followed specifications from the National and State marine parks and EPBC recovery plans as described in Section 4.

The 'probabilities' forecast in the modelling and discussed below are for the arrival of oil at concentrations exceeding defined thresholds at areas (defined for Sensitive Receptors). The probability score provides a quantitative ranking of the potential for exposure of specific geographic areas and are calculated as the proportion of simulations (out of a hundred spill simulations) that crossed into that area at a certain concentration (e.g., >50 mg/L). Results are given for a range of threshold concentrations for multiple oil states (I.e., floating, entrained, dissolved). These scores do not indicate the probability that a single individual (for example, an individual bird or whale) would be exposed because of a single spill event, because this would require the coincidence of a spill occurring in the first instance and that individual and the oil at the same location within the wider receptor. The reported probabilities are the result of 100 replicate spill simulations.

To undertake analysis for exposure it is necessary to define one or more threshold concentrations that define when exposure will be counted, accounting for the potential for effect of the oil at the threshold concentrations. These thresholds need to serve consideration of a wide definition of effect. Multiple thresholds were used as a guide to the gradation of possible effects. The thresholds defined in Table 8-12 include a short discussion on their basis with details provided in the spill modelling study report (RPS 2023).

Table 8-12: Thresholds used for spill impact assessment

Instantaneous surface oil threshold[1]	Instantaneous in-water threshold	Shoreline threshold[4]
Change to the environment ≤1 g/m^2 Ecological impact: ≤10 g/m^2	Dissolved aromatics[2] Change to the environment ≤10 ppb Ecological impact: ≤50 ppb Entrained oil[3] Change to the environment ≤10 ppb Ecological impact: ≤100 ppb	Low: 10-100 g/m^2 (impacts to shorebirds)

1 - Floating surface oil

Estimates for the minimal thickness of floating oil that might result in harm to seabirds through ingestion from preening of contaminated feathers, or the loss of the thermal protection of their feathers, has been estimated by different researchers at approximately 10 g/m^2 (French-McCay 2009) to 25 g/m^2 (Koops et al. 2004). Hence, the 10 g/m^2 threshold is likely to be moderately conservative in terms of environmental harm for effects on seabirds, for example. The lower threshold of 1 g/m^2 is likely to be an indicator of where there is a visual presence of an oil slick that may trigger social and economic impacts but where there is little potential for environmental impact.

2 - Dissolved (largest contributor to toxicity)

Low: 10 ppb–50 ppb

Actual toxicity depends on both concentration and the duration of exposure, being a balance between acute and chronic effects. To put these thresholds into context, global data from French et al. (1999) and French-McCay (2003, 2002), which showed that species sensitivity (fish and invertebrates) to dissolved aromatics exposure in the water column >4 days (96-hour LC_{50}) under different environmental conditions varied from 6 ppb-400 ppb, with an average of 50 ppb. This range covered 95% of aquatic organisms tested, which included species during sensitive life stages (eggs and larvae).

Based on scientific literature, the lower threshold of 10 ppb is not considered to be of significant biological impact and represents the low exposure area contacted by the spill. The higher thresholds of 50 ppb and is more likely to be indicative of potentially harmful exposure to fixed habitats over short exposure durations (French-McCay 2002). The Australian and New Zealand Environment and Conservation Council (ANZECC) and Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ) 2000 water quality guidelines (ANZECC/ARMCANZ 2000) listed 7 ppb as the trigger value for investigation and protection of 99% of species. As an instantaneous occurrence, it is considered precautionary and indicative of water quality change that may exert behavioural or sub lethal effects due to short duration.

Based on scientific literature, the lower threshold of 10 ppb is not considered to be of significant biological impact and represents the outer boundary of the area contacted by the spill. The higher thresholds of 50 ppb and 400 ppb is more likely to be indicative of potentially harmful exposure to fixed habitats over short exposure durations (French-McCay 2002).

3 - Entrained (soluble aromatics)

The 10-ppb threshold represents the lowest concentration and corresponds generally with the lowest trigger levels for chronic exposure for entrained hydrocarbons in the ANZECC/ARMCANZ (2000) water quality guidelines. Due to the requirement for relatively long exposure times (>24-hours) for these concentrations to be significant, they are likely to be more meaningful for juvenile fish, larvae and planktonic organisms that might be entrained (or otherwise moving) within the entrained plumes, or when entrained hydrocarbons adhere to organisms or is trapped against a shoreline for periods of several days or more. The 10-ppb threshold exposure zone is not considered to be of significant biological impact. This exposure zone represents the area contacted by the spill and conservatively defines the outer boundary of the area of influence from a hydrocarbon spill.

The 100-ppb threshold is considered conservative in terms of potential for toxic effects leading to mortality for sensitive mature individuals and early life stages of species. This threshold has been defined to indicate a potential zone of acute exposure, which is more meaningful over shorter exposure durations. The 100-ppb threshold has been selected to define the moderate exposure zone. Contact within this exposure zone may result in impacts to the marine environment.

4 - Shoreline contact

Shoreline oil concentrations are relevant to describing the risks of oil stranding on shorelines and beaches. French et al. (1996) and French-McCay (2009) have defined an oil exposure threshold of 100 g/m^2 for shorebirds and wildlife (furbearing aquatic mammals and marine reptiles) on or along the shore, which is based on studies for sub-lethal and lethal impacts. The 100 g/m^2 threshold has been used in previous environmental risk assessment studies (French McCay et al. 2004; French-McCay 2003; NOAA 2013b). This threshold is also recommended in AMSA's foreshore assessment guide as the acceptable minimum thickness that does not inhibit the potential for recovery and is best remediated by natural coastal processes alone (AMSA 2015). Contact within these exposure zones may result in impacts to the marine environment. A threshold of 10 g/m^2 has been defined as the zone of potential 'low' exposure. This exposure zone represents the area visibly contacted by the spill and defines the outer boundary of the area of influence from a hydrocarbon spill.

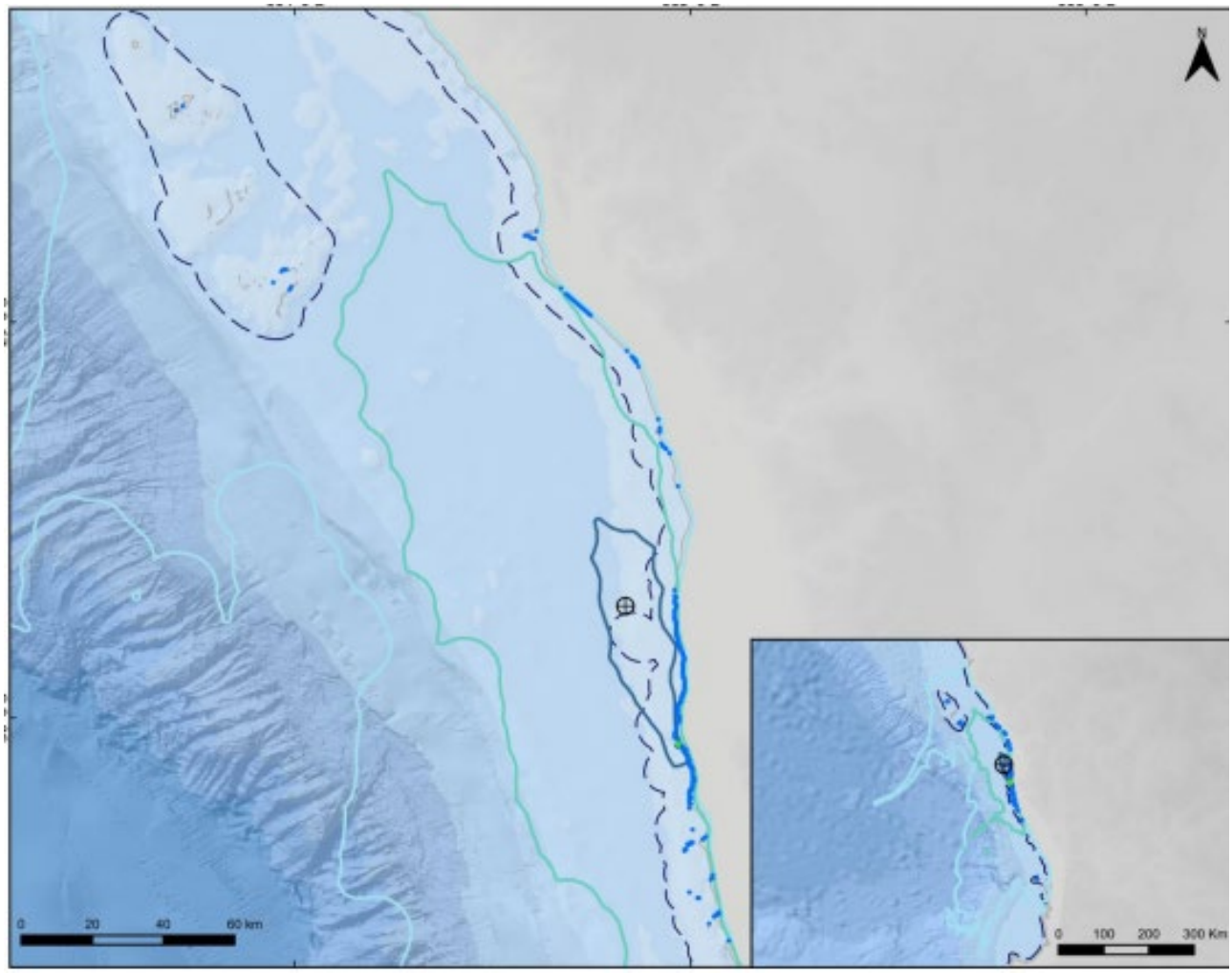


Figure 8-4: Predicted annualised zones of potential contact with surface floating oil, shoreline, entrained, and dissolved from a 320 m3 accidental spill of MGO

Receptors most at risk within the EMBA, whether resident or migratory include plankton, fishes and invertebrates, cetaceans, pinnipeds, sea and shorebirds and shoreline habitats. In addition, the following receptors were considered-cultural and heritage values (e.g., shipwrecks) community amenities, commercial and recreational fishing, shipping and other users. Special attention was given to sensitive biota and protected species, MNES, KEFs and threatened communities as well as the values of State and Commonwealth marine protected area, including open water pelagic habitats.

The primary impact pathways have been identified as:

- Potential for toxicity and physical oiling for biological receptors and the coating of historical wrecks, public facilities (such as beaches, boat ramps, heritage sites etc.)
- Potential disturbance to shoreline habitats, risk of vessel strikes etc. from post-spill response and monitoring operations (discussed in Section 8.7).

Considering the likely receptors in the EMBA (refer Section 4) and their sensitivities. The components listed above suggest around 41% of the spilled volume will evaporate within the first day and about 54% of the volume may persist for over a week on the surface under calm conditions. Of the less volatile 54%, about 40% will resist evaporation for 1-3 weeks and thus can contribute to the exposure's opportunities considered over the timescale that is the subject of this assessment. Approximately 5% (by mass) of the oil will not evaporate over the longer term (several weeks). MGOs (and MDOs) are categorised as a Group 2, non-persistent oil according to the International Tanker Owners Pollution Federation (ITOPF 2011). Given that a source vessel has yet to be contracted, the exact blend and characteristics of the fuel to be used are

unknown and the characteristics of a typical marine MDA blend have been used in the modelling (Table 8-11), the main thresholds for the risk assessment are summarised below, with additional grades discussed in the full report (RPS 2023) to ensure completeness of the risk assessment.

Given the short-lived nature of a spill scenario in general and the nature of MGO and its predicted weathering, the focus is on instantaneous impacts. Simulations confirm little or no opportunity for long-term impacts through ongoing contamination.

8.6.3.3 Potential impacts and probability of exposure to sensitive receptors

8.6.3.3.1 Seabirds and shorebirds

There are numerous listed threatened and/or migratory seabird and shorebird species that could occur in the OA or EMBA and could potentially forage or nest as detailed in Section 4.3.9. The details of the potential impacts to these receptors from each oil fraction is described below.

Seabirds rafting, resting, diving, preening and feeding at sea have the potential to contact surface oil at various exposure levels. If seabirds have a long duration of exposure to areas of heavy surface oiling, it is likely that some individuals may die because of exposure through pathways such as reduced insulation and waterproofing (leading to hypothermia dehydration, drowning or starvation), ingestion, impaired flight and navigation, food chain biomagnification and tissue damage (ITOPF 2011; AMSA 2017). Direct oiling of nests is considered extremely unlikely given their location above the water line, but plumage contamination of adults can affect hatchling success (French-McCay 2009). Penguins spend much of their time in water and if oiled rapidly lose insulation and buoyancy (Hook et al. 2016). The Iron Baron vessel spill (325 tonnes bunker fuel, Tasmania,1995) is estimated to have resulted in the deaths of up to 20,000 penguins (Hook et al. 2016).

Shorebirds foraging for food in intertidal areas or along the high tide mark/splash zone may encounter weathered hydrocarbons that may be brought back to nests and/or ingested. Being weathered, oils transported to the sandy nests (e.g., of hooded plovers or fairy terns) is likely to permeate through the sand, limiting accumulation on the feathers of young or adults. Toxicity effects from ingestion of contaminated prey caught in the intertidal zone are unlikely as given the characteristics of MGO, the more toxic volatile components are likely to have evaporated prior to stranding.

However, the potential of exposure from surface and shoreline oil is very limited to the volatile nature of MGO, which rapidly evaporates, dissolves and entrains. The sea surface area and area of shoreline that could be affected by oil at biologically relevant concentrations is extremely small relative to the distribution of the bird species that could be affected. Surface oil is only expected to travel up to 33 km from the spill location and shoreline contact is only expected at Bowes River - Broken Anchor Bay, Glenfield Beach - Bowes River, Green Head – Leeman, Leeman – Coolimba and Thirsty Point - Booker Valley receiving greater than 10 g/m2. Therefore, foraging and the health of birds in these relatively small areas could be impacted by surface and shoreline oiling. However, MGO quickly permeates porous sediments (NOAA 2012), limiting duration of exposure to fauna on the shoreline. In addition, MGO has a relatively small proportion of longer-chain residual components (<5% that persist over weeks) compared to other hydrocarbons and is there not expected to have long-term effects on shorelines. Similarly, impacts from surface oil are expected to be relatively short-term as the surface oil will rapidly disperse.

The bird species detailed in Table 4-10 could be present in the event of a spill; however, the presence of each species will vary seasonally, and some species may not be present. The wide geographical range of most shorebirds and seabird species within the EMBA are likely to result in impacts only to individuals or populations at one location but not necessarily extend to populations on a regional or global scale.

The areas with elevated entrained and dissolved hydrocarbons are single trajectories and short term. Fish and invertebrate prey species residing in or swimming through these small discontinuous zones that are prey for seabird and shorebirds will have a low probability of suffering acute or chronic toxicity effects, so birds consuming them are similarly not expected to suffer toxicity effects at a population level.

8.6.3.3.2 Marine turtles

Four species of marine turtles listed as MNES under the EPBC Act were identified as potentially occurring in the EMBA (Section 4.3.8). All four marine turtle species are listed as both Threatened and Migratory with 'foraging, feeding or related behaviour known to occur within area'. No marine turtle Habitat Critical or BIAs (e.g., foraging, internesting, mating and nesting areas) are recognised within the EMBA, despite having been defined for each of the listed turtle species. All species of marine turtles in Australian waters are managed under the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017).

Spilled oil may impact reptiles through oiling sensitive tissues (eyes, respiratory) and through ingestion via contaminated food or absorption through the skin causing dermal pathologies. Contamination of eggs can result in toxic impacts to embryos with decreased survival of hatchlings and increased deformities and hatchlings being impaired by shoreline oil and more prone to predation (Shigenaka & Milton 2003). Turtles are therefore vulnerable to surface oiling from an oil spill however it should be noted that adult turtles only spend 1–10% of their time at the sea surface with each dive lasting between 30–70 minutes (French-McCay 2009). In addition, there are no Habitat Critical or BIAs for marine turtles within the EMBA and the low chance of encountering significant numbers of turtles in general during the survey, limits potential impacts to individuals and the risk is negligible.

Overall, given the rapid evaporation (limiting inhalation exposure to the early phase of a spill) and weathering of surface oil, the infrequent occurrence of marine turtles in the EMBA, and the short time turtles typically spend at the surface, the absence of nesting beaches or other Habitat Critical/BIAs in the EMBA means any impacts to marine turtles are expected only on individual basis and the risk is assessed as negligible.

8.6.3.3.3 Marine mammals – pinnipeds

A description of pinnipeds (sea lions and seals) in the EMBA is provided in Section 4.3.7. The PMST report identified one threatened pinniped species, the ASL, that is known to occur within the EMBA. This species is listed as Endangered under the EPBC Act. Although not protected under the EPBC Act as a Threatened or Migratory species, the long-nosed fur seal also occurs in the EMBA.

As pinnipeds spend time on or near the surface, they are at risk from sea surface oils through direct oiling. Direct oiling of fur seal pups can induce hypothermia by destroying their lanugo insulation. Adult fur seals have blubber, but oil can still affect waterproofing qualities (other pinnipeds are less impacted) oil can "stick" flippers to fur seal bodies preventing escape from predators or hindering swimming skin, eye, respiratory irritation/damage leading to infections and starvation inhalation of vapours may damage the respiratory system (AMSA 2011).

Ingestion of oil (e.g., contaminated prey, cleaning pups etc.) may damage digestive tracts, suppress immune systems or damage mucous membranes. There is 100% probability that ASL foraging areas could be contacted entrained oil at 10ppb and up to 98% probability of contact from dissolved oil.

Seals may override their avoidance of noxious spills in order to stay near haul out areas and pups, (Geraci & St Aubin1988) increasing risk of exposure. Oil residues may possibly disguise scent that seal pups and mothers rely upon to identify each other leading to pup abandonment and starvation (Fogden 1971).

Engelhardt (1982) states seals have the enzyme systems necessary to convert some adsorbed hydrocarbons into polar metabolites which can be excreted in urine. Volkman et al. (1994) report benzene and naphthalene ingested by seals is rapidly absorbed into the blood through the gut causing acute stress with damage to the liver considered likely, and death where large volumes are ingested.

Due to the extreme philopatry of females and limited dispersal of males between breeding colonies, the removal of only a few individuals annually may increase the likelihood of decline and possible extinction of small colonies. This could further weaken genetic resilience, impacting its ability to cope with other natural or anthropogenic impacts and could reduce genetic diversity between colonies, placing small breeding colonies under pressure of survival from even low levels of anthropogenic mortality.

Known haul-outs, resting sites and foraging waters around breeding colonies (Beagle Islands, North Fisherman Is, Buller Is, Carnac Island, Garden Island) all have ≤1% probability of >1 g/m^2 floating oil.

The ASLs and long-nosed fur seals may be exposed to surface MGO while surfacing, exiting and entering the water, and depending on duration and concentration, may result in irritation to mucous membranes around the eyes and nose. There is 100% probability that Australian sealion foraging areas could be contacted by floating oil at concentrations greater than 1g/m^2 in the event of an oil spill. Should the seal inhale volatile vapours from a fresh slick acute and/or chronic toxicity impacts could result. This would be unlikely to occur to more than several individuals at most and given the brief time spent on the surface, unlikely to result in permanent damage or mortality. Likewise, ASLs and long-nosed fur seals may be exposed to shoreline oil and experience some degree of dermal contact.

Surface oil is highly unlikely to contact shorelines and if shoreline contact occurs the length of shoreline contact is very small (refer Shoreline section above). Therefore, the potential for contact with pinnipeds while they occupy shorelines is very small. The area of potential contact with surface floating oil is limited to the area shown in Figure 8-5. Since the presence of the surface oil is temporary and the area is an extremely small portion of their foraging area the risk to pinnipeds from an oil spill is considered low.

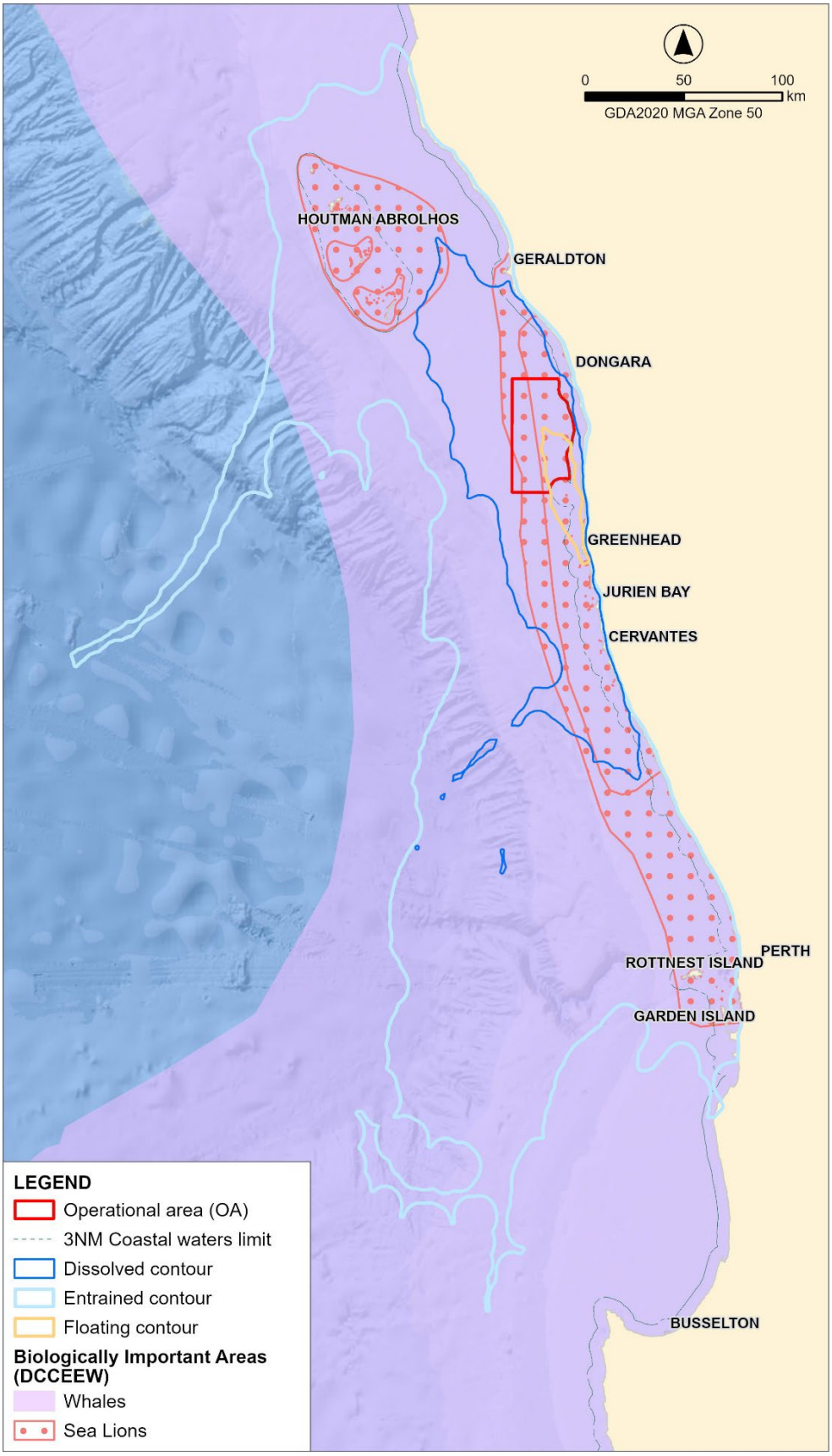


Figure 8-5: Marine mammal BIAs with areas overlapped by dissolved (≤10 ppb), entrained (≤10 ppb), and floating oil (≤1 ppb)

8.6.3.4 Marine mammals – cetaceans

A description of the cetaceans within the EMBA is provided in Section 4.3.8.

The EMBA supports internationally significant populations of several cetaceans. The PMST report identified 38 marine cetacean species with 12 listed as Threatened / Vulnerable and/or Migratory MNES under the EPBC Act that may potentially occur within the EMBA. The National Conservation Value Atlas (NCVA) showed that five of these species have BIAs defined within the EMBA. The EMBA overlaps with foraging BIAs for pygmy blue whales and sperm whales, migration BIAs for pygmy blue whales, humpback whales and southern right whales.

As mammals, (air breathing) cetacean species are vulnerable to sea surface oiling. The inhalation of oil droplets, vapours or fumes may damage mucous membranes, damage airways or may cause death depending on the extent of exposure. Some cetacean feeding methods lead to greater likelihood of ingestion. For example, baleen whales are particularly vulnerable when feeding as they filter feed by skimming the sea surface for krill. This can lead to ingesting surface oil and fouling of their baleen plates. If large quantities of zooplankton (key prey) exposed to the spill were ingested, chronic toxicity impacts to baleen whales may occur (see plankton) Toothed cetaceans (e.g., dolphins) feed directly on fish and squid and are less likely to ingest surface oil.

Cetaceans have mostly smooth skin with limited area of pelage (i.e., hair-covered skin) or rough surfaces (e.g., barnacles) which will cause oil adherence. Adsorption through the skin is therefore limited (low) and dissolved hydrocarbons are expected to have less impact (Geraci & St Aubin 1988). Maternal transfer of contaminant to embryos is reported in NRDA (2012) and Hook et al (2016). Effects include hypothermia, organ dysfunction, damaged lungs and airways, gastrointestinal ulceration, eye and skin lesions, decreased body mass and stress with behaviour changes.

After the Macondo spill (2010), dolphin populations from Louisiana, USA that had been exposed to prolonged and continuous oil showed higher incidences of lung and kidney disease than those in other urbanised environments (Hook et al. 2016). The spill may have contributed to unusually high perinatal mortality in bottlenose dolphins (Hook et al. 2016).

As a highly mobile species, in general it is unlikely cetaceans traversing and foraging within the EMBA will be constantly exposed to hydrocarbons in the water column (surface or dissolved) for long continuous durations (e.g., >96 hrs) that could lead to chronic toxicity effects. However, pelagic species may continue to be attracted to specific areas for breeding or feeding, in spite of a tendency to avoid noxious spill. As such weathered oils may continue to present a problem to baleens by fouling their sieves.

French-McCay (2009) stated that a 10-25 g/m^2 oil threshold has the potential to impart a lethal dose on some marine species, however, also estimates a probability of 0.1% mortality to cetaceans if they encounter these thresholds based on the proportion of the time spent at surface. Biological consequences of physical contact with very localised areas of low to high concentrations surface oil are unlikely to lead to any long- term impacts, with temporary skin irritation and very light fouling/matting of baleen plates likely to occur (it is unknown whether the latter would affect feeding ability). Therefore, effects at the population level on the cetaceans present in the EMBA are considered unlikely.

Given the low numbers of cetaceans foraging and transient through the area during the seismic survey period (February to March – i.e. outside the migratory periods for pygmy blue, southern right and humpback whales in the region), the rapid dispersion of MGO and subsequent weathering of volatiles (limiting inhalation exposure to the early stage of a spill) and the relatively small, discontinuous pockets of elevated entrained and dispersed oil, impacts are not forecast at a population level, consequences are ranked minor and the risk is Low.

8.6.3.5 Plankton

Zooplankton is vulnerable to oil due to its small size, high surface area to volume ratio and (in many cases) high lipid content (which facilitates oil uptake) (Hook et al. 2016), causing mortality, decline in egg production and swimming speed. Hydrocarbons have been shown to result in detrimental impacts to phytoplankton (González et al. 2009) but according to Varela et al. (2006) studies of planktonic communities following spills of a similar nature to that of a vessel fuel tank spill did not detect statistically significant impacts resulting from hydrocarbon exposure. Hook et al. (2016) reports phytoplankton as not typically sensitive to oil impacts but does accumulate oil rapidly due to small size and high surface area, with effects on photosynthesis dependent on concentration range.

Variations in the temporal scale of oceanographic processes typical of the ecosystem can have a greater influence on plankton communities than a direct spill (Volkman et al. 1994) as reproduction by survivors or migration from unaffected areas rapidly replenishes losses with field observations showing minimal or transient effects on marine plankton. Once background water quality has been re-established, communities will take weeks or months to recover allowing for seasonal influences on the assemblage characteristics (ITOPF 2011).

Plankton populations in the EMBA are expected to be highly variable both spatially and temporally and are likely to comprise characteristics of tropical and temperate Australia populations. Plankton within the EMBA are expected to reflect the conditions of the SWMR on-shelf areas. The Leeuwin Current also plays a key role in the distribution of species in the region. The warm water transported southward has extended the distribution of tropical and subtropical species to areas further south than would otherwise occur.

Plankton found in the open waters of the EMBA are expected to be widely represented within waters of the greater SWMR with recruitment through migration likely within weeks to months maximum. Given the expected rate at which the spill would disperse and weather, the dynamic nature of planktonic communities (Davenport et al. 1982), and the variability in plankton populations in both space and time, impacts to marine plankton are predicted to be minimal, transient and insignificant in the long-term. However, consideration must be given to the importance of coastal krill in the cetacean (e.g., pygmy blue whale) and fish food chains.

8.6.3.6 Fishes (including sharks)

A description of fishes and sharks in the EMBA is provided in Section 4.3.3 and 4.3.7 respectively.

Pathways to exposure include direct dermal contact (e.g., oiling gills (Hook et al. 2016)), ingestion (directly and through contaminated prey; refer Plankton section above) and inhalation (diffusion of elevated dissolved components across the gills). Impacts range including mortality, decreased size, inhibited swimming, changes in oxygen consumption, changes to reproduction, DNA damage, organ lesions and increased parasitism. Sub-lethal impacts include a range of organ malfunctions, gill hyperplasia and increased infection as well as alterations in behaviours such as feeding, migration, swimming and burrowing behaviours (Kennish 1996). Embryos, larvae and juveniles are at the most sensitive life stage, with exposure potentially resulting in decreased spawning success and abnormal larval development.

Fishes and sharks are non-air breathing so less affected by surface oils. Some syngnathid species (i.e., seahorses, pipefishes) associated with nearshore reefs and rafts of floating seaweed may encounter surface oil. Some demersal species may be susceptible to oiled sediments particularly those that are site-restricted (e.g., to reefs and seabed features). Pelagic species in the water column are susceptible to entrained and dissolved components but tend to be highly mobile and less likely to suffer extended exposure due to patterns of movement. Adult fish kills reported after spills occur mostly in shallow water, near shore benthic species (Volman et al. 2004). The overlap of the oil fractions with the white shark BIA is shown in Figure 8-6. Given the widespread distributions of the white shark (listed as Vulnerable and Migratory), shortfin mako shark (Migratory) and porbeagle shark (Migratory) it is likely that these species may traverse the EMBA. Surface entrained and dissolved fractions of MGO have the potential overlap with the white shark foraging BIA. However, in the south-west white shark population individuals are very sparsely distributed with an estimated 760 to 2250 adults present between the west coast of Tasmania and Exmouth on the WA coast (Hillary et al. 2018). This very low density coupled with the low concentration and ephemeral nature of an MGO spill is likely to result in a reduced risk of impact to the white shark population.

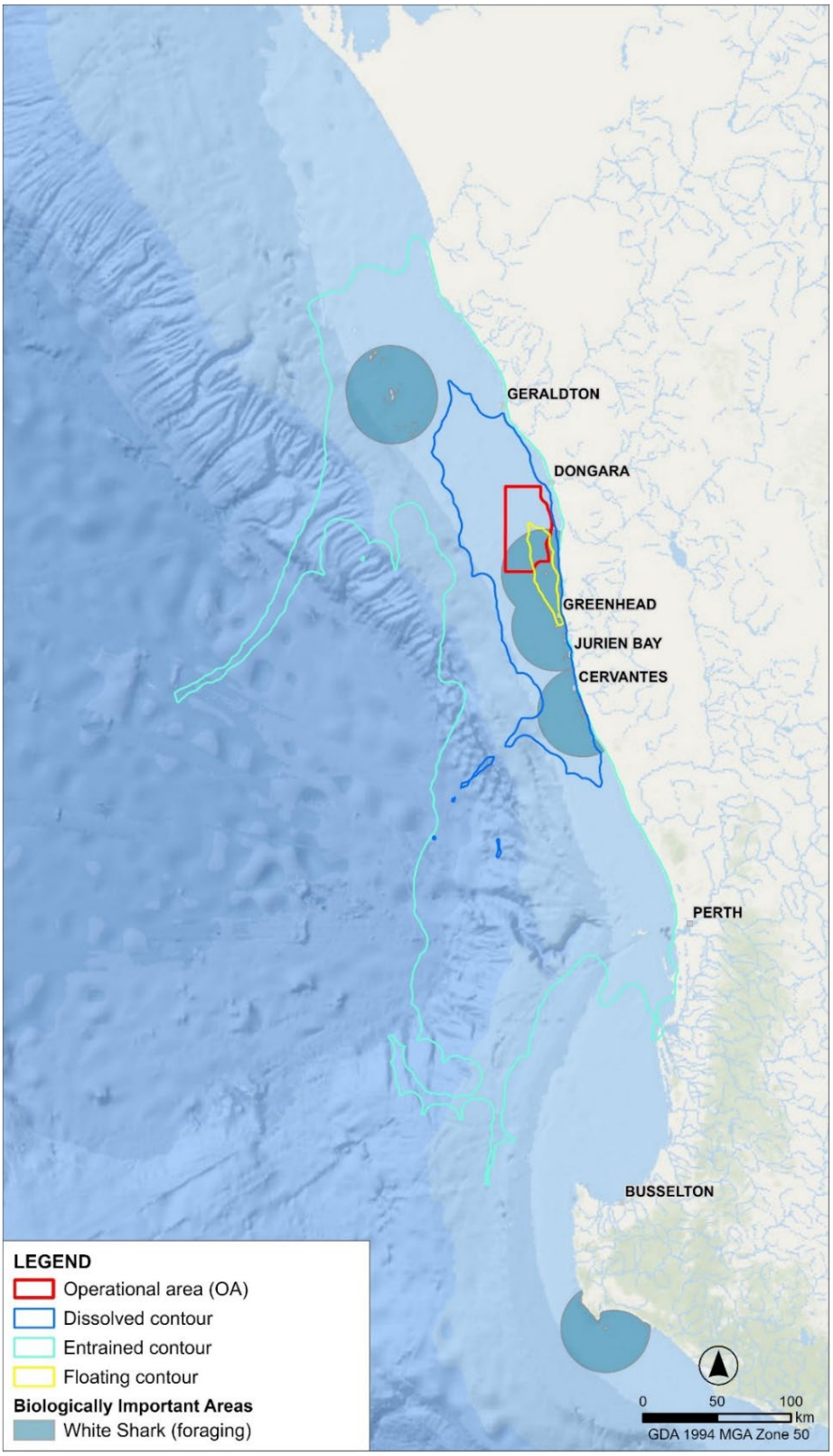


Figure 8-6: White shark foraging BIA with areas overlapped by dissolved (≤10 ppb), entrained (≤10 ppb), and floating oil (≤1 ppb)

Most fish are mobile and unlikely to incur sufficient exposure over a period long enough to be impacted above harm thresholds. Most fish tend to remain in the mid pelagic zone, limiting contact with surface hydrocarbon. MDO/MGO spills in open water are diluted so rapidly that adult fish kills are rarely observed (NOAA 2012) and (ITOPF 2011). Hence, impacts from surface oil are predicted to be low and not at population levels.

Numerous commercially targeted fish and larvae could be exposed within the EMBA in the unlikely event of a spill. Fish associated with benthic habitats and KEFs in the EMBA could also be exposed to entrained and dissolved fractions of MGO. Fish within the moderate zone of exposure and that are unable to avoid the area of exposure may experience some sublethal and lethal effects. These effects will pass after the MGO spill has dispersed resulting in concentrations unlikely to cause ongoing effects.

8.6.3.7 Shorelines

A description of shoreline types within the EMBA is presented in Section 4.4.3. They tend to be regularly cleaned by wave action and have a low sediment total organic carbon, thus a low abundance of marine life (Hook et al. 2016). The low organic carbon and large particle size means shoreline oil permeates readily, the depth of penetration depending on particle size (greater penetration in coarse beach sand than in fine muds in tidal flats and estuaries). The low viscosity of MGO means it quickly penetrates, aided by burrows (e.g., worm holes) and root pores.

Oil can accumulate in cracks, crevices, rock pools, overhangs and shade areas that provide habitats for soft bodies fauna such as sea anemones, sponges and seasquirts (Hook et al. 2016). The vulnerability of these communities depends on topography, composition and position. A vertical rock face on a wave exposed coast is likely to be remain unoiled if a slick is held back by the action of the reflected wave. A gradual sloping boulder shore in a calm backwater of a sheltered inlet can trap large amounts of oil which may penetrate the substratum. The complex patterns of water movement close to rocky coastlines can concentrate oil while oil often collects on the high tide mark while lower parts may be untouched (IPIECA 1995).

The waves and tide that washed the oil onto the rocks soon starts to remove it, with the rate of weathering depending on wave exposure, weather conditions, shore characteristics etc. Gradual leaching can result in constant low-level pollution and microbial breakdown begins which is slower in cold or temperate environments. Silts and clay can assist removal by flocculation. Marine snails and other grazing fauna can remove significant amounts of oil.

As oil weathers it becomes more viscous and less toxic, often leaving little residue on shore rock. This can remain an unsightly stain for years but is unlikely to cause further ecological damage. Oil tends not to remain on wet rock or algae but likely to stick firmly if the rock is dry (IPIECA 1995).

The impact of oil on any marine organism depends on the toxicity and viscosity, amount of oil, sensitivity of the organism and length of contact. Even where the immediate damage to rocky shores from oil spills has been considerable, it is unusual to result in a long-term damage and the communities have often recovered within two or three years (IPIECA, 1995). This is because oil is not normally retained in the rocky shores in a form or quantity that causes long-term impacts, and because most rocky shore species have a considerable potential for re-establishing populations.

Many rocky shore animals have also been found to withstand heavy oiling – it typically requires smothering for a few tides to fatally impact barnacles and intertidal sea anemones. Limpets, littorinid snails and other grazing molluscs are usually more susceptible. A particularly toxic oil may result in high mortality through a direct effect or through a narcotic effect where the oil causes the animals to lose their grip on the rock, become available to predators or die of desiccation (IPIECA 1995).

If the shoreline is not further oiled, the spores of macroalgae also settle and grow resulting in an abnormally dense cover of seaweed. Simultaneously the juvenile limpets and snails which settle and develop in damp and protected sub-habitats, move out to gradually repopulate the open rock. They grow quickly on the large quantities of food and gradually reduce the seaweed cover to normal levels. The whole process may take less than 2–3 years for the shore to look 'normal' although in some cases the balance between the algae and grazers may take longer to stabilise (IPIECA 1995).

Oiling greater than 1g/m^2 threshold could result in acute toxicity and mortality of many invertebrate communities, especially where oil penetrated through animal burrows (IPIECA 1999). However, rapid recovery is expected as components are weathered and removed from the environment and recruitment from unaffected individuals and nearby

areas occurs. The results of exposure to oil may be acute (e.g., die-off of amphipods and replacement by more tolerant species such as some worm species (IPIECA 1999) or chronic (e.g. gradual accumulation of oil and genetic damage) (Hook et al. 2016).

After the *Sea Empress* spill off the coast of Wales in 1996, many amphipods (sandhoppers), cockles and razor shells died with mass strandings of both intertidal species (such as cockles) and shallow sub tidal species. Populations of mud snails recovered within a few months, but some amphipod populations had not returned to normal after one year. Long-term depletion of sediment fauna could have adverse effects on birds or fish that use the tidal flats as feeding grounds (IPIECA 1999).

Modelling indicates that, in the unlikely event of a vessel collision or grounding resulting in a loss of marine diesel, there is potential for hydrocarbon contact with the shoreline via dissolved, entrained, and floating oil pathways (Figure 8-7). While dissolved hydrocarbons are primarily confined to offshore waters, modelling shows they may approach or reach the shoreline at several locations along the Western Australian coast. Potential shoreline contact is predicted at Jurien Bay, Green Head, Leeman, Dongara, and Glenfield Beach, particularly where low-energy environments and nearshore currents may facilitate accumulation. Although dissolved concentrations are expected to be low, there remains a risk of sub-lethal effects to sensitive coastal habitats such as seagrass meadows, macroalgal beds, and intertidal reef systems. These habitats form part of the West Coast Inshore Lagoons Key Ecological Feature (KEF) and support the western rock lobster fishery. Impacts may include physiological stress or reduced reproductive success in marine flora and invertebrates, particularly in sheltered embayments or lagoon systems with limited water circulation.

The entrained hydrocarbon contour, which represents dispersed oil droplets in the water column, spans a broad stretch of coastline between Mandurah and Kalbarri, encompassing sections of the West Coast Inshore Lagoons KEF and areas critical to the western rock lobster fishery. Entrained oil may be retained longer in nearshore lagoons, reef platforms, and embayments, increasing the potential for shoreline interaction. If present, entrained hydrocarbons could temporarily affect shoreline flora and fauna through both toxic and physical mechanisms, particularly in environments with limited natural flushing.

Due to the volatile nature of MGO, only limited shoreline contact by floating oil is predicted. The areas potentially exposed to surface oiling greater than 10 g/m² include Glenfield Beach (3 km), Green Head (8 km), and Leeman (2 km) on the mainland, and 3 km of shoreline each at the Houtman Abrolhos Islands and the Pelsaert Group. Where floating oil does strand, short-term toxic and smothering effects may occur to intertidal flora and fauna. Several of these sites, including Green Head and Leeman, lie within or adjacent to the Jurien Bay Marine Park, and portions of the predicted contact zone overlap with habitat important to the Western Rock Lobster Fishery and the West Coast Inshore Lagoons KEF. Shallow reef platforms and lagoon environments in these locations may enhance oil retention on the shoreline, although overall impacts are expected to be temporary given the high volatility and rapid weathering characteristics of MGO.

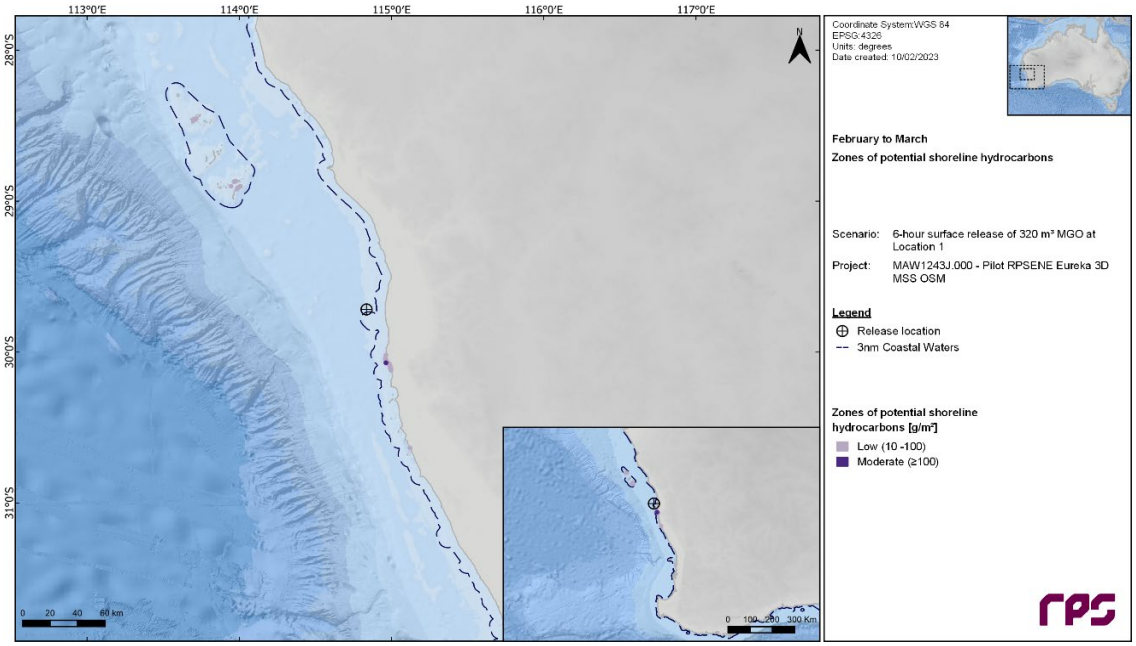


Figure 8-7: Areas of shoreline that could potentially be contacted by hydrocarbons

8.6.3.7.1 Benthic habitats

Acute or chronic exposure through surface contact and/or ingestion can result in toxicological risks. The presence of an exoskeleton (e.g., crustaceans such as rock lobster) will reduce hydrocarbon absorption through the surface membrane but invertebrates with no exoskeleton and larval forms may be more vulnerable to impacts from pelagic hydrocarbons.

Marine invertebrates and larva are likewise more at risk from entrained and dissolved hydrocarbons than adults with an exoskeleton. Should localised impacts to larval stages occur, population recruitment that year can be impacted. Tissue taint of invertebrates exposed to hydrocarbons can remain for several months, although taint may eventually be lost. NOAA (2002) describes lobsters when exposed to a light hydrocarbon losing their taint after 2-5 months.

Minute oil droplets may impact aquatic biota mechanically (e.g., filter feeders) or act as a conduit for exposure to semi-soluble hydrocarbons taken up by the gills or digestive tract (McCay-French 2009). Toxicity is primarily attributed to water soluble polycyclic aromatic hydrocarbons (PAHs), especially dissolved naphthalene. ANZECC/ARMCANZ (2000) identifies the 96-hr LC50 concentrations for naphthalene as 57,000 ppb for the bivalve mollusc (Katelysia opima) and 850 to 5700 ppb for six species of marine crustaceans.

Dispersed and non-dispersed oil can also deplete oxygen in bottom waters through the bacterial metabolism of oil (and/or dispersants), and surface oil blocking light (NRDA 2012).

After the Macondo well blowout (Gulf of Mexico, 2010) BP (2015) reported that less than 2% of the sediment samples tested exceeded EPA benchmarks for aquatic biota, and these were largely sampled from the area close to the wellhead (BP 2015). Felder et al. (2014) studied offshore benthic seaweeds in water depths of 55–75 m before and after the blowout, finding a post spill die-off of seaweeds and a decrease from 60 species to 10. Crabs, lobsters and prawns associated with the seaweeds and benthic substrates also declined as much as 29–42%, although other influences may have been involved so definitive links to the oil spill are not possible. Nevertheless, residual hydrocarbons may have contributed to localised deaths, decline in fertility of surviving female decapods and reduced recruitment (Felder et al. 2014).

Following the Montara well blowout in the Timor Sea in 2009, surveys of the Barracouta and Vulcan shoals (which lie about 20–30 m below the surface in surrounding deep waters greater than 150 m) did not detect obvious visual signs of major disturbance (Heyward et al. 2010). Due to the lack of pre-impact data, the presence of low-level severely degraded oil at some shoals detected later could not be directly linked to the Montara spill.

Both the entrained and dissolved fractions of MGO have the potential to contact benthic habitats at 10 ppb causing chronic exposure and 100 ppb causing toxic effects. Figure 4 9 and Figure 8 8 show the reefs, shoals, banks and KEFs that could be contacted by thresholds of oil that could affect benthic organisms. Other benthic organisms within these zones that are not associated with a recognised benthic habitat feature could also exposed to entrained and dissolved MGO. These impacts are likely to be temporary due to the transient and pulsed nature of the spill and are predicted to fully recover fully, resulting in a low impact.

Surface oil is unlikely to impact benthic habitats except on shorelines which is detailed above.

8.6.3.8 KEFs

In the event of an oil spill there is the potential for several KEFs to be contacted either dissolved, entrained oil or both fractions (Figure 8-8). Contact by surface oil has not been considered credible because all the KEFs are seabed features and surface oil cannot contact them. An overlap between the dissolved or entrained oil with a KEF indicates there is potential for contact in the event of a spill. However, the probability of contact with a KEF varies through space and time with changes in weather and metocean conditions and the probability of contact is very low at greater distances from the source of the spill.

The Western rock lobster KEF could be contacted by dissolved and entrained oil at biologically relevant thresholds. It is possible for this KEF to be contacted by dissolved oil from just north of Geraldton to approximately 100 km south of Cervantes. Entrained oil could affect a greater portion of the Western rock lobster KEF with possible contact extending approximately 200 km north of Geraldton to approximately 150 km south of Perth at concentrations greater than 10 ppb. However, for both dissolved and entrained oil fractions only a small portion of the KEF between these northern and southern points could be contacted by dissolved oil at concentrations greater than 10 ppb. The area of the KEF that could be contacted by oil is small relative to the size of the KEF.

The Western demersal slope and associated communities KEF and Perth Canyon and adjacent shelf break and other west coast canyons KEF could only be contacted by entrained oil greater than 10 ppb (except for a very small overlap with dissolved oils). The potential overlap with entrained oil extends from the most southern extent of the KEFs to the about 150 km north of Geraldton. The area of the KEFs that could be contacted by oil is very small relative to the size of the KEF.

All the Commonwealth marine environment surrounding the Houtman Abrolhos Islands could be contacted by entrained oil greater than 10 ppb. Only a very small portion of the south-eastern edge of the KEF could be contacted by dissolved oil at concentrations greater than 10 ppb.

The Commonwealth marine environment within and adjacent to the west coast inshore lagoons KEF from approximately 100 km north of Geraldton to approximately 100 km south of Perth could be contacted by entrained oil at concentrations greater than 10 ppb. The area of this KEF potentially contacted by dissolved oil is significantly smaller than that contacted by entrained, spanning from near Geraldton to a small portion of the KEF about 300 km south of Geraldton.

The Ancient coastline at 90-120 m depth KEF could be contacted by both dissolved and entrained oil fractions with the entrained fraction covering a significantly larger area than the dissolved. However, this KEF extends the length of the WA coastline and therefore the area covered by the potential spill is an extremely small portion of the KEF. The physical structures of the KEF, such as the rocky reefs, limestone pavements and benthic contours are unlikely to be affected by the dissolved and entrained oil fractions. However, the flora and fauna communities that inhabit the KEFs could be impacted by an oil spill and the nature and extent of these potential impacts are detailed int the relevant sections of this impact assessment.

Given that the ancient coastline at 90-120 m depth KEF is important in the region, such impacts are notable. However, being a large dynamic, open, and well-mixed ocean environment, and given the nature and behaviour of the MGO, impacts are expected to be recoverable within a year and not have any individual or cumulative consequence higher than Low.

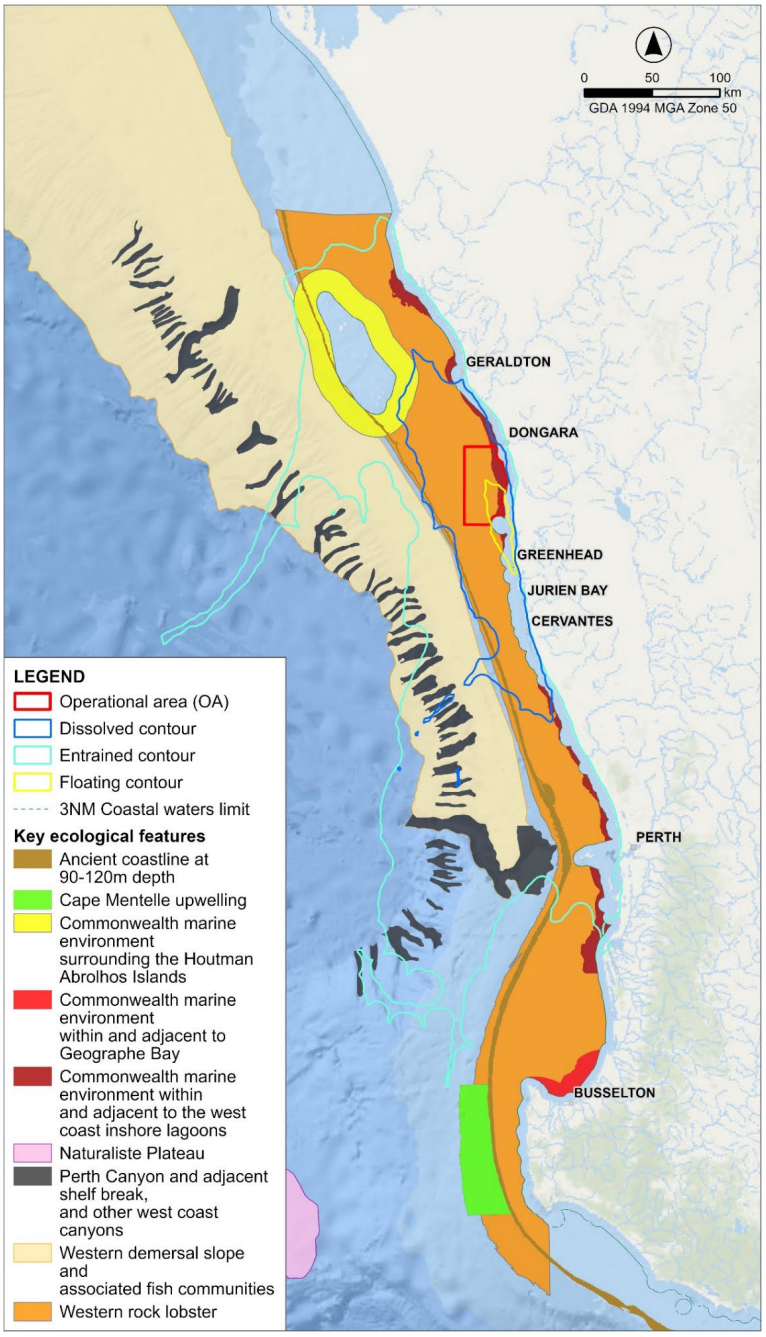


Figure 8-8: Overlap of KEFs with dissolved, entrained and floating oil

8.6.3.8.1 Macroalgal and coral communities

A description of macroalgal communities is provided in Section 4.3.2.

Macroalgae are generally limited to growing on intertidal and sub tidal rocky substrata in shallow waters to 10 m water depth, so may be exposed to subsurface, entrained and dissolved hydrocarbons. However, some are susceptible to surface hydrocarbons exposure more so in intertidal habitats as opposed to subtidal habitats.

Blumer (1971) and Cintron et al. (1981) document smothering, fouling and asphyxiation effects on marine plants. In macroalgae, oil can act as a physical barrier for the diffusion of carbon dioxide across cell walls (O'Brien & Dixon 1976), the impact depending largely on the degree of exposure and how much the hydrocarbon adheres to the algae which varies with oil state and stickiness. The presence of mucilage layer or fine 'hairs' will influence how much oil sticks. Connell

& Miller (1981) reviewed post spill field studies noting a wide range of variability in the level of impact, but in all instances the algae appeared to be able to recover rapidly from even heavy oiling. This was because for most algae, new growth is produced near the base of the plant while the distal parts exposed to the oil are continually lost. French-McCay et al. (2004) indicated that oiled kelp beds had a 90% recovery within 3–4 years of impact however full recovery to pre-spill diversity may not occur for longer periods.

Intertidal macroalgal beds are more prone to oil spills than subtidal beds because although the mucous coating prevents oil adherence, oil that is trapped in the upper canopy can increase the persistence of the oil, which impacts upon site attached species. Additionally, when oil sticks to dry fronds on the shore they can become overweight and break because of wave action (IPIECA 2002). Hook et al. (2016) on the other hand, states that kelp is typically resistant to oil though the fauna associated with it may be more sensitive. IPIECA (1995) also states that brown seaweeds are relatively insensitive to oil due to the slimy mucilage that coats all their surfaces so that even after a heavy oiling, most of the seaweeds are washed clean by the next high tide and largely remain undamaged.

Edgar & Barrett (1995) studied the impacts on, and the recovery of, subtidal reefs affected the Iron Baron spill (Northern Tasmania, 1995), that the release of large quantities of fuel oil did not substantially affect populations of sub tidal reef associated organisms with no significant change in numbers of species on reefs nor in the densities of the most abundant animal and plant species.

Macroalgae response to hydrocarbons depends on its life stage, with gamete, larval and zygote stages more at risk than adult growth stages (Lewis & Pryor 2013). Toxic effects concentrations for algae exposed to hydrocarbons varied greatly amongst species with studies ranging from 0.002-10,000 ppm (Lewis & Pryor 2013).

Macrophytes including seagrasses and macroalgae require light to photosynthesise. So, in addition to the potential impacts from direct smothering exposure to entrained and dissolved hydrocarbons, the presence of entrained oil in the water column can affect the light quantities and the ability of macrophytes to photosynthesis.

Macroalgae will generally be limited to seabed areas within the photic zone (approximately less than 100 m deep) where rocky and hard substratum exists. These areas include the islands (e.g., Beagle Islands, Abrolhos Islands and Rottnest Island) and rocky reefs within approximately 100 km of the shoreline. Impacts from entrained and dissolved fractions of oil are most likely in water depths >5 m, while surface oil has the potential to impact macroalgae in intertidal areas and to depths of approximately 5 m.

Exposure of entrained and dissolved hydrocarbons to shallow subtidal corals has the potential to result in lethal or sublethal toxic effects, resulting in acute impacts or death at moderate-to-high exposure thresholds (Loya & Rinkevich 1980; Shigenaka 2001; DoT 2018), including increased mucus production, decreased growth rates, changes in feeding behaviours and expulsion of zooxanthellae (Peters et al. 1981; Knap et al. 1985). Adult coral colonies, injured by oil, may also be more susceptible to colonisation and overgrowth by algae or to epidemic diseases (Jackson et al. 1989). Lethal and sublethal effects of entrained and dissolved oils have been reported for coral gametes at much lesser concentrations than predicted for adult colonies (Heyward et al. 1994; Harrison 1999; Epstein et al. 2000). Goodbody-Gringley et al. (2013) found that exposure of coral larvae to oil and dispersants negatively impacted coral settlement and survival, thereby affecting reef resilience. Sub-lethal effects to corals may include polyp retraction, changes in feeding, bleaching (loss of zooxanthellae), increased mucous production resulting in reduced growth rates and impaired reproduction (Negri & Heyward 2000). In the unlikely event of a marine diesel spill occurring at the time of coral spawning at potentially affected coral locations or in the general peak period of biological productivity, there is potential for a reduction in successful fertilization and coral larval survival due to the sensitivity of coral early life stages to hydrocarbons (Negri & Heyward 2000).

Coral communities in the EMBA are predominantly associated with the island fringing reefs and other reefs, banks and shoals (Figure 4 7). The probability of exposure to corals at these locations varies depending on their location and the oil fraction type, with corals in shallow intertidal areas being the only corals potentially impacted by floating oil. The probability of impacts to corals by floating oil above 1g/m2 at all reefs, shoals and islands is <1%. Impacts from entrained oil above 10 ppb is highest at the Abrolhos Islands at 41% and at Geelvink Channel Shoals at 41%. The probability of impacts from dissolved oil above 10 ppb<1% at all the islands and of all the reefs, banks and shoals is highest at North Tail Reef (4%).

8.6.3.8.2 Commercial fisheries

A description of commercial fisheries in the EMBA is provided in Section 4.4.2. Table 8-13 lists overlap between the oil fraction types and the historically fished areas of the WA-managed commercial fisheries. The thresholds used to delineate the overlap do not infer a biological or ecological impact but warrant further investigation under the ANZECC guidelines.

Table 8-13: Overlap between each WA-managed commercial fishery and floating at ≤1g/m2, dissolved at ≤10 ppb, and entrained oil

Fishery	Historical catch/effort		
	Floating	Dissolved	Entrained
Abalone Managed Fishery (AMF)	X	✓	X
Abrolhos Islands and Mid-West Trawl Managed Fishery (AIMWTMF)	X	✓	X
Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLMF)	✓	✓	✓
Mackerel Managed Fishery (MMF)	X	✓	X
Marine Aquarium Fish Managed Fishery (MAFMF)	✓	✓	✓
Octopus Interim Managed Fishery (OIMF)	✓	✓	✓
Open Access Fishery (OAF)	✓	✓	✓
South-West Coast Salmon Managed Fishery (SWCSMF)	✓	✓	✓
Specimen Shell Managed Fishery (SSMF)	✓	✓	✓
West Coast Deep Sea Crustacean Managed Fishery (WCDSCMF)	✓	✓	✓
West Coast Demersal Gillnet and Demersal Longline Managed Fishery (WCDGDLMF)	✓	✓	✓
West Coast Demersal Scalefish Managed Fishery (WCDSMF)	✓	✓	✓
West Coast Purse Seine Managed Fishery (WCPSMF)	X	✓	✓
West Coast Rock Lobster Managed Fishery (WCRLMF)	✓	✓	✓

Lost or reduced fishing time can result if fisheries are unable to access specific fishing areas due to spill response activities, possible exclusion zones and avoidance of areas where vessels and equipment may be oiled. Temporary fisheries closures may be established by WA Department of Fisheries or voluntarily by the fishermen themselves because of the risk of the catch being tainted. Davis et al. (2002) reported detectable tainting after a 24-hour exposure to crude concentrations of 0.1 ppm, marine fuel concentrations of 0.33 ppm and diesel concentrations of 0.25 ppm. Concentrations of petroleum in fish, crustacea and mollusc tissues can pose significant potential for adverse human health effects and until products are cleared by health authorities they could be restricted for sale and human consumption. The main potential impact of real or perceived tainting of target species is financial loss to licence holders and fishing crew; however, there may also be wider economic consequences such as reduced employment in fishing services in the region.

Nevertheless, a fisheries closure due to tainting concerns is expected to be short-term. After the Montara oil spill (Timor Sea, 2009) as a precautionary measure, the WA Department of Fisheries advised commercial fishers to avoid fishing in waters affected by oil from this spill, suggesting fish were not safe for human consumption. However, testing of fish caught in the visible slick found no detectable petroleum hydrocarbon in fish muscle samples, suggesting they were safe for human consumption. Limited ill effects were detected in a small number of fish (PTTEP 2013). No consistent effects of exposure on fish health could be detected within two weeks following the end of the well release. In addition, most studies (both laboratory trials or fish collected after spills) find evidence of elimination of PAHs in fish tissue, returning to reference levels within two months of exposure (Challenger & Mauseth 2011; Davis et al. 2002; Gagnon & Rawson 2011).

The impacts to commercial fishing from a public perspective may be more significant and longer term than the ecological impacts. Decreased catches may also occur due to ecological impacts on target species within the area of the spill. Larvae of commercial species and their planktonic food sources are the most vulnerable to hydrocarbon impacts (refer Plankton section above). Various species are likely to spawn in the area, whether in shallower shelf waters (e.g., whiting and snapper) or deeper slope waters (e.g., pink ling and blue grenadier). Most of these species are broadcast spawners making their larvae vulnerable to the effects of an oil spill. However, in the case of those species in which the spawning period overlaps the period of the proposed seismic survey, the area of a potential oil spill is very small relative to the area over which spawning occurs, and broad scale mixing because of oceanic currents is expected to minimise potential impacts of a short-term oil spill. In terms of impacts to adults, Gagnon & Rawson (2011) studied several fish species after the Montara blowout in the Timor Sea (light condensate) in four phases. Immediately after the blowout ceased, fish were exposed to and metabolised hydrocarbons, however, no consistent adverse effects on fish health or reproductive activity were detected. Five months after the blowout, continued exposure was indicated through the detection of elevated liver detoxification enzymes and PAH biliary metabolites in three out of four species collected, and elevated oxidative DNA damage. A year later, trends showed a return to reference levels with often (but not always) comparable biomarker levels in fish collected form reference and impacted sites. No reported studies of oil spills on cartilaginous fish (including sharks rays and sawfish) were found in the literature. It is not known how the data on bony fish would relate to cartilaginous fish.

Fish assemblage recovery depends on the intensity and duration of the spill, composition of the hydrocarbon and any dispersant used and life cycle attributes e.g., abundant short lived fecund species may recover quicker than long lived less abundant species with small movement ranges. Given the forecast rapid weathering and dissipation of a spill and the relatively small area where for a short period entrained and dissolved hydrocarbons could exceed thresholds, impacts from a hydrocarbon spill are unlikely to result in measurable effects on fishery catch returns. and impacts on commercial stocks and fishermen is expected to be minor.

8.6.3.8.3 Other Users – Public Amenity, Scuba Diving and Snorkelling

Hydrocarbon presence on the sea surface may create a safety hazard to other marine users. Volatilisation of hydrocarbon lighter ends may initially create conditions at the sea surface at the time of the initial release with a resultant fire hazard potential. Safety hazards associated with the release quickly reduce with distance, and time, from the spill. As such, safety impacts to third party marine users could only be experienced within very small distance of the spill source and within a short time of release given the weathering characteristics of MGO.

The shorelines that could be contacted by floating oil are detailed above in the shoreline section. The presence of oil on these shorelines could create a safety and public amenity in the event of a spill.

Recreational boating, fishing, swimming and diving is popular along much of the mid-west coast of WA. There are various coastal communities such as Geraldton, Dongara, Cervantes and Leeman and small squatters' camps, such as Grey, support the boating, fishing, diving and swimming throughout most of the year. Surface oil can coat fishing equipment/vessels especially where equipment is retrieved to the vessel and dissolved and entrained fractions could taint recreational catches and contaminate recreational equipment such as dive gear.

Other users would primarily be impacted by being displaced by the surface slick. As such, recreational fishing effort and swimming/diving would be expected to be moved outside the area of the impact of the slick. Public sensitivity is rated as High but given the intermittent nature of the coastline oiling from a single event, the spread-out nature of the coastal towns, the rapid evaporation and dissipation of MGO and temporary nature of any closures, impacts are assessed as Moderate.

8.6.3.8.4 Places of heritage and cultural Indigenous importance, and Commonwealth and State marine protected areas

A description of shipwrecks and other heritage sites is provided in Sections 4.4.6 and 4.4.7 respectively. Impacts of a spill include oiling, which is relevant to those values that are not fully submerged and are below the high-water mark. No shipwrecks that are in <5 m water depth have been identified inside the floating oil contour.

Impacts on submerged wrecks are discussed sparsely in the literature. Some research (BOEM 2018) has shown that the abundance and diversity of bacterial communities living on wrecks, making them more habitable for marine life (such as coral, crabs and fish) has increased following the Macondo spill. Figure 4 41 shows the quantity and location of shipwrecks that could potentially be contacted by entrained oil.

No Commonwealth heritage listed sites (see Section 4.4.7) are impacted by surface oil. The Batavia shipwreck in the Abrolhos Islands could be contacted temporarily by entrained oil; however, as described above the impacts are expected to be negligible.

Cultural Indigenous importance: A description of known cultural heritage values is provided in section 4.4.6 and an assessment of the potential impact to marine species of cultural significance is included earlier in this section. The closest known registered sites that are below the HWM include the Irwin River (18907) and Leander Point (5280); however, these sites are on the shoreline and there is no predicted impact to shoreline in this area. Sea Country interests have been identified within the EMBA but with the limited spill size and expected rapid evaporation and dissipation of MGO, impacts to cultural heritage are assessed as low.

Marine protected areas: A description of marine protected areas is given in Sections 4.4.1.

The potentially contacted types of shorelines range from rocky beaches, sandy beaches, mud flats and estuaries. Each of these will influence the volume of oil that could be retained ashore and its thickness before saturation occurs. Sandy beaches may allow oil to infiltrate through the sediments, thus increasing its ability to hold more oil ashore over tidal cycles and various wave actions than an equivalent area of water; hence, oil can increase in thickness onshore over time.

Algae and immobile benthic animals that colonise intertidal rocky shores are vulnerable to oil spills. Filter feeders such as molluscs are especially liable to ingest oil with lethal and various sub-lethal effects. The latter include alteration in respiration rates, decreases in filter feeding activity, reduced growth rates, biochemical effects, increased predation, reproductive failure and mechanical destruction by waves due to inability to maintain hold on substrate (Ballou et al. 1989; Connell & Miller 1981).

A review by Connell & Miller (1981) of field studies conducted after spill events indicated a high degree of variability in level of impact, but in all instances, the algae appeared to be able to recover rapidly from even very heavy oiling. They attributed the rapid recovery of algae to the fact that for most algae new growth is produced from near the base of the plant while the distal parts (which would be exposed to the oil contamination) are continually lost.

Laboratory tests have illustrated the sensitivity of seagrasses to both surface oil and dissolved or physically dispersed hydrocarbons (e.g., Hatcher & Larkum 1982). Stress response has also been demonstrated for seagrass at low hydrocarbon concentrations similar to that expected to occur in oil spill situations (Thorhaug et al. 1991).

The susceptibility of seagrass to hydrocarbon spills will depend largely on their distribution. Deeper communities will be protected from oiling under all but the most extreme weather conditions. Shallow seagrasses are more likely to be affected by dispersed oil droplets or, in the case of emergent seagrasses, by direct oiling. Intertidal seagrass communities would theoretically be the most susceptible because the leaves and rhizomes may both be affected. Refer Macroalgae section above.

Subtidal areas exposure to dissolved aromatic and entrained hydrocarbon concentrations were both predicted to be below the low exposure level, and that there is only a slight chance of a spill impacting any areas where seagrasses might occur (e.g., Corner Inlet).

Table 8-14 below is a summary of the probability of exposures for a selection of marine parks (see full report in Appendix E) for additional smaller or less exposed Parks.

Table 8-14: Summary of probabilities (%) of exposure to marine protected areas

	>10 g/m^2 floating oil	>100 ppb entrained oil	Probability of shoreline contacted >10 g/m^2	Comment
Commonwealth Marine Parks				

Abrolhos AMP	<1	24	N/A	No shoreline. Approximately only half of MP could be contacted by entrained oil. Low impacts to features of high biodiversity, protected birds and mammals (e.g., humpbacks), plankton and management plan values.
Jurien AMP	<1	10	N/A	Low probability of impacts to seabird and shorebird habitats, and seagrasses.
Perth Canyon AMP	<1	<1	N/A	Negligible probability of exposure to sensitive receptors.
South-West Corner AMP	<1	<1	N/A	Negligible probability of exposure to sensitive receptors.
Two Rocks AMP	<1	<1	N/A	Negligible probability of exposure to sensitive receptors.
State Marine Parks				
Jurien Bay MP	<1	29	10	
Marmion MP	<1	<1	<1	
Shoalwater Islands MP	<1	<1	<1	

NC: No contact. NA: Not Applicable

This is a selection of parks and reserves with higher exposures and/or have higher values. While some other marine parks and reserves may have coastlines that could be exposed to a spill the probability of weathered oil coming ashore above thresholds that may affect coastal habitats (>100 g/m^2) is low and full recovery expected within a year). Given the low level of impact predicted, the values expressed in the Marine Park Management Plans are met and risks to cultural values are assessed as Low.

Inherent risk	**Extent:** Small extent of pollution on the surface water to within a few 100 kms. Very minimal to negligible contact with shorelines. Injury or death to marine fauna and seabirds through ingestion or contact. Duration: days, weeks or months depending on level of contact, location and receptors. **Level of uncertainty of risk:** High. Spill source volumes are limited, noting modelling used a volume (320 m^3). The environmental impact of MGO is well understood, and very conservative thresholds have been selected to define the EMBA.		
	Consequence	Likelihood	Risk ranking
	Moderate	Unlikely	Moderate

8.6.4 Risk treatment

8.6.4.1 Demonstration of ALARP

Pilot is committed to ensuring continual risk reduction and identifying if additional control measures may be applied that are practicable – and hence not disproportionate to the sacrifice (e.g., cost) of implementation Control measures have not been adopted where the cost of implementation is disproportionate to the benefit gained.

The potential for a vessel collision leading to a spill cannot be eliminated completely. Power that could be used as a substitute (such as solar, wind or biofuels) are not commercially proven in such applications. Pilot considers the adopted controls to be appropriate in reducing the environmental risks to ALARP. No other controls measures have been identified that may practicably or feasibly be adopted to further reduce the risks of impacts without disproportionate costs compared to the benefit of risk reduction (Table 8-15).

Table 8-15: Cost benefit analysis and residual risk evaluation of accidental oil spill – vessel collision/ grounding

Control measures	Cost benefit analysis	Risk reduction	Control adopted
ALARP assessment technique – legislative requirements, good practice			
Compliance with specifications set by internationally recognised maritime legislation – MARPOL 73/78 Annex I	Benefits outweigh costs; Legal requirement	Yes	Yes
Vessel design such that the fuel tanks are located internally and protected by other tanks e.g., water ballast or void space. Note – the location of the fuel tanks on the analogue vessel are designed such that the water ballast tanks protect the fuel tanks	The costs of retrofitting unprotected tanks and/or the non-availability of such vessels (hence impacts to schedule) outweighs the benefit	Yes	No.
Survey and supply/chase vessels will be compliant with: Marine Order 91 – Marine pollution prevention—oil Marine Order 30 - Prevention of collisions Marine Order 27 - Safety of navigation and radio equipment Marine Order 21 - Safety and emergency arrangements	Benefits outweigh costs; standard procedures	Yes	Yes
The Australian Hydrographic Office (AHO) advised of the survey details (survey location, timing) four weeks prior to mobilisation and following demobilisation for issue of Notice to Mariners	Benefits outweigh costs	Yes	Yes
AMSA's JRCC will be advised of the survey vessel's details (including vessel name, call-sign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone), area of operation and requested clearance from other vessels. This information will be notified to AMSA JRCC 24 to 48 hours before operations commence via email address (rccaus@amsa.gov.au) or phone (1800 641 792 or +61 2 6230 6811)	Benefits outweigh costs	Yes	Yes
AMSA JRCC will be notified at the end of the survey when operations have been completed (via email address (rccaus@amsa.gov.au) or phone: 1800 641 792 or +61 2 6230 6811)	Benefits outweigh costs	Yes	Yes
Support/chase vessels will undertake surveillance (during a spill) and manage interactions with other marine users' vessels transiting near the seismic vessel or streamers	Benefits outweigh costs	Yes	Yes
Vessel to maintain appropriate lighting, navigation and communication systems always to inform other users of the position and intentions of the survey vessel, in compliance with the *Navigation Act 2012* and Chapter 5 of the SOLAS Convention	Benefits outweigh costs; legal requirement	Yes	Yes

Control measures	Cost benefit analysis	Risk reduction	Control adopted
Continuous (24-hour) survey operations, with survey team and bridge crew monitoring for weather and metocean conditions and other vessels always during seismic acquisition	Benefits outweigh costs	Yes	Yes
No refuelling of vessels to occur within the OA	Benefits outweigh costs	Yes	Yes
Vessels with fuel tank more than 320m3 will not be contracted to undertake the activity	This may result in inability to contract a vessel to undertake activity. If a vessel does have a fuel tank more than 320m3 there are other mitigations that could be implemented to ensure no increase in risk	No	No
Vessels will be limited to 10m depth	This may result in an inability to acquire parts of the survey area, depending on tide action and local bathymetry. Vessels will have navigational equipment and experienced personnel to deem safe depths for the local conditions.	No	No
In an emergency event where there is a loss of propulsion or steering on any vessel, anchors should be deployed immediately to reduce grounding risks and awaiting towing support.	This control ensures a timely response to a loss of propulsion or steering event.	Yes	Yes
Support vessels will always maintain a 2m depth under keel (except when scouting water depths).	This control ensures awareness of grounding risks and reduces risks to benthic habitats.	Yes	Yes
The seismic vessel will always maintain a 5m depth under keel.	This control ensures awareness of grounding risks and reduces risks to benthic habitats.	Yes	Yes

Residual risk evaluation				
Residual risk	Consequence	Likelihood	Risk ranking	Decision type
	Moderate	Unlikely	Moderate	B

8.6.4.2 Demonstration of acceptability

The demonstration of acceptability for lower-order impacts and risks is achieved by showing that they have been reduced to ALARP. This involves evaluating the effectiveness of all identified control measures, considering functionality, availability, reliability, survivability, compatibility, and cost–benefit factors. Where this evaluation confirms that no further reduction in impact or risk can reasonably be achieved, the ALARP threshold has been met. In accordance with NOPSEMA's Environment Regulations and guidance, once ALARP is demonstrated for a lower-order impact or risk, it is deemed to be of an acceptable level.

The risk assessment has concluded that an accidental hydrocarbon release resulting from a vessel collision represents a moderate risk rating that may result in medium-scale, medium-term impacts on ecosystems, species, and habitats. These potential impacts have been carefully evaluated in the context of their extent and duration.

The risk assessment concluded potential risks to commercial fish species and fish stocks as a result of a hydrocarbon spill were unlikely to result in measurable effects on fishery catch returns and risks to commercial stocks and fishermen would to be minor, ensuring AL 49 is met.

In conducting this assessment, Pilot has given due consideration to EPBC Act listed MNES, Marine Reserve Management Plan Values and Threatened Species Recovery Plans / Conservation Advice ensuring AL 48 has been met. . The assessment also considers compliance with MARPOL 73/78 Annex I, Marine Orders 21, 27, 30, and 91, as well as requirements set forth by AMSA and the AHO, ensuring AL 51 is met.

The adopted control measures are in line with good industry practice and fully comply with relevant legislative requirements. Furthermore, these measures align with the principles of ESD. Pilot has thoroughly explored additional opportunities to further mitigate impacts and risks associated with potential vessel collisions and subsequent hydrocarbon releases, as discussed in previous sections.

It is noted that while oil spill concerns were raised during the public comment period for the EP, no specific feedback has been received from relevant persons regarding this aspect of the project. This demonstration ensures AL 50 has been met.

Given these factors, Pilot believes the adopted control measures are appropriate and sufficient to manage the impacts and risks from vessel collision and potential hydrocarbon release to a level that is acceptable.

8.6.4.3 Environmental performance outcomes, standards and measurement criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for accidental oil spill (vessel collision) are presented below in Table 8-16.

Environmental performance standards and relevant measurement criteria have been developed for each control measure adopted in Section 8.5.4.1.

Table 8-16: Environmental performance outcomes, standards and measurement criteria –accidental oil spill – vessel collision/grounding

Environmental performance outcomes	Environmental performance standards	Measurement criteria
EPO 22 Vessel crews are prepared to respond to a spill, including Vessel master initiating action to reduce fuel loss EPO 22A No release of hydrocarbons to the marine environment.	PS 85 Compliance with MARPOL 73/78 Annex I (as applied in Australia under the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*); and Marine Order 91 - Marine pollution prevention—oil): Current SOPEP in place All vessels hold a valid IOPP Certificate, where required, under vessel class	MC 106 Records demonstrate the SOPEP is in place on the survey vessel MC 62 Records demonstrate all vessels hold an IOPP certificate, if required under vessel class
	PS 93 The SOPEP and OPEP are approved and tested prior to the survey vessel commencing acquisition (emergency response drills) and to test interfaces between the SOPEP, OPEP, NatPlan, and Western Australia OSCP.	MC 116 Records demonstrate the SOPEP and OPEP are approved, tested (desktop exercise) and available to relevant persons on the survey vessel
	PS 94 Responsibilities of vessel crew under the OPEP and SOPEP are communicated to relevant personnel and included as part of the project induction	MC 114 Records show that the project induction (including induction material) includes responsibilities of vessel crew for response and notification protocols under the OPEP and SOPEP
	PS 95 All relevant crew trained in implementation of the OPEP and SOPEP	MC 116 Training, induction and competency matrix to confirm that crew have been trained on implementation of the OPEP and SOPEP prior to commencing seismic data acquisition
	PS 96 The Vessel Master/s will authorise actions in accordance with the vessel- specific SOPEP (or equivalent according to class) and the survey- specific OPEP to limit the escape of MDO.	MC 73 Daily operations reports verify that the SOPEP and OPEP were implemented.
EPO 23 Communications to advise others of presence to prevent collision	PS 97 Survey and supply/chase vessels will be compliant with: Marine Order 30 - Prevention of collisions Marine Order 27 - Safety of navigation and radio equipment Marine Order 21 - Safety and emergency arrangements	MC 118 Records demonstrate that the survey and support/chase vessels are compliant with Marine Orders 30, 27 and 21

Environmental performance outcomes	Environmental performance standards	Measurement criteria
	PS 20 The Australian Hydrographic Office (AHO) advised of the survey details (survey location, timing) four weeks prior to mobilisation and following demobilisation for issue of Notice to Mariners	MC 24 Records of notification of survey details sent to the AHO four weeks prior to survey mobilisation and within two weeks of survey demobilisation
	PS 22 AMSA's JRCC will be advised of the survey vessels details (including vessel name, call-sign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone), area of operation and requested clearance from other vessels. This information will be notified to AMSA JRCC 24 to 48 hours before operations commence via email address (rccaus@amsa.gov.au) or phone (1800 641 792 or +61 2 6230 6811)	MC 26 Pre-survey notification demonstrates that AMSA JRCC have been notified of the survey vessel details and movements 24 to 48 hours prior to the start of the survey
	PS 111 AMSA JRCC will be notified at the end of the survey when operations have been completed (via email address (rccaus@amsa.gov.au) or phone: 1800 641 792 or +61 2 6230 6811).	MC 27 End of survey notification demonstrates that AMSA JRCC have been notified of the completion of survey operations
	PS 98 Escort/support vessel(s) will undertake surveillance (during a spill) and manage interactions with other marine users and vessels transiting near the seismic vessel or streamers	MC 119 Support vessel log confirms vessel is employed for the duration of the activity and manages interactions with other marine users and vessels
	PS 17 All vessels to maintain appropriate lighting, navigation and communication to inform other users of the position and intentions of the survey vessel, in compliance with the *Navigation Act 2012* and Chapter 5 of the SOLAS Convention	MC 21 Records show no failure to comply with requirements for appropriate navigation, lighting and communication during survey, in accordance with the *Navigation Act 2012* and Chapter 5 of the SOLAS Convention. Any records of failure to comply are documented
	PS 110 Continuous (24 hour) survey operations, with survey team and bridge crew monitoring for weather and metocean conditions and other vessel position and depth always during seismic acquisition	MC 23 Records confirm bridge was manned continuously during survey operations, and that survey vessel crew have appropriate qualifications

Environmental performance outcomes	Environmental performance standards	Measurement criteria
EPO 24 Vessels contracted will ensure compliance with modelled fuels and volumes	PS 115 Activity vessels will not use heavy fuel oil	MC 76 Bunkering records demonstrate volume of MGO or MDO used on all vessels
	PS 117 Activity vessel fuel tanks will not hold more than modelled amount fuel.	
EPO 25 No refuelling in the Operational Area	PS 118 Activity vessels will not undertake refuelling or vessel-to-vessel bunkering in the Operational Area.	MC 130 Records will show locations that refuelling occurred
EPO 26 Collect operational monitoring data to support the spill response and collect scientific monitoring data to characterise environmental impacts.	PS 99 Pilot will undertake operational and scientific monitoring in accordance with the Operational and Scientific Monitoring Program (OSMP).	MC 120 Daily operations reports and overall study reports verify that the OSMP was implemented.

8.7 Risk 6 – Oil spill response

In accordance with the Pilot Energy risk assessment methodology (Section 6) this risk is classified as lower order.

8.7.1 Identification of hazard and extent

Hazard	In the event of an oil spill, several potential responses may be initiated; dependent on direction from the Control Agency (AMSA, refer to Section 8.7), the location and size of the spill, the potential for sensitive environmental receptors to be impacted and the resources available. Typical responses generally involve additional vessels and may involve equipment and field survey teams. These extra activities introduce additional risks to environmental, socio-economic and cultural receptors, as well as increasing the likelihood of many of the impacts and risks assessed within this EP. The following response strategies have been considered for the two credible spill scenarios (representing one Level 1 and one Level 2 spill) under this EP, and are assessed with relevance to the Eureka 3D MSS in Table 8-3: • Monitor and evaluate • Mechanical dispersion • Containment and recovery • Shoreline protection • Shoreline clean-up • Chemical dispersion
Extent	EMBA
Duration	Duration of survey – up to 40 days in early February to the end of March.

8.7.2 Defined acceptable levels

For lower-order impacts and risks, Pilot Energy defines the acceptable level as the point at which the residual impact or risk has been reduced to as low as reasonably practicable (ALARP). This means that all relevant control measures have been identified and implemented to the extent that no additional practicable measures are available without costs being grossly disproportionate to the environmental benefit gained. In this context, the acceptable level is inherently linked to the ALARP outcome, recognising that residual impacts and risks for this lower order risk are tolerable, consistent with legislative requirements, and aligned with relevant environmental and stakeholder expectations.

8.7.3 Risk analysis and evaluation

Potential risks	The activities associated with a hydrocarbon spill response introduce additional risks to marine fauna and habitats, as well as increasing the likelihood of many of the impacts and risks already described within this EP. Examples of additional risks include: Increased risk of disturbance of seabirds/shorebirds/marine megafauna Increased risk of vessel strikes Physical damage to shallow subtidal habitats and communities (e.g., reefs, seagrass) from anchoring of shoreline protection booms Increased risk to shallow subtidal habitats and communities from remobilisation of intertidal hydrocarbons/dispersed hydrocarbons and/or chemical control agents applied intertidally Damage to sensitive intertidal habitats and food resources due to trampling, vehicles, cropping, removal of oiled sediment, hot water/jet washing, chemical control agents/dispersants.

Predicted effects	Application of spill response strategies from vessel spills, where not adequately assessed, have the potential to significantly increase impacts to environmental sensitivities in comparison to an unmitigated spill (e.g., *Exxon Valdez*). Several of the proposed methods have the potential for increasing impacts if applied without appropriate consideration (e.g., shoreline clean-up, application of chemical control agents/dispersants).		
Inherent risk	Consequence	Likelihood	Risk ranking
	Minor	Possible	Moderate

8.7.4 Risk treatment

8.7.4.1 Demonstration of ALARP

Pilot is committed to ensuring continual risk reduction and identifying if additional control measures may be applied that are practicable – and hence not disproportionate to the sacrifice (e.g., cost) of implementation, in line with the ALARP assessment process. Control measures have not been adopted where the cost of implementation is disproportionate to the likely benefit gained.

Pilot considers the adopted controls to be appropriate in reducing the environmental risks to ALARP (Table 8-17). No other controls measures have been identified that may practicably or feasibly be adopted to further reduce the risks of impacts without disproportionate costs compared to the benefit of risk reduction.

Response actions will be based on a Spill Impact Mitigation Assessment (SIMA) approach, which will be used to consider the advantages and disadvantages of the different spill response options to determine if there would be a net environmental benefit or dis-benefit resulting from the implementation of a particular response in comparison to an unmitigated spill response strategy. SIMA considers the hydrocarbon type, the sensitivities of the regional area of the spill, and the potential effects (positive and negative) of the proposed response strategy. The decision context focuses on the potential level of impact, spatial scale of impact and duration of impact. The method to be used will be in line with global industry best-practice (IPIECA 2019; IPIECA_API-IOGP 2017).

SIMA is used for preliminary assessment to determine the initial spill responses required. In the actual event of a spill, the SIMA is revisited every operational cycle as more information becomes available e.g., on actual conditions, spill trajectory path and locations of sensitive receptors; and/or where a significant change in risk has been identified. This review process allows response strategies to be dimensioned to the nature and scale of the actual incident to provide optimal results (refer to the OPEP in Section 8.7.9).

8.7.4.2 Demonstration of acceptability

Pilot Energy's risk assessment methodology requires that the demonstration of acceptability for lower-order impacts and risks is achieved by showing that they have been reduced to ALARP. This involves evaluating the effectiveness of all identified control measures, considering functionality, availability, reliability, survivability, compatibility, and cost–benefit factors. Where this evaluation confirms that no further reduction in impact or risk can reasonably be achieved, the ALARP threshold has been met. Once ALARP is demonstrated for a lower-order impact or risk, it is deemed to be of an acceptable level.

This assessment has concluded that, with the implemented control measures, Oil Spill Response activities represent a low-risk rating that is unlikely to result in potential impacts beyond localised effects with no lasting consequences. These impacts, should they occur, are expected to be limited in both extent and duration.

Pilot has thoroughly explored additional opportunities to further mitigate impacts and risks associated with Oil Spill Response activities, as discussed in previous sections. The adopted control measures are in line with good industry practice and fully comply with relevant legislative requirements. Furthermore, these measures align with the principles of ESD.

No specific concerns regarding Oil Spill Response activities have been raised by relevant stakeholders. Given these factors, Pilot believes the adopted control measures are appropriate and sufficient to manage the impacts and risks from Oil Spill Response activities to a level that is broadly acceptable.

8.7.4.3 Environmental performance outcomes, standards and measurement criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for oil spill response are presented below in Table 8-18. Environmental performance standards and relevant measurement criteria have been developed for each control measure adopted in Section 8.7.4.1.

Table 8-17: Cost benefit analysis and residual risk evaluation – oil spill response

Control measures	Cost benefit analysis	Risk reduction	Control adopted
ALARP assessment technique – good practice			
In the event of an oil spill, the survey Vessel Master will implement available controls and resources of the SOPEP	Benefits outweigh costs; legal requirement	Yes	Yes
Commercial and recreational fishers and other users in the area would be advised of any large spill and associated response activities via Pilot's 24-hour 'look-ahead' correspondence	Benefits outweigh costs requirement	Yes	Yes
A hydrocarbon spill will be immediately (verbally within 2-hours) reported to ensure all notifications are provided as per Section 10.8.2	Benefits outweigh costs; regulatory requirement	Yes	Yes
Operational monitoring will be undertaken e.g., to inform AMSA about the behaviour, likely trajectory and key sensitivities at risk from a spill (Section 8.7)	Benefits outweigh costs	Yes	Yes
Oil spill response training and competencies are to be maintained to avoid unplanned environmental impacts due to human error	Benefits outweigh costs	Yes	Yes
ALARP assessment technique – EIA			
Response actions will be based on a Spill Impact Mitigation Assessment (SIMA) approach, which considers the advantages and disadvantages of the different spill response options to determine if there would be a net environmental benefit resulting from the implementation of a particular response relative to an unmitigated spill impact.	Benefits outweigh costs	Yes	Yes
Residual risk evaluation			

Residual risk	Consequence	Likelihood	Risk ranking	Decision type
	Minor	Unlikely	Low	A

Table 8-18: Environmental performance outcomes, standards and measurement criteria – oil spill response

Environmental performance outcomes	Environmental performance standards	Measurement criteria
EPO 27 Spill response arrangements to minimise impacts to the environment implemented in accordance with the vessel SOPEP and OPEP in this EP	PS 99 For a level 1 spill, the survey vessel master will implement available controls and resources of the SOPEP	MC 73 Incident report verifies the SOPEP was implemented
	PS 100 Depending on the nature and scale of the spill, an Incident Action plan will be prepared by the planning officer to guide response activities	MC 121 Incident Action Plan and Incident Log confirm OMPs and SMPs are activated in accordance with the initiation criteria provided in Table 9-1 and Table 9-2 of the Joint Industry OSM Framework (APPEA, 2021)
	PS 101 Response actions will be based on a SIMA approach defined by AMSA/DoT	MC 122 SIMA outcomes and/or reports
	PS 102 The survey vessel master is responsible for notification (written and verbal) of a spill to the sea to the AMSA JRCC and subsequent reporting (as per Section 8.7)	MC 123 Records of verbal communications and copies of marine pollution report (POLREP) report and situation reports (SITREPs) as per Section 8.7
	PS 103 Commercial and recreational fishers and other users in the area would be advised of any large spill and associated response activities via Pilot's 24-hour 'look-ahead' correspondence	MC 124 Copies of relevant person notifications and incident report(s) in the event of a spill
	PS 98 Support vessels undertaking the Eureka 3D MSS are used as vessels of opportunity to monitor the spill (operational monitoring) if safe to do (as agreed with AMSA)	MC 125 Incident Report/operational monitoring reports, consultation records
	PS 104 On-call Scientific Monitoring response service agreement in place	MC 126 Copy of service contract with Scientific Monitoring subcontractor prior to commencement of the survey