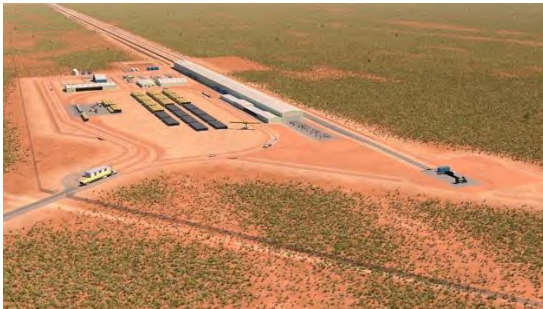


# Subsea 7 Learmonth Bundle Site – Invasive Marine Species and Pathogen Desktop Risk Assessment

Date: 29 September, 2018

Prepared for Subsea7 Australia Contracting Pty Ltd.



subsea 7



Report prepared by





TITLE: Subsea 7 Learmonth Bundle Site - Invasive Marine Species and Pathogen Desktop Risk Assessment

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## EXECUTIVE SUMMARY

To support oil and gas developments throughout the Asia-Pacific region, Subsea 7 Australia Contracting Pty Ltd. (Subsea 7) is proposing to build and operate a new pipeline Bundle fabrication facility at Heron Point near Learmonth (Exmouth) in Western Australia. Subsea 7 engaged the services of Biofouling Solutions Pty Ltd. (BFS) to address Item 31 of the Environmental Scoping Document (ESD) which states the following intention:

*Identify any known marine pests or pathogens in the area potentially affected by the operation of the proposal, and/or adjacent waters. Conduct a risk assessment to identify whether the proposed activities are likely to introduce or extend the range of introduced marine pests or pathogens. Identify the control measures by which these may be avoided/mitigated. Based on the outcomes of the risk assessment, determine in consultation with EPA Services and the Department of Primary Industries and Regional Development whether there is a need to design and conduct a baseline survey in accordance with the guidelines provided by the Australian National System for the Prevention of Marine Pest Incursions.*

This desktop risk assessment follows international standards, although the process was slightly modified to suit the required ecological risk assessment. It included the following five steps: 1) threat identification, 2) hazard pathway identification, 3) hazard pathway analysis, 4) risk identification and assessment, and 5) overarching risk assessment based on the information provided by Subsea 7 on the proposed Learmonth Pipeline Bundle construction and launching process.

Threat identification involved determining which Invasive Marine Species (IMS) and pathogens pose a credible threat and should be considered in this risk assessment. The hazard pathway identification process involved determining the different potential pathways where IMS and/or pathogens could be either introduced to (or transported out) of the Exmouth Gulf. Ballast water and vessel biofouling associated with the proposed project vessels were considered the most likely pathways for the introduction/spread of IMS and pathogens. However, specific details pertaining to proposed vessel movements, particularly between Bundle launches was not available in the early proposal phase. Consequently, the hazard pathway analysis considered four different generic vessel interaction scenarios. These included:

1. All vessels associated with the proposed project remain within the Exmouth Gulf.
2. One or more vessels visit/reside outside Exmouth Gulf, but remain within ports and/or shallow coastal waters of Western Australia.
3. One or more vessels visit/reside in interstate ports and/or shallow coastal waters of Australia.
4. One or more vessels visit/reside in international ports and/or shallow coastal waters outside Australia.

A Consequence–Likelihood (C x L) method was used to assess the level of the identified hazard pathway components associated with the key identified threats. The risk assessment approach applied here is a widely used method (Standards Australia, 2012) and is applied by many Western Australian Government

agencies. Conducting the hazard or risk analysis using the C x L methodology involved selecting the most appropriate combination of consequence (levels of impact) and the likelihood (levels of probability) of future scenarios on the basis of IMS subject matter expertise and experience. The combination of consequence and likelihood scores were used to determine the overall risk rating. Risk ratings were first assessed in the absence of any management control measures, followed by reassessment assuming application of management controls identified in this document. The later scores provide a measure of residual risk despite all reasonable management control measures being undertaken.

Based on available information, the only IMS recorded in the Exmouth Gulf is the invasive colonial ascidian, *Didemnum perlucidum* (Monniot, 1983) which appears to be confined to artificial structures such as wharf piles within the Exmouth Marina. The only known pathogen documented to date in the Exmouth Gulf is an unknown species of infectious intracellular ciliate which was found in the digestive glands of cultured oysters (*Pinctada maxima*) in the Exmouth Gulf in 2006, and appears to have caused oyster oedema disease and severe mortality. It is understood that the oyster oedema disease is now distributed along the Western Australian coastline (Jones and Creeper, 2006). There are only three IMS listed on the Western Australian Prevention List for Introduced Marine Pests recorded in Western Australian waters; the dinoflagellate *Alexandrium minutum* (Halim, 1960) the bivalve *Musculista senhousia* (Benson in Cantor, 1842) and the polychaete *Sabella spallanzanii* (Gmelin, 1791).

While IMS and/or pathogens can be translocated to new locations in many different ways, the most likely mechanism/s associated with the proposed Bundle construction site and launching process is via the movement of construction and Bundle launch vessels associated with the project. While the proposed launching site is proposing to consist of only rock and not wharf piles, mooring, pontoons, etc, and the general lack of pollution at the Bundle launching site, the addition of anthropogenic rock may provide suitable substrate for *D. perlucidum*. Nevertheless, it is unlikely that this species establishment would cause any demonstratable impacts across any of the four core values. In addition, given the apparent lack of IMS and pathogens detected within the Exmouth Gulf to date, and the nature of the proposed operations, there appears to be a greater theoretical probability for the Exmouth Gulf to receive IMS and pathogens via these two pathways than donating them to other regions. Therefore, no further assessment of the consequences and likelihood of the proposed operations introducing IMS and pathogens to locations outside the Exmouth Gulf was undertaken.

The Exmouth Gulf is home to numerous important commercial fisheries such as the Exmouth Prawn Fishery and important shellfish fisheries such as scallops and native oysters, all of which are vulnerable to pathogens and diseases. While the discharge of infected ballast water could be considered the greatest vector for the introduction of pathogens and diseases, there is also potential for transport of mature adult decapods nestled amongst excessive levels of biofouling within niche areas on vessel hulls to also disperse non-indigenous parasites, pathogens and viruses such as *Carcinonemertes epialti*, *Sacculina* spp. or Baculovirus (responsible for White Spot Disease). A White Spot Disease outbreak has recently occurred in Queensland



with major impacts on commercial prawn farming. The likelihood for significant adverse consequences if it is also introduced into the Exmouth Prawn Fishery are considered 'very high'. Furthermore, Exmouth Gulf supports nationally and internationally renowned recreational fisheries that are vulnerable to pathogens and diseases either directly (in the case of toxic diatoms, or indirectly via declines in their food resources, for instance via decapod population impacts potentially associated with white spot disease).

Based on the proposed activities and the risk identification and assessment process, in the absence of management control measures the following scenarios were identified as posing 'High' marine biosecurity risks:

- One or more vessels visit/reside within ports and/or shallow coastal waters of Western Australia have a 'High' risk of introducing pathogens into Exmouth Gulf upon their return.
- One or more vessels visit/reside in interstate ports and/or shallow coastal waters have a 'High' risk of introducing pathogens into Exmouth Gulf upon their return.
- One or more vessels visit/reside in international ports and/or shallow coastal waters have a 'High' risk of introducing IMS and pathogens.

The above scenarios all involve potential transport of IMS and/or pathogens in ballast water discharge and/or vessel biofouling. Accordingly, the following treatments or management measures could be implemented to reduce the overarching risks to 'Low' (i.e. achieving an acceptable level of risk).

1. Any vessels obtaining ballast water from outside the Exmouth Gulf, but within Australian waters, should use the Commonwealth Department of Agriculture and Water Resources Quick Domestic Ballast Water (DBW) Risk Assessment Tool to guide management actions and avoid the potential to introduce IMS and/or pathogens via ballast water discharge.

2. The highest risk of vessels introducing any IMS and/or pathogens via vessel biofouling would be those which reside in locations outside Exmouth Gulf, and could infect project vessels and be transported to Exmouth Gulf either during the construction phase of the Bundle launch ramp or during the process of Bundle launches. Where possible Subsea 7 should commit to giving preference to local and Australian vessels. BFS understands that Subsea 7 has already committed to this initiative and should local vessels prove unavailable or unsuitable, only then would international vessels be considered. In these events, Subsea 7 could use the WA DPIRD online 'Vessel Check' Biofouling Risk Assessment Tool prior to re-entry into Western Australian waters. In addition, Subsea 7 may also need to apply the same measure to any construction barges/vessels if they have resided in shallow inshore waters outside the Exmouth Gulf. It is also important to acknowledge that BFS has been involved in a number of projects involving Subsea 7 vessels to date and found their management of biosecurity risks to be of the highest quality and standards. Subsea 7 takes biosecurity concerns very seriously and has always adopted a precautionary approach to ensure that all biosecurity risks are managed to acceptable levels.



While it is acknowledged that the Exmouth Gulf has yet to be thoroughly surveyed for IMS, the likelihood of high risk IMS being established and remaining undetected appears relatively 'unlikely'. This is because the Exmouth Gulf has not been subjected to on-going potential infection from visiting international vessels, particularly relative to neighbouring ports like Dampier, Cape Lambert and Port Hedland. In addition, the Exmouth Gulf remains relatively undisturbed and lacks significant addition of artificial structures such as wharf pylons, mooring, pontoons, etc. all of which are renowned for facilitating IMS incursions. Nevertheless, given that all scenarios were risk assessed as posing an overall 'Low' risk of introducing IMS and pathogens into the Exmouth Gulf (with the implementation of management measures where appropriate), there would be little current justification in designing and conducting a baseline survey for IMS in accordance with the guidelines provided by the Australian National System for the Prevention of Marine Pest Incursions.



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## 1 BACKGROUND

Subsea 7 Australia Contracting Pty Ltd. (Subsea 7) is proposing to build and operate a new pipeline Bundle fabrication facility at Heron Point near Learmonth (Exmouth) in Western Australia to support oil and gas developments throughout the Asia-Pacific region. The fabrication technology was established in 1978 at a facility north of Wick, Caithness in the far North of Scotland and has since manufactured and installed over 78 pipeline bundles in the North Sea, eight in Africa and three in Australia.

The proposed pipeline Bundle fabrication facility near Learmonth will include a Bundle track of approximately 10 km and an access road from Minilya-Exmouth Road approximately of 3 km (**Figure 1**). The proposal includes the construction of a fabrication shed, for Bundle construction, a storage area where the Bundle materials will be stored prior to use, and two approximately 10 km rail Bundle tracks for finalising each bundle construction and their launching. A Bundle launch-way, crossing the beach and extending into the shallow subtidal area, will facilitate the launch of each Bundle.



**Figure 1.** Proposed location of Subsea 7's Learmonth Bundle Fabrication Facility.

Once a Bundle has been fabricated, launching a bundle will involve the seaward end of the bundle being connected to a tug (the 'Leading Tug') via a long tow wire. The tug then slowly ( $\leq 5$  knots) steams offshore, pulling the bundle along the rail track and into the ocean. The first 40 km will be towed in the off-bottom mode until the bundle is situated in the Parking Area where the Bundle will be checked and surface buoyancy removed in preparation for surface towing (**Figure 2**). The Bundle will be towed on the surface for the next 44 km through the Marine Park. From there, the Bundles will be towed offshore along a pre-determined route to their site of deployment.



**Figure 2.** Proposed Bundle Towing Route.



Bundle launch activities are expected to result in 2-days of offshore activity per launch in the Heron Point and Exmouth Gulf area with a maximum of three launches per annum. Each Bundle tow will have a specific vessel fleet, with a typical vessel fleet made up of:

- 1 x Command Vessel (shallow water work)
- 2 x Anchor Handling Tugs
- 1 x Trail Tug
- 1 x Guard Vessel (for the inshore operations)
- 1 x Work Vessel
- 1 x Project Support Boat

Subsea 7 submitted their Learmonth Pipeline Bundle Fabrication Facility Proposal to the Western Australia Environmental Protection Authority (WA EPA) for assessment. The WA EPA made the decision to assess the development under a Public Environmental Review (highest level of assessment). Subsea 7 are required to address Item 31 of their Environmental Scoping Document (ESD) which states:

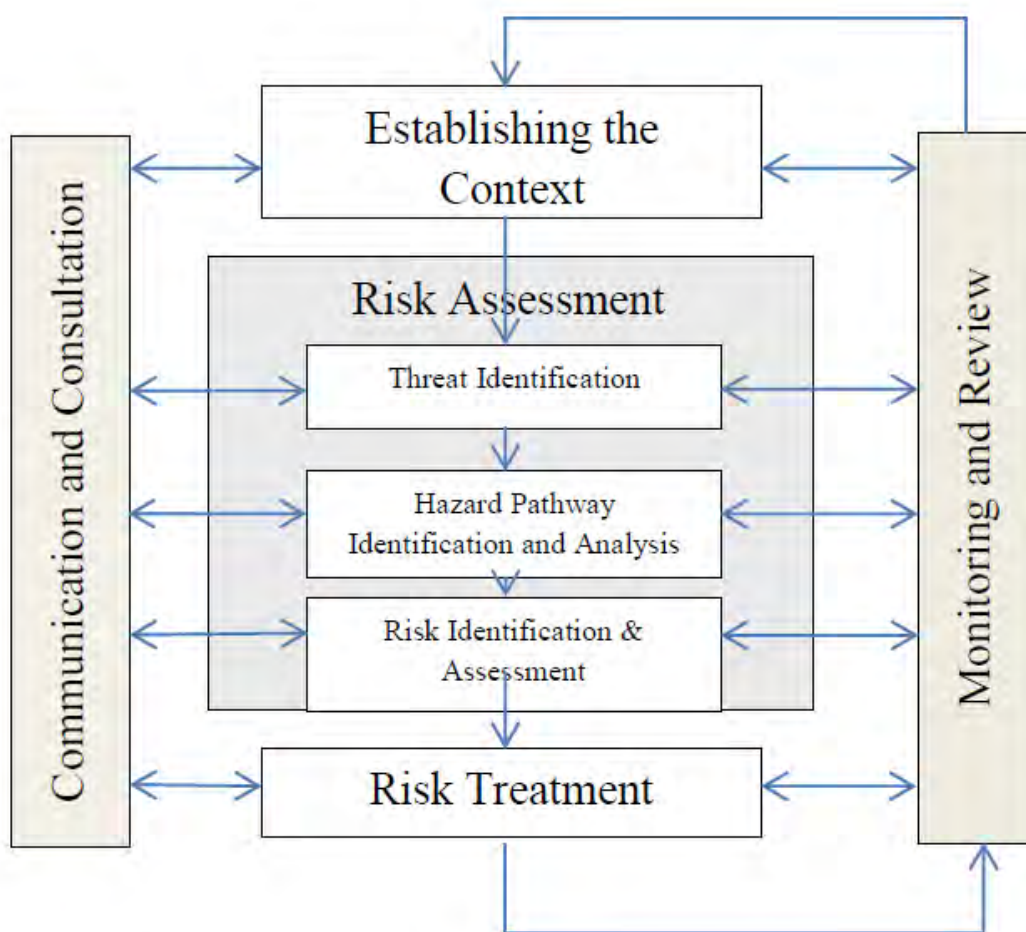
*Identify any known marine pests or pathogens in the area which is potentially affected by the operation of the proposal, and/or adjacent waters. Conduct a risk assessment to identify whether the proposed activities are likely to introduce or extend the range of introduced marine pests or pathogens. Identify the control measures by which these may be avoided/mitigated. Based on the outcomes of the risk assessment determine in consultation with EPA Services and the Department of Primary Industries and Regional Development whether a there is a need to design and conduct a baseline survey in accordance with the guidelines provided by the Australian National System for the Prevention of Marine Pest Incursions.*

Subsea 7 engaged the services of Biofouling Solutions Pty Ltd. (BFS) to conduct the required desktop risk assessment. BFS is experienced with conducting risk assessments for the assessing the probability and consequences of marine pests (hereafter referred to as Invasive Marine Species or IMS) being introduced to new locations predominantly via vessel biofouling and to some extent, via vessel ballast water discharges, however BFS does not specialise in the management of pathogens. Therefore, while the following risk assessment considers the probability and consequences of the introduction and/or dispersal of pathogens to the best of our ability, BFS recommend that subject matter experts in this specific field be consulted if further refinement or information is required beyond the outcomes of this assessment.



## 2 METHODS

Conducting desktop risk assessments normally follow the international standards (e.g. ISO 31000, 2009; IEC/ISO; 2009; Standards Australia-HB89; 2012). This typically involves a three-step process, 1) risk identification, 2) risk analysis, and 3) risk evaluation. However, on the basis of details provided for the proposed Learmonth Pipeline Bundle construction process the process for completing these steps have been slightly modified to suit the required ecological risk assessment. It includes the following steps: 1) threat identification, 2) hazard pathway identification, 3) hazard pathway analysis, 4) risk identification and assessment, and 5) overarching risk assessment based on the information provided (see **Figure 3** for conceptual process). This adaptation to the risk assessment process has been adopted for a number of different management situations in Australia (e.g. Fletcher et al., 2002; Fletcher, 2005; Jones and Fletcher, 2012; Western Australian Department of Fisheries, 2015).



**Figure 3.** Risk assessment and management conceptual process (modified from Standards Australia, 2012).

## 2.1 Threat Identification

Threat identification centres on assessment of the potential for IMS and pathogens to be either introduced into, or transported out of, the Exmouth Gulf as a consequence of the proposed Learmonth Bundle construction and launching process. This is based on the fact that the introduction, establishment and spread of IMS and pathogens into new locations where they did not formally exist can cause catastrophic ecological, economic, human health and social/cultural consequences (Carlton, 1996, 2001; Pimental, 2000; Hewitt et al., 2011). The next steps were to determine: a) which IMS and pathogens pose a threat, and b) what their known presence and distribution is within the Exmouth Gulf, and around Australia.

### 2.1.1 Step 1. Determining which IMS and/or Pathogens Pose a Threat

To determine which IMS and pathogens pose a credible threat and should be considered in this risk assessment, we refer to the outcomes of previous state and commonwealth government species specific risk assessments. In Western Australia, the lead organisation for managing IMS and pathogen threats and responses is the Western Australian Department of Primary Industries and Regional Development (WA DPIRD). This department has been pro-active in protecting Western Australian waters from IMS and pathogens associated with a natural resource boom and major increases in international shipping. In November, 2016, the WA DPIRD released a list of 'Noxious Fish' under Schedule 5 of the *Fish Resource Management Regulations 1995*<sup>1</sup>. All vessels entering Western Australian waters (this includes interstate vessels) must be free of any 'live, Noxious Fish' listed under Schedule 5. All of these IMS have been previously risk assessed by either the Commonwealth's Department of Agriculture and Water Resources (DAWR) (i.e. Hewitt et al. 2011) or by WA DPIRD as having the potential to be introduced, establish, reach pest densities and cause demonstrable impacts within Australian waters. These impacts can be across any one or more of the aforementioned four core values (i.e., ecological, economic, human health and social/cultural). Determining which pathogens pose a threat involved an internet search which determined that both Western Australia and the Commonwealth Government have separate notifiable lists of aquatic diseases which could be used as part of this assessment<sup>2,3</sup>.

### 2.1.2 Step 2. Determining the presence and distribution of IMS and Pathogens

Determining the presence and distribution of IMS and pathogens listed above involved internet searches, consulting numerous IMS baseline port survey reports conducted between 1995 to 2003, where possible gaining access to additional survey reports undertaken by private companies as part of their Environmental Approval Process, and finally liaising with representatives from the WA DPIRD and DAWR.

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<sup>1</sup> See <http://www.fish.wa.gov.au/Sustainability-and-Environment/Aquatic-Biosecurity/Translocations-Moving-Live-Fish/Pages/Noxious-Banned-Fish.aspx> for list of 'noxious fish'.

<sup>2</sup> See <https://www.agric.wa.gov.au/livestock-biosecurity/reportable-animal-diseases-western-australia> for reportable animal diseases for Western Australia.

<sup>3</sup> See <http://www.agriculture.gov.au/animal/aquatic/reporting/reportable-diseases> for Australia's National List of Reportable Diseases of Aquatic Animals).

## 2.2 Hazard Pathway Identification

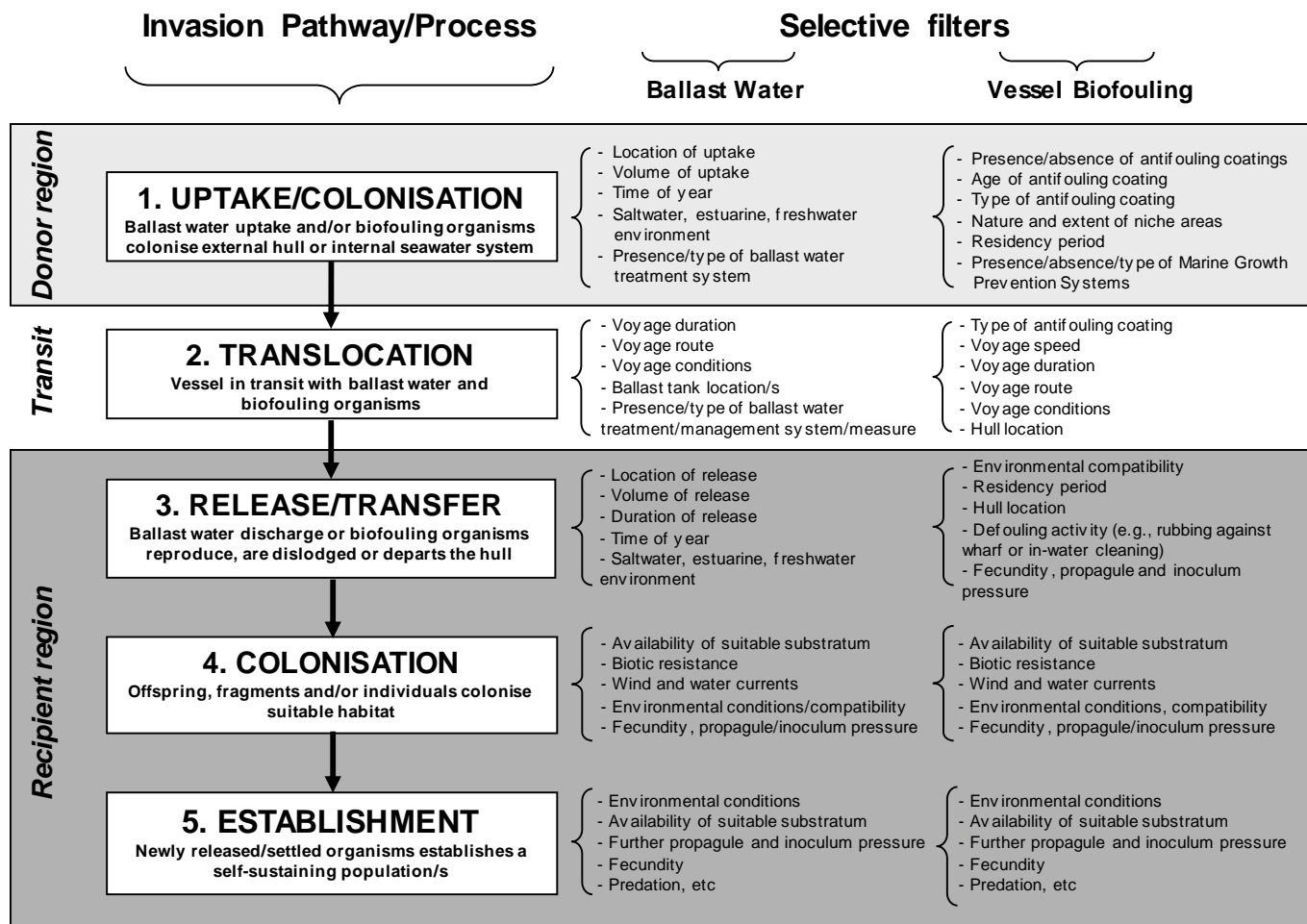
The hazard pathway identification process involved identifying the different potential pathways that could feasibly transport IMS and pathogens from the identified lists either into or out of the Exmouth Gulf. While a variety of pathways are known to be responsible for translocating IMS and/or pathogens around the world including shipping, fisheries, mariculture, aquarium trade (e.g., Carlton, 1985, 1987, 1992; Cohen and Carlton, 1995; Thresher et al., 1999; Ruiz et al., 2000; Minchin and Gollasch, 2002; Hewitt et al., 2004), international shipping is considered to be responsible for the majority of inadvertent IMS and pathogen introductions around the world (e.g. Carlton, 1987; Cranfield, 1998; Minchin and Gollasch, 2002; Nehring, 2002).

In particular, ocean-going vessels can transport IMS in ballast water, and biofouling attached to submerged immersible equipment, within internal seawater systems and/or on the exterior of the hull (Schormann et al., 1990; Carlton et al., 1995; AMOG Consulting, 2002). For the past three decades, ballast water has been considered the primary vector responsible for the dispersal of IMS and pathogens around the world (Carlton, 1985; Thresher et al., 1999; Eldredge and Carlton, 2002). However, recent research suggests the role of ballast water was probably overstated for its role for dispersing IMS, and up to 69% of these introductions may have occurred via biofouling (Hewitt et al., 1999, 2004; Hewitt and Campbell, 2010). Therefore, the pathway identification process focussed on identifying the potential for the aforementioned IMS and pathogens to be either introduced into or out of the Exmouth Gulf via the movement of the vessels associated with the proposed Learmonth Bundle construction and launching process<sup>4</sup>.

In order for IMS and/or pathogens to be successfully translocated from a donor region and establish in a recipient region via ballast water or vessel biofouling, they must pass through a sequence of invasion pathway processes including: 1). Uptake/Colonisation, 2). Translocation, 3). Release/Transfer, 4). Colonisation, and 5). Establishment) and overcome a series of associated selective filters at each stage (See **Figure 4**). However, it is important to acknowledge that even if IMS or pathogens successfully negotiate this pathway to become an establish in a new location/s, does not necessarily mean they will become problematic and cause demonstrable impacts on one or more core values (e.g. economic, environmental, social/cultural, and/or human health).

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<sup>4</sup> The likelihood of IMS and/or pathogens to be introduced as a result of land-based activities such as the creation of the proposed bundle launch area constructed from quarry derived rocks is considered extremely low.



**Figure 4.** Stages of the invasion pathway/process and the various selective filters IMS and pathogens must endure during the process via either ballast water or vessel biofouling.

For each invasion pathway process in the sequence above, selective filters (factors) can affect the total number of organisms and species that transition successfully (survive) to the next stage. This is critical for not only determining hazard pathways, but also analysing their probability of successfully becoming established. For example, it is now widely appreciated that ‘propagule pressure’ (or the number of individuals introduced), is a primary determinant of establishment success for introduced populations (see Lockwood et al., 2005, 2009; Simberloff, 2009 for reviews of relevant literature). ‘Propagule pressure’ is a composite measure of the number of individuals released into a region. It incorporates estimates of the absolute number of individuals involved in any one release event (defined here as inoculum pressure) and the number of discrete release events (Lockwood et al., 2005, 2009). ‘Propagule pressure’ increases as inoculum pressure and/or the number of releases increases. In marine systems the release of ‘propagules’<sup>5</sup>

<sup>5</sup> Propagule by strict definition refers to ‘a vegetative structure that can become detached from a plant and gives rise to a new plant, e.g. a bud, sucker, or spore’. Here we use the term to describe reproductive particles from both plants (propagules) and invertebrate larvae.



from either ballast water discharge or vessel biofouling assemblages most commonly involves release of reproductive or early-life history stages such as planktonic larvae, but can also potentially involve release of fragments capable of asexual reproduction and/or mature adult organisms.

Therefore, some of the critical selective filters/factors that are likely to influence the potential for IMS and/or pathogens to be either introduced into or out of the Exmouth Gulf via the movement of the vessels by either ballast water and/or vessel biofouling associated with the proposed Learmonth Bundle construction and launching process include (but not limited to):

***Ballast water***

- Location of any ballast water uptake and discharge.
- Volume of any ballast water uptake and discharge.
- Duration of ballast water retention prior to discharge.
- Whether any form of ballast water management measures occur prior to discharge (e.g. ballast exchange, or the vessel possesses an International Maritime Organization (IMO) Type 2 approved Ballast Water Management System capable of meeting the D-2 standard, etc.).

***Vessel Biofouling***

- Antifouling coatings (presence/absence, type, condition and thoroughness of application over the submerged hull, including within niche areas).
- Niche areas (nature and extent of non-toxic or unprotected areas vulnerable to biofouling settlement).
- Marine Growth Prevention Systems (MGPS) (presence/absence, location, and extent of application throughout all or only some of the internal seawater systems).
- Presence/absence of box or keel coolers.
- Location and duration of residency periods between successive bundle launches.
- Location and duration of residency periods within the Exmouth Gulf during or between successive bundle launches.
- Proposed hull and internal seawater husbandry activities (nature and extent, frequency, location, etc.).

The specific information relevant to assessing the influence of the selective filters listed above for both ballast water and biofouling are not presently available given that the project is still in the proposal phase, and details of the specific vessels and their potential voyage histories and voyage plans are unavailable.



## 2.3 Hazard Pathway Analysis

In the absence of specific vessel information relevant to the potential for IMS and/or pathogens to be introduced into or out of the Exmouth Gulf via ballast water or vessel biofouling, the hazard pathway analysis used several different generic vessel interaction scenarios. These included:

1. All vessels associated with the proposed project remain within the Exmouth Gulf.
2. One or more vessels visit/reside outside Exmouth Gulf, but remain within ports and/or shallow coastal waters of Western Australia.
3. One or more vessels visit/reside in interstate ports and/or shallow coastal waters of Australia.
4. One or more vessels visit/reside in international ports and/or shallow coastal waters outside Australia.

The rationale behind the use of these generic scenarios is that as vessels are increasingly exposed to potential source populations of IMS and/or pathogens their likelihood of becoming contaminated and subsequently acting as a vector or pathway for further spread increases. Hence, vessels that have greater exposure to IMS and/or pathogens are more likely to: a) become contaminated, and b) spread IMS and/or pathogens.

The potential consequences of the IMS and pathogens being introduced into or out of the Exmouth Gulf via the different pathways (i.e. ballast water and vessel biofouling) were assessed for these four different scenarios using **Table 1**. Potential consequences were assessed using six of the most relevant measures of potential impact (i.e. ecosystem structure, habitat, economic, social structure, food security, and social amenity; see Fletcher, 2014). The likelihood of these consequences of IMS and/or pathogens occurring in the Exmouth Gulf if introduced via ballast water and vessel biofouling as a result of the four different scenarios was assessed using **Table 2**. In addition, the first assessment assumed the absence of any management control measures as a precautionary approach.

The Consequence–Likelihood method was used to assess the level of the identified hazard pathway components associated with the key identified threats. This approach is a widely used method (Standards Australia, 2012) and applied by many Western Australian Government agencies through WA RiskCover. Conducting the hazard or risk analysis using the Consequence-Likelihood (C x L) method involved selecting the most appropriate combination of consequence (levels of impact; **Table 1**) and the likelihood (levels of probability; **Table 2**) of this consequence actually occurring. The combination of these scores is then used to determine the overall risk rating using the structure recommended under **Table 3**; IEC/ISO, 2009, Standards Australia, (2012).

**Table 1.** Levels of consequence for each of the values/objectives relevant to the Subsea 7 Learmonth Bundle IMS and/or pathogen risk assessment (modified from Fletcher, 2014).

Value/Objective	Minor (1)	Moderate (2)	Major (3)	Severe (4)
Ecosystem Structure and Function	Measurable minor changes to ecosystem structure, but no measurable change to function.	Maximum acceptable level of change in the ecosystem structure with no material change in function.	Ecosystem function now altered with some function or major components now missing and/or new species are prevalent.	Extreme change to structure and function. Fundamental changes in the structure or function of the ecosystem.
Habitat	Measurable impacts very localised. Area directly affected well below maximum accepted.	Maximum acceptable level of impact to habitat with no long-term impacts on region-wide habitat dynamics.	Above acceptable level of loss/ impact with region-wide dynamics or related systems may begin to be impacted.	Level of habitat loss clearly generating region-wide effects on dynamics and related systems.
Economic	Detectable but not significant to the economic pathways for the industry or the community.	Some levels of reduction for a major fishery or a large reduction in a small fishery that the community is not dependent upon.	Major sector-wide decline and economic decline with clear flow on effects to the community.	Permanent and widespread collapse of economic activity for industry and the community including possible debts.
Social structure	Impacts may be measurable but no significant impacts observed.	Clear impacts but no local communities threatened or social dislocations	Severe impacts on social structures, at least at a local level.	Complete alteration to social structures present within a region.
Food security	Food security concerns but no impacts observed.	Direct impacts on food resources but not to the point where these are threatened.	Significant and long-term (>weeks) impacts on food for a community. Likely to lead to health problems.	Severe ongoing reductions in food resources leading to starvation, abandonment of region, or requiring aid.
Social amenity	Temporary or minor additional stakeholder restrictions or loss of expectations.	Ongoing restrictions or decrease in expectations	Long-term suspension or restriction of expectations in some key activities.	Permanent loss of all key expectations for recreational activities.

**Table 2.** Levels of likelihood for each of the main risks analysed in during this risk assessment (modified from Fletcher, 2015).

Level	Descriptor
<b>Remote (1)</b>	The consequence not heard of in these circumstances, but still plausible within the time frame (indicative probability 1-2%).
<b>Unlikely (2)</b>	The consequence is not expected to occur in the time frame but some evidence that it could occur under special circumstances (indicative probability of 3-9%).
<b>Possible (3)</b>	Evidence to suggest this consequence level may occur in some circumstances within the time frame (indicative probability of 10 to 39%).
<b>Likely (4)</b>	A particular consequence is expected to occur in the timeframe (indicative probability of 40 to 100%).

**Table 3.** Hazard/Risk Analysis Matrix. Numbers in each cell correspond to the Hazard/Risk Score. Colour corresponds to the Hazard/Risk Rankings in **Table 4**.

Consequence Level		Likelihood Level			
		Remote	Unlikely	Possible	Likely
		1	2	3	4
<b>Minor</b>	1	1	2	3	4
<b>Moderate</b>	2	2	4	6	8
<b>Major</b>	3	3	6	9	12
<b>Severe</b>	4	4	8	12	16

**Table 4.** Risk Evaluation, Rankings and Outcomes (adopted from Western Australian Department of Fisheries, 2015).

Risk Level	Hazard/Risk Score (C x L)	Description	Likely Management Response
Negligible	0-2	Acceptable with no management actions required.	Brief justification
Low	3-4	Acceptable with no direct management actions or monitoring required.	Full justification and periodic reports
Moderate	6-8	Acceptable with specific, direct management and regular monitoring.	Full regular performance report
High	9-16	Unacceptable unless additional management actions are undertaken. This may involve a recovery strategy with increased monitoring or even complete cessation of the activity.	Frequent and detailed performance reporting

The International standards definition of risk is defined as “the effect of uncertainty on objectives” (ISO, 2009). This definition of risk is vital when examining risk as it will inherently include the level of uncertainty generated from having incomplete information (Standards Australia, 2012). In the context of assessing the threats and risk associated with the proposed Learmonth Bundle construction and launching process, the objectives to be achieved are the maintenance of sustainable ecosystems and their dependent fisheries, such that they are not significantly impacted by the introduction into or out of the Exmouth Gulf as a consequence of the proposed project. Consequently, a “significant impact” that would result in a high risk would be one or more IMS and/or pathogens are introduced into or spread beyond Exmouth Gulf which have the potential to permanently alter the longer-term sustainability of the ecosystem and/or its dependent commercial or recreational fisheries.

Residual consequences, likelihoods and resultant levels of hazard or risk are intrinsically reliant upon the effectiveness of the risk mitigation controls implemented (Standards Australia, 2012). Determining the most appropriate combinations of consequence and likelihood scores therefore should involve the collation and analysis of all information available. *“The best-practice technique for applying this method now makes use of all available lines of evidence for an issue and is effectively a risk-based variation of the ‘weight of evidence’ approach that has been adopted for many assessments”* (Linkov et al., 2009; Wise et al., 2007; Fletcher, 2014; Western Australian Department of Fisheries, 2015). The hazard evaluation step uses the outcomes of the risk analysis to help make decisions about which hazards require the implementation of management measures, the level of management measures and the priority for action. The different levels of management action can be determined by having the hazard or risk scores separated into different categories of hazard (**Table 4**).

## 2.4 Risk Identification and Assessment

In consideration of the identified hazards and their potential pathways, overarching risks were identified associated with the proposed Learmonth Bundle construction and launching operations. Assessment of these overarching risks was conducted as described for the hazard pathway assessment described above. The inherent hazards or risks were first assessed in the absence of any management control measures, followed by assessment of residual risk following application of the identified management controls.

### 3. THREAT IDENTIFICATION, HAZARD PATHWAY IDENTIFICATION AND HAZARD PATHWAY ANALYSIS

#### 2.5 Threat Identification

##### 2.5.1 IMS and pathogens known to occur within Exmouth Gulf

McDonald (2008) conducted a likelihood analysis of non-indigenous marine species being introduced into fifteen ports in Western Australia through ballast water and biofouling. The analysis used vessel visits data collated for each of the 15 ports during 2006 and compared the relative number of vessel visits, their ports of origin, volumes and locations of ballast water uptake/discharges, size of vessels and vessel types. This report concluded that the Port of Exmouth was the least likely of the 15 Western Australian ports examined for the introduction of non-indigenous marine species.

This study provided the Western Australian Department of Fisheries (now known as Western Australian Department of Primary Industries and Regional Development or WA DPIRD) with the rationale for prioritising port surveillance activities for IMS. At the time of writing, the WA DPIRD has yet to conduct a port survey targeting IMS in the Port of Exmouth due to the relative lack of international vessel visits or regular trade. While there are some private surveys which have occurred to support various proposed activities, such surveys (e.g. Chevron 2014) are not publicly available. Hence, based on available information, the only IMS recorded from within this region is the invasive colonial ascidian, *Didemnum perlucidum* (Monniot, 1983) which appears to be confined to artificial structures such as wharf piles within the Exmouth Marina (WA DPIRD Maps as of 1 August, 2014; Wells, 2018).

With respect to pathogens, the only occurrence documented to date appears to be severe mortality of *Pinctada maxima* by an infectious intracellular ciliate in the digestive glands of cultured oysters in the Exmouth Gulf in 2006 (Jones and Creeper, 2006). It is understood that the oyster oedema disease is now distributed along the Western Australian coastline. However, it is important to acknowledge that very little monitoring for pathogens has occurred around Australia, hence it is possible that there are many pathogens established within Australian waters which remain undetected.

##### 2.5.2 IMS and pathogens known to occur elsewhere in Western Australian waters

According to Huisman et al. (2008), 102 species of marine algae and animals have been reported as introduced into Western Australian waters. Although, of these, only three IMS listed on the Western Australian Prevention List for Introduced Marine Pests (WAPLIMP) were recorded in this study; the dinoflagellate *Alexandrium minutum* (Halim, 1960), the bivalve *Musculista senhousia*<sup>6</sup> (Benson in Cantor, 1842) and the polychaete *Sabella spallanzanii* (Gmelin, 1791). However, several other IMS listed on the WAPLIMP have been recorded within Western Australian waters including:

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<sup>6</sup> This species has been renamed and is now known as *Arcuatula senhousia* (<http://www.marinespecies.org/aphia.php?p=taxdetails&id=505946>).



- Invasive *Didemnum* spp., *Didemnum perlucidum* throughout most ports extending from Esperance to Broome.
- Asian Paddle Crab, *Charybdis japonica*, single specimen detected in the Peel-Harvey Estuary, Mandurah in 2010 and a further three specimens detected in Mosman Bay, Swan River in 2012/13. Not considered established in Western Australian waters.
- Asian green mussels, *Perna viridis* detected on numerous vessels visiting various ports such as Fremantle, Henderson, Garden Island, Barrow Island, Dampier, etc. Not considered established in Western Australian waters.
- Bay barnacles, *Amphibalanus improvisus* detected on several vessels while visiting various ports throughout Western Australia. Not considered established in Western Australian waters.

Interestingly, Hewitt (2002), Huisman et al. (2008) and Wells (2018) all concluded that despite marine invasions occurring in virtually all regions of the world, relatively few introductions have been detected in the Tropical regions of Australia. These authors hypothesised that clearly the region is receiving constant inoculation pressure by the large volume of visiting international vessels, but despite this, there is a significant lack of established marine pests to date, hence it is possible that the higher diversity of native tropical communities provides increased resistance to invasions through an increase in biotic interactions.

## 2.6 Hazard Pathway Identification and Analysis

As identified in the methods, the most likely pathway for the introduction or spread of IMS and pathogens into or out of the Exmouth Gulf are likely to be associated with the vessels proposed to be used during the construction and Bundle launches, either via ballast water discharge and/or vessel biofouling. However, given the apparent lack of IMS and pathogens detected within the Exmouth Gulf to date and the nature of the proposed operations, there appears to be a greater theoretical probability for the Exmouth Gulf to receive IMS and pathogens via these two pathways than donating them to other regions. Therefore, no further assessment of the consequences and likelihood of the proposed operations introducing IMS and/or pathogens to locations outside the Exmouth Gulf were undertaken.

Despite the region receiving constant inoculation pressure by the large volume of visiting international vessels, there appears to be a low number of established IMS and it is possible that the higher diversity of native tropical communities provides for increased resistance to invasions. In addition, the occurrence of IMS around the world appears to coincide with highly modified, polluted, disturbed port environments where there is an abundance of artificial structures (e.g. Glasby et al. 2007; Dafforn et al. 2008, 2009). Artificial structures such as wharf piles, moorings, pontoons, etc. particularly those which are floating and occur in protected embayments seem to house more IMS than natural unmodified habitats. Hence, given that the proposed launching site is proposing to consist of only rock and not wharf piles, mooring, pontoons, etc, and the general lack of pollution at the Bundle launching site, while it is possible for the addition of

anthropogenic rock may provide suitable substrate for *D. perlucidum*, it is unlikely that the species establishment would cause any demonstratable impacts across any of the four core values.

The Exmouth Gulf is home to a number of important commercial fisheries such as the Exmouth Prawn Fishery and important shellfish fisheries such as scallops and native oysters all of which are particularly vulnerable to the introduction of pathogens. While the discharge of contaminated ballast water could be considered the greatest pathway for the introduction of pathogens, in the event any of the vessels are likely to take on, or discharge, ballast water within the Exmouth Gulf, there is also potential for mature adult decapods nestled amongst excessive levels of biofouling within niche areas to also disperse non-indigenous parasites, pathogens and viruses such as *Carcinonemertes epialti*, *Sacculina* spp. or White Spot Disease Baculovirus (Coutts and Dodgshun, 2007). Therefore, in light of the impacts of the White Spot Disease outbreak in Queensland, the potential for similar consequences to occur if successfully introduced into the Exmouth Prawn Fishery could be considered 'severe'. Hence, this potential consequence was a fundamental influence when assessing the consequences amongst the various scenarios.

### 3. RISK IDENTIFICATION AND ASSESSMENT

#### 2.6.1 All vessels associated with the proposed project remain within the Exmouth Gulf.

This scenario assumes that vessels associated with the project reside within the Port of Exmouth are capable of further spreading existing IMS and/or pathogens via either ballast water and/or vessel biofouling within the Exmouth Gulf. Given that there is only one recorded incident of an infectious intracellular ciliate in the digestive glands of cultured oysters, *Pinctada maxima* and one IMS, namely *D. perlucidum* within the Exmouth Gulf, the consequences of these existing species being further spread and causing additional impacts could be considered to be of 'minor' consequence (i.e. **Minor = 1; Appendix 1**). However, the likelihood of this consequence occurring varies between the two pathways with a 'possible' likelihood via ballast water discharge for both IMS and pathogens (i.e. **Possible = 3; Appendix 1**) and an 'unlikely' likelihood for IMS and pathogens spread via vessel biofouling (i.e. **Unlikely = 2; Appendix 1**). This resulted in the overall risk level for ballast water to spread both IMS and pathogens as **Low** (i.e. **Minor 1 x Possible 3 = Low (3); Appendix 1**) and **Negligible** for vessel biofouling to spread both IMS and pathogens (i.e. **Minor 1 x Unlikely 2 = Low (2); Appendix 1**).

#### 2.6.2 One or more vessels visit/reside outside Exmouth Gulf, but remain within ports and/or shallow coastal waters of Western Australia.

This scenario assumes that one or more vessels associated with the project visit/reside within ports and/or shallow coastal waters of Western Australia and potentially introduce new IMS and/or pathogens upon their return to the Exmouth Gulf. This scenario has been split into a further two different scenarios: 1) the potential for a construction barge associated with the construction of the launching ramp to introduce IMS and/or pathogens, and 2) the potential for vessels associated with the proposed bundle launches to introduce IMS and/or pathogens.





The overall consequence of this scenario differs between pathways (i.e. ballast water and vessel biofouling) and their ability to disperse IMS and/or pathogens. For example, the consequence of a construction barge or one or more Bundle launch vessels introducing IMS via ballast water is considered to be 'minor' (i.e. **Minor = 1; Appendix 1**), while the consequence of introducing pathogens is considered to be 'severe' (i.e. **Severe = 4; Appendix 1**). The consequence of a construction barge or one or more Bundle launch vessels introducing IMS via vessel biofouling is considered to be 'minor' (i.e. **Minor = 1; Appendix 1**), but 'major' for pathogens (i.e. **Major = 3; Appendix 1**).

The likelihood of these consequences occurring differs between a construction barge and one or more Bundle launch vessels introducing IMS and/or pathogens via ballast water or vessel biofouling. For example, the likelihood of the consequence of a construction barge introducing IMS via ballast water discharge is considered to be 'possible' (i.e. **Possible = 3; Appendix 1**), and 'likely' via vessel biofouling (i.e. **Likely = 4; Appendix 1**). The likelihood of the consequence of a construction barge introducing IMS via ballast water discharge and vessel biofouling is considered to be 'possible' (i.e. **Possible = 3; Appendix 1**).

The likelihood of the consequence of one or more Bundle launch vessels introducing IMS via ballast water discharge and vessel biofouling is considered to be 'unlikely' (i.e. **Unlikely = 2; Appendix 1**). However, the likelihood of the consequence of one or more Bundle launch vessels introducing pathogens via ballast water discharge is considered to be 'possible' via ballast water discharge (i.e. **Possible = 3; Appendix 1**), but 'remote' via vessel biofouling (i.e. **Remote = 1; Appendix 1**).

Overall risk levels were assessed as 'low' for a construction barge and one or more Bundle launch vessels to introduce IMS via for ballast water or biofouling (**Appendix 1**). Similarly, the overall risk level for one or more vessels to introduce pathogens via vessel biofouling was also considered to be **Low** (i.e. **Major 3 x Remote 1 = Low (3); Appendix 1**). However, the overall risk level of a construction barge or one or more vessels to introduce pathogens via ballast water discharge from other ports outside the Exmouth Gulf was considered to be **High** (i.e. **Severe 4 x Possible 3 = High (12); Appendix 1**). Similarly, the overall risk level for a construction barge to introduce pathogens via vessel biofouling was also considered to be **High** (i.e. **Major 3 x Possible 3 = High (12); Appendix 1**).

#### *2.6.3 One or more vessels visit/reside in interstate ports and/or shallow coastal waters of Australia.*

This scenario assumes that one of more vessels associated with the project visit/reside in interstate ports and/or shallow coastal waters within Australia, but have the potential to introduce new IMS and/or pathogens upon their return to the Exmouth Gulf. The consequence of this scenario differs between pathways and their ability to disperse IMS and pathogens. Hence, the consequence of one or more vessels introducing IMS via ballast water is considered to be 'minor' (i.e. **Minor = 1; Appendix 1**) while pathogens is considered to be 'severe' (i.e. **Severe = 4; Appendix 1**). The consequence of vessel biofouling introducing IMS is considered to be 'minor' (i.e. **Minor = 1; Appendix 1**), but 'severe' for pathogens (i.e. **Severe = 4; Appendix 1**).





The likelihood of the consequence of one or more vessels successfully introducing IMS or pathogens via ballast water or vessel biofouling varies. For example, the likelihood of the consequence of one or more vessels introducing IMS and pathogens via ballast water discharge is considered to be 'possible' (i.e. **possible = 3; Appendix 1**). The likelihood of the consequence of one or more vessels introducing IMS via vessel biofouling is considered to be 'unlikely' (i.e. **Unlikely = 2; Appendix 1**), but 'remote' for pathogens (i.e. **Remote = 1; Appendix 1**).

The overall risk level for ballast water to spread IMS was assessed as **Low** (i.e. **Minor 1 x Possible 3 = Low (3); Appendix 1**). Similarly, the overall risk level for one or more vessels to introduce both IMS and pathogens via vessel biofouling was also considered to be **Low** (i.e. **IMS = Minor 1 x Unlikely 2 = Low (2); Pathogens = Severe 4 x Remote 1 = Low (4); Appendix 1**). However, the overall risk level for one or more vessels to introduce pathogens via ballast water discharge from interstate ports was considered to be **High** (i.e. **Severe 4 x Possible 3 = High (12); Appendix 1**).

#### *2.6.4 One or more vessels visit/reside in international ports and/or shallow coastal waters outside of Australia.*

This scenario assumes that one or more vessels associated with the project visit/reside within international ports and/or shallow coastal waters outside Australia and therefore have the potential to introduce new IMS and/or pathogens upon their return to the Exmouth Gulf. The consequence of this scenario is very similar between the two pathways. For instance, the consequence of one or more vessels introducing IMS via ballast water and biofouling is considered to be 'major' (i.e. **Major = 3; Appendix 1**). Although, the consequence of one or more vessels introducing pathogens via ballast water or vessel biofouling is considered to be 'severe' (i.e. **Severe = 4; Appendix 1**).

The likelihood of the consequence of one or more vessels successfully introducing IMS via ballast water is considered to be 'possible' (i.e. **Possible = 3; Appendix 1**). Similarly, the likelihood of the consequence of one or more vessels successfully introducing IMS via vessel biofouling is also considered to be 'possible' (i.e. **Possible = 3; Appendix 1**). However, the likelihood of the consequence of one or more vessels successfully introducing pathogens via vessel biofouling is considered to be 'remote' (i.e. **Remote = 1; Appendix 1**). This resulted in the overall risk level for ballast water to spread IMS and pathogens as **High** (i.e. **IMS = Major 3 x Possible 3 = High (9); Pathogens = Severe 4 x Possible 3 = High (12); Appendix 1**). Conversely, the overall risk level for vessel biofouling to introduce pathogens was assessed as **Low** (i.e. **Severe 4 x Remote 1 = Low (4); Appendix 1**).

### **3 RISK TREATMENT**

Based on the risk identification and assessment process, the following residual risks which resulted in 'High' overall risk levels based on the proposed activities according to the various scenarios were identified.



- A construction barge and/or one or more vessels visit/reside within ports and/or shallow coastal waters of Western Australia have a 'High' risk of introducing pathogens into Exmouth Gulf upon their return.
- One or more vessels visit/reside in interstate ports and/or shallow coastal waters have a 'High' risk of introducing pathogens into Exmouth Gulf upon their return.
- One or more vessels visit/reside in international ports and/or shallow coastal waters have a 'High' risk of introducing IMS and pathogens via ballast water discharge.
- One or more vessels visit/reside in international ports and/or shallow coastal waters and have a 'High' risk of introducing IMS via vessel biofouling.

In light of these aforementioned 'High' residual risks, the following treatments or management measures could be implemented to reduce the overarching risks to 'Low' (i.e. achieving an acceptable level of risk with no direct management actions or monitoring required).

#### *3.1.1 Ballast Water*

In the event that any of the vessels proposed to be used for the project are required to use/discharge ballast water within the Exmouth Gulf, then the need to manage the ballast water will depend on the origin of the ballast water uptake. For example, any vessels obtaining ballast water from outside Australian waters will be required to abide by Australia's Mandatory Ballast Water Management Requirements, Version 7 to ensure that they do not discharge high risk ballast water in Australian waters. A summary of these are as follows:

#### **Management Options**

Australia is in the process of phasing out ballast water exchange in favour of a method that is compliant with the International Maritime Organization's (IMO) D-2 discharge standard. In order to achieve this, vessels will be required to install an IMO Type 2 approved Ballast Water Management System (BWMS), or use one of the other approved methods of management.

Vessels constructed on or after 8 September, 2017 will be required to meet the Regulation D-2 discharge standard from the date they are put into service. Vessels constructed before 8 September, 2017 will need to comply with the Regulation D-2 standard by either the first or second five-year renewal survey of the vessel associated with the International Oil Pollution Prevention Certificate (IOPP) under the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex I. Vessels must comply with the Regulation D-2 standard by their first renewal survey date, when the first renewal survey takes place:

- On or after 8 September, 2019, or
- A renewal survey has been completed on or after 8 September, 2014, but prior to 8 September, 2017.

Vessels must comply with the Regulation D-2 standard by their second renewal survey date, when the first renewal survey takes place:

- After 8 September, 2017, and
- Before 8 September, 2019.

Any existing vessels to which the IOPP renewal survey under MARPOL Annex I does not apply must meet the Regulation D-2 standard from 8 September, 2024.

New vessels	Existing vessels where	For other existing vessels	Existing vessel not required to have an IOPP certificate
Keel laid on or after 8 September 2017:	Completed IOPP renewal survey between 8 September 2014 and 7 September 2017:	First IOPP renewal survey on or after 8 September 2019 OR Second IOPP renewal survey on or after 8 September 2017	Tankers of less than 150GT and ships other than oil tankers of less than 400GT:
Install a BWMS upon delivery	Install BWMS at the first IOPP renewal survey on or after 8 September 2017	Install BWMS at whichever occurs first	Install BWMS no later than 8 September 2024

Source: The North of England P&I Association Limited

### Other Approved Methods of Ballast Water Management

The approved methods of ballast water management are:

- Use of a BWMS
- Ballast water exchange conducted in an acceptable area (i.e. sequential exchange, flow-through, dilution).
- Use of low risk ballast water (such as fresh potable water, high seas water or fresh water from an on-board fresh water production facility).
- Retention of high-risk ballast water on board the vessel.
- Discharge to an approved ballast water reception facility.

**For a copy of Australia's Mandatory Ballast Water Management Requirements – Version 7 see**

<http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/avm/vessels/ballast/australian-ballast-water-management-requirements.pdf>

Any vessels obtaining ballast water from outside the Exmouth Gulf, but within Australian waters, have the potential to introduce IMS and/or pathogens via ballast water discharge and should use the Commonwealth Department of Agriculture and Water Resources Quick Domestic Ballast Water (DBW) Risk Assessment Tool.

See <http://www.agriculture.gov.au/biosecurity/avm/vessels/ballast#quick-domestic-ballast-water-risk->



[assessment-tool](#). This risk assessment provides an indication of whether ballast water taken up at an Australian port and discharged at another Australian port, will be considered low or high risk based on the Australian Ballast Water Risk Assessment. This tool does not provide a formal risk based exemption. An application must be made in the Maritime Arrivals Reporting System (MARS) for a risk based exemption. A vessel issued with a risk based exemption from MARS for a particular voyage is not required to manage the relevant ballast water prior to discharge at the intended port. Any high risk ballast water **MUST** be managed prior to discharge at the intended port. For more information on how to comply with biosecurity requirements for ballast water, including acceptable areas for undertaking ballast water exchange, refer to Australia's Mandatory Ballast Water Management Requirements – Version 7 as stated previously.

If any of these aforementioned measures were to be adopted, the consequence of the introduction of IMS or pathogens into the Exmouth Gulf via ballast water would remain the same (i.e. **Severe = 4; Appendix 1**), although the likelihood of this consequence occurring could be lowered to 'remote' (i.e. **Remote = 1; Appendix 1**). Therefore, the overall risk of project vessels introducing any IMs or pathogens via ballast water could be considered as having a **Low** risk (i.e. **Severe 4 x Remote 1 = Low; Appendix 1**).

### 3.1.2 Biofouling

The highest risk of vessels introducing any IMS and/or pathogens via vessel biofouling would be those which reside in locations outside Exmouth Gulf, and could infect project vessels and be transported to Exmouth Gulf either during the construction phase of the Bundle launch ramp or during the process of Bundle launches. It is also important to acknowledge that BFS has been involved in a number of projects involving Subsea 7 vessels to date and found their management of biosecurity risks to be of the highest quality/standards. Subsea 7 takes biosecurity concerns very seriously and has always adopted a precautionary approach to ensure that all biosecurity risks are managed to acceptable levels. As such, Subsea 7 have committed to giving preference to local and Australian vessels for each Bundle launch and tow. Should local vessels prove unavailable or unsuitable, only then would international vessels be considered. In these events, Subsea 7 could use the WA DPIRD online 'Vessel Check' Biofouling Risk Assessment Tool prior to re-entry into Western Australian waters. See <https://vesselcheck.fish.wa.gov.au/>. In addition, Subsea 7 may also need to apply the same measure to any construction barges/vessels if they have resided in shallow inshore waters outside the Exmouth Gulf.

Options for managing vessels assessed as posing an 'Uncertain' or 'High' theoretical risk of introducing IMS via vessel biofouling include:

- **Dry-docking:** Thoroughly clean/remove all biofouling, including inside all niche areas, followed by thorough application of a suitable antifouling coating to ensure that the vessel departs the dry-docking with the highest level of immunity to biofouling/IMS settlement thereafter. Internal seawater systems should also be thoroughly cleaned and where possible, Marine Growth Prevention Systems renewed/services or installed within all active seawater systems. All topside immersible

equipment should be inspected and cleaned wherever necessary. Where possible, have an approved IMS inspector attend the dock to oversee and document the cleaning and biofouling management measures. See <http://www.fish.wa.gov.au/Sustainability-and-Environment/Aquatic-Biosecurity/Vessels-And-Ports/Pages/Biofouling-Inspectors.aspx> for guidance of suitable biofouling inspectors.

- **In-water inspection/clean:** Where possible, have a WADPIRD approved IMS inspector coordinate an in-water inspection using a competent commercial diving company. Where IMS are detected, in-water cleaning maybe applicable depending on the extent of contamination and local in-water cleaning requirements. The qualified IMS must be able to achieve a high level of confidence that the final inspection has successfully decontaminated the vessel so that it poses a low risk of introducing any IMs into Australian waters. In addition, vessels should aim to depart overseas waters as soon as possible, and must not exceed more than seven cumulative day's residency within shallow inshore coastal waters prior to arrival in Australian waters.

In addition to the above, all vessels should possess Biofouling Management Plans and associated Record Books which outline the various management strategies the vessels have adopted in order to minimise the unwanted accumulation of biofouling and potential IMS. The adoption of Biofouling Management Plans and associated Record Books is recommended by:

- International Maritime Organization – Guidelines for the Control and Management of Ship's Biofouling to Minimise the Transfer of Invasive Aquatic Species. See <http://www.imo.org/en/OurWork/Environment/Biofouling/Pages/default.aspx>
- Commonwealth Government's various National Guidelines for managing vessel biofouling (see [http://www.marinepests.gov.au/marine\\_pests/Pages/Biofouling-and-marine-pests.aspx](http://www.marinepests.gov.au/marine_pests/Pages/Biofouling-and-marine-pests.aspx)).
- Western Australian Department of Primary Industries and Regional Development. See <http://www.fish.wa.gov.au/Sustainability-and-Environment/Aquatic-Biosecurity/Vessels-And-Ports/Pages/Biofouling-management-tools-and-guidelines.aspx>

If any project vessels visited/resided in any international ports and/or shallow waters, but they adopted any of these aforementioned measures, while the consequence of the vessels to potentially introduce IMS via vessel biofouling would remain the same (i.e. either **Major 3 or Severe = 4; Appendix 1**), the likelihood of this consequence occurring could be lowered to 'remote' (i.e. **Remote = 1; Appendix 1**). Therefore, the overall risk of project vessels introducing any IMS and/or pathogens via biofouling could be considered as having a **Low** risk (i.e. either **Major 3 or Severe 4 x Remote 1 = Low (3 or 4); Appendix 1**).



#### 4 NEED FOR BASELINE ASSESSMENT OR ON-GOING MONITORING

While it is acknowledged that the Exmouth Gulf has yet to be thoroughly surveyed for IMS, the likelihood of high risk IMS remaining undetected could be considered 'unlikely'. This is because the Exmouth Gulf has not been subjected to on-going potential infection from visiting international vessels relative to neighbouring ports like Dampier, Cape Lambert and Port Hedland. In addition, the Exmouth Gulf remains relatively undisturbed, pristine with a significant lack of artificial structures such as wharf pylons, mooring, pontoons, etc. all of which are renowned for facilitating IMS incursions. Furthermore, McDonald (2008) concluded that the Port of Exmouth was the least likely of the 15 Western Australian ports examined for the introduction of non-indigenous marine species.

Nevertheless, given that all scenarios were risk assessed as posing an overall 'Low' risk of introducing IMS and/or pathogens into the Exmouth Gulf (with the implementation of management measures where appropriate), there would be little benefit in designing and conducting a baseline survey for IMS in accordance with the guidelines provided by the Australian National System for the Prevention of Marine Pest Incursions.

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## Appendix 1 Risk Assessment Analyses Outputs

SCENARIO	PATHWAY	IMS or Pathogens/ Diseases	Without Any Management Measures					With Management Measures			
			Consequence	Likelihood	Unmanaged Risk	Management Measures	Comments	Consequence	Likelihood	Residual Risk	Management Measures
1). All vessels reside within Exmouth Gulf	A) Ballast Water	IMS	Minor (1)	Possible (3)	Low (3)	Acceptable with no direct management actions or monitoring required.	- Didemnum perlucidum only recorded IMS in Exmouth Gulf. - D. perlucidum prefers to inhabit artificial structures particularly surface referenced structure (wharf piles, moorings, pontoons). - D. perlucidum unlikely to cause any impacts at launching site if successfully introduced. - Natural currents and unmanagement movement of vessels and likely to a greater risk.	N/A	N/A	N/A	N/A
		Pathogens	Minor (1)	Possible (3)	Low (3)	Acceptable with no direct management actions or monitoring required.	- Only one recorded pathogen recorded within Exmouth Gulf. - Impacts likely to be minor. - Natural currents and unmanagement movement of vessels and likely to a greater risk.	N/A	N/A	N/A	N/A
	B) Biofouling	IMS	Minor (1)	Unlikely (2)	Negligible (2)	Acceptable with no management actions required.	Didemnum perlucidum only recorded IMS in Exmouth Gulf. - D. perlucidum prefers to inhabit artificial structures particularly surface referenced structure (wharf piles, moorings, pontoons). - D. perlucidum unlikely to cause any impacts at launching site if successfully introduced. - Natural currents and unmanagement movement of vessels and likely to a greater risk.	N/A	N/A	N/A	N/A
		Pathogens	Minor (1)	Unlikely (2)	Negligible (2)	Acceptable with no management actions required.	- Only one recorded pathogen recorded within Exmouth Gulf. - Impacts likely to be minor. - Natural currents and unmanagement movement of vessels and likely to a greater risk.	N/A	N/A	N/A	N/A



			Without Any Management Measures					With Management Measures			
SCENARIO	PATHWAY	IMS or Pathogens/ Diseases	Consequence	Likelihood	Unmanaged Risk	Management Measures	Comments	Consequence	Likelihood	Residual Risk	Management Measures
2)a. Construction barge visit/reside outside Exmouth Gulf, but remain within ports and/or shallow coastal waters of Western Australia.	A) Ballast Water	IMS	Minor (1)	Possible (3)	Low (3)	Acceptable with no direct management actions or monitoring required.	- IMS recorded within WA waters unlikely to have significant impacts within Exmouth Gulf. - Lack of surface referenced artifical structures at site unlikely to provide sufficient substrates.	N/A	N/A	N/A	N/A
		Pathogens	Severe (4)	Possible (3)	High (12)	Unacceptable unless additional management actions are undertaken. This may involve a recovery strategy with increased monitoring or even complete cessaition of activity.	- Nature and extent of pathogens throughout WA waters is unknown. - Proposed activity has the potential to introduce new pathogens which has the potential to cause severe impacts/consequences. - This risk could be reduced to Low if the Commonwealth Department of Agriculture and Water Resources Quick Domestic Ballast Water (DBW) Risk Assessment Tool is adopted.	Severe (4)	Remote (1)	Low (4)	Acceptable with no direct management actions or monitoring required.
	B) Biofouling	IMS	Minor (1)	Likely (4)	Low (4)	Acceptable with no direct management actions or monitoring required.	- Minimal (~48 hour) exposure period during bundle launch activities. - Lack of surface-referenced artificial structures at site unlikely to provide suitable habitat for new IMS establishment. - Unmanaged movement of vessels into area likely to pose a greater risk.	N/A	N/A	N/A	N/A
		Pathogens	Major (3)	Possible (3)	High (9)	Unacceptable unless additional management actions are undertaken. This may involve a recovery strategy with increased monitoring or even complete cessaition of activity.	- Nature and extent of pathogens throughout WA waters is unknown. - New pathogens have the potential to cause severe impacts/consequences. - Although, likelihood of pathogens to be translocated via vessel biofouling on a construction barge is considered to be likely. - Risk could be reduced to Low if vessels adopt the Western Australian Department of Primary Industries and Regional Development's on-line 'Vessel Check' decision support tool and the adoption of appropriate biofouling management requirements.	Major (3)	Remote (1)	Low (3)	Acceptable with no direct management actions or monitoring required.



SCENARIO	PATHWAY	IMS or Pathogens/ Diseases	Without Any Management Measures				Comments	With Management Measures			
			Consequence	Likelihood	Unmanaged Risk	Management Measures		Consequence	Likelihood	Residual Risk	Management Measures
2)b. One or more of the Bundle launch vessels visit/reside outside Exmouth Gulf, but remain within ports and/or shallow coastal waters of Western Australia.	A) Ballast Water	IMS	Minor (1)	Unlikely (2)	Low (2)	Acceptable with no direct management actions or monitoring required.	- IMS recorded within WA waters unlikely to have significant impacts within Exmouth Gulf. - Lack of surface referenced artificial structures at site unlikely to provide sufficient substrates.	N/A	N/A	N/A	N/A
		Pathogens	Severe (4)	Possible (3)	High (12)	Unacceptable unless additional management actions are undertaken. This may involve a recovery strategy with increased monitoring or even complete cessation of activity.	- Nature and extent of pathogens throughout WA waters is unknown. - Proposed activity has the potential to introduce new pathogens which has the potential to cause severe impacts/consequences. - This risk could be reduced to Low if the Commonwealth Department of Agriculture and Water Resources Quick Domestic Ballast Water (DBW) Risk Assessment Tool is adopted.	Severe (4)	Remote (1)	Low (4)	Acceptable with no direct management actions or monitoring required.
	B) Biofouling	IMS	Minor (1)	Unlikely (2)	Low (2)	Acceptable with no direct management actions or monitoring required.	- Minimal (~48 hour) exposure period during bundle launch activities. - Lack of surface-referenced artificial structures at site unlikely to provide suitable habitat for new IMS establishment. - Unmanaged movement of vessels into area likely to pose a greater risk.	N/A	N/A	N/A	N/A
		Pathogens	Major (3)	Remote (1)	Low (3)	Acceptable with no direct management actions or monitoring required.	- Nature and extent of pathogens throughout WA waters is unknown. - New pathogens have the potential to cause severe impacts/consequences. - Although, likelihood of pathogens to be translocated via vessel biofouling based on the proposed operations is considered to be remote.	N/A	N/A	N/A	N/A





			Without Any Management Measures					With Management Measures			
SCENARIO	PATHWAY	IMS or Pathogens/ Diseases	Consequence	Likelihood	Unmanaged Risk	Management Measures	Comments	Consequence	Likelihood	Residual Risk	Management Measures
3). One or more vessels visit/reside in interstate ports and/or shallow coastal waters.	A) Ballast Water	IMS	Minor (1)	Possible (3)	Low (3)	Acceptable with no direct management actions or monitoring required.	- IMS recorded in Australian waters unlikely to have significant impacts within Exmouth Gulf. Lack of surface-referenced artificial structures at site unlikely to provide suitable habitat for new IMS establishment. - Unmanaged movement of vessels into area likely to pose a greater risk.	N/A	N/A	N/A	N/A
		Pathogens	Severe (4)	Possible (3)	High (12)	Unacceptable unless additional management actions are undertaken. This may involve a recovery strategy with increased monitoring or even complete cessation of activity.	- Nature and extent of pathogens throughout Australian waters is largely unknown. - Proposed activity has the potential to introduce new pathogens which has the potential to cause severe impacts/consequences. - Highest risk could be vessels visiting areas in Queensland which are infected with the White Spot Syndrome. - This risk could be reduced to Low if the Commonwealth Department of Agriculture and Water Resources Quick Domestic Ballast Water (DBW) Risk Assessment Tool was used.	Severe (4)	Remote (1)	Low (4)	Acceptable with no direct management actions or monitoring required.
	B) Biofouling	IMS	Minor (1)	Unlikely (2)	Low (3)	Acceptable with no direct management actions or monitoring required.	- Minimal (~48 hour) exposure period during bundle launch activities. - Lack of surface-referenced artificial structures at site unlikely to provide suitable habitat for new IMS establishment. - Unmanaged movement of vessels into area likely to pose a greater risk.	N/A	N/A	N/A	N/A
		Pathogens	Severe (4)	Remote (1)	Low (4)	Acceptable with no direct management actions or monitoring required.	- Nature and extent of pathogens throughout Australian waters is unknown. - New pathogens have the potential to cause severe impacts/consequences. - Although, likelihood of pathogens to be translocated via vessel biofouling based on the proposed operations is considered to be remote.	N/A	N/A	N/A	N/A



SCENARIO	PATHWAY	IMS or Pathogens/ Diseases	Without Any Management Measures					With Management Measures			
			Consequence	Likelihood	Unmanaged Risk	Management Measures	Comments	Consequence	Likelihood	Residual Risk	Management Measures
4). One or more vessels visit/reside in international ports and/or shallow coastal waters.	A) Ballast Water	IMS	Major (3)	Possible (3)	High (9)	Unacceptable unless additional management actions are undertaken. This may involve a recovery strategy with increased monitoring or even complete cessation of activity.	- Introduction of new IMS in Exmouth has the potential to cause major impacts, although likelihood of IMS successfully established within the Exmouth Gulf considered to be less than major port areas where there is an abundance of surface-referenced artificial substrates. - This risk could be reduced to Low if the Commonwealth Department of Agriculture and Water Resources Mandatory Ballast Water Management Requirements - Version 7 are adopted.	Severe (4)	Remote (1)	Low (4)	Acceptable with no direct management actions or monitoring required.
		Pathogens	Severe (4)	Possible (3)	High (12)	Unacceptable unless additional management actions are undertaken. This may involve a recovery strategy with increased monitoring or even complete cessation of activity.	- This is considered to be the highest consequence and likelihood activity. - Proposed activity has the potential to introduce new pathogens which has the potential to cause severe impacts/consequences. - This risk could be reduced to Low if the Commonwealth Department of Agriculture and Water Resources Mandatory Ballast Water Management Requirements - Version 7 are adopted.	Severe (4)	Remote (1)	Low (4)	Acceptable with no direct management actions or monitoring required.
	B) Biofouling	IMS	Major (3)	Possible (3)	High (9)	Unacceptable unless additional management actions are undertaken. This may involve a recovery strategy with increased monitoring or even complete cessation of activity.	- The introduction of IMS via unmanaged biofouling has the potential to cause major impacts. - The introduction of IMS into Australian waters via biofouling has occurred previously, although the introduction of IMS into the Exmouth Gulf is less likely to due to project vessels only intending on spending ~48 hours in the area during bundle launches. - Lack of surface-referenced artificial structures at site unlikely to provide suitable habitat for new IMS establishment. - Unmanaged movement of vessels into area likely to pose a greater risk. - Risk could be reduced to Low if vessels adopt the Western Australian Department of Primary Industries and Regional Development's on-line 'Vessel Check' decision support tool and the adoption of appropriate biofouling management requirements.	Severe (4)	Remote (1)	Low (4)	Acceptable with no direct management actions or monitoring required.
		Pathogens	Severe (4)	Remote (1)	Low (4)	Acceptable with no direct management actions or monitoring required.	- The introduction of new pathogens have the potential to cause severe impacts/consequences. - Although, likelihood of pathogens to be translocated via vessel biofouling based on the proposed operations is considered to be remote.	N/A	N/A	N/A	N/A