Introduced Marine Pest Monitoring and Management Plan

Ashburton Salt Project

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Acronyms & Abbreviations

Acronym/Abbreviation	Description
AFC	Antifouling coating
APMPL	Australian Priority Marine Pest List
BCH	Benthic Communities &habitat
BWTS	Ballast water treatment system
CCIMPE	Consultative Committee on Introduced Marine Pest Emergencies
DAFF	Department of Agriculture Fisheries and Forestry
DAWE	Department of Agriculture, Water and the Environment
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DPIRD	Department of Primary Industries and Regional Development
EEPL	Exotic Environmental Pests, Weeds and Diseases
eDNA	Environmental DNA
EPA	Environmental Protection Authority
EPO	Environmental Protection Outcomes
ha	hectare
km	kilometre
GL	gigalitre
IMO	International Maritime Organisation
IMPs	Introduced Marine Pests
IMPMMP	Introduced Marine Pest Monitoring and Management Plan
LPoC	Last Port of Call
m	metre
m^3	cubic metre
MARS	Marine Arrivals Reporting System
MDET	Monitoring Design Excel Template
mg/L	milligrams per litre
MPSC	Marine Pest Sectoral Committee
MTPA	million tonnes per annum

Acronym/Abbreviation	Description
NIMPCG	National Introduced Marine Pests Coordination Group's
nm	nautical miles
NTU	Nephelometric Turbidity Units
NZMPI	New Zealand Ministry for Primary Industries
OGV	Ocean going vessels
PPA	Pilbara Ports Authority
PSU	Practical salinity unit
SWASP	State Wide Array Surveillance Program
TDS	Total Dissolved Solids
the National System	the National System for the Prevention and Management of Introduced Marine Pest Incursions
transhipper	self-propelled transhipment vessel
VBRAMP	Vessel Biofouling Risk Assessment and Management Procedure
WA	Western Australia

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1. Introduction

1.1. Project Summary

K plus S Salt Australia Pty Ltd (K+S) propose to develop and operate a greenfield Solar Salt Project (the proposed Ashburton Salt Project) on the Western Australian coast, approximately 40 km south-west of the townships of Onslow, within the shire of Ashburton (Figure 1). The Ashburton Salt Project (the Project) will produce up to 4.7 million tonnes per annum (mtpa) of salt through solar salt farming, a process involving the evaporation of sea water using sunlight and wind.

The Project includes the construction of the solar evaporation and crystallisation ponds and associated infrastructure including:

- a seawater intake (comprising an intake sump, pipelines, pumps and channel)
- concentration and crystallisation ponds
- salt wash plant
- stockpiles and conveyors
- bitterns discharge infrastructure (including a dilution pond, pipeline and diffuser)
- jetty and product loading infrastructure
- access road, internal site roads and haul roads (for construction materials and, during operations for site maintenance and product transfer)
- borrow pits for extraction of clay and other construction materials
- drainage diversions
- dredging and onshore placement of dredged material
- buildings such as offices, storage and workshops
- sewage treatment
- water monitoring bores
- small desalination plant
- service corridors
- electricity and natural gas distribution
- equipment parking and laydown areas
- fuel storage and a refuelling station
- helipad.

The proposed Project layout is shown in Figure 2. The summary project description is detailed in Table 1, with key physical and operational elements of the Ashburton Salt Project identified in Table 2.

Table 1 Short Summary of the Project

Project Title	Ashburton Salt Project
Proponent Name	K plus S Salt Australia Pty Ltd
Short Description	It is proposed to construct and operate a solar salt Project approximately 40 km southwest of Onslow, WA. The Project includes the construction of solar salt evaporation and crystallisation ponds and associated infrastructure/activities (seawater intake pumps / channel / pipeline(s); seawater concentration ponds and salt crystallisation ponds; internal site roads; electricity generation and reticulation; fuel storage sites; a jetty and product loading facilities; a salt wash plant and associated ponds; salt stockpiles and conveyors; onsite buildings such as offices, storage, workshops and possibly accommodation; sewage treatment facilities and landfill; water management/monitoring bore(s); helipad; desalination plant; equipment parking and laydown areas; bitterns discharge infrastructure which includes a channel, dilution pond, pipeline and diffuser; drainage diversion/s and levees; access roads; borrow pit areas for rock, clay and other construction materials; and dredging and land based dredge spoil disposal).

Table 2 Location and proposed extent of physical and operational elements

Element	Location	Proposed Extent
Physical Elements		
Evaporation and crystallisation ponds	Figure 2	Disturbance footprint of no more than 10,397 ha within a 20,990 ha Ashburton Salt Project Development Envelope
Support infrastructure		Disturbance footprint of no more than 1,596 ha within a 20,990 ha Ashburton Salt Project (includes: seawater intake pumps/channel/pipeline(s); internal site roads; electricity generation and reticulation; fuel storage sites; a jetty and product loading facilities; dredging; land based dredge spoil disposal; a salt wash plant and associated ponds; salt stockpiles and conveyors; onsite buildings such as offices, storage, workshops and accommodation; sewage treatment facilities; landfill; water management/monitoring bore(s); equipment parking and laydown areas; bitterns discharge infrastructure which includes a channel, dilution pond, pipeline and diffuser; drainage diversion(s) and levees; borrow pits; helipad; and desalination plant.)
Access roads (including road upgrades and river crossing/bridge		Clearing of no more than 155 ha within a 20,990 ha Ashburton Salt Project Development Envelope (77 ha for main access road and 78 ha for internal site access roads)
Operational Elements		
Seawater intake	Figure 2	Seawater intake of no more than 250 GL per annum
Wastewater (bitterns)		Marine discharge of no more than 20 GL per annum (consists of no more than 10 GL per annum bitterns, diluted with seawater at a ratio of approximately 1 to 1)

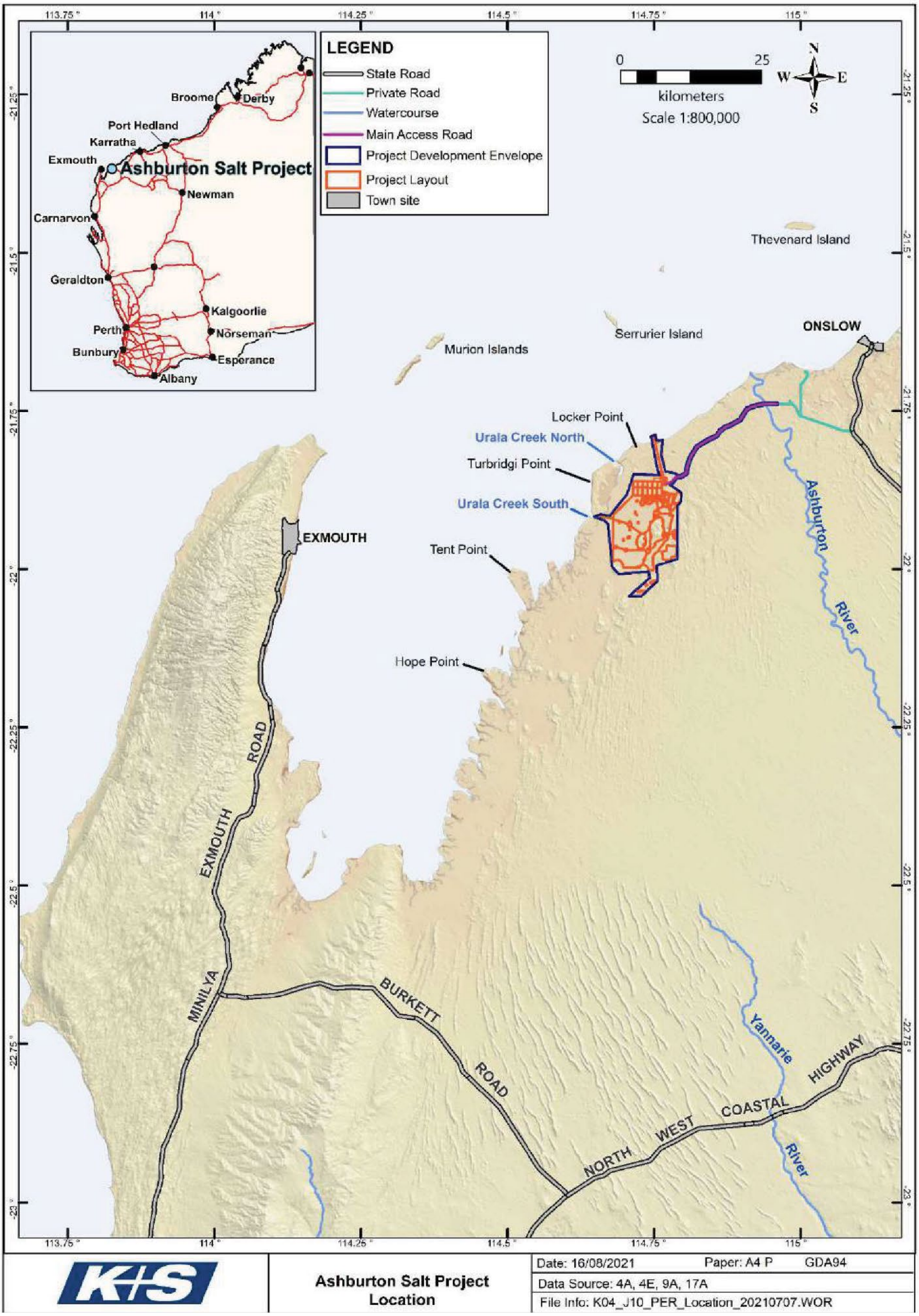

Figure 1 Regional location of the Project

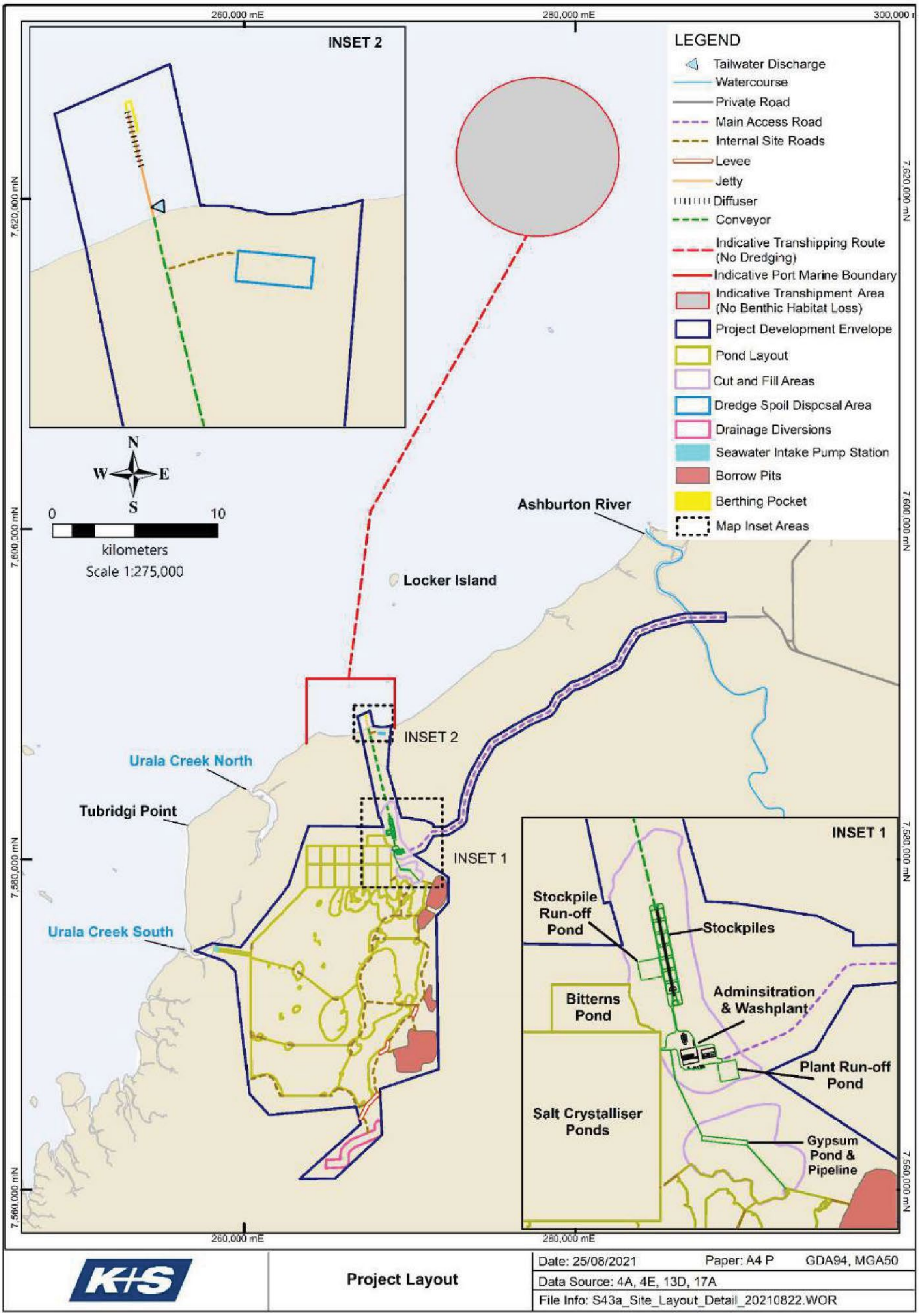

Figure 2 Proposed development envelopes and indicative layout

1.2. Purpose of this Plan

The scope of this Introduced Marine Pest Monitoring and Management Plan (IMPMMP) is to undertake a desktop Introduced Marine Pests (IMPs) investigation and risk assessment that is aligned with the National System for the Prevention and Management of Marine Pests Incursions (The National System) and the Marine Pest Plan (DAWR 2018). Specifically, the plan includes the following key elements:

- Review of the history and current status of IMPs in the Ashburton region and on the Pilbara coast
- Analysis of risk and likelihood of introduction of IMPs during the construction phase and operational life of the Project through vessel movements and activities
- Analysis of potential impacts to the Project and the wider environment of a potential marine environment of a potential marine pest introduction
- Identification of IMP transfer risk species for the Project area using the National System Monitoring Design Excel Template (MDET)
- Risk assessment of IMP translocation due to the Project and identification of relevant management controls to reduce risk
- Address the commitment of the Environmental Scoping Document to prepare an IMPMMP
- Define detailed management and monitoring actions to ensures that the project Environmental Protection Outcomes (EPOs) are achieved.

1.3. Objectives

The objective of the IMPMMP is to identify IMPs of potential risk and to assign appropriate management actions and mitigation measures, where necessary, to ensure that the state Environmental Protection Outcomes can be achieved.

- To prevent the establishment and proliferation of IMPs
- To control (and eradication) any IMPs have established and proliferated
- To minimise the transfer of any established IMPs further within Western Australian waters
- To protect benthic communities and habitat (BCH) so that biological diversity and ecological integrity are maintained
- To protect marine fauna so that biological diversity and ecological integrity are maintained.

2. Regulations and Guidelines for Introduced Marine Species

2.1. Defining Introduced Marine Pests

Introduced marine species are animals, plants, algae, and other biota existing in a region beyond their natural geographical range, to which they have generally been translocated by human activity. Australia currently has over 250 known introduced marine species but only a small proportion have been recognised as pests. The National Marine Pest Plan 2018-2023 defines IMPs as introduced species that cause harm to the environment, social amenity, or industry, or have the potential to do so if they were to be introduced, established, or spread in Australia's marine environment (DAWR 2018). Some examples of the impacts of IMPs include:

- Competition with native species for resources
- Predation on native species
- Alteration of trophic interactions and food-webs
- Loss of commercial and recreational fisheries harvest
- Human illness
- Reduced coastal aesthetics
- Damage to marine and industrial infrastructure
- Reduced aquaculture productivity.

2.2. Laws, Guidelines and Policies

Several Commonwealth and State Regulations and Guidelines can be used within Commonwealth and State water to enforce biosecurity. Australia has committed to International Maritime Organisation Conventions and a significant amount of leadership in the form of legislative instruments and guidance is provided at the Commonwealth level. Within Western Australia (WA), the Department of Primary Industries and Regional Development (DPIRD) is the lead agency responsible for developing and implementing the necessary management arrangements and biosecurity control activities to restrict the introduction and translocation of invasive marine and freshwater species in the WA aquatic environment. Several Acts and Regulations can be used within WA state waters (within three nautical miles) to enforce biosecurity. Relevant laws, guidelines and policies are listed in Table 3.

Table 3 Laws, guidelines and policies related to IMPs in Western Australia

Commonwealth
Biosecurity Act (2015) and Biosecurity Regulations (2016)
Biosecurity Amendment (Ballast Water and Other Measures) Act 2017 (Amendment Act)
Biosecurity (Ballast Water and Sediments) Determination 2017
Australian Ballast Water Management Requirements 2019
National Biofouling Management Guidelines (Commonwealth of Australia 2022) (Voluntary Guidelines)
Marine Pest Plan 2018-2023 (DAWR 2018)
State
Aquatic Resources Management Act (2016)
Fish Resources Management Act (1994) and Regulations (1995)
Pearling Act (1990)
Ports Authority Act (1999) and Regulations (2001)
Biodiversity Conservation Act (2016)
Environmental Protection Act (1986)
Biosecurity and Agricultural Management Act (2007)

2.3. National Approach to IMP Management

Following a series of high-profile marine pest detections in Australia in the 1980s and 1990s, the National Introduced Marine Pest Coordination Group (NIMPCG), established in 2000, developed the National System. The National System comprised a suite of detailed biosecurity reform measures intended for development and implementation by Australian governments, industry, and research organisations.

In 2011 the Marine Pest Sectoral Committee (MPSC) replaced the NIMPCG as the government body responsible for coordination of Australia's marine pest risk management arrangements. The MPSC coordinates a national approach to marine pest biosecurity to stop the spread of marine pests. The committee includes members of the Australian Government, State and Territory governments, New Zealand Government and technical or scientific experts. The committee shares responsibilities for managing marine pests with national and local agencies. Industry groups also take an active role. Australia's national strategic plan for marine pest biosecurity *Marine Pest Plan 2018-2023* outlines the national priorities for marine pest biosecurity and sets out strategic direction for potential investment over the next 5 years. The plan is a joint initiative of key marine pest biosecurity stakeholders. The Department of Agriculture, Water and the Environment (DAWE), now the Department of Climate Change, Energy, the Environment and Water (DCCEEW), coordinated the implementation of activities under the plan, under the direction of MPSC and partners.

The National Priority List of Exotic Environmental Pests, Weeds and Diseases (EEPL) was released in November 2020. The purpose of the EEPL was to strengthen Australia's environmental biosecurity and develop a national approach to address biosecurity risk to Australia's environment. The EEPL implementation plan is currently being drafted, this plan will identify and prioritise the needed actions to reduce the risk of these pests entering, establishing, and spreading through the Australian environment (DAFF 2022)

A number of priority, target and trigger species lists have been developed under the direction of Government bodies in order to assist management and monitoring of IMPs in Australia. Key species lists referred to in this report are detailed below.

2.3.1. Australian Priority Marine Pest List

The Australian Priority Marine Pest List (APMPL) identifies 10 of Australia's significant marine pests. This list includes 3 established and 7 exotic species (Table A-1, Appendix A). To decide on the priority pests, experts identified species that were: nationally significant, able to be identified in the marine environment and able to be eradicated. The Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) trigger list was replaced by the APMPL.

2.3.2. NIMPCG List

A database of introduced marine species worldwide, which identified 55 species considered to present the greatest threat to the Australian marine environment (Table A-2, Appendix A: NIMPCG 2009a; b). This database considered species from existing introduced marine species lists shown below.

- A list of species for which domestic ballast water management would be required (currently seven species).
- The priority pest list (domestic list) in National Priority pests: part II. Ranking of Australian Marine Pests. Final Report for the Department of Environment and Heritage (Hayes et al. 2004).
- The priority pest list (international list) in National Priority pests: part II. Ranking of Australian Marine Pests. Final Report for the Department of Environment and Heritage (Hayes et al. 2004).
- The Trigger List of Introduced Marine Pests used in emergency management by CCIMPE (CCIMPE trigger list).

The salinity and temperature tolerance range for these species was included with the intention that designers of monitoring programs could refine their target species list to the environmental conditions at the site. This is completed using the Monitoring Design Excel Template (MDET) which was originally developed in line with the Australian Marine Pest Monitoring Guidelines (DAFF 2010).

3. Existing Environment

The Project is located within the southern reaches of the North-west Marine region, northeast of the Exmouth Gulf and Ningaloo Marine Park. The Exmouth Gulf is enclosed by the Cape Range Peninsula to the west and the Yannarie Coastal Plain to the east and is one of the largest embayment's with an approximate size of 3,000 km^2. The Exmouth Gulf is the start of the shallow Pilbara waters region, which are a stark contrast to the waters outside the deep waters off the Ningaloo reef. The Exmouth Gulf is home to a large diversity of intertidal habitats and mangroves creating nutrient-rich waters for a variety of marine invertebrates and vertebrate species. The Leeuwin Current forms within the Exmouth Gulf and is its start point for the current to head south down the coast. The Exmouth Gulf and the Ningaloo Reef ecosystems are inherently connected and ecologically linked (EPA 2021).

Identifying the environmental conditions and habitat types at the proposed Ashburton Salt Project provides valuable information on the suitability of the conditions for potential IMP introduction, survival, translocation, and reproduction. These environmental factors will determine which IMP species pose the most risk to the Ashburton region (see Section 5.4).

3.1. Climate & Oceanography

The climate at the Project is classified as hot, semi-arid with potentially significant rainfall occurring during late January through March and then May to July (K+S 2021). The dry season occurs from late August through to December. The tropical cyclone season in the region runs from the middle of December to April, with a peak activity in February and March. Climate data is collected at Onslow Airport, approximately 40 km north-east of the Project. Mean maximum daily temperatures are typically highest in January and February with 36.5°C, and lowest in July with 25.6 °C (BoM 2022).

Winds are generally south or south-westerly for most of the year, with more south-westerly winds common during the summer months around the Exmouth Gulf region. During the cyclone season wind patterns are similar, though higher winds are typically blowing from westerly and north-westerly directions (K+S 2021).

Wave energy in the area is typically relatively low, with typical directions of west to north-northeast and generally sheltered from swell wave energy from the south-west by the North West Cape. Swells can also be generated during cyclones or storms further away and these are more likely to come from the north and northeast (Water Technology 2022). Water movement is primarily driven by a combination of tidal and wind, in addition to the various currents influencing the area (Water Technology 2022). At the Project site, tides are semidiurnal with a mean spring tidal range of approximately 0.89 m as measured at Exmouth and Onslow, with a general consistency of tidal height within Exmouth Gulf and along the coast.

3.2. Geomorphology

The Project is located inshore on supratidal salt flats, adjacent to the northeast shore of the Exmouth and the Onslow Coastal Tract, encompassing geomorphic feather from both regional scale units. The area extends from a coastal shoreline comprised of either a tidal mangrove zone (i.e., fringing the northern more extent of Exmouth Gulf) or sandy beaches (i.e., that extend east from Tubridgi Point), across the salt flats of the Onslow Plain to where this plain abuts the terrestrial habitats of the Carnarvon Dunefield on the mainland (AECOM 2022a).

3.3. Water Quality

A risk assessment of IMP species can be informed by identifying the physical water characteristics at the Project location. Water quality (including salinity, temperature, and turbidity) of the receiving environment has a notable influence on the survivorship of marine species, including IMPs. The likelihood of survival of IMPs at the Project location can be calculated if the known water quality tolerance ranges of the potential IMPs.

3.3.1. Salinity

Variable salinity levels are common in nearshore waters of the west Pilbara (Pearce et al. 2003). Nearby water quality studies at Locker Point have been measuring in-situ salinity levels from December 2018 to October 2020, have identified a median salinity of 40 PSU (practical salinity unit), with a range from 36.3 PSU to 41.6 PSU (Water Technology 2022). Total Dissolved Solids (TDS) was also measured over the same period, which is also a good indicator of salinity. During the monitoring period, salinity ranged from 36.3 PSU to 41.6 PSU, with a median of 40 PSU and 80th percentile of 40.7 PSU. TDS ranged from 35,621 to 40,155 mg/L, with a median of 38,755 mg/L and 80th percentile of 39,456 mg/L. Water samples were also taken approximately once a month during the monitoring period, and laboratory testing of TDS was conducted by a NATA accredited laboratory. The laboratory TDS results were similar to the in-situ results, with the laboratory results ranging from 36,000 to 41,000 mg/L, a median of 39,000 mg/L and an 80th percentile of 41,000 mg/L (Water Technology 2022). The Ashburton River is located approximately 25 km north east of the Project. The Ashburton River is generally fresh, the TDS within the river being ~133 mg/L.

Salinity levels

3.3.2. Sea Temperature

Sea surface temperature within the vicinity of the Project vary between 20°C in August to a maximum of 30°C in March (Water Technology 2022). With a wide temperature range in the region, some IMP species may be unable to survive or reproduce successfully. However, increasing water temperatures and ocean acidification may favour the establishment and spread of marine pests (DAWR 2018).

3.3.3. Turbidity

Nearshore waters within and around the Project area are characterised by variable turbidity. Generally, the region experiences high variability in turbidity due to storm events and cyclones, flooding events result in periods of very high turbidity. As demonstrated from the results from the Wheatstone Project found turbidity increased to 77 NTU (Nephelometric Turbidity Units) during storm and cyclone events (MScience 2009). Water sampling conducted within the Project area (Locker Point) from December 2018 to February 2020 NTU ranged from 0.6 to 8.3 NTU for the laboratory results, and from 0.29 to 13.4 NTU for the in-situ results.

3.4. Benthic Communities & Habitat

A range of studies to assess impacts to benthic communities and habitats have been conducted for the Ashburton Project (AECOM 2022a; K+S 2021). The benthic habitat types which have been identified across the Ashburton Project area include:

- Soft sediment (potential seagrass), macroalgae dominated reef and macroalgae and sparse coral reef in the subtidal zone
- Mangroves, transitional mudflats, algal mats, sandy beaches, and tidal creeks in the intertidal zone

- Salt flats and samphire in the Supratidal zone (note that the Supratidal zone is not mapped within the Local Assessment Unit (LAU) boundaries as it is not considered part of the scope of EPA Technical Guidance – Protection of Benthic Communities and Habitats (EPA 2016a).

Construction of the Project components (nearshore) and offshore transhipment anchorage area will alter the habitat available for marine pest settlement. Dredging of up to 17,000 m^3 of the berth pocket, 200 m x 35 m x 6 m of water depth (LAT) – this requires dredging of approximately 2.5 m of seabed, to accommodate the transhipment vessels adjacent to the purpose built loading platform at the end of the jetty.

In addition, the construction of the jetty and loading infrastructure supported by marine piles, offshore anchorage, and berth pocket will create new areas where colonisation of sessile/sedentary marine species is possible. Existing habitats and habitat modifications will be considered within this report, as well as any existing infrastructure, as a potential point of translocation to or from the Project.

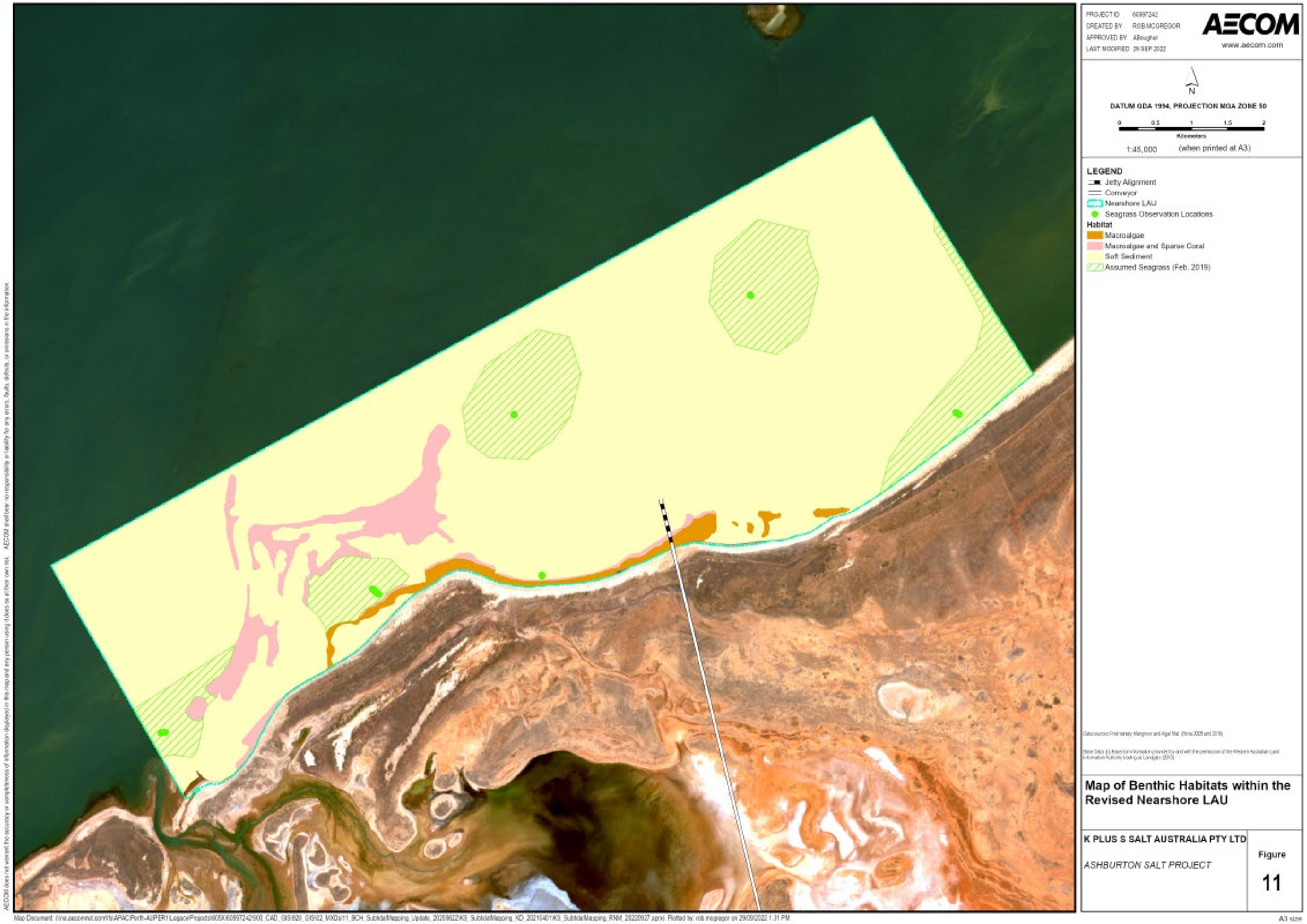

Figure 3 Subtidal BCH mapping (AECOM 2022a)

3.5. Marine Fauna

The Project is located is within the southern reaches of the North-west Marine region, northeast of the Exmouth Gulf and the Ningaloo Marine Park.

A marine fauna impact assessment was undertaken for the Project by AECOM (2022b), which collated desktop literature review and gap analysis information, and field survey data. Identification of 'key' species as those with the highest conservation value, which could be impacted by the Project ensures that the correct level of attention is paid to those at greatest potential risk. The key conservation significant species were identified based on their status and likelihood of occurrence in the Project area. Key species that were identified as 'likely to occur' within the project area are:

- Green sawfish (*Pristis zijsron*)
- Green guitarfish (*Glaucostegus typus*)
- Bottlenose wedgefish (*Rhynchobatus australiae*)
- Nervous shark (*Carcharhinus cautus*)
- Humpback whale (*Megaptera novaengliae*)
- Australian humpback dolphin (*Sousa sahulensis*)
- Dugong (*Dugong dugon*)
- Hawksbill turtle (*Eratmochelys imbricata*)
- Flatback turtle (*Natator depressus*)
- Green turtle (*Chelonia mydas*)
- Loggerhead turtle (*Caretta caretta*).

The Project footprint also intersects with several commercial fisheries boundaries. Only two fisheries have been identified to potentially impacted by the Project, these are:

- Exmouth Gulf Prawn Fishery
- North Coast Prawn Fishery including Onslow Prawn Managed Fishery (OPMF)

The target species; king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), blue endeavour prawns (*Metapenaeus endeavouri*) and banana prawns (*Penaeus merguiensis*) of the Exmouth Gulf Prawn Fishery and the OPMF, these target species could potentially be impacted by a potential introduction on marine pests as discussed in Section 5.1.

4. Introduced Marine Species and Pests in Western Australia

A search of the Department of Primary Industries and Regional Development (DPIRD) - Fisheries online Biosecurity alerts portal identified eight marine pest alerts for WA were current at the time of this report, with observations of:

- Asian green mussel (*Perna viridis*) on a vessel at Barrow Island and at Henderson in 2013[1]
- Asian paddle crab (*Charybdis japonica*) in Perth and Mandurah
- Black-striped mussel (*Mytilopsis sallei*)[1]
- European green crab (*Carcinus maenas*)[2]
- Japanese kelp (*Undaria pinnatifida*)[2]
- Northern pacific seastar (*Asterias amurensis*)[2]
- Redclaw crayfish (*Cherax quadricarinatus*)
- Spangled perch (*Leiopotherapon unicolor*).

None of these pest species are known to have established self-sustaining populations in WA waters but all represent a serious threat. Five of these species are listed on the APMPL, with three species already established in other parts of the country. The five species on the APMPL are also listed on the NIMPCG list (2009a, b).

From previous survey records and unpublished reports in 2008, Huisman et al. (2008) identified 102 known introduced marine and estuarine species in WA. Of these species 60 species were considered to have been introduced by anthropogenic activity. Of the 102, 3 were listed on the Australian National IMPs list at the time (NIMPCG 2009a, b): the dinoflagellate *Alexandrium minutum*, the bivalve *Musculista senhousia* and the polychaete *Sabella spallanzanii* (Wells 2018).

A comprehensive review by Huisman et al. (2008) found that 15 introduced marine species (Table 4) have been previously identified as present in the Pilbara but have not established self-sustaining populations, except for *Didemnum perlucidum*. None of the other species are on the NIMPCG list or the APMPL.

The white colonial ascidian (*D. perlucidum)* has established a self-sustaining population at various locations around the Pilbara (Wells 2018). The species has potential to cause harm to the environment it is introduced into, however it has been widely found in marine industrial areas across WA. The species was identified at the Port of Ashburton, Port of Onslow and at Barrow Island through settlement array surveillance monitoring (DPIRD 2017).

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[1] Exotic Priority pest on APMPL
[2] Exotic Priority pest on APMPL

Table 4 IMPs established in the Pilbara (adapted from Huisman et al. 2008)

Group	Species	Onslow	Barrow Island	Dampier	Port Hedland
Bryozoans	*Amathia distans*				×
	Amathia vidovici				×
	Bowerbankia gracilis				×
	Bugula neritina			×	×
	Bugula stolonifera				×
	Savignyella lafonti		×		×
	Tricellaria occidentalis		×		
	Zoobotryon verticillatum				×
Crustaceans	*Amphibalanus amphitrite*			×	×
	Amphibalanus reticulata		×	×	×
	Megabalanus ajax		×	×	
	Megabalanus rosa		×	×	×
	Megabalanus tintinnabulum	×	×	×	×
Hydroids	*Antenella secundaria*				×
Ascidians	*Didemnum perlucidum*		×	×	

5. Identification of Relevant Risks

5.1. Resources at Risk

The consequences/level of impact of IMP translocation is dependent on the value and sensitivity of the receiving environment and the value and susceptibilities of the Projects assets.

The Project is located ~40 km south-west of the townships of Onslow and is within the southern reaches of the North-west Marine region, northeast of the Exmouth Gulf and the Ningaloo Marine Park. The Exmouth Gulf one of four important resting area for humpback whales along the WA coastline during their southern migration (DAWE 2020), which is utilised from July to November each year (peak September and October) (Irvine and Salgado Kent 2019). The Exmouth Gulf is adjacent to the Ningaloo Marine Park outer waters are Commonwealth waters and the inner waters are State waters, to protect the World Heritage listed Ningaloo Reef. The Exmouth Gulf is inherently connected and ecologically linked the Ningaloo Reef ecosystem (EPA 2021). With the Exmouth Gulf was originally included within the optimal UNESCO Ningaloo Coast World Heritage area list; however, it was not included (UNESCO 2011).

In addition, the region also hosts serval other important marine species conservation status identified in Section 3.5, which could potentially be impacted from the introduction of marine pests from the Project. The Project is located within the Exmouth Gulf East Wetland, which is a Nationally Important Wetland and the Exmouth East Shore Mangrove Management Area.

Commercial implication as a result of IMP introduction would be substantial, including physical detriment to assets, damage to business reputation, and increased regulatory requirements. Damage to, or inhibition of infrastructure functionality by IMP, such as the fouling of vessels and equipment is likely to result in reduced vessel efficiency, and more frequent dry-dock inspections and hull cleaning would then be required. Water intakes may become so fouled by colonial ascidians like *Didemnum spp* that they are no longer functional.

Commercial fisheries that operate within the vicinity of the Project and have the potential to negatively impacted by IMP introduction into the area, with historical introduction of IMP have been the leading cause behind the collapses of fisheries (e.g., Port Phillip Bay introduction of North Pacific Sea star). Post-larval brown tiger prawns occupy shallow seagrass and algal communities, generally less than 2 m deep (Ovenden et al. 2007). Juvenile brown-tiger prawns are generally found in dense patches of seagrass, with higher densities of juveniles found in seagrass beds that are in close proximity to mangroves. The banana prawn has a lifecycle that includes a post-larval and juvenile phase, which is restricted to mangrove lined estuaries. The western king prawn juveniles are found within shallow tidal flat, embayments with sand or mud substrates, and generally associates with mangrove habitats and seagrass beds. Loss of this habitat through competition with IMP, predation of post-larval and juvenile from IMP and resource competition could all potentially impact the Exmouth Gulf Prawn Fishery and the Onslow Prawn Managed Fishery.

Although not identified as a fishery at risk from the Project, the Northern Demersal Scalefish Aquatic Resource relies on the bluespotted emperor. The bluespotted emperor is restricted primarily to WA waters, extending from the Exmouth Gulf to Darwin. Spawning and nursery areas for the species are thought to be restricted to the West Pilbara. The Pilbara region has the highest relative density of the bluespotted emperor and is the distribution point for the species across other regions. Juvenile bluespotted emperors are strongly associated with inshore macroalgae beds, often found in water depths less than 10 m, as the habitat is critical nursery habitat for the species. The spatial distribution of adults also exhibits markedly higher abundances in shelf waters adjacent to large expanses of inshore macroalgae beds. Recruitment of the bluespotted emperor, therefore, may be impacted by predation of juveniles or from loss/degradation to these inshore macroalgae habitats from IMP. This could potentially impact the Norther Demersal Scalefish Aquatic Resource throughout WA.

5.2. Risk Factors

There is a diverse range of factors that may affect the likelihood of an IMP arriving and establishing at the Project area. For a successful marine pest introduction to take place they need to be transported from a location where already present, and the receiving environment must be suitable for their survival.

5.2.1. IMP Vectors

Vectors are the mechanism by which a potential marine pest can be translocated from donor to receiving node. Primary vectors of concern include biofouling on vessel hulls and other surfaces, ballast water, or other internal water or sediment carried by a vessel or marine equipment. The most common transportation vectors for the introduction of IMP are biofouling on vessels, debris, and submersible equipment, or in ballast water/sediment and seacocks/sea strainers. There has been reports of ~250 non-indigenous marine species in Australian waters, and of these reports 75% have been introduced via biofouling (McDonald et al. 2015).

The assumption with IMP introduction is that the likelihood of them occurring within an area is related to the number of vessels that visit the area from a source location. The likelihood of translocation is dependent upon the following factors to determine a vessels risk (modified from McDonald et al. 2015):

- Frequency and duration of vessel visits (assumption greater duration of stay, greater potential of transfer)
- Vessel operating speeds (e.g., stationary, or slow- moving vessels in port areas allow fouling pests to attach, while transit times between ports will affect survivorship in ballast water, slower vessels great potential of pest settlement)
- Type of vessel operations (i.e., direct contact with seabed brings higher risk of pest transfer and settlement)
- Origin location (Last Port of Call – LPoC)
- Level of hull biofouling and prevention (anti-foulant coatings)
- Capacity and use of ballast water throughout journey. Time on voyage from LPoC, relating to the duration that species can survive in ballast water
- Presence and size of internal vessel areas such as sea chests, anchor cable lockers, propeller shafts (more niches greater potential for transfer)
- Size of vessel and corresponding size of hull wetted area (assumption bigger vessel the greater the surface area for biofouling)
- Frequency/rigour of inspection of internal areas and treatment systems used
- Dry docking - duration since the last dry-docking or removal from the water
- Maintenance constraints (assumption structural profiles that inhibit effective maintenance the greater the potential for pests to settle on hull).

These risk factors are incorporated into several private sectors and government supplied risk assessments, including DPIRD biosecurity 'Vessel Check Biofouling Risk Assessment. Under the *Biosecurity Act 2015*, all vessels are required to use the Marine Arrivals Reporting System (MARS), which includes ballast water management requirements, which incorporates risk factors listed above relating to ballast water.

In a likelihood assessment for IMP risk in the Indian Ocean Territories completed by McDonald et al. (2015), vessel types were rated in terms of their IMP translocation potential, based on a combination of the above factors. The analysis focussed on vessel characteristics and likelihood of carrying pests, rather than being geographically specific. As such, where congruence in vessel types exist between that and this assessment, likelihood ratings are considered transferable for use here. The vessel types proposed for use in construction and operations of the Project and their relative likelihood ratings are presented in Table 5. Note that the backhoe/cutter suction dredge, barge (split-hopper) or transhipper vessels were not included in McDonald et al. (2015) however, the process outlined in that document was followed to derive their relative risk ratings.

Table 5 Vessel and immersible equipment for the Project and their relative likelihood of IMP transfer ratings (adapted from McDonald et al. 2015), with one (1) the lowest risk and three (3) the highest

Number	Project Phase	Vessel/Equipment Type	Relative Likelihood Rating
4	Construction	Tug	2
1	Construction	Backhoe or cutter suction dredge	3
1-2	Construction	Barge (Split-hopper)	3
	Construction	Support vessels (crew transfer, tender vessels, offshore support vessels)	1
30-70 per year	Operational	Panamax Ocean Going Vessels (OGV)	1
400 to 600 movements per year between jetty and anchorage	Operational	Purpose-built shallow draft, self-propelled transhipment vessel ('transhipper')	2
	Operations	Small vessels for local transport	1

5.2.2. Receiving Environment

The conditions at the receiving environment are factors which can influence the likelihood of marine pest introduction. These factors include:

- Similarity of the receiving environment to the marine pest's location of origin (habitat/substrate type, bioregional matching, physico-chemical conditions, temperature, and salinity regimes)
- Availability of substrate/habitat
- Availability of prey/food/nutrients
- Presence of predators

- Competition with local/native biota
- Distance of the Project site to high risk areas (ports, harbours, aquaculture facilities).

The existing environment at the Project and adjacent to the Project are described in Section 3. The Project will alter the existing habitat available for the establishment of marine pests, by the increasing the available hard substrate (~50 jetty piles and intake pipelines), as well as change in substrate depth and composition in the dredging berth pocket. These dredge, disturbed, and constructed area and surfaces are more likely to be colonised by opportunistic invasive marine species before a native community is established (Wells and McDonald 2010).

Proposed vessels for the Project listed in Table 5 have not yet been contracted and as such, the origin of these vessels is unknown. K+S is considering the Project to participate in supplying future growth in salt demand in Asia, therefore it is likely that some of the OGVs and possibly construction vessels will be sourced from China and/or southeast Asia ports. Ports in those regions have similar environmental conditions to the Project. Many IMP species on the NIMPCG list (Appendix A; Table A-2) either originate from or are established in large southeast Asian ports such as Singapore. Notably. these include the Asian green mussel (*Perna viridis*) and Black-striped mussel (*Mytilopsis sallei*) (McDonald et al. 2015). There is a greater likelihood for introduction of such species to the Project from vessel originating from China and southeast Asian ports due to bioregional matching.

The Port of Dampier ~240 km to the north-east of the Project was the highest ranked port for the introduction of a non-indigenous marine species, due to a range of factors including number and type of vessels, their port of origin, ballast water characteristics and deadweight tonnage – as a proxy for hull fouling potential (McDonald 2008). The Exmouth Port (~40 km from Project) was the ranked to have the lowest likelihood of non-indigenous marine species introduction and Barrow Island Port was the ranked 10th (out of 15 Ports ranked in report) for likelihood of IMP introduction. Both these ports have low ranking based on the low number of vessel visits and more importantly low number of international vessels into the ports.

5.3. Project Risk Areas

There are a diverse range of factors that may affect the likelihood of an IMP arriving and establishing within the Project area. For a successful IMP introduction to take place they need to be transportation from a location where they are already present, and the receiving environment must be suitable for their survival.

Nodes are the locations to, or from which, a potential marine pest is transported. Nodes can be broad like a port or region, or as refined as a structure within a port or harbour such as a mooring or pylon. Nodes with an IMP translocation risk for the proposed Ashburton Salt Project include:

- Anchorage at transhipment area
- 400 to 600 transhipper movements each year
- Jetty construction
- Substrate surrounding and below the pile jetty
- 700m pile supported jetty (approximately 50 piles)
- Dredging (200 m x 35 m x 6m), ~2.5 m of seabed, total volume 17,000 m^3
- 67 ocean going vessels (OGVs) to anchor point each year
- Possible maintenance dredging

- Outfall and intake pipelines in intertidal and sub-tidal zones
- Immersible equipment activities (e.g., immersible equipment, anchor chain locker and associated chain).

The 700 m trestle jetty is being constructed to facilitate the loading of salt product onto purpose-built shallow draft, self-propelled transhipment vessels ('transhippers'). There transhippers will travel at an approximate speed of **nine** knots and have a maximum draft of 6 m (when fully loaded). Jetty construction will require dolphins and restraint structure and will comprise of approximately 50 tubular piles. The jetty will be constructed in phases, with the first 180 m of the trestle jetty will be constructed on the mud flat reef, which will be exposed at low tide, the remaining 530 m will be completed in shallow water at low tide.

The transhippers will transport the salt to the OGVs, that will be anchored approximately 14 nautical miles (nm) offshore. It has been projected that transhippers time cycle is 13.21 hours of this 4.25 hours will be spent travelling two and from the jetty to offshore loading locations. The remaining time will be spent loading and unloading. It will take an estimated 9 transhipper cycles (approximately 4.8 days) to load the OGV, with the transhippers approximate speed of 9 knots.

The number of transhipper movements and OGVs is variable and will be dependent of the demand of the salt product produced by the Project. The following estimates have been made to indicate the scale of the potential operational vessel movements:

- Based on a maximum project production level of 4.7 million tonnes per annum (MTPA), ocean going vessel capacity of 70,000 t and 8,000 t transhipper parcel loads:
  - 67 ocean going vessels proceeding to anchor points per year.
  - 587 transhipper movements per year.
- Based on a slightly lower project production level of 4.5 MTPA, ocean going vessel capacity of 150,000 t and 12,000 t transhipper parcel loads:
  - 30 ocean going vessels proceeding to anchor points per year.
  - 375 transhipper movements per year.

5.4. Risk Species

The Project area has not specifically been surveyed for IMPs; therefore this section identifies marine species which are most likely to be introduced to the Project area. The white colonial sea squirt (*D. perlucidum*) is a known and listed IMP that was first detected in Fremantle waters in 2010, and since has rapidly spread throughout WA. It can now be found from Esperance on the southeast coast, along the west coast, to the Kimberly in the northeast and in Darwin, Northern Territory (NT). The species is widespread throughout the Pilbara, and as noted in the Ashburton Salt Project: Draft Environmental Review Document (K+S 2021) *D. perlucidum* is expected to colonise the artificial structures introduced as part of the Project (e.g., jetty piles) (AECOM 2022b).

The species of risk were identified using the environmental conditions collected from Water Technology 2022, which found Locker Point to have a temperature range of 20 to 30°C, and a salinity range of 36.3 PSU to 41.6 PSU (median of 40 PSU and mean of 39.22 PSU). The surrounding environments of adjacent to the Project area which are also resources at risk, the Exmouth Gulf (temperature 18 - 30°C, hypersaline 36 – 38.5 mg/L), and

Onslow (temperature 20-30°C, salinity median 37.7 PSU, max 40 PSU) have slightly different temperature and salinity thresholds which could allow for the translocation and spread of the pests into these areas from the Project site. Therefore, species thresholds were. The species were identified using a combination of the following sources:

1. The primary source is National Introduced Marine Pests Coordination Group's (NIMPCG) original Monitoring Design Excel Template (MDET) which considers the salinity and temperature tolerance range for invasive marine species with the intention that designers of monitoring programs could refine their target species list to the environmental conditions at the site. MDET was originally developed in line with the Australian Marine Pest Monitoring Guidelines[1]. Known environmental conditions at the Project location were used to refine the marine pest species. The user guide for the MDET suggest including the species where one of the life stages is excluded by narrowly exceeding the thresholds, e.g., *Crepidula fornicate* larvae has undefined threshold, but the adult's salinity threshold is 40 ppt which is equal to the median salinity at Locker Point, therefore the larvae can be introduced and are able to survive in the conditions and the adult could potentially establish within the salinity range in the region. The thresholds used with the MDET may be based on limited data (DAFF 2010), therefore, species which narrowly (±3 °C/ppt buffer) exceed the temperature or salinity thresholds are included within the risk species list. If one of the species life-stages was found not to tolerate the conditions, all life stages for that species were excluded from the table due to the inability for it to reproduce (in line with Wells 2018). The BCH at the Project area is predominantly soft substrate with potential seagrass present, however hard substrate of macroalgae dominated reef, and macroalgae and sparse coral reef is also found in the area. The Project will also contribute to additional hard substrate (e.g., jetty piles) available that can support the introduction of IMP. Therefore, the habitats found within the Project area have the potential to support all NIMPCG trigger list species identified from environmental tolerances. We acknowledge the NIMPCG has been superseded at the federal level by the Marine Pest Sectoral Committee (MPSC) as the government body responsible for coordination of Australia's marine pest risk management arrangements. The MPSC coordinates a national approach to marine pest biosecurity to stop the spread of marine pests and provide expert scientific, technical and policy advice on marine pest related biosecurity issues to the National Biosecurity Committee (NBC) (DAWR 2018)
2. Secondary sources included the more recently updated Australian Priority Marine Pest List (APMPL) for marine pests that are at risk of introduction and causing harm in Australian waters (DAWE 2021) Species of the APMPL are identified as the highest risk at a National (MPSC) level.
3. At a state level the WA requirements the Western Australian Prevention List for Introduced Marine Pests (DPIRD 2016) identifies species that are (1) present on national aquatic pest lists or (2) of concern to the protection of WA aquatic resources (Appendix B), along with species described as noxious fish under the *Fish Resources Management Regulations 1995*. Species on this list which environmental tolerances matched the conditions to the Project are included.

Table 6 NIMPCG (2009a;2009b) listed IMP species that are at risk of translocation within the Project area

Species phylum	Species name	Common Name	Hard substrate	Soft substrate (epifauna)	Soft substrate (infauna)	Plankton/pelagic
Ballast Water						
Bacillophyta/diatoms	*Chaetoceros convolutus*	Centric Diatom				✓
Ctenophore	*Beroe ovata*	-				✓
	Mnemiopsis leidyi	Comb jelly				✓
Cnidaria	*Blackfordia virginica*	-				✓
Biofouling and Ballast water						
Annelida	*Hydroides dianthus*	Serpulid tube worm	✓			✓
Ascidiacea	*Didemnum spp.*	Colonial sea squirt	✓	✓		✓
	Didemnum perlucidum[+]	White sea squirt	✓	✓		✓
Chlorophyta	*Caulerpa racemosa*	Sea grapes	✓	✓		✓
	Caulerpa taxifolia	Aquarium weed	✓	✓		
	Codium fragile spp. tomentosoides	Dead man's fingers	✓	✓		✓
Crustacea/Cirripedia	*Amphibalanus eburneus (syn. Balanus eburneus)*[+]	Ivory barnacle	✓			✓
	Balanus glandula[+]	Common acorn barnacle	✓			✓
	Chthamalus proteus[+]	Atlantic barnacle	✓			✓

Species phylum	Species name	Common Name	Hard substrate	Soft substrate (epifauna)	Soft substrate (infauna)	Plankton/pelagic
Crustacea/Brachyura	*Carcinus maenas**	European green crab	✓	✓		✓
	Hemigrapsus sanguineus	Asian shore crab	✓			✓
	Hemigrapsus takanoi/penicillatus	Brush-clawed shore crab/hairy-clawed shore crab	✓	✓		✓
	*Rhithropanopeus harrisii**	Harris mud crab	✓	✓		✓
Crustacea/Copepoda	*Acartia (Acanthacartia) tonsa*	Calanoid copepod				✓
	Tortanus dextrilobatus	-				✓
Dinophyceae	*Alexandrium monilatum*	Toxic dinoflagellate			✓	✓
	Alexandrium tamarense	Toxic dinoflagellate			✓	✓
	Gymnodinium catenatum	-			✓	✓
	Pfuesteria piscicida	Toxic dinoflagellate			✓	✓
Mollusca/bibalvia	*Crassostrea gigas*	Giant oyster	✓			✓
	Ensis directus	Jack-knife clam			✓	✓
	Musculista senhousia	Asian bag mussel	✓	✓		✓
	Mya arenaria	Soft-shell clam			✓	✓
	*Mytilopsis sallei** *Mytilopsis spp. and Congeria spp.⁺*	Black-striped mussel	✓	✓		✓
	*Perna perna**	Brown mussel	✓			✓
	*Perna viridis**	Asian green mussel	✓			✓

Species phylum	Species name	Common Name	Hard substrate	Soft substrate (epifauna)	Soft substrate (infauna)	Plankton/pelagic
Mollusca/gastropoda	*Crepidula fornicata*	Slipper limpet	✓	✓		✓
	Rapana venosa	Asian rapa whelk	✓	✓		✓
Pisces	*Siganus luridus*	Dusky spinefoot	✓			✓
	Siganus rivulatus	Marbled spinefoot	✓			✓
Rhodophyta	*Bonnemaisonia hamifera*	Bonnemaison's hook weed	✓	✓		✓
	Grateloupia turuturu	Devil's tongue weed	✓			✓
	Womersleyella setacea	Red polysiphonous macroalga	✓			✓
+Not a NIMPCG species but identified in the Western Australian Prevention List for Introduced Marine Pests (DPIRD 2016) and suited to environmental conditions at the Project area *Also listed on Australian Marine Pest List (Appendix A)						

37 possible risk species were identified as having potential to establish within the surrounding Project waters, based on the environmental tolerances. Of these species 36 have planktonic life stage history stage, which can be transferred through vessel ballast water during either the construction and/or operational phases of the Project.

The surrounding BCH of the Project area is dominated by soft sediment substrate (macroalgae dominated reef and macroalgae and sparse coral reef in the subtidal zone), with the indicative jetty location occurring over all three mapped BCH types mapped: macroalgae, macroalgae and sparse coral, seagrass and soft sediment. The species that have soft substrate life stages have the greatest likelihood of occurrence within the Project area, as this is the most abundant habitat type. The species that have life-stages that require hard substrate have a reduced likelihood of survival and establishment at the primary node (OGV anchorage) due to habitats in the area assumed to be dominated by soft sediment. However, hard substrate habitats are present at the secondary node (jetty and sparse coral), the construction of the ~50 pile jetty will increase the amount of viable hard substrate habitat for species to establish. Successful establishment of an IMP on these habitats is less likely during the operational phase as translocation would rely on secondary node transfer.

5 high risk species (APMP) have potential of being introduced and surviving (from MDET) are *Rhithropanopeus harrisii, Mytilopsis sallei, Perna perna, Perna viridis,* and *Carcinus maenas*. These species have planktonic life stage history stage, which can be transferred through vessel ballast water during either the construction and/or operational phases of the Project. They also have the potential to establish at the secondary nodes, however all potential hard substrates are secondary nodes and have a lower risk of IMP translocation. Controls to mitigate risk of these taxa being introduced and secondarily transferred have been identified in Section 7. Controls to mitigate risk of these taxa being introduced and secondarily transferred, regular dry dock maintenance of anti-foulant coatings across vessel hulls and all niche environments (e.g., sea chests/strainers) and use of passive monitoring (eDNA sampling) to enable early warning of any of concern of introductions.

Habitats available at the Proposal location, therefore, have potential to support all NIMPCG trigger list species identified from environmental tolerances. This is particularly the case for species that have life stages relevant to soft substrate

6. Risk Assessment

This document seeks to determines the risk and likelihood IMP introduction during the construction phase and operational life of the Project. This section details the methodology used, which is consistent with the Australian and New Zealand Standard for Risk Management (AS/NZS ISO 31000:2018).

6.1. IMP Risk Assessment Procedures

Within the overarching framework, various methodologies, and factors to consider for risk assessment of marine biosecurity have been discussed and implemented in the past. These include focus on environmental matching between donor and recipient ports (ICES 1996; Hilliard and Raaymakers 1997), species – specific assessments (Carlton et al. 1995; Hayes and Hewitt 1998) or Quantitative Import Risk Assessments (Kellar 1993; Morley 1993) among others. At a basic level, species – specific assessment requires identification of environmental conditions and infection status at donor and recipient ports for each species.

PPA currently employ the Vessel Biofouling Risk Assessment and Management Procedure (VBRAMP; PPA 2020) which is endorsed and approved by DPIRD. A component of VBRAMP is the 'Vessel-Check' biofouling risk assessment which is implemented at the Port of Ashburton. Vessel check is a biosecurity decision support tool developed by DPIRD and implemented into an online portal. Vessel-Check is intended for use by owners, operators, agents, and managers of commercial vessels (which have a transponding AIS system) for all international and interstate vessel movements to Western Australia. The Vessel-Check portal provides an indicative risk assessment for a vessel, based primarily on the documented management practices used to mitigate the transfer of IMPs. It follows the 'best practice' set out by the International Maritime Organisation (IMO) biofouling guidelines. 'Vessel-Check' provides risk categories and management controls for vessels, including requirements for inspection and inspection frequency.

Separate Ballast Water risk assessments are also currently utilised. Those risk assessments are implemented on an operational vessel basis rather than at a project scale (i.e., before the vessel arrives or departs those responsible for the vessel (i.e., vessel master, vessel operator) are required to submit a risk assessment to the port).

6.2. Project Risk Assessment Methodology

The approach utilised in the risk assessment for this Project aims to rank the likelihood and consequence associated with different hazards at a project scale using best-of-knowledge estimates. Figure 4 visualises the process whilst the below provides an overview.

IMP Risk Assessent Process

Step 1: Identify key risk and hazard activities (Section 5)

Step 2: Rate associated risk (Table 7) of translocating IMP (Table 6) to the resources at risk (Section 5.1)

Step 3: Determine likelihood and consequence (Table 9) of translocating IMP (Table 6) to the resources at risk (Section 5.1) using examples (Table 10)

Step 4: Determine management and mitigation required (Table 12 & 13)

Step 5: Identify risk controls to ensure as low as reasonably practicable (ALARP)

Figure 4 IMP risk management process

Activities that present hazards or key risk activities associated with the Project were identified. These activities were then divided into the different phases of; construction and operation. Each hazard was independently rated using Table 7 based on the consequences of translocation of risk IMP species (Table 6) to the resources at risk (Section 5.1), with consideration of the Project adjacent to the Exmouth Gulf and Ningaloo Marine Park influencing the *environmental perception*. Viable habitat was also considered for the IMP species considered most likely to be encountered. The likelihood of successful IMP translocation arising from each of the hazardous activities was then estimated using Table 8, which also considered the vessel type risk rating (Table 5), node of introduction and phase of works (Table 9). Examples of considerations when assessing levels of consequence and likelihood are found in Table 10.

Initial risk the existing control are pre-existing control measures that are already implemented within Commonwealth and WA waters. None known to Project is where existing controls have yet to be defined and for initial risk worst case scenario was assumed, i.e., dredge is not dry transported and LPoC of the dredge was from an origin of where IMP species are present.

The risk grading level determined the level of management and mitigation needed to be taken for each hazardous activity. This was achieved by using Table 11, which details the risk tolerance of each risk grading level. For example, extreme risks are completely unacceptable and any activity posing this risk must be terminated or avoided. However, low risk activities may be deemed to proceed with caution and monitoring. There are a range of controls to lower the risk grading level that a manager can use. In their simplest form these are elimination, substitution, engineering controls, administrative controls, and risk retainment. Controls revolve around lowering either the consequence (severity) or the likelihood of the hazard. After careful risk analysis, grading and determining levels of acceptability, matters that were deemed to have all relevant controls or treatments applied are provided a risk ranking of As Low as Reasonably Practicable (ALARP).

Table 7 Consequence ratings for assessment of hazardous activities relating to IMPs

	Negligible	Minor	Moderate	Major	Catastrophic
Environment-ecosystem	No impact or, if impact is present, then not to an extent that would draw concern from a reasonable person. No impact on the overall condition of the ecosystem.	Impact is present but not to the extent that it would impair the overall condition of the ecosystem, sensitive population or community in the long-term.	Impact is present at either a local or wider level. Recovery periods of 5 - 10 years anticipated	Impact is significant at either a local or wider level or to a sensitive population or community. Recovery periods of 10 - 20 years are likely.	Impact is clearly affecting the nature of the ecosystem over a wide area OR impact is catastrophic and possibly irreversible over a small area or to a sensitive population or community Recovery periods of greater than 20 years likely OR condition of an affected part of the ecosystem irretrievably compromised.
Environment perception	No media attention	Individual complaints.	Negative regional media attention and regional group campaign.	Negative national media attention and national campaign	Negative and extensive national media attention and national campaigns.

Table 8 Likelihood of occurrence definitions relating to IMPs

Likelihood	Frequency	Probability
Almost certain	Expected to occur more or less continuously throughout a year (e.g., more than 250 days per year)	95-100 % chance of occurring
Likely	Expected to occur once or many times in a year (e.g., one to 250 days per year)	71-95 % chance of occurring
Possible	Expected to occur once or more in the period of one to 10 years	31-70 % chance of occurring
Unlikely	Expected to occur once or more in the period of 10 to 100 years	5-30 % chance of occurring
Rare	Expected to occur once or more over a timeframe greater than 100 years	0-5 % chance of occurring

Table 9 Risk grading matrix

		Consequence				
		Catastrophic	Major	Moderate	Minor	Negligible
LIKELIHOOD	*Almost certain*	Extreme	Extreme	High	High	Medium
	Likely	Extreme	High	High	Medium	Medium
	Possible	High	High	Medium	Medium	Low
	Unlikely	High	Medium	Medium	Low	Low
	Rare	Medium	Medium	Low	Low	Low

Table 10 Example of risk assessment consideration

Likelihood	Consequence
• Suitability of habitat for IMPs under consideration • Introduction of new hard substrate habitat of the pile jetty (~50 piles) • Proximity of habitat to vector • Is this a known risk vector? • Has this hazard occurred previously elsewhere (locally)? • Frequency of event – once/rarely/often	• Perceived relative ecological value of area-adjacent to Exmouth Gulf and Ningaloo Marine Park • Media attention of IMPs near Exmouth Gulf and the Ningaloo Marine Park • Relative commercial and recreational value of area • Sensitivity of area (Project area is dominated with soft sediment BCH and variable turbidity with dynamic salinity range) • Susceptibility of Project infrastructure (e.g., seawater intakes, increasing hard substrate, transhippers)

Table 11 Risk grading levels and their relative 'tolerance' including guidance on risk mitigation

Grade	Risk Mitigation Actions
Low	Expected to occur more or less continuously throughout a year (e.g., more than 250 days per year)
Medium	Mitigation actions to reduce the likelihood and consequences to be identified and appropriate actions (if possible) to be identified endorsed by Director / Manager level.
High	If uncontrolled, a risk event at this level may have a significant impact on the operation of a business unit. Mitigating actions need to be very reliable and should be approved and monitored in an ongoing manner by the General Manager.
Extreme	Activities and projects with unmitigated risks at this level should be avoided or terminated. This is because risk events graded at this level have the potential to cause serious and ongoing damage to the organisation, the community or the environment. Reporting emerging or continuing risks exposures at this level to the General Manager. The Chairman should be advised of identified or emerging strategic risks which have been graded at this level.

6.3. Risk Assessment Results

Results of the IMP Risk Assessment for the Project are summarised in Table 12. Overall, the risk ratings for possible marine pest introduction due to Project elements and operation is low with the appropriate management measures outlined in Section 7.

The construction phase of the Project has the vectors which the highest risk, with the key reasons being the vessel types, origins and characteristics. Barge (for piling driving) and dredge are both slow moving and make direct contact with the substrate, presenting the greatest likelihood of IMP translocation to the Project if these vessels are sourced from high risk international ports in southeast Asia. The slow speeds and time spent moored of these vessels in these high-risk ports create a higher likelihood of IMP colonisation. Further, the construction phase will increase the amount of hard substrate viable which have the potential to be colonised by IMPs such as *Perna viridis* or *Mytilopsis sallei.* Due to the ability of many IMP species to rapidly colonise disturbed habitat, the dredged berthing pocket has a higher potential for successful IMP settlement than the surrounding undisturbed substrate. Recommended risk management controls for the barge and dredge are outline in Table 13 and involved Antifouling coating (AFC) and inspection requirements during the tender process, as well as recent dry-dock inspections. The anchorage of OGV (primary node) are deemed to have the greatest risk of IMP introduction where soft substrates are likely to be the dominant habitat type.

During the operational phase of the Project, the OGV anchorage (primary node) are at greatest risk of IMP introduction where soft substrates are likely to be the dominant habitat type. Seven high risk species for these soft substrates that have potential of being introduced and surviving (from MDET) are *Alexandrium monilatum, Ensis directus, Mya arenaria, Mytilopsis sallei, Crepidula fornicate, Rapana venos* and *Bonnemaisonia hamifera*. All potential hard substrates are secondary nodes and have a lower risk of IMP translocation. Controls to mitigate risk of these taxa being introduced and secondarily transferred have been identified to include regular dry dock maintenance of anti-foulant coatings across vessel hulls and all niche environments (e.g., sea chests/strainers) and use of passive monitoring to enable early warning of any of concern of introductions.

Table 12 IMP Risk Assessment Results

Initial Risk					Residual Risk			
Activity or Element with Potential impacts on the environment	**Marine Pest Pathway**	**Consequence**	**Likelihood**	**Risk Level**	**Existing Controls and Management measures**	**Consequence**	**Likelihood**	**Risk Level**
Construction Phase								
De-ballasting of Dredging/Construction Vessels	Introduction of IMP via ballast water	Moderate	Possible	Medium	*Biosecurity Act 2015*, Ballast Water Management Requirements, Pre-Arrival Reports (PAR), Maritime Arrivals Reporting System (MARS) See section 7 and	Moderate	Rare	Low
Anchoring/mooring/berthing of Dredging/Construction Vessels	Introduction of IMP via dislodgment of biofouling	Moderate	Unlikely	Medium	Antifoulant coating on vessel hulls. VBRAMP See section 7	Moderate	Rare	Low
Use of barge for wharf/pile driving	Introduction of IMP through dislodgement of biofouling or direct transfer	Moderate	Likely	High	See section 7	Moderate	Rare	Low
Use of barge or similar at site	Introduction of IMP via dislodgment of biofouling	Moderate	Possible	Medium	Antifoulant coating (AFC) See section 7	Moderate	Rare	Low
Use of dredge berthing pocket	Introduction of IMP via ballast discharge or dislodgement of biofouling Translocation of IMP from direct contact with seabed Slow moving, number of hull niches, and spend substantial time in coastal waters	Moderate	Likely	High	See section 7 Recommend source dredge from Australian waters and if possible transported dry	Moderate	Rare	Low
Use of immersible construction materials (pylons, pipework, jetty)	Introduction of biofouling IMP through dislodgement or direct introduction	Moderate	Rare	Low	See section 7	Moderate	Rare	Low
Operational phase								
Anchoring of operational Vessels	Introduction of IMP via ballast water or	Moderate	Possible	Medium	Transhipper anchorage points restricted to offshore anchorage. Antifoulant coating on vessel hull. See section 7	Moderate	Rare	Low

Initial Risk					Residual Risk			
Activity or Element with Potential impacts on the environment	**Marine Pest Pathway**	**Consequence**	**Likelihood**	**Risk Level**	**Existing Controls and Management measures**	**Consequence**	**Likelihood**	**Risk Level**
	dislodgement of biofouling							
Transhippers operations	Introduction of IMP through transfer from bulk carrier (ballast water) or biofouling	Moderate	Unlikely	Medium	See section 7	Moderate	Rare	Low
OGV operations	Introduction of IMP through ballast water discharge or biofouling at offshore transshipment	Moderate	Rare	Low	Ballast water exclusion zone around the Ningaloo Marine Park and Exmouth Gulf See section 7	Moderate	Rare	Low
Use of immersible equipment (e.g., anchors/ moorings/rope)	Introduction of biofouling IMP through dislodgement or direct introduction	Moderate	Possible	Medium	See Section 7 and 8	Moderate	Rare	Low
Use of Support Vessels	Introduction of IMP via biofouling	Moderate	Unlikely	Medium	Section 7	Moderate	Rare	Low
De-ballasting of Operational Vessels	Introduction of IMP via ballast water	Moderate	Possible	Medium	Biosecurity Act 2015, Ballast Water Management Requirements, Pre-Arrival Reports (PAR), Maritime Arrivals Reporting System (MARS) Section 7	Moderate	Rare	Low
Jetty structure new hard substrate available for IMP establishment	Introduction of IMP from transiting vessels via biofouling or ballast water establishing on jetty piles	Moderate	Unlikely	Medium	Section 7	Moderate	Rare	Low

7. Risk Management Strategies and Management Measures

Ballast water exchange is not permitted around the Ningaloo marine park and the Exmouth gulf, with this region being identified as the Ningaloo Reef Marine Park Exclusion Zone (Figure 5). Within this area ballast water must not be exchanged within 20 nm of the territorial sea baseline. Outlined in the Australian Ballast Water Management Requirements (2020) ballast water exchange should occur at least 200 nm from nearest land and in waters 200 m deep. If this cannot be achieved ballast water must occur at least 12 nm from the nearest land and in water at least 50 m deep, while also complying to the Ningaloo Reef Marine Park Exclusion Zone. All vessels engaged by the Project will comply fully with ballast water management protocols and will be undertaken in accordance with Australian Government protocols, which are detailed in the latest version of Australian ballast water management requirements (DAWE 2020).

A ship's biofouling may contain marine organisms that are pests and have potential to be transferred long distances through transport via vessel hull or niche areas. If these organisms become established at the project location, they can seriously impact the marine environment. Non-trading vessels, such as dredge vessels and associated plant are highlighted as a high-risk item as they are slow moving, generally spend substantial lengths of time in coastal waters and have numerous hull niches to transport marine organisms. Antifouling coating (AFC) requirements (<2 years since AFC applied, compliance with National AFC guidelines) will be used during marine construction and operation tender processes to manage vessels and immersible equipment prior to mobilising to the Project area, especially for high risk vessels such as badges and dredged. In addition, vessels and immersible equipment will be sourced from Australian waters where possible.

To manage biofouling risk, vessels mobilising to the project will register for Vessel Check and complete the online risk assessment. Vessels assessed as low risk by Vessel Check will mobilise. Vessels assessed as medium or high risk by Vessel Check will be inspected and any required remedial action undertaken before mobilisation Dredging vessels are high- risk for the potential introduction of marine pests into an area due to the risk factors associated with the vessel, the vessel has direct contact with seabed brings higher risk of pest transfer and settlement. They are also slow moving, generally spend substantial lengths of time in coastal waters and have numerous hull niches to transport marine organisms.

Management actions proposed to minimise the potential impacts associated with IMP for the both the construction and operational phases of the Project are described in Table 13

Table 13 Management actions to minimise the risk of introduced marine pests

Task	Action	Responsibility	Timing
Management Actions	WA DPIRD's 'Vessel Check' risk assessment (https://vesselcheck.fish.wa.gov.au) submitted to the Client (including supporting documentation) for all dredging and support vessels (i.e., Dredge vessel and Barges) that mobilise to the Proposal area from interstate or international waters. Risk assessment must indicate that the vessel poses a low risk of IMP to Project Waters See Appendix C for procedure on registering to the Vessel-Check Portal	Dredging Contractor All vessel operators	Prior to vessel(s) entering Australian / Western Australian waters
	Implement Pre Arrival Reports (PAR) and MARs- if ballast water exchange occurs at sea it must meet requirements of the Australian Ballast Water Management Requirements (2020) and must not occur within the Ningaloo Reef Marine Park Exclusion Zone. Discharge of ballast water for any vessel mobilised during the Project shall be managed consistently with the mandatory requirements of the Department of Agriculture Fisheries and Forestry (DAFF) and the Australian Ballast water requirements (2020)	Dredging Contractor All vessel operators	Prior to entering the Project area
	All vessels will have a ballast water management plan and ballast water exchanges will be in accordance with IMO requirements and the Commonwealth *Biosecurity Act 2015*.	Dredging Contractor All vessel operators	Prior to mobilisation If ballast water discharge is required
	Vessels coming from international origins they must comply to the MARS and Vessel Compliance Scheme (VCS)	All vessel operators from international origins	Prior to vessel(s) entering Australian / Western Australian waters

Task	Action	Responsibility	Timing
	Introduction of IMP through the transhipper operations and anchoring. Anchoring to be restricted to offshore location which adheres to the ballast water exchange must adhere to the Ningaloo Reef Marin Park Exclusion Zone. Dry-dock inspection of transhippers throughout operational life of the Project.	All vessel operators The Client	Duration of Project
	Implement the State Wide Array Surveillance Program (SWASP) using e DNA in collaboration with DPIRD (Appendix E)	The Client DPIRD representative	Pre and post dredging Biannually for the lifetime of the Project See Appendix E
Measures	Vessel Check IMP risk assessment undertaken for all dredging and support vessels (i.e., Dredge vessel and Barge) entering the Project waters	Dredging Contractor	Prior to vessel(s) entering the Project area
	Vessel Company (or an authorised representative) registers on the Vessel-Check Portal and sets up appropriate users for the company (i.e., vessel operations/managers/officers, vessel masters, vessel agents etc). Go to: https://www.vessel-check.com	The Client or Vessel Company	Prior to vessel mobilisation
	Source dredge from Australian waters, dredge transported dry, if possible, to limit risk of biofouling.	The Client	Prior to dredge mobilisation
	Antifouling coating (AFC) requirements (<2 years since AFC applied, compliance with National AFC guidelines) will be used during marine construction and operation tender processes to manage vessels and immersible equipment prior to mobilising to the Project. In addition, vessels and immersible equipment will be sourced from Australian waters where possible.	All vessel operators The Client	All vessels mobilised for the Project
	Inspection of submersible equipment on OGV and transhippers (e.g., anchors/moorings/rope) and AFC requirements	Vessel operators	5 yearly dry-dock inspection of transhippers

Task	Action	Responsibility	Timing
	For vessels with a Ballast water treatment system (BWTS), a Type Approval Certificate must be onboard	Vessel operator	Prior to vessel(s) entering the entering Australian waters
	Ballast water management undertaken in accordance with IMO and Commonwealth *Biosecurity Act 2015* requirements.	Dredging Contractor Vessel operators	Prior to vessel(s) entering the Project area
Reporting / Evidence	'Vessel Check' risk assessment report (including supporting documentation). Including the Vessel-check portals indicative risk rating.	Dredging Contractor Vessel operators	Prior to vessel(s) entering the Project area
	Confirmation of ballast water exchange at sea, treatment or other risk management measures application shall be required in the pre-arrivals form prior to entry to the Project area	Dredge contractor Vessel operations	Prior to vessel(s) entering Project area
	Type Approval Certificate for OGVs and transhippers that have BWTS implemented	Vessel operator	Prior to vessel(s) entering Australian waters
	Confirmation of AFC requirements (<2 years since AFC applied, compliance with National AFC guidelines)	Dredging Contractor Badge operator	Prior to vessel(s) mobilising to site
	Follow best practice guidelines for invasive marine species inspection of transhipper and equipment (DPIRD2017)	Vessel operator	5 yearly dry-dock inspection of transhippers
Target	No introduction or movement of IMPs.	Dredging Contractor Vessel operators The Client	Throughout all Project phases
Contingency	If ballast water does not meet DAFF Biosecurity requirements, discharge shall not occur in State waters.	Dredging Contractor Vessel operators	Prior to vessel(s) mobilising to site
	'Vessel-check' indicative risk rating of vessel entering state waters/Project area is ranked as Low. If (Domestic Commercial Vessels (DCV) and Registered	Vessel operators The Client	Prior to mobilisation

Task	Action	Responsibility	Timing
	Australian Vessels) has an indicative risk score of **Moderate** or **High** will not be permitted to Proposal area		
	Notify DPIRD if the introduction of IMPs is suspected in accordance with existing procedures under the collaborative SWASP.	Dredging Contractor	Immediately
	Notify DPRID via FishWatch within 24 hours is any detection of possible risk species	Vessel operators The Client	Within 24 hours
	Confirmation of risk species, the Proponent will work with DRIPD and follow their directions for the control (and eradication) of confirmed risk species. The Client will implement procedures outlined in Section 7.1 and cooperate with the appropriate agencies.	The Client	Following DPIRD time

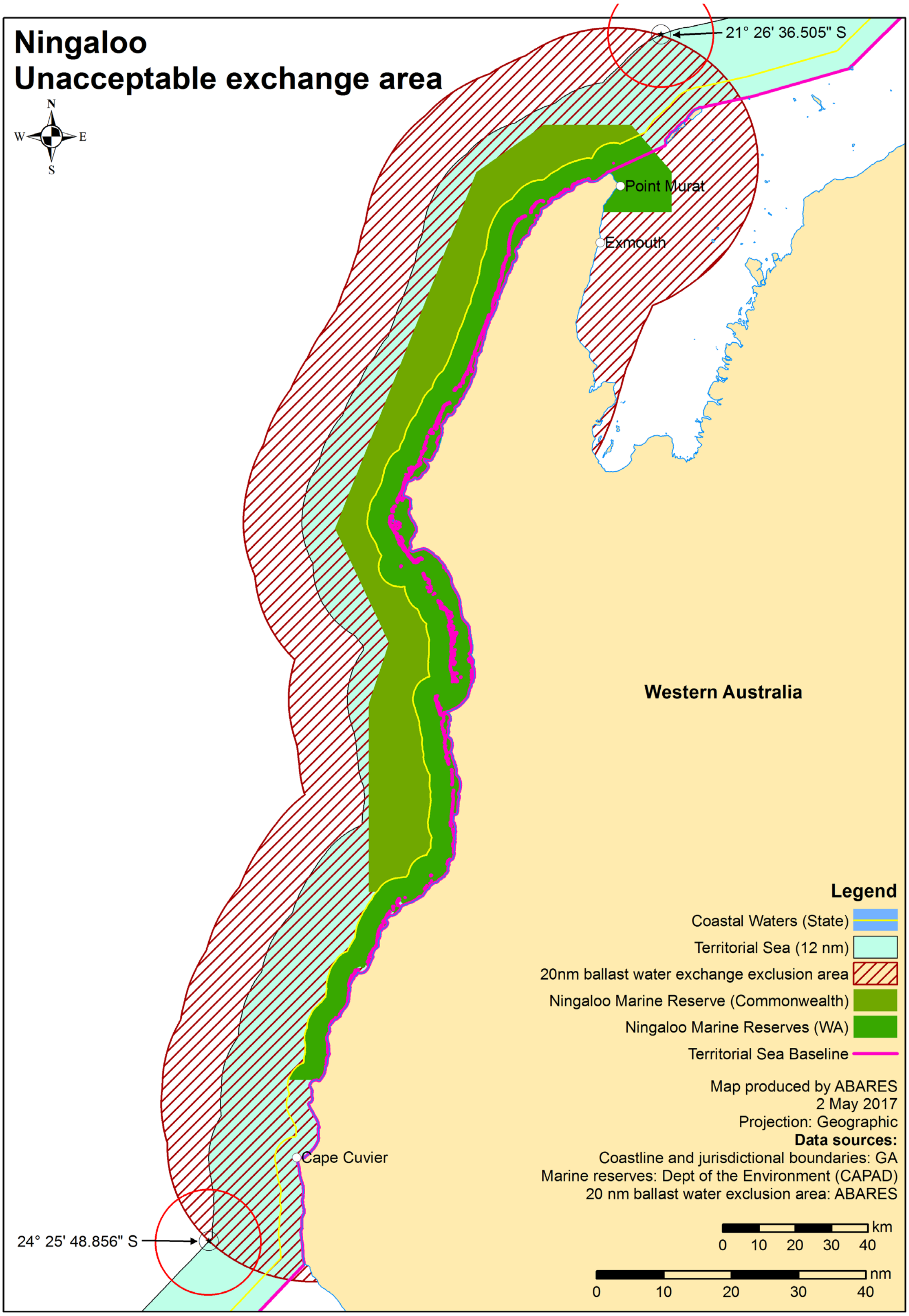

Figure 5 Ningaloo 20 nm ballast water exchange exclusion area

7.1. Detection of possible risk species

Eradication of marine pests is often extremely difficult and not often possible. Eradication it is only possible in extremely unusual circumstance where the population can be effectively isolated (Wittenberg and Cock 2001). Therefore, the management procedures following a possible detection of a marine pest will aim to try an isolate the transport vectors to reduce the spread and establishment in the receiving environment.

The methods implemented to control a marine pest incursion will depend on the species present, where the pest has been identified, and the nature of the outbreak. Governing authorities and relevant agencies for marine pest will provide with guidance for the response to the detection of marine pest. The possible responses of a marine pest incursion are:

- Eradication of the pest from the infested area
- Containment, control, and zoning aiming to contain and slow the spread of the species.

If a possible risk species is identified within the Project area through the management methods outlined in Table 13 a notification to DPIRD must be sent off within 24 hours, if the possible species identified is a species listed Table A-1 it is essentials for the Client to send off the notification to ensure that notifying parties meet the requirements for the possibility of cost sharing under the National environmental Biosecurity Response Agreement (NEBRA). While waiting on confirmation of possible risk species the Client will implement the following steps to limit the spread of possible risk species:

- Initiating voluntary restrictions on affected vectors (i.e., transhipper vessels, removal of fouled submersible equipment, etc.)
- Notifying relevant Ports and agencies if necessary (e.g., detection post dredging and dredge moved to another Port)
- Begin investigation into other potential vectors; and determine if one or more relevant translocation vectors still operational
- Investigate if the suspected species listed on Table A-1.

Confirmation of risk species from DPIRD and/or from the IMP monitoring (eDNA) results, the Client will follow the guidance from the relevant authorities and will restrict the affected vectors (i.e., transhipper vessels etc.) if directed to.

If the species is identified as being of national significance, there have been five marine pest response manuals develop to provide guidance on responding to marine pest emergencies, which provide guidance for responding to suspected or confirmed marine pest incursion. The Client agrees to cooperating to the possible response measures outlined in following phases in the Rapid response manual generic (MPSC 2019) and the Biosecurity Incident Management System Marine pest version (MPSC 2020):

- Investigation phase
- Alert phase
- Operations phase
- Stand-down phase.

If further eradication and containment measures are required, the Client will liaise and work with DPIRD and related agencies to eradicate or control the risk species. If the alert phase is triggered than the Client agrees to co-operate with the appropriate management team and will ensure appropriate measure are implemented, which could include (but not limited to):

- restrictions on movement of potential vectors, such as submersible equipment, vessels, and ballast water into and out of the Project area
- Controlling movement in and out of the Project area
- A hotline phone number for reported sightings of the pests and inquiries from affected parties
- Tracing potential vectors that have left the site (i.e., transhippers, OGV)
- Redirecting vessels that have already left the site to appropriate sites for inspection and/or decontamination, if appropriate
- Notifying and, where appropriate, consulting relevant experts.

8. Reporting Requirements

All vessel operations utilised during the Ashburton Salt Project shall adhere and be consistent with the following mandatory biofouling requirements:

- Anti-Fouling and In-Water Cleaning Guidelines (DoE and NZMPI 2015)
- National Biofouling Management Guidelines for Commercial Vessels (MPSC 2018a)
- National Biofouling Management Guidance for Non-Trading Vessels (MPSC 2018b)
- Australian biofouling management requirements (DAWE 2022)
- Department of Agriculture Fisheries and Forestry mandatory requirements
- Australian Ballast Water Management Requirements (DAWE 2020)

Any activity that has the potential to disturb or dislodge biofouling on a ship and/or ship's antifoul coating should be prohibited and only undertaken following consultation and endorsement from consultation and endorsement from the relevant Port Authority and DPIRD Aquatic Biosecurity. Such activities include (but are not limited to);

- In-water hull cleaning
- Cleaning of internal seawater systems (including sea-chests and engine cooling pipes)
- Propeller 'polishing' (cleaning)
- Careening (i.e., the practice of beaching ships for hull cleaning and antifouling removal).

The Proponent may consider seeking approval for such activities in exceptional circumstances, such as where a net environmental benefit or immediate safety risk can be demonstrated. Such application shall be directed to DPIRD.

IMP reporting requirements for the Project are provided in Table 14.

Table 14 IMP Reporting Requirements

	Content	Timeframe	Responsibility	Recipient
Presence of IMP or Potential IMP	Report any identification of IMP or Potential IMPs see Appendix D for procedure	• Within 24 hours • Within 24 hours if identification of potential IMP is subsequently confirmed	Vessel operator Contractor Ashburton Salt Representative	DPIRD FishWatch (1800 815 507) aquatic.biosecurity@dpird.wa.gov.au
SWASP monitoring collection of eDNA water samples	Report DNA extraction result Identification of any risk species Summary report See Appendix E	Construction phase • Pre-dredge • Post-dredge Operational phase • Biannually	Ashburton Salt Representative/Contractor	DPIRD FishWatch (1800 815 507) aquatic.biosecurity@dpird.wa.gov.au
International Vessels	All vessel operator entering Australian territory waters must complete mandatory pre-arrival report (PAR) through MARs (DAWE 2022) Vessel-Check | Marine Biofouling Biosecurity Management Tool	Prior to entering Australia waters	Vessel operator	DCCEEW
Vessel-Check Portal	Register for the Vessel-Check Portal Provide the Client with 'Vessel Check' risk assessment report, including the Vessel-check portals indicative risk rating.	Prior to mobilisation to state waters Or prior to mobilisation to Project area Depending on origin of vessel	Vessel company/vessel operators Dredge contractor	The Client [hold client email]

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9. Reference List

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Appendix A. APMP and NIMPCG Species lists

Table A-1 Australian Priority Marine Pest List

Established	Exotic
European shore crab; European green crab (*Carcinus maenas*)	Asian green mussel (*Perna viridis*)
Japanese Kelp (*Undaria pinnatifida*)	Black striped false mussel (*Mytilopsis sallei)*
Northern Pacific seastar (*Asterias amurensis*)	Brown mussel (*Perna perna)*
	Charru mussel (*Mytella strigata*)
	Chinese mitten crab (*Eriocheir sinensis)*
	Harris' mud crab (*Rhithropanopeus harrisi)*
	New Zealand green-lipped mussel (*Perna canaliculus*)

Table A-2 NIMPCG list species (NIMPCG 2009a, b)

Species Phylum	Species Name
Crustacea/Copepoda	*Acartia tonsa*
Dinophyceae	*Alexandrium catenella*
Dinophyceae	*Alexandrium minutum*
Dinophyceae	*Alexandrium monilatum*
Dinophyceae	*Alexandrium tamarense*
Echinodemata	*Asterias amurensis*
Crustacea/Cirripedia	*Balanus eburneus*
Crustacea/Cirripedia	*Balanus improvisus*
Ctenophore	*Beroe ovata*
Cnidaria	*Blackfordia virginica*
Rhodophyta	*Bonnemaisonia hamifera*
Crustacea/Brachyura	*Callinectes sapidus*
Crustacea/Brachyura	*Carcinus maenas*
Chlorophyta	*Caulerpa racemosa*
Chlorophyta	*Caulerpa taxifolia*
Bacillophyta/diatoms	*Chaetoceros concavicornis*
Bacillophyta/diatoms	*Chaetoceros convolutus*
Crustacea/Brachyura	*Charybdis japonica*
Chlorophyta	*Codium fragile spp. tomentosoides*
Mollusca/Bivalvia	*Corbula amurensis*
Mollusca/Bivalvia	*Crassostrea gigas*
Mollusca/gastropoda	*Crepidula fornicata*
Ascidiacea	*Didemnum spp.*

Species Phylum	Species Name
Dinophyceae	*Dinophysis norvegica*
Mollusca/Bivalvia	*Ensis directus*
Crustacea/Brachyura	*Eriocheir sinensis*
Rhodophyta	*Grateloupia turuturu*
Dinophyceae	*Gymnodinium catenatum*
Crustacea/Brachyura	*Hemigrapsus sanguineus*
Crustacea/Brachyura	*Hemigrapsus takanoi/penicillatus*
Annelida	*Hydroides dianthus*
Mollusca/Bivalvia	*Limnoperna fortunei*
Annelida	*Marenzelleria spp.*
Ctenophore	*Mnemiopsis leidyi*
Mollusca/Bivalvia	*Musculista senhousia*
Mollusca/Bivalvia	*Mya arenaria*
Mollusca/Bivalvia	*Mytilopsis sallei*
Mollusca/Bivalvia	*Perna perna*
Mollusca/Bivalvia	*Perna viridis*
Dinophyceae	*Pfiesteria piscicida*
Crustacea/Copepoda	*Pseudodiaptomus marinus*
Bacillophyta/diatoms	*Pseudo-nitzschia seriata*
Mollusca/gastropoda	*Rapana venosa*
Crustacea/Brachyura	*Rhithropanopeus harrisii*
Annelida	*Sabella spallanzanii*
Phaeophyta	*Sargassum muticum*
Pisces	*Siganus luridus*
Pisces	*Siganus rivulatus*
Crustacea/Copepoda	*Tortanus dextrilobatus*
Pisces	*Tridentiger barbatus*
Pisces	*Tridentiger bifasciatus*
Phaeophyta	*Undaria pinnatifida*
Mollusca/Bivalvia	*Varicorbula gibba*
Rhodophyta	*Womersleyella setacea*

Appendix B. Western Australian Prevention List for Introduced Marine Pests (DPIRD 2016)

Table A 3 WA Prevention List for Introduced Marine Pests (DPIRD 2016) This list contains species that may be spread via biofouling or ballast water that are (1) present on national aquatic pest lists or (2) of concern to the protection of WA aquatic resources.

Group	Genus	Species	Common Name
Fish	*Acanthogobius*	*flavimanus*	Yellow Fin Goby
Crustacean – shrimp etc	*Acartia (Acanthacartia)*	*tonsa*	Calanoid copepod
dinoflagellate	*Alexandrium*	*catenella*	Toxic dinoflagellate
Toxic dinoflagellate	*Alexandrium*	*minutum*	Toxic dinoflagellate
Toxic dinoflagellate	*Alexandrium*	*monilatum*	Toxic dinoflagellate
dinoflagellate	*Alexandrium*	*tamarense*	Toxic dinoflagellate
Crustacean - barnacle	*Amphibalanus*	*eburneus (syn. Balanus eburneus)*	Ivory barnacle
Crustacean - barnacle	*Amphibalanus*	*improvisus (syn. Balanus improvisus)*	Bay barnacle
Bivalve mollusc	*Anadara*	*transversa (syn. A. demiri)*	Transverse arc clam
Bivalve mollusc	*Arcuatula*	*senhousia (syn. Musculista senhousia)*	Asian bag mussel; Asian date mussel
Echinoderm – sea star	*Asterias*	*amurensis*	Northern Pacific seastar
Crustacean - barnacle	*Balanus*	*glandula*	Common acorn barnacle
Comb jelly	*Beroe*	*ovata*	-
Hydroid	*Blackfordia*	*virginica*	-
Macroalga	*Bonnemaisonia*	*hamifera*	Bonnemaison's hook weed
Bivalve mollusc	*Brachidontes*	*pharaonis*	Variable mussel
Crustacean – crab	*Callinectes*	*sapidus*	Chesapeake blue crab
Crustacean – crab	*Carcinoscorpius*	*rotundicauda*	Mangrove horseshoe crab
Crustacean – crab	*Carcinus*	*maenas*	European green crab
Macroalga	*Caulerpa*	*taxifolia*	Aquarium weed
Diatom	*Chaetoceros*	*concavicornis*	Centric diatom
Diatom	*Chaetoceros*	*convolutus*	Centric diatom
Crustacean – crab	*Charybdis (Charybdis)*	*japonica*	Asian paddle crab

Group	Genus	Species	Common Name
Crustacean - barnacle	*Chthamalus*	*proteus*	Atlantic barnacle
Sponge	*Cliona*	*thoosina*	Boring sponge
Macroalga	*Codium*	*fragile fragile (syn. C. fragile tomentosoides)*	Dead man's fingers
Bivalve mollusc (freshwater)	*Corbicula*	*fluminea*	Asian clam; Asiatic clam
Bivalve mollusc	*Corbula*	*gibba (syn. Varicorbula gibba)*	Basket shell
Bivalve mollusc	*Crassostrea*	*ariakensis*	Suminoe oyster
Bivalve mollusc	*Crassostrea*	*gigas*	Giant oyster
Bivalve mollusc	*Crassostrea*	*virginica*	American oyster
Gastropod mollusc	*Crepidula*	*fornicata*	Slipper limpet
Ascidian – sea squirt	*Didemnum*	*perlucidum*	White sea squirt
Ascidian – sea squirt	*Didemnum*	*spp.*	Colonial sea squirt
Ascidian – sea squirt	*Didemnum*	*vexillum*	Colonial sea squirt
Crustacean – shrimp etc	*Dikerogammarus*	*villosus*	Killer shrimp
Toxic dinoflagellate	*Dinophysis*	*norvegica*	Toxic dinoflagellate
Bivalve mollusc (freshwater)	*Dreissena*	*bugensis*	Quagga mussel
Bivalve mollusc (freshwater)	*Dreissena*	*polymorpha*	European zebra mussel
Bivalve mollusc	*Ensis*	*directus*	Jack-knife clam
Crustacean – crab	*Eriocheir*	*sinensis*	Chinese mitten crab
Crustacean – crab	*Eriocheir*	*spp.*	Mitten crabs
Macroalga	*Fucus*	*evanescens*	Brown macroalga
Sponge	*Gelliodes*	*fibrosa*	Gray encrusting sponge
Bivalve mollusc	*Geukensia*	*demissa*	Ribbed mussel
Macroalga	*Grateloupia*	*turuturu*	Devil’s tongue weed
Toxic dinoflagellate	*Gymnodinium*	*catenatum*	-
Crustacean – crab	*Hemigrapsus*	*penicillatus [syn. Grapsus (Eriocheir) penicillatus)]*	Hairy-clawed shore crab
Crustacean – crab	*Hemigrapsus*	*sanguineus*	Asian shore crab
Crustacean – crab	*Hemigrapsus*	*takanoi*	Brush-clawed shore crab
Polychaete worm	*Hydroides*	*dianthus*	Serpulid tube worm, limy tube worm
Bivalve mollusc	*Limnoperna*	*fortunei*	Golden mussel
Gastropod mollusc	*Maoricolpus*	*roseus*	New Zealand screwshell

Group	Genus	Species	Common Name
Polychaete worm	*Marenzelleria*	*spp.*	Red gilled mudworm
Comb jelly	*Mnemiopsis*	*leidyi*	Comb jelly
Bivalve mollusc	*Monia*	*nobilis (syn. Anomia nobilis)*	Jingle shell
Bivalve mollusc	*Mya*	*arenaria*	Soft-shell clam
Bivalve mollusc	*Mytella*	*charruana*	Charru mussel
Bivalve mollusc	*Mytilopsis*	*leucophaeata*	Dark false mussel
Bivalve mollusc	*Mytilopsis*	*sallei*	Black-striped mussel
Bivalve mollusc	*Mytilopsis spp. (entire genus) and Congeria spp. (entire genus)*	*Black-striped mussel*	Bivalve mollusc
Fish	*Neogobius*	*melanostomus*	Round goby
Crustacean – crab	*Pachygrapsus*	*fakaravensis*	Polynesian grapsid crab
Bivalve mollusc	*Perna*	*canaliculus*	New Zealand Mussel
Bivalve mollusc	*Perna*	*perna*	Brown mussel
Bivalve mollusc	*Perna*	*viridis*	Asian green mussel
Toxic dinoflagellate	*Pfiesteria*	*piscicida*	Toxic dinoflagellate
Bivalve mollusc	*Potamocorbula*	*amurensis (syn. Corbula amurensis)*	Asian clam;
Crustacean – shrimp etc	*Pseudodiaptomu s*	*marinus*	Calaniod copepod
Diatom	*Pseudo-nitzschia*	*seriata*	Pennate diatom
Gastropod mollusc	*Rapana*	*venosa (syn. R. thomasiana)*	Asian rapa whelk
Crustacean – crab	*Rhithropanopeus*	*harrisii*	Harris mud crab
Polychaete worm	*Sabella*	*spallanzanii*	European fan worm
Macroalga	*Sargassum*	*muticum*	Japweed
Fish	*Siganus*	*luridus*	Dusky spinefoot
Fish	*Siganus*	*rivulatus*	Marbled spinefoot
Crustacean - barnacle	*Solidobalanus (Hesperibalanus)*	*fallax*	Warm-water barnacle
Crustacean – shrimp etc	*Tortanus (Eutortanus)*	*dextrilobatus*	-
Fish	*Tridentiger*	*barbatus*	Shokihaze goby
Fish	*Tridentiger*	*bifasciatus*	Shimofuri goby
Fish	*Tridentiger*	*trigonocephalu s*	Chameleon Goby
Macroalga	*Undaria*	*pinnatifida*	Japanese kelp

Group	Genus	Species	Common Name
Macroalga	*Womersleyella*	*setacea (syn. Polysiphonia setacea)*	Red polysiphonous macroalga

Appendix C. Vessel-Check Portal for completing Vessel-Risk assessment

For registering a non-trading commercial vessel with the Portal and complete a Vessel-Check Risk Assessment procedures summarised below in

Table A 4 Overview for registering with the Vessel-check portal and completing a Vessel-risk assessment

Step	Requirements
1	Vessel company (or authorised representative possibly the Client) to register on the Portal and set up appropriate users for the company (i.e., vessel operations/managers/officers, vessel master, vessel agents etc.) Create an account at: https://www.vessel-check.com/
2	Appropriate person (i.e., vessel technical manager, vessel agent or vessel master/officer) creates a profile for each vessel by supplying each vessel(s): • Management Planning and vessel specific niche areas • Supporting documentation (e.g., Biofouling Management Plan and Record Book, Antifoulant Coating Certificate).
3	Appropriate Person updates the Portal Biofouling Record Book when Management actions are implemented in accordance with the Biofouling Management Plan
4	The Portal (based on supplied information in the vessel's profile) calculates an indicative risk (High, Medium or Low) associated with the vessel, when the vessel designates in its onboard transponding AIS system or manually through the Portal that it intends to: • depart from any other port within State waters or interstate or international waters to the Project area; and • depart from Project area to another location within State waters (i.e., demobilisation). • Appropriate Person shall manually update the Portal Operating Profile element when for vessel Lay-up periods. Important Note: The indicative risk score (*High, Medium or Low*) provided by Vessel-Check is an average of all the metrics considered within the Vessel-Check Portal

Appendix D. Detection of possible IMP procedure

In the case that a possible IMP risk species is identified through the completion of any of the management procedures during the construction and operational phase of the Project the detection must be reported to DPIRD within 24 hours and including the following the reporting requirements outlined by DPIRD (2022). The recording and photographs are to be supplied to DPIRD via the following options within 24 hours:

- FishWatch on 1800 815 507
- Email aquatic.biosecurity@dprid.wa.gov.au
- Local DPIRD office

Recording

The detection of a possible IMP the contractor or vessel manager must record the following information and supply it to the Ashburton Salt Environmental manager to report to DPIRD

- Location (GPS coordinates, address, or nearest landmarks)
- Date and time of detection
- Size of possible IMP detected
- Colour of IMP detected
- Water depth of where species was detected
- Environment/BCH (i.e., beach, sand, rock pool, in weed, water, river, attached to structure)

Photograph

The record must also include a photograph of the IMP detected to be completed as early as possible and ideally within the environment where it was found, with photograph being completed prior to preserving or refrigeration of sample

- Photograph must include entire sample undisturbed and include surroundings (if possible)
- Close up of IMP with scale for reference (ruler, coin, thumb etc.)
- Close up of any characteristic marks or colours
- Photos to be check for clarity and glare

Collection

Following completing of recording and photographing IMP before collecting specimen. Specimen/s to be collected and stored in a Ziplock plastic bag or plastic container:

- Label using a pencil Ziplock bag or container with date, collectors name and contact details, location and any other details listed above in Step 1. Record it) and place it in the bag with the sample.
- Store the sample in a cold esky or fridge. Do not freeze it (unless there is no other way to preserve it).
- FishWatch will advise where you can drop off your sample - usually your local DPIRD office.

Appendix E. eDNA IMP Monitoring

SWASP monitoring has been implemented throughout WA Ports using PVC plates soaked for two months at a time, which are deployed twice per year. The SWASP monitoring also included a yearly shoreline surveillance monitoring program which is completed by a Port representative as well as with a DPIRD staff member.

Environmental DNA (eDNA) is a fast emerging survey method for detection marine pests, with eDNA methods often outperform traditional survey approaches in sensitivity and cost effectiveness (Ellis et al. 2022). eDNA results indicate that results from eDNA methods within complex and open marine environments remain relatively localised, with growing evidence of the effectiveness and value of using eDNA for characterising the distribution and presence of marine pest (Ellis et al. 2022). eDNA extraction from water samples is therefore a cost effective alternative and allows for timely detections, which providing a critical framework for follow up surveys and potential eradication programs (Ellis et al. 2022), therefore is the proposed sampling method.

eDNA monitoring will be implemented for the Project as cost effective method to monitor for marine pests, and procedures are modified from the implemented SWASP monitoring programs.

Timing

eDNA samples will be collected at the following timings, to monitoring for risk species during both the construction and operational phases of the project:

- Pre-dredge
- Post-dredge
- Bi-annually during lifetime of the Project
- Yearly shoreline survey

Sampling

Water samples will be collected through the water column at areas identified as highest risk for marine pest introductions and establishment. These locations will be determine following the finalisation of the Project as they will depend on confirmation of the Project layout and operations.

The methods will follow standard eDNA field collect, storage and extraction procedures. The samples will be extracted and analysed by a qualified laboratory (possibly eDNA Frontiers (Curtin University) molecular biologists). Results will be processed using next generation sequencing (eDNA) and be supplied to the Client and DPIRD.

Reporting

Results from the IMP monitoring will be supplied to the Client and will also be sent to DPIRD to add to their SWASP data storage.