Jurien Bay Boat Harbour Maintenance Dredging – Long Term Monitoring and Management Plan

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Amendment Record

The Amendment Record below records the history and issue status of this document.

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Note: Refer to previous revisions of this document for complete document history.

List of Abbreviations and Terms

Acronyms and measurement units	
ANZG	Australian and New Zealand Government
ANZECC/ARMCANZ	Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand
ASS	Acid sulfate soils
BCH	Benthic communities and habitats
BTEX	Benzene, toluene, ethylbenzene and xylene
ºC	Degrees Celsius
CA	Commonwealth of Australia
CALM Act	Conservation and Land Management Act 1984
CD	Chart datum
CSMC	Cockburn Sound Management Council
CSD	Cutter suction dredge
DAWE	Australian Department of Agriculture, Water and the Environment
DBCA	Western Australian Department of Biodiversity, Conservation and Attractions
DCCEEW	Australian Department of Climate Change, Energy, the Environment and Water
DBT	Dibutyltin
DEIA	Dredging Environmental Impact Assessment
DO	Dissolved oxygen
DoEE	Australian Department of the Environment and Energy
DoT	Western Australian Department of Transport
DPLH	Western Australian Department of Planning, Lands and Heritage
EMF	Department of Transport's Maintenance Dredging – Environmental Management Framework
EPA	Western Australian Environmental Protection Authority
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environmental Protection Biodiversity Conservation Act 1999*
EQC	Environmental Quality Criteria
FRP	Filterable reactive phosphorus
GPS	Global positioning system
ha	Hectare
H2S	Hydrogen sulfide

IDER	Initial Desktop Environmental Review
IMS	Introduced marine species
JBMP	Jurien Bay Marine Park
JBMPMP	Jurien Bay Marine Park Management Plan
km	Kilometre
km^2	Kilometre square
LAC	Light attenuation coefficient
LAU	Local Assessment Unit
LoR	Laboratory limit of reporting
LTMMP	Long Term Monitoring and Management Plan
m	Metre
m^3	Cubic metre
MBT	Monobutyltin
mm	Millimetre
Mm^3	Million cubic metres
MAG	Maritime Advisory Group
NAGD	National Assessment Guidelines for Dredging
NH3	Ammonia
NH4+	Ammonium
no.	Number
NOx	Nitrate+nitrite
NSHA	Noongar Standard Heritage Agreement
NTU	Nephelometric Turbidity Units
NVCP	Native Vegetation Clearing Permit
PAHs	Polycyclic aromatic hydrocarbons
PAR	Photosynthetically active radiation
PSD	Particle size distribution
RIU	Remote imagery unit
SAP	Sampling and Analysis Plan
SAPIR	Sampling and Analysis Plan Implementation Report
SDP	Sea Dumping Permit
SD Act	*Environment Protection (Sea Dumping) Act 1981*
SWALSC	South-West Land and Sea Council
TACC	Technical Advisory and Consultative Committee

TBT	Tributyltin
TN	Total nitrogen
TNTM	Temporary Notice to Mariners
TOC	Total organic carbon
TP	Total phosphorous
TPHs	Total petroleum hydrocarbons
TRHs	Total recoverable hydrocarbons
UCL	Upper confidence limit
µm	micron
WA	Western Australia
WCRLMF	West Coast Rock Lobster (Managed) Fishery
ZoHI	Zone of High Impact
ZoI	Zone of Influence
ZoMI	Zone of Moderate Impact

Executive Summary

The Jurien Bay Boat Harbour (hereafter; the Boat Harbour) is located north of the Jurien Bay town site and ~225 km north of Perth, Western Australia. Western Australian Department of Transport (DoT) is responsible for management and maintenance of the Boat Harbour under the *Marine and Harbours Act 1981*. DoT is required to carry out routine maintenance dredging within and adjacent to the Boat Harbour (hereafter; the dredge area) over the period 2020–2030. The maintenance dredging will involve the removal of sand and wrack material using a small cutter-suction dredge or similar plant.

Offshore disposal is proposed for dredged sediments into a naturally deep basin (hereafter; the Offshore Disposal Area). This area was selected based on its proximity to the dredge area, natural retentive nature, capacity to receive dredged material over the next ten years and lack of benthic habitat. The Offshore Disposal Area is within the Jurien Bay Marine Park (JBMP).

This document presents a Long-Term Monitoring and Management Plan (LTMMP) for maintenance dredging at the Boat Harbour over the 2020–2030 period. LTMMPs outline both the framework and specific measures for management, mitigation and monitoring of potential environmental impacts. LTMMPs are a statutory requirement for the issue of a long-term Sea Dumping Permit under the *Environment Protection (Sea Dumping) Act 1981*. This LTMMP also forms the environmental impact assessment and management document for issue of a Lawful Authority under the *Conservation and Land Management Act 1984*.

Dredge area sediments have been tested and assessed against the National Assessment Guidelines for Dredging (CA 2009) framework and are considered suitable for unconfined ocean disposal. Modelling of the extent of turbid plumes at the disposal area indicates that significant reduction in light attenuation (and associated impacts to benthic habitats) is unlikely. Impacts to marine fauna, water quality and direct smothering to benthic communities and habitat are also considered to be unlikely to occur. However, monitoring and management will be completed to ensure the environmental impacts of offshore disposal are minimised to as low as reasonably practicable.

Weekly and end of campaign environmental reports will be compiled to ensure all data collected is of sufficient quality and is compliant with this LTMMP. Any exceedances of management targets will result in management actions implemented to ensure no significant impact to the environment.

Stakeholder consultation has commenced and will continue throughout the Project duration. The DoT Maritime Advisory Group (MAG) will be utilised as the primary, long-term stakeholder input into maintenance dredging. Other key stakeholders, including Department of Biodiversity, Conservation and Attractions (DBCA) Marine Park Managers, will be consulted through the life of the permit.

This LTMMP will undergo revision prior to each maintenance dredging campaign to ensure it is still current and management and monitoring is in keeping with best scientific practice. Significant revisions will be provided to Department of Climate Change, Energy, the Environment and Water (DCCEEW; formerly the Department of Agriculture, Water and the Environment) and DBCA for approval prior to implementation.

Contents

Tables

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1 Introduction

The Jurien Bay Boat Harbour (hereafter referred to as the Boat Harbour) is north of the Jurien Bay town site and ~225 km north of Perth, Western Australia (WA; Figure 1.1). The Boat Harbour's entrance channel has a dredge design depth of -4.0 m–5.0 m chart datum (CD), and the basin has design depths of -3.5 m CD, reducing to -3.0 m–2.0 m CD in the inner areas.

In January 1988, the Boat Harbour opened to provide refuge and service facilities for the Central West Coast fishing industry. The Boat Harbour is within an exclusion zone of the Jurien Bay Marine Park (JBMP) and contains 69 boat pens, four service jetties, a four-lane public boat ramp and boat maintenance facilities. The Boat Harbour supports a range of community uses, including recreational tourism and commercial and industrial development, with several land-backed facilities. Four live western rock lobster exporting facilities are located at the Boat Harbour. These storage facilities require seawater with adequate dissolved oxygen levels to sustain the western rock lobsters and retain the freshness necessary for transport.

The Western Australian Department of Transport (DoT) is responsible for management and maintenance of the Boat Harbour under the *Marine and Harbours Act 1981.* DoT is required to complete routine maintenance dredging within and adjacent to the Boat Harbour over the period 2020–2030. The maintenance dredging will involve the removal of sand and wrack (seagrass and macroalgae detached from the seabed) and benefits of the works will include:

- restoring the Boat Harbour to design depths to ensure safe navigation
- removing potential restrictions to natural flushing
- removal of significant volumes of wrack and eliminating the source of decomposing organic material within the Boat Harbour
- deepening the area along the northern breakwater to slow wrack and sediment alongshore transport into the Boat Harbour and to return the shoreline to pre-construction alignment
- ensure ongoing operational use of the Boat Harbour, surrounding industry and facilities.

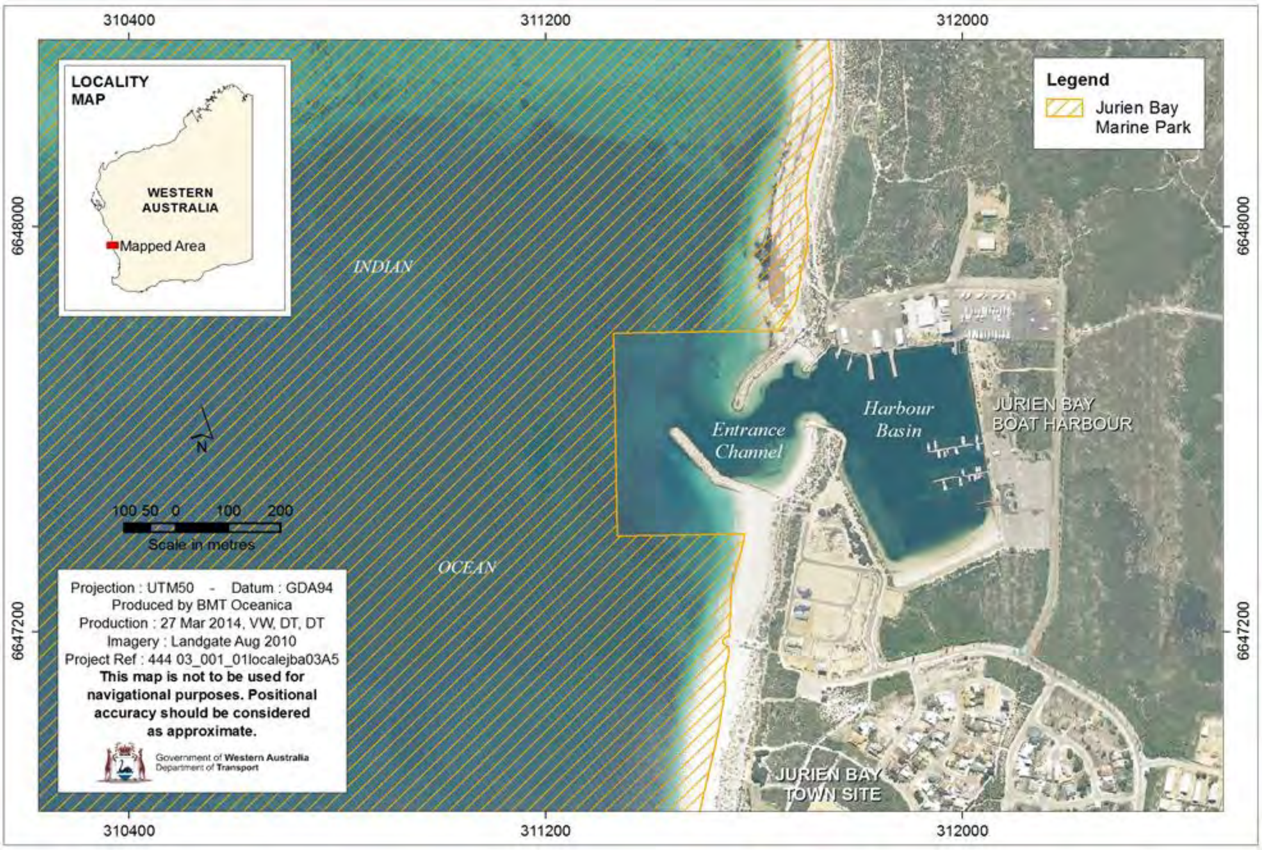

Figure 1.1 Jurien Bay Boat Harbour and the boundary of the Jurien Bay Marine Park, Western Australia

1.1 Purpose of this document

This document presents a Long Term Monitoring and Management Plan (LTMMP) for maintenance dredging of the Boat Harbour over the 2020–2030 period. LTMMPs outline both the framework and specific measures for management, mitigation and monitoring of potential environmental impacts. LTMMPs are a statutory requirement for the issue of a long-term Sea Dumping Permit (SDP) under the *Environment Protection (Sea Dumping) Act 1981*. This LTMMP also forms the environmental impact assessment and management document for issue of a Lawful Authority under the *Conservation and Land Management Act 1984.* The LTMMP will be implemented in accordance with required approval conditions.

1.1.1 Continuous improvement

This LTMMP will undergo revision prior to each maintenance dredging campaign to ensure it is still current and management and monitoring is in keeping with best scientific practice. Significant revisions will be provided to DCCEEW and Department of Biodiversity, Conservation and Attractions (DBCA) for approval prior to instigation. The Jurien Bay Maritime Advisory Group (MAG) will be invited to provide comment on the LTMMP following substantial revisions (Section 8.1).

1.2 Overall environmental management framework

1.2.1 Environmental Management Framework

DoT has a Maintenance Dredging – Environmental Management Framework (EMF; BMT 2023a) that provides guidance for the environmental management of their state-wide maintenance dredging operations. The EMF includes guidance on sediment sampling and analysis with reference to relevant environmental guidelines. The intention of the EMF is to ensure DoT's maintenance dredging activities fulfil the following objectives:

- protection of the environment
- clear, relevant and practical identification of environmental issues
- efficient management and completion of environmental assessments as required.

The EMF is updated ~annually, ensuring that best practice environmental management is applied to maintenance dredging. This LTMMP has been written in accordance with the DoT's EMF (BMT 2023a), and defines the specific methods, actions and roles required of the Principal (DoT) and Dredging Contractor (hereafter; Contractor).

1.2.2 Jurien Bay Marine Park

The Boat Harbour's dredging and disposal areas overlap with the general use zone of the JBMP. The JBMP is currently managed via the Jurien Bay Marine Park Management Plan (JBMPMP) 2005–2015 (CALM 2005). The JBMP extends along the coastline between Wedge Island to the south and Green Head to the north, and offshore 3 nautical miles. Under the JBMPMP, dredging activities are permitted in general use zones, but is subject to assessment and approval (CALM 2005).

DBCA are responsible for overall management of the JBMP to ensure its values as stipulated in CALM (2005) are maintained and improved. This includes assessment of proposed dredging and disposal activities. Of relevance to this LTMMP are the management objectives and targets contained in Table 1.1 for environmental factors that may be potentially impacted by maintenance dredging. This LTMMP has been written to ensure these management objectives are met throughout the proposed dredging and disposal, and the associated values for each factor are maintained.

Table 1.1 Environmental values, management objectives and management targets for at-risk factors in the Jurien Bay Marine Park

Environmental factor	Ecological value	Management objective	Management target
Water and sediment quality	The waters and sediments of the JBMP are largely pristine and are essential to the maintenance of a healthy marine ecosystem.	To ensure the water and sediment quality of the JBMP is not significantly impacted by the input of contaminants.	No change from background levels, unless approved by the appropriate government regulatory authorities.
Seagrass meadows	Extensive and diverse perennial seagrass meadows are an important habitat and nursery area for marine life and are important primary producers.	To ensure seagrass meadows in the JBMP are not permanently damaged by existing and future mooring and anchoring activities.	No permanent loss in the above-ground biomass of perennial seagrass from 2004 levels as a result of human activities in the JBMP.

Environmental factor	Ecological value	Management objective	Management target
Macroalgal communities	Extensive subtidal macroalgal communities with high floral diversity occur in the JBMP. These communities are important primary producers and refuge areas for diverse fish and invertebrate assemblages.	To develop an increased understanding of the distribution and diversity of macroalgal habitats in the JBMP.	No reduction in macroalgal species diversity or macroalgal habitat below 2004 levels as a result of human activities in the JBMP.

Source: CALM (2005)

1.3 Previous dredging and disposal

The Boat Harbour has historically been maintained through dredging (capital and maintenance), wrack trawling and land-based excavation. Historical dredge frequency and volumes for previous maintenance campaigns are outlined in Table 1.2 and further details are provided in the below sections.

Table 1.2 Historical dredging, wrack trawling and sand excavation works completed at Jurien Bay Boat Harbour

Year	Volume	Comments
2023	~46,000 m^3	Maintenance dredging and disposal to approved offshore disposal area.
2020/21	~37,000 m^3	Maintenance dredging and disposal to approved offshore disposal area.
2016/17	~62,000 m^3	Maintenance dredging and disposal to cleared onshore disposal area.
2014/15	~87,800m^3	Maintenance dredging and disposal to cleared onshore disposal area.
2014	~8500 m^3	Sand excavation.
	~4100 tonnes	Wrack trawling.
2013	~2000 tonnes	Wrack trawling.
2011	~100 tonnes	Wrack trawling.
2005/06	~41,000 m^3	Maintenance dredging, disposal to dunes, wrack disposal options considered.
1988	~550,000 m^3	Capital construction. Material removed from the Boat Harbour for residential development south and south-east of the Boat Harbour. A portion of the material was also disposed of to the north of the Boat Harbour.

1.3.1 Capital dredging

Capital dredging to construct the Boat Harbour was carried out in 1985 and completed in 1986 (Table 1.2). The basin was dry-excavated to approximately -3 m CD, the entrance channel to approximately -3.5–4 m CD and the harbour entrance to approximately -5–6 m CD (JFA 2006). Material removed from the Boat Harbour was used for residential development to the south and south-east of the Boat Harbour. However, a portion of the material was also disposed to the north of the Boat Harbour (JFA 2006). The total volume of material removed during the Boat Harbour construction was ~550,000 m^3.

1.3.2 Maintenance dredging

Since construction, the Boat Harbour has required maintenance dredging on five occasions, in 2005/2006, 2014/15 2016/17, 2020/21 and 2023 (Table 1.2; BMT Oceanica 2014a,b; BMT 2021, BMT 2023b). Dredged material from the 2005/2006 campaign was disposed of onto sand dunes north of the Boat Harbour (and subsequently re-vegetated). Sediment from the 2015/16 and 2016/17 campaigns was disposed of into cleared areas onshore and progressively revegetated.

However, this is not considered to be appropriate for future campaigns, as there is a finite amount of area that can be cleared and continual clearing of native vegetation for the disposal of marine sediments is not considered environmentally sustainable. The first maintenance campaign to involve offshore disposal (covered by this LTMMP and associated approvals) was completed in 2020/21, and sediments were disposed to the approved Offshore Disposal Area (SD2019/3984) via floating and submerged pipelines (BMT 2021). The second offshore disposal campaign was completed in 2023 (BMT 2023b).

1.3.3 Wrack trawling

Wrack trawling in the Boat Harbour's entrance channel was completed in 2011, 2013 and 2014 (Table 1.2). The 2011 campaign was a trial that involved the removal of ~100 tonnes of wrack (JFA 2012). Prolonged stormy weather conditions in Jurien Bay in winter 2013 led to a substantial wrack build up within the Boat Harbour and along nearby beaches. This resulted in fish kills and poor navigability within the Boat Harbour's basin and entrance channel. As a result, emergency trawling works removed ~2000 tonnes of wrack from the Boat Harbour in October/November 2013 (BMT Oceanica 2013). Similar works were completed in June/July 2014 when 4100 tonnes of wrack was removed in an attempt to pre-emptively reduce the amount of wrack in the Boat Harbour's entrance channel ahead of 2014 winter storms.

During each campaign, wrack was removed from the entrance channel using a beam trawl and a heavy-duty net. The wrack was placed within the DoT's Harbour Reserve and reused as mulch by local Jurien Bay residents. Minor turbidity was observed during the three trawling campaigns, but the turbid plume was not seen to extend beyond the Boat Harbour breakwaters (BMT Oceanica 2014c,d).

1.3.4 Sand excavation

Excavation of sediments adjacent to the Boat Harbour's inner northern sand trap was completed in 2014 (Table 1.2). The works involved the removal of ~8500 m^3 of sand to improve navigability in the entrance channel and allow access to the Boat Harbour's jetties. The material was stockpiled on the inner northern sand trap and was be used for the construction of the onshore bunded disposal area for the 2014/2015 dredging campaign. Turbidity generated during the sand excavation campaign did not extend beyond the Boat Harbour breakwaters (BMT Oceanica 2014e).

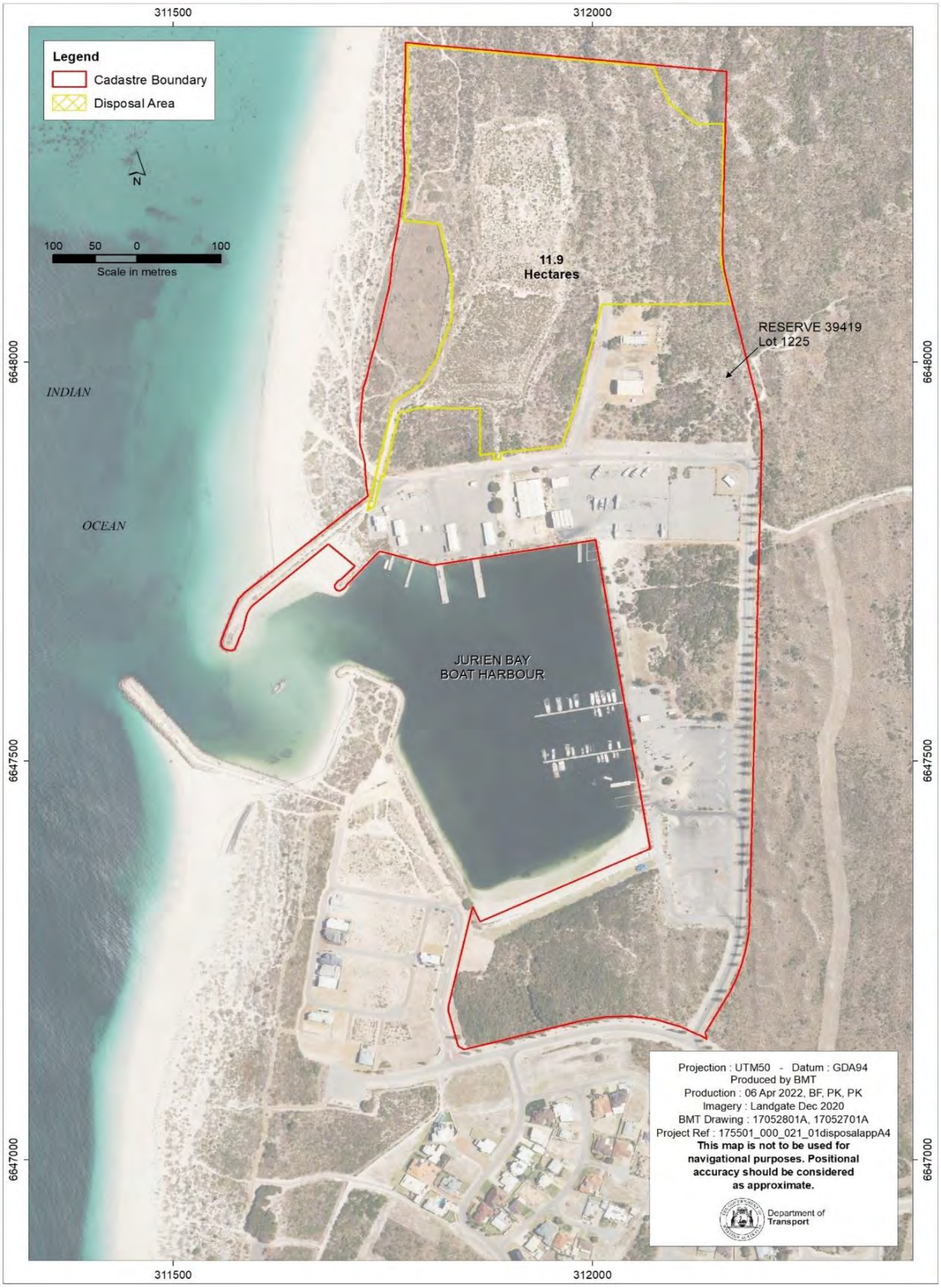

Figure 1.2 Jurien Bay Boat Harbour reserve and Onshore Disposal Area for the 2014/2015 and 2016/17 maintenance dredging campaigns

Notes:

1. The north-eastern boundary extent of the Onshore Disposal Area was reduced following the Aboriginal Heritage survey that identified a potential Aboriginal Heritage site

2. The boundary extent has changed over time to allow for extensions to receive additional dredged material.

2 Description of Dredging and Disposal

2.1 Dredging

Maintenance dredging campaigns involve the removal of recently deposited marine sediments and wrack to restore design depths with the primary purpose of maintaining safe navigation into and within the Boat Harbour. Accretion of sand and wrack is a dynamic process with material accreting in different areas and volumes depending on weather conditions which vary temporally. Therefore, maintenance dredging could reasonably be required at any location within the exclusion zone of the JBMP to maintain waterways into and within the Boat Harbour. Figure 2.1 shows design depths within the navigation channel and basin. It also shows target depths for areas immediately adjacent to the channel and entrance structures that are presently affected by significant accretion and are anticipated to require dredging in the near-to mid-future (Figure 2.1). Maintenance dredging areas shown in Figure 2.1 represent the presently anticipated areas requiring dredging but future dredging within the exclusion zone of the JBMP would be amended to include any accretion impacting safe navigation of the Boat Harbour's entrance. Coordinates for the exclusion zone of the JBMP (where the shoreline boundaries of the JBMP extend out to the east of the Boat Harbour's entrance) where any future maintenance dredging could occur are presented in Figure 2.2 and listed in Table 2.1.

Since construction of the Boat Harbour, significant accretion of more than 500,000 m^3 of sediment has accumulated along the beaches immediately north and south of the Boat Harbour's entrance resulting in the shoreline moving seaward ~80–100 m. This accretion has introduced a large sand supply immediately adjacent to the Boat Harbour, formed a more direct pathway for alongshore sediment transport to deliver material to the Boat Harbour's entrance, increasing the need for maintenance dredging. Removal of some of the accreted sand from the shoreline north and south of the Boat Harbour (north Areas C and K and south Area G; Figure 2.1) has become necessary to improve the performance of the entrance breakwaters in inhibiting material accretion within navigational areas and to reduce the frequency of maintenance dredging. Coordinates of the proposed Area K located within the JBMP to be included in the maintenance dredging area are presented in Figure 2.2 and listed in Table 2.1. In Area K, the dredging area has been designed to return this segment of the north shoreline to the pre-construction alignment and provide capacity for accretion outside the harbour.

The depth of sediment accretion above design depths will vary per campaign; however, the maximum estimated dredging depth is anticipated ~5 m below CD (Table 2.2). Dredge areas, target dredge depths and estimated dredge volumes including over-dredge allowance (based on September 2018 survey) are shown in Table 2.2. The maximum dredging volume (inclusive of the over-dredge allowance) per maintenance campaign is anticipated to be ~210,100 m^3 with an estimated duration of ~40 weeks (Table 2.2). The dredge volumes are conservative and will vary prior to each maintenance dredging campaign. It is unlikely there will be sufficient funding available to achieve all target areas, volumes and depths in an individual maintenance campaign, the anticipated volume per campaign is more likely to be ~80,000 m^3 based on historical dredging volumes (Table 1.2), with an anticipated campaign duration of ~18 weeks. Areas within the Boat Harbour that are still at or below the declared design depths will require minimal or no dredging. These areas will be determined from pre-dredge hydrographic surveys prior to each maintenance dredging campaign.

It is anticipated that dredging will be completed with a small cutter-suction dredge (CSD), as used for the previous maintenance dredging campaigns. The use of a CSD should limit turbid plumes and sedimentation to the dredge area, though this depends on sediment characteristics and local hydrodynamics (Ports Australia 2014)

2.2 Sediment redistribution

Condition 4 of the approved SDP (SD2019/3984) requires the Offshore Disposal Area does not become shallower than -8 m CD from the disposal of dredged material. Sediment redistribution within the Offshore Disposal Area may be required if the height from disposal of dredged material exceeds the conditioned height tolerance limit in the SDP. Sediment redistribution involves the redistribution of previously dredged marine sands from the Boat Harbour deposited within the Offshore Disposal Area. Based on previous dredge volumes, a typical maintenance dredging campaign can range between ~40,000–70,000 m^3. (Table 1.2). A small portion of material disposed offshore may require small-scale redistribution of the deposited dredged material if the conditioned height is exceeded during disposal. It is anticipated that the duration for remedial dredging will be short-term at the campaign completion. Sediment redistribution will only be required in the event the Contractor disposes dredged material above -8 m CD to allow for flexibility to rectify disposal heights and ensure safe navigability in the JBMP. The Contractor will be instructed to ensure the vertical height tolerance is monitored during the maintenance dredging campaign and frequent repositioning of the disposal pipeline is undertaken to avoid accretion of sands above the conditioned height.

Redistribution methods within the Offshore Disposal Area may vary dependent on operational considerations and equipment availability but are likely to include ploughing or dredging of potential high spots generated from deposited dredged material into adjacent deeper pockets of unvegetated seabed (Figure 2.4). Any redistribution works will be considered as 'operational' dredging days as specified in approvals and the same environmental monitoring methods and management actions outlined in this LTMMP will be applied (Section 7).

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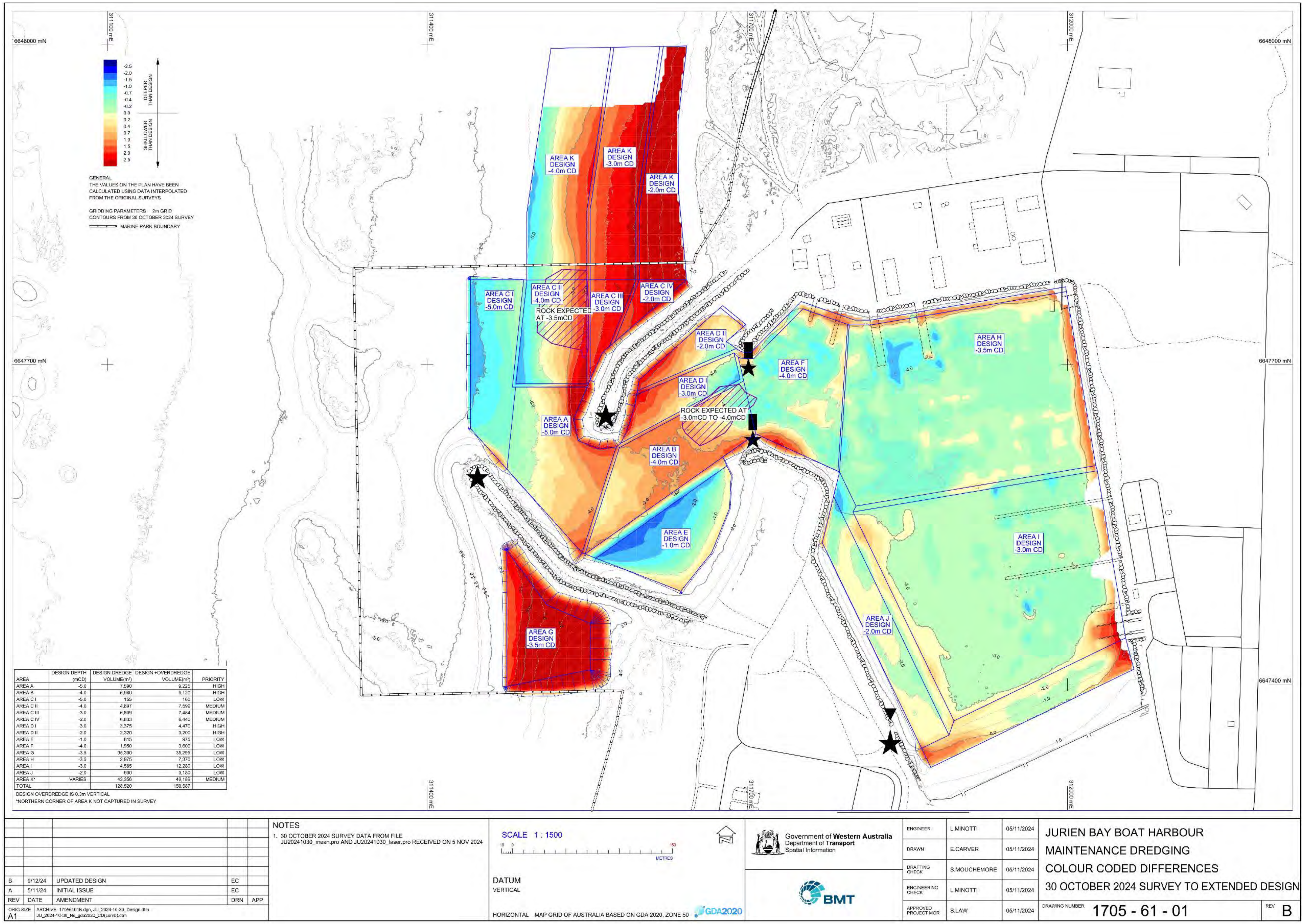


AREA	DESIGN DEPTH (mCD)	DESIGN DREDGE VOLUME(m^3)	DESIGN +OVERDREDGE VOLUME(m^3)	PRIORITY
AREA A	-5.0	7,590	9,225	HIGH
AREA B	-4.0	6,980	9,120	HIGH
AREA C I	-5.0	155	160	LOW
AREA C II	-4.0	4,897	7,599	MEDIUM
AREA C III	-3.0	6,509	7,484	MEDIUM
AREA C IV	-2.0	6,833	6,440	MEDIUM
AREA D I	-3.0	3,375	4,470	HIGH
AREA D II	-2.0	2,320	3,200	HIGH
AREA E	-1.0	815	975	LOW
AREA F	-4.0	1,950	3,600	LOW
AREA G	-3.5	35,300	35,295	LOW
AREA H	-3.5	2,975	7,370	LOW
AREA I	-3.0	4,565	12,280	LOW
AREA J	-2.0	900	3,180	LOW
AREA K*	VARIES	43,356	49,189	MEDIUM
TOTAL		128,520	159,587	

DESIGN OVERDREDGE IS 0.3m VERTICAL
*NORTHERN CORNER OF AREA K NOT CAPTURED IN SURVEY

Figure 2.1 Jurien Bay Boat Harbour proposed maintenance dredging areas and volumes

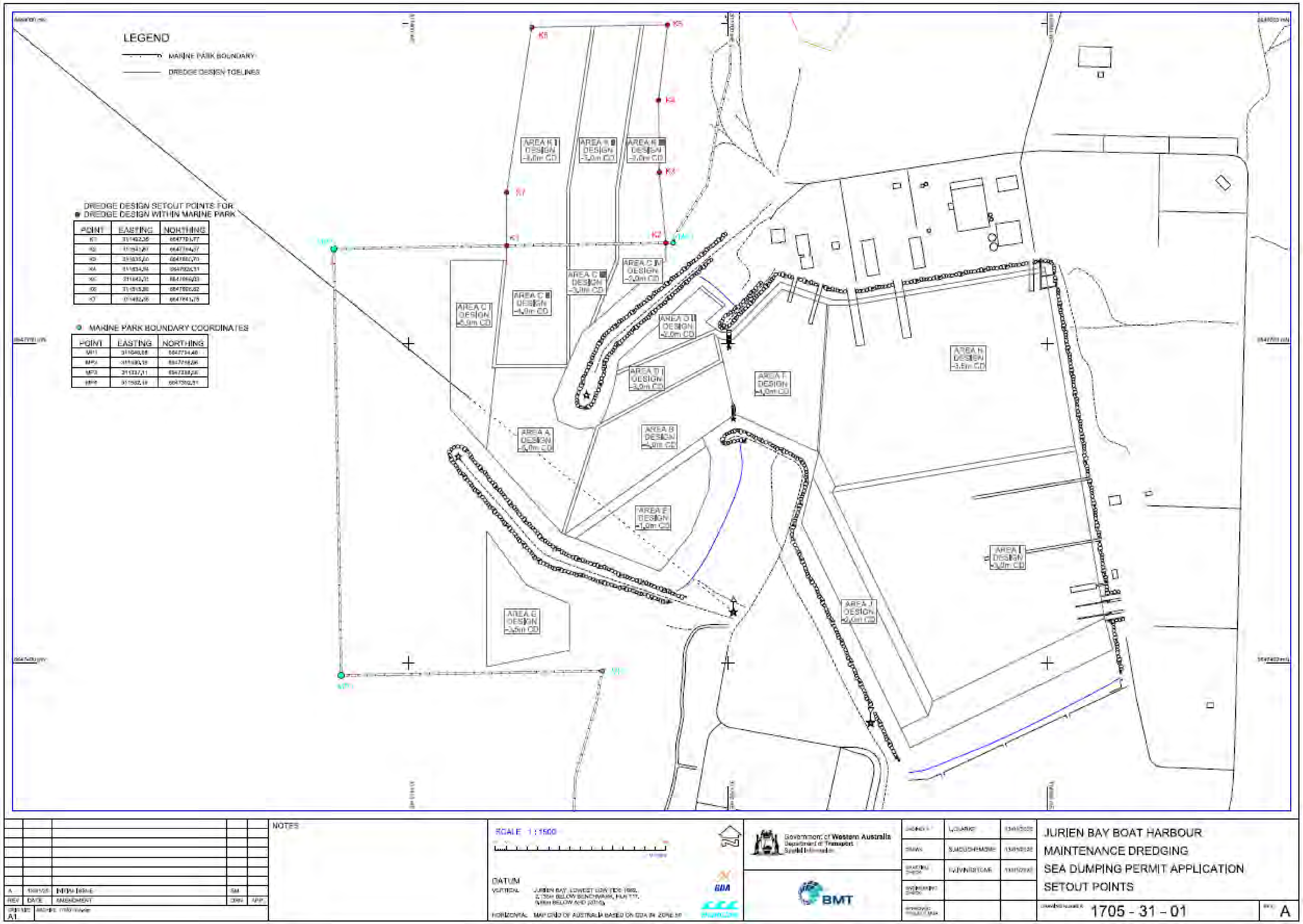


Figure 2.2 Jurien Bay Boat Harbour proposed maintenance dredging areas and corner point coordinates

Table 2.1 Corner point coordinates for the exclusion zone of the Jurien Bay Marine Park and for the proposed maintenance dredging area located within the Jurien Bay Marine Park (Area K)

Area	Corner point	Easting[1]	Northing[1]	Latitude	Longitude
JBMP boundary	MP1	311648	6647794	30° 17.217' S	115° 2.498' E
	MP2	311330	6647788	30° 17.217' S	115° 2.300' E
	MP3	311337	6647388	30° 17.434' S	115° 2.300' E
	MP4	311582	6647392	30° 17.434' S	115° 2.453' E
Area K	K1	311492	6647791	30° 17.217' S	115° 2.401' E
	K2	311641	6647794	30° 17.217' S	115° 2.494' E
	K3	311635	6647860	30° 17.181' S	115° 2.491' E
	K4	311634	6647928	30° 17.144' S	115° 2.492' E
	K5	311643	6647999	30° 17.106' S	115° 2.497' E
	K6	311515	6647996	30° 17.106' S	115° 2.418' E
	K7	311492	6647841	30° 17.190' S	115° 2.402' E

Notes:

1. GDA 94, UTM 50J
2. JBMP = Jurien Bay Marine Park
3. Refer to Figure 2.2 for explanation of areas and location of corner points.

Table 2.2 Target dredge depths and estimated dredge volumes for the proposed Jurien Boat Harbour maintenance dredging campaigns

Dredge area	Target dredge depth (m CD)	Dredge design volume (m^3)	Dredge design and over-dredge (0.3 m) volume (m^3)
A	-5.0	9340	12,120
B	-4.0	5700	8020
CI	-5.0	0	40
CII	-4.0	5880	7250
CIII	-3.0	8350	9340
CIV	-2.0	7390	8210
DI	-3.0	3880	4950
DII	-2.0	3670	4780
E*	-1.0	710	1560
F	-4.0	1100	2490
G*	-3.5	27,360	31,120
H*	-3.5	2810	7380
I*	-3.0	4650	12,970
J*	-2.0	860	3220
K*	Varies	86,050	96,650
Total	N/A	167,750	210,100

Notes:

1. Refer to Figure 2.1 for explanation of dredge areas
2. '*' = Provisional areas and volumes; 'm' = metre; 'CD' = chart datum, 'm^3' = cubic metre, 'N/A' = not applicable
3. Volumes are conservative and represent upper estimates within each dredge area and will vary for each maintenance dredging campaign depending on natural siltation rates. Average campaings volumes in recent campaigns have not exceeded 50,000 m^3 (Table 1.2)
4. Small-scale sediment redistribution may be undertaken within the Offshore Disposal Area if disposal of dredged exceeds the conditioned height limit stipulated in Condition 4 of the approved SDP (SD2019/3984).

2.3 Disposal

For maintenance dredging campaigns it is proposed that marine sediments from the Boat Harbour will be disposed offshore. The proposed Offshore Disposal Area is located ~1 km northwest of the Boat Harbour in ~12 m water depth (Figure 2.3, Table 2.3). Dredged material from the Boat Harbour will be hydraulically pumped via a floating/submerged pipeline. The Offshore Disposal Area is ~36 ha and has the capacity to receive dredged material over the next ten years to a maximum volume of ~1.1 Mm^3 (based on ~five campaigns, biennially). It is anticipated the overall depth of the Offshore Disposal Area will be reduced to -8.0 m CD. If the disposal of dredged material within the Offshore Disposal Area exceeds the conditioned height limit specified in the SDP (SD2019/3984), small-scale sediment redistribution may be required at the completion of the campaign. Sediment high spots will be redistributed to adjacent areas of deeper unvegetated seabed (Figure 2.4) to achieve the conditioned height tolerance (Section 2.2). The Contractor will be required monitor disposal heights during dredging and sediment redistribution will only be undertaken if required. The Offshore Disposal Area is located within the JBMP and disposal of material is subject to additional approvals from DBCA. Several alternative disposal options have been previously considered for the placement of dredged material for maintenance dredging campaigns (BMT Oceanica 2017). In consideration of the principles of waste avoidance and promotion of resource recovery, offshore placement was prioritised over the onshore alternatives, to:

- reduce the potential for dredged material to be re-distributed back into the Boat Harbour
- retain sediments within the natural marine system
- avoid routine clearing of onshore native vegetation (Figure 2.3).

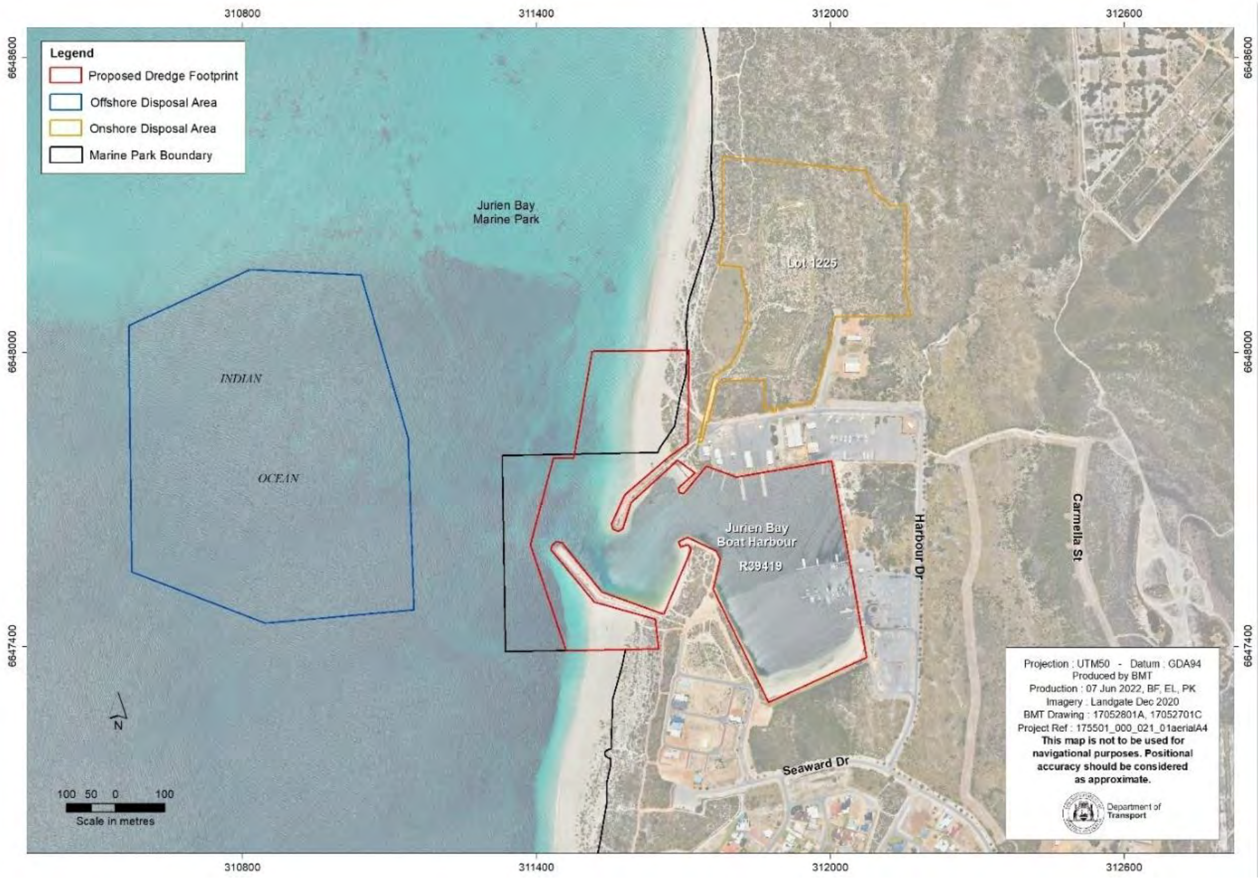


Figure 2.3 Jurien Bay Boat Harbour maintenance dredging layout: proposed Dredge Area, Offshore Disposal Area, alternative Onshore Disposal Area and Jurien Bay Marine Park excision boundary

Table 2.3 Jurien Bay Boat Harbour proposed Offshore Disposal Area corner point coordinates

Corner	Easting[1]	Northing[1]	Latitude	Longitude
North-west	310568	6648054	30° 17.066' S	115° 1.827' E
North	310816	6648168	30° 17.007' S	115° 1.984' E
North-east	311042	6648157	30° 17.015' S	115° 2.125' E
East	311138	6647824	30° 17.196' S	115° 2.181' E
South-east	311151	6647474	30° 17.386' S	115° 2.185' E
South	310847	6647447	30° 17.397' S	115° 1.995' E
South-west	310574	6647551	30° 17.338' S	115° 1.826' E

Note:

1. GDA 94, UTM 50S

2.3.2 Disposal area assessment

The Offshore Disposal Area has been chosen based on its proximity to the Dredge Area (<2 km pumping distance), retentive nature (Annex A) and sparse benthic habitats (Section 5.3.1, Figure 2.4). Figure 2.4 demonstrates the criteria applied to site selection of the Offshore Disposal Area with consideration of maximum pumping distance and distribution of benthic habitats throughout this area. Previously, offshore disposal onto the Favourite Island Sandbar had been nominated (BMT Oceanica & BMT JFA 2014); however, this area is no longer considered suitable because:

- the shallow depth increases the area required to accommodate sediments for the 10-year permit duration and the area is exposed to greater wave action (resulting in movement of disposed material away from the area)
- the sandbar acts as a source to the beach north of the Boat Harbour (BMT 2018a), and sediments are naturally transported by coastal processes from this area into the Boat Harbour's entrance channel.

Anticipated potential impacts to the physical, biological and social environments from using the proposed Offshore Disposal Area are discussed in Section 6. Associated monitoring and management to reduce potential impacts are detailed in Table 7.3and Section 7.3.

The Offshore Disposal Area will not be entirely utilised in one campaign, rather progressively filled from several maintenance campaigns over a 10-year duration. The area is anticipated to be retentive (Annex A) with little movement of sand outside of the modelled impact areas. Following adoption of monitoring and management measures, use of the Offshore Disposal Area presents minimal risk of significant environmental impacts and is considered suitable for the proposed maintenance dredging campaigns.

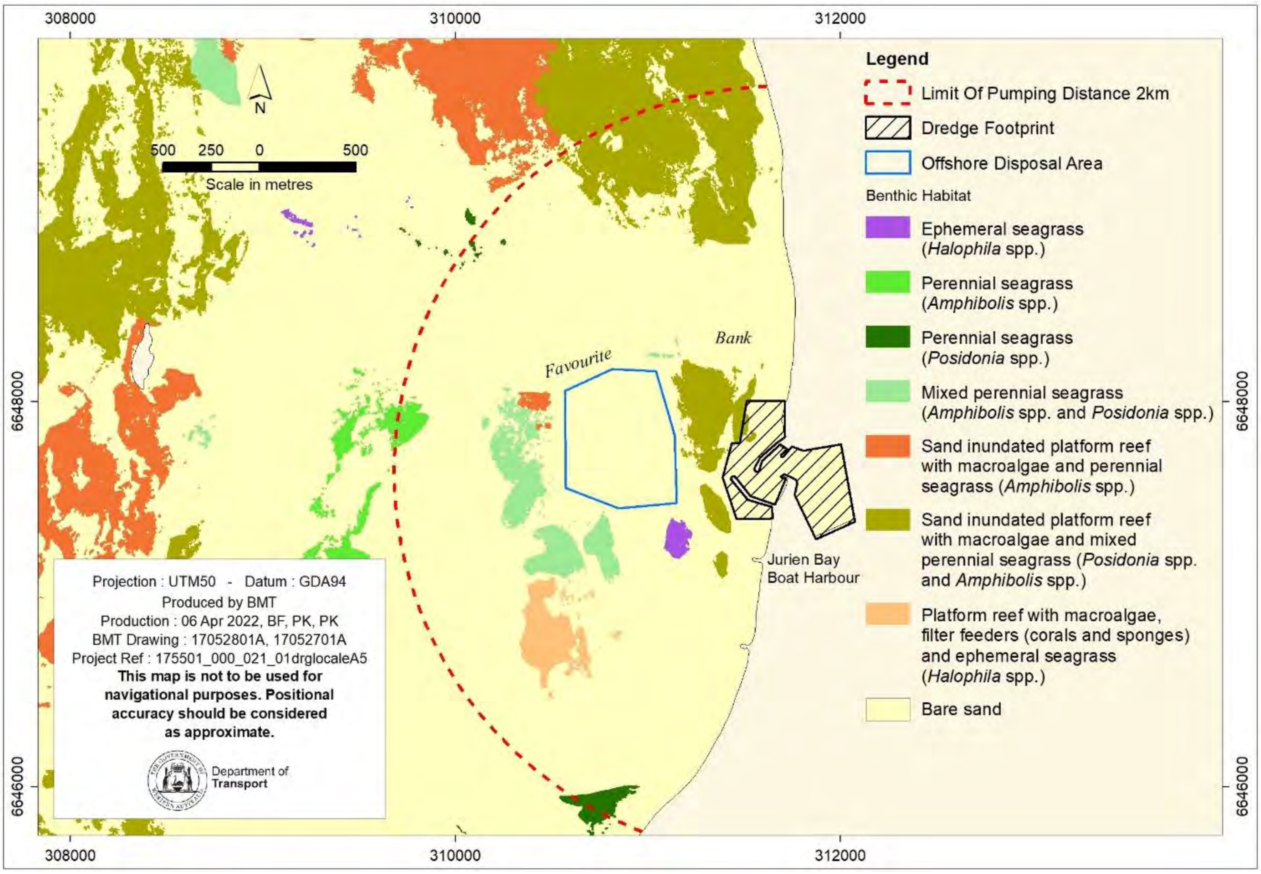


Figure 2.4 Classification and distribution of benthic habitat and communities surrounding Jurien Bay and Criteria for selection of Jurien Bay Offshore Disposal Area

2.3.3 Alternatives considered

Alternatives to sea disposal were assessed in the context of risk to financial, environmental, social and human health factors (Table 2.4). Not dredging the Boat Harbour is considered an unfeasible alternative to ocean disposal and would result in the closure of the Boat Harbour from infilling and risk to navigational safety. This would mean that DoT is not meeting its obligations under the *Marine and Harbour Act 1981*, and the users of the Boat Harbour and Jurien Bay community would likely suffer social and economic impacts.

Landfill disposal of sediment is not considered in keeping with the objectives of the *Waste Avoidance and Resource Recovery Act 2007*. In addition, the large volumes of material and associated trucking costs, fees and levy's mean that landfill disposal is economically prohibitive.

Beach disposal has previously been considered by DoT for maintenance dredging. Beach disposal involves pumping the dredge slurry ~3 km north of Boat Harbour and disposing dredged material directly onto the beach within the JBMP. It is assumed that disposal will occur above the low water mark. Once complete, the area of material disposed will encompass ~50–100 m across shore, and between 350 m and 1 km (pre-emptive dredging) along the shoreline. This option was considered not feasible due to engineering constraints with pumping distances, the proximity to terrestrial native vegetation, benthic habitats (nearshore reef), and the risk that disposed material would exacerbate sand accretion north of the Boat Harbour and increase flow of wrack and sand back into the Boat Harbour.

Onshore disposal of sediments has been considered as an alternative option. DoT has obtained a clearing permit under Part V of the EP Act (permit CPS 6181/2) for the remaining area within the Harbour Reserve. However, the onshore disposal of marine sediments is not considered suitable because:

- available capacity of the available Harbour Reserve area is insufficient to accommodate the estimated dredging volume without increasing the ground elevation in excess of 4 m above natural surface
- onshore disposal would raise the level of the ground throughout the lease by at least 4 m significantly affecting future development options
- onshore disposal of sediments is not considered environmentally sustainable in the long-term to clear terrestrial native vegetation to accommodate dredged material
- the dredge material is not contaminated and is considered suitable for unconfined ocean disposal according to the National Assessment Guidelines for Dredging (NAGD; CA 2009) framework, and therefore presents a low risk of causing contamination
- sediments and wrack originate from the JBMP, therefore returning the material to the JBMP is considered the most ecologically sustainable and responsible approach.

Table 2.4 Summary of alternative options considered for Jurien Bay Boat Harbour maintenance dredging

Option	Description	Comparative cost	Environmental impacts	Social impacts	Human health impacts
Sea dumping	Disposal of sediments to the proposed Offshore Disposal Area	This scenario is the most cost effective and is a baseline for comparison with other disposal options	Low – management of impacts per this LTMMP (Section 7) will ensure minimal long-term impacts to the environment	Low – no ongoing impacts are anticipated; however, there would be some loss of amenity during the works (Section 6)	None – material for disposal is clean marine sands (Section 4.3)
Onshore disposal	Disposal of sediments to a cleared DoT onshore reserve	Incurs costs in addition to the baseline due to: • vegetation clearance • earthworks for bunded enclosure and drainage management • management of land degradation (i.e. weed control, dust suppression)	High – clearing of up to 14.22 ha native dune vegetation to allow for disposal of marine sediment	Medium – located within the Yued Indigenous Land Use Agreement and with potential disturbance to Southwest Native Title Settlement Land. Poor public perception would be anticipated from clearing terrestrial native vegetation to dispose marine sediment that should remain in its natural system	Low – potential for ongoing dust impacts from disposed sediment
Disposal to landfill	Disposal of sediments to local landfill	Incurs costs in addition to the baseline due to: • establishment of temporary holding and dewatering dams • vegetation clearance • rehandling dredged material when loading into trucks	Low – disposal of sediments to landfill is not in keeping with the *Waste Avoidance and Recovery Act 2007*	Low – some loss of amenity would be anticipated during the works and poor social perception from significant use of allocated state funded Maintenance Dredging Program budget to accommodate trucking	None

Option	Description	Comparative cost	Environmental impacts	Social impacts	Human health impacts
		• establishing temporary roads to the dewatering area • significant trucking costs for volumes required • significant landfill disposal costs (levy) for volume required – up to $150/m^3 • revegetation or stabilisation of temporary holding areas		and levy's and/or from removing marine sediment from its natural system	
Beach disposal	Disposal of sediments to the beach north of the Boat Harbour	Incurs costs in addition to the baseline due to: • significant distance to pump material to a suitable location north from dredge areas • mobilisation of ~3 times the length of pipeline required for offshore disposal to reduce the risk of rapid return of sand into the Boat Harbour • mobilisation and operation of 2 additional booster pumps	Medium – disposal of sand to the nearshore/beach environment could alter coastal processes of Jurien Bay and potentially smother benthic habitats	Low – some loss of amenity would be anticipated during the works	None

Option	Description	Comparative cost	Environmental impacts	Social impacts	Human health impacts
		• machinery required to manage and reprofile the disposal area			
Not dredging	Not dredging the Boat Harbour	n/a	High – this is likely to result in closure of the Boat Harbour and poor water quality conditions resulting in fish kills, as experienced historically	High – no dredging will limit navigational access to the Boat Harbour, restricting/ceasing commercial and recreational use and the anticipated poor water quality from not dredging the Boat harbour would also reduce amenity	Medium – poor water quality could lead to human health impacts from primary (i.e. swimming) and secondary contact (i.e. odour; boating, water sports)

Notes:

1. **Comparative cost assessment is per campaign**
2. **DoT= Western Australian Department of Transport; LTMMP = Long Term Monitoring and Management Plan; n/a = not applicable.**

3 Regulatory Approvals and Policy Content

The anticipated approvals required for ongoing maintenance dredging of the Boat Harbour and offshore disposal are:

- Lawful Authority under the *Conservation and Land Management Act 1984* (CALM Act)
- Issue of a SDP under the *Environmental Protection (Sea Dumping) Act 1981* (SD Act)
- Potential referral and/or native vegetation clearing permit under the *Environment Protection Act 1986* (EP Act)
- Establishment of a Noongar Standard Heritage Agreement with the Yued Group.

3.1 Department of Biodiversity Conservation and Attractions Lawful Authority

A Lawful Authority is required from DBCA to dispose sediments within JBMP. To issue the Lawful Authority, DBCA will need to be satisfied that proposed dredging and disposal will not impact on the values of the JBMP, detailed in the JBMPMP (CALM 2005; Table 1.1).

Approval for offshore disposal of sediments and wrack dredged from the Boat Harbour and JBMP into a naturally deep basin in the JBMP was obtained for both the 2021/2022 and 2023 maintenance dredging campaigns, respectively. Subsequent approvals will be obtained following further consultation with DBCA, and any conditions imposed on DoT through a Lawful Authority will be met through the implementation of this LTMMP.

3.2 Environmental Protection (Sea Dumping) Act 1981

Ocean disposal of dredged material is regulated by a SDP issued under the SD Act by DCCEEW. Under the SD Act, the Australian Government assesses proposals to load and dump wastes and other materials at sea, permits acceptable activities, and sets conditions of approval to mitigate and manage environmental impacts.

DCCEEW has the authority to grant 10-year SDP’s for long-term routine maintenance dredging requiring ocean disposal. This LTMMP was submitted to DCCEEW (formerly DAWE) for assessment and approval of a 10-year SDP permit for ongoing maintenance of the Boat Harbour. A SDP (no. SD2019/3984, valid 12 October 2020 to 30 September 2030) was approved pursuant to implementation of this LTMMP and permit conditions. Conditions imposed on DoT through this SDP will be met through the implementation of this LTMMP.

3.3 Environment Protection Act 1986

Although potential impacts to the Environmental Protection Authority's (EPA's) environmental factors of marine environmental quality and benthic communities and habitat (BCH; EPA 2021a) may be anticipated, offshore disposal of sediments will likely not require referral under Part IV of the EP Act. The objectives for each environmental factor can be met through the implementation of this LTMMP. Review and approval of the LTMMP by DCCEEW and DBCA under the SD and CALM Acts (as relevant Determining Authorities) will ensure objectives are met and environmental impacts are minimised.

Within the dredge area there is 0.5 ha of sand inundated platform reef with macroalgae and mixed perennial seagrass (*Posidonia* spp. and *Amphibolis* spp.) (refer to Section 5.3.1). The type of CSD anticipated to be used for the dredging is for removal of soft sediment and would not have the capability to remove harder substrates like reef structures. Mapped areas of BCH within the dredge areas will therefore be actively avoided during dredging and no direct removal is anticipated. If direct removal of BCH is considered required, a Native Vegetation Clearing Permit (NVCP) will need to be obtained under Part V of the EP Act.

If modifications to the existing dredge laydown area (onshore) require the direct removal of native vegetation, a NVCP will need to be obtained under Part V of the EP Act. If future disposal of material is required to the historical Onshore Disposal Area (Section 2.3), this will be regulated through the existing NVCP (permit CPS 6181/2).

3.4 Noongar Standard Heritage Agreement

The Boat Harbour and adjacent lands are within a Native Title Determination Area registered under the South-West Land and Sea Council (SWALSC) Indigenous Land Use Agreement for the Yued Group. The Yued Noongar Standard Heritage Agreement (NSHA) is a State Government endorsed heritage agreement for use by Government proponents seeking to undertake on-ground activities that are anticipated to impact heritage values (including those in State waters) in the native title Determination Area. DoT have executed the NSHA with SWALSC (for and on behalf of the Yued Agreement Group; (Reference No. LEG,1463, 27 February 2020).” and under this agreement, DoT is required to consult with Yued group for on-ground activities occurring within the determination area to ensure cultural values are protected and compliance with the *Aboriginal Heritage Act 1972*.

4 Sediment Sampling and Analysis

4.1 Currency of sediment quality data

To support this LTMMP, sampling and analysis of sediments were undertaken in May 2024 from the proposed Boat Harbour Dredge Area and Offshore Disposal Area (Figure 2.3). Sampling and analysis of sediments were completed in-line with the previously approved Sediment Sampling and Analysis Plan (SAP; further detail available in Section 4.2) and results are presented in a SAP Implementation Report (SAPIR; further detail available in Section 4.3). A review of previous sediment sampling and analysis completed at the Boat Harbour is provided in Section 4.4.

In accordance with the NAGD (CA 2009), sampling and analysis of sediments from the proposed dredge area and Offshore Disposal Area will be completed every five years for the duration of the SP Permit and this LTMMP. Prior to each maintenance dredging campaign, an Initial Desktop Environmental Review (IDER) will also be completed, as required by the EMF (BMT 2023a), to assess the adequacy of the sediment quality data for application, regardless of its currency. If the IDER demonstrates that there is a valid reason (i.e. report of significant environmental incident since last sampling occasion, significant change to surrounding land use tenure since last sampling occasion, etc.) for the sediment quality data to be considered as inadequate for continued application, additional sampling would be undertaken, as required.

4.2 Sediment sampling and analysis plan

The Sediment Sampling and Analysis Plan (SAP) is provided in Annex B (BMT 2024a). The SAP was prepared to facilitate sampling and analysis of sediments from the proposed Boat Harbour Dredge Area and Offshore Disposal Area (Figure 2.3) in May 2024 (refer Section 4.3) and will be applied to future sampling occasions (required every five years; Section 4.1). The SAP includes a review of the potential sources of contamination of the sediment proposed to be dredged (Annex B).

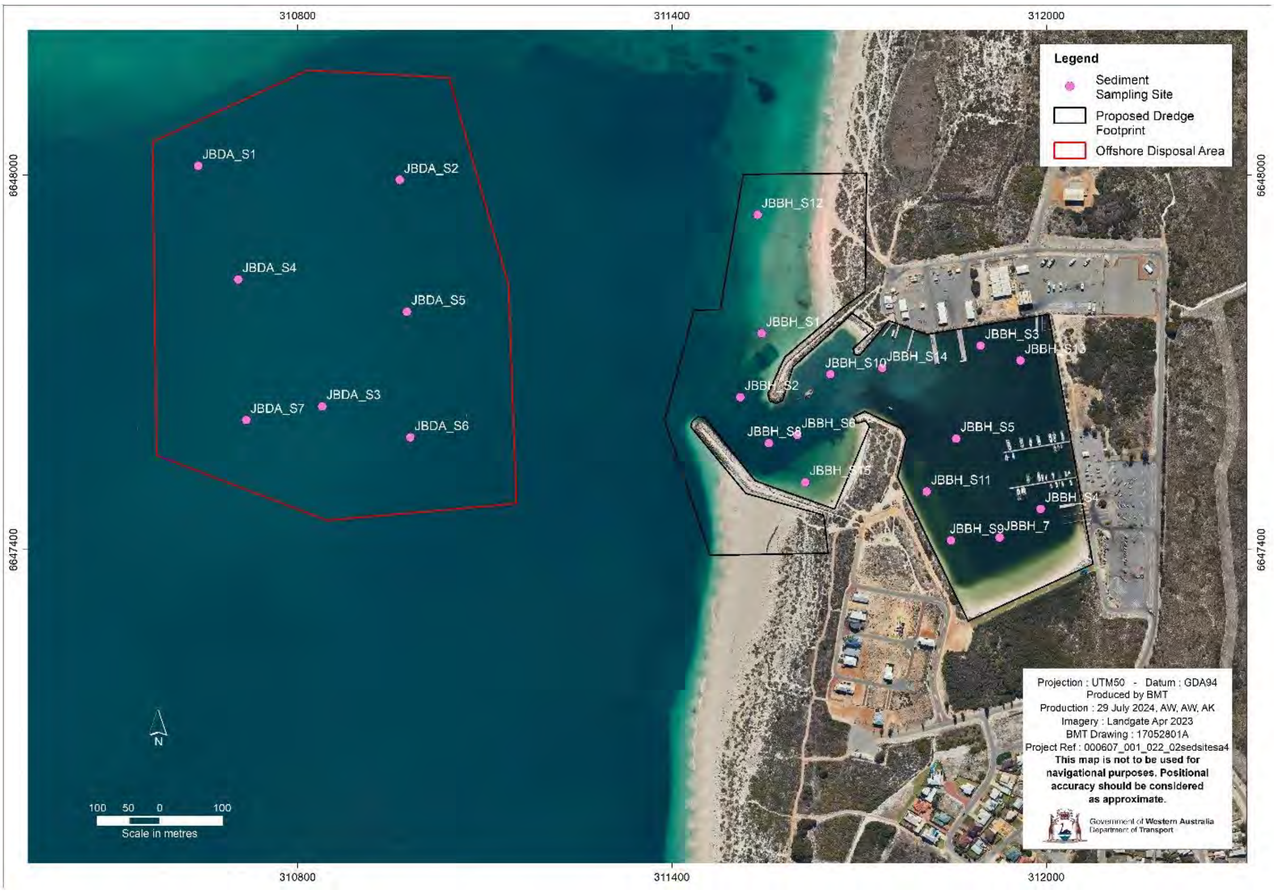
4.3 Description of the material for disposal

The full results from sampling and analysis completed in May 2024 are detailed in the SAPIR ~~()~~ (BMT 2024b). Surface sediment grab samples were collected from twelve sites[1] within the dredge area and from seven sites within the Offshore Disposal Area (Figure 4.1).

Dredge area sediments were analysed for particle size distribution (PSD), total organic carbon (TOC), total metals, elutriate nutrients and hydrocarbons (total recoverable hydrocarbons [TRHs], total petroleum hydrocarbons [TPHs], polycyclic aromatic hydrocarbons [PAHs] and benzene, toluene, ethylbenzene and xylene [BTEX]). Sediments were generally characterised by fine grained sands with fast settling rates (<2 minutes for 50% of particles to settle through 1 m of water and <45 minutes for 90% of particles to settle through 1 m of water) and low TOC content (0.16–1.23%; BMT 2024b). Concentrations of total metals were below the relevant NAGD Screening Levels (CA 2009). Sediment results showed elevated concentrations of elutriate nutrients. Mean concentrations of elutriate total phosphorous (TP), filterable reactive phosphorus (FRP), total nitrogen (TN), nitrate+nitrite (NOx) and ammonia (NH_3) exceeded the relevant ANZECC/ARMCANZ (2000) default trigger values for physical and chemical stressors for south-west Australia for slightly disturbed marine inshore ecosystems. The mean concentration of elutriate ammonia (NH_3) exceeded the relevant ANZG (2018) trigger value for toxicants at the 99% species levels

[1] *The number of samples collected was lower than the target number due to refusal of the sediment grab. Refer to the SAPIR (BMT 2024b) for further information.*

of protection. Concentrations of hydrocarbons were below the relevant NAGD Screening Levels (CA 2009).



Offshore Disposal Area sediments were sampled to establish ambient baseline concentrations and were analysed for PSD, TOC, hydrocarbons and metals. Sediments were characterised by fine grained sands with low TOC content (0.22–1.95%; BMT 2024b) and concentrations of total metals were below the relevant NAGD Screening Levels (CA 2009).

Figure 4.1 Sediment sampling sites within the proposed Jurien Bay Boat Harbour Dredge Area and Offshore Disposal Area

4.4 Review of previous sampling and analysis

Sediments and wrack within the Boat Harbour have historically been sampled to inform Dredging Environmental Impact Assessment (DEIA) for maintenance dredging campaigns and sampling results are summarised below.

4.4.1 Sediment sampling and analysis 2005

In 2005, six sediment cores were obtained from within the Boat Harbour entrance channel and one from within the basin (Oceanica & JFA 2005). The sediment samples were analysed for PSD, TOC, total metals and elutriate nutrients. Results showed sediments within the Dredge Area were comprised of clean medium/fine sands interspersed with decomposing seagrass wrack layers. There was no evidence of acid sulfate soils (ASS; Oceanica & JFA 2005). Sediment PSD showed material was predominantly medium to fine marine sands (83–96%) with some silt (<15%) and clay (<3.0%) and rapid settling velocity (Oceanica & JFA 2005). The TOC content of sediments was assessed via weight loss from combustion for one hour at 500ºC and 1000ºC with results ranging between 5–14% and 35–39%, respectively. Total metal concentrations were below relevant ANZECC/ARMCANZ (2000) interim sediment quality guidelines (available guidelines for comparison at the time). Elevated concentrations of elutriate nutrients were detected. Elutriate ammonia exceeded the relevant ANZECC/ARMCANZ (2000) water quality guideline at one site; however, this was considered attributable to decomposing seagrass within sediments. Elutriate nutrient results were considered over conservative of potential water quality impacts given the dilution within the receiving environment and water to sediment mix during dredging is sufficient to reduce concentrations below relevant guidelines.

4.4.2 Sediment sampling and analysis 2014

In April 2014, seven sediment cores were sampled within the inner northern breakwater sandtrap to support a sediment dredging and wrack trawling (DEIA; BMT Oceanica 2014a). The sediment samples were analysed for PSD, TOC, total and elutriate metals, total nutrients, organotins (tributyltin [TBT], monobutyltin [MBT] and dibutyltin [DBT]), hydrocarbons (TRHs, PAHs and BTEX) and elutriate hydrogen sulfide (H2S). Sediments were mostly comprised of medium grained sands, with small amounts of organic material. Particle size distribution results showed sediments were predominantly sands (96–100%), with some silt (<4%), clay (<0.2%) and gravel (<1%) and short settling times (<2.5 minutes for 90% of particles) across all sample sites.

The TOC content of the sediments ranged from 2.3–6.6%. Total metals, organotin and hydrocarbons concentrations were below the relevant NAGD Screening Levels (CA 2009). One site recorded a low-level exceedance for mercury at depth (0.2 mg/kg), however; remaining sediment samples within the dredge area were below the laboratory limit of reporting (LoR) and therefore overall test statistics met the NAGD Screening Level (CA 2009). Elutriate analysis of mercury at the individual site that exceeded was below the LoR. High concentrations of total nutrients were recorded and considered attributable to the decomposing seagrass wrack entrained within the sediments (it is noted that there are no sediment quality guidelines available for total nutrients). All sediments had concentrations of elutriate H_2S below the LoR.

In August 2014, sediment cores were collected from 19 sites within the Boat Harbour's entrance channel and basin and were analysed for PSD, TOC, total metals, total and elutriate nutrients, organotins (TBT, MBT and DBT), hydrocarbons (PAHs, TRHs and BTEX) and ASS (BMT Oceanica 2014b). Sediments comprised of by fine to medium sands with small portions of silt and gravel with fast settling rates. Most samples contained organic matter (in the range of <1–90%), exhibited a sulfidic odour and had low TOC content (<1% for most samples with exception to one sample that had a TOC content of 15% due to the sample being characterised by 90% organic matter). Total metals, organotins and hydrocarbons concentrations were below the relevant NAGD Screening Levels (CA 2009). Elevated concentrations of total and elutriate nutrients were detected in sediment samples and elutriate nutrients exceeded relevant ANZECC/ARMCANZ (2000) water quality guidelines. Elevated nutrient concentrations were attributed to decomposing seagrass wrack that accumulates in the Boat Harbour. Boat Harbour sediments were below the DEC (2013) ASS Action Criteria for all but one sample; however, exhibited an overall net negative acidity following acid base accounting thereby indicating a low risk of ASS generation during dredging and disposal.

4.4.3 Sediment sampling and analysis 2019

In April 2019, surface sediment samples were collected from 15 sites within the Boat Harbour entrance channel and basin, and seven sites within the Offshore Disposal Area. Boat Harbour sediments were analysed for PSD, TOC, total and elutriate metals, elutriate nutrients and hydrocarbons. Concentrations of total metals and hydrocarbons were below NAGD Screening Levels (CA 2009). Mean concentrations of elutriate arsenic, total chromium, lead and nickel, and cadmium were below the relevant ANZG (2018) DGVs for toxicants at the 99% species protection level. Mean concentrations of elutriate copper and zinc from dredge area sediments exceeded the relevant ANZG (2018) DGVs for toxicants at the 90% and 99% species levels of protection. Based on the results presented in the SAPIR (BMT 2019a), Dredge Area sediments were considered suitable for unconfined ocean disposal under the EPSD Act.

Elutriate nutrients (TP, FRP, TN, NOx, NH4+ and NH3) exceeded the relevant ANZECC/ARMCANZ (2000)[2] marine water quality default trigger values. As per the NAGD (CA 2009), the elutriate nutrient data was scaled to account for initial dilution at the disposal area for appropriate assessment against the relevant ANZECC/ARMCANZ (2000) marine water quality default trigger values (BMT 2022).

Offshore Disposal Area sediments were characterised by very fine to fine grained sands and fine to medium silts with short settling times: <3 minutes for 50% of particles to settle through 1 m, and <1 hour for 90% of particles to settle through 1 m of water. Offshore disposal area sediments contained low TOC content (0.25–3.79%) and concentrations of total metals and hydrocarbons were below the relevant NAGD Screening Levels (CA 2009).

4.4.4 Wrack sampling and analysis 2011

In November 2011, wrack trawled from the entrance channel of the Boat Harbour was sampled and analysed for total metals, organotins (TBT, MBT and DBT) and hydrocarbons (TPHs, PAHs and BTEX) (Oceanica 2012). Given that there are no specific guidelines available to assess contamination within wrack, results were compared to NAGD Screening Levels for sediment quality (CA 2009). Concentrations of total metals, organotins and hydrocarbons were below the relevant NAGD Screening Levels (CA 2009) with exception to a low-level cadmium exceedance in one sample and an exceedance of the 95% upper confidence limit (UCL) for concentrations of TPHs. The cadmium exceedance was not of concern given that metal concentrations in seagrass are often higher than those in sediments due to bioaccumulation (Oceanica 2012; and those references cited herein). Analysis of TPHs identifies both petroleum-based and nonpetroleum-based hydrocarbons, which are typically associated with vegetable and animal products (including oils, sugars and fatty acids). To remove any interference from these nonpetroleum based compounds, a silica gel clean-up of the samples should be performed, of which was not completed by the laboratory that completed the analysis. It was therefore considered that the elevated concentrations of TPHs were unlikely to be petroleum-based hydrocarbons, but organics from biogenic matter instead.

4.4.5 Wrack sampling and analysis 2014

Wrack samples were collected April 2014 from six sites within the Boat Harbour entrance channel. The wrack samples were analysed for TOC, total metals, total nutrients, organotins (TBT, MBT and DBT), hydrocarbons (TPHs, PAHs and BTEX) and elutriate H_2S. All samples exhibited a sulfidic odour and were predominantly characterised by *Amphibolis* spp. stems. Total metals, organotins and hydrocarbons concentrations were below the relevant NAGD Screening Levels (CA 2009). The samples had high TOC content (100%) with elevated concentrations of total nutrients, as expected given the marine flora organic constituents. Concentrations of elutriate H_2S were also detected but no marine guidelines are available for comparison to assess potential impacts. Wrack naturally accretes and resuspends from natural processes within the marine system and potential impacts from elevated concentrations of total nutrients and elutriate H_2S were not considered to be of concern assuming sufficient dilution within the receiving environment.

[2] *At the time of preparing this document the ANZG (2018) marine water quality guidelines were not available for application for all analytes due to resolving issues/inconsistences on the website, and it was recommended to refer to the ANZECC/ARMCANZ (2000) marine water quality guidelines in the interim.*

5 Description of the Environment

5.1 Physical environment

The Boat Harbour is located within the greater South-West Marine Region, which is divided further into seven bioregions, as defined by the Integrated Marine and Coastal Regionalisation of Australia Version 4.0 (DEWHA 2007). The Southwest Shelf Transition bioregion comprises the continental shelf between Perth in the south and Kalbarri in the north. This bioregion extends from nearshore areas to the edge of the continental shelf, the majority of which is under Commonwealth jurisdiction. With a maximum depth of 200 m, this nearshore bioregion is characterised by a high level of marine biodiversity, including sub-tropical, tropical and temperate marine species (DEWHA 2007).

5.2 Climate

Jurien Bay experiences a Mediterranean climate with hot, dry summers and mild, wet winters. During summer, mean monthly temperature ranges between ~16–31ºC and during winter between ~9–21ºC (BoM 2024). Rainfall in Jurien Bay is highly variable throughout the year, with an annual rainfall average of ~531 mm (BoM 2024). Seasonal rainfall levels range from a maximum monthly average of ~110 mm in July to a minimum monthly average of ~6 mm in December (BoM 2024).

Wind data recorded between 1969 and 2024 indicates that winds are predominantly from the east and south-east in the morning (0900) and from the south and south-west in the afternoon (1500) (BoM 2024; Figure 5.1). Mean annual wind speed was 17.2 and 22.8 km/h at 0900 and 1500 respectively, infrequently exceeding 50 km/h (BoM 2024; Figure 5.1).

Figure 5.1 Jurien Bay wind speed and direction

Source: BoM (2024)

Notes:

1. **Wind speed recorded at Jurien bay between 1969 and 2024 at 0900 (left) and 1500 (right)**
2. *** = calm is <0.5%**

5.2.1 Geology and geomorphology

The Southwest Shelf Transition bioregion includes a narrow continental shelf (40–80 km wide) that is characterised by complex physical features (DEWHA 2007). Nearshore, eroded limestone reefs and pinnacles form ridges, depressions and inshore lagoons. The inner shelf is a smooth plain with a series of ridges that develop into a tropical reef in the northern area of the bioregion (e.g. Houtman Abrolhos Islands). The greater Gingin-Dandaragan coastline is characterised by Safety Bay Sand from the Quindalup Dune systems. The coastal areas of the Jurien Bay region consist of curved beaches backed by low dunes. The shoreline in the Jurien Bay area consists of a continuous beach that is more exposed in the north and sheltered in the south (Eliot et al. 2012). Onshore, parabolic dunes in the south migrate north, forming mobile sand sheets with vegetation cover.

Beaches are separated by sand promontories or points, rocky headlands and low limestone cliffs. A series of elongated limestone reefs run parallel to the shore and provide the shoreline with some shelter from offshore waves (Oceanica & JFA 2005). Associated with these reefs are numerous emergent rocks and islands (CALM 2005).

5.2.2 Hydrodynamics

Hydrodynamics of the continental shelf are influenced by the Leeuwin and Capes currents, and seasonal variations in wind regimes (Gallop et al. 2012). The Leeuwin Current drives the offshore currents along the shelf break; whereas coastal currents are mostly wind-driven (DEWHA 2007). The Leeuwin Current is a warm, narrow and shallow current that transports tropical waters southward with low nutrients and salinity levels, predominantly during the Autumn and Winter months (March–August) (Gersbach et al. 1999, DEWHA 2007). The Leeuwin Current forms eddies in several predictable locations in this bioregion, including Jurien Bay. These eddies occur as cross-shelf currents that mix nutrient-rich, deep waters with the shallower water from the continental shelf, thereby enhancing the overall biological productivity for the region.

The Capes Current is a cool, counter-current that flows northward close inshore, resulting in localised upwelling and cooler water on the upper continental shelf (Pearce & Pattiaratchi 1999). In the Southwest Shelf Transition bioregion, the Capes Current also transports temperate species larvae from the southern regions to the northern areas along the inner, nearshore shelf (DEWHA 2007). The Capes Current is present mostly in the summer months (December–February).

Coastal currents are predominantly wind-driven by the strong south-westerly sea breezes occurring each afternoon (DEWHA 2007). This sea breeze system generates winds generally in excess of 50 km/h (Pattiaratchi et al. 1997), thus creating diurnal changes to wave heights, wave periods, nearshore currents and sediment levels and transport (Masselink & Pattiaratchi 1998). Under ambient conditions, the winter wind regime is generally calm and south-westerly, with a weaker sea breeze component. Winter storms (mid-latitude depressions) may generate strong winds, usually from the north-west (Lemme et al. 1999).

5.2.3 Coastal processes

Sand along the Jurien Bay coastline is transported via several coastal processes. Wind influences sand movement in the ocean (with the nearshore waves and currents) and on land, forming transgressive dunes (Ecoscape 2005). In winter, storm events generally transport nearshore sand in a southerly direction; whereas in summer, prevailing winds tend to transport nearshore sand in a northerly direction. In addition, waves and tides generate longshore currents that result in the littoral drift and cross-shelf transport of sand.

Onshore of Jurien Bay, unstable landforms are highly susceptible to changes from weather and metocean processes (Eliot et al. 2012). This coastal risk is evident in exposed beaches, mobile sand sheets and active blowouts in the sand dune complexes. Historically, wind and rainfall changes increased the coastal activity in the area, causing substantial fluctuations in sand dunes and blowouts.

5.2.4 Water and sediment quality

In February 2004, water samples were collected from 14 sites located in the nearshore, lagoonal and offshore areas of the JBMP and were analysed for dissolved metals and organic chemicals (DoE 2005). Concentrations of dissolved metals in the water samples were all below the relevant ANZECC/ARMCANZ 2000 trigger values for toxicants at the 99% species levels of protection and concentrations of organic chemicals were all below the LoR (DoE 2005). Spatial and seasonal nutrient dynamics were also examined from nearshore, lagoonal and offshore areas of the JBMP in 2014 and results found low concentrations of nutrients across all sampling periods with little variation between sampling areas (Rule et al. 2012).

A description of Boat Harbour sediment quality is provided in Section 4.

5.3 Biological environment

The Southwest Shelf Transition bioregion contains a unique mixture of both tropical and temperate marine species, including a high number of endemic fauna as well as the highest seagrass species diversity globally (DEWHA 2007). In the nearshore areas (<50 m deep), the biological environment is characterised by Australia's largest, continuous limestone reef with numerous rocks and islands creating sheltered environments for diverse mixture of temperate and tropical species of marine flora and fauna (CALM 2005, Eliot et al. 2012).

5.3.1 Benthic communities and habitats

To inform long-term dredging and disposal options, and marine environmental monitoring and management for the Boat Harbour maintenance dredging campaigns, BMT completed benthic habitat mapping of Jurien Bay in November 2017 (BMT 2018b; Annex D). The specific objectives of the mapping project were to:

1. collect digital baseline data on the spatial extent and characteristics of BCH in the mapping area, and
2. qualitatively characterise the extent of BCH surrounding the Boat Harbour and develop a mapping product of suitable quality to meet multiple purposes (including informing dredging operations and potential future environmental approvals applications, if necessary).

A total of 3667.2 ha of BCH were mapped during the project and the following dominant habitat types were identified (Table 5.1):

- bare sand (57.9%),
- sand inundated platform reef with macroalgae and mixed perennial seagrass (*Posidonia* spp. and *Amphibolis* spp.) (18.3%)
- sand inundated platform reef with macroalgae and perennial seagrass (*Amphibolis* spp.) (13.9%)
- reef dominated by macroalgae (6.1%).

A small proportion of mapped BCH is inhabited by mixed perennial seagrass (*Amphibolis* spp. and *Posidonia* spp.; 2.6%) and even less by mono-specific perennial and ephemeral seagrass meadows (~1.0% for *Amphibolis* spp., *Posidonia* spp. and *Halophila* spp. combined). Filter feeders such as corals and sponges within the mapped area represented only a small proportion (0.3%). Macroalgae habitat were dominated by the kelp Ecklonia radiata with fewer Sargassum spp. and red foliose species, where present as part of mixed assemblages (BMT 2018b).

The nearshore area north of the Boat Harbour is mostly comprised of a mixed assemblage of macroalgae and perennial seagrass (*Posidonia* spp. and *Amphibolis* spp.) overlying a sand inundated platform reef, extending ~500 m to 1 km offshore (Figure 5.2). South of the Boat Harbour, BCH is less vegetated and is dominated by mobile sands with small scattered meadows of perennial seagrass (mixed assemblages of *Posidonia* spp. and *Amphibolis* spp. and mono-specific assemblages of *Posidonia* spp.) and ephemeral seagrass (*Halophila* spp.; Figure 5.2). This predominantly sandy area surrounding the Boat Harbour extends ~3 km offshore.

Further offshore, BCH is dominated by a mixed assemblage of macroalgae and perennial seagrass (*Amphibolis* spp.) on sand inundated platform reef (Figure 5.2). Next to the dominant offshore BCH, areas containing a mixed assemblage of macroalgae and mixed perennial seagrass (*Amphibolis* spp. and *Posidonia* spp.) also occur (Figure 5.2). In the north-west offshore region of the mapped area there is an expansive area of reef dominated by macroalgae (Figure 5.2).

Inside the Boat Harbour entrance channel, BCH is predominantly characterised by wrack overlying bare sand. Adjacent to the Boat Harbour entrance channel, wrack and sparse meadows of seagrass (*Posidonia* spp.) are present covered in sand and epiphytic growth of calcareous algae. These seagrass meadows appeared partially dead and flattened on the seafloor, and therefore were classified as wrack for mapping purposes. It is noted that areas of wrack have been classified as bare sand in Figure 5.2. The extent of sand inundated platform reef with macroalgae and mixed perennial seagrass (*Posidonia* spp. and *Amphibolis* spp.) inside the dredge footprint boundary is 0.5 ha (Figure 5.2).

The selection of a suitable Offshore Disposal Area was based on the findings of the mapping project. The proposed Offshore Disposal Area is described in Section 3.2 and is located over bare sand (Figure 5.2).

Table 5.1 Area and proportion occupied by benthic habitat categories

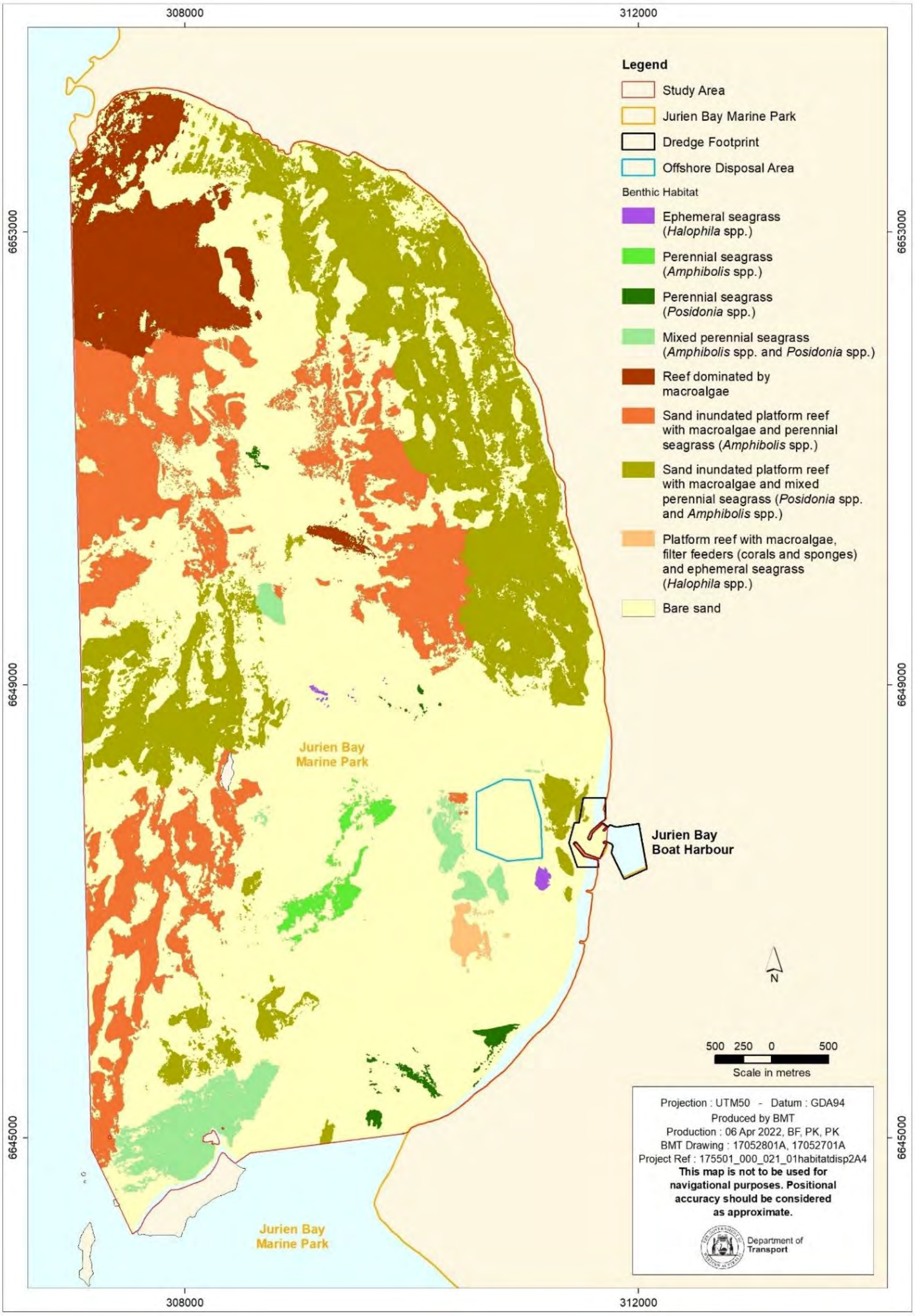
Benthic habitat type	Area (ha)	Proportion[1] (%)
Ephemeral seagrass (*Halophila* spp.)	2.6	0.1
Perennial seagrass (*Amphibolis* spp.)	23.4	0.6
Perennial seagrass (*Posidonia* spp.)	12.2	0.3
Mixed perennial seagrass (*Amphibolis* spp. and *Posidonia* spp.)	94.5	2.6
Reef dominated by macroalgae	222.1	6.1
Sand inundated platform reef with macroalgae and perennial seagrass (*Amphibolis* spp.)	508.2	13.9
Sand inundated platform reef with macroalgae and mixed perennial seagrass (*Posidonia* spp. and *Amphibolis* spp.)	670.2	18.3
Platform reef with macroalgae, filter feeders (corals and sponges) and ephemeral seagrass (*Halophila* spp.)	11.5	0.3

Benthic habitat type	Area (ha)	Proportion[1] (%)
Bare sand	2122.5	57.9
Total	3667.2	100

Source: BMT (2018b)

Note:

1. Percentages do not add up to exactly 100% due to rounding.



Source: BMT (2018b)

Figure 5.2 Classification and distribution of Jurien Bay benthic communities and habitat

5.3.3 Protected flora and fauna

The threatened fauna that are likely to occur in the vicinity (within 5 km) of the Boat Harbour were determined using the EPBC Act Protected Matters Search Tool (DCCEEW 2024; Annex E). The results identified 49 listed threatened species as potentially occurring within a 5 km radius of the Boat Harbour. Relevant to maintenance dredging campaigns, listed threatened species included plants (5), birds (26), mammals (6), marine reptiles (4) and sharks (5); Table 5.2).

Table 5.2 Threatened flora and fauna species identified as potentially occurring within 5 km of the Jurien Bay Boat Harbour

Taxa group	Scientific name	Common name	EPBC Act status
Birds	*Anous tenuirostris melanops*	Australian Lesser Noddy	Vulnerable
	Calidris acuminata	Sharp-tailed Sandpiper	Vulnerable
	Calidris canutus	Red Knot, Knot	Vulnerable
	Calidris ferruginea	Curlew Sandpiper	Critically Endangered
	Charadrius leschenaultii	Greater Sand Plover, Large Sand Plover	Vulnerable
	Diomedea amsterdamensis	Amsterdam Albatross	Endangered
	Diomedea epomophora	Southern Royal Albatross	Vulnerable
	Diomedea exulans	Wandering Albatross	Vulnerable
	Leipoa ocellata	Malleefowl	Vulnerable
	Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit	Endangered
	Macronectes giganteus	Southern Giant-Petrel, Southern Giant Petrel	Endangered
	Macronectes halli	Northern Giant Petrel	Vulnerable
	Numenius madagascariensis	Eastern Curlew, Far Eastern Curlew	Critically Endangered
	Phaethon rubricauda westralis	Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird	Endangered
	Phoebetria fusca	Sooty Albatross	Vulnerable
	Pterodroma mollis	Soft-plumaged Petrel	Vulnerable
	Rostratula australis	Australian Painted Snipe	Endangered
	Sternula albifrons	Little Tern	Vulnerable
	Sternula nereis nereis	Australian Fairy Tern	Vulnerable
	Thalassarche carteri	Indian Yellow-nosed Albatross	Vulnerable

Taxa group	Scientific name	Common name	EPBC Act status
	Thalassarche cauta	Shy Albatross	Endangered
	Thalassarche impavida	Campbell Albatross, Campbell Black-browed Albatross	Vulnerable
	Thalassarche melanophris	Black-browed Albatross	Vulnerable
	Thalassarche steadi	White-capped Albatross	Vulnerable
	Tringa nebularia	Common Greenshank, Greenshank	Endangered
	Zanda latirostris	Carnaby's Black Cockatoo, Short-billed Black-cockatoo	Endangered (listed as *Calyptorhynchus latirostris*)
Mammals	*Balaenoptera musculus*	Blue whale	Endangered
	Dasyurus geoffroii	Chuditch, Western Quoll	Vulnerable
	Eubalaena australis	Southern right whale	Endangered
	Macroderma gigas	Ghost Bat	Vulnerable
	Neophoca cinerea	Australian sea lion	Vulnerable
	Parantechinus apicalis	Dibbler	Endangered
Marine reptiles	*Caretta caretta*	Loggerhead turtle	Endangered
	Chelonia mydas	Green turtle	Vulnerable
	Dermochelys coriacea	Leatherback turtle	Endangered
	Natator depressus	Flatback turtle	Vulnerable
Sharks	*Carcharias taurus (west coast population)*	Grey nurse shark	Vulnerable
	Carcharodon carcharias	Great white shark	Vulnerable
	Pristis pristis	Freshwater Sawfish	Vulnerable
	Rhincodon typus	Whale shark	Vulnerable
	Sphyrna lewini	Scalloped Hammerhead	Conservation Dependent
Flora	*Andersonia gracilis*	Slender Andersonia	Endangered
	Caleana dixonii	Sandplain Duck Orchid	Endangered (listed as *Paracaleana dixonii*)
	Eucalyptus argutifolia	Yanchep Mallee, Wabling Hill Mallee	Vulnerable
	Hemiandra gardneri	Red Snakebush	Endangered
	Thelymitra stellata	Star Sun-orchid	Endangered

Source: EPBC Act Protected Matters Search Tool (DCCEEW 2024; Annex E).

Birds

The Boat Harbour may be visited by seabirds and shorebirds, although the area is not known to contain critical habitats for any of these species (DCCEEW 2024; Annex E). The Boat Harbour is not located in close proximity (<5 km) to a wetland of International Importance under the Ramsar Convention (DCCEEW 2024; Annex E). However, at least 15 species of seabirds use the offshore islands within the JBMP as breeding and nesting areas and are recognised as a significant ecological value of the greater Central West Coast region (CALM 2005). It is therefore likely that protected seabird species may be sighted frequently at the Boat Harbour as they transit to nearby nesting areas.

Mammals

Six threatened mammal species may occur within 5 km of the Boat Harbour: blue whale, southern right whale, Australian sea lion, chuditch, dibbler and ghost bat (DCCEEW 2024; Annex E). No critical habitats for these species are known to occur within 5 km of the Boat Harbour (DCCEEW 2024; Annex E).

Blue whales are documented in deep waters off the Perth coast, near the edge of the continental shelf (500–1000 m water depth) and feeding in the Perth Canyon and Rottnest Trench annually between January and May (McCauley & Jenner 2010, McCauley et al. 2001). Rare sightings of southern right whales have been recorded along the WA coastline, but there are no known critical habitats for this species in the Jurien Bay region (Bannister et al. 1996). Therefore, although these whale species are known to migrate and feed in deeper waters off the WA coastline, sightings of these whale species in the vicinity of the Boat Harbour are likely to be rare and infrequent.

Australian sea lion rookeries and haul-out sites are documented along WA's Central West Coast, supporting a population of ~800–1000 animals that breed on offshore islands, including East Beagle, North Fisherman and Buller Islands (CALM 2005). Of these rookeries, North Fisherman Island is the closest (<20 km north) to the Boat Harbour. Australian sea lion monitoring data have been collected from the Central West Coast, documenting ~150 pups born in this area (Campbell 2005). These sea lions may be genetically distinct from the nearest population and thus, may require additional conservation and protection (CALM 2004). Up to 18 offshore islands of the Central West Coast are known haul-out sites for Australian sea lions (CALM 2004). Male Australian sea lions are known to forage 60–180 km away from their rookeries (Hamer et al. 2011). Therefore, Australian sea lions are known to breed and haul-out at offshore islands in the Jurien Bay area, and it is likely that this species may be encountered frequently as they transit to rookery and haul-out sites along the Central West Coast.

Among other listed marine mammal species identified as 'Other Matters Protected by the EPBC Act' (DCCEEW 2024; Annex E), bottlenose dolphins (including both *Tursiops aduncus* and *T. truncatus*) are likely to be sighted in the vicinity of the Boat Harbour (DCCEEW 2024; Annex E). These dolphins are primarily found between the continental shelf and the coastline (<200 m water depth) in reef, sandy and seagrass habitats (DSEWPaC 2012a). With resident groups in nearshore waters of WA, bottlenose dolphins are considered to be a coastal species regularly sighted in the JBMP (CALM 2005). In both estuarine and coastal habitats in Perth, surveys documented resident bottlenose populations for over 20 years on a year-round basis, confirming their long-term residency and short-term associations with coastal, non-resident dolphins (Finn 2005; Chabanne et al. 2012). Therefore, as bottlenose dolphins are known to occur throughout WA marine areas, it is likely that they may be encountered in proximity to the Boat Harbour.

Chuditches are known to occur in the south-west corner of Australia, as the remaining populations occur in jarrah forests and woodlands. There have been occasional records in drier woodland and mallee shrubland in the Wheatbelt and Goldfield regions (DEC 2012). It is unlikely for Chuditch populations to occur in the terrestrial dredge area laydown areas given the existing level of disturbance in the Harbour Reserve and unsuitable habitat. Ghost bats are known to roost in caves and deep cracks in rocks, and unlikely to occur in close proximity to the Boat Harbour given the located within a disturbed Harbour Reserve and absence of suitable habitat.

A known dibbler population is found on three offshore islands in the Jurien Bay area, following translocation efforts in 2000 (Moro 2003). A small population is also found near Albany; however, the mainland population has been severely diminished by fox predation and there is no evidence of dibblers north of Albany. Dibblers tend to favour dense heath and mallee-heath areas, which are not found around Jurien Bay (Moro 2003). It is therefore unlikely that dibblers will be sighted in the vicinity of the Boat Harbour.

Marine reptiles

Four marine turtle species may occur in proximity to the Boat Harbour; green, flatback, leatherback and loggerhead turtles (DCCEEW 2024; Annex E). In the South-West Marine Region, these species are commonly found in coral and rocky reefs, sandy beach and seagrass habitats (DEWHA 2007). Although no breeding or nesting is known to occur in the vicinity of the Boat Harbour (DCCEEW 2024; Annex E), resident green and loggerhead turtles are sighted throughout the year, most likely foraging, while the leatherback and flatback turtles are recognised as occasional visitors in the area (CALM 2005, DEWHA 2007). None of these species have critical habitats within the vicinity of the Boat Harbour, with key known habitats for breeding and nesting found in the north-west region of WA (DSEWPaC 2012b, DEWHA 2007). Therefore, it is possible that infrequent sightings of marine turtles may occur in proximity to the Boat Harbour.

Sharks

Five shark species were identified as possibly occurring in proximity to the Boat Harbour (DCCEEW 2024; Annex E), all of which are known to reside in warm, temperate seas (DEWHA 2007). The grey nurse shark is commonly found in inshore waters as well as deeper waters along the continental shelf, and they spend most of their time at depths between 20–60 m (DSEWPaC 2012c). In the South-West Marine Region, there are no known movement patterns, critical habitats or aggregation areas for this species, and their occurrence in the vicinity of the Boat Harbour is likely to be rare and infrequent.

Great white sharks are known to occur in the South-West Marine Region and the coastal waters of Perth, possibly with a seasonal pattern of travelling south in summer months (DEWHA 2007). Most of the great white sharks have been recorded along the 100 m depth contour in Australian waters (DSEWPaC 2012c). They can be found in inshore (in rocky reefs and shallow coastal bays) and offshore areas (such as the continental shelf and slope). Although they are considered to be rare compared to other shark species, great white sharks are known to aggregate around seal and sea lion colonies around Australia (DSEWPaC 2012c). Despite this, sightings of great white sharks in the vicinity of the Boat Harbour are likely to be rare and infrequent.

Whale sharks are not known to aggregate or have interactions in the South-West Marine Region, as the largest congregation of whale sharks are known to occur in Ningaloo Reef in north-west WA (DSEWPaC 2012c), which is more than 800 km north of the Boat Harbour. Although they have a wide range and broad distribution in tropical and temperate waters, it is unlikely that whale sharks will be sighted near the Boat Harbour.

Sawfish are not known to aggregate in the South-West Marine Region, as the last significant populations of sawfish is known to occur in the North-West Marine Region (Stevens et al 2008). It is unlikely that sawfish will be sighted near the Boat Harbour.

Scalloped hammerheads have a wide distribution occurring from Sydney, New South Wales around to tropical north to Geographe Bay in the southwest of WA (Lopez et al 2022). Scalloped hammerheads are known to occur in the coastal and offshore waters from Jurien Bay to more tropical regions in the North West of Australia (Lopez et al 2022). Despite this, sightings of scalloped hammerheads in the vicinity to the boat harbour are unlikely and rare.

Flora

The threatened flora species are found in swamps, winter-wet flats, sandplains, open heath, shrubland and woodland or forest areas (DEC 2006, CALM 2000, CALM 2004) and are not likely to be found in the foredune adjacent to the Boat Harbour. The foredune vegetation immediate adjacent to Onshore Disposal Area and Boat Harbour consists of degraded and regularly disturbed patches of coastal vegetation species and native shrubs and considered unlikely to support populations of protected flora due to the existing level of disturbance in the Harbour Reserve.

5.3.4 Other fauna of significance

Western rock lobster

The western rock lobster (*Panulirus cygnus*) is the target species of WA's largest and most valuable fishery; the West Coast Rock Lobster (Managed) Fishery (WCRLMF; DPIRD 2019a). In 2014, the estimated value of the WCRLMF was $359 million based on the total commercial catch of 5947 tonnes (DPIRD 2019a). At Jurien Bay, commercial fishing for western rock lobster forms a significant component of the town's economy, where there is a commercial fishing fleet that operate out of the Boat Harbour and live crayfish receival depots located on the Boat Harbour's premises.

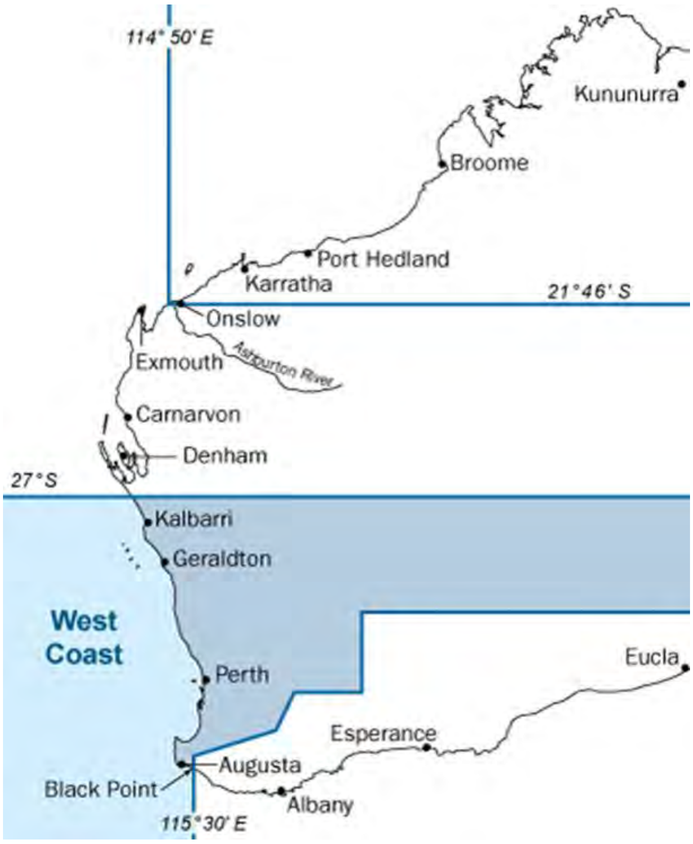
Endemic to WA, the western rock lobster inhabits clear, oxygenated waters from the North West Cape south to Cape Leeuwin (Chittleborough 1975) but is most abundant between Geraldton and Perth (DoF 2011a). The lifecycle of the western rock lobster is well known and includes a planktonic pelagic stage (living in the open ocean) of ~9–11 months before migrating to shallow coastal (<20 m) regions to begin the benthic life cycle stage (living on the seafloor) (DoF 2011a). Full development from larvae to sexual maturity takes ~4.5–6 years (Gray 1992).

Inshore and outer reefs, such as those that occur along the Jurien Bay coastline, are important habitat for post-puerulus (late-larval stage) and juvenile western rock lobster, which typically inhabit small crevices of coastal limestone reefs (Chittleborough et al. 1975, Fitzpatrick et al. 1989; cited in MacAuthur et al. 2007, Jernakoff 1990). Juveniles usually inhabit these reefs for 3–4 years, feeding and growing, until reaching ~80 mm carapace length and undergo a synchronised moult event (DoF 2011a, Bellchambers et al. 2012). This particular moultis significant as it marks the beginning of the 'white' phase of the western rock lobster's lifecycle that coincides with its migratory phase when the lobsters leave the coastal reefs and embark on a mass migration to offshore deep water (up to 100 m deep) breeding grounds (DoF 2011a, Bellchambers et al. 2012). This event typically occurs in November through to mid-January each year (Gray 1992).

Blue swimmer crab

The blue swimmer crab (*Portunus armatus*; formerly known as *P. pelagicus*) is found along the entire WA coast, in a wide range of inshore and continental shelf areas, from the intertidal zone to ~50 m depth (Fletcher and Santoro 2012). Within the West Coast bioregion (Figure 5.3), the species is targeted by four commercial fisheries (DPIRD 2019b). In 2013/14, the estimated value of the West Coast bioregion blue swimmer crab fishery was $1 million based on the total commercial catch of 163 tonnes. At Jurien Bay, the blue swimmer crab is a popular species targeted by recreational fishers but is not commercially fished.

Blue swimmer crabs typically reside beneath sand during the day and are most active at night when they become mobile to search for food (DoF 2011b). The timing and movements of blue swimmer crabs vary among locations (DoF 2011b). In the ocean, blue swimmer crabs begin life as small larvae termed 'zoea' and develop over a ~4–6 week period during summer, drifting in bays along the coast up to 80 km offshore (DoF 2011b). Zoea are easily preyed upon by fish and experience very high rates of morality during this period (DoF 2011b). By late summer, most of the survivors reach shallow nursery areas where they settle on the seafloor and begin to moult frequently and grow rapidly, transforming into a more crab-like state called 'megalopae' (DoF 2011b). By autumn, most megalope have formed into juvenile crabs (with a 3–6 cm wide carapace), and by winter, most juvenile crabs have reached maturity (with a 9 cm wide carapace; DoF 2011b). Mating typically takes place in autumn, and then spawn in spring and early summer, producing between 180 000–2 million eggs in a single spawning (and may spawn more than once in a season; DoF 2011b).



Source: DPIRD (2019c)

Figure 5.3 West coast bioregion

Finfish

The inshore lagoons of the South West Shelf Transition (Section 5.1) are inhabited by demersal and pelagic fish (DEWHA 2007). Extensive schools of migratory fish visit the area annually including herring, garfish, tailor and Australian salmon (DEWHA 2007). These small to mid-sized predators feed on smaller pelagic fish and squid, and in turn are preyed upon by larger predatory species such as mulloway, snapper, samson fish, Spanish mackerel and whaler sharks (DEWHA 2007). Small pelagic fish including herring, sardine, scaly mackerel, jack mackerel, yellow tail, blue mackerel, anchovy, blue sprat and sandy sprat, are considered a particularly important trophic link between plankton communities and larger fish-eating predators (DEWHA 2007).

The high biodiversity of marine species that occur in the region has resulted in recreational fishing being a valued activity at Jurien Bay. Some popular finfish species targeted by recreational fishers at Jurien Bay include the West Australian dhufish (*Glaucosoma hebraicum*), Pink Snapper (*Pagrus auratus*) and Baldchin Groper (*Choerodon rubescens*; DoF 2008; as cited in Lozano-Montes et al. 2011). The West Australian dhufish and Baldchin Groper are endemic to WA, whereas the Pink Snapper has a larger distribution and is found in coastal waters off China, Japan, Taiwan, the Philippines, New Zealand and Australia (DoF 2011c,d,e).

The peak spawning period for West Australian dhufish is typically between December and March, when water temperatures are elevated (DoF 2011c). Adult West Australian dhufish prefer to live around rocky outcrops and ledges in water 20–50 m deep (DoF 2011c). For Baldchin Groper, the peak spawning period is between November to early January (DoF 2011d). Baldchin Grouper are most abundant at the Abrolhos Islands (located ~350 km north north-west of Jurien Bay), which is also where their main known spawning aggregation area is located (DoF 2011d). The timing of the spawning season for Pink Snapper varies with its location; in WA there are two significant spawning aggregation areas for this species that includes Shark Bay (located ~600 km north of Jurien Bay), where fish spawn between April to October, and Cockburn Sound (located ~250 km south of Jurien Bay), where fish spawn between October to December (DoF 2011e). Pink Snapper typically live in waters 20–250 m deep (DoF 2011e).

6 Potential Environmental Impacts

The potential environmental impacts on environmental factors that may arise due to maintenance dredging campaigns have been assessed in the context of the EPA's Environmental Factors and Objectives (EPA 2023). The potential environmental impacts are discussed in the sections below and are anticipated to affect the following EPA (2023) environmental factors:

- BCH (Section 6.2)
- marine and terrestrial environmental quality (Section 6.3)
- marine fauna (Section 6.4)
- coastal processes (Section 6.5)
- social surroundings (Section 6.6).

6.1 Modelling potential impacts to the environment

To assess potential impacts of offshore disposal to surrounding sensitive environmental receptors, modelling was completed to simulate the extent of any turbid plume from disposal of dredged material, and the retentive or dispersive nature of the Disposal Area under worst-case conditions (Annex A). The model considered tide, wind and wave interactions to predict the estimated plume extent and TSS concentration upon the cessation of daily dredging in the Disposal Area. A representative summer period of one month (November 2017) was used to assess the likely dredge plume dispersion and fate of dredged material following disposal. This period was considered representative of a summer wind pattern, when dredging is most likely to occur. Two storm events (measured between 18 May and 16 June 2016) were used to simulate worst case conditions for spoil ground stability. Sediment PSD from BMT (2019b) were used to represent dredge material.

Results demonstrated that although the selected simulation period is relatively energic (which could potentially result in higher intensity plume dispersion), TSS levels reduced below 5 mg/L within 3 hours after cessation of dredging. Remaining TSS in the water column further settled to below a model-detectable level (1 mg/L) before the start of dredging the next day. Sedimentation from disposal activities was primarily limited to within the Disposal Area.

The result of the acute storm simulation demonstrated that the spoil ground (filled to design level of -8m CD) is stable under both the northerly and southerly severe storm conditions. The resuspension of the fine materials from the disposal area is minimal due to the storm activities.

The full modelling methods, inputs, assumptions and results are detailed in Annex A.

6.2 Benthic communities and habitats

The main potential impacts from dredging on seagrasses include physical removal or burial of vegetation at the dredging/disposal areas, and increased turbidity (light reduction) and increased sedimentation to adjacent seagrass meadows (Erftemeijer & Lewis 2006). In addition, temporarily reduced dissolved oxygen concentration, release of nutrients and contaminants (from contaminated sediments) and hydrographic changes may also occur and have indirect effects on the seagrass ecosystem (Erftemeijer & Lewis 2006).

Given the dredging and disposal activities are likely to be completed within a 4–5 month period (~18 weeks) and settling velocities indicate that 90% of particles should settle through the water column in ~12 hours (BMT 2019a;) impacts from light reduction are considered to be minimal. Dredging will predominantly occur on weekdays, allowing some recovery and a reduction in potential stress on marine flora through increased light availability (following the findings of Statton et al. 2017). Regardless, the relative impacts and subsequent management for protecting BCH has been assessed the context of EPA (2021) Technical Guidance: Environmental Impact Assessment of Marine Dredging Proposals.

6.2.1 Indirect impacts to benthic communities and habitats

The primary indirect impact of increased water column turbidity is the associated reduction in photosynthetically available light to benthic primary producers (Erftemeijer & Lewis 2006). Resulting impacts can be short or long-term in nature, depending on the period and intensity of shading. The capacity of seagrasses to cope with episodes of light deprivation from overlying turbid waters may not only depend on the absolute quantity of light they receive and the duration over which it is reduced, but also on how the light deprivation varies through time, for example, the temporal separation (frequency) of pulsed turbidity events (Statton et al. 2017). Seagrass initially responds to stress from light reduction through physiological adjustments, before responding through morphological adjustments like reduced leaf extension, shoot density or canopy height (Mackey et al 2007, Ralph 2007, Collier et al 2007, 2008, 2009, 2012a,b, Lavery et al. 2009, McMahon et al. 2011, 2013). A long, continuous period of low light is more detrimental to seagrasses than 'pulses' of lower light interspersed with high light levels, even if the total light received by the plant over the same period is consistent (Statton et al 2017).

Mapped seagrass communities near the dredge area consist of *Posidonia* spp. (primarily P. sinuosa) and *Amphibolis* spp. (primarily *A. griffithii*), and sand inundated reef platforms with macroalgae and mixed perennial seagrass (BMT 2018b). Therefore, these communities are potentially at risk of reduced light resulting from turbid plumes during dredging and disposal.

McMahon et al. (2011) studied light reduction for *A. griffithii* meadows in Jurien shaded for 3 months with full recovery after 300 days. Light requirements for *P. sinuosa*, have similar minimum light requirements to *A. griffithii*; however; a longer recovery period (Short et al. 2017).

Macroalgae species have a higher tolerance to decreased light availability (0.5–0.01% of surface light; Markanger & Sand-Jensen 1994) compared to seagrasses (2–24% for various *Posidonia* and *Amphibolis* spp.; Erftemeijer & Lewis 2006). The key 'environmental window' for temperate seagrasses and macroalgae species is between October and April, based on sensitive life history periods (Short et al. 2017). Therefore, this section only considers indirect impacts of increased water column turbidity on the dominant seagrass species (*P. sinuosa and A. griffithii*), as a conservative approach to protecting all benthic primary producers in the region.

Relationship between modelled total suspended solids and light attenuation coefficient

The relationship between the modelled TSS (Section 6.1) and LAC was determined by laboratory simulations completed by the Marine and Freshwater Research Laboratory using sediment and wrack samples collected from the Boat Harbour sediment sampling (BMT 2019a,b). A subset of Jurien Bay sediment samples JBBH_S1–JBBH_S15 were wet sieved to collect <180 µm fractions. These fractions are representative of composite fine sands and silts from across these sites.

Homogenous portions of the <180 µm sieved material were added to a 1000 L seawater tank mesocosm with a light source at the base - fitted with a diffuser, two logging photosynthetically active radiation (PAR) light sensors (0.5 m apart - 600 mm and 100 mm away from light source), two submersible pumps to produce a well-mixed simulated plume within the tank and a YSI logger to measure turbidity/Nephelometric Turbidity Units (NTU) during sequential additions of sediments. Following each sediment addition, the mixing was allowed to equilibrate and then triplicate TSS/NTU samples were collected from the tank water and NTU and PAR were logged.

A total of 10 samples in triplicate (total of 30) were collected sampled for TSS and NTU measurement. LAC was calculated from measured PAR data, and the correlation between LAC and TSS/NTU determined specific to the Jurien Bay sediments. These correlations are provided in Figure 6.1 and Figure 6.2 respectively. The strong correlation between both TSS and LAC (R2 = 0.98, Figure 6.1) and turbidity (R2 =0.98, Figure 6.2) suggest LAC can be determined from turbidity from modelled TSS.

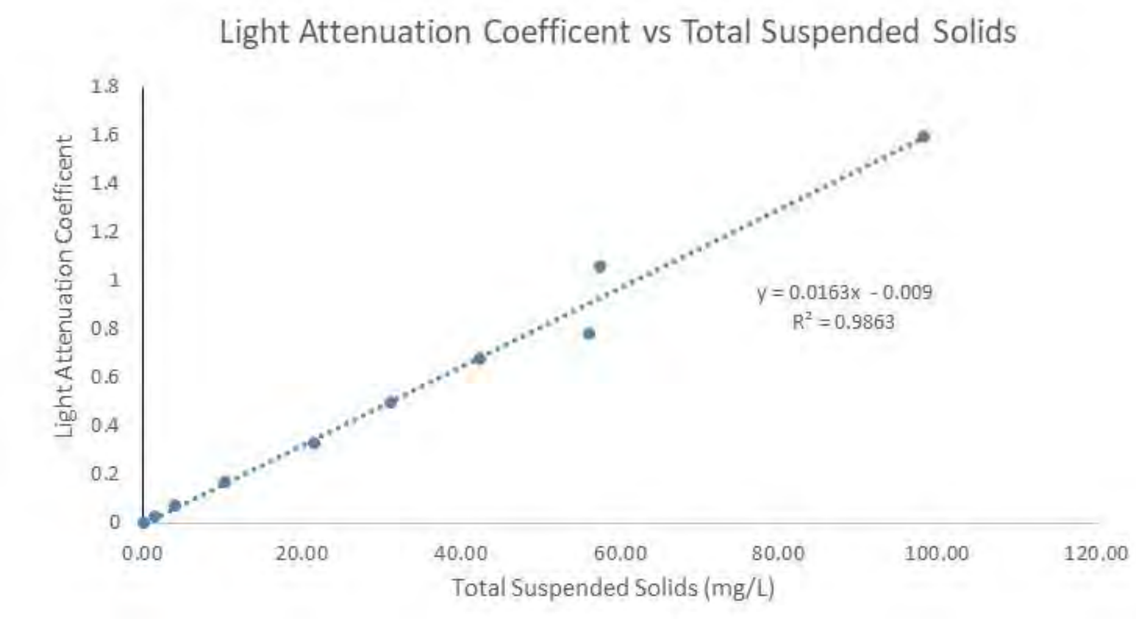


Figure 6.1 Total suspended solids correlation to light attenuation coefficient for Jurien Bay Boat Harbour sediment samples

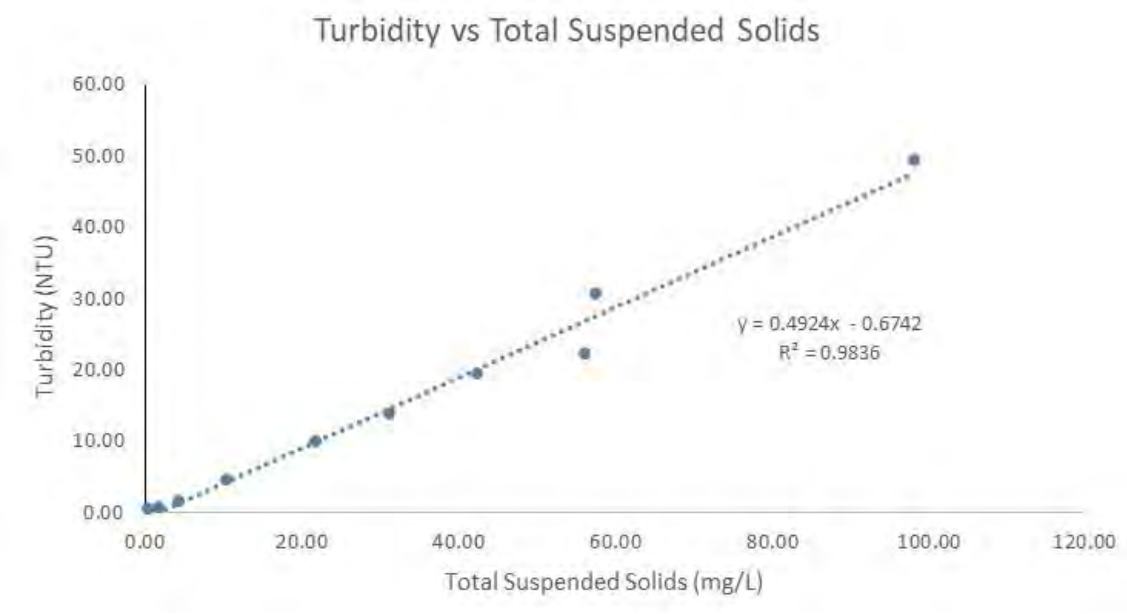


Figure 6.2 Total suspended solids correlation to turbidity for Jurien Bay Boat Harbour sediment samples

Seagrass light impact thresholds

The Cockburn Sound Management Council (CSMC) previously provided annual environmental quality criteria (EQC) for Light Attenuation Coefficient (LAC; CSMC 2018) to determine thresholds for seagrass protection. The CMSC (2018) EQC for LAC for high and moderate protection levels have been applied as the threshold values for potential impacts to seagrass in Jurien Bay (Table 6.1).

Table 6.1 Levels of protection and correlating light attenuation coefficient, total suspended solids and turbidity threshold criteria for Jurien Bay seagrass light assessment

Levels of protection	LAC[1]	Modelled TSS (mg/L)	Modelled Turbidity (NTU)
Moderate	0.114	7.89	3.05
High	0.096	6.80	2.50

Notes:

1. Data sourced from CSMC (2018)
2. LAC = light attenuation coefficient, TSS = total suspended solids, NTU = nephelometric turbidity units.

The CSMC (2018) values are considered applicable because data are current and from a similar environment to Jurien Bay (Warnbro Sound, ~250 km south). The data were also collated over a long time period and represent a robust spatial and temporal long-term dataset. The data collected as part of the McMahon and Lavery (2008) study were considered in the development of triggers; however, absence of baseline light data for the proposed disposal area meant that meaningful Hsat baseline data could not be calculated for the derivation of appropriate thresholds.

Modelled zones of protection for Jurien Bay were developed by comparing the LAC threshold criteria (Table 6.1) with TSS equivalents from the model. The zones were overlaid on mapped BCH (Figure 5.2) to show modelled potential impacts in relation to the offshore disposal area. These zones are demonstrated in Figure 6.2. The contours delineate the 95% confidence intervals for the relevant LAC/TSS threshold at CSMC (2018) EQC for high and moderate protection from Table 6.1. These zones were used to determine potential BCH loss from a reduction in light attenuation during disposal activities (refer Section 6.2.3).

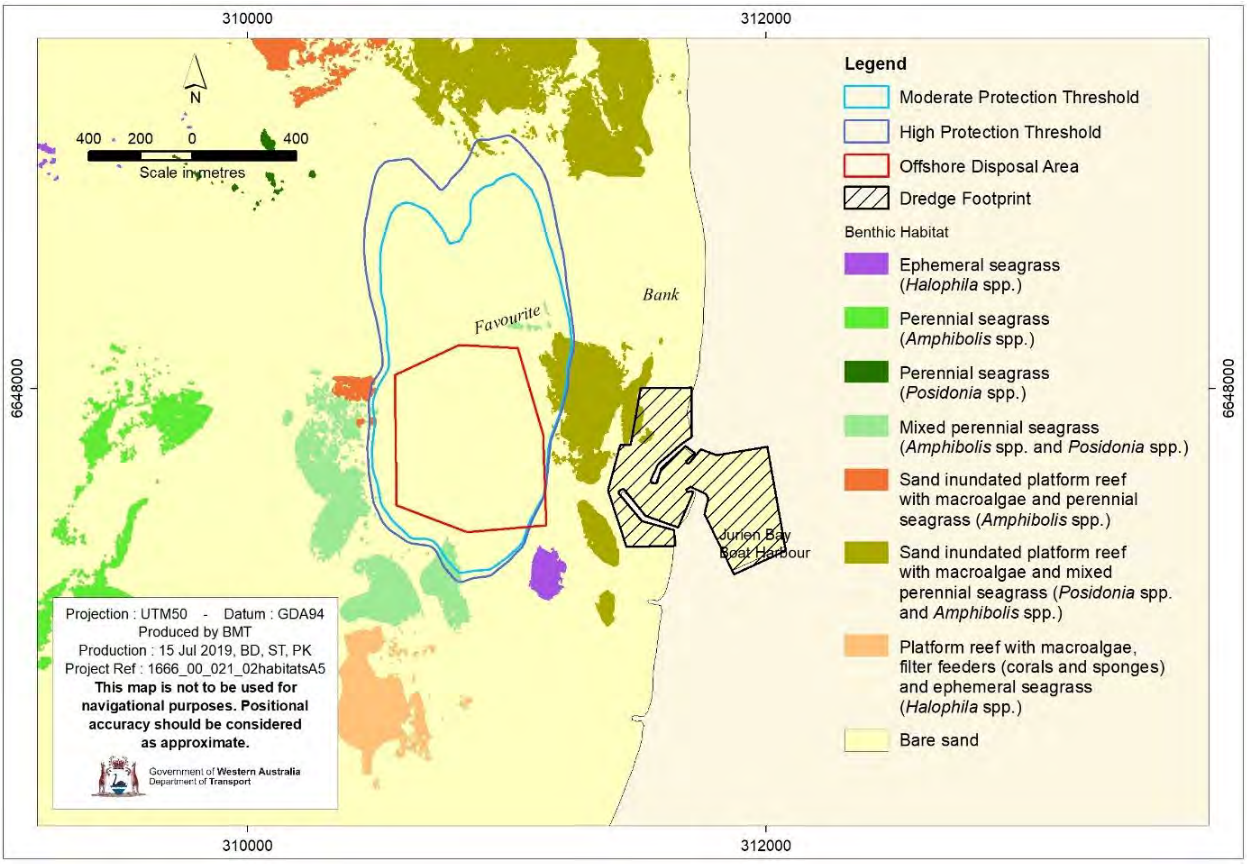


Figure 6.3 Modelled ecological protection zones based seagrass light impact thresholds

6.2.2 Direct impacts to benthic communities and habitats

Where configuration of the disposal pipeline is along the seafloor, the pipeline will be positioned such that BCH are avoided where practicable to minimise direct impacts to mapped BCHs (refer to Section 5.3.1). Where direct avoidance of BCH is not practicable, it is anticipated interaction of the pipeline with the seabed would be highly localised and temporarily sunk overlying the seabed through the weight of the slurry in the pipeline. The pipeline diameter is ~30 cm and the weight of the filled pipeline would be sufficient to minimise movement on the seafloor, and potential impacts of scouring are considered low. There will be no direct removal of mapped areas of benthic habitats within the dredge area (0.5 ha of sand inundated platform reef with macroalgae and mixed perennial seagrass [*Posidonia* spp. and *Amphibolis* spp.]; Section 5.3.1) as these areas will be actively avoided during dredging (Section 3.3). If direct removal of BCH is considered required, a NVCP will need to be obtained under Part V of the EP Act.

Sedimentation from disposal of dredged material was modelled (refer Annex A for details). Results demonstrated that sedimentation outside of the Offshore Disposal Area was limited, with nearby BCH experiencing at most 0.10–0.15 m of sedimentation from the disposal plume (Figure 6.3). The model showed a maximum sedimentation thickness of 0.60–0.65 m within the Offshore Disposal Area (Figure 6.3).

Given the low level of sedimentation modelled beyond the Offshore Disposal Area and high tolerance of seagrass species to sedimentation (Coupland 1997, Cabaco et al. 2008), significant permanent impacts are not anticipated. However, the anticipated area of seagrass impacted by sedimentation has been included in a cumulative loss assessment (Section 6.2.3).

Sediment infauna has been shown to be able to migrate through up to 30 cm of burial (Wilber & Clarke 2007). Given the level of sedimentation outside of the Offshore Disposal Area is anticipated to be less than 30 cm, impacts to infauna are not anticipated to be significant.

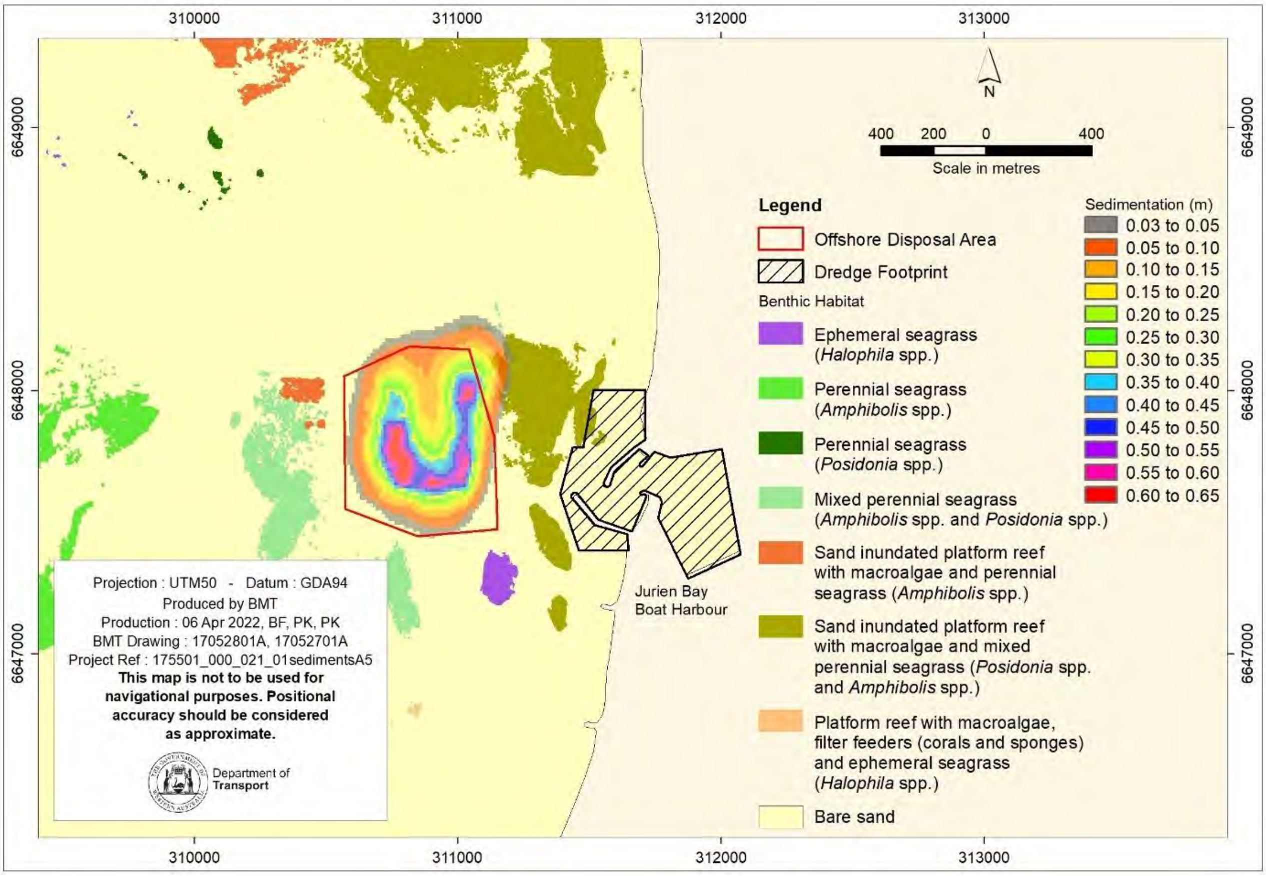


Figure 6.4 Modelled sedimentation thickness within the Offshore Disposal Area resulting from one maintenance campaign at Jurien Bay

Stability of sediment placed in the Offshore Disposal Area

The stability of dredged sediment placed within the Offshore Disposal Area was assessed over acute storm conditions which cover the main storm characteristics at Jurien Bay (including northerly, westerly and southerly winds, Annex A). Results demonstrated that the filled disposal area (filled to design level of -8 m CD) is anticipated to be stable under severe storm conditions from the range of directions with minimal resuspension of fine materials at the northern and southern boundaries of the disposal area (<0.1 mg/L).

The resuspension of the fine materials from the Offshore Disposal Area was minimal from storm activities. The model demonstrated the natural shallow areas in the vicinity of the offshore disposal area, including the sand bar and beaches in Jurien Bay would experience significantly higher bed shear stress when compared with the Offshore Disposal Area (filled to -8 m CD) and therefore are more prone to erosion and sediment mobility (compared with the filled offshore disposal area).

6.2.3 Cumulative impacts to benthic communities and habitats

Delineating zones of impact

Assessment of potential dredging impacts to BCH has been completed in-line with EPA (2021) guidance. To comply with this guidance, proponents must demonstrate impacts according to zones of potential habitat loss. The three zones (zone of high impact [ZoHI], zone of moderate impact [ZoMI] and zone of influence [ZoI]) are described in Table 6.2.

Table 6.2 Impact zone definitions

Zone	Definition
Zone of High Impact (ZoHI)	The area where serious damage to benthic communities is predicted or where impacts are considered to be irreversible. The term serious damage means 'damage to benthic communities and/or their habitats that is effectively irreversible or where any recovery, if possible, would be unlikely to occur for at least 5 years'. Areas within and immediately adjacent to proposed dredge and disposal sites are typically ZOHI
Zone of Moderate Impact (ZoMI)	The area within which predicted impacts on benthic organisms are sub-lethal, and/or the impacts are recoverable within a period of 5 years following completion of the dredging activities. This zone abuts, and lies immediately outside of, the ZOHI
Zone of Influence (ZoI)	The area within which changes in environmental quality associated with dredge plumes are predicted and anticipated during the dredging operations, but where these changes would not result in a detectible impact on benthic biota (e.g. a reduction in biomass).

Source: EPA (2021).

The following sections provide the rationale and justification for the conservative establishment of these zones for Jurien Bay, based on: (i) predictive modelling of the plume extent and intensity; and (ii) the tolerance of benthic biota.

Zones of impact have been determined for dredge and disposal areas for potential BCH loss assessment and during dredging monitoring (Table 6.3; Figure 6.4). The zones have been determined from the modelled LAC thresholds for seagrass (Figure 6.2) in relation to the boundaries of the dredge and disposal areas. A 50 m buffer has been applied to the dredge footprint to determine the ZoMI, based on the observed plume during previous campaigns (BMT Oceanica 2014c,d,e; BMT JFA 2015; BMT JFA 2017).

Given dredging will primarily occur within the Boat Harbour entrance and not near BCH (and that only small turbid plumes are generated by CSD in marine sands), there is a comparatively greater risk of potential impacts to BCH at the Offshore Disposal Area (where there is a point source of turbidity throughout maintenance campaigns). The ZoI boundary was defined as the edge of the discernible plume, where modelled TSS returns to <1 mg/L above background. No impacts to BCH are anticipated within the ZoI (EPA 2021); however; the boundary was used to determine appropriate placement of monitoring sites (Section 7.3.2).

Table 6.3 Zones of impact and correlating light attenuation coefficient, total suspended solids and turbidity

Impact zone	LAC[1]	Modelled TSS (mg/L)	Modelled Turbidity (NTU)
Zone of High Impact	0.114	7.89	3.05
Zone of Moderate Impact	0.096	6.80	2.50
Zone of Influence	n/d	1.00	n/d

Notes:

1. Data sourced from CSMC (2018).
2. LAC = light attenuation coefficient, TSS = total suspended solids, NTU = nephelometric turbidity units, n/d = not determined.

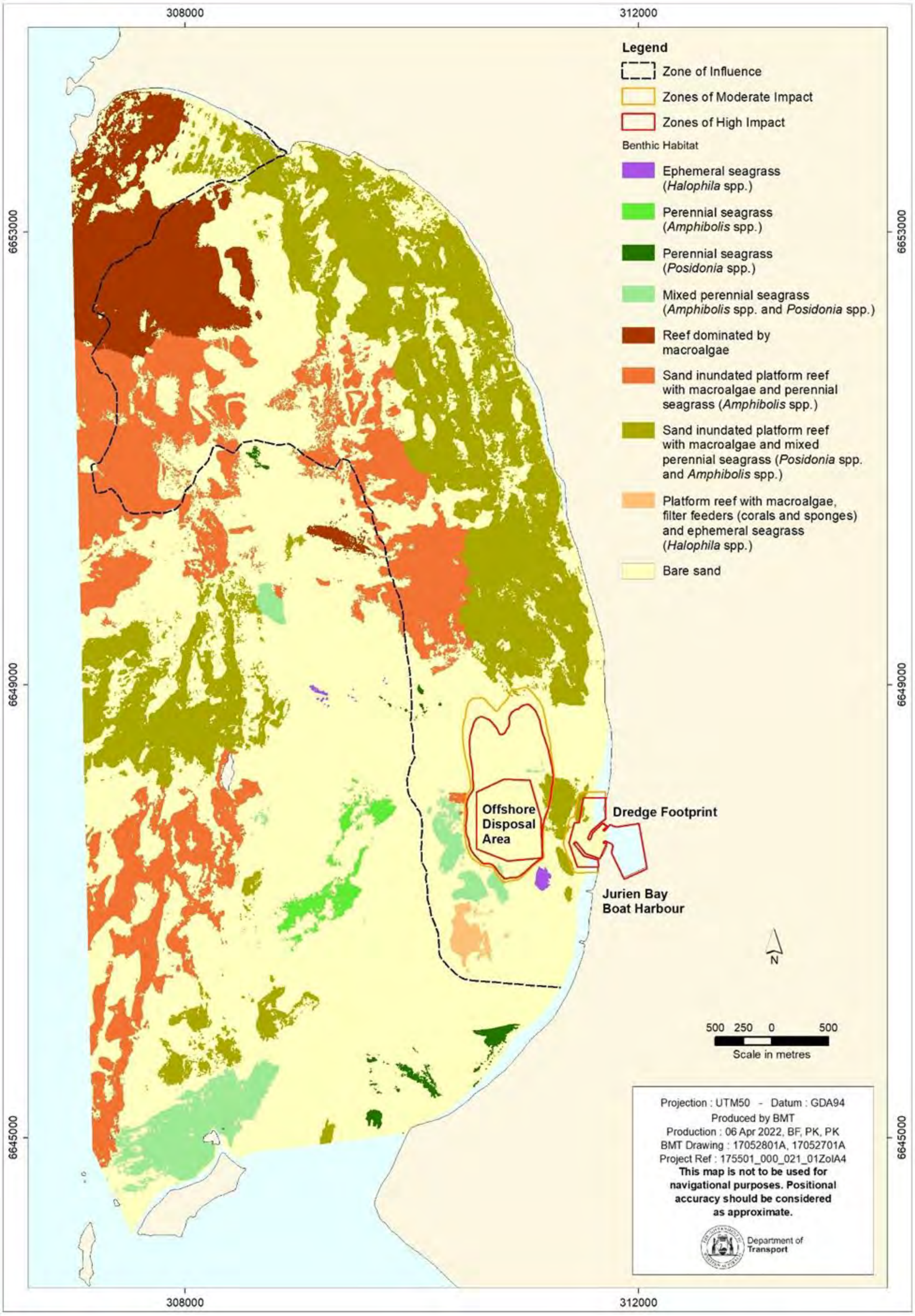


Figure 6.5 Zones of High and Moderate Impact and Zone of Influence for Jurien Bay maintenance dredging campaigns

Benthic community and habitat loss assessment

A loss assessment has been completed in the context of EPA's Technical Guidance – Environmental Impact Assessment of Marine Dredging Proposals (EPA 2021). The proportion of each habitat within the ZoHI (permanent loss) and ZoMI (recoverable loss) has been determined.

The entire area mapped in BMT (2018b) was used as a local assessment unit (LAU). This is considered suitable for an impact assessment in the context of EPA (2021) as the area mapped is similar to the recommended LAU size (37 km^2 compared to the recommended 50 km^2) and is representative of the local ecological environment and key processes. Given the presence of the JBMP and the lack of current infrastructure within the mapped area it is considered that the BCH mapped in BMT (2018b) is representative of pre-European settlement and is a suitable baseline for assessment of impacts to BCH in line with EPA (2021).

Habitat areas from within the ZoHI and ZoMI were conservatively combined for a cumulative loss assessment. This allows for an assessment of the unlikely outcome that habitats within the ZoMI do not recover between dredging campaigns. Bare sand presents the highest proportion of potential loss (5.6%, Table 6.4), followed by sand inundated platform reef (3.4%, Table 6.4) and perennial seagrass beds (1.2%, Table 6.4). Remaining habitat categories did not fall within the ZoHI or ZoMI (Table 6.4). Bare sand is unlikely to be 'lost' as dredge material being placed in the ZoHI will result in bare sand habitat (which will be available for re-colonisation), and bare sand within the ZoHI but outside the dredge or disposal areas is unlikely to be impacted by maintenance dredging campaigns.

It should also be noted that the LAU is less than the EPA (2021) suggested area, and should an entire 50 km^2 be mapped, it is likely that the proportion of potential habitat loss would be less than those reported in Table 6.4. The habitat with the largest proportion lost (Sand inundated platform reef with macroalgae and mixed perennial seagrass [*Posidonia* spp. and *Amphibolis* spp.] Table 6.4) is well represented throughout Jurien Bay (and the wider JBMP [CALM 2005]). Therefore, potential small-scale loss as a result of dredging and disposal activities is not anticipated to result in a significantly impact the ecological values of the JBMP as defined in the JBMPMP (CALM 2005).

Table 6.4 Anticipated cumulative permanent and temporary benthic habitat loss for Jurien Bay maintenance dredging campaigns

Benthic habitat type[2]	Area mapped[3]	Area of permanent loss (ZoHI)[3]	Area of recoverable loss (ZoMI)[3]	Total area impacted	Proportion of total mapped
Ephemeral seagrass (*Halophila* spp.)	2.6	0.0	0.0	0.0	0.0%
Perennial seagrass (*Amphibolis* spp.)	23.4	0.0	0.0	0.0	0.0%
Perennial seagrass (*Posidonia* spp.)	12.2	0.0	0.0	0.0	0.0%
Mixed perennial seagrass (*Amphibolis* spp. and *Posidonia* spp.)	94.5	0.8	0.4	1.1	1.2%
Reef dominated by macroalgae	222.1	0.0	0.0	0.0	0.0%
Sand inundated platform reef with macroalgae and	508.2	<0.1	0.2	0.2	<0.1%

Benthic habitat type[2]	Area mapped[3]	Area of permanent loss (ZoHI)[3]	Area of recoverable loss (ZoMI)[3]	Total area impacted	Proportion of total mapped
perennial seagrass (*Amphibolis* spp.)					
Sand inundated platform reef with macroalgae and mixed perennial seagrass (*Posidonia* spp. and *Amphibolis* spp.)	670.2	2.6	2.2	4.8	0.7%
Platform reef with macroalgae, filter feeders (corals and sponges) and ephemeral seagrass (*Halophila* spp.)	11.5	0.0	0.0	0.0	0.0%
Bare sand	2122.5	97.1	21.8	118.9	5.6%

Notes:

1. **'ZoHI' = Zone of High Impact; 'ZoMI' = Zone of Moderate Impact**
2. **Habitat types impacted within the ZoHI is predicted to be irreversible, habitat types impacted within the ZoMI are predicted to recover within two years following completion of dredging activities**
3. **All areas presented in hectares.**

To ensure that impacts to light attenuation are equivalent to those modelled and the ZoHI and ZoMI are appropriate, light will be monitored during dredging. Light monitoring and management requirements are given in Table 7.3, and methods provided in Section 7.3.2.

6.3 Marine and terrestrial environmental quality[3]

6.3.1 Hydrocarbon spills and waste

Various hydrocarbons will be used during maintenance dredging, including fuel, oil and lubricants for the maintenance dredging machinery. There is a subsequent potential risk of accidental hydrocarbon spills to the marine environment, negatively impacting all Boat Harbour users as well as marine flora and fauna. Rubbish and hazardous waste may also be generated, which can pollute the environment if not contained and removed from site. Hydrocarbon use and waste will be actively managed during the campaign, as outlined in Section 7.2.

6.3.2 Release of nutrients and contaminants

Nutrients

Dredge Area sediments sampled in May 2024 comprised elevated concentrations of elutriate nutrients (Section 4.3). Mean concentrations of elutriate TP, FRP and TN exceeded the relevant ANZECC/ARMCANZ (2000) default trigger values for physical and chemical stressors for south-west Australia slightly disturbed marine inshore ecosystems (Section 4.3). Consistently high concentrations of nutrients in marine environments (particularly in enclosed waters such as the Boat Harbour) may cause excess algal growth that can subsequently lead to reduced light penetration and oxygen in the water column. The mean concentration of elutriate NH_3 exceeded the relevant ANZG (2018) trigger value for toxicants for 99% species level of protection (Section 4.3) and was below the 95% species level of

[3] At the time of preparing BMT (2019a), the ANZG (2018) marine water quality guidelines were not available for application due to resolving issues/inconsistences on the website, and it was recommended to refer to the ANZECC/ARMCANZ (2000) marine water quality guidelines in the interim.

protection. Consistently high concentrations of ammonia in marine environments can be toxic to biota (ANZECC/ARMCANZ 2000).

Elevated concentrations of elutriate nutrients from Dredge Area sediments have been reported within the Boat Harbour since 2005 (Section 4.4) likely from the high proportion of decomposing wrack material within the sediments (some dredge area sediment samples contained up to 30% organic matter; BMT 2019a). In May and September 2018, the Boat Harbour was estimated to respectively contain ~916 tonnes and ~3297 tonnes (wet weight) of wrack material (dominated by *Amphibolis* spp.) covering ~34% (or ~4.7 ha) and ~39% (or ~5.5 ha) of the seafloor within the Boat Harbour (BMT 2018b). These findings were comparable to estimates by Oldham et al. (2017) for respective months in September 2016. The environmental impacts that have previously occurred from significant accumulations of wrack within the Boat Harbour are discussed in Section 6.3.3; any potential impacts to Boat Harbour water quality from the release of nutrients during dredging will be short-term and considered negligible compared to the long-term (chronic) impacts from reduced water quality that currently exist within the Boat Harbour from wrack accumulation.

It is noted that the ANZECC/ARMCANZ (2000) are environmental guidelines and should not be applied directly to effluent concentrations from laboratory samples, rather dilution must be considered within the receiving environment. In accordance with NAGD (CA 2009), the relevant ANZECC/ARMCANZ (2000) marine water quality trigger values should not be exceeded after allowing for initial dilution, defined as 'that mixing that occurs within four hours of dumping'. Given that elutriate tests use a dilution of 1:4, wet sediment: added seawater, water quality impacts are greatly overestimated by the order of a hundred times or more (and often much more) compared to what would be expected after the four-hour mixing period (CA 2009).

As per the NAGD (CA 2009), the elutriate nutrient data was scaled to account for initial dilution at the discharge area for appropriate assessment against the relevant ANZECC/ARMCANZ (2000) marine water quality trigger values (Table 6.5). The elutriate nutrient data was first converted to a dilution of 1:9 (wet sediment: added seawater), which provides a better representation of the concentrations likely to be present in the average dredge slurry (Table 6.5). Following guidance from the NAGD (CA 2009), initial dilution was then approximated as: 'the liquid and suspended particulate phases of the waste may be assumed to be evenly distributed after four hours over a column of water bounded on the surface by the release zone and extending to the ocean floor, thermocline or halocline, if one exists, or to a depth of 20 m, whichever is shallower' (for the Offshore Disposal Area a release zone of 36 ha and a depth of 12 m applied; Table 6.5). However, an accurate remaining volume of the Offshore Disposal Area following disposal of dredged material from 2021 and 2023 maintenance dredging campaigns was calculated from the most recent hydrographic survey (July 2023), which was used for elutriation calculations (3,976,682 m^3; Table 6.5). The volume of material to be discharged over the four-hour period was based on a dredging production rate of 105 m^3/hour (this is the average dredging production rate of previous Boat Harbour maintenance dredging campaigns; BMT JFA [2017]; BMT JFA [2015]). The resultant concentrations of elutriate nutrients were well below the relevant ANZECC/ARMCANZ (2000) marine water quality trigger values (Table 6.5); therefore, potential impacts from the release of nutrients at the Offshore Disposal Area is anticipated to be negligible.

Since water circulation and movement within the shallow and partially-enclosed Boat Harbour basin would be limited compared to receiving environment at the Offshore Disposal Area located in deeper open ocean, there is a higher likelihood of potential nutrient related impacts occurring in this area during maintenance dredging.

While it was considered unlikely that the potential release of nutrients during dredging and disposal would cause a significant environmental impact, given the location of the Boat Harbour is near the JBMP and that the Offshore Disposal Area is located within the JBMP, initial monitoring measures were implemented during the first maintenance campaign (BMT 2021). Water quality monitoring was completed on two occasions during dredging, and the results were compliant with the management trigger on both monitoring occasions (BMT 2021). Potential impacts from release of nutrients during dredging and disposal is considered unlikely to cause a significant environmental impact based on monitoring results and water quality monitoring during dredging following the 2021 campaign was discontinued. If routine sediment sampling results show nutrients concentrations are significantly higher than historical concentrations recorded in the Boat Harbour and exceed relevant guidelines, the requirement to reinstate water quality monitoring during maintenance dredging will be assessed. Elutriate nutrient concentrations from the 2024 sampling were not significantly higher than sampling completed in 2019 (BMT 2019a, 2024).

Contaminants

Concentrations of total metals and hydrocarbons in dredge and disposal area sediments sampled in May 2024 were below relevant NAGD (CA 2009) Screening Levels (Section 4.3) indicating that sediments were suitable for unconfined ocean disposal. Samples from April 2019 were elutriated for metals concentrations to determine the potential release of metals in the water column within the JBMP during disposal. Mean concentrations of elutriate metals (specifically for copper and zinc) in dredge area sediments, exceeded the relevant ANZECC/ARMCANZ (2000) trigger values for toxicants at the 99% species levels of protection (Section 4.3). After scaling the elutriate metal data to account for initial dilution at the Offshore Disposal Area, concentrations of elutriate metals were well below the relevant ANZECC/ARMCANZ (2000) trigger values for toxicants at the 99% species level of protection. While potential impacts associated with the release of contaminants during disposal was anticipated to be negligible, initial water quality monitoring was completed on two occasions during the 2020/21 maintenance dredging campaign to measure realised potential impacts (Section 6.3.2; BMT 2021). The results of this monitoring were compliant with the management trigger on both monitoring occasions (BMT 2021). Potential release of contaminants during dredging and disposal is considered unlikely to cause significant environmental impact, based on monitoring results and water quality monitoring during dredging for subsequent campaigns will be discontinued. If routine sediment sampling results show potential contaminant concentrations are significantly higher than historical concentrations recorded in the Boat Harbour and exceed relevant guidelines, the requirement to reinstate water quality monitoring during maintenance dredging will be assessed. Metal concentrations did not exceed relevant NAGD Screening Levels (CA 2009) and dredge material is considered suitable for offshore disposal (BMT 2024).

Table 6.5 Concentrations of elutriate nutrients of sediment samples from Jurien Bay Boat Harbour dredge area scaled to account for initial dilution at the Offshore Disposal Area for assessment against the relevant ANZECC/ARMCANZ (2000) and ANZG (2018) marine water quality trigger values

Analyte	Elutriate nutrients (µg/L)							
	TP	FRP	TN	NO_x	NH_3	Nitrite	Nitrate	TKN
Default trigger values for south-west Australia marine inshore waters[2]	20	5	230	5	5	–	4	–
90% species level of protection					1200			
99% species level of protection[3]	–	–	–	–	500	–	–	–
Concentrations of elutriate nutrients from Dredge Area sediments (assuming dilution of 1:4 wet sediment: added seawater)[4]								
Mean[7]	186.0	44.6	1195.8	nd	904.7	nd	nd	1195.8
Max	1005.0	100.0	2900.0	nd	1730.0	nd	nd	2900.0
Concentrations of elutriate nutrients from Dredge Area sediments (assuming dilution of 1:9 wet sediment: added seawater)[5]								
Mean[7]	82.7	19.8	531.5	nd	402.1	nd	nd	531.5
Max	446.7	44.4	1288.9	nd	768.9	nd	nd	1288.9
Concentrations of elutriate nutrients from Dredge Area sediments (assuming dilution of 1:9 wet sediment: added seawater and an even distribution of concentrations within the limits of the Offshore Disposal Area from a dredging production rate of 105 m^3/hour and a four hour discharge period)[6]								
Mean[7]	<0.1	<0.1	<0.1	nd	<0.1	nd	nd	<0.1
Max	<0.1	<0.1	0.1	nd	<0.1	nd	nd	0.1

Notes:

1. 'TP' = total phosphorus; 'FRP' = filterable reactive phosphorus; 'TN' = total nitrogen; 'NOx' = nitrate+nitrite; 'NH3' = ammonia; TKN' = total kjeldahl nitrogen; '–' = no guideline value available; 'nd' = statistic not determined because the dataset contains >25% of values below the laboratory limit of reporting
2. ANZECC/ARMCANZ (2000) default trigger values for physical and chemical stressors applicable to south-west Australia for slightly disturbed marine inshore ecosystems
3. ANZG (2018) trigger values for toxicants at the 99% (applicable to offshore disposal area) species level of protection
4. DGVs for PC stressors were derived from ANZG (2018) Integrated Marine and Coastal Regionalisation of Australia (IMCRA) mesoscale bioregion surface water Central West Coast (Autumn; 80th percentile DGVs in µmol/L converted to µg/L); ANZECC/ARMCANZ (2000) DGVs for PC stressor for South-West Australian marine inshore waters, i.e., coastal lagoons (excluding estuaries), embayments, and water less than 20 metres deep for ammonia, NOx, TN and TP
4. Dilution of 1:4 wet sediment: added seawater is the concentration the laboratory used to undertake the elutriate testing
5. Dilution of 1:9 wet sediment: added seawater provides a better representation of the concentrations likely to be present in the average dredge slurry
6. Concentrations were scaled in accordance with guidance from the NAGD (CA 2009).
7. Where data was below the laboratory limit of reporting half of the value was used to calculate the mean value

8. **Red text indicates exceedance of the relevant ANZECC/ARMCANZ (2000) or ANZG (2018) marine water quality trigger value.**

6.3.3 Hypoxia

Hypoxia is the condition in which dissolved oxygen (DO) is below the level necessary to sustain most animal life (CENR 2000). If large amounts of organic material are released into the water column at the dredging or disposal areas, bacterial decomposition of this material could deplete oxygen levels and lead to hypoxia.

The Boat Harbour has a history of accumulating substantial amounts of wrack, shed from offshore seagrass beds and transported into the Boat Harbour during north-westerly storms. The accumulation and subsequent decomposition of wrack that is unable to naturally flush out of the Boat Harbour causes hypoxic conditions to occur within the Boat Harbour basin. In October 2013 and November 2014, hypoxic conditions in the Boat Harbour basin coincided with fish kill events. Emergency and pre-emptive wrack trawling campaigns have previously been undertaken as a management solution to improve the water quality within the Boat Harbour basin (Section 1.3).

During previous maintenance dredging campaigns, monitoring of DO within the water column of the Boat Harbour basin has been undertaken (BMT JFA 2015, BMT JFA 2017). During the monitoring, highly variable DO levels were recorded that ranged from 0–122% (BMT JFA 2015, BMT JFA 2017). Despite periods where very low levels of DO were recorded within the Boat Harbour basin during previous maintenance dredging campaigns, this was not considered of concern since the DO levels were within the range of those known to occur during periods where no maintenance dredging is occurring (from the high amount of decomposing wrack in the Boat Harbour) and no adverse environmental impacts were observed (i.e. fish kill events; BMT JFA 2015, BMT JFA 2017).

Dredge area sediments sampled in April 2019 and May 2024 comprised considerable portions of organic material (up to 30%; BMT 2019a, BMT 2024b); therefore, maintenance dredging may potentially contribute to hypoxia within the Boat Harbour basin, in the short-term, when the organic material is released into the water column. The benefit of periodic maintenance dredging that removes accumulated wrack from the Boat Harbour basin to enable improvement to water quality in the long-term is considered to outweigh any potential short-term negative impacts. At the offshore disposal area, dilution in the receiving environment is anticipated to be sufficient for the potential impact of hypoxia to be considered low risk.

Active monitoring measures for indicators of hypoxia related impacts (i.e. localised fish kills) will be implemented during maintenance dredging campaigns as outlined in Section 7.3.

6.3.4 Introduced marine species

The arrival of machinery at the dredging and disposal areas may potentially introduce non-native introduced marine species (IMS) from other areas, thereby disrupting the local ecosystem. IMS may be transported between sites within ballast water and on vessel hulls (i.e. biofouling). However, the risk of transferring IMS to the JBMP during maintenance dredging campaigns is considered negligible because:

- The dredge to be used during the campaign has no ballast water.
- The vessel hull has an anti-foul coating, and prior to mobilisation, the dredge and pipes will be cleaned to ensure that no water or sediment remains when loading the vessel onto the trailer for transport.
- The vessel be dry docked and travelling via road to Jurien Bay.

In consideration of the above, no active management associated with introduced with marine species is required. Should the dredge or associated support vessels be sourced from outside WA, from a port with known introduced marine pests, or not conform to the justification above, management will be required, as detailed in Section 7.2.

6.3.5 Vegetation disturbance/removal

No native vegetation is anticipated to be directly removed or cleared during ongoing maintenance dredging campaigns. However, if vegetation disturbance or removal is required, an application for a NVCP or Native Vegetation Clearing Referral will be prepared and submitted for approval.

6.4 Marine fauna

6.4.1 Marina fauna collision and/or entanglement

There is a potential risk of marina fauna collision and/or entanglement from the presence of vessels, equipment and machinery during Boat Harbour maintenance dredging campaigns. Potential impacts of marine fauna collision and/or entanglement incidences may include death, injury, adverse behavioural and physiological changes, and reduced body condition and/or immune function to individual fauna. Active monitoring and management measures will be implemented during maintenance dredging campaigns, outlined Section 7.2, to minimise the risk of potential marina fauna collision and entanglement incidences.

Approximately 90% pipeline will be submerged onto the seafloor except for ~40 m at each end where the pipe connects to the dredge or is suspended below the water surface by the disposal buoy. This configuration substantially reduces the risk of marine fauna colliding with the disposal pipeline.

6.4.2 Environmental impact of noise

Noise generated by dredging has the potential to disturb marine fauna, causing temporary or long-term avoidance of an area that may be important for feeding, reproduction or sheltering. Underwater sounds may interfere with communication systems of fish and marine mammals, masking important biological cues or causing behavioural disturbance (Richardson et al. 1995, National Research Council 2005, Southall et al. 2007). Intense underwater sounds in close proximity to marine fauna may cause temporary or permanent hearing damage or death (Southall et al. 2007). These impacts may affect critical behaviours and functions, such as feeding, migration, breeding and response to predators, all of which may ultimately affect an individual animal's survival (National Research Council 2005). Depending on the duration and intensity of underwater noise, an animal may avoid the source of the disturbance completely, thereby altering the overall use and ecology of that marine environment.

The Boat Harbour is not an important area for feeding, reproduction or sheltering by marine mammals. It is unlikely that marine mammals close to the Boat Harbour will be significantly impacted by the low-frequency sounds generated from maintenance dredging. Bottlenose dolphins have hearing thresholds that are most sensitive to higher frequencies (Southall et al. 2007), and no hearing information exists for Australian sea lions or the larger baleen whales (such as blue or humpback whales). Therefore, based on known hearing sensitivities and the temporary duration of maintenance dredging campaigns, it is unlikely that the underwater noise will have a significant impact on any marine fauna likely to be in the area.

6.4.3 Impacts to protected fauna and other fauna of significance

Consideration of the 'significant impact criteria' (Table 6.6) for critically endangered and endangered species, defined under the EPBC Act Significant Impact Guidelines 1.1, was conservatively applied to risk assess potential impacts from maintenance dredging campaigns to protected fauna (Section 5.3.2) and other fauna of significance (Section 5.3.4) likely to occur in the vicinity of the Boat Harbour. The outcome of the assessment indicates there is a low risk of maintenance dredging campaigns impacting on protected fauna and other fauna of significance (Table 6.6). The Project is therefore not considered significant to warrant referral or assessment under the EPBC Act.

Table 6.6 Assessment of significant impact criteria for critically endangered and endangered species

Criteria	Significant impact criteria	Risk	Notes
1	Lead to a long-term decrease in the size of a population	Low	Maintenance dredging campaigns are small scale and short-term in duration (Section 2.1). There is a low risk of maintenance dredging campaigns disrupting the breeding cycle of a population (refer to notes for significant impact criteria #3). There is a low risk of maintenance dredging campaigns adversely affecting BCH (refer to notes for significant impact criteria #4). There is a low risk of maintenance dredging campaigns introducing IMS or disease to the Project area (refer to notes for significant impact criteria #7 and #8). Dredge Area sediments are characterised by relatively clean marine sands that present a low environmental risk of introducing stressors or toxicants into the environmental at levels harmful to marine flora/fauna (Section 4.3 and 6.3.2). Monitoring and management measures are in place to minimise the risk of potential marina fauna collision and entanglement incidences (Table 7.3
2	Fragment an existing population into two or more populations	Low	As above (refer to notes for significant impact criteria #1).
3	Disrupt the breeding cycle of a population	Low	There are no documented critical breeding, nesting or spawning areas for threatened fauna or other fauna of significance in the Project area (Sections 5.3.2 and 5.3.4)
4	Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Low	The potential impact of maintenance dredging campaigns causing direct and indirect impacts to BCH has been risk assessed in Section 6.2 and it is considered to not be ecologically significant. Disposal of dredged sediments to the proposed Offshore Disposal Area is anticipated to result accretion of up to ~70 cm per campaign within the disposal area, and ~1-3 cm immediately adjacent to the Offshore Disposal Area (Section 6.2.2). Monitoring of the dredge and disposal position will be completed during maintenance dredging campaigns to ensure operations remain restricted to the approved areas (Section 7.3.1). Sub-sea light loggers will be deployed to monitor light-attenuation during maintenance dredging campaigns (Section 7.3.2). Ongoing turbidity monitoring will be undertaken during maintenance dredging campaigns (Section 7.3.2)
5	Adversely affect habitat critical to the survival of a species	Low	As above (refer to notes for significant impact criteria #4).

Criteria	Significant impact criteria	Risk	Notes
6	Reduce the area of occupancy of the species	Low	As above (refer to notes for significant impact criteria #4).
7	Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	Low	The potential impact of maintenance dredging campaigns introducing IMS to the Project area has been risk assessed in Section 6.3.4 and is considered negligible. Management measures are in place to ensure no IMS are introduced to JBMP (Table 7.3).
8	Introduce disease that may cause the species to decline	Low	The risk of non-native species being introduced to the Project area from maintenance dredging campaigns is considered negligible (Section 6.3.4); therefore, the potential risk of introducing disease to the Project area via this pathway is also considered negligible. It is considered that there are no other significant pathways for disease to be transferred to the Project area from maintenance dredging campaigns.
9	Interfere with the recovery of the species.	Low	The Project area does not feature in action recovery plans for critically endangered or endangered species (DBCA 2018; CA 2015; DSEWPaC 2011; DSEWPaC 2012d).

6.5 Coastal processes

Maintenance dredging campaigns are not anticipated to impact on the coastal processes of Jurien Bay. The Offshore Disposal Area is anticipated to be retentive (Annex A), therefore, sand is not expected to migrate back onshore. Dredging of the beach to the north and south of the Boat Harbour breakwater will, at worse, return the shoreline toward pre-construction alignment. It is anticipated that the dredged area will then naturally infill as sediment moves north and south toward the Boat Harbour, as has taken place following previous maintenance dredging campaigns at the Boat Harbour. Therefore, impacts to coastal processes are not anticipated to require monitoring or management.

6.6 Social surroundings

6.6.1 Public safety, visual amenity and beach access

The Boat Harbour is widely utilised for recreational boating, fishing, swimming and other recreational activities. The operation of heavy machinery within the Boat Harbour during dredging will temporarily impact visual amenity and pose a short-term risk to public safety when accessing the Boat Harbour and groynes (used for recreational fishing). Any short-term negative impacts of the dredging campaign to public amenity are likely outweighed by the long-term improvement in access to the Boat Harbour as a result of the dredging. The dredging is not expected to have an adverse impact on recreational users of the Boat Harbour since the impact on users and public safety shall be limited due to:

- minimised where possible with no dredging occurring over public holiday periods and weekends
- fencing and public information signs will be installed on site
- pipeline lay-down areas will be specifically designated and sign-posted to preserve public safety.

Nevertheless, public safety, visual amenity and beach access will be actively managed during campaigns (Section 7.2).

There may be some impact on commercial operators that intake water from the Boat Harbour for live lobster holding tanks. However, the potential negative impacts of maintenance dredging campaigns are outweighed by the long-term improvement to the overall harbour amenity as a result of dredging. Maintenance dredging is not expected to have any impact on recreational users of the southern inner beach. The impact on harbour users and public safety will be limited because:

- The duration of the dredging campaign will be minimised where possible and no dredging will occur over the Christmas holiday period. Dredging will occur Monday to Saturday (inclusive, unless prior approval is obtained)
- The material to be dredged will be relatively clean marine sediments with no aesthetic or health concerns to the public
- The level of conflict between Boat Harbour and beach users and maintenance operations has been manageable to date.

The dredging is considered to pose a medium risk level to public safety and harbour amenity at the Boat Harbour, and a low risk level at the Offshore Disposal Area. The impact of dredging on public safety and harbour amenity at both sites will be actively managed, as outlined in Section 7.2.

6.6.2 Navigational hazards

The Boat Harbour is primarily utilised by recreational vessels. Maintenance dredging operations may pose a navigational hazard to vessels as the dredge has no self-propulsion (using only anchors and spuds to move). The discharge pipeline is typically submerged onto the seabed, with the exception of short end-sections of floating pipeline at the dredge and discharge end. The dredge and pipelines will be clearly visible on the water surface during the day and both the dredge and floating pipeline sections are illuminated at night. The dredge will maintain a navigable channel, and vessel access through the entrance channel will be monitored where practicable throughout the dredging works. A TNTM will be issued to inform the public of navigational hazards associated with maintenance dredging. Boat Harbour maintenance dredging campaigns are not anticipated to impact navigational use; however, marine safety will require management throughout dredging operations

6.6.3 Social impact of noise

Residential areas are usually considered to be the most sensitive receptors to noise, whereas commercial and recreational areas are considered to be less sensitive. Several residential properties are located on the southern side of the Boat Harbour (~200–500 m away from the dredge area). Vessels launch, land and motor through the Boat Harbour on a daily basis, thus creating a high level of ambient noise already in the area.

The short-term period of the dredging campaign will restrict noise exposure to a short-term and temporary duration. Previous dredging and trawling campaigns have not received noise complaints from the community around the Boat Harbour. Therefore, it is unlikely that noise generated by dredging will significantly impact local residents. In addition, measures to further limit the social impact of noise will be outlined in Section 7.2, along with contingency measures should public complaints be received.

6.6.4 Heritage

Aboriginal heritage

A search of Department of Planning, Lands and Heritage (DPLH) Aboriginal Cultural Heritage Inquiry System shows no Registered, Lodged or Historic Aboriginal Heritage Sites within the dredge or disposal areas (DPLH 2024).

An Activity Notice pursuant to Clause 8.2 of the NSHA for the maintenance dredging campaigns was submitted to SWALSC as the Yued Body Corporate on 15 August 2019, and updated and resubmitted 22 October 2020 (Section 3.4). Following assessment, SWALSC advised an Aboriginal archaeological and ethnographic Site Identification heritage survey of the Onshore Disposal Area and equipment laydown areas was required to assess potential impacts to Aboriginal heritage. A survey was undertaken 23 February 2021 and no existing Aboriginal archaeological sites or artefacts were identified in the areas; however, a potential Aboriginal cultural site was identified within the north-eastern corner of the Onshore Disposal Area (Archae-aus 2021). The site was lodged as an Other Heritage Place for review by the Aboriginal Cultural Material Committee (DPLH 2021) for assessment as an Aboriginal Site under the *Aboriginal Heritage Act 1972*. The site was excised from the Onshore Disposal Area (with a 30 m buffer) for direct avoidance should onshore disposal is required in future campaigns (Archae-aus 2021).

European heritage

A search of the Heritage Council State Heritage Office inHerit database revealed no European Heritage sites that would be impacted by proposed dredging or disposal works (GWA 2024).

A search of DCCEEW's Underwater Cultural Heritage Database showed no heritage sites within the vicinity of Jurien Bay (DCCEEW 2024).

A search of the WA Museum Shipwreck database showed one shipwreck in the vicinity of Jurien Bay (WA Museum 2024). The "Lubra" is located ~3 km southwest of the Offshore Disposal Area and interaction with the dredge or disposal activities is not anticipated.

7 Management Measure and Contingencies

7.1 Roles and responsibilities

The roles and responsibilities for the implementation of the commitments outline in the LTMMP (this document) are summarised in Table 7.1.

Table 7.1 Roles and responsibilities

Role	Responsibility
Proponent (DoT) and Proponents Representative (BMT)	Contract holder and ultimately responsible for all aspects of the Project Responsibility for the implementation of LTMMP Responsible for reporting any HSEQ incidents as a result of the Project Ensure clear communication of Project milestones to relevant stakeholders
Environmental Representative (BMT)	Prepares and implements a Sampling and Analysis Plan in accordance with the requirements of this LTMMP Complete required environmental management and monitoring commitments of this LTMMP Ensures adequate training for employees carrying out the requirements of this LTMMP Prepares environmental monitoring/compliance reports Provides environmental advice, as required
Dredging Contractor (Contractor)	Ensures employees are adequately trained in-line with the requirements of this LTMMP Complete required environmental management and monitoring commitments of this LTMMP Report any HSEQ incidents to DoT/BMT within 24 hours Ensure all equipment is in good working order Implement management and monitoring
All personnel involved with the Project	Comply with all contract requirements including implementation of LTMMP and supporting documentation requirements Adequately trained to perform the task at hand Report any HSEQ incidents as soon as practical

Notes:

1. 'LTMMP' = Long Term Monitoring and Management Plan; 'HSEQ' = Health, Safety, Environment and Quality

7.2 Management strategies and actions

Management objectives and management targets for each environmental factor (EPA 2023) are provided in Table 7.2. These objectives and targets have been adapted from CALM (2005) to ensure the values of the JBMP are maintained throughout maintenance dredging campaigns. These objectives and targets will be met through environmental management and monitoring actions, and triggers for response, as outlined in Table 7.3. Where required, methods for monitoring potential impacts are provided in Section 7.3.

Table 7.2 Management objectives and targets for the Jurien Bay Boat Harbour maintenance dredging campaigns

Environmental Factor[1]	Management Objective[2]	Management Target[2]
Benthic communities and habitats	To ensure seagrass meadows in the JBMP are not permanently damaged	No permanent loss of perennial seagrass meadows from dredging and disposal activities
	To develop an increased understanding of the distribution and diversity of macroalgal habitats in the marine park	No reduction in macroalgal species diversity or macroalgal habitat as a result of human activities in the JBMP.
Marine and terrestrial environmental quality	To ensure the water and sediment quality of the marine park is not significantly impacted by the input of contaminants.	No change from background levels, unless approved by the appropriate government regulatory authorities.
Marine fauna	To ensure that human activity does not significantly disturb marine fauna populations in the JBMP	No significant disturbance to mammal, pinniped, seabird and turtle populations in the JBMP from human activities.
Social surroundings	To ensure social surroundings (Aboriginal and European heritage, public amenity) are not significantly interrupted by dredging and disposal activities	Maintenance of public access and amenity to beached and the Boat Harbour. No impact to Aboriginal or European heritage sites

Notes:

1. EPA (2023)
2. Adapted from CALM (2005)

Table 7.3 Summary of environmental management commitments for the Jurien Bay Boat Harbour maintenance dredging campaigns

Factor	Potential Impact	Monitoring				Management Trigger	Management			
		Action	Responsibility	Timing/ Frequency	Evidence		Action	Responsibility	Timing/ Frequency	Evidence
Benthic communities and habitats	Direct loss or burial of subtidal benthic habitats outside of defined dredge area	Dredge position monitoring to ensure no dredging outside of proposed design footprint (Section 7.3.1)	BMT	During dredging	Positional data from an independent GPS logger affixed to dredge	Recorded position outside of approved dredge area while dredging (checked weekly)	Inform Contractor immediately Move dredge back to inside approved dredge area boundary	BMT Contractor	As required	Summarised in weekly progress reports
		Placement of disposal pipeline end no closer than 20 m from the Offshore Disposal Area boundary (Section 7.3.1)	Contractor		Position of disposal pipeline end at each re-location recorded on daily reports	Recorded position outside of approved disposal area boundary (checked weekly)	Inform Contractor immediately Move disposal pipeline end back to inside approved disposal area boundary	BMT Contractor		
		Placement of disposal pipeline in areas devoid of mapped benthic primary producer habitat where practicable	Contractor		BMT to provide Contractor with the spatial data of the mapped benthic primary producer habitats for their reference during configuration of disposal pipeline	Disposal pipeline unsecured and observed over an extensive area of mapped benthic primary producer habitat	Move disposal pipeline to area devoid of mapped benthic primary producer habitat, where possible	Contractor		
	Indirect loss of benthic habitats	Plume sketches (Section 7.3.2)	Contractor	On every working day during dredging	Plume sketches sent to BMT weekly	Plume sketch records visible turbid plume outside of the ZoI	BMT to discuss in consultation with Contractor revising dredging and/or disposal methods and/or locations to manage excessive visible turbid plume extent Contractor to implement measures to manage excessive visible turbid plume extent	BMT Contractor		
		Site photographs (Section 7.3.2)			Site photographs sent to BMT weekly	Site photograph verifies record of visible turbid plume outside the ZoI in plume sketch				
		Remote imagery (Section 7.3.2)	BMT	During dredging	One low resolution image will automatically be sent to BMT daily and high-resolution images will be downloaded after campaign completion	Remote imagery verifies record of visible turbid plume outside the ZoI in plume sketch				
		Drone aerial photography (Section 7.3.2)		Monthly during dredging	Drone aerial photography	Georeferenced image shows visible turbid plume outside of the ZoI	BMT to discuss in consultation with Contractor revising dredging and/or disposal methods and/or locations to manage excessive visible turbid plume extent Contractor to implement measures to manage excessive visible turbid plume extent	BMT Contractor		
						Georeferenced image shows dredge outside of approved dredge area during dredging or disposal pipeline end outside of approved disposal area during disposal	Inform Contractor immediately Move dredge back to inside approved dredge area boundary or disposal pipeline end back to inside approved disposal area boundary	BMT Contractor		
		Sub-sea light logging at impact sites located on the outer boundaries of the ZoHI and ZoMI and at reference sites located outside of the ZoI (Section 7.3.2)	BMT	During dredging	Loggers serviced with data downloaded at ~6 week intervals Results reported in the relevant weekly progress report(s)	Median impact site LAC exceeds the relevant impact zone boundary LAC threshold defined in Table 6.3 and the 80^{th} percentile of the reference sites	Inform DBCA of the management trigger exceedance Modify dredging/disposal method to reduce turbidity (i.e. move disposal pipeline further away from disposal area boundary or deeper into the water column) Complete next logger service with data download after ~4 weeks	BMT Contractor/BMT	As required	Summarised in the relevant weekly progress report(s)

Factor	Potential Impact	Monitoring				Management Trigger	Management			
		Action	Responsibility	Timing/ Frequency	Evidence		Action	Responsibility	Timing/ Frequency	Evidence
							If management trigger exceedance continues, dredging and disposal to temporarily cease pending approval to continue following consultation with DBCA			
		Tracking of cumulative dredging/sea dumping hours	BMT	Throughout the campaign	Dredge logs provided by Contractor Results reported in the relevant weekly progress report(s)	Cumulative dredging/sea dumping hours exceed the 1,080-hour limit specified in the Reg4 LA Exceedance of 12-hour days followed by a minimum of 12-hour break in sea dumping	Inform DBCA of the management trigger exceedance and suspend dredging/sea dumping BMT to discuss in consultation with DoT/DBCA prior to recommencement of dredging/sea dumping	BMT	As required	Summarised in weekly reports and close out reports
Marine and terrestrial environmental quality	Release of nutrients or contaminants	Screening of dredge/disposal area sediments in accordance with EMF (BMT 2023a) and NAGD (CA 2009) (Section 7.3.3)	BMT	~<5 yearly prior to dredging	SAPIR and DEIA reports	Contaminants above relevant guidelines	Assess requirement for re-sampling for new contamination	BMT	As required, prior to dredging occurring	Summarised in DEIA and SAPIR
		Reassess the requirement to reinstate water quality monitoring during dredging potential contaminant concentrations significantly exceed historical concentrations recorded in Boat Harbour sediments	BMT	One off during relevant maintenance dredging campaign as indicated from sediment sampling (Section 7.3.3)	SAPIR and laboratory results	Median analyte concentration over a defined area above the ANZG (2018) marine water quality guidelines or 80th percentile of reference site data	Increase dredge slurry dilution, change location of dredge area Re-sample as soon as practicable to confirm effectiveness If issue persists, stop dredging and consult with DBCA	Contractor BMT	As required	Summarised in weekly reports and close out reports
	Hydrocarbon spills and waste into the environment	Inspect and maintain equipment Visually inspect work area for spills and waste/rubbish Follow/maintain approved refuelling procedures Appropriately store all fuels, oils and lubricants on site Keep and maintain a spill kit on site with all necessary materials for mitigation of accidental spillage of hydrocarbons Monitor public complaints	Contractor	Throughout the campaign	Requirement communicated to Contractor prior to campaign commencement Any spills, malfunctioning equipment or complaints received to be noted in the relevant weekly progress report(s)	Evidence of hydrocarbon leaks on dredge, dredge equipment, or within the dredge and disposal area Evidence of any waste/rubbish not contained in an appropriate manner Public complaint regarding hydrocarbon spills or waste/rubbish	Manage the spill/waste following the work instructions and using the items in the spill kit if practicable Review equipment/work method to ensure no further spills Immediately notify BMT and if significant spill, notify the DoT Maritime Environmental Emergency Response Unit (24 hour reporting number: [08] 9480 9924) Determine if additional environmental sampling or notification to DBCA is required	Contractor Contractor Contractor BMT/DoT	As required	Summarised in the relevant weekly progress report(s)
		Ensure work site is clear of rubbish following campaign completion		After campaign completion						
	Introduced marine species	If vessels and dredge related equipment (i.e. pipeline) are from interstate or international location then there is a requirement to be risk assessed using the Department of Primary Industries and Regional Development risk assessment	Contractor	Prior to dredging	Department of Primary Industries and Regional Development risk assessment tool reports Origin of vessel and dredge related equipment (i.e. pipeline) communicated to Contractor	Outcome of the origin of the vessel and dredge related equipment Outcome of risk assessment does not comply with a low risk rating	Complete actions to manage vessels and equipment to a low risk rating and complete risk assessment again to check effectiveness	Contractor	As required	Department of Primary Industries and Regional Development risk assessment tool reports

Factor	Potential Impact	Monitoring				Management Trigger	Management			
		Action	Responsibility	Timing/ Frequency	Evidence		Action	Responsibility	Timing/ Frequency	Evidence
		tool (https://vesselcheck.fish.wa.gov.au/) Locally acquired vessels and dredge related equipment (i.e. pipeline) will undergo suitable risk assessment and will not require DPIRD risk assessment tool			prior to the campaign commencement					
		Visual inspection of vessels and dredge related equipment (i.e. pipeline) for suspected marine pests		Prior to, during and after dredging	Any sightings of suspected marine pests to be noted in the relevant weekly progress report(s)	Sighting of suspected marine pest(s)	Immediately notify FishWatch (1800 815 507) of presence of any suspected marine pest(s)			Summarised in the relevant weekly progress report(s)
Flora and vegetation	Vegetation disturbance / removal	No vegetation disturbance /removal Contractor will use designated access routes	Contractor	Throughout the campaign	Requirement communicated to the Contractor by BMT prior to campaigns commencement and in this LTMMP	Requirement for vegetation disturbance /removal	Obtain a NVCP prior to undertaking any vegetation disturbance / removal	BMT / DoT	As required	NVCP
Marine fauna	Marine fauna collision	MFO on board dredge vessel during dredging (can be one of the dredge crew)	Contractor	While dredging is occurring	Marine fauna observation and/or interaction log (maintained to species level, where possible; Annex F)	Marine fauna observed within 300 m from dredge while operating	Suspend dredging until either 20 minutes after the last marine fauna is observed in the monitoring zone (within 300 m from the dredge), or the dredge vessel has moved to another position where a minimum distance of 300 m between the dredge vessel and any marina fauna can be maintained Complete marine fauna observation log (Annex F) and provide to BMT If observed marine fauna are injured or dead, DBCA and DCCEEW are to be notified immediately and dredging is only to resume following approval from DBCA and DCCEEW	Contractor Contractor BMT	As required	Reported in marine fauna observation and/or interaction logs and summarised in weekly progress reports
						Marine fauna collision incident with dredge vessel while operating	Suspend dredging until either 20 minutes after the last marine fauna is observed in the monitoring zone (within 300 m from the dredge), or the dredge vessel has moved to another position where a minimum distance of 300 m between the dredge vessel and any marina fauna can be maintained Complete marine fauna interaction log (Annex F) and provide to BMT If marine fauna from the collision incident are injured or dead, DBCA and DCCEEW are to be notified immediately and dredging is only to resume following approval from DBCA and DCCEEW	Contractor Contractor BMT		
Social surroundings		Monitor public complaints	Contractor	Throughout the campaign		Public or navigational safety incident		Contractor	As required	

Factor	Potential Impact	Monitoring				Management Trigger	Management			
		Action	Responsibility	Timing/ Frequency	Evidence		Action	Responsibility	Timing/ Frequency	Evidence
	Public safety (including navigational safety)	Dredge/vessel master to maintain visual contact with approaching vessels and Boat Harbour access			Requirement communicated to Contractor prior to campaign commencement Any public or navigational safety incidents or complaints received to be noted in the relevant weekly progress report(s)	Public complaint regarding public or navigation safety	Cease works if required to prevent further incidents until safety risk is resolved Inform BMT immediately and if applicable, implement management actions as per the Safety Management Plan Complete incident report and investigation	Contractor BMT		Incident report to DoT and other relevant regulators, as required
		Monitor VHF channel 16 and respond to any incidents involving dredging equipment								
		Correct lighting always displayed on dredge vessel and pipeline								
		Conformance to Safety Management Plan outlined in Project Execution Plan								
		TNTM	Contractor/BMT	Prior to dredging	TNTM					
	Social impact of noise	Monitor public complaints	Contractor	Throughout the campaign	Requirement communicated to Contractor prior to campaign commencement Any malfunctioning equipment or complaints received to be noted in the relevant weekly progress report(s)	Significant number of valid complaints received in relation to noise	Implement noise control measures (i.e. noise monitoring, minimise hours of construction)	Contractor	As required	Summarised in the relevant weekly progress report(s)
		Equipment and silencers are in working order to maintain noise levels								
		Operate between 0700 and 1800 Monday to Saturday unless otherwise directed in accordance with Australian Standards 1269 and 2436, Environmental Protection (Noise) Regulations 1997 (DEP 1997), and any additional requirements of the local government authority and relevant regulatory authorities								

Notes:

'BCH' = benthic communities and habitats; 'BMT' = BMT Commercial Australia Pty Ltd; 'Contractor'' = Dredging Contractor ; 'DBCA' = Department of Biodiversity, Conservation and Attractions; 'DEIA' = Dredging Environmental Impact Assessment; 'DoT' = Department of Transport; 'EMF' = Environmental Management Framework; 'GPS' = global positioning system; 'JBMP' = Jurien Bay Marine Park; 'm' = metre; 'MFO' = Marine Fauna Observer; 'NAGD' = National Assessment Guidelines for Dredging; 'NVCP' = Native Vegetation Clearing Permit; 'SAPIR' = Sampling and Analysis Plan Implementation Report; 'TNTM' = Temporary Notice to Mariners; 'VHF' = very high frequency; ; 'ZoI' = Zone of Influence; 'ZoMI' = Zone of Moderate Impact; 'ZoHI' = Zone of High Impact.

The term 'immediately' should be treated as within 24 hours.

7.3 Monitoring methods

7.3.1 Direct loss or burial of subtidal benthic habitats outside of defined dredge area

An independent global positioning system (GPS) logger will be mounted on the dredge to monitor the position of the dredge. Positional data from the GPS logger will be sent to BMT in real time and reviewed weekly to ensure the dredge does not operate outside of the defined dredge area. The Contractor will position the disposal pipeline end no closer than 20 m from the Offshore Disposal Area boundary and record its position at each re-location. The Contractor will include the recorded positions on daily reports that will be submitted to BMT and reviewed weekly to ensure no disposal occurs outside of the approved area. Following dredging and disposal, a hydrographic survey will be completed to assess if dredging depths were achieved and provide a broad-scale spatial representation of potential nearshore seabed elevations within the disposal area. Results will be discussed in the campaign closeout report (Section 7.4).

7.3.2 Indirect impacts to benthic communities and habitats

Plume sketches, remote imagery, site photographs and drone aerial photography

The Contractor will complete a sketch of the extent of visible turbid plumes at the dredging and disposal areas on every working day (nominally Monday to Saturday) during maintenance dredging campaigns. Any aesthetic water quality observations of significant changes to biological or ecological indicators (e.g. localised fish kills, significant localised algal blooms and/or presence of rubbish, foams or oils on water surface) beyond natural variation will also be recorded (via the provided aesthetics water quality observations checklist on the plume sketch). Plume sketches will be completed daily between 1100 and 1300 when sun glint on the water surface is minimal. Plume sketches will be completed on a pre-designed template (Annex G). All fields in the plume sketch template are to be completed (including the aesthetics water quality observation checklist). The Contractor will provide all completed plume sketches to BMT weekly during maintenance dredging campaigns for review.

Two remote imagery units (RIUs) will be installed by BMT to monitor turbidity and water quality aesthetics during maintenance dredging campaigns. One RIU will be installed with a view of the Boat Harbour and the second RIU will be installed on the dredge vessel. Each RIU will remotely capture time and date stamped images to a resolution of up to 12 megapixels at half-hourly intervals during daylight hours. One low-resolution image from each RIU will be automatically sent to BMT daily and reviewed weekly. High-resolution images from each RIU will be downloaded after campaign completion and compiled to form time-lapse videos.

The Contractor will take daily site photographs of the disposal area on every working day (nominally Monday to Saturday) during maintenance dredging campaigns. If a RIU malfunctions, the Contractor will also be required to take daily photographs at the relevant site. The photographs will be taken at a time (nominally between 1100 and 1300) and in a direction to minimise sun glint from the water surface. A digital camera with resolution ≥12 megapixels will be used to take the photographs. Wherever possible, the same camera will be used for the duration of the campaign to ensure all photographs are of the same quality. The camera should be configured such that the date and time of the photographs will be automatically stamped on the image. The Contractor will provide all site photographs to BMT weekly during maintenance dredging campaigns for review.

BMT will coordinate the capture of drone aerial photography monthly during maintenance dredging campaigns. The capture of drone aerial photography will record a large-scale visual record of the works and spatial extent of any visible turbid plumes during dredging and disposal. Drone aerial photography will ideally be orthorectified and should cover the entire extent of any visual plume from dredging and disposal. BMT will review the drone aerial photography as soon as practicable during maintenance campaigns.

The plume sketches, remote imagery, site photographs and drone aerial photography will be used to assess the likelihood of potential turbidity related environmental impacts occurring from maintenance dredging campaigns and to ensure any aesthetic water quality observations of significant changes to biological or ecological indicators beyond natural variation are documented and/or captured. Observations from the plume sketches, remote imagery, site photographs and drone aerial photography will be discussed in the close-out report (Section 7.4).

Tracking cumulative dredging/sea dumping hours

Dredging/sea dumping hours will be tracked via weekly dredge logs received from the Contractor. Hours will be summarised in the weekly reports throughout the campaign duration. When the cumulative dredging/sea dumping hours approach the limit specified in the DBCA issued Regulation 4 Lawful Authority (total of 1,080 hours of dredging/sea dumping; and 12 hour days followed by a minimum of 12 hour break in sea dumping), DoT will be notified. If exceedances of management triggers are reported (Table 7.3), DBCA will be notified of the non-conformance. DBCA will be consulted if any extension of the campaign is anticipated beyond the limits specified in the conditions of the Regulation 4 Lawful Authority.

Sub-sea light logging

Sub-sea light loggers will be deployed at three impact sites located on the outer boundaries of the ZoHI and ZoMI (in high risk areas, as determined by modelling), at two reference sites located outside of the ZoI (Table 7.4; Figure 7.1) and at one onshore site (location to be determined) before, during and after offshore disposal. Loggers will be deployed for a ~six-week period prior to being retrieved, downloaded and re-deployed throughout the campaign duration. A TNtM will be obtained and DCBA approval (through the Regulation 4 Lawful Authority) for subsea logger locations. Loggers will record light data at ~15 minute intervals during daylight hours.

Data from the light loggers will be processed per the EPA (2005) standard operating procedures. Data will be analysed following each download to assess compliance with the management trigger (Table 7.3) and will verify the predictive numerical plume extent modelling used to establish the impact zones (refer to Section 6.2.3). Since the thresholds that were used to define modelled boundaries of potential impact zones are based on CMSC (2018) EQG for LAC in Cockburn Sound (refer to Section 6.2.1), the management trigger also factors assessment of LAC established at reference sites (Figure 7.1) should application of CMSC (2018) EQG for LAC in Cockburn Sound vary spatially to the environment at Jurien Bay. Results will be reported in the weekly environmental checklists (template in Annex H) and campaign closeout report (Table 7.3).

There were no exceedances of the management trigger during the 2020/21 or 2023 campaigns (BMT 2021, BMT 2023b) and a stepped approach will be applied for future campaigns (Table 7.3), whereby if an exceedance is detected after ~six weeks of monitoring, the loggers will be serviced and data downloaded ~four weeks later. If an exceedance continues, then dredging and disposal will temporarily cease pending approval to continue following consultation with DBCA.

If exceedances of management triggers are reported (Table 7.3), an additional investigation into the accuracy of modelled predictions for plume dispersion will be completed and summarised in the campaign closeout report. If it is identified the modelled predictions for plume dispersion are not accurate, the model will be updated for improvement prior to the next maintenance dredging campaign and any dependent environmental management measures will be revised accordingly.

Table 7.4 Jurien Bay light logger monitoring site coordinates

Site	Easting	Northing	Depth (m)
JB_ZoMI	310 964	6 648 970	7.2
JB2_ZoHI	310 983	6 648 819	6.3
JB_R1	309 577	6 646 147	6.3
JB_R2	309 497	6 645 629	7.5
JB1_ZoHI	311 233	6 648 088	6.2

Notes:

1. **'ZoI' = Zone of Influence, 'ZoMI' = Zone of Moderate Impact, 'ZoHI' = Zone of High Impact.**
2. **GDA94, UTM50S**

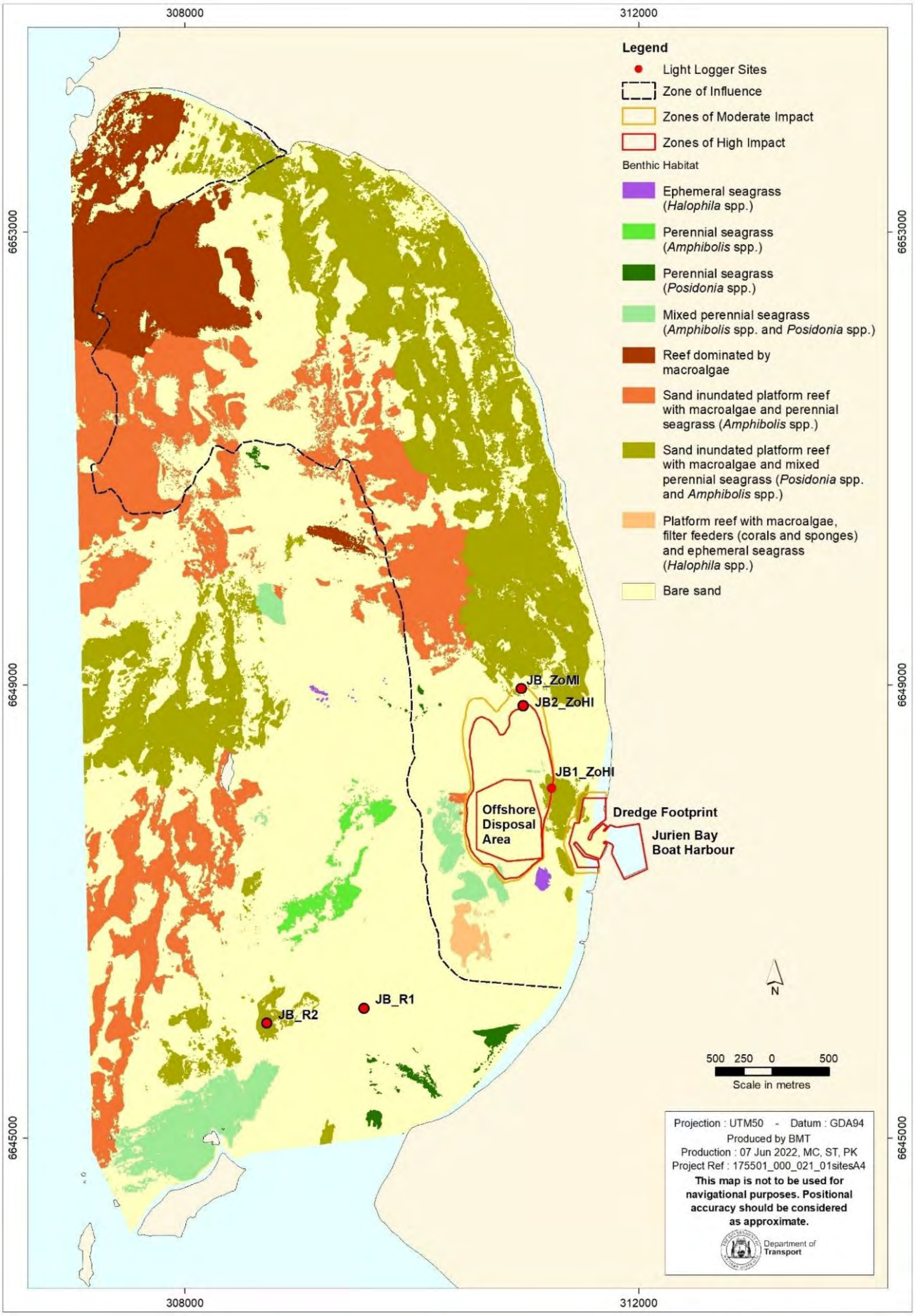


Figure 7.1 Jurien Bay light logger monitoring sites during maintenance dredging campaigns

7.3.3 Release of nutrients or contaminants

Screening of dredge/disposal area sediments

In accordance with NAGD (CA 2009) and EMF (BMT 2023a), sampling and analysis of sediments from the proposed Boat Harbour dredge areas and Offshore Disposal Area will be completed every five years throughout the life of the SD Permit and LTMMP (Section 4.1). This is required to ensure appropriate monitoring and management continues to be implemented during maintenance dredging campaigns based on good quality and current sediment quality data (CA 2009). As outlined in Section 4, sediment sampling and analysis will be completed following the procedures detailed in the approved SAP (Annex B; BMT 2024a). If routine sediment sampling and analysis identifies an increased risk of release of nutrients or contaminants above relevant guidelines and significantly higher than the historical range recorded in Boat Harbour sediments (Section 6.3.2), the requirement for during dredging water quality monitoring will reassessed for subsequent campaigns (Section 7.3.3).

During dredging water quality sampling

If indicated during screening of dredge/disposal area sediments (Section 7.3.3), water quality monitoring for analytes of potential concern (as identified from sediment sampling and analysis) will be completed (Table 7.2). Water sampling will be undertaken at the edge of the Offshore Disposal Area (according to the plume trajectory) and at three reference sites (Table 7.2). Water quality monitoring will be undertaken once off during dredging of the Boat Harbour sediments as determined during initial screening of dredge/disposal area sediments (Section 7.3.3). The requirement for additional water quality sampling will be assessed if exceedances are observed following receipt of the results from the initial monitoring. The selected sample analytes will be based results where exceedances of sediment guidelines are observed in the initial screening (Section 7.3.3).

To accurately target the disposal area plume, a drogue shall be released at the discharge point prior to sampling. Movement of the drogue shall be tracked for ~20 minutes and based on the location of the drogue at this time, a plume trajectory will be calculated. A single depth integrated water sample will be obtained at the point where the plume trajectory meets the edge of the disposal area boundary. Depth integrated water samples will also be collected from three reference sites (one sample per site) located ~1 km up-current of the disposal area and beyond the influence of the plume to ascertain the background water quality for comparison (Table 7.2). The water samples against the management triggers (Table 7.2; as described in Section 7.2).

The data from each sampling event will be analysed as soon as practicable upon receipt. If any of the results exceed the management triggers (Section 7.2), DBCA will be notified and the disposal area plume will be re-sampled for the exceeded analyte as soon as practicable. Investigations to the possible cause-effect pathways for the exceedance will be conducted to ascertain if dredging operations are the cause of the exceedance. If the exceedance continues and is attributable to dredging operations, DBCA will be notified and the agreed mitigation measures (this may include reducing dredging output and/or modification of dredge/disposal methods) to reduce the impact on water quality will be implemented. A survey will be conducted as soon as practicable once mitigation measures are implemented to ascertain if the exceedance remains.

7.4 Reporting and auditing

The dredging contractor (Contractor) will provide all monitoring data weekly to BMT. BMT will then prepare a weekly environmental monitoring report, outlining monitoring completed and conformance with the LTMMP (Annex H). Any exceedances of a management trigger will be reported as per Table 7.3.

The LTMMP (this document) will be publicly available on DoT's website for the duration of maintenance dredging campaigns. The DoT website will also indicate that environmental monitoring results can be made available on request. BMT will compile any public complaints into a complaint register. BMT will report any significant environmental incidents to DBCA, DCCEEW and DoT within 48 hours.

BMT will also compile, analyse and interpret all environmental monitoring data in the close-out report on completion of maintenance dredging campaigns. The close-out report will include an audit of project performance against this LTMMP.

This LTMMP will also be reviewed and updated to reflect best practise in environmental management and monitoring prior to each dredge campaign, per Section 1.1.1.

8 Stakeholder Consultation

8.1 Jurien Bay Maritime Advisory Group

Given that maintenance dredging campaigns proposed under this LTMMP are small-scale and of short-term duration, it is not considered necessary that a technical advisory and consultative committee (TACC) be established specific to maintenance dredging activities. DoT maintains a MAG for Jurien Bay, which currently meet ~annually or as required. In the context of the requirements of the LTMMP, the MAG is considered to fulfil the requirements of a TACC. The MAG purpose is to:

- provide and maintain strong local community/stakeholder input into management decisions affecting maritime facilities and activities in the State
- assist in the formulation of planning and development strategies, standards and guidelines for the Boat Harbour, including the review of options for the development of new facilities and leases
- address safety and environmental issues involving the harbour and adjacent waters, including the designation and management of special use areas
- raise and discuss any coastal management or other issues (including environmental incidents) that may be of concern in the area, to enable these issues to be communicated to appropriate persons within DoT.

The MAG membership consists of 6–12 members who have an interest in the Boat Harbour. The membership reflects a fair representation of all user groups of the Boat Harbour. Typical membership may include members from:

- Local Government/relevant State Government Agencies
- Industry/User Groups, such as the professional fishing industry, charter boat industry, service vessels etc
- Regional Development Organisations
- Recreational/Stakeholder/Community User groups
- Local business/Chamber of Commerce
- Leaseholders
- DoT (Regional Services Manager/Facility Manager)
- DoT (Coastal Facilities representative).

The quorum for all MAGs shall be half of the members of the MAG. For resolutions of a meeting to be valid, the number of members necessary to form the quorum must be present throughout the meeting. Meeting minutes are retained by the DoT representative, and disseminated to DoT managers for action, as required, including the state-wide maintenance dredging program team.

8.2 Stakeholder consultation completed to date

Stakeholder consultation, encompassing relevant decision-making authorities, interested parties and the Jurien Bay local community was completed over a two-week consultation period. Ongoing consultation throughout the permit duration will be completed via the MAG (Section 8.1) and with relevant decision-making authorities, as required. A summary of consultation completed to date is provided in Table 8.1. Details of consultation (including responses to queries, media releases and email correspondence) is provided in Annex I.

Table 8.1 Stakeholder consultation completed in relation to the Jurien Bay Boat Harbour maintenance dredging campaigns and proposed offshore disposal

Date	Stakeholder type	Description of consultation
2014-ongoing	Department of Biodiversity, Conservations and Attractions	Ongoing liaison and consultation with Jurien Bay Marine Park (JBMP) managers on the maintenance of Jurien Bay Boat Harbour (JBBH) and protection of JBMP values throughout maintenance dredging campaigns. Department of Transport (DoT) currently holds an existing licence (2971/101) to "undertake dredging of marine sediment and disposal of marine wrack and sediment in JBMP". This Long Term Monitoring and Management Plan (LTMMP) is the supporting document for a Regulation 4 Lawful Authority application to dispose dredged material into the proposed Offshore Disposal Area within the JBMP. On 14 April 2023 DoT submitted a request to DBCA to extend the 2023 maintenance dredging campaign beyond the 90-day limit specified in the Regulation 4 Lawful Authority. DBCA consulted with the Conservation and Parks Commission and approved a 41-day extension to the campaign.
2018-onging	Department of Climate Change, Energy, the Environment and Water (formerly; Department of Agriculture, Water and the Environment (DAWE))	This LTMMP formed the supporting document for an application for a Sea Dumping Permit to dispose dredged material into the JBMP. Consultation with DAWE specific to this Project commenced in 2018, and endorsement of the SAP (BMT 2019b) was received on 1 April 2019. Consultation with DCCEEW occurred prior to sampling in May 2024 to understand the re-approval requirements of the new SAP (BMT 2024a). DCCEEW confirmed in February 2024 that re-approval of the SAP was not required; however, the SAPIR would need to be submitted. The SAPIR (BMT 2024b) was submitted to DCCEEW on 4 November 2024.
27/03/2019 -ongoing	Department of Planning, Lands and Heritage (DPLH),	DoT has entered into a Noongar Standard Heritage Agreement with SWALSC as the representative Body corporate for the Yued Group. Potential impacts Aboriginal heritage or native title associated with the proposed maintenance campaigns will be managed under this

Date	Stakeholder type	Description of consultation
	South West Land and Sea Council (SWALSC) and Yued Group	agreement (refer to Section 3.4). Prior to the commencement of maintenance dredging campaigns the SWALASC and Yued Group are notified.
20/12/2022	Department of Primary Industries and Regional Development (DPIRD)	Consultation with DPIRD Aquatic Biosecurity occurred to ensure the risk of introduced marine species was low when mobilising the dredge vessel to Jurien Bay for completion of the 2023 maintenance dredging campaign. DPIRD confirmed that the dredge vessel posed an acceptable level of biosecurity risk and no further actions were required.
02/08/2019	Department of Water and Environmental Regulation (DWER) – Environmental Protection Authority Services Division	DoT informed DWER of the proposed maintenance dredging campaigns and upcoming stakeholder consultation process via email (attached Annex I). Feedback was invited from DWER, however; to date, (26 March 2020) no reply has been received. DWER mid-west office were also contacted as part of the community consultation, however; declined to provide feedback on the proposed dredging and disposal.
21/08/2019	Jurien Bay residents JBBH pen holders, lease holders and JBBH Maritime Advisory Group (MAG)	An article was published into the local Jurien Bay paper 'Craytales' (Annex I) for circulation to the local community on 21 August 2019. Public comment was invited until 4 September 2019, through DoT's website. A targeted email obtaining the same information was circulated to the JBBH MAG, pen holders and lease holders (Annex I). A total of six comments were received during the stakeholder consultation process, which are provided with DoT's response in Annex A.

In addition, a number of key stakeholders and government departments relevant to maintenance dredging at Boat Harbour already work in close unison to determine:

- the requirement for dredging
- the proposed volumes, disposal areas and timing of the maintenance campaigns
- dredge management in accordance with DoT's EMF (BMT 2023a) and any other licence or permit issued.

A description of each of these key stakeholders and their role in decision-making for Boat Harbour maintenance dredging campaigns is provided in Table 8.2. This framework allows for informed decision-making on the requirement for dredging, and the management required to reduce potential environmental impacts to as low as reasonably practicable.

Table 8.2 Key stakeholders involved in decision making for maintenance dredging at Jurien Bay Boat Harbour

Name/Department	Description	Role
DoT Navigational Safety	The Navigational Safety branch of DoT is responsible for ensuring that waterways managed by DoT are maintained to ensure navigable safety. This includes: • regular hydrographic surveys of waterways to ensure charted depths are maintained • maintenance of navigational aids • management of public complaints in regard to navigational safety • if required, instigation of maintenance dredging of waterways and boat harbours.	The Navigational Safety branch will be informed should a navigational safety issue exist at the Boat Harbour that needs management or remediation.
DoT MBU	The MBU branch of DoT is responsible for the day-to-day management of DoT's marine facilities and infrastructure. This includes: • liaison with key stakeholders and facility users • management and implementation of the state-wide maintenance dredging program • reviews of hydrographic survey data to ensure designs depths are maintained • management of public complaints in relation to DoT facilities	MBU are responsible for completing maintenance dredging of DoT assets to maintain navigable depths. This includes developing and implementing environmental impact assessment and management plans, stakeholder consultation and dredge contractor management. MBU will determine the requirement for dredging at Jurien Bay Boat Harbour, the timing of works and implementation of specific management, in accordance with its state-wide maintenance dredging program
DBCA Jurien Bay	The Jurien Bay DBCA is the managing authority for the JBMP	As managing authority for the disposal site, DBCA will be consulted prior to any works, and a lawful authority issued to DoT under the CALM Act

Note:

1. 'DoT' = Western Australian Department of Transport; 'MBU' = Maritime Business Unit, 'DBCA' = Department of Biodiversity, Conservation and Attractions, JBMP = Jurien Bay Marine Park.

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Annex A Jurien Bay Boat Harbour Maintenance Dredging Plume Modelling Report

Offshore Dredge Disposal at Jurien Bay: Assessment of Dredge Plume Dispersion and Disposal Area Stability

R-1666_00-2

January 2020

Document Control Sheet

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BMT Western Australia Pty Ltd has prepared this report in accordance with our Integrated Management System, certified to OHSAS18001, ISO14001 and ISO9001

Status

This report is 'Draft' until approved for final release by the Project Director (or their authorised delegate) as indicated below by signature. A Draft report may be issued for review with intent to generate a 'Final' version but must not be used for any other purpose.

Approved for final release:

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List of Terms and Abbreviations

CD	Chart Datum (m)
DEIA	Dredging Environmental Impact Assessment
DoT	Department of Transport
FV	Finite Volume
JBBH	Jurien Bay Boat Harbour
km	Kilometre
m	Metre
m^3	Cubic metre
mg/L	Milligrams per litre
m/s	Metre per second
NLSWE	Non Linear Shallow Water Equation
NOAA	National Oceanic and Atmospheric Administration
PSD	Particle Size Distribution
ST	Sediment Transport
TSS	Total suspended solids (mg/L)
3D	Three dimensional
2D	Two dimensional
WWIII	Wave Watch three

1 Introduction

1.1 Background

Maintenance dredging is required at Jurien Bay Boat Harbour (JBBH) to maintain navigability and water quality. Maintenance dredging has been undertaken using a cutter suction dredge on three occasions since harbour construction in 1986; 2006, 2014/2015 and 2016/2017.

Considerable accretion of sand and wrack has occurred since the last maintenance dredging campaign at JBBH such that maintenance dredging will be required in 2020. It is anticipated that at least 80,000 m^3 of material will need to be removed: 60,000 m^3 from the entrance and 20,000 m^3 immediately south of the entrance. For planning purposes, a breakdown of accreted material volumes and dredging areas is shown in Drawing 1705-26-02-A (Appendix A).

While the total material volume within all dredging design areas including over dredge is approximately 210,000 m^3, it is anticipated that, due to limitations in budget and equipment availability, single maintenance dredging campaigns will be limited to ~80,000 m^3 over a period of about 18 weeks.

1.2 Study objectives

The objectives of this numerical study are:

- assess the likely dispersion/advection of the plume resulting from dredging disposal at the proposed offshore disposal area
- assess the mobility/stability of dredged material placed within the proposed offshore dredge disposal area.

Outcomes from this study are intended to inform a Dredging Environmental Impact Assessment (DEIA).

The scope of the assessment is outlined below:

- Analysis and simulation (by numerical modelling) of the hydrodynamic processes likely to influence sediment plume dispersion and dredge disposal area stability.
- Simulation of the likely dredge plume dispersion and assessment of the spatial and temporal evolution of the plume characteristics.
- Assessment of the mobility/stability during severe storm conditions of the dredged material placed within the proposed offshore disposal area (disposal area stability assessment).

The outcomes of the study will be subsequently used in the DEIA for assessing the likely impact of the proposed maintenance dredging work and offshore disposal on the sensitive environmental receptors.

1.3 Review of sediment transport in Jurien Bay

Regional metocean conditions, coastal processes, landforms and sediment movement have been well described in various sources (e.g. DoP, 2012; Woods and Gilkes, 1982; Chua, 2002; Holloway 2008).

In summary, regional metocean conditions are dominated by prevailing winds from the southwest to southeast during summer and from the northwest to southwest during winter. Ocean swell is persistent from the southwest all year and within Jurien Bay swell is extensively refracted and diffracted by passage through, and around reefs, islands and banks.

Jurien Bay lies at the very northern end of the primary sediment Cell extending from Moore River to North Head. Within Jurien Bay itself there are three tertiary sediment cells (DoP, 2012) listed in Table 1-1.

Table 1-1 Jurien Bay tertiary sediment cells

Cell	Cell area
30	Island Point to Middle Head
31	Middle Head to Pumpkin Hollow
32	Pumpkin Head to North Head

In general, the coastal sediment transport in this region is dominated by onshore transport of unconsolidated material from coastal landscape inundated during the Holocene (Woods, 1982) and distribution of nearshore sediment from south to north by south-westerly seas and swells. The following key points drawn from Woods (1982) summarise the present understanding of sediment transport around Jurien Bay and are illustrated in Figure 1-1.

- Sediment is transported northward from Essex Bay (to the south) into Jurien bay through the passage between Boullanger Island and Island Point; in shallow water and near the beach. This pathway spills into the south end of Jurien Basin and also feeds sediment into the beach system.
- Along the beach, sediment transport is predominantly to the north. Sheltered from southerly wind waves there is significant shoreline accretion in the lee of Island Point.
- Evidence indicates there is significant long-term (~350 years) variability in the feed of sediment into the south of Jurien Bay affecting the rate of shoreline progradation between Island Point and Favourite Bank.
- Refracting swell and wind-driven currents are the dominant mechanism transporting sediment onshore along Favorite Bank (the sand bank extending between Favourite Island and the mainland) which joins the shore approximately 600 m north of JBBH. Steep banks north and south of the Jurien Basin indicate infilling of the basin along both margins.
- Nearshore sediment transport is considered to be predominantly northward from Favorite Bank.
- Finer sediment traversing Favorite Bank appears to be deposited near Middle Head suggesting that net northward littoral drift reduces significantly north of Middle Head.
- Although some net northward alongshore transport was anticipated near JBBH due to southerly wind waves, factors in favour of siting the facility in its present location included sheltering by Boullanger and Favorite Banks to the south and north, limited fetch, and lack of feed of fine sediments from either the south or north.

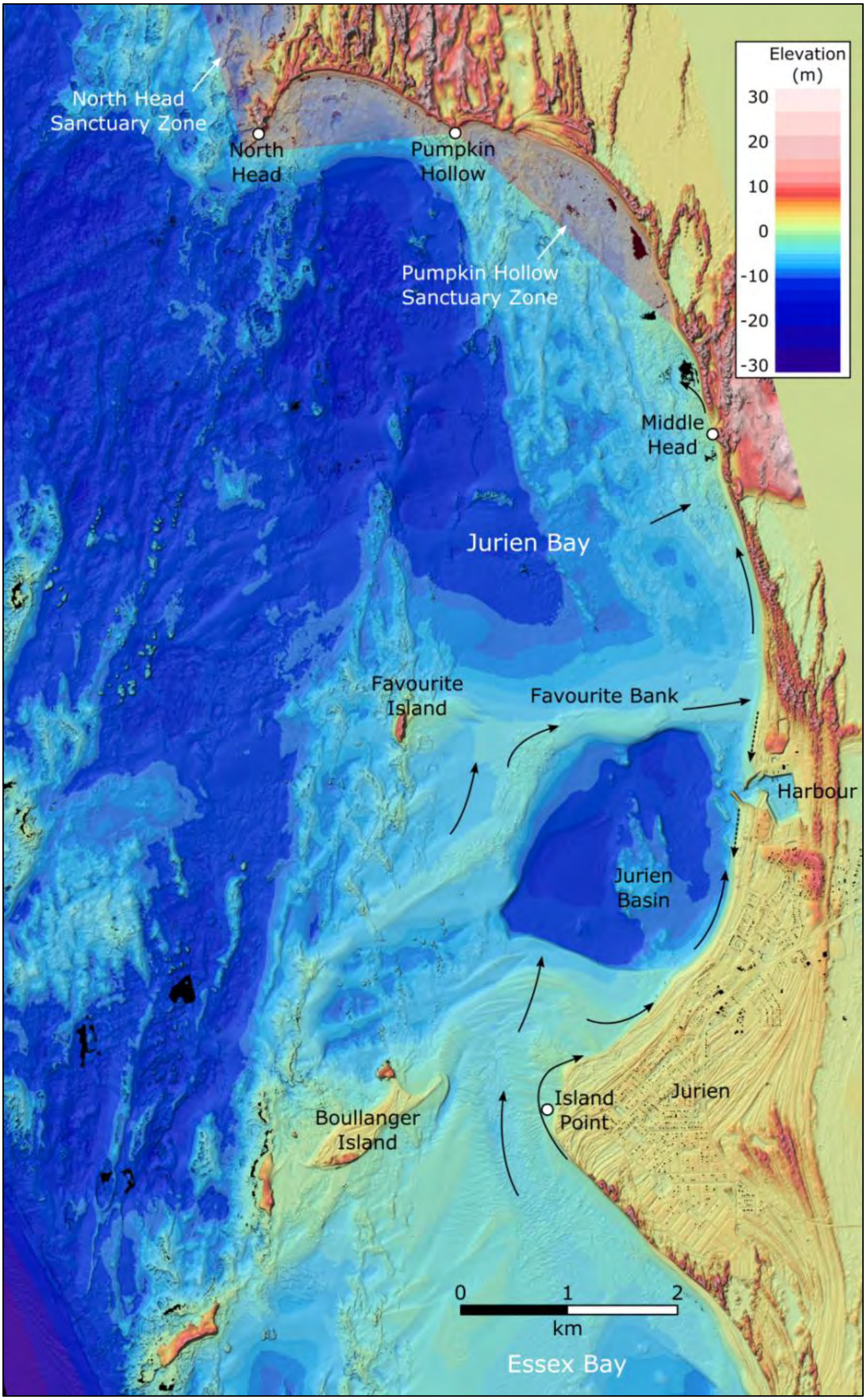

Figure 1-1 Jurien Bay sediment transport pathways (elevation map from LIDAR 2016)

From the coastal response around the harbour and other monitoring data over the 35 years since the assessment by Woods and Gilkes (1982) the following observations can be made:

- Net northward transport along the Jurien townsite shoreline has been significant since 1985 with an average annual influx of approximately 43,000 m^3 per year into this area.
- Near the harbour winter storms typically result in a net southerly transport as evidenced by local shoreline erosion immediately south of the harbour entrance.
- There is a net southward transport into the area between the harbour entrance and Favorite Bank, evidenced by the lobe of accretion in this area and net erosion in the 1 km north of Favorite Bank. This is likely due to the southward transport by northwesterly winds and waves typical during the early phase of winter storms, depositing sediment near the northern breakwater; an area at least partially sheltered from southerly wind waves during storms or summer seabreeze.
- The substantial shoreline accretion south of the harbour represents sediment that would otherwise have fed into beaches north of JBBH. The total 1.7 million m^3 of accretion north and south of JBBH since ~1985, if distributed along the 11 km shoreline between Island Point and Pumpkin Head would result in the shoreline prograding by 15–20 m, or 0.7 m/year; equivalent to the rate of shoreline advance measured from 1942-1965 and inferred from landform and sediment dating (Wood, 1982).
- Between 1985 and 2004 there was essentially no shoreline movement from Favorite Bank north. However, between 2004 and 2016 the shoreline in this area prograded up to 2 m/yr. This suggests that there is significant variability in the rate of sediment feeding from Favorite Bank into the nearshore system, with a sand supply pulse during the 2004–2016 period. This may also be the reason for the significant increase in rate of shoreline accretion north of the harbour during the same period. Furthermore, it is interesting to note that the zone of shoreline accretion extends well north of Middle Head, previously inferred to be the terminus of northward transport (Wood, 1982).

North of Middle Head the presence of nearshore reef platform and perched beach increases. Between 500–700 m north of Middle Head the platform becomes intertidal and is fringed by water up to 5 m deep. This area forms a natural sink for sand. Transport of sand northward past this platform may only occur substantially when there is an abundance of sand feeding the beach in this area.

Approximately 1.5 km south of Pumpkin Hollow the shoreline swings westward toward North Head. This segment of coast is sheltered by North Head from northwest storm waves and faces more or less directly toward the predominant southwest winds and waves. This combined with the broad, shallow reef sheltering the beach from incident waves is expected to result in minimal sediment transport except during energetic events coinciding with very high tide and storm surge levels.

1.4 Interpretation of model results for sediment pathway at beaches

Hydrodynamic modelling of storm events shows very energetic alongshore currents extending approximately 4 km north of the harbour (Figure 1-2). During northerly winds the broad southward alongshore current rapidly intensifies between chainage 9–10 km (Figure 1-2). This is due to this area receiving reduced sheltering from northerly winds by North Head and the presence of shallow reef nearshore. Current velocity and shear stress both decrease between chainage 7–8 km, which indicates an area of net deposition during northerly winds. South of Favorite Bank currents and shear stress increase somewhat toward the harbour.

During southerly winds the pattern is fairly similar to the northerly condition, but with alongshore current directed northward. However, between chainage 7–8 km, just north of Favorite Bank the current and shear stress is significantly higher than during northerly winds.

Shoreline movement analysis showed that from 1965 on, the shoreline between chainage 7–8 km was either static or eroding. This is consistent with the model showing an increase in shear stress to the south of this region during southward currents, and an increase in shear stress to the north during northward currents. The zone of reduced current speeds and shear stress lies between about 1–1.5 km north of the harbour. Although both winter southerly winds and summer southwest sea breezes drive northward seas and a northward sediment transport along the beach, the model indicates there is sufficient energy drive a significant southward transport from this area during northwest storms bringing sand toward the harbour. On this basis it is not advisable to dispose of material from maintenance dredging on the beach within about 2 km north of the harbour.

Immediately north of chainage 10 km the model indicates that transport both to the north and south is significantly lower. In this area 2016 LIDAR data indicates a shallow reef platform extending up to 400 m off the beach, with sheltered pools up to about 5 m deep in places. General accretion in this area is supported by nearshore cuspate sand features indicated in the LIDAR data and by shoreline accretion rates of up to 2 m/yr between chainage 10–11 km from 2004–2016.

Locating a beach disposal area between chainage 9–10 km will likely result in a major fraction of placed material being dispersed northward, either as sand on the perched beach, thin sand cover on the shallow reef or into the deeper pools.

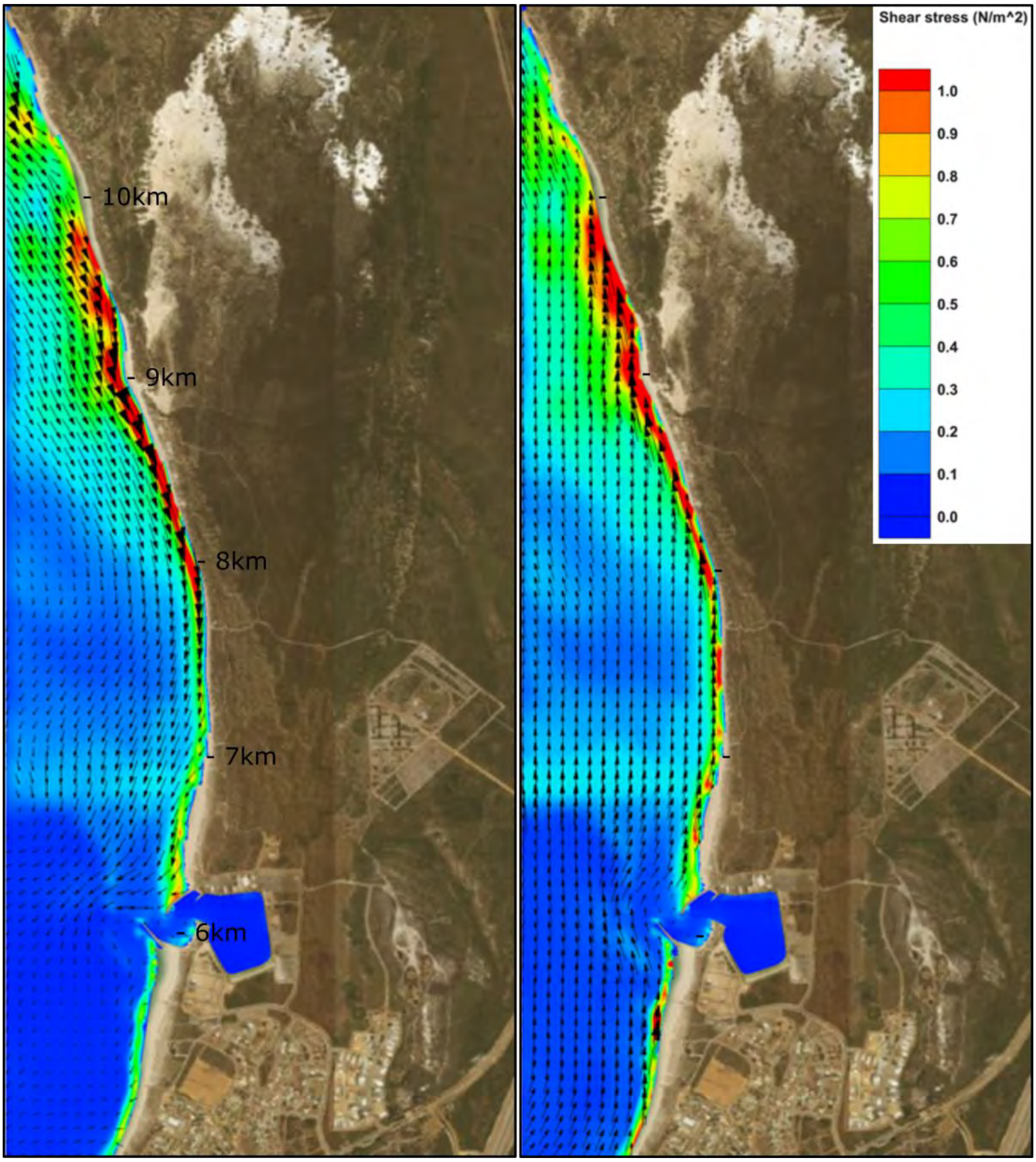

Figure 1-2 Modelled current vectors and shear stress along beach disposal area. NW wind 5PM 19/07/2014 (left); southerly wind 6AM 22/07/2014 (right)

2 Numerical Modelling

2.1 Model description

A calibrated wave and hydrodynamic modelling framework for Jurien Bay (BMT 2016) was used to assess the dredge plume fate over the period of dredging and assess the stability of the offshore dredge disposal area during acute storm conditions. The domain of the wave and hydrodynamic model is shown in Figure 2-1 and Figure 2-2, respectively.

The hydrodynamic modelling framework includes the following physical processes:

- Water levels and currents associate with astronomical tides, shelf waves and barotropic circulation
- Synoptic winds, atmospheric pressure and local winds
- Wind induced currents
- Open ocean swell waves, wind-driven waves
- Wave propagation, wave breaking, wave induced currents, bed shear stress and orbital velocity
- Salinity, temperature and stratification

The model domain used to simulate the 3-dimensional hydrodynamic circulation in Jurien Bay and in the vicinity of the JBBH covers the coastal waters from Perth to Geraldton. The model framework is comprised of a wave component (SWAN) and a circulation component (TUFLOW Finite Volume [FV]). The domains for each component are shown in Figure 2-1 and Figure 2-2, respectively.

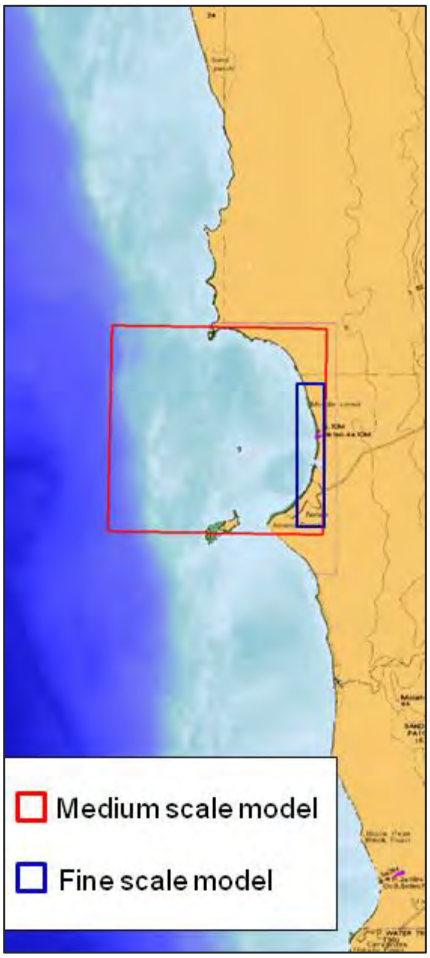

Figure 2-1 Nearshore nested SWAN grid domains

Figure 2-2 Domain of the Hydrodynamic model

The modelling framework has been calibrated against data measured by the Department of Transport (DoT) and was successfully used to the simulate waves, circulation and transport of seagrass wrack in Jurien Bay (BMT 2017, BMT 2018). The model, domain and calibration are briefly outlined in the following sections.

2.1.1 Wave model (SWAN)

The SWAN wave model is a third-generation spectral wave model based on the wave action balance equation with sources and sinks and can be used on any scale relevant for wind generated surface gravity waves (Delft University of Technology 2006, Booij and Holthuijsen 1999). This is a global industry standard modelling package that has been applied with reliable results to many investigations worldwide.

Wave forcing was included in the present study for the role of wave action in sediment dispersion and resuspension for assessment of both the dredge plume and disposal area stability.

Resolving wind waves propagating from offshore deep waters to nearshore shallow waters at a large scale requires local refinement of the grid near the coast. This was achieved by employing a nesting approach. The resolution of the model is increased from offshore to nearshore by applying four nested (stepped) grids. The established large-scale wave model for Jurien covers an area of approximately 170 km (offshore) x 380 km (along the coastline). Figure 2-1 illustrates the second nested grid (semi-coarse scale grid) and the area of the medium scale and fine scale grid which provides high resolution wave information in the shallow nearshore areas in the vicinity of the disposal area and boat harbour.

The wave model was forced with a combination of waves from a global model (NOAA WWIII) and the local wind measured at Jurien Bay. The nested wave model reproduced local wave generation, propagation of waves into Jurien Bay and resolved wave breaking over reefs and nearshore.

The SWAN wave model was coupled with the 3-dimensional TUFLOW FV hydrodynamic model to simulate the dispersion of the dredge discharge plume and resuspension of material in the offshore disposal area. This required the wave simulations (wave and hydrodynamic) to be completed separately, with the model output stored at hourly intervals on regular grids. During the subsequent sediment re-suspension and dispersion simulations, the wave conditions were linearly interpolated spatially from the grids to the TUFLOW FV mesh.

2.1.2 Hydrodynamic model (TUFLOW FV)

TUFLOW-FV is a finite-volume hydrodynamic model (including both two and three-dimensional (2D and 3D) schemes), developed and distributed by BMT WBM (2013), which solves the Non-Linear-Shallow-Water-Equations (NLSWE). By adopting the flexible mesh approach the entire large-scale area and the high-resolution nearshore area are covered in a single mesh. The flexible mesh allows for seamless boundary fitting along complex coastlines or channels as well as efficiently representing complex bathymetries with a minimum number of computational elements (TUFLOW FV 2014).

2.1.3 Sediment transport model

TUFLOW FV Sediment Transport (ST) is a sediment transport modelling module. It was coupled with the wave and hydrodynamic models to simulate the following aspects of sediment movement:

- dispersion, settling and resuspension of particles released into the water column at the disposal area (dredge plume modelling)
- resuspension of particles from the seabed within the disposal area, and their subsequent transport and deposition during a severe storm (disposal area stability assessment).

The sediment transport modelling scope excludes the response of the existing native bed materials to the metocean conditions (e.g. bed erosion and accretion on the beaches) and focuses on assessing the likely impact of the dredge dispose material above the background native suspended sediment levels.

2.2 Model validation

The wave and hydrodynamic model were forced with a combination of the global model data and local measurements. The wave and circulation models were previously calibrated for the period of July 2014 when measured wave and current data were available at three locations as shown in Figure 2-3 (BMT 2017). The instrument locations cover approximately 2.5 km along the coastline and are located in various depths from approximately 5 m to 13 m. The three instruments have various exposures to the incoming wave energy (due to the sheltering caused by shallow reefs) suitability representing the variation in the metocean conditions (wave and currents) experienced from the north to the south of the Jurien Boat Harbour.

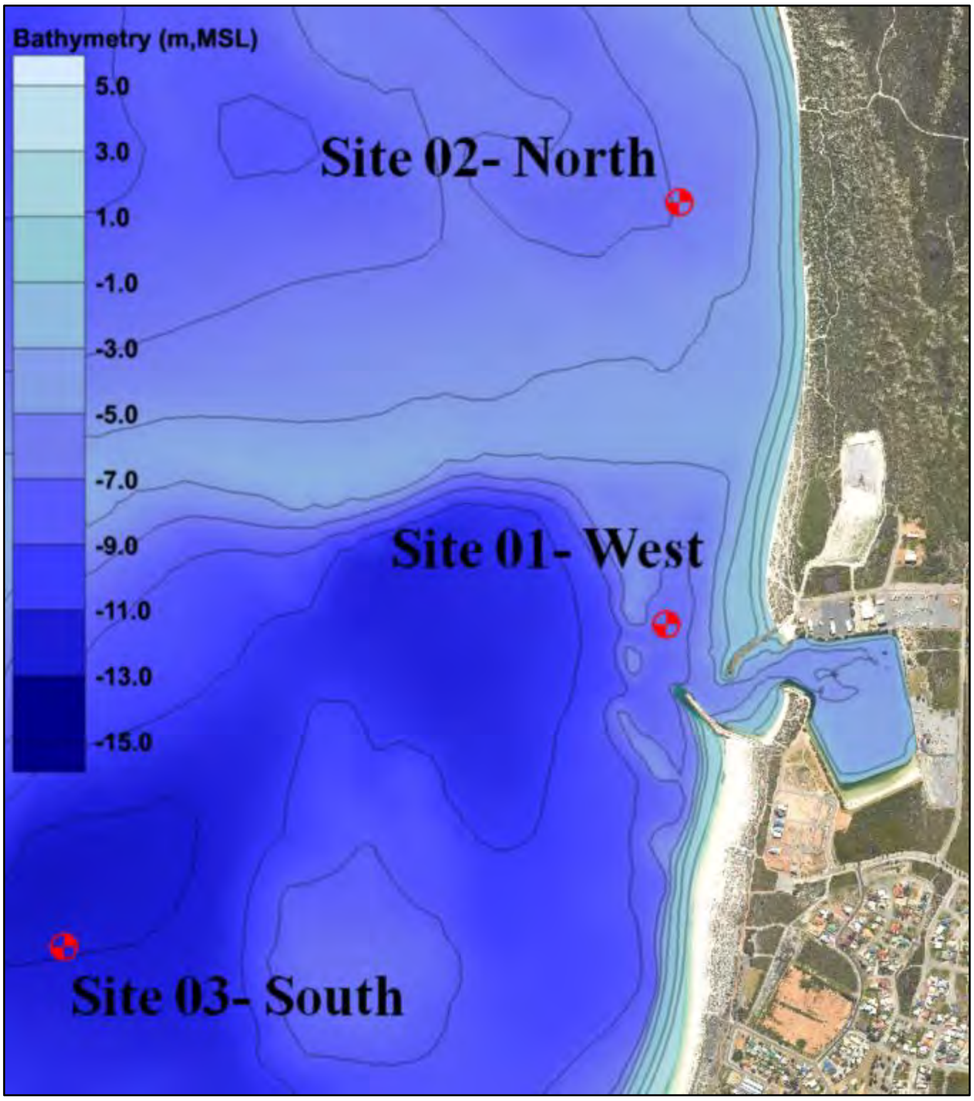

Figure 2-3 Locations for July 2014 acoustic wave and current instrument deployment

Modelled water level and currents were validated at three measurement sites in Jurien Bay (Figure 2-4). The modelled water levels and current profiles were strongly correlated to instrument records at all three measurement sites, demonstrating the capability of the model framework for investigating the circulation within Jurien Bay. Further detail on the modelling boundary conditions and validation is available in BMT (2017).

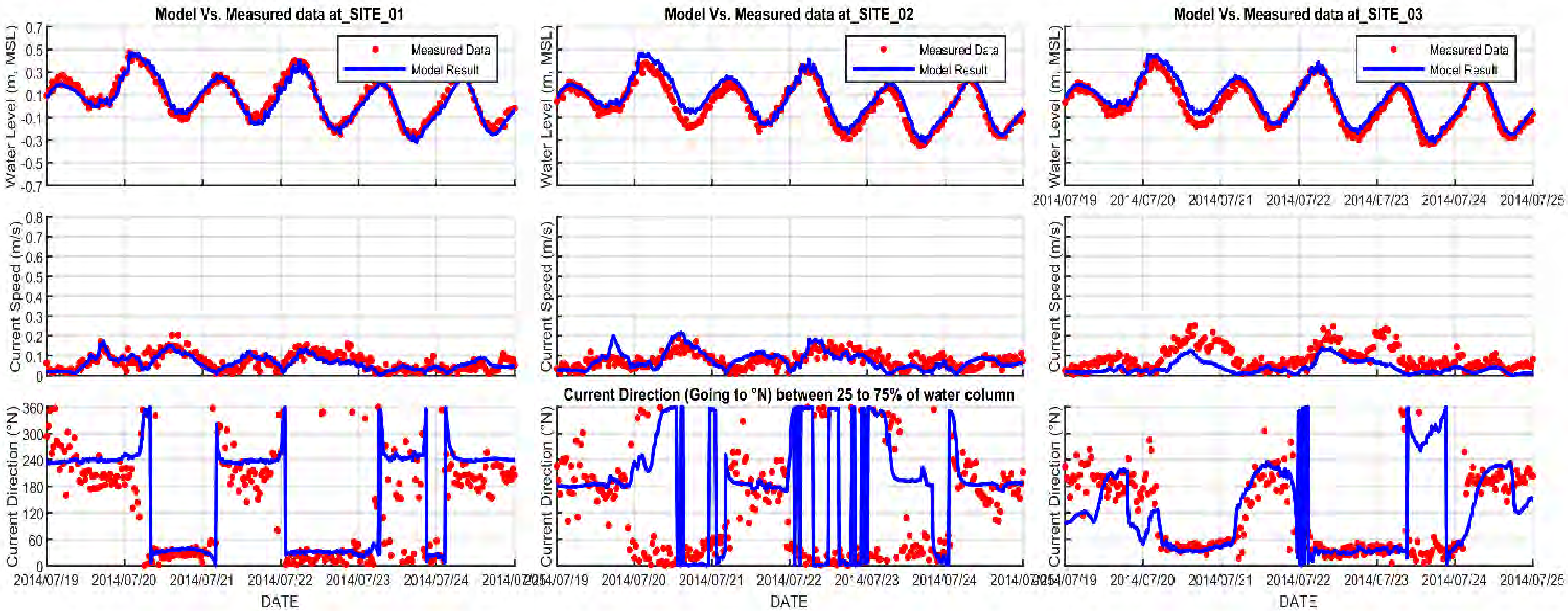

Figure 2-4 Validation of modelled water level (top), current speed (middle) and current direction (bottom) with measured data at three sites

2.3 Dredge disposal plume modelling

2.3.1 Dredged material characteristics

The particle size distributions (PSD) for materials to be dredged were obtained from the environmental sampling report (BMT 2019). Three particle fractions of sand, silt and clay were simulated to assess the dispersion and fate of the dredge discharge plume. A weighted average distribution of the sediment fractions was calculated based on the PSD of sediment samples and the volume of dredging at each area (Table 2.1). The volume of dredging for each area was obtained from the dredge design drawing BMT 1705-26-02_RevA (Appendix A).

The settling velocity for each of the particle fractions applied in the numerical model is tabulated Table 2.1. The settling velocities have been nominated conservatively to represent the settling process and for all the fractions are consistent with, or lower than settling velocities used on Wheatstone project as in Sun et al. (2016).

Table 2.1 Composition of modelled dredge material

Sediment Type	Grain Size (µm)	Composition (%)	Settling Velocity (mm/sec)
Sand	>63	96.0	10
Silt	4-63	3.9	1
Clay	0-4	0.1	0.05

2.3.2 Discharge of dredged material to the disposal area

The simulation mirrors the anticipated practice for discharge of dredged material. Dredged material is released within the proposed offshore disposal area (Figure 2-5) The discharge point is moved gradually within the boundary of the disposal area. In the plume modelling simulations, the dredge disposal is released within the top two metres of the water column.

Parameters for dredging operations used as inputs to the plume model are summarised in Table 2.2. It has been conservatively assumed that the dredge will work seven days a week (rather than the typical five) and 12 hours per day. There is no allowance for dredge standby (e.g. due to weather) and shorter hours (e.g. mechanical maintenance or during weekends) in this assessment.

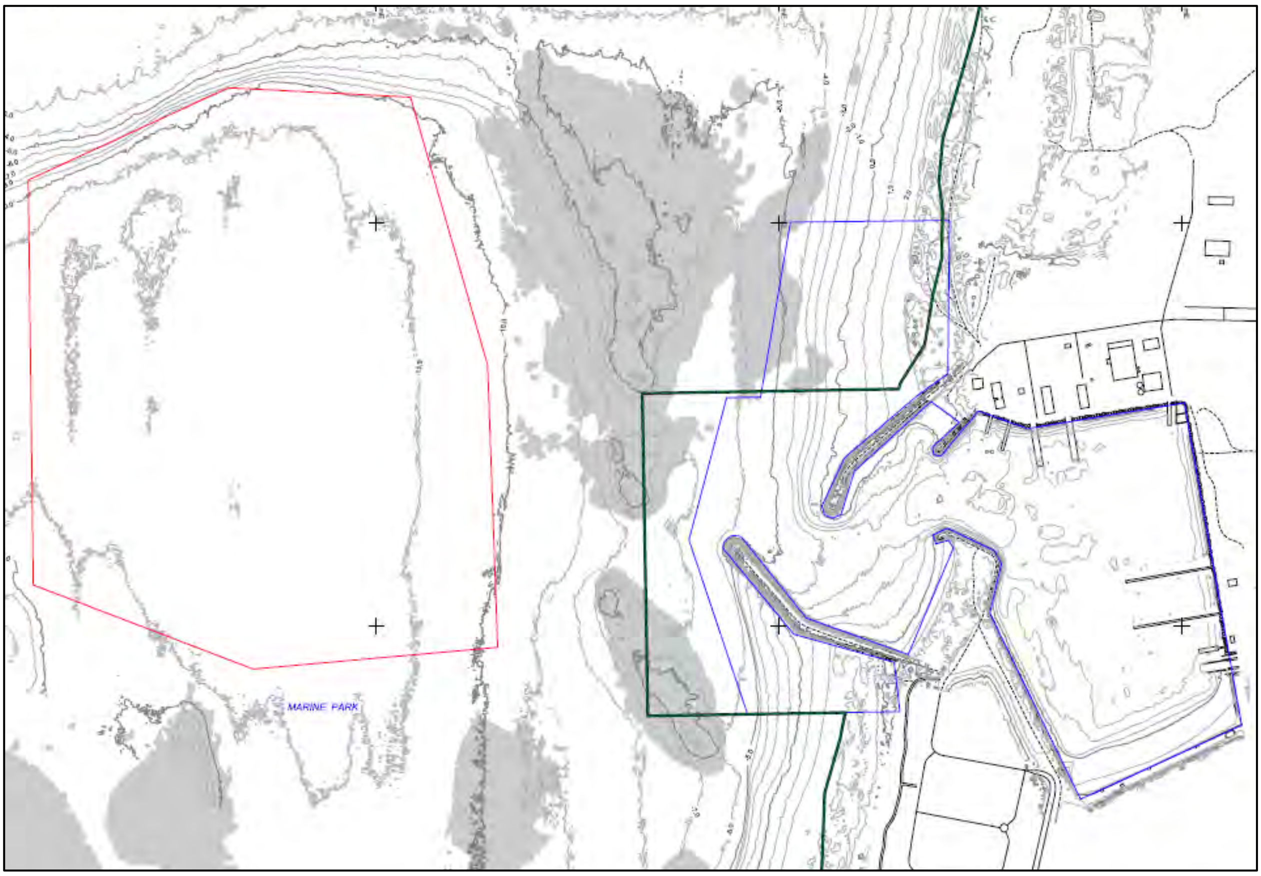

Figure 2-5 Dredging area (blue), offshore disposal area (red) and Jurien Bay Marine Park boundary (green)

Table 2.2 Dredging operation parameters used in the plume modelling

Parameter	Value	Unit
Production rate	100	m^3/hr
Operating days	7	days/week
Dredging hours	12	hours/day

2.3.3 Conditions during dredging

The available measured wind data from 2014–2018 was reviewed and winds during November were identified as representative of the variety of wind conditions over the period of future maintenance dredging campaigns (over spring and summer). Maintenance dredging at JBBH has been consistently completed between October and March. Figure 2-6 shows the monthly wind roses of the measured data at Jurien Bay, as shown the wind characteristics of November are representative for the nominated periods of maintenance dredging.

The period of November 2017 was selected for the simulation to assess the likely dredge plume fate dispersion. November 2017 was selected for the plume modelling period as it incorporates a range of weather conditions likely to be experienced during the dredging campaigns. These conditions include the occasional spring storm (cold front), periods of 1-3 days of light winds, and the summer daily cycle of morning easterly winds and afternoon south-westerly sea breeze (Figure 2-7).

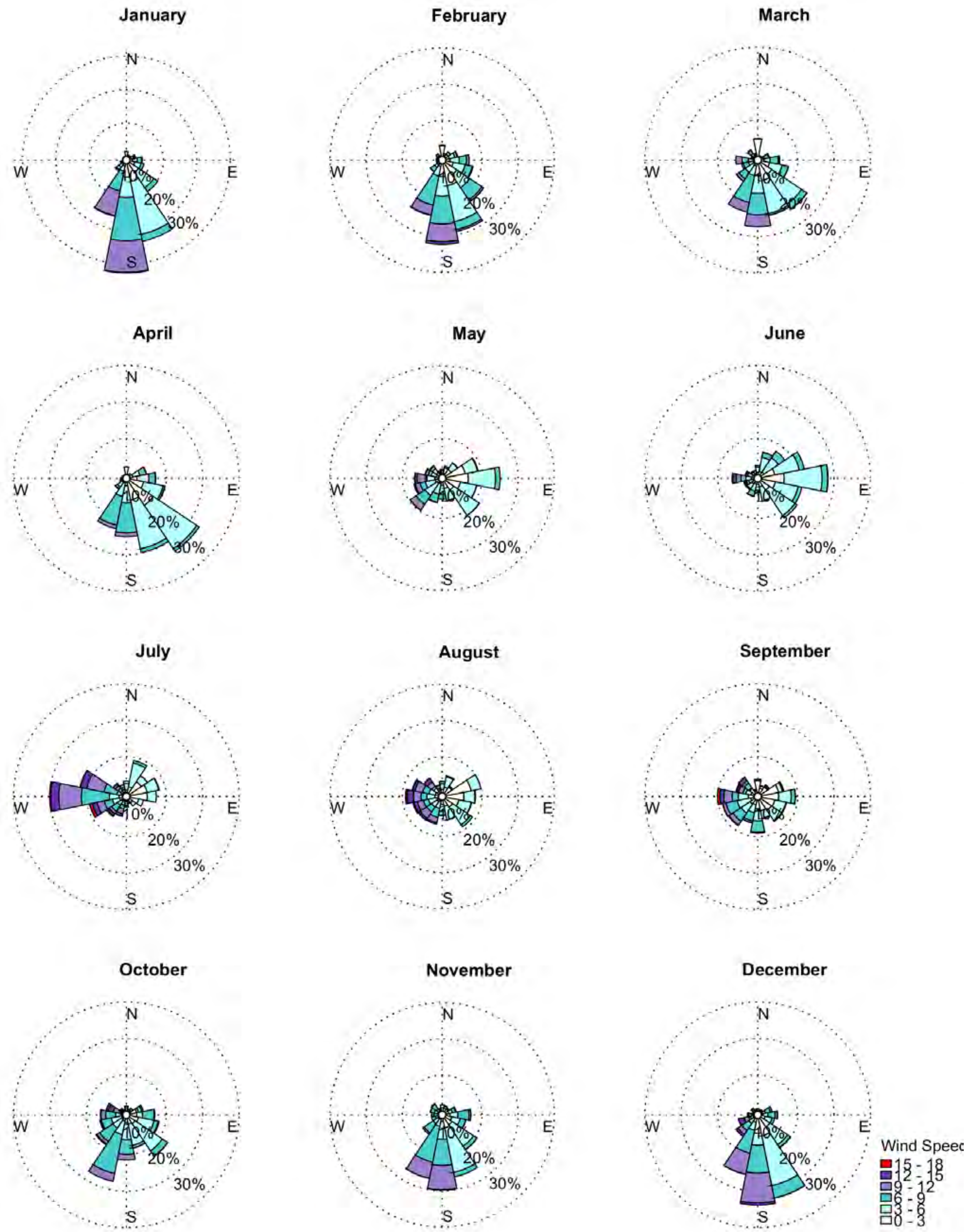

Figure 2-6 Wind roses (m/s) of available measured data at Jurien Bay (May 2014 to Feb 2018)

The results of the assessment are presented in Section 3 of this report.

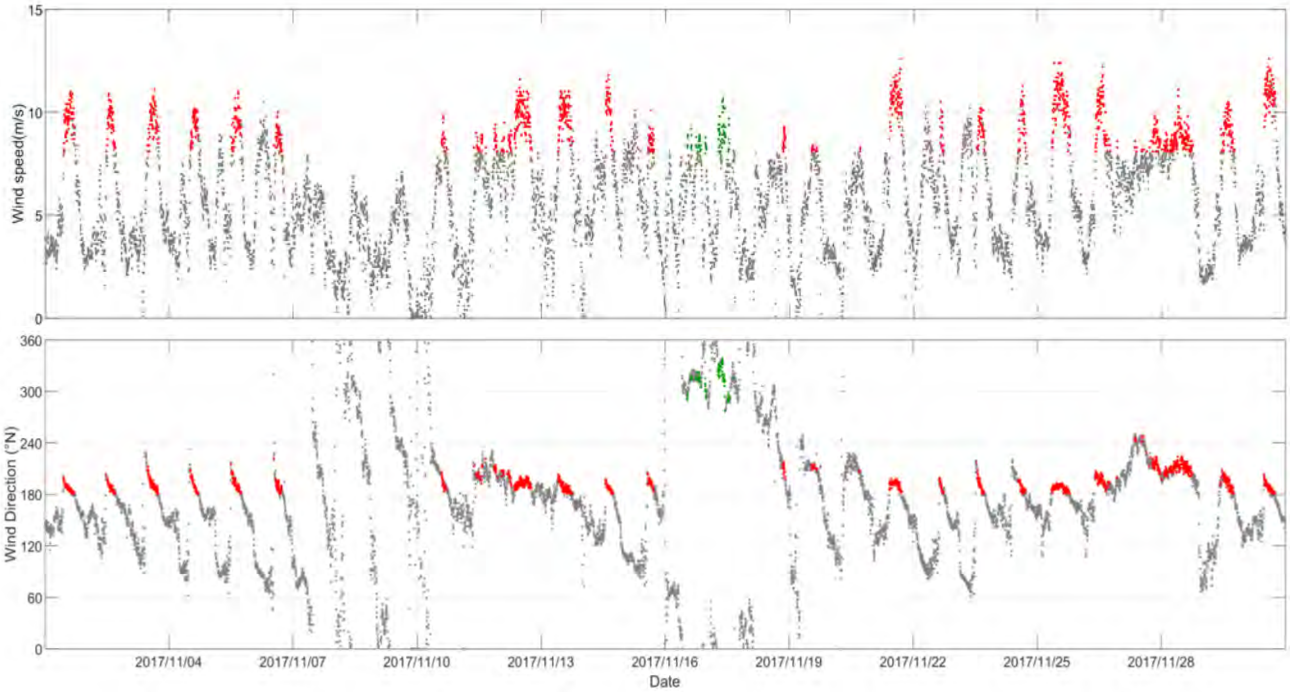

Figure 2-7 November 2017 wind time series. (red indicates wind speed >8 m/s between 180-270 degrees; green indicates wind >8 m/s between 270-360 degrees)

2.4 Disposal area stability assessment

The stability of the proposed dredge disposal area was assessed under severe storm forcing conditions, during which larger waves and stronger currents have the potential to remobilise dredged material placed on the seabed within the offshore disposal area. The assessment was carried out for the design fill level of -8mCD at the proposed disposal area. This level has been estimated to accommodate 10–12 dredging campaigns over ~15–20 years based on the historical maintenance dredging volumes. In the model, the seabed level within the disposal area was raised to the level of -8 mCD (~4 m above the existing bed level). The raised disposal area at -8 mCD hereafter in this report is referred to as the filled disposal area.

2.4.1 Seabed composition at the filled disposal area

To assess the stability of the filled disposal area, it was conservatively assumed that prior to the storm the seabed material would have the same sediment composition as the dredged material. This assumes that no fine material will be dispersed out of the proposed disposal area during the dredging and discharge operation.

In reality, and as demonstrated by plume modelling (Section 3), a portion of the fine sediment fraction (e.g. silt and clay) discharged will disperse out of the disposal area before settling to the seabed and, therefore, the remaining materials at the seabed within the disposal area will contain less fines and will be less prone to sediment resuspension and movement. To isolate the sediment movement only for the filled disposal area, the seabed material for areas outside the disposal area was configured as a non-erodible bed.

2.4.2 Acute storm scenario

2.4.2.1 Selection of the acute storm event

The storm scenario modelled was selected based on review of historical wind data at Jurien. Wind speed and direction recorded from 18/5/2016 to 16/6/2016 is shown in Figure 2-8. During the survey period a major storm occurred on 21/5/2016 with a period of almost 12 hours where winds greater than 10 m/s blew with a northerly component, with a northerly maximum of 20.3m/s. The wind direction then swung rapidly to the southwest with speeds exceeding 10 m/s for another 12 hours, with a southerly maximum of 21.8 m/s. Although there were other wind events during the survey period only on 24/5/2016 were winds from the northwest, exceeding 10 m/s for 6 hours, with a maximum speed of 14.3 m/s. Remaining events were relatively short and do not well represent the potential of northerly storms.

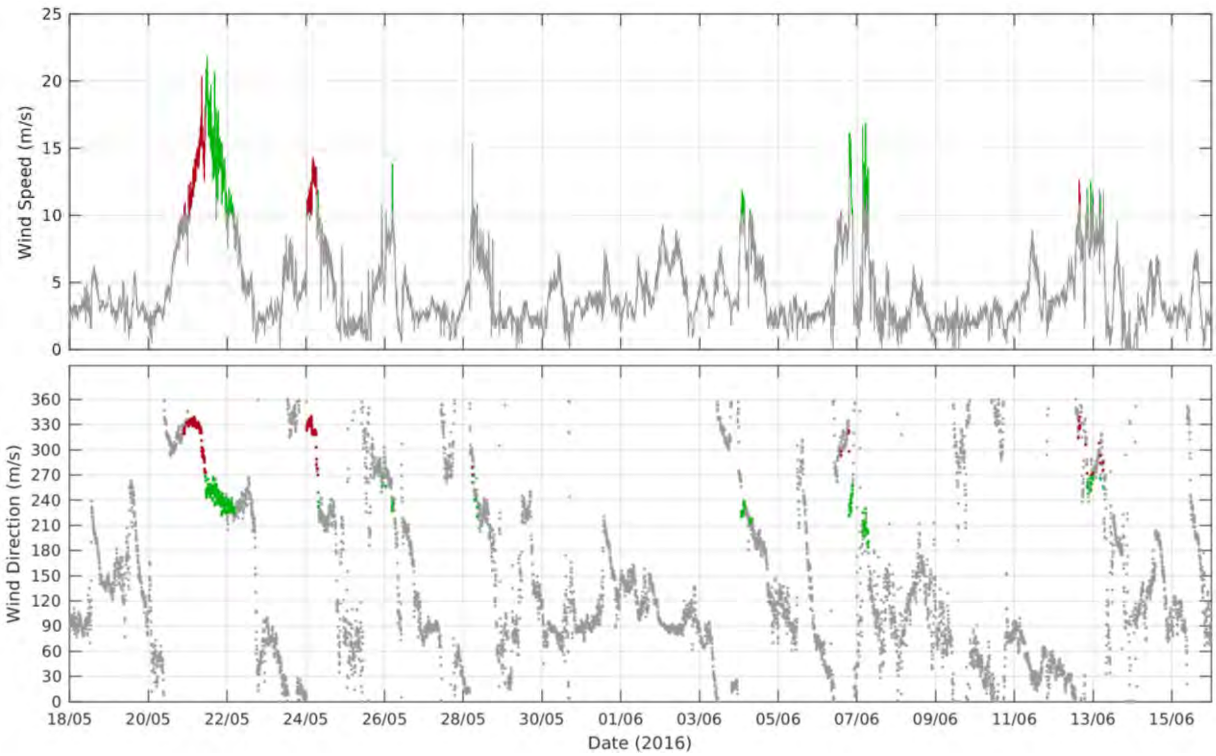

Figure 2-8 Jurien wind 18/5/2016 to 16/6/2016 (red indicates wind speed >10 m/s between 180-270 degrees; green indicates wind >10 m/s between 270-360 degrees)

The period from 20/5/2016 to 23/5/2016 was selected as the condition for the disposal area stability assessment runs and is shown in Figure 2-9.

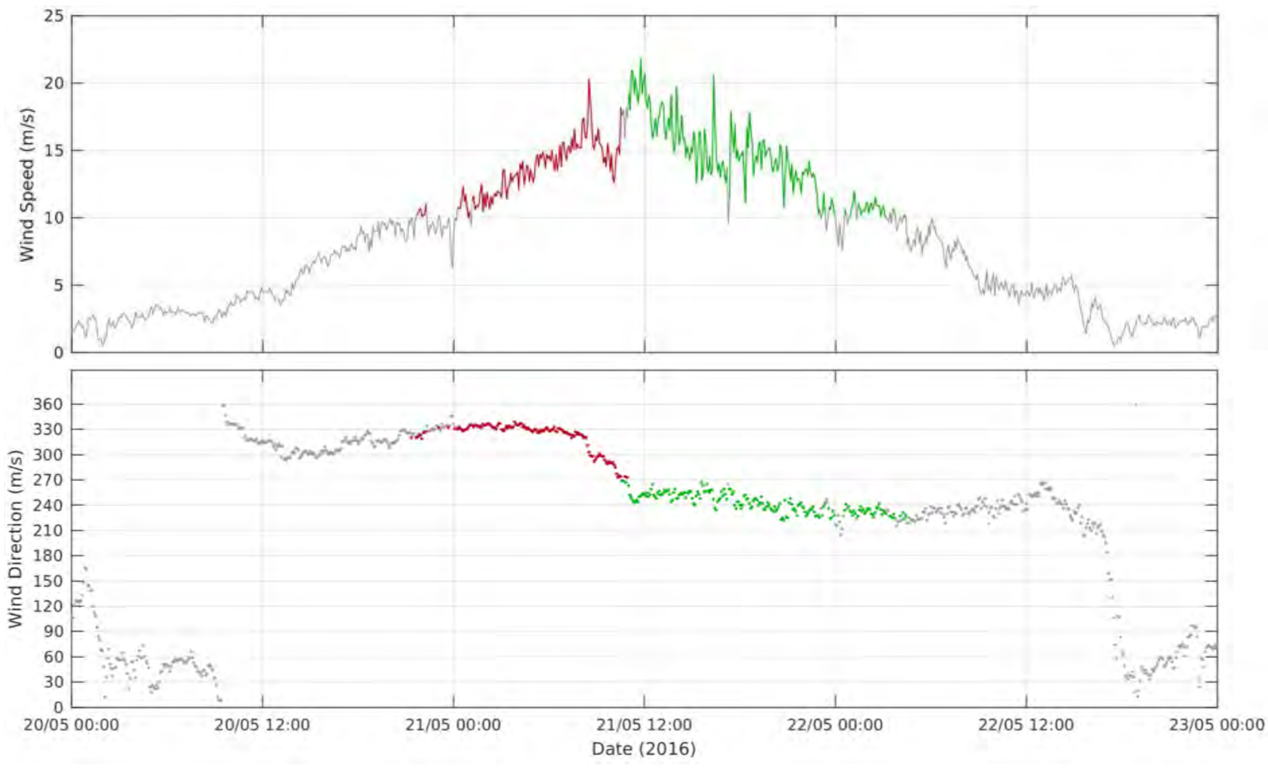

Figure 2-9 Wind speed and direction measured at Jurien Bay used for the modelled storm (20-23 May 2016)

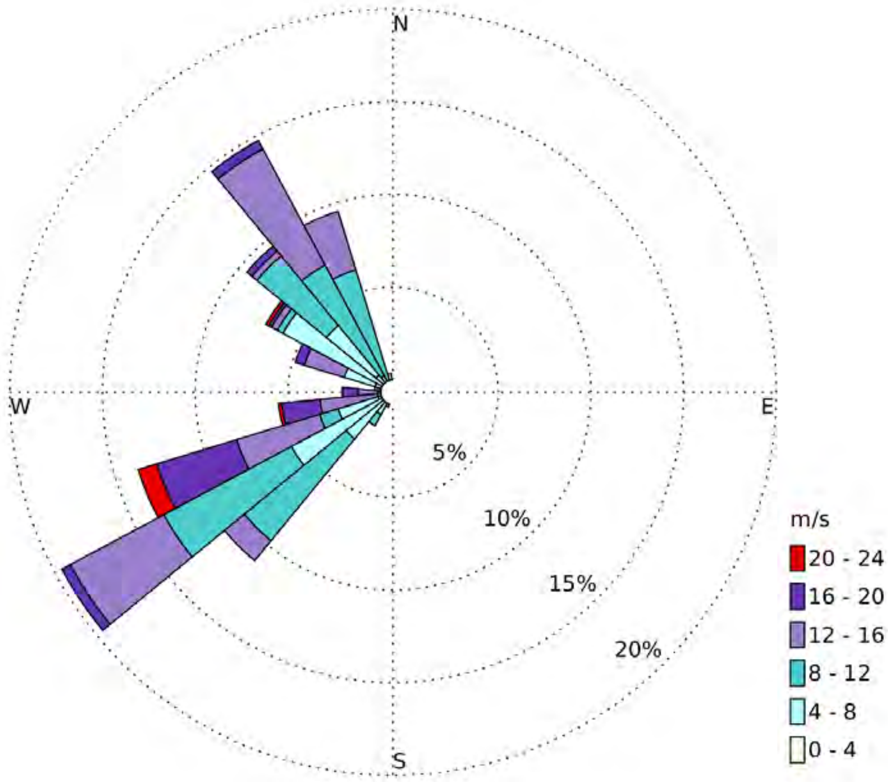

Figure 2-10 Wind rose for the modelled storm (20-23 May 2016)

2.4.2.2 Review of the measured wave data over the acute storm period

Figure 2-11 demonstrates the measured wave height, direction and period over the selected acute storm period at Jurien Site 01-West AWAC location which is the closest instrument to the proposed disposal area (instrument location shown on Figure 2-3. The instrument head depth is approximately -8 m CD which is close to the design fill level of -8mCD at the proposed disposal site.

As shown the significant wave height of ~1.6 m has been captured at the peak of the storm. To demonstrate the likelihood of such a severe event, all the available measured wave data over the period of March 2014 to October 2017 was analysed. Figure 2-12 and Figure 2-13 illustrate the wave roses of the measured wave height and period over the noted period. As shown the predominant wave energy sectors at the instrument location are the north west and westerly sectors. This is partially due to the fact that the nearshore reefs provide sheltering against the southerly sea waves and south westerly swell conditions.

Figure 2-14 presents the exceedance curve of the measured total significant wave height over the noted period of 3.5 years (March 2014 to 2017 October). Approximately 99% of the time the omnidirectional significant wave height at the disposal area is below 1.0 m. The review of the measured wave data also supports that the selected 2016 storm condition with the wave height of approximately 1.6 m is a very rare extreme storm at the disposal area.

As shown the selected storm period 20/5/2016 to 23/5/2016 represents the range of wind and wave conditions considered to be most important for sediment transport, namely strong winds from the northwest, west and southwest. The result of the disposal area stability assessment is presented in the next section.

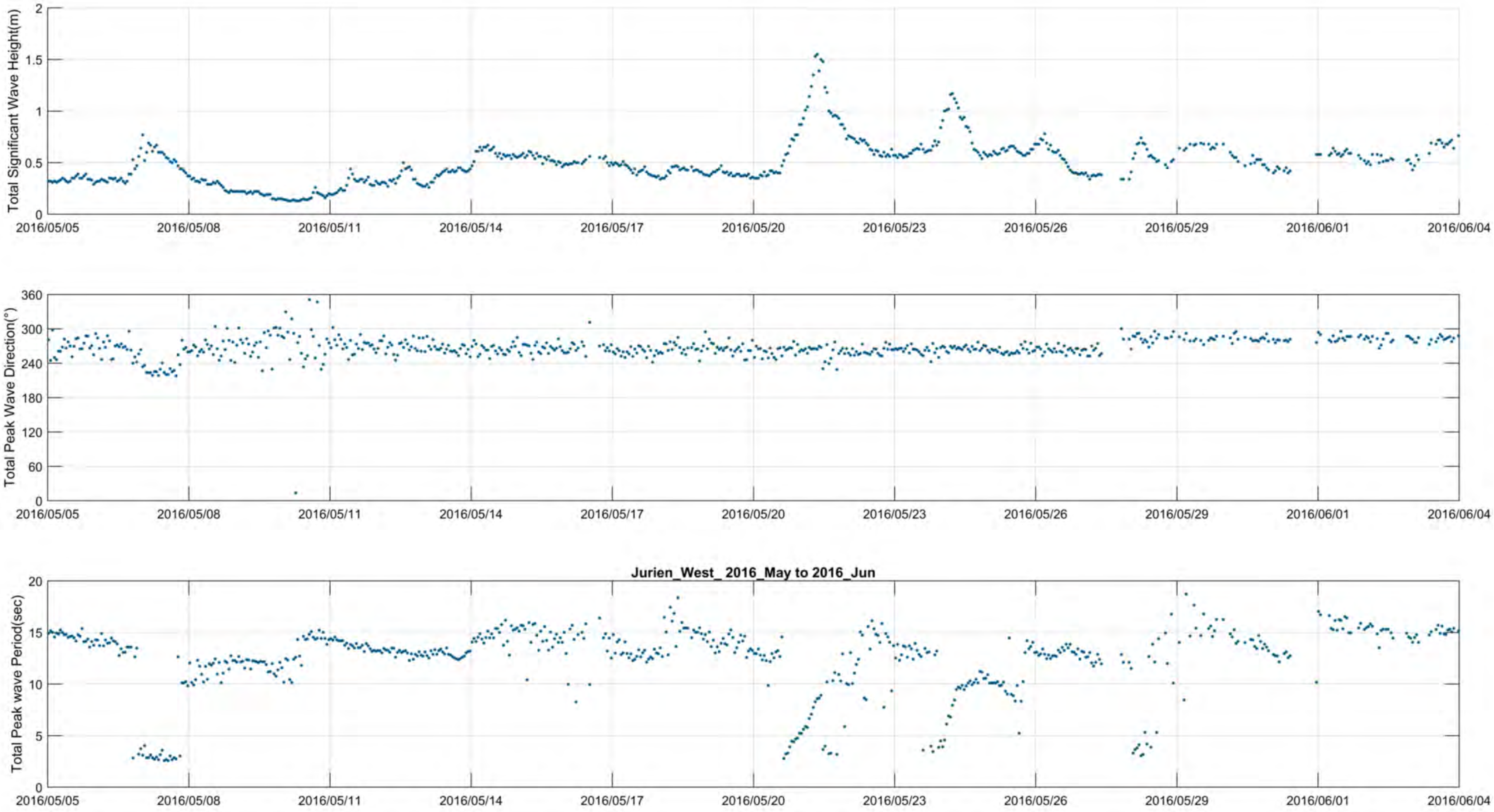

Figure 2-11 Time series of the measured wave height, period and direction during 2016 storm at Jurien Site 01-West AWAC

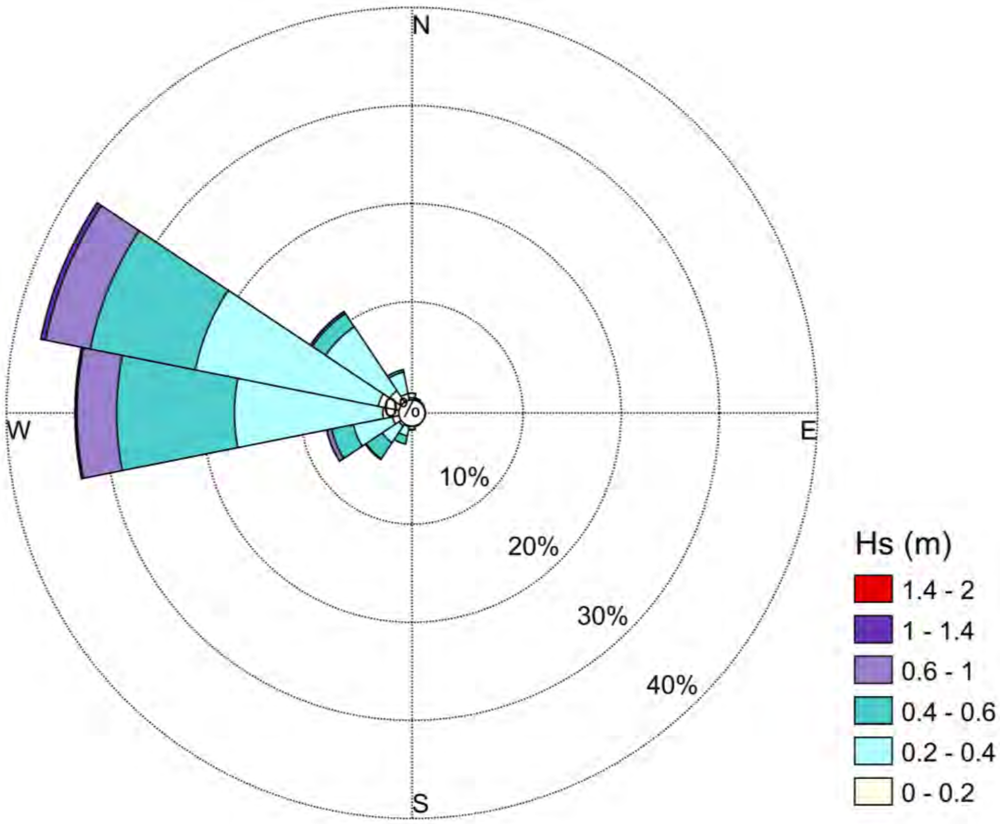

Figure 2-12 Significant wave height rose at Jurien Site 01-West AWAC (available measured data from March 2014 to October 2017)

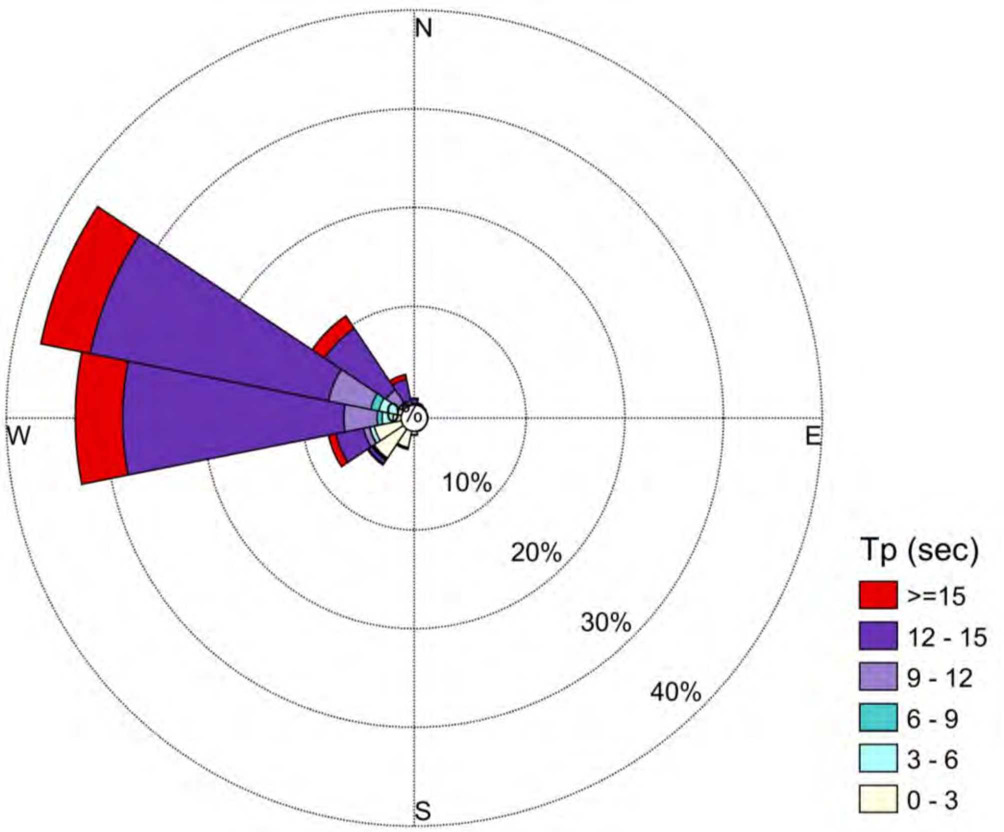

Figure 2-13 Peak wave period rose at Jurien Site 01-West AWAC (available measured data from March 2014 to October 2017)

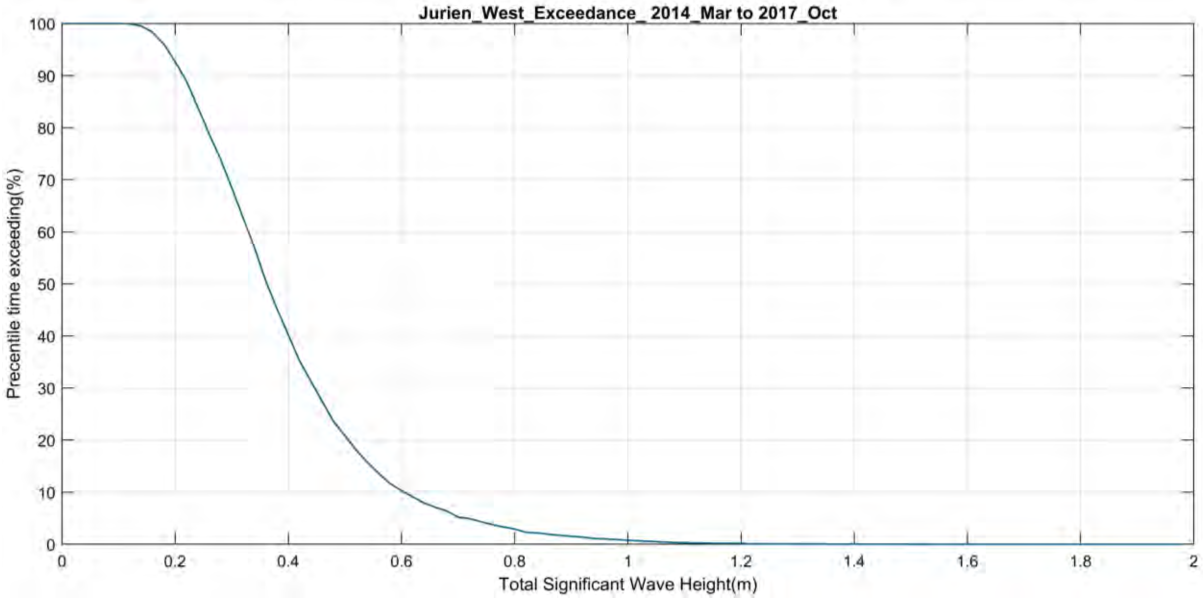

Figure 2-14 Exceedance curve of significant wave height at Jurien Site 01-West AWAC (available measured data from March 2014 to October 2017)

3 Modelling Results

3.1.1 Dredge plume modelling assessment

Spatial plots of 90th and 95th percentile plots (10% and 5% exceedance levels respectively) of the Total Suspended Solid (TSS which is a representative measure of the plume sediment concentration) are presented in Figure 3-1 and Figure 3-2. The TSS exceedance plots demonstrate a tendency for the sediment plume to advect more toward the north of Jurien Bay (compared to the southward plume extent). This behaviour is likely influenced by the predominant southerly winds, in addition the southern section of Jurien Bay being partially sheltered from the dominant south westerly swell direction (due to the nearshore reef, Fisherman Islands and Favourite Bank) as opposed to the north section of Jurien Bay where swells and south westerly seas can penetrate into the bay, while experiencing less reduction due to sheltering (BMT 2017).

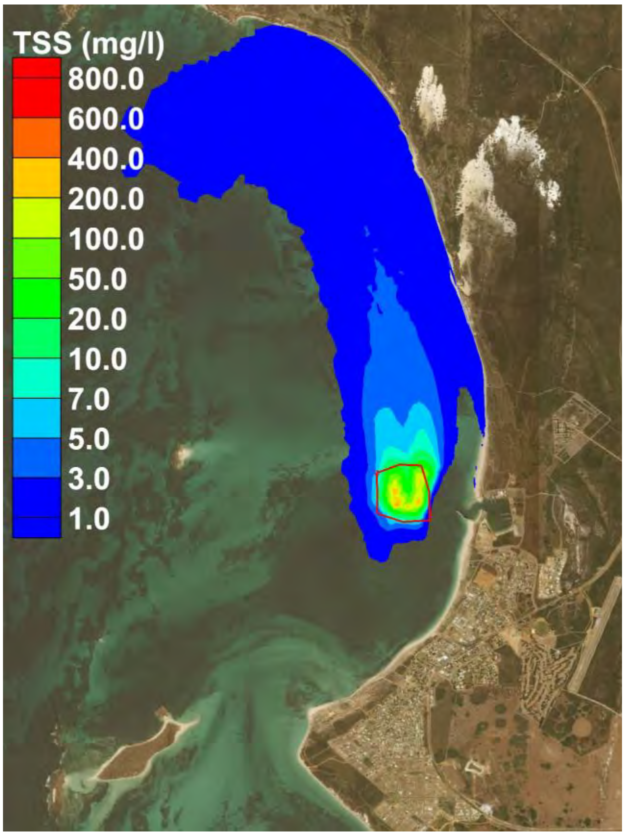

Figure 3-1 95th percentile TSS contours (5% of time exceedance). Red polygon shows the designated proposed dredge disposal area

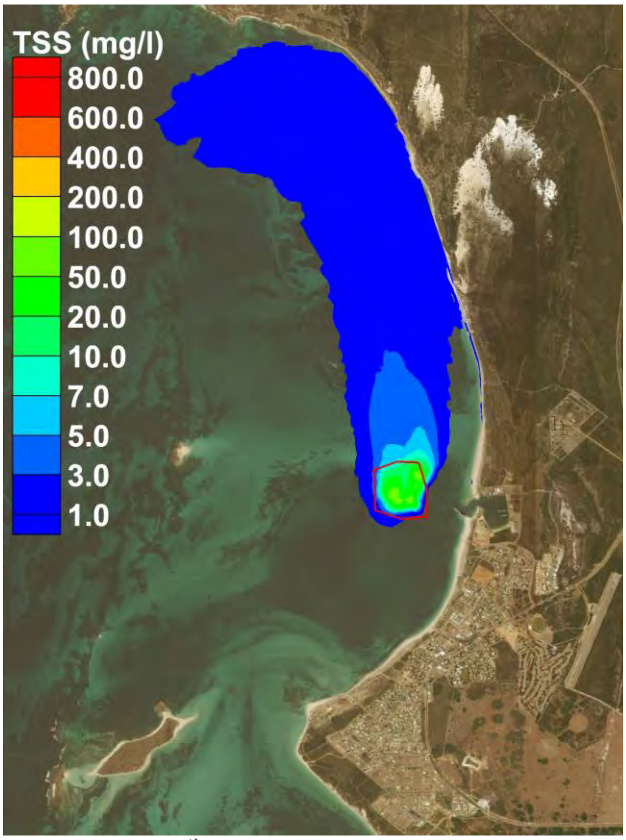

Figure 3-2 90th percentile TSS contours (10% of time exceedance). Red polygon shows the designated proposed dredge disposal area.

Figure 3-3 shows the simulated seabed sedimentation levels at the end of dredge plume scenario. The model results show that approximately 90% of the dredge disposal material settled within the footprint of the designated disposal area.

The dredge plume simulation results demonstrated that although the November 2017 simulation period is relatively energic (which could potentially result a more persistent plume, greater plume extent, and delayed particle settlement), every day during the 12 hours of no-dredging, TSS levels reduced below 5 mg/L a few hours after stopping the daily dredging operation. Most of the suspended solids settled overnight and on the next day the remaining TSS level in the water column was minimal (below 1 mg/L) prior to recommencement of dredging operations. Figure 3-5 and Figure 3-6 show the modelled TSS timeseries during the dredge plume scenario at three points located at 0 km, 0.5 km and 1.5 km south of the disposal area and three points located 0 km, 1.5 km and 3 km north of the disposal area (locations shown on Figure 3-4).

These modelling results will subsequently be mapped and compared against the trigger levels for the sensitive environmental receptors as part of the DEIA scope of work.

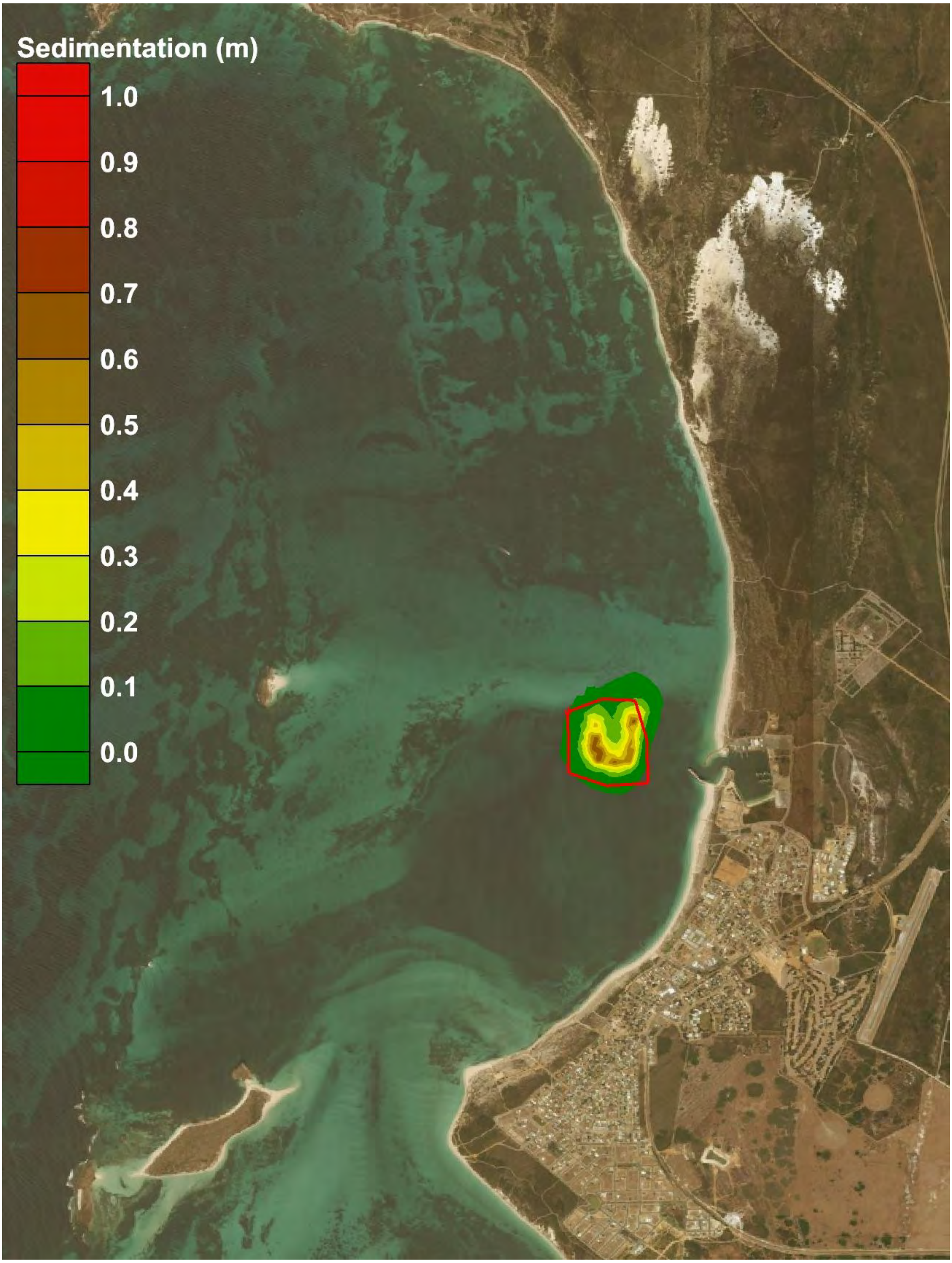

Figure 3-3 Seabed sedimentation thickness at the end of the plume simulation (red polygon shows the proposed dredge disposal area)

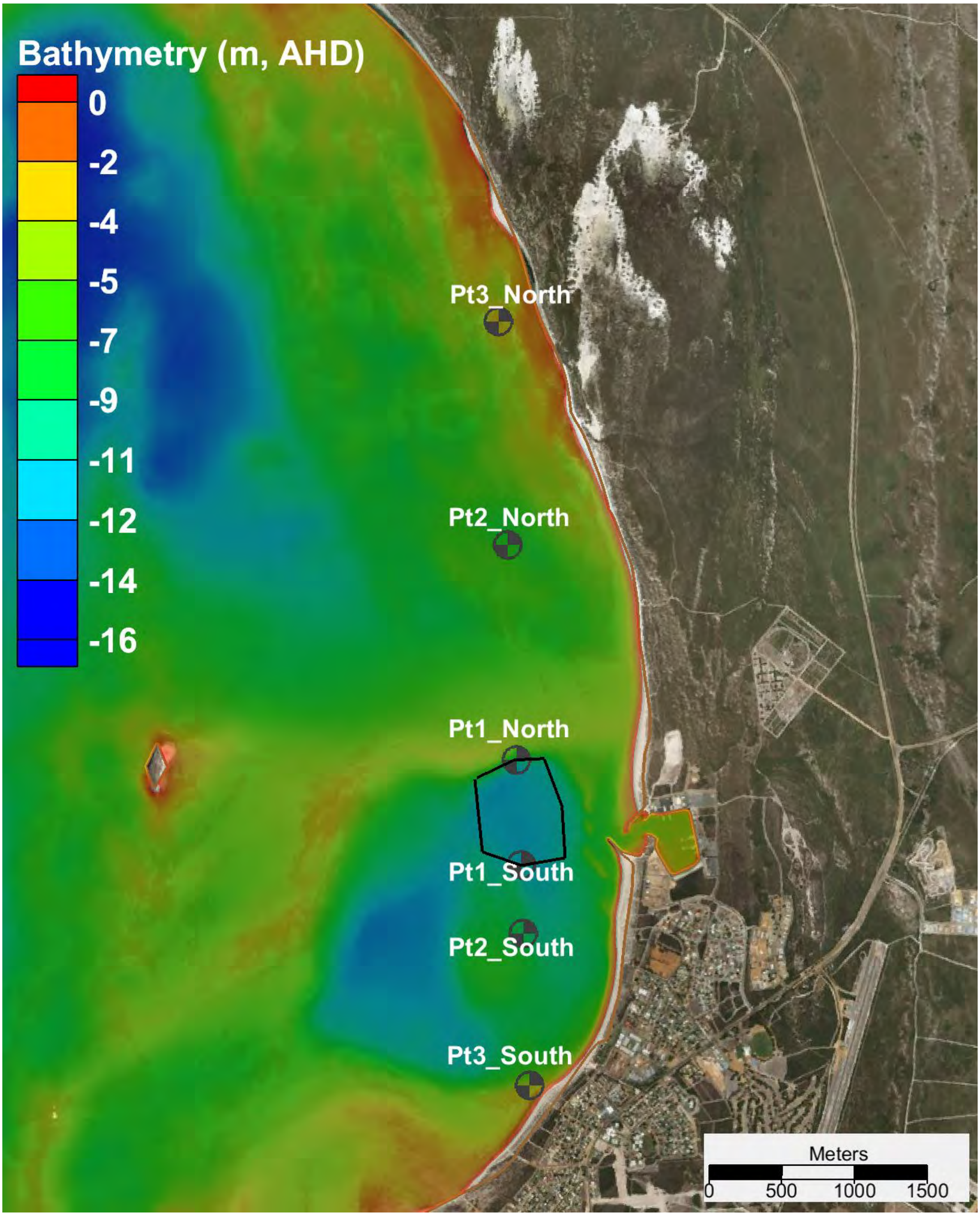

Figure 3-4 Locations of extracted TSS time series north and south of the disposal area

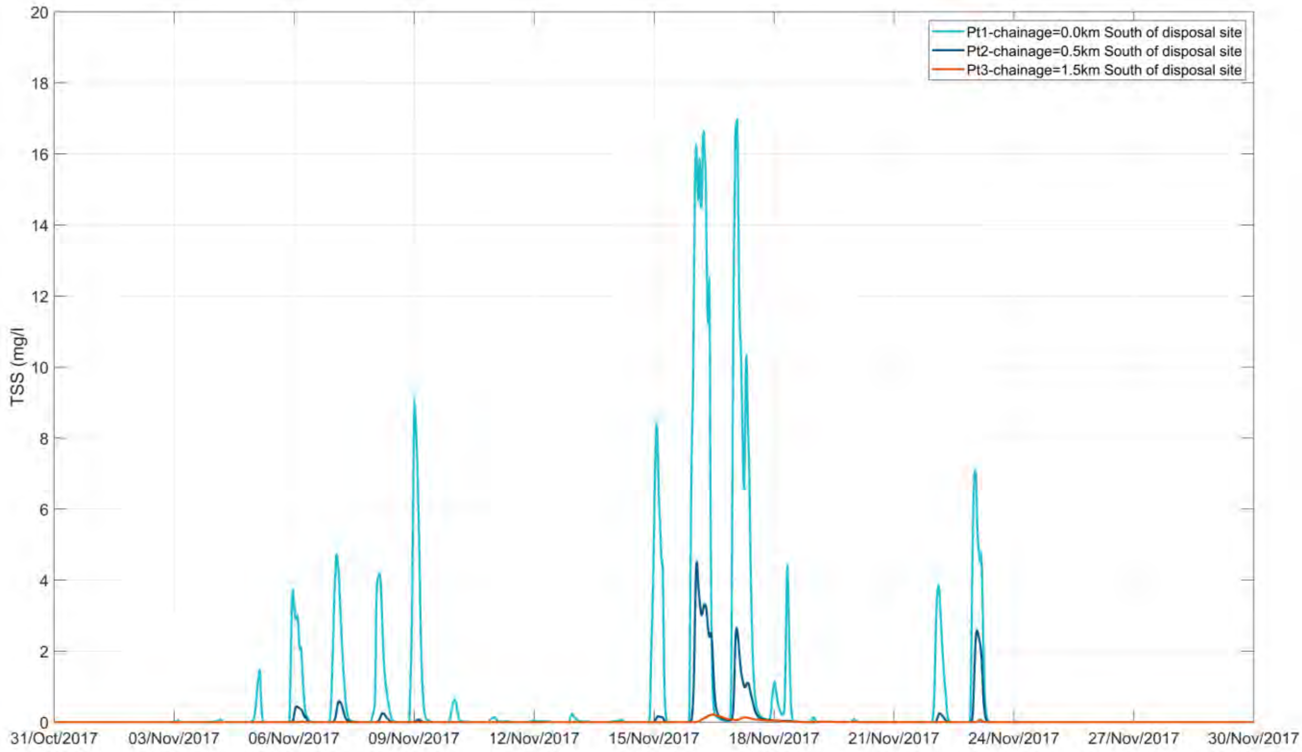

Figure 3-5 Modelled total suspended solids time series at points south of the disposal area during the plume modelling period (location of the points demonstrated in Figure 3 4)

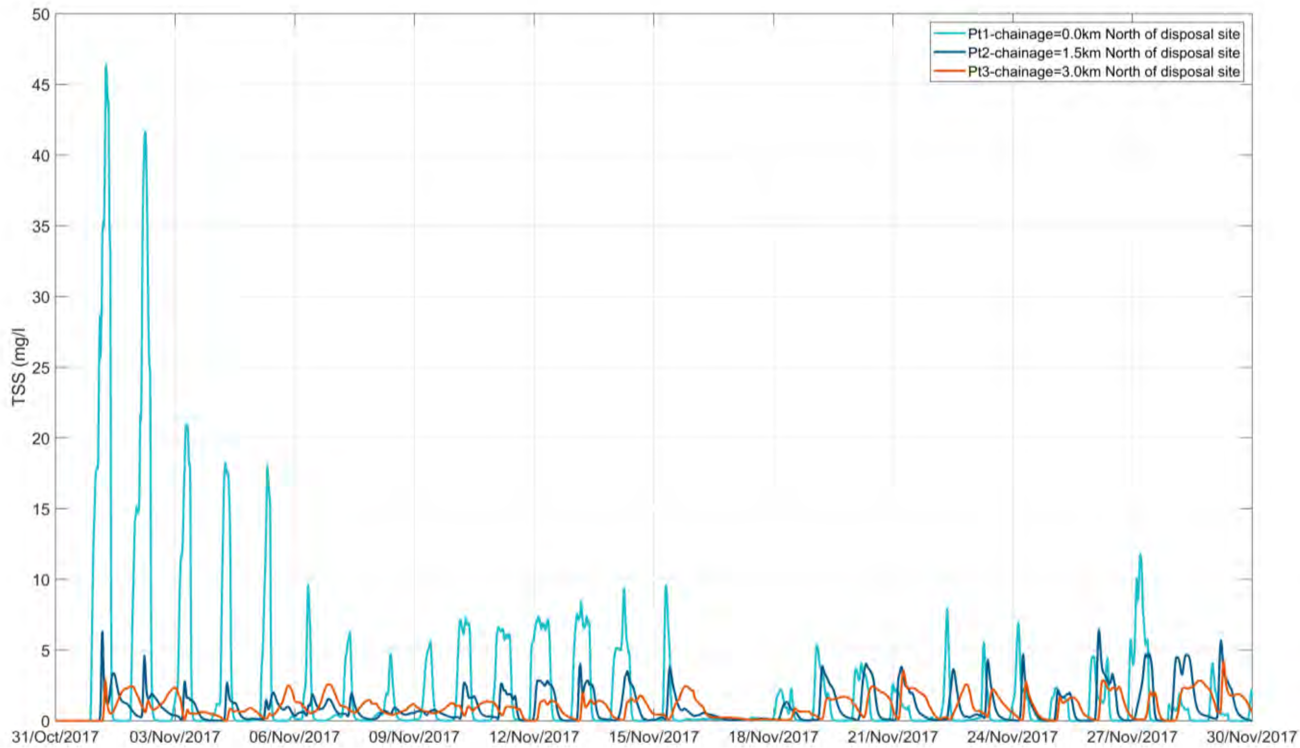

Figure 3-6 Modelled total suspended solids time series at points north of the disposal area during the plume modelling period (location of the points demonstrated in Figure 3 4)

3.1.2 Disposal area stability

The result of the acute storm simulation indicated that the filled disposal area is stable under both the northerly and southerly severe storm conditions. The storm simulations resulted in no erosion or change to the bed levels of the disposal area. The resuspension of the fine materials from the disposal area due to the storm activities is minimal with TSS from resuspended sediment being less than 0.1 mg/L at both the at northern and southern boundaries (Figure 3-7 and Figure 3-8).

The model results demonstrated that the natural shallow areas in the vicinity of the disposal area, including the sand bar and beaches in the Jurien Bay are experiencing significantly higher bed shear stress compared with the filled disposal area and therefore, are more prone to erosion and sediment mobility. This suggests that the proposed offshore disposal area may still remain stable if the design fill level is raised above -8 mCD, providing additional capacity for disposal of maintenance dredging material in future. If required, the model can be used to assess the maximum fill level at which the disposal area is stable, and the resuspension level of the sediments is yet below the trigger level of the receptors.

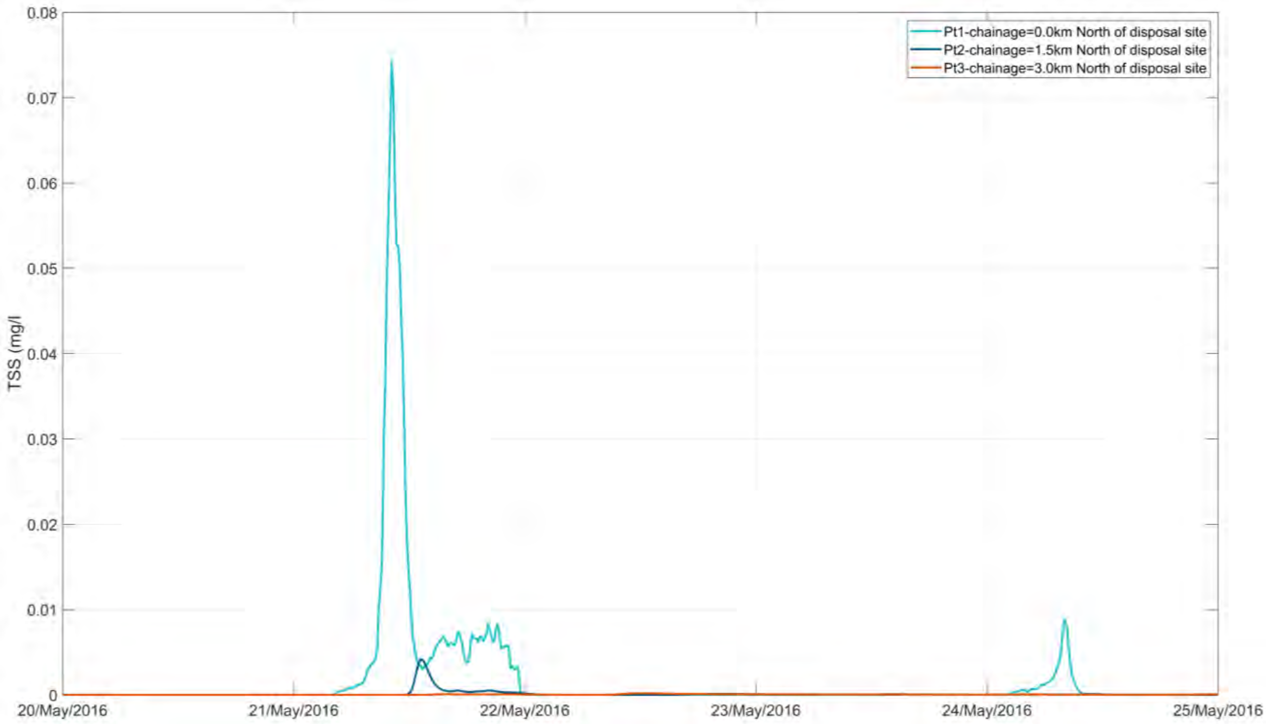

Figure 3-7 Time series plot at the northern boundary of the disposal area over the acute storm event (location of the points demonstrated in Figure 3-4)

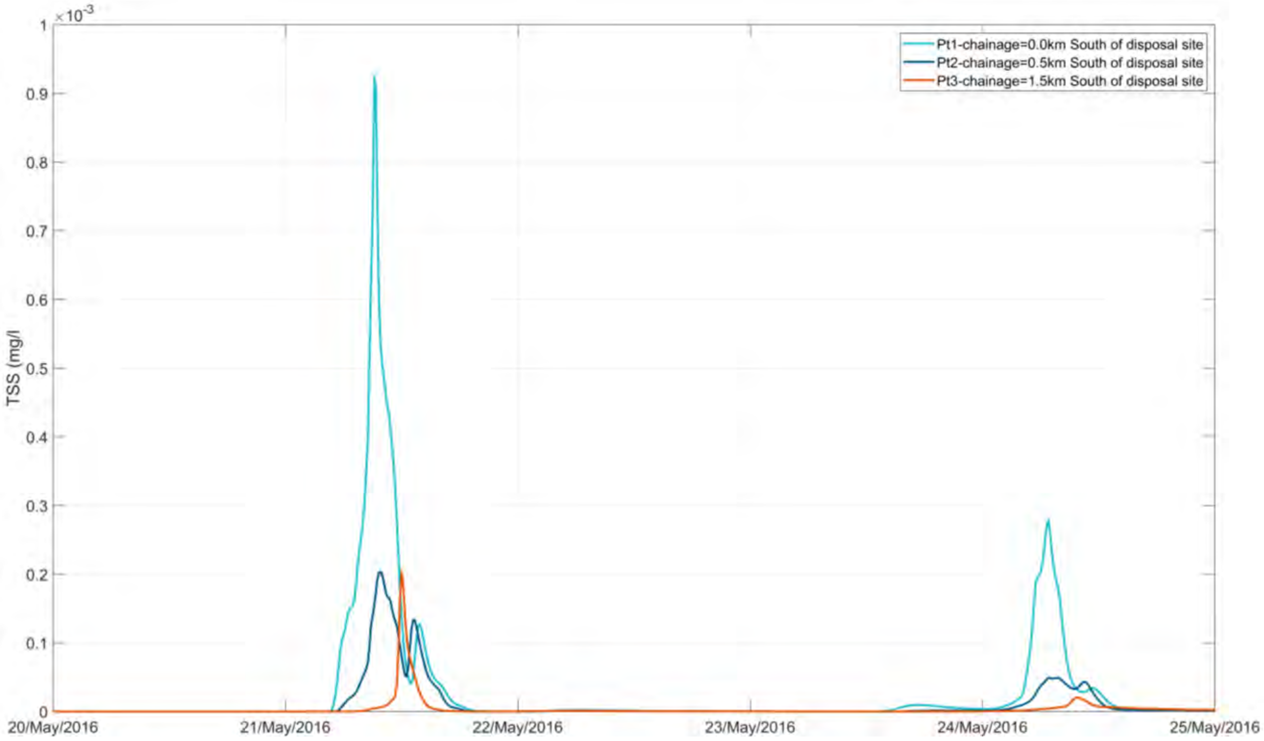

Figure 3-8 Time series plot at the southern boundary of the dredge disposal over the acute storm event (location of the points demonstrated in Figure 3-4)

4 Summary

A numerical modelling study was carried out to assess the likely dredge plume dispersion and stability of the filled disposal area. BMT previously calibrated wave and hydrodynamic modelling framework was used for this study. A representative period of one month was simulated to assess the likely dredge plume fate dispersion. The particle size distributions for materials to be dredged were obtained from the environmental sampling report and used to define the dredge disposal release source.

The dredge plume simulation results demonstrated that TSS level every day reduces below 5 mg/L a few hours after stopping the daily dredging operation (12 hours/day). Most of the suspended solids settle to the seabed overnight and the remaining TSS level in the water column is minimal (below 1 mg/L) prior the dredging operation start on the next day. The model results were used to prepare spatial exceedance maps of TSS and identifying the likely area of impact due to the dredge disposal.

Stability of the dredge disposal area under acute storm conditions was also assessed using the above noted sediment transport modelling framework. The stability assessment was carried out over acute storm conditions which cover the main storm characteristics at Jurien Bay (Including northerly, westerly and southerly storm winds). The modelling results demonstrated that the filled disposal area to the design level of -8 mCD was stable over the simulated acute storm conditions. The storm simulations resulted in no erosion or change to the bed levels of the disposal area. The resuspension of the fine materials from the disposal area was minimal due to the storm activities. The model results demonstrated that the natural shallow areas away from the disposal area, including the sand bar and beaches of Jurien Bay experience significantly higher bed shear stress compared with the filled disposal area (filled to -8 mCD) and therefore are more prone to erosion and sediment mobility.

5 References

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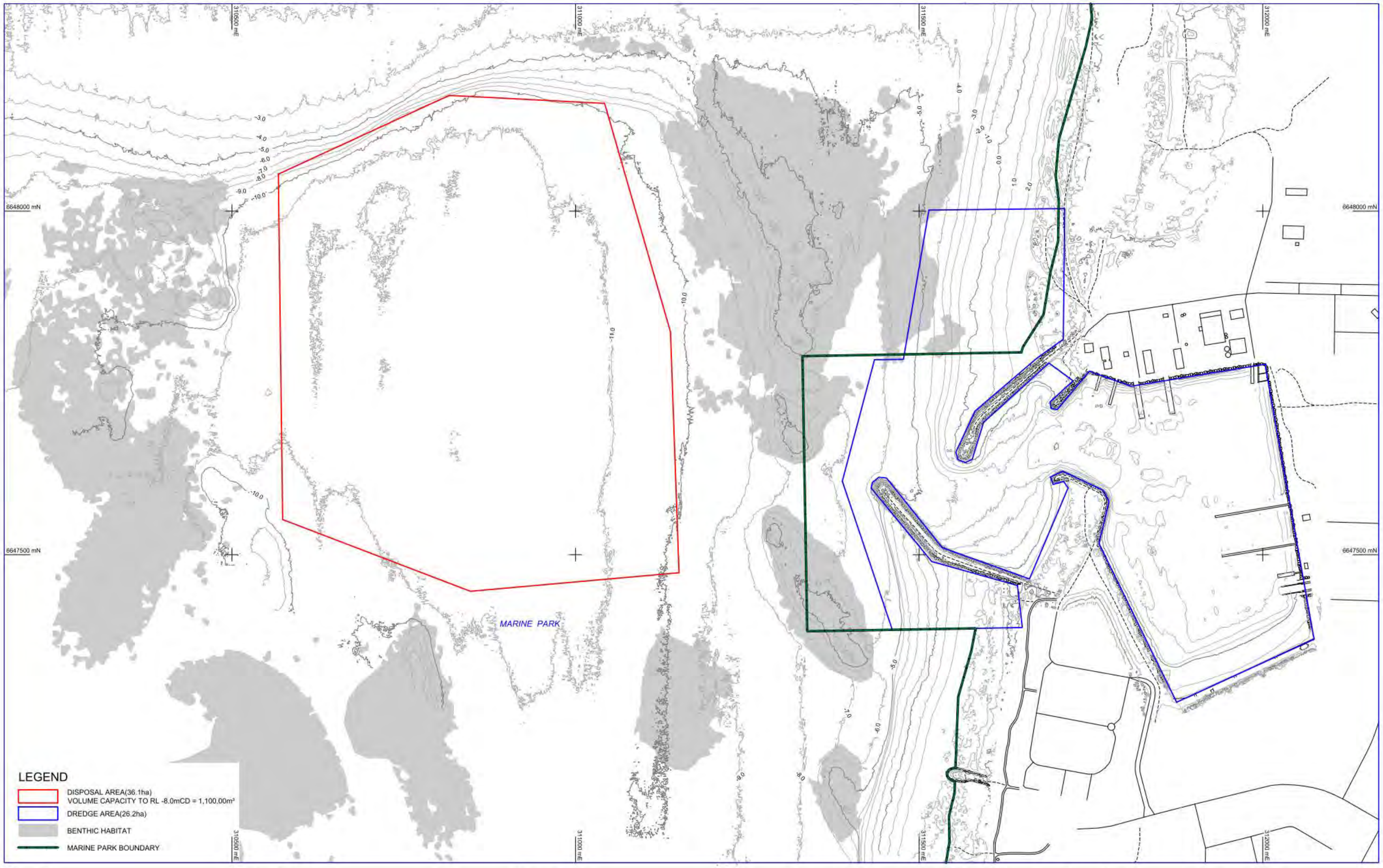
Appendix A Drawings



A	06/02/19	INITIAL ISSUE	SM	
REV	DATE	AMENDMENT	DRN	APP

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NOTES

1. CONTOURS FROM 4 SEPTEMBER 2018 SURVEY
2. 4 SEPTEMBER 2018 SURVEY DATA FROM FILE JU20180904_Combined.pro RECEIVED ON 26 SEPTEMBER 2018
2. BENTHIC HABITAT AREAS FROM: JURIEN BAY BENTHIC HABITAT MAPPING. PREPARED FOR DEPARTMENT OF TRANSPORT BY BMT, REPORT NO. 444_07_001/1_REV1, PERTH, WESTERN AUSTRALIA

SCALE 1 : 2500

50 0 200 METRES

DATUM

VERTICAL: JURIEN BAY, LOWEST LOW TIDE 1982. 2.136m BELOW BENCHMARK, HLR 117. 0.88m BELOW AHD (2014).

HORIZONTAL: MAP GRID OF AUSTRALIA BASED ON GDA 94, ZONE 50

GDA

BebbCart

Government of Western Australia
Department of Transport
Spatial Information

BMT

ENGINEER	K.HEERA	06/02/2019
DRAWN	S.MOUCHEMORE	06/02/2019
DRAFTING CHECK	C.LIVINGSTONE	06/02/2019
ENGINEERING CHECK		
APPROVED PROJECT MGR		

JURIEN BAY BOAT HARBOUR
MAINTENANCE DREDGING
DREDGING AND OFFSHORE DISPOSAL SITES

DRAWING NUMBER 1705 - 28 - 01 REV A

Annex B Jurien Bay Boat Harbour Maintenance Dredging 2024 Sediment Sampling and Analysis Plan

Jurien Bay Boat Harbour – Long-term Maintenance Dredging Sediment Sampling and Analysis Plan

Customer	Department of Transport
Project	000607.001_022
Deliverable	R-000607.001-22
Version	0
Date	02 May 2024

Document Control

Document Identification

Title	Jurien Bay Boat Harbour – Long-term Maintenance Dredging Sediment Sampling and Analysis Plan
Project No	000607.001_022
Deliverable No	R-000607.001-22
Version No	0
Version Date	02 May 2024
Customer	Department of Transport
Customer Contact	S Mettam
Classification	BMT (OFFICIAL)

Author	H Farid
Reviewed By	A Kempton, L Synnot
Project Manager	A Kempton

Amendment Record

The Amendment Record below records the history and issue status of this document.

Version	Version Date	Distribution	Record
A	16 January 2024	S Law	Engineering review
B	28 March 2024	L Synnot	Editorial and Technical Review
C	24 April 2024	A Kempton	Editorial and Technical Review
D	01 May 2024	L Synnot	Director review
0	03 May 2024	S Mettam	Client review

Acronyms and Measurement Units

Acronyms	
ANZECC/ARMCANZ	Australian and New Zealand Environment and Conservation Council / Agriculture and Resource Management Council of Australia and New Zealand
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
ASS	Acid sulfate soils
BCH	Benthic communities and habitat
BTEX	Benzene, toluene, ethylbenzene and xylene
CALM Act	*Conservation and Land Management Act 1984*
CD	Chart Datum
CoC	Chain of Custody
COPC	Contaminants of Potential Concern
CPC	Conservation and Parks Commission
CSD	Cutter Suction Dredge
DBCA	Western Australian Department of Biodiversity Conservations and Attractions
DBT	Dibutyltin
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
DEIA	Dredging Environmental Impact Assessment
DGV	Default Guideline Value
DOC	Dissolved organic carbon
DoT	Western Australian Department of Transport
DWER	Western Australian Department of Water and Environmental Regulation
EDM	Environmental Data Management
EMF	Environmental Management Framework
EPSD Act	*Environmental Protection (Sea Dumping) Act 1981*
FRP	Filterable reactive phosphate

GIS	Geographical Information System
GPS	Global Positioning System
H_2S	Hydrogen sulfide
IC	Inorganic carbon
JHA	Job Hazard Analysis
JBMP	Jurien Bay Marine Park
LoR	Limit of reporting
LTMMP	Long Term Monitoring and Management Plan
MBT	Monobutyltin
NAGD	National Assessment Guidelines for Dredging
NATA	National Association of Testing Authorities
NH_3	Ammonia
NH_4^+	Ammonium
NO_3	Nitrate
NO_2	Nitrite
NO_x	Nitrate+Nitrite
OC	Organic carbon
PAHs	Polycyclic aromatic hydrocarbons
PPE	Personal protection equipment
PQL	Practical Quantitation Limits
PSD	Particle size distribution
QA/QC	Quality Assurance and Quality Control
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
RPM	Revolutions per minute
SAP	Sampling and Analysis Plan
SAPIR	Sampling and Analysis Plan Implementation Report

SDP	Sea Dumping Permit
TBT	Tributyltin
TKN	Total kjeldajl nitrogen
TN	Total nitrogen
TOC	Total organic carbon
TP	Total phosphorus
TPHs	Total petroleum hydrocarbons
TRHs	Total recoverable hydrocarbons
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Authority
WA	Western Australia
Measurement Units	
ºC	Degrees celsius
cm	Centimetre
ha	Hectare
km	Kilometre
km/h	Kilometre per hour
L	Litre
m	Metre
mg/kg	Milligram per kilogram
ml	Millilitre
mm	Millimetre
m^3	Cubic metre
M m^3	Million cubic metres
µm	Micrometre
%	Percent
>	Greater than

<	Less than
≤	Equal or less than
~	Approximately

Contents

Tables

Figures

1 Introduction

1.1 Background

Jurien Bay is located in the Wheatbelt region of Western Australia (WA), ~225 km north of Perth. The Jurien Bay Boat Harbour (hereafter: Boat Harbour), situated about 2 km from the townsite, was constructed in 1986 to offer protected waters and service amenities for the fishing industry. The Boat Harbour area spans ~14 ha and has a volume of ~369,000 m^3 (BMT Oceanica 2015). The Boat Harbour has an entrance channel that leads into a large basin area containing service jetties, fuel jetties, and boat lifting/maintenance facilities on the northern boundary and jetty pens and public boat ramps on the eastern boundary (Figure 1.1). Public amenities such as toilets, a beach, and car parking facilities are also available. The Boat Harbour serves various community purposes, including providing access to recreational tourism within the region and land area for commercial developments, with several land-backed facilities. The Boat Harbour is within an exclusion zone of the surrounding Jurien Bay Marine Park (JBMP; Figure 1.1), which is a popular destination for recreational activities such as fishing, swimming, diving, snorkelling, and water sports.

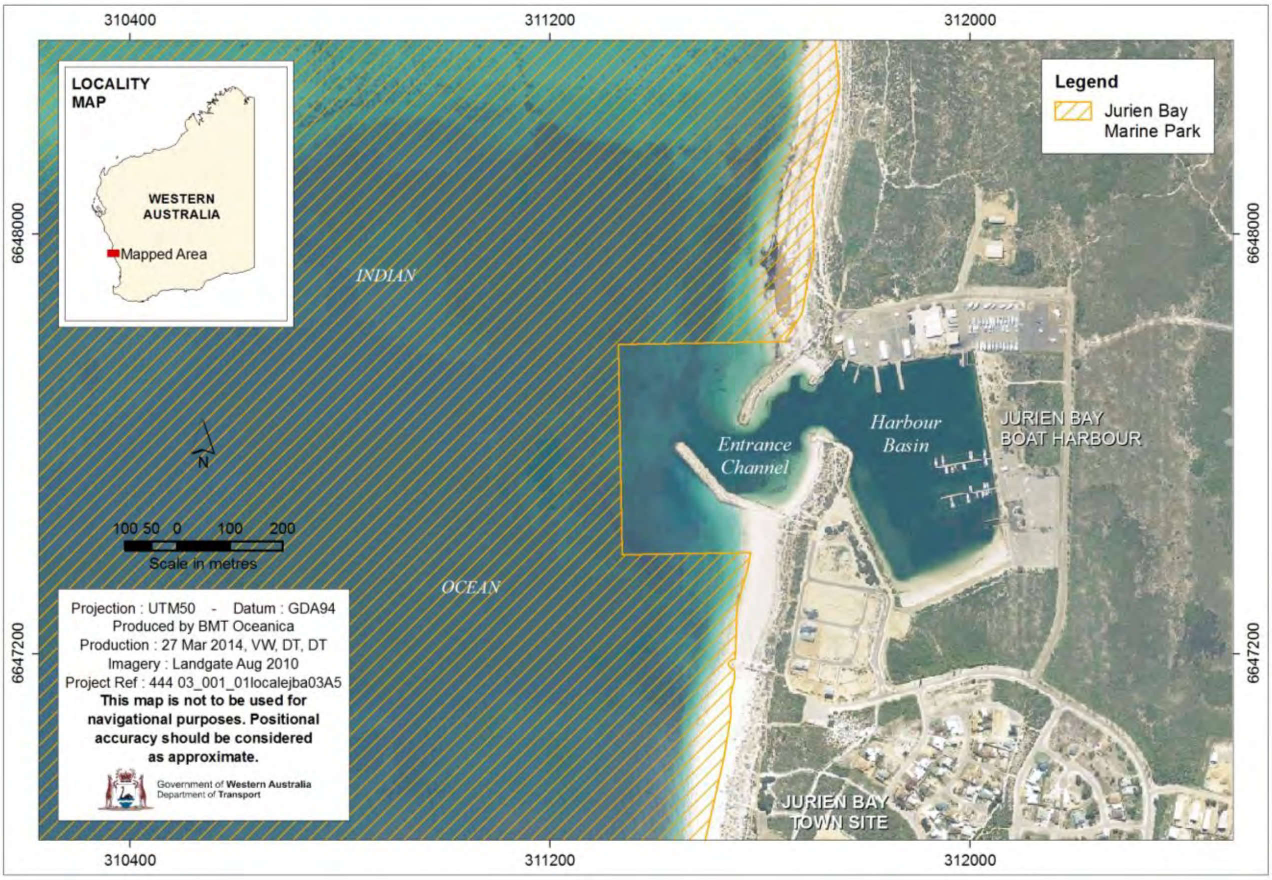


Figure 1.1 Jurien Bay Boat Harbour and surrounding Marine Park, WA

The Western Australia Department of Transport (DoT), on behalf of the Minister of Transport, is responsible for managing and maintaining the Boat Harbour under the *Marine and Harbours Act 1981*. Sediment and wrack (detached seagrass and macroalgae) typically accumulate in the Boat Harbour and its entrance channel, affecting navigable depths for safe vessel access. Decomposition of wrack accumulation has occasionally led to deoxygenation in the Boat Harbour waters (BMT Oceanica 2013a, b), resulting in fish kills and odour concerns (BMT Oceanica 2015). DoT undertake regular maintenance dredging within the Boat Harbour to maintain safe navigability and overall water quality.

Maintenance dredging has been undertaken ~biennially since 2014, with ~60,000 m^3 of dredged material removed per campaign. Dredged material from maintenance dredging campaigns was historically disposed to an onshore disposal area within the Boat Harbour reserve (Figure 1.2); however; due to limited capacity within this area and an ongoing requirement to clear native vegetation to accommodate dredged material, DoT commenced feasibility studies to assess the suitability of offshore disposal within an area of the JBMP (Figure 1.2, Section 2.2). The potential environmental impacts, technical studies and proposed monitoring and management for offshore disposal were outlined in the 'Jurien Bay Boat Harbour Long Term Monitoring and Management Plan' (LTMMP; BMT 2022) to support a 10-year sea dumping permit duration and other anticipated environmental approvals.

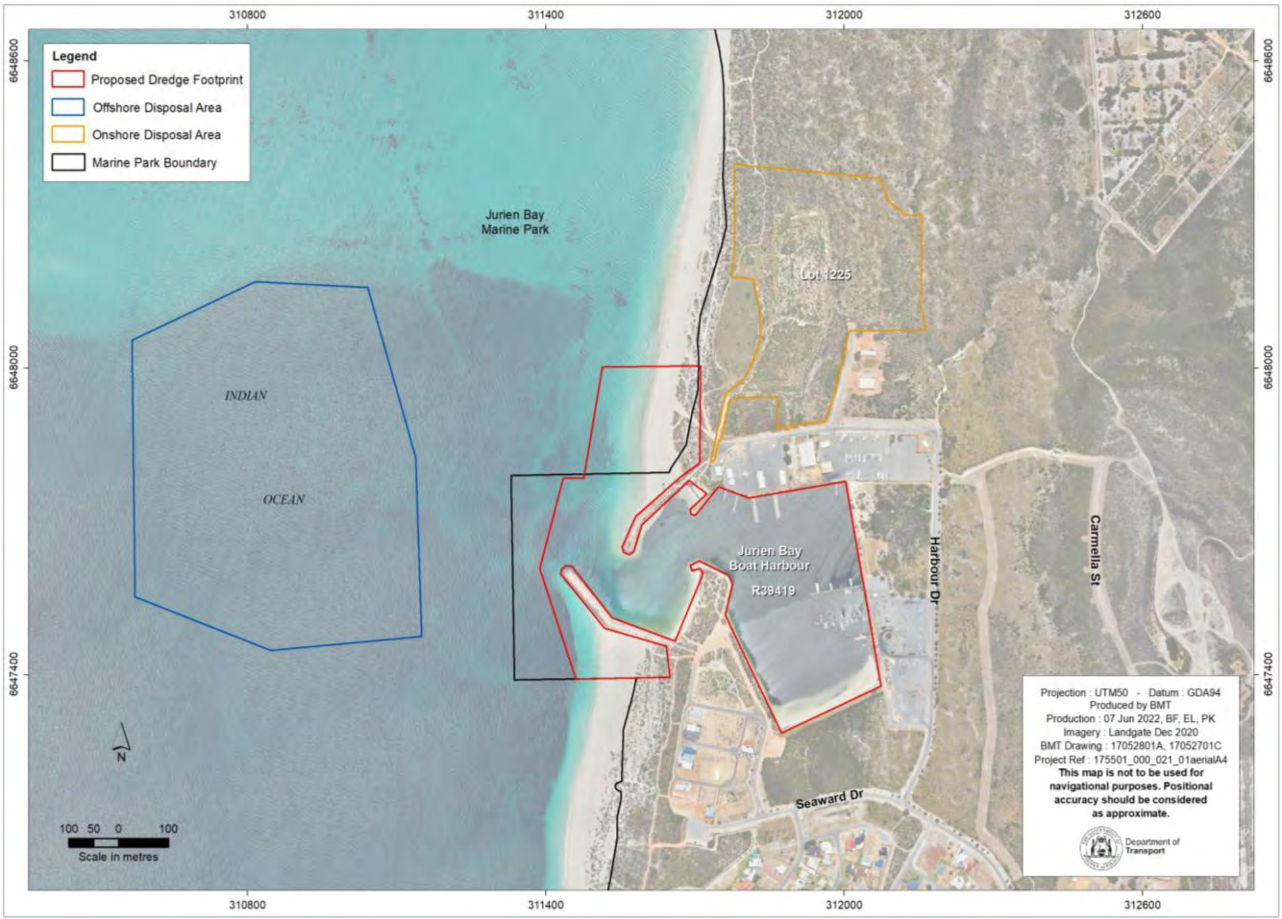


Figure 1.2 Jurien Bay Boat Harbour proposed dredge area, offshore disposal area, alternative onshore disposal area and Jurien Bay Marine Park boundary

In 2020 DoT received the following environmental approvals to permit sea dumping of dredged material offshore of the Boat Harbour:

- Regulation 4 Lawful Authority issued under the *Conservation and Land Management Act 1984* (CALM Act) with advice sought from the Conservation and Parks Commission (CPC) from the WA Department of Biodiversity Conservations and Attractions (DBCA) to permit the disposal of dredged material into the JBMP.

- Sea Dumping Permit (SDP; SD2019/3984) issued under the *Environmental Protection (Sea Dumping) Act 1981* (EPSD Act) from the Commonwealth Department of Climate Change, Energy the Environment and Water (DCCEEW) to permit offshore disposal of dredged material granted for a 10-year permit duration (2020–2030).

Sediment sampling and analysis was previously completed in 2019 (BMT 2019a) and is required at 5 yearly intervals by the SDP and LTMMP (BMT 2022) to identify potential impacts from dredging and disposal during maintenance dredging operations and determine monitoring and management measures.

1.2 Document purpose

This document is a revision of the previously approved 2019 sediment sampling and analysis plan (SAP; BMT 2019a) and outlines the 2024 sediment SAP in support of SDP and requirements informed in the LTMMP (BMT 2022). DCCEEW confirmed this SAP revision does not require approval; however, the results are to be submitted to DCCEEW for review and assessment of the contamination status (L. Rose, DCCEEW, pers. comm. 5 February 2024). Sediment investigations within the Boat Harbour and Offshore Disposal Area (Figure 1.2) are required to adequately characterise the physical and chemical properties of dredge and disposal area sediments. This SAP provides an overview of proposed sampling in-line with requirements of DoT's Environmental Management Framework (EMF; BMT 2023) and the National Assessment Guidelines for Dredging (NAGD; CA 2009) five phases of assessment for ocean disposal suitability:

- Phase I assessment involves the review of “existing information on the material proposed for ocean disposal, to determine which contaminants need investigation and to assess whether existing information sufficiently characterises the sediments without further testing" (CA 2009; Section 4.3).

- Phase II assessment involves “identifying and investigating the list of contaminants which could be present at elevated levels in the sediments of the dredge area and therefore require analysis" (CA 2009; this document and Sections 5 and 6.4.1).

- Phase III assessment involves elutriate and bioavailability testing (Section 6.4.2).

- Phase IV assessment involves toxicity and bioaccumulation testing (Section 6.4.3).

- Phase V assessment involves the weight of evidence assessment (Section 6.4.4).

In addition to the NAGD five phases of assessment (CA 2009), this document also includes:

- a description of the proposed maintenance dredging campaign and key legislation and guidelines (Sections 2 and 3),
- a review of existing information on sediment characteristics within the dredging and disposal areas, as well as potential sources of contamination (Section 4.3),
- an outline of the proposed sampling program, including information on the number, type, and location of samples required to characterise the sediments for dredging and disposal adequately (Section 5.2),
- the proposed methods for sampling, sample preservation, transportation and storage to ensure the integrity of the samples (Section 5.3.8), and
- the proposed quality assurance and quality control (QA/QC) procedures (Section 6.1).

The sediment sampling results will be reported in a SAP Implementation Report (SAPIR), which will inform potential revisions to the LTMMP (BMT 2022) and future approvals, where required.

2 Project Description

2.1 Dredging

The Boat Harbour entrance channel and basin design depths are outlined in Table 2.1and Figure 2.1. Maintenance dredging campaigns involve the removal of marine sediments and wrack accumulation to restore design depths from discrete areas (Areas A, B, D–F and H–J; Figure 2.1). Accretion of a large volume of marine sands around entrance channel breakwaters may also require maintenance dredging: one area immediately north of the northern breakwater (Areas C and K, Figure 2.1) and another area immediately south of the southern breakwater (Area G; Figure 2.1).

The depth of sediment accretion above design depths varies seasonally and is dependent on the rate of natural siltation; however; the maximum estimated dredging thickness is anticipated ~5 m below the current seabed surface (Table 2.1). Dredge areas, target dredge depths and estimated dredge volumes, including over-dredge are shown in Table 2.1. The absolute maximum total dredging volume (inclusive of the over-dredge volume) per maintenance campaign is anticipated to be ~210,100 m^3 with an estimated duration of 40 weeks (Figure 2.1; Table 2.1). The dredge volumes are conservative and represent upper estimates for target volumes and areas for the proposed 10-year permit duration and will vary prior to each maintenance campaign depending on siltation rates. It is also unlikely there will be available funding from DoT's state-wide maintenance dredging program to achieve all target areas (Figure 2.1; Table 2.1), and dredge areas will be prioritised based on siltation rates. The volume range of an individual maintenance campaign is likely to be ~60,000–80,000 m^3 based on historical dredging volumes and an anticipated campaign duration of 18 weeks (Table 4.2). Areas within the Boat Harbour that are still at or below the declared design depths will require minimal or no dredging. These areas will be determined from pre-dredge hydrographic surveys prior to each maintenance campaign.

Table 2.1 Target dredge depths and estimated dredge volumes for the proposed Jurien Boat Harbour maintenance dredging campaigns

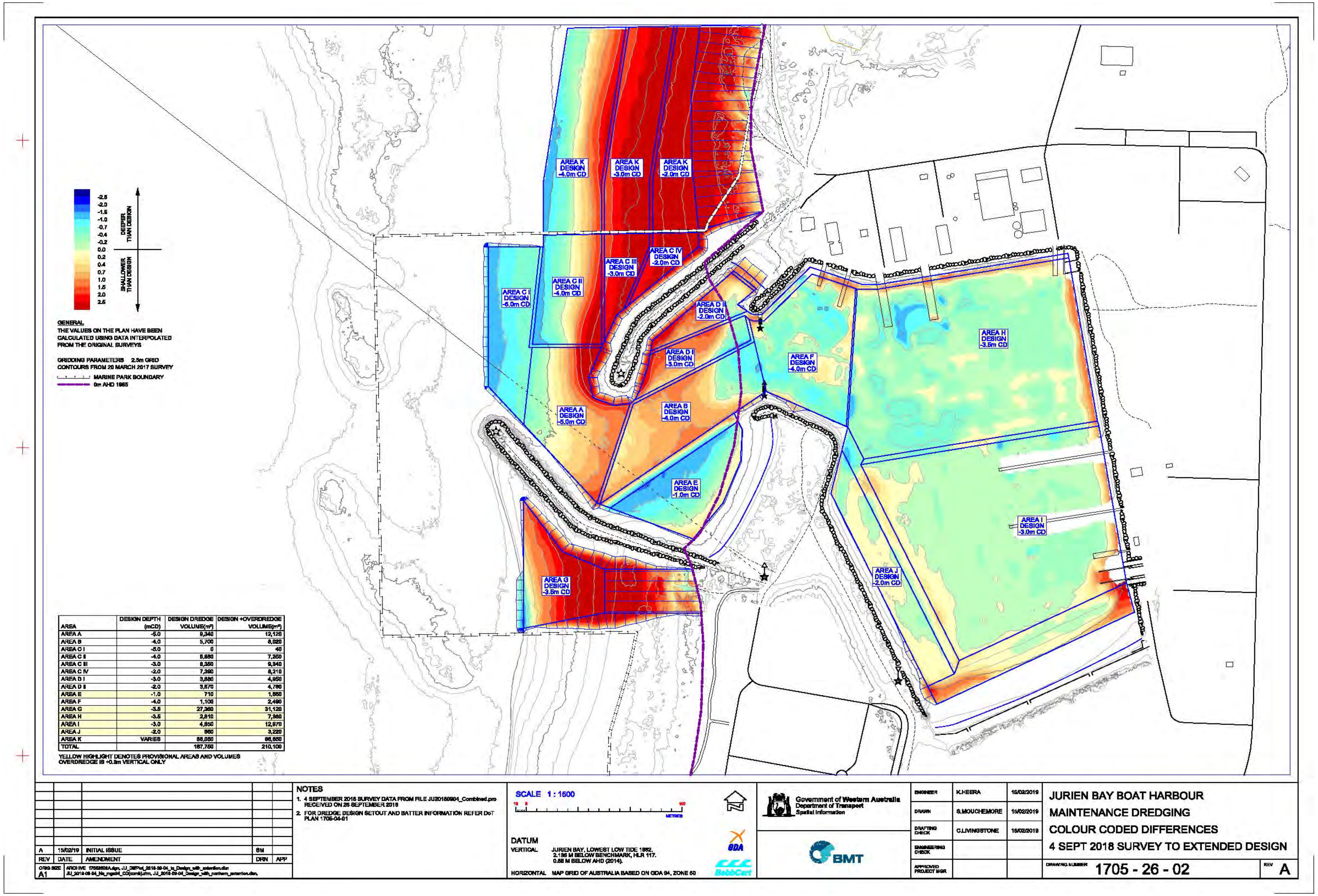
Dredge area[1,2]	Target dredge depth (m CD)[3]	Dredge design volume (m^3)[4]	Dredge design and over dredge (0.3 m) volume (m^3)
A	-5.0	9,340	12,120
B	-4.0	5,700	8,020
CI	-5.0	0	40
CII	-4.0	5,880	7,250
CIII	-3.0	8,350	9,340
CIV	-2.0	7,390	8,210
DI	-3.0	3,880	4,950
DII	-2.0	3,670	4,780
E*	-1.0	710	1,560
F	-4.0	1,100	2,490
G*	-3.5	27,360	31,120
H*	-3.5	2,810	7,380

Dredge area[1,2]	Target dredge depth (m CD)[3]	Dredge design volume (m^3)[4]	Dredge design and over dredge (0.3 m) volume (m^3)
I*	-3.0	4,650	12,970
J*	-2.0	860	3,220
K*	Varies	86,050	96,650
Total	N/A[3]	167,750	210,100

Notes:

1. **Refer to Figure 2.1 for the explanation of dredge areas**
2. **'*' = Provisional areas and volumes**
3. **'m' = metre, 'CD' = chart datum, 'm^3' = cubic metre, 'N/A' = not applicable**
4. **Volumes are conservative and represent upper estimates within each dredging area and will vary for each maintenance campaign depending on natural siltation rates.**

Dredging is anticipated to be completed with a small cutter suction dredge (CSD). The use of a CSD should limit turbid plumes and sedimentation to the dredge area, though this depends on sediment characteristics and local hydrodynamics (Ports Australia 2014).



AREA	DESIGN DEPTH (mCD)	DESIGN DREDGE VOLUME(m^3)	DESIGN +OVERDREDGE VOLUME(m^3)
AREA A	-5.0	9,340	12,120
AREA B	-4.0	5,700	8,020
AREA C I	-5.0	0	40
AREA C II	-4.0	5,880	7,250
AREA C III	-3.0	8,350	9,840
AREA C IV	-2.0	7,390	8,210
AREA D I	-3.0	3,880	4,950
AREA D II	-2.0	3,570	4,780
AREA E	-1.0	710	1,660
AREA F	-4.0	1,100	2,490
AREA G	-3.5	27,360	31,120
AREA H	-3.5	2,810	7,880
AREA I	-3.0	4,850	12,970
AREA J	-2.0	960	3,220
AREA K	VARIES	88,050	96,650
TOTAL		167,750	210,100

YELLOW HIGHLIGHT DENOTES PROVISIONAL AREAS AND VOLUMES
OVERDREDGE IS +0.3m VERTICAL ONLY

Figure 2.1 Jurien Bay Boat Harbour proposed dredging areas and volumes

2.2 Disposal

For maintenance dredging campaigns it is proposed that marine sediments from the Boat Harbour will be disposed offshore. The proposed offshore disposal area is located ~1 km northwest of the Boat Harbour in ~12 m water depth (Figure 1.2; Figure 2.2). Dredged material from the Boat Harbour will be entrained as a slurry and hydraulically pumped via a floating or submerged pipeline to the disposal area (Figure 1.2). The offshore disposal area is ~36 ha and has the capacity to receive dredged material over the 10 years of permit duration to a maximum volume of ~1.1 M m^3. The overall depth of the offshore disposal area will be reduced to -8.0 chart datum (CD). The offshore disposal area is in the JBMP (Section 4.1.5) and disposal of material is subject to ongoing approvals from DBCA. Several alternative disposal options were previously considered for the placement of dredged material for Boat Harbour maintenance campaigns (BMT Oceanica 2017). Offshore placement was prioritised over the onshore alternatives, due to the shorter pumping distance and reduced potential for dredged material to be re-distributed back into the Boat Harbour, to retain sediments within the natural marine system to avoid clearing of onshore native vegetation within the Harbour Reserve (Figure 1.2), and in consideration of the principles of waste avoidance and promotion of resource recovery.

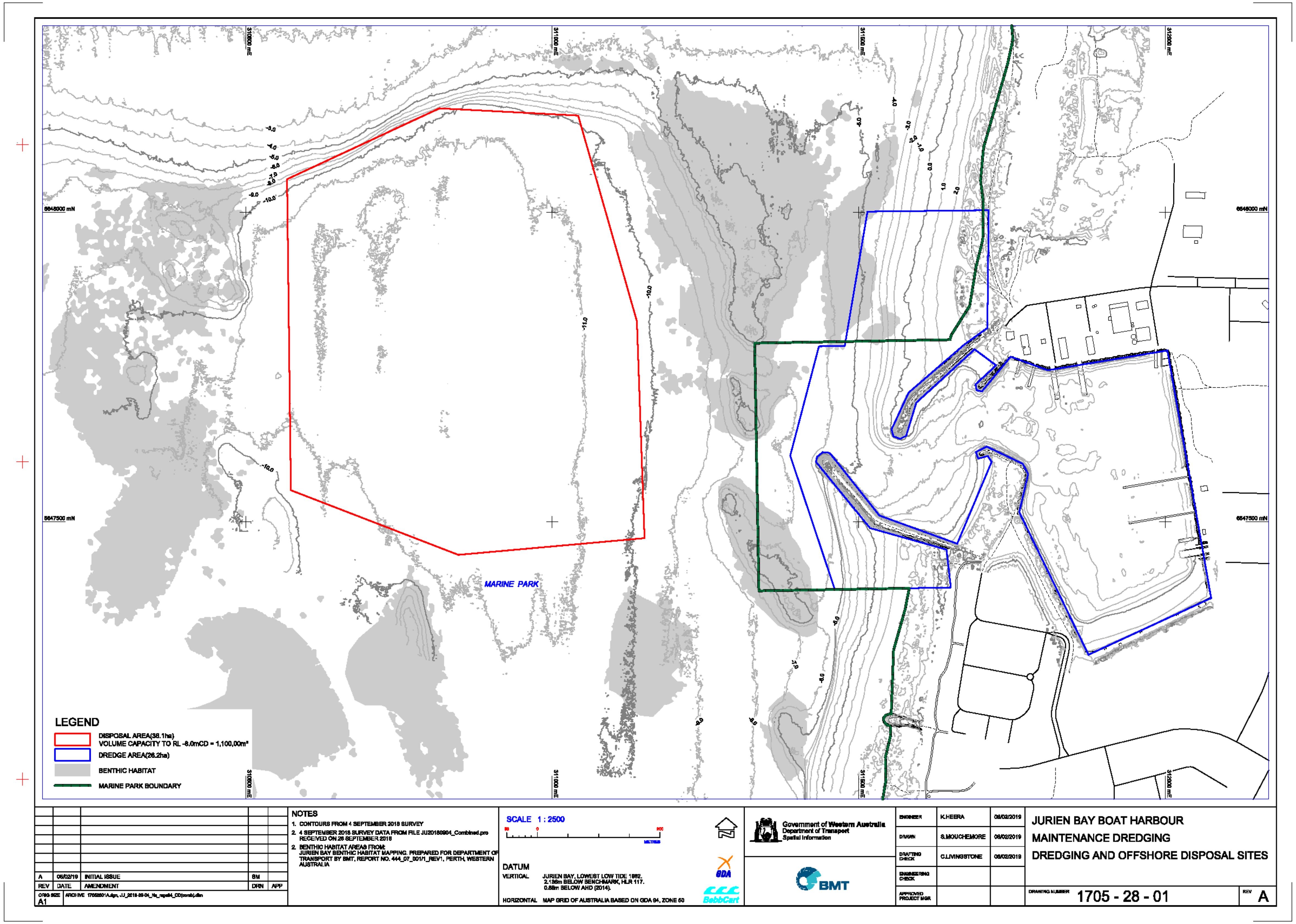


Figure 2.2 Jurien Bay Boat Harbour maintenance campaigns offshore disposal area, underlying benthic habitat and Jurien Bay Marine Park excision boundary

3 Regulatory Overview

The legislation and guidelines relevant to defining this SAP are detailed in Sections 3.1 to 3.2. Application of other relevant legislation and guidelines with greater consideration to the offshore disposal area occurring within JBMP (Figure 2.2) are assessed in LTMMP (BMT 2022). This SAP has been produced to support five yearly sampling in-line with the approved SPD and LTMMP. The sampling results will support ongoing approvals and will inform potential revisions to the LTMMP (BMT 2022) as per SDP requirements.

3.1 Environmental Protection (Sea Dumping) Act 1981

The EPSD Act applies to the disposal of controlled materials in Australian Waters other than waters within the limits of the State or the Northern Territory. Department of Climate Change, Energy, the Environment and Water (DCCEEW) assesses environmental impacts, permits proposals to load and dump materials seaward of the low water mark to the limits of the Exclusive Economic Zone, and sets conditions of approval to mitigate and manage environmental impacts.

3.1.1 National Assessment Guidelines for Dredging

The NAGD (CA 2009) provides supporting information to the EPSD Act. The regulatory framework set out in the NAGD is applied to ensure the impacts of dredged material loading and disposal are adequately assessed and, if permitted, that impacts are managed responsibly and effectively. The NAGD (CA 2009) sets out methods for:

- evaluating alternatives to ocean disposal
- assessing sediment quality
- assessing dredging and disposal sites
- assessing potential impacts on the marine environment and other users
- determining management and monitoring requirements.

3.1.2 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

Contaminants in sediments that exceed NAGD Screening Levels (CA 2009) require bioavailability and elutriate testing (Section 6.4.2) to assess the bioavailable fractions for uptake by marine organisms and potential impacts to marine water quality from contaminants released during dredging and disposal (CA 2009). The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) are applied to assess water quality impacts from physical/chemical stressors and/or toxicants.

Default guideline values (DGVs) for physical and chemical stressors are available for marine geographic regions from regional reference site data in surface and bottom waters. The DGVs for toxicants are derived for differing levels of species protection, with the level of protection determined through the current or desired condition of the ecosystem that is assigned. The 90% and 99% species protection will be applied to Boat Harbour dredging and disposal areas, respectively, with a higher level of protection required for disposal of material into the JBMP.

3.2 Department of Transport Maintenance Dredging Environmental Management Framework

Department of Transport has an EMF (BMT 2023) that provides guidance for environmental management and monitoring of state-wide maintenance dredging operations. The intention of the EMF is to ensure that DoT's maintenance dredging activities are:

- completed with consideration of environmental factors and environmental regulatory requirements
- protection of the environment
- clear, relevant, and practical identification of potential environmental impacts
- open engagement with stakeholders
- effective environmental monitoring and management.

The EMF is updated annually, ensuring that best practice environmental management is applied to maintenance dredging. This SAP has been designed and implemented in accordance with the latest revision of the EMF (BMT 2023) to ensure that the above objectives are achieved.

3.3 Anticipated environmental approvals

Future Boat Harbour maintenance dredging campaigns will require Regulation 4 Lawful Authorities issued under the CALM Act via DBCA and formal advice from the CPC. The current approved Regulation 4 Lawful Authority conditions allows for one 90-day dredging campaign between 30 July 2022 and 30 July 2024 and condition 17 states a 24-month period of no dredging following the previous campaign completion that was in July 2022. Should future revisions to the LTMMP (BMT 2022) be considered likely to have a new or increased impact or reduce the public accessibility of information then under condition 11 of the SDP the LTMMP would require reapproval by DCCEEW under the EPSD Act.

4 Background Information

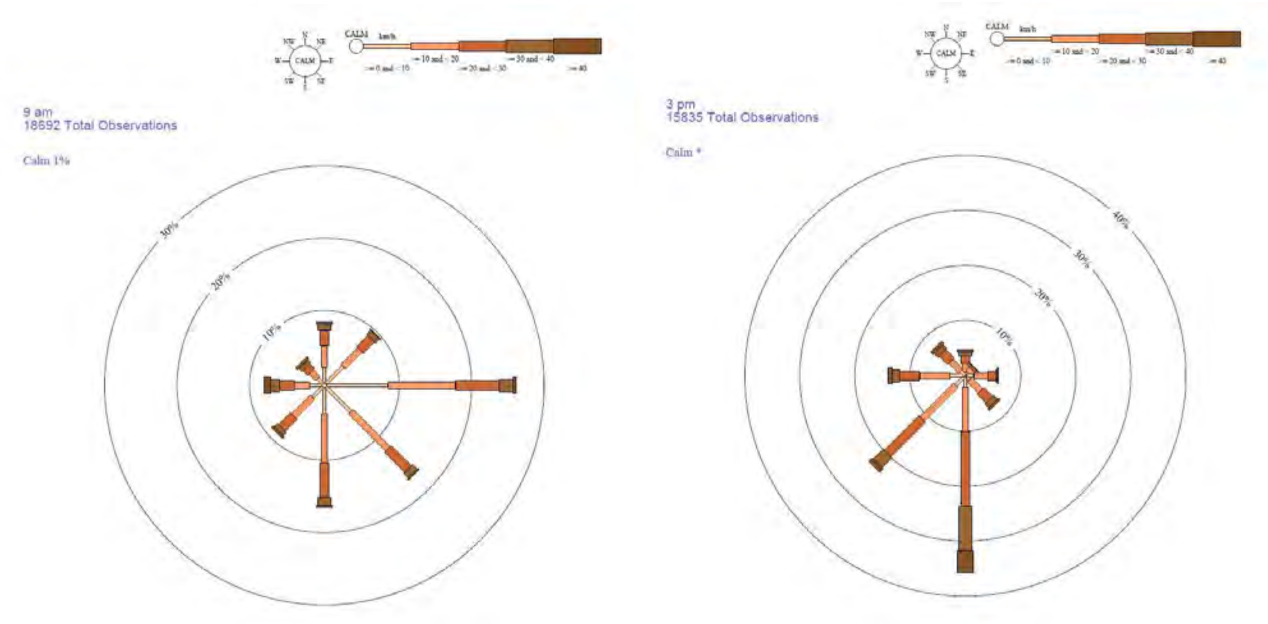
4.1 Physical environment

The Boat Harbour is located within the greater South-West Marine Region, which is divided further into seven bioregions, as defined by the Integrated Marine and Coastal Regionalisation of Australia Version 4.0 (DEWHA 2007). The Southwest Shelf Transition bioregion comprises the continental shelf between Perth in the south and Kalbarri in the north. This bioregion extends from nearshore areas to the edge of the continental shelf, the majority of which is under Commonwealth jurisdiction. With a maximum depth of 200 m, this nearshore bioregion is characterised by a high level of marine biodiversity, including sub-tropical, tropical and temperate marine species (DEWHA 2007).

4.1.1 Climate

Jurien Bay experiences a Mediterranean climate with hot, dry summers and mild, wet winters. During summer, the mean monthly temperature ranges between ~28–31ºC and during winter, between ~9.5–10ºC (BoM 2024). Rainfall in Jurien Bay is highly variable throughout the year, with an annual rainfall average of ~527 mm (BoM 2024). Seasonal rainfall levels range from a maximum monthly average of ~110 mm in July to a minimum monthly average of ~6 mm in December (BoM 2024).

Wind data recorded between 1969 and 2023 indicates that winds are predominantly from the east and south-east in the morning (09:00) and from the south and south-west in the afternoon (15:00; BoM 2024; Figure 4.1). Mean annual wind speed was 17.2 and 22.8 km/h at 09:00 and 15:00, respectively, rarely exceeding 40 km/h (BoM 2024; Figure 4.1).



Source: BoM (2024)

Notes:

1. **Wind speed recorded at Jurien Bay between 1969 and 2024 at 09:00 (left) and 15:00 (right)**
2. **'*' = calm is <0.5%**

Figure 4.1 Jurien Bay wind speed and direction

4.1.2 Hydrodynamics

Hydrodynamics of the continental shelf are influenced by the Leeuwin and Capes currents, and seasonal variations in wind regimes (Gallop et al. 2012). The Leeuwin Current drives the offshore currents along the shelf break; whereas coastal currents are mostly wind-driven (DEWHA 2007). The Leeuwin Current is a warm, narrow and shallow current that transports tropical waters southward with low nutrients and salinity levels, predominantly during the Autumn and Winter months (March–August) (Gersbach et al. 1999, DEWHA 2007). The Leeuwin Current forms eddies in several predictable locations in this bioregion, including Jurien Bay. These eddies occur as cross-shelf currents that mix nutrient-rich, deep waters with the shallower water from the continental shelf, thereby enhancing the overall biological productivity of the region.

The Capes Current is a cool, counter-current that flows northward close inshore, resulting in localised upwelling and cooler water on the upper continental shelf (Pearce & Pattiaratchi 1999). In the Southwest Shelf Transition bioregion, the Capes Current also transports temperate species larvae from the southern regions to the northern areas along the inner, nearshore shelf (DEWHA 2007). The Capes Current is present mostly in the summer months (December–February).

Coastal currents are predominantly wind-driven by the strong south-westerly sea breezes occurring each afternoon (DEWHA 2007). This sea breeze system generates winds generally in excess of 50 km/h (Pattiaratchi et al. 1997), thus creating diurnal changes to wave heights, wave periods, nearshore currents and sediment levels and transport (Masselink & Pattiaratchi 1998). Under ambient conditions, the winter wind regime is generally calm and south-westerly, with a weaker sea breeze component. Winter storms (mid-latitude depressions) may generate strong winds, usually from the north-west (Lemme et al. 1999).

4.1.3 Geology and geomorphology

The Southwest Shelf Transition bioregion includes a narrow continental shelf (40–80 km wide) that is characterised by complex physical features (DEWHA 2007). Nearshore, eroded limestone reefs and pinnacles form ridges, depressions, and inshore lagoons. The inner shelf is a smooth plain with a series of ridges that develop into a tropical reef in the northern area of the bioregion (e.g. Houtman Abrolhos Islands). The greater Gingin-Dandaragan coastline is characterised by Safety Bay Sand from the Quindalup Dune systems. The coastal areas of the Jurien Bay region consist of curved beaches backed by low dunes. The shoreline in the Jurien Bay area consists of a continuous beach that is more exposed in the north and sheltered in the south (Eliot et al. 2012). Onshore, parabolic dunes in the south migrate north, forming mobile sand sheets with vegetation cover.

Beaches are separated by sand promontories or points, rocky headlands, and low limestone cliffs. A series of elongated limestone reefs run parallel to the shore and provide the shoreline with some shelter from offshore waves (Oceanica & JFA 2005). Associated with these reefs are numerous emergent rocks and islands (CALM 2005).

4.1.4 Coastal processes

Sand along the Jurien Bay coastline is transported via several coastal processes. Wind influences sand movement in the ocean (with the nearshore waves and currents) and on land, forming transgressive dunes (Ecoscape 2005). In winter, storm events generally transport nearshore sand in a southerly direction, whereas in summer, prevailing winds tend to transport nearshore sand in a northerly direction. In addition, waves and tides generate longshore currents that result in the littoral drift and cross-shelf transport of sand.

Onshore of Jurien Bay, unstable landforms are highly susceptible to changes from weather and metocean processes (Eliot et al. 2012). This coastal risk is evident in exposed beaches, mobile sand sheets and active blowouts in the sand dune complexes. Historically, wind and rainfall changes increased the coastal activity in the area, causing substantial fluctuations in sand dunes and blowouts.

4.1.5 Jurien Bay Marine Park

In 2003, the JBMP was designated a Class A Marine Park under the CALM Act. Located adjacent to the Boat Harbour, the JBMP comprises marine waters between Wedge Island and Green Head, WA. The JBMP's offshore boundary extends to the WA State limit (three nautical miles offshore) and encompasses an area of over 82,000 ha (CALM 2005). The Marine Park includes offshore islands that are vested as Class A nature reserves under the CALM Act, as well as sea lion and seabird breeding grounds, seagrass meadows that serve as nursery areas for western rock lobsters and the migratory path of several whale species (CALM 2005). Management of the environment within the JMBP is administered by DBCA, through the JBMP Management Plan (CALM 2005).

4.2 Biological environment

The Southwest Shelf Transition bioregion contains a unique mixture of both tropical and temperate marine species, including a high number of endemic fauna as well as the highest seagrass species diversity globally (DEWHA 2007). In the nearshore areas (<50 m deep), the biological environment is characterised by Australia's largest, continuous limestone reef with numerous rocks and islands creating sheltered environments for a diverse mixture of temperate and tropical species of marine flora and fauna (CALM 2005, Eliot et al. 2012).

4.2.1 Benthic communities and habitats

To inform long-term dredging and disposal options, and marine environmental monitoring and management for the Boat Harbour maintenance dredging campaigns, benthic habitat mapping of Jurien Bay was completed November 2017 (BMT 2018). The specific objectives of the mapping project were to:

i. collect digital baseline data on the spatial extent and characteristics of benthic habitats in the mapping area, and

ii. qualitatively characterise the extent of benthic communities and habitat (BCH) surrounding the Boat Harbour and develop a mapping product of suitable quality to meet multiple purposes (including informing dredging operations and potential future environmental approvals applications, if necessary).

A total of 3667.2 ha of BCH were mapped during the project and the following dominant habitat types were identified (Table 4.1):

- bare sand (57.9%),
- sand inundated platform reef with macroalgae and mixed perennial seagrass (*Posidonia* spp. and *Amphibolis* spp.;18.3%)
- sand inundated platform reef with macroalgae and perennial seagrass (*Amphibolis* spp.; 13.9%)
- reef dominated by macroalgae (6.1%)

A small proportion of mapped BCH is inhabited by mixed perennial seagrass (*Amphibolis* spp. and *Posidonia* spp.; 2.6%) and even less by mono-specific perennial and ephemeral seagrass meadows (~1.0% for *Amphibolis* spp., *Posidonia* spp. and *Halophila* spp. combined). Filter feeders such as corals and sponges within the mapped area represented only a small proportion (0.3%). Macroalgae habitats were dominated by the kelp *Ecklonia radiata* with fewer *Sargassum* spp. and red foliose species, where present as part of mixed assemblages (BMT 2018).

The nearshore area north of the Boat Harbour is mostly comprised of a mixed assemblage of macroalgae and perennial seagrass (*Posidonia* spp. and *Amphibolis* spp.) overlying a sand inundated platform reef, extending ~500 m to 1 km offshore (Figure 4.2). South of the Boat Harbour, the BCH is less vegetated and is dominated by mobile sands with small scattered meadows of perennial seagrass (mixed assemblages of *Posidonia* spp. and *Amphibolis* spp. and mono-specific assemblages of *Posidonia* spp.) and ephemeral seagrass (*Halophila* spp.; Figure 4.2). This predominantly sandy area surrounding the Boat Harbour extends ~3 km offshore.

Further offshore, the BCH is dominated by a mixed assemblage of macroalgae and perennial seagrass (*Amphibolis* spp.) on sand inundated platform reef (Figure 4.2). Next to the dominant offshore benthic habitat, areas containing a mixed assemblage of macroalgae and mixed perennial seagrass (*Amphibolis* spp. and *Posidonia* spp.) also occur (Figure 4.2). In the north-west offshore region of the mapped area, there is an expansive area of reef dominated by macroalgae (Figure 4.2).

Inside the Boat Harbour entrance channel, the benthic habitat is predominantly characterised by wrack overlying bare sand. Directly adjacent to the Boat Harbour entrance channel, wrack, and sparse meadows of seagrass (*Posidonia* spp.) covered in sand and epiphytic growth of calcareous algae. These seagrass meadows appeared partially dead and flattened on the seafloor and, therefore, were classified as wrack for mapping purposes. It is noted that areas of wrack have been classified as bare sand in Figure 4.2.

The selection of a suitable offshore disposal area was based on the findings of the mapping project. The proposed offshore disposal area is described in Section 2.2 and is located over bare sand (Figure 4.2).

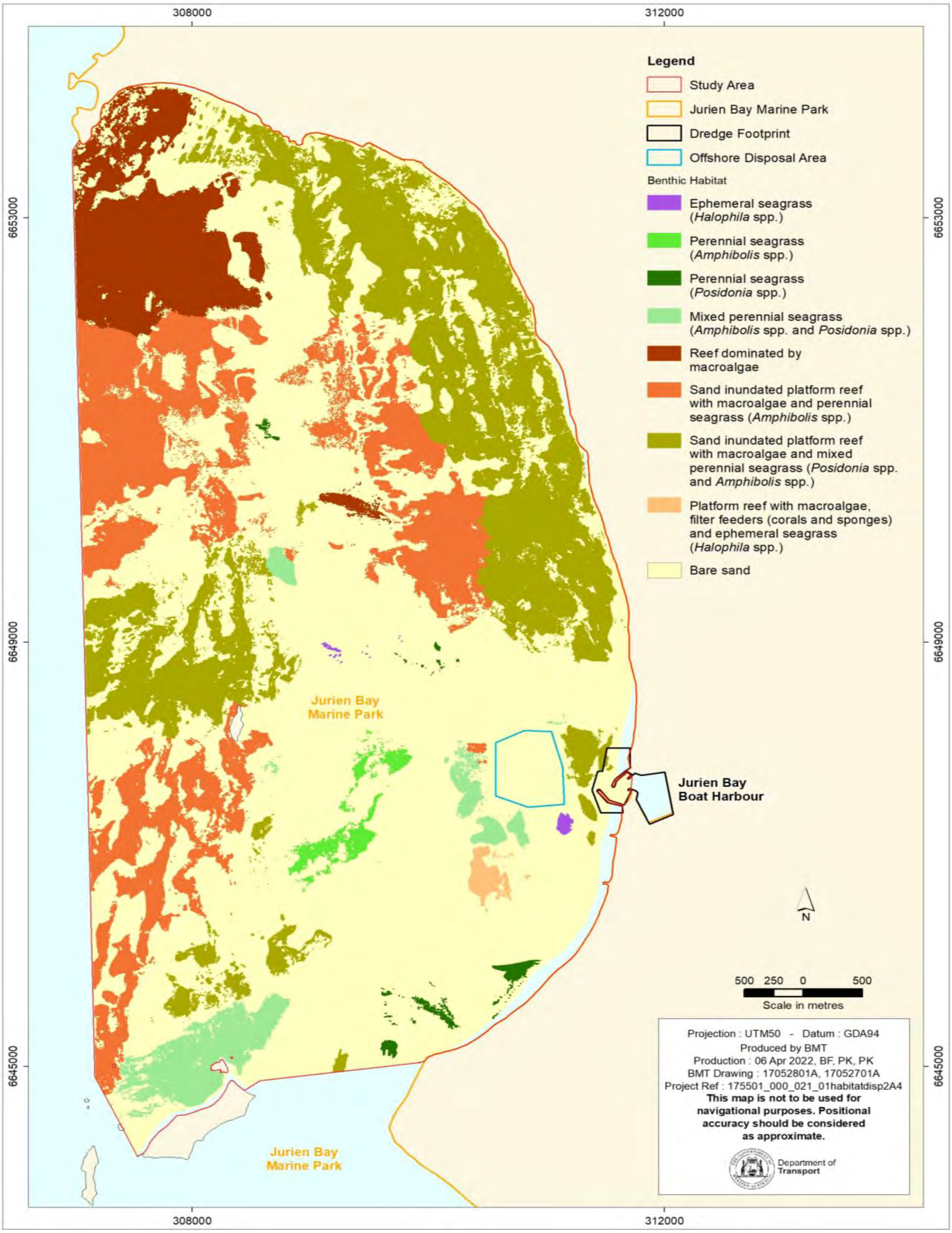
Table 4.1 Area and proportion occupied by benthic habitat categories

Benthic habitat type	Area (ha)	Proportion[1] (%)
Ephemeral seagrass (*Halophila* spp.)	2.6	0.1
Perennial seagrass (*Amphibolis* spp.)	23.4	0.6
Perennial seagrass (*Posidonia* spp.)	12.2	0.3
Mixed perennial seagrass (*Amphibolis* spp. and *Posidonia* spp.)	94.5	2.6
Reef dominated by macroalgae	222.1	6.1
Sand inundated platform reef with macroalgae and perennial seagrass (*Amphibolis* spp.)	508.2	13.9
Sand inundated platform reef with macroalgae and mixed perennial seagrass (*Posidonia* spp. and *Amphibolis* spp.)	670.2	18.3
Platform reef with macroalgae, filter feeders (corals and sponges) and ephemeral seagrass (*Halophila* spp.)	11.5	0.3
Bare sand	2122.5	57.9
Total	**3667.2**	**100**

Source: BMT (2018)

Note:

1. Percentages do not add up to exactly 100% due to rounding.



Source: BMT (2018)

Figure 4.2 Classification of Jurien Bay benthic communities and habitat and distribution

4.3 Review of previous sampling and analysis

The offshore disposal area (Figure 2.2) was first sampled in 2019 as outlined in the previously approved SAP (BMT 2019a), however; the dredging area (Boat Harbour) sediments have been characterised on several occasions and the results are outlined below.

4.3.1 Sediment sampling and analysis 2005

In June 2005, six sediment cores were obtained from within the Boat Harbour entrance channel and one from within the basin (Oceanica & JFA 2005). The sediment samples were analysed for particle size distribution (PSD), Total organic carbon (TOC), total metals and elutriate nutrients. Results showed sediments within the dredge area were comprised of clean medium/fine sands interspersed with decomposing seagrass wrack layers. There was no physical observations of acid sulfate soils (ASS) and sediments comprised of clean carbonate-rich sands (Oceanica & JFA 2005). Sediment PSD showed material was predominantly medium to fine marine sands (83–96%) with some silt (<15%) and clay (<3.0%) and rapid settling velocity (Oceanica & JFA 2005). The TOC content of sediments was assessed via weight loss from combustion for one hour at 500ºC and 1000ºC with results ranging between 5–14% and 35–39%, respectively. Total metal concentrations were below relevant ANZECC/ARMCANZ (2000) interim sediment quality guidelines (available guidelines for comparison at the time). Elevated concentrations of elutriate nutrients were detected. Elutriate ammonia exceeded the relevant ANZECC/ARMCANZ (2000) water quality guideline at one site; however; this was considered attributable to decomposing seagrass within sediments. Elutriate nutrient results were considered over conservative of potential water quality impacts given the dilution within the receiving environment and water to sediment mix during dredging is sufficient to reduce concentrations below relevant guidelines.

4.3.2 Sediment sampling and analysis 2014

In April 2014, seven sediment cores were sampled within the Boat Harbour inner northern breakwater sand trap to support a sediment dredging and wrack trawling Dredging Environmental Impact Assessment (DEIA; BMT Oceanica 2014a). The sediment samples were analysed for PSD, TOC, total and elutriate metals, total nutrients, organotins (tributyltin [TBT], monobutyltin [MBT] and dibutyltin [DBT]), hydrocarbons (total recoverable hydrocarbons [TRHs], polycyclic aromatic hydrocarbons [PAHs] and benzene, toluene, ethylbenzene and xylene [BTEX]) and elutriate hydrogen sulfide (H_2S). Sediments were mostly comprised of medium grained sands, with small amounts of organic material. Particle size distribution results showed sediments were predominantly sands (96–100%), with some silt (<4%), clay (<0.2%) and gravel (<1%) and short settling times (<2.5 minutes for 90% of particles) across all sample sites.

The TOC content of the sediments ranged from 2.3–6.6%. Total metals, organotin and hydrocarbons concentrations were below the relevant NAGD Screening Levels (CA 2009). One site recorded a low-level exceedance for mercury at depth (0.2 mg/kg), however; remaining sediment samples within the dredge area were below the laboratory limit of reporting (LoR) and overall test statistics met the NAGD Screening Level (CA 2009). Elutriate analysis of mercury at the individual site that exceeded was below the LoR. High concentrations of total nutrients were recorded and considered attributable to the decomposing seagrass wrack entrained within the sediments (it is noted that there are no sediment quality guidelines available for total nutrients). All sediments had concentrations of elutriate H_2S below the LoR.

In August 2014, sediment cores were collected from 19 sites within the Boat Harbour's entrance channel and basin and were analysed for PSD, TOC, total metals, total and elutriate nutrients, organotins (TBT, MBT and DBT), hydrocarbons (PAHs, TRHs and BTEX) and ASS (BMT Oceanica 2014b). Sediments comprised of by fine to medium sands with small portions of silt and gravel with fast settling rates. Most samples contained organic matter (in the range of <1–90%), exhibited a sulfidic odour and had low TOC content (<1% for most samples with exception to one sample that had a TOC content of 15% due to the sample being characterised by 90% organic matter). Total metals, organotins and hydrocarbons concentrations were below the relevant NAGD Screening Levels (CA 2009). Elevated concentrations of total and elutriate nutrients were detected in sediment samples and elutriate nutrients exceeded relevant ANZECC/ARMCANZ (2000) water quality guidelines. Elevated nutrient concentrations were attributed to decomposing seagrass wrack that accumulates in the Boat Harbour. Boat Harbour sediments were below the DEC (2013)[1] ASS Action Criteria for all but one sample. The sample, however; exhibited an overall net negative acidity following acid base accounting thereby indicating a low risk of ASS generation during dredging and disposal.

4.3.3 Sediment sampling and analysis 2019

In April 2019, surface sediment samples were collected from 15 sites within the Boat Harbour entrance channel and basin and seven sites within the offshore disposal area (BMT 2019b).

Boat Harbour entrance channel and basin

Boat Harbour sediments were analysed for PSD, TOC, total and elutriate metals, elutriate nutrients (total phosphorus [TP], filtrable reactive phosphorus [FRP], total nitrogen [TN], Nitrate+Nitrite [NO_x], ammonium [NH_4^+] and ammonia [NH_3], nitrite [NO_2], nitrate [NO_3], and total kjeldajl nitrogen [TKN]) and hydrocarbons (TRHs/ total pertroleum hydricarbons [TPHs], PAHs and BTEX). The results are presented in full in BMT (2019b).

Sediments were generally characterised by fine to medium grained sands and silts with fast settling rates (<2 minutes for 50% of particles to settle through 1 m of water and <1.2 hours for 90% of particles to settle through 1 m of water) and low TOC content (0.08–1.31%). Some dredge area sediment samples contained considerable portions of organic matter (0–30%) and debris (0–20%) and exhibited a sulfidic odour.

Concentrations of total metals and hydrocarbons were below NAGD Screening Levels (CA 2009). Mean concentrations of elutriate arsenic, total chromium, lead and nickel, and cadmium were below the relevant ANZG (2018) DGVs for toxicants at the 99% species protection level. Mean concentrations of elutriate copper and zinc from dredge area sediments exceeded the relevant ANZG (2018) DGVs for toxicants at the 90% and 99% species levels of protection.

Elutriate nutrients (TP, FRP, TN, NO_x, NH_4^+ and NH_3) exceeded the relevant ANZECC/ARMCANZ (2000)[2] marine water quality default trigger values. As per the NAGD (CA 2009), the elutriate nutrient data was scaled to account for initial dilution at the disposal area for appropriate assessment against the relevant ANZECC/ARMCANZ (2000) marine water quality default trigger values (BMT 2022). The elutriate nutrient data was first converted to a dilution of 1:9 (wet sediment: added seawater), which provides a better representation of the concentrations likely to be present in the average dredge slurry (BMT 2022). Initial dilution was then approximated as: '*the liquid and suspended particulate phases of the waste may be assumed to be evenly distributed after four hours over a column of water bounded on the surface by the release zone and extending to the ocean floor, thermocline or halocline, if one exists, or to a depth of 20 m, whichever is shallower*' (CA 2009) (for the offshore disposal area a release zone of 36 ha and a depth of 12 m applied). The volume of material to be discharged over the four-hour period was based on a dredging production rate of 105 m^3/hour (the average dredging production rate of previous Boat Harbour maintenance dredging campaigns (BMT 2019a). Based on the

[1] *DEC (2013) was the available criteria for comparison at the time but has since been superseded by DER (2015).*

[2] *At the time of preparing this document the ANZG (2018) marine water quality guidelines were not available for application for all analytes due to resolving issues/inconsistences on the website, and it was recommended to refer to the ANZECC/ARMCANZ (2000) marine water quality guidelines in the interim.*

results presented in the SAPIR (BMT 2019b), dredge area sediments were considered suitable for unconfined ocean disposal under the EPSD Act.

Offshore disposal area

Offshore disposal area (Figure 1.2) sediments were sampled to establish ambient baseline concentrations for comparison of data between dredge and disposal sediments and were analysed for PSD, TOC, hydrocarbons and total metals (BMT 2019b). Sediments were characterised by very fine to fine grained sands and fine to medium silts with short settling times: <3 minutes for 50% of particles to settle through 1 m, and <1 hour for 90% of particles to settle through 1 m of water. Offshore disposal area sediments contained low TOC content (0.25–3.79%) and concentrations of total metals and hydrocarbons were below the relevant NAGD Screening Levels (CA 2009).

4.3.4 Wrack sampling and analysis 2011

In November 2011, wrack trawled from the entrance channel of the Boat Harbour was sampled and analysed for contaminants of potential concern (COPC) including TOC, total metals, total nutrients, TBT, TRHs, BTEX, PAHs and H_2S. There are currently no specific guidelines to assess COPC within wrack, and results were compared to the NAGD Screening Levels for sediment quality (CA 2009). Results were below the NAGD Screening Levels (CA 2009) for all COPC within wrack, except cadmium that recorded a low-level exceedance (1.7 mg/kg), and TPHs. Analysis of TPHs identified both petroleum-based and nonpetroleum-based hydrocarbons, which are typically associated with vegetable and animal products (including oils, sugars, and fatty acids). To remove any interference from these nonpetroleum based compounds, a silica gel clean-up of the samples should be performed. It was determined that the laboratory did not perform a silica-gel clean up. It is therefore likely that the TPHs concentration was unlikely to be petroleum-based hydrocarbons but were organics from biogenic matter instead (BMT Oceanica 2013b).

4.3.5 Wrack sampling and analysis 2014

Wrack samples were collected in April 2014 from six sites within the Boat Harbour entrance channel to support a DEIA completed for pre-emptive wrack trawling in 2014 (Section 4.4.3). The results are presented in full in BMT Oceanica (2014a). All wrack samples had a sulfurous odour and COPC (total metals, TBT, TPHs, PAHs, BTEX) were below the NAGD Screening Levels (CA 2009). Wrack samples consisted of mostly *Amphibolis* spp. stems, with some *Posidonia* spp. (BMT Oceanica 2014c). Elutriate H_2S and nutrient concentrations within wrack samples were elevated, however; there are no available marine guidelines for comparison to assess potential impacts, and nutrients are naturally elevated in marine flora given the organic constituents (BMT Oceanica 2014a). Dilution within the receiving marine environment was anticipated to reduce nutrient concentrations below relevant guidelines and no impacts were expected given wrack naturally accretes and resuspends from natural processes within the marine system (BMT Oceanica 2014a).

4.3.6 During dredging water quality monitoring 2020/21

In accordance with the LTMMP (current at the time of monitoring; BMT 2020), water quality monitoring was required on two occasions during the 2020/21 maintenance dredging campaign during dredging and disposal to realise the potential impact from elutriate nutrients (NH_3, FRP, TP, NO_x, TP, and TN) and metals (zinc and copper) concentrations that exceeded guidelines in the 2019 sampling campaign (Section 4.3.3). Water quality monitoring results were compliant with the management trigger in the LTMMP (BMT 2020) and the relevant and ANZG (2018) marine water quality guidelines for both monitoring occasions indicating the release of potential contaminants during dredging was not realised (BMT 2021).

4.4 Historical dredging and disposal

A review of capital construction, maintenance dredging, and wrack trawling campaigns completed between 1988 and 2017 was previously presented in the approved SAP (BMT 2019a). Table 4.2 has been updated to incorporate maintenance dredging campaigns completed since 2017.

Table 4.2 Historical dredging, wrack trawling and sand exaction works completed at Jurien Bay Boat Harbour

Year	Volume	Comments
2023	~46,000 m^3	Maintenance dredging and disposal to offshore disposal area within JBMP
2020/21	~37,000 m^3	Maintenance dredging and disposal to offshore disposal area within JBMP
2016/17	~62,000 m^3	Maintenance dredging and disposal to cleared onshore disposal area
2014/2015	~88,000 m^3 (including ~4,700 m^3 wrack)	Maintenance dredging and disposal to cleared onshore disposal area
2014	~8,500 m^3 ~4,100 m^3 (wrack)	Sand excavation near Fisheries jetty using land-based plant, wrack trawling
2013	~7,100 m^3	Wrack trawling
2011	~45 tonnes	Wrack trawling
2005/2006	~41,000 m^3	Maintenance dredging and disposal to dunes, wrack disposal options considered
1988	~550,000 m^3	Capital construction of the Boat Harbour. The majority of the material removed from the Boat Harbour was re-used for land reclamation in the south and southeast of the Boat Harbour for residential development. A portion of the material was also disposed of to the north of the site.

4.4.2 Capital dredging

Capital dredging to construct the Boat Harbour was carried out in 1988 (Table 4.2). The basin was dry excavated to ~ -3 m CD and the entrance channel to ~-3.5–4 m CD. The harbour entrance was dredged to ~ -5–6 m CD (JFA 2006). Majority of the material removed from the Boat Harbour was placed to the south and south-east of the Boat Harbour for residential development. However, a portion of the material was also disposed north of the site (JFA 2006). The total volume of material removed during the Boat Harbour construction was ~550,000 m^3.

4.4.3 Maintenance dredging

Since construction, the Boat Harbour has required several maintenance campaigns (Table 4.2). Dredged material from the 2005/06 campaign was disposed onshore to sand dunes north of the Boat Harbour (and subsequently re-vegetated). Dredged material from the 2014/15 and 2016/17 campaigns was disposed of into cleared areas onshore within the Harbour Reserve (Figure 4.3). Dredge material from the 2020/2021 and 2023 campaigns was disposed offshore within the JBMP.

4.4.4 Wrack trawling

Wrack trawling in the Boat Harbour entrance channel has been completed in 2011, 2013 and 2014 (Table 4.2). The 2011 campaign was a trial that involved the removal of ~45 tonnes of wrack (JFA 2012). Prolonged stormy weather conditions in winter 2013 led to substantial wrack ingress into the Boat Harbour and along the nearby beaches. Wrack trapped within the entrance channel led to poor navigability and decomposition resulted in localised fish kills. As a result, emergency trawling works removed ~7,100 m^3 of wrack from the Boat Harbour in October/November 2013 (Drawing No. 1463-14-1A). Similar works were completed in June/July 2014 when 4,100 m^3 of wrack was removed pre-emptively to reduce the amount of wrack in the Boat Harbour entrance channel ahead of winter storms.

During each campaign, wrack was removed from the entrance channel using a beam trawl and a heavy-duty net. The wrack was placed within the DoT Harbour Reserve (Figure 4.3) and later used as mulch by local Jurien Bay residents. Minor turbidity was observed during the trawling campaigns, but the turbid plume was not seen to extend beyond the Boat Harbour breakwaters.

4.4.5 Sand excavation

Excavation of sediments adjacent to the Boat Harbour inner northern sand trap was completed in 2014 (Table 4.2). The works involved the removal of ~8,500 m^3 of material to improve navigability in the entrance channel and allow access to the Boat Harbour jetties. The material was placed on the inner northern sand trap for the construction of the onshore bunded disposal area in the 2014/2015 dredging campaign. Turbidity generated during the sand excavation campaign did not extend beyond the Boat Harbour breakwaters.

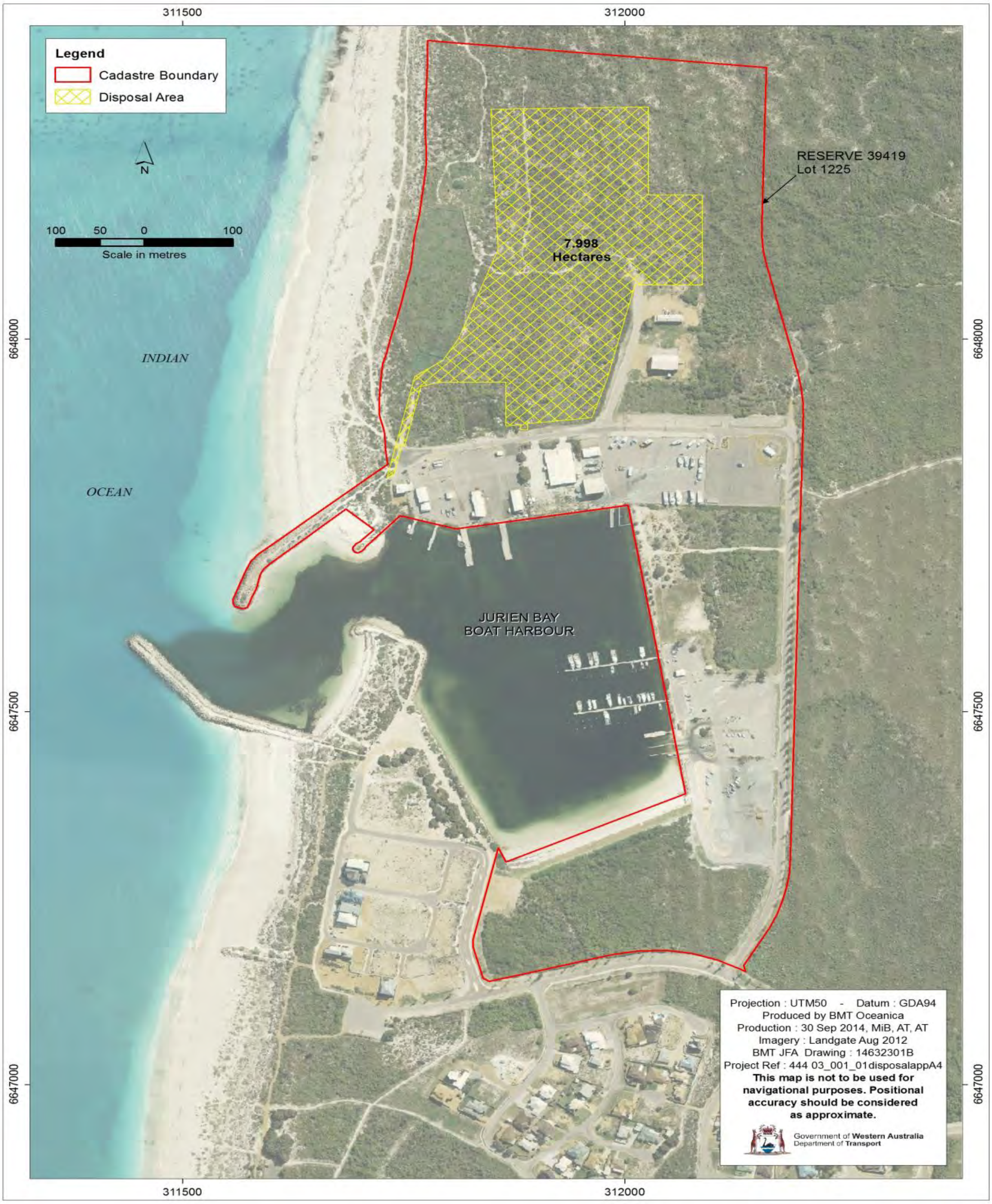


Figure 4.3 Jurien Bay Boat Harbour Reserve and onshore disposal area for the 2014–2017 maintenance dredging campaigns

5 Sampling and Analysis Plan

5.1 Contaminants of potential concern

The Boat Harbour is a small boating facility constructed along an arid stretch of rural coastline. Clean marine sands and wrack are transported into the Boat Harbour from the JBMP via longshore sediment drift processes and typically accrete seasonally around the breakwaters and entrance channel (Figure 1.1). Maintenance dredging is required frequently to remove sediment and wrack accretion to maintain Boat Harbour design depth for navigability.

5.1.1 Dredging area

Review of sediment quality data within the last 5 years and combined results from 2005–2019 indicate material within the Boat Harbour is suitable for dredging and ocean disposal (Section .4.3). The results from 2005, 2014 and 2019 sampling occasions are not contemporary (CA 2009), however; provide a historical contamination profile for the Boat Harbour and considered to support the review and selection of potential contaminants in future campaigns for the following reasons:

- the usage patterns of the Boat Harbour have not changed since the 2005 sampling (S Mettam, DoT, pers. comm., 29 September 2022), and land use surrounding the facility remains unchanged in reviews of aerial imagery between 2003–2024 (Google Earth Pro), so the likelihood of significant variation in results is low,
- there are no historical contaminated sites that require monitoring and management (DWER 2024),
- the sampling sites were within the same dredge areas as outlined in the previously approved SAP (BMT 2019a),
- a search of Department of Water and Environmental Regulation's Contaminated Sites Databased confirms there are no reported contaminant spills within 1 km of the Boat Harbour (DWER 2024).

The Boat Harbour is not considered susceptible to potential contamination from agricultural sources such as pesticides, or manufacturing sources such as polychlorinated biphenyls. Organotins were globally banned in 2008 and previous sediment sampling results indicate a low risk of organotin contamination (Section 4.3). Review of the latast ASS risk area maps (DWER 2017) relevant to the Boat Harbour location and previous sediment quality data (Section 4.3) indicates the risk of generating ASS during dredging and disposal is unlikely. Therefore, the dredge areas are classified as 'probably clean' for the purposes of sediment sampling based on likely cause effect pathways and review of historical data (Section 4.3). The potential sediment contaminant sources in the dredge and disposal areas have been reviewed in Table 5.1 and sediments within these areas will not be sampled for pesticides, herbicides, organotins and ASS. Accordingly, it is proposed to adopt a reduced analyte suite (CA 2009) similar to the one used in the previous Sampling and Analysis Plan (BMT 2019a) to sample sediments within dredge areas as follows:

- key metals and metalloids (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc)
- organics (TPHs/TRHs, BTEX and PAHs)

- elutriate nutrients[3] (TN, TP, NH_3/NH_4, FRP and NO_x)

Sediments will also be analysed for moisture and TOC for normalisation as a measure of bioavailability for organic contaminants (CA 2009). Samples will be analysed for PSD to estimate plume dispersion and to calculate settling velocity to provide an indication of plume intensity.

Table 5.1 Potential sources of contamination risk at Jurien Bay Boat Harbour and offshore disposal area

Contaminant of potential concern	Risk rating	Reasons for risk rating	Assessment required?
Metals	Medium	While the existing concentrations of total metals from dredge area sediments were below NAGD Screening Levels (CA 2009), mean concentrations of elutriate copper and zinc exceeded the relevant ANZG (2018) marine water quality default trigger values (Section 4.3.3; CA 2009). Vessels, anti-foulant paints, shipping operations, marine structures made from metals, and stormwater inputs remain a risk for source inputs to the Boat Harbour . Total metal concentrations from offshore disposal area sediments were also all below NAGD Screening levels (CA 2009) and contamination remains low risk in this area. However, the offshore disposal area will be sampled again for comparison between dredged and disposal area sediments as consistent with the previous revision of the SAP (BMT 2019a).	Yes
Elutriate nutrients	Low	Review of existing sediment sampling results from over the last 10 years (Section 4.3) showed elevated concentrations of elutriate nutrients likely from high wrack content within the Boat Harbour. Offshore disposal of dredged material commenced 2019 and water quality monitoring during dredging was completed to assess potential release of nutrients from the disposal of Boat Harbour sediments given sample results indicated elevated concentrations (Section 4.3.3). Water quality results during dredging were below relevant marine water quality guidelines indicating initial dilution within the receiving environment is sufficient and the risk of potential eutrophication impacts are considered low (Section 4.3.6; BMT 2021). While the risk of eutrophication impacts is considered low, the Boat Harbour remains a nutrient sink and ongoing source therefore elutriate nutrients will be sampled to provide a contemporary understanding of the potential risk of nutrient release during dredging and disposal.	Yes
Hydrocarbons	Low	Potential ongoing source from refuelling vessels within the Boat Harbour and commercial operations; however, previous sediment quality results from the dredge and	Yes

[3] *There are no guidelines for total nutrients in sediments, therefore only elutriate nutrient concentrations will be analysed to assess potential impacts from nutrient release during dredging and disposal.*

Contaminant of potential concern	Risk rating	Reasons for risk rating	Assessment required?
		offshore disposal areas met relevant guidelines (Section 4.3.3).	
Tributyltin	Very Low	Vessels are frequently moored near the Boat Harbour, and vessel maintenance is undertaken within DoT's lease areas. Previous sediment quality results were below relevant guidelines (Section 4.3). Given the global ban in 2008, the risk of organotin contamination is considered very low in both the dredge and offshore disposal areas.	No
Acid sulfate soils (ASS)	Very low	Sediment quality results from 2014 (Section 4.3.2) showed the risk of acid generation from marine sediments during dredging and disposal is unlikely due the high carbonate content of the marine sands. The dredging and disposal areas are not located in an ASS risk area (DWER 2017) or within a high-risk environment (e.g. near a riverine/estuarine environments). Additionally, the dredging and disposal methods will limit aerial exposure of dredged material (Section 2.2; DER 2015).	No

5.1.2 Disposal area

The proposed offshore disposal area (Figure 2.2) is located within JBMP and a Maximum Level of Ecological Protection and requires activities to be managed to ensure no changes beyond natural variation in ecosystem processes, biodiversity, abundance and biomass of marine life or in the quality of water, sediment and biota. There are no surrounding land uses or likely cause effect pathways with potential contaminant source inputs. Accordingly, a reduced analyte suite (BMT 2019a) is proposed for the offshore disposal area and sediments will be sampled for PSD to inform plume dispersion, TOC, hydrocarbons and a basic metal suite should alternative disposal options be required.

5.2 Sampling design and rationale

5.2.1 Sampling design

The absolute maximum dredging volume for an individual maintenance campaign is ~210,100 m^3 (inclusive of over-dredge; Table 4.2) and the total cumulative dredge volume is expected to be ~1.1 M m^3 over the proposed 10-year SDP duration (Section 2). As the proposed dredging volume for an individual campaign is less than 500,000 m^3 and the distribution of potential contaminants is likely to be uniform, the entire dredging area has been treated as a single site (CA 2009). Accordingly, a minimum of 29 sites are required to be sampled in the dredge areas (based on 550,000 m^3 for the remaining five years of the SDP). Given material is classified as 'probably clean' for the purposes of sediment sampling based on recent good quality data, sample numbers will be halved to 15 sites as per the NAGD (CA 2009; Section 4.3). The sampling numbers are developed from individual campaign volumes given the low risk of contamination (Table 5.1), frequency of maintenance dredging, and commitment to re-sample the Boat Harbour five years into the permit duration.

There is a low risk of potential contamination within the offshore disposal area (Section 5.1.2). In accordance with the NAGD (CA 2009), seven sites will be sampled within the proposed offshore disposal area for metals and TOC for comparison to ambient baseline concentrations sampled in 2019 (BMT 2019b). This data will facilitate the comparison of sediment data between dredge and disposal areas, assess plume dispersion using PSD data, and provide results to evaluate alternative disposal options, if required (BMT Oceanica 2017).

5.2.2 Sampling sites

Sediment sampling sites have been randomly distributed throughout the dredging and disposal area footprints using ArcGIS v10 software (Figure 5.1). Some sites were manually re-positioned to ensure adequate sample depth and coverage, and adjacent to areas with the highest risk of potential contaminants. The coordinates of the sediment sampling sites are listed in Table 5.2. Quality assurance and quality control (QA/QC) samples as described in NAGD (CA 2009) and Section 5.2.4 will be collected as required during the field survey.

5.2.3 Sampling depth

Boat Harbour sediments are considered to be relatively well mixed, given the moderate to high levels of vessel activity and frequency of maintenance dredging campaigns (Section 5.2.1). Sediments within the Boat Harbour are considered representative of clean marine sands accumulated between maintenance campaigns, and previous results have demonstrated there was no contamination at depth in high-risk areas (Section 4.3). As sediments are long-term accumulators of contaminants, it is not anticipated that the recent accretion of marine sands between maintenance campaigns will present a contamination risk in surface layers or at depth. Therefore, a grab sampler, which collects the surface ~20 cm of sediment is considered appropriate to collect representative samples within the Boat Harbour. Surface layer sediments within the proposed dredging and disposal areas will be sampled at coordinated sites as outlined in Figure 5.1.

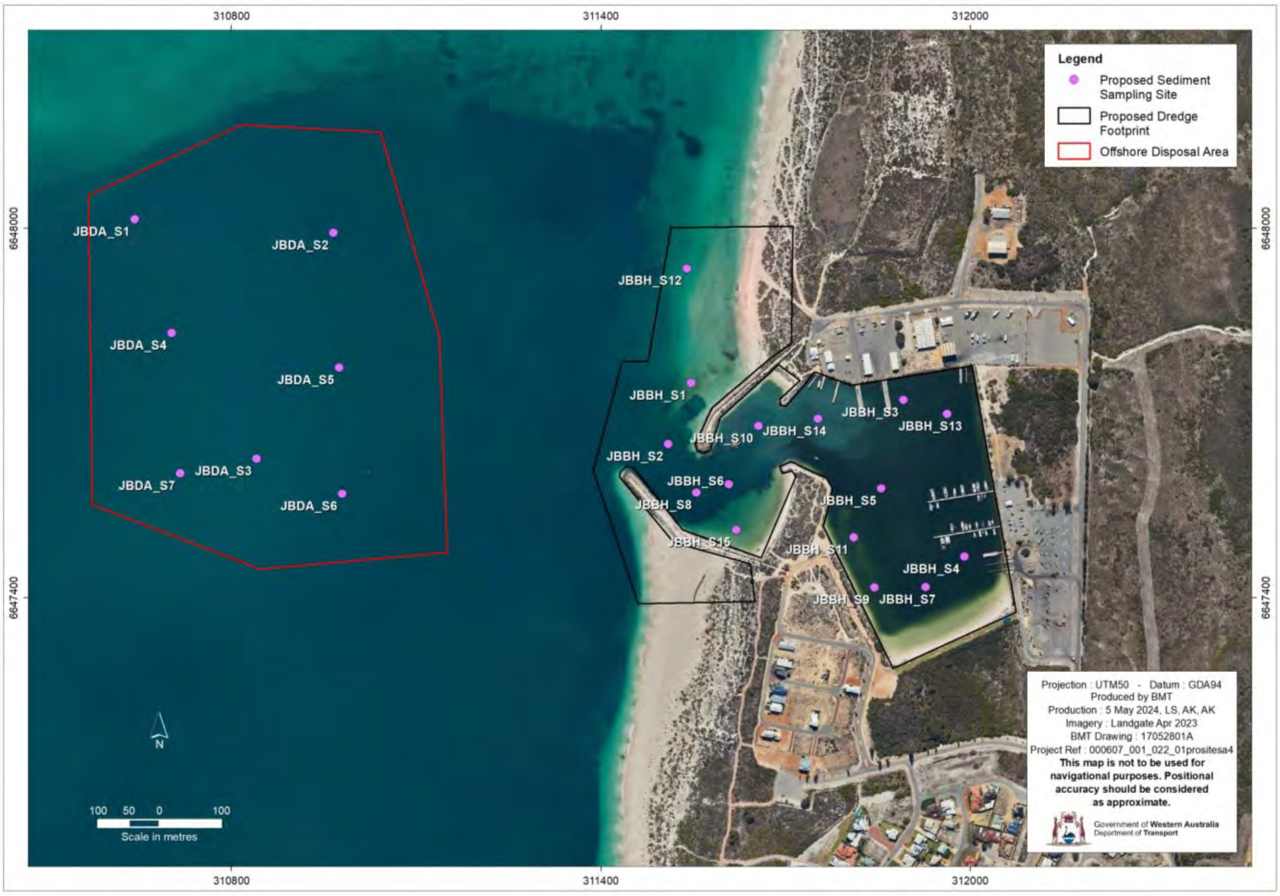


Figure 5.1 Jurien Bay Boat Harbour sediment sampling sites at the dredging and disposal areas

Table 5.2 Site coordinates and target sampling depths within the Jurien Bay Boat Harbour dredge area and offshore disposal area

Sampling area[1]	Sampling site[1]	Coordinates (UTM50 GDA94)[2]		Target sampling depth (m)
		Easting	Northing	
Dredge area	JBBH_S1	311547	6647749	0.2
	JBBH_S2[3]	311510	6647650	0.2
	JBBH_S3	311892	6647721	0.2
	JBBH_S4	311991	6647467	0.2
	JBBH_S5	311856	6647578	0.2
	JBBH_S6[3]	311608	6647584	0.2
	JBBH_S7	311928	6647418	0.2
	JBBH_S8	311556	6647571	0.2
	JBBH_S9	311845	6647417	0.2
	JBBH_S10[3]	311656	6647679	0.2
	JBBH_S11	311811	6647498	0.2
	JBBH_S12	311540	6647935	0.2
	JBBH_S13	311963	6647698	0.2
	JBBH_S14	311753	6647691	0.2
	JBBH_S15	311620	6647510	0.2
Disposal area	JBDA_S1	310643	6648015	0.2
	JBDA_S2	310966	6647993	0.2
	JBDA_S3	310841	6647626	0.2
	JBDA_S4	310703	6647830	0.2
	JBDA_S5	310975	6647774	0.2
	JBDA_S6	310980	6647569	0.2
	JBDA_S7	310717	6647602	0.2

Notes:

1. **Refer to Figure 5.1 for sampling sites and locations. Site locations are subject to change depending on accessibility in the field (Section 5.3.4).**
2. **'UTM' = Universal Transverse Mercator; 'GDA' = Geocentric Datum of Australia**
3. **Quality assurance and quality control triplicate (JBBH_S6 and JBBH_S10) and split (JBBH_S2) sampling sites; refer to Section 5.2.4.**

5.2.4 QA/QC samples

Two types of QA/QC samples will be included in the field sampling plan, as recommended by the NAGD (CA 2009):

- triplicate: at 10% of sampling sites, three separate samples will be collected from the same site to determine the variability of the sampling scale's physical and chemical sediment characteristics at the scale of sampling.
- split: at 5% of sampling sites, the sample shall be thoroughly mixed and then split into three sub-samples to assess laboratory variation. Two of the three samples will be analysed at the primary laboratory (intra-laboratory splits), and the third sample will be analysed by a reference laboratory (inter-laboratory split).

For the proposed sampling design (Section 5.2.1), two triplicate sample (sites JBBH_S6 and JBBH_S10) and one split sample (site JBBH_S2) will be collected. Analysis for PSD will be completed on the triplicate sample, but not on the split sample.

One rinsate blank will be completed for each item of reused equipment per day to assess contamination among samples meets relevant data quality objectives (Section 6.3.6). One trip blank will be completed to assess potential during transport and storage contamination.

A total of 15 samples will be analysed from the proposed dredging area (Table 5.3). A further seven samples will be collected from the disposal area. Six QA/QC samples will be collected in addition to primary samples (Table 5.3).

Table 5.3 Proposed number of samples to be analysed at Jurien Bay Boat Harbour dredging and disposal areas

Sampling site	Number of samplings
Dredge area	15
Disposal area	7
QA/QC[2]	6
Total	**28**

Notes:

1. Refer to Figure 5.1 and Table 5.3 for sampling sites and locations.
2. Quality assurance and quality control triplicate (JBBH_S6 and JBBH_S10) and split sampling sites (JBBH_S2); refer to Section 5.2.4.

5.3 Field operations and procedures

The field procedures used during the sampling are consistent with NAGD (CA 2009) and are detailed in the following sections.

5.3.1 Health and safety

Prior to the commencement of the field survey, a Field Plan and a Job Hazard Analysis (JHA) shall be completed to identify and address the workplace health and safety associated with the survey. All field personnel shall be required to review and sign the Field Plan and JHA.

There is a low risk of personal injury from the use of the sampling equipment. Similarly, the sediments to be sampled are considered to pose little risk to the health of field personnel. Decon 90 (a detergent) will be used in the field for cleaning sampling equipment among sites. No other chemicals will be used in the field. Decon 90 is a biodegradable concentrate that combines anionic and non-anionic surface-active agents with stabilising agents, alkalis and non-phosphate detergent builders to produce a highly effective cleaning compound. Nitrile gloves will be worn by personnel involved in the handling of sediments and appropriate personal protection equipment (PPE) will be worn by all field personnel.

5.3.2 Equipment and personnel

Two personnel are required to complete the sediment sampling during a two-day field campaign. No diving or snorkelling is required, and sediment sample collection will be vessel based within the dredging and disposal areas using a grab sampler. The following equipment will be used during the sampling program:

- 2 x hand-held geographical positioning system (GPS) units
- vessel GPS
- Van Veen grab
- rinsed sample containers provided by the laboratory
- ziplock bags
- Munsell soil colour chart and scale bar
- eskies and ice bricks
- inert nitrile gloves
- pyrex glass bowls
- white plastic spoons
- Decon 90
- plastic tubs and brushes for washing
- digital camera
- drop camera
- field and sediment logs
- chain of custody (CoC) forms
- JHA
- daily operations reports
- first aid kit
- PPE (steel-cap boots, sunglasses, sunscreen, long trousers, long-sleeved high-visibility shirts, wide-brimmed hats and gloves)
- field mobile phone
- electrical tape
- permanent markers
- waterproof pens
- spare batteries for camera and GPS.

5.3.3 Contingency

In the event of delays due to bad weather or critical equipment failure, sampling will be continued as soon as safely possible. In case of extended delays, any samples already collected will be submitted to the laboratory for testing rather than being held until the completion of the entire sampling program. Any deviation from the procedures outlined in this document will be noted in the implementation report, and records of sample delivery to the laboratories will be filed and supplied on request.

The recommended sample holding times, storage and transport, as defined within the NAGD (CA 2009; Section 5.3.8), will be adhered to.

5.3.4 Sediment collection and processing

A hand-held GPS will be used to locate the proposed sediment sampling sites (Figure 5.1). The 'actual' location of each site will be recorded on the GPS (accuracy ±5 m) to mark and confirm the sampled location. Actual sediment sampling locations will be recorded with a GPS unit for presentation in the implementation report.

Sediment samples from the dredge and disposal areas will be collected using a Van Veen grab to a depth of ~0.2 m. One grab sample will be collected from most sampling sites, with three grabs collected from the triplicate sampling site (Table 5.2). A drop camera will be used to confirm the habitat at the disposal area (Section 5.2.1).

5.3.5 Seawater collection

Approximately 20 L of seawater will be collected for elutriate analysis (if required). The seawater will be collected on the last day of sampling and as close to transportation time as possible to ensure it arrives at the laboratory as soon as possible after sampling. Local seawater from Jurien Bay will be collected from an area away from potential sources of contamination and turbidity.

5.3.6 Sample processing and labelling

Each sample will be placed directly into a glass bowl. Before placing the sediment into laboratory sample containers, the following data and metadata will be entered onto a field log:

- date and time of sampling
- sampling site number
- sample identifier (ID)
- coordinates of each location at which samples are taken (recorded on a GPS)
- identity of personnel
- water depth of sampling location
- sediment characteristics including Munsell colour, texture, angularity, odour, sediment type, grain size, presence of foreign material, organics and shell fragments
- local weather conditions at time of sampling, such as tides, swells and currents
- a photograph of each sediment sample

At each site following collection sediment grabs will be photographed and sediment descriptions recorded. Samples for volatile substances (TPH/TRH, PAH and BTEX) will be collected immediately into the appropriate vials directly from the grab to limit the exposure of volatiles. The remaining sample will be homogenised within a Pyrex glass bowl using a plastic spoon until the colour and texture is uniform. The mixing of the sample will be limited to avoid oxygenation of the sample. An appropriate volume will be collected for each analyte as described in Section 5.3.8 and placed into the appropriate sample containers provided by the laboratory. Excess sediment will be disposed on-site at the time of sampling. Sampling equipment will be cleaned with Decon 90 and rinsed thoroughly with clean seawater between each sampling site.

All sample containers will be clearly labelled in two locations with a unique ID, the date of collection, and the BMT project number. A field sediment inventory log will also be kept ensuring that each sample can be identified, and a photograph of each field log will be taken as a back-up, as often as required. The field log will record:

- date of sampling
- sampler
- sampling location and GPS coordinates
- sample containers collected.

5.3.7 Cross-contamination control

To avoid cross-contamination between sampling at the individual sites, all sampling equipment will be washed in Decon 90 after each sampling site and rinsed with fresh seawater. One rinsate blank will be collected for each item of reused equipment per day to assess decontamination among samples. Field personnel handling the samples will wear a pair of inert gloves, changing these between sample collection at each site.

5.3.8 Sample storage, and transport

The recommended sample volumes and sample container types for each analyte are outlined in Table 5.4, along with preservation techniques and storage conditions. Glass pre-cleaned sample containers will be used to store sediments other than PSD samples, which will be stored in double Ziploc bags. The samples will be kept in an esky with ice until they can be transported to a refrigerator or freezer on completion of the day's sampling. The samples will remain in storage until transported to the laboratories in eskies with ice blocks to ensure that the samples remain cool.

Table 5.4 Recommended volumes, preservation, storage and holding times for sediment and analytes

Analyte	Typical sample size	Sample container	Preservation technique	Storage condition	Storage holding time[1]	Reference
Metals	400 ml[2]	Pre-cleaned glass jar with Teflon-lined lid	Refrigerate (or freezer for extended storage)	≤4°C	6 months (Hg 28 days unless frozen)	CA (2009)
Moisture[3]	50 ml		Refrigerate (or freezer for extended storage)	<6°C	14 days	NEPC (2013)
Total organic carbon	50 ml		Refrigerate (or freezer for extended storage)	<6°C	28 days, unless frozen	NEPC (2013)
Elutriate nutrients[4]	100 ml		Refrigerate	<4°C	14 days	CA (2009)
Organics (TPHs, PAHs, BTEX)	250 ml[2]	Solvent-rinsed glass jar with Teflon-lined lid, filled with zero headspace	Refrigerate	≤4ºC, in the dark	14 days if refrigerated	CA (2009)
Elutriate seawater	1 L per sample	White plastic drums	Refrigerate	4°C, in the dark	14 days	CA (2009)
Particle size distribution	200 ml	Ziploc bag or equivalent resealable plastic bag	Refrigerate	<4°C	Undetermined	CA (2009)

Notes:

1. **Represents holding time prior to sample extraction by the laboratory, extract holding times also apply**
2. **Includes sample for whole sediment, elutriate and bioavailable analysis**
3. **No holding time applies for moisture content if the results are used for dry weight reporting and performed on the same day as the chemical analytes of interest**
4. **Sediments for elutriate analysis cannot be frozen and have a holding time of 14 days**
5. **'ml' = millilitre, 'L' = litre, '≤' = less than or equal to, 'C°' = degrees Celsius; metals = arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc; elutriate nutrients = total nitrogen, total phosphorus, ammonia/ammonium, filterable reactive phosphate,**

nitrate/nitrite, 'TPHs' = total petroleum hydrocarbons, 'TRHs' = total reactive hydrocarbons, 'PAHs' = polycyclic aromatic hydrocarbons, 'BTEX' = benzene, toluene, ethylbenzene, xylene

5.3.9 Chain of custody forms

A detailed CoC form will be prepared and will accompany samples to designated laboratories. The CoC forms allow tracking of individual samples, ensure correct analysis and storage, and that the recommended holding times are being adhered to, where possible. The CoC forms must be signed by the laboratories on receipt of the sample and returned to BMT. The CoC forms will include:

- place of sampling
- sample site ID, client name and BMT project number
- sampling date
- requested analysis
- sample storage request
- appropriate PPE requirements for sample handling
- sample transport details including date of dispatch.

6 Analysis Plan

6.1 Laboratory analysis and quality assurance, quality control

In recognition of the low-risk of contamination within sediments (Section 4.3), a risk-based approach has been adopted in selecting analytes within the dredge and disposal areas for analyses based on likely contaminant cause effect pathways (Table 5.1). The sediment samples from the proposed dredging and disposal areas will therefore be tested for a range of different analytes (Table 6.1) based on the COPC from review of historical data and recent facility usage (Section 4.3).

Table 6.1 Selected analyte analysis plan for Jurien Bay Boat Harbour dredging and disposal areas

Area	Site[1,2]	Metals[3]	Elutriate[4] nutrients	TOC[2,5]	TRHs/TPHs[2]	PAHs[2]	BTEX[2]	PSD[2]
Dredge area	JBBH_S1	✓	✓	✓	✓	✓	✓	✓
	JBBH_S2[6]	✓	✓	✓	✓	✓	✓	✓
	JBBH_S3	✓	✓	✓	✓	✓	✓	✓
	JBBH_S4	✓	✓	✓	✓	✓	✓	✓
	JBBH_S5	✓	✓	✓	✓	✓	✓	✓
	JBBH_S6[6]	✓	✓	✓	✓	✓	✓	✓
	JBBH_S7	✓	✓	✓	✓	✓	✓	✓
	JBBH_S8	✓	✓	✓	✓	✓	✓	✓
	JBBH_S9	✓	✓	✓	✓	✓	✓	✓
	JBBH_S10[6]	✓	✓	✓	✓	✓	✓	✓
	JBBH_S11	✓	✓	✓	✓	✓	✓	✓
	JBBH_S12	✓	✓	✓	✓	✓	✓	✓
	JBBH_S13	✓	✓	✓	✓	✓	✓	✓
	JBBH_S14	✓	✓	✓	✓	✓	✓	✓
	JBBH_S15	✓	✓	✓	✓	✓	✓	✓
Offshore disposal area	JBDA_S1	✓		✓	✓	✓	✓	✓
	JBDA_S2	✓		✓	✓	✓	✓	✓
	JBDA_S3	✓		✓	✓	✓	✓	✓
	JBDA_S4	✓		✓	✓	✓	✓	✓
	JBDA_S5	✓		✓	✓	✓	✓	✓
	JBDA_S6	✓		✓	✓	✓	✓	✓

Area	Site[1,2]	Metals[3]	Elutriate[4] nutrients	TOC[2,5]	TRHs/TPHs[2]	PAHs[2]	BTEX[2]	PSD[2]
	JBDA_S7	✓		✓	✓	✓	✓	✓
QA/QC	Triplicate	✓	✓	✓	✓	✓	✓	✓
	Split	✓	✓	✓	✓	✓	✓	

Notes:

1. Refer to Figure 5.1 and Table 5.3 for sediment sampling site locations
2. 'JBBH' = Jurien Bay Boat Harbour, 'JBDA' = Jurien Bay Disposal Area, 'TOC' = total organic carbon; 'TPHs' = total petroleum hydrocarbons, 'TRHs' = total recoverable hydrocarbons, 'PAHs' = poly-aromatic hydrocarbons, 'BTEX' = benzene, toluene, ethylbenzene and xylene, 'PSD' = particle size distribution
3. Metals = arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc
4. Elutriate nutrients = total nitrogen, total phosphorus, ammonia/ammonium, filterable reactive phosphorus and nitrate/nitrite
5. Analysis required for normalisation as a measure of bioavailability for organic contaminants
6. Quality assurance and quality control triplicate (JBBH_S6 and JBBH_S10) and split (JBBH_S2) sampling sites; refer to Section 5.2.4.

6.1.1 Dredging areas sample analysis

All sediment samples within the dredge areas will be analysed for metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc), elutriate nutrients (TP, FRP, TN, NOx, NH_4^+, NH_3), TOC, hydrocarbons (PAHs, TPHs, TRHs, BTEX) and PSD in recognition of the low-risk of contamination and the likely COPC (Section 4.3; Table 6.1). The PSD data will assess plume dispersion and calculate particle settling times to provide an indication of potential turbidity generated from dredging and disposal. TOC will provide a measure of contaminant mobility within the sediment for assessment against the NAGD (CA 2009).

6.1.2 Disposal area sample analysis

There is a low risk of contamination at the offshore disposal area and sediment samples will be analysed for PSD to inform plume dispersion, TOC, hydrocarbons, and a metal suite (Section 5.1.2).

6.1.3 Analysis laboratories

It is proposed[4] that Australian Laboratory Services (ALS) will be the primary laboratory for chemical analysis of sediment samples and ChemCentre will be the reference laboratory for chemical analysis. Murdoch University's Marine and Freshwater Research Laboratory (MAFRL) will complete PSD analysis; no reference laboratory is required for PSD analysis. Limits of reporting of laboratories used in this study are listed and compared to practical quantitation limits (PQL) in Table 6.2. There are no relevant guidelines for BTEX and the primary samples will be analysed to the required PQL.

Samples will be consigned using CoC forms to the laboratories for analysis. As part of their procedures, both the primary laboratory and the reference laboratory will test blanks, spikes and standards and complete laboratory duplicates as required by the NAGD (CA 2009) and to the satisfaction of the National Association of Testing Authorities (NATA) requirements.

[4] *Analysis laboratories will be NATA accredited and subject to change.*

Table 6.2 Practical quantitation limits and limits of reporting for analysis laboratories and relevant contaminants concern with Jurien Bay Boat Harbour dredging and disposal areas

Parameter (mg/kg)		PQL	NAGD Screening Level	ALS	ChemCentre	MAFRL	PQL limit met
Arsenic		1	20	1	0.2	n/a	Y
Cadmium		0.5	1.5	0.1	0.05	n/a	Y
Chromium		1	80	1	0.05	n/a	Y
Copper		1	65	1	0.1	n/a	Y
Lead		1	50	1	0.5	n/a	Y
Mercury		0.01	0.15	0.01	0.01	n/a	Y
Nickel		1	21	1	0.1	n/a	Y
Zinc		1	200	1	0.25	n/a	Y
TPH	C6–C9	n/a	n/a	3	25	Y	n/a
	C10–C14	n/a	n/a	3	50	Y	n/a
	>C15–C28	n/a	n/a	3	50	Y	n/a
	>C16–C35 (aromatic)	n/a	n/a	90	200	Y	n/a
	>C16–C35 (aliphatics)	n/a	n/a	100	100	Y	n/a
	>C35 (aliphatics)	n/a	n/a	100	100	Y	n/a
	C29–C36	n/a	n/a	5	n/a	Y	n/a
	Total	n/a	550	–	n/a	Y	n/a
TRH	C6–C10	n/a	n/a	10	–	n/a	n/a
	>C10–C16	n/a	n/a	50	25	n/a	n/a
	>C16–C34	n/a	n/a	100	100	n/a	n/a
	>C34–C40	n/a	n/a	100	100	n/a	n/a
	Total	n/a	550	100	n/a	n/a	n/a
BTEX		0.2	n/a	0.2	0.2	n/a	Y
PAHs		0.005	10 000	0.004–0.005	0.005	n/a	Y
Elutriate nutrients[2] (mg/L)		n/a	n/a	0.005–0.05	0.005–0.01	n/a	n/a
Moisture content (%)		0.1	n/a	0.03	0.1	n/a	Y
Total organic carbon (%)		0.1	n/a	0.02	0.05	n/a	Y

Parameter (mg/kg)	PQL	NAGD Screening Level	ALS	ChemCentre	MAFRL	PQL limit met
PSD	Size distribution and rates of settlement after 50% and 90% of settlement	Size distribution and rates of settlement after 50% and 90% of settlement	n/a	n/a	Wet sieving (>106 µm), and laser diffraction (106–0.3 µm)	Y

Note:

1. 'NAGD' = National Assessment Guidelines for Dredging (CA 2009), 'PQL' = practical quantitation limit, 'ALS' = Australian Laboratory Services, 'MAFRL' = Marine and Freshwater Research Laboratory, 'TPH' = total petroleum hydrocarbons, 'TRHs' = total recoverable hydrocarbons, 'BTEX' = benzene, toluene, ethylnenzene, xylene, 'PAH' = polycyclic aromatic hydrocarbons, 'n/a' = not applicable, 'Y' = yes, 'N' = no, '–' = not supplied
2. Elutriate nutrients = total nitrogen, total phosphorus, ammonia/ammonium, filterable reactive phosphorus and nitrate/nitrite

6.2 Proposed laboratory analytical methods

6.2.1 Metals

Whole sediment

Analytical methods for total metals will consist of a strong acid digest and then analysing for metals with either Inductively Coupled Plasma-Optical Emission Spectrometer (ICP–OES) or Graphite Furnace Atomic Absorption Spectrometry (GF–AAS) (mercury only) by both ALS and ChemCentre laboratories.

Elutriate

Elutriate testing will be conducted by shaking a representative sediment sample with four times the volume of seawater (ratio of 1:4). Samples will be placed on an end-over-end-shaker at room temperature for 30 minutes and then allowed to settle for 1 hour. The supernatant will be centrifuged at 3000 revolutions per minute (rpm) for 3 minutes and then filtered through 0.45 µm disposable syringe filters. Ultra trace metal analysis will be performed with an Agilent 770 x ICP-MS (Inductively Coupled Plasma – Mass Spectrometry) to achieve the lowest reporting levels possible. The elutriate water will also be tested as a blank by the same methods and subtracted from the elutriate test results.

6.2.2 Total recoverable hydrocarbons and benzene, toluene, ethylbenzene and xylene

Sediment extraction will be completed using a dicholoromethane/hexane solution. The extract will be analysed via gas chromatography – mass spectrometry. The method follows the United States Environmental Protection Authority (USEPA) methods (5030A, 8020, 8000A and 8260).

6.2.3 Polycyclic aromatic hydrocarbons

Sediment will be extracted with dichloromethane/acetone solution and injected into a gas chromatograph with detection by a mass selective detector (USEPA method 8270).

6.2.4 Elutriate nutrients

Elutriate testing is carried out by shaking a representative sediment sample with four times the volume of seawater (ratio of 1:4). Samples are placed on an end-over-end shaker at room temperature for 30 minutes and then allowed to settle for 1 hour. The supernatant is centrifuged at 3000 rpm for 3 minutes and then filtered through 0.45 µm disposable syringe filters. The filtered supernatant is measured for dissolved nutrients using the following methods: filterable reactive phosphorus analysed by the ascorbic acid method; nitrate and nitrite by copper-cadmium reduction; and ammonium by the alkaline phenate method. All nutrient analyses are carried out using a Lachat Quick-Chem 8500 Automated Flow Injection Analyser. The elutriate water is also tested as a blank by the same methods and subtracted from the elutriate test results.

6.2.5 Total organic carbon

TOC will be determined from a sample pre-treated with acid to remove inorganic carbon (IC) (carbonates and bicarbonates). The residue is filtered, washed and collected on a glass fibre filter. The filter with residue is placed into a crucible and is dried in an oven at 40°C for several hours. The organic carbon (OC) in the dried sample in the crucible is determined using a total carbon analyser. The dissolved organic carbon (DOC) in the acid solution is determined using ICP-AES after purging to remove any dissolved inorganic carbon (carbon dioxide). The final TOC result will be the sum of the OC in the solid residue and the DOC in the solution.

6.2.6 Particle size distribution

Sediment samples will be analysed for PSD by laser diffraction to categorise particle sizes between 0.02 and 500 µm. The particle size distribution for particles >500 µm will be measured by wet sieving. Particle size fractions will be reported to the Wentworth (1922) scale (Table 6.1).

Table 6.1 Wentworth scale particle size fraction

Size class	Particle size (µm)
Clay	<4
Fine silt	4–16
Medium silt	16–31
Course silt	31–62
Fine sand	62–250
Medium sand	250–500
Coarse sand	500–2000
Pebbles/Cobbles/Boulders	>2000

6.3 Data analysis

6.3.1 Particle settling times

The PSD data from samples in the proposed dredging and disposal areas (Figure 5.1) will be used to inform plume dispersion and calculate particle settling times to give an indication of the turbidity duration during dredging and disposal. Information on the method used to calculate particle settling times is provided in Section 6.2.6. Particle settling times will be calculated using Stoke's Law, which estimates the particle settling velocity based on the diameter and density of the particles. The settling velocities will then be used to estimate the time taken for sediment to settle through 1 m of water. Settling times will not be calculated for sediment samples that are >45% silt and clay as Stoke's Law is not applicable for material with this high a proportion of fine sediment.

6.3.2 Normalisation

As TOC is the main binding constituent for organic substances in marine sediments, the NAGD (CA 2009) requires organics (e.g. TPHs/TRHs, BTEX, PAHs) to be normalised to 1% TOC for comparison with the

NAGD Screening Levels (CA 2009). Normalisation is only appropriate over a TOC range of 0.2–10%. For TOC <0.2% or TOC >10%, the maximum and minimum values of 0.2 and 10% TOC will be used for normalisation, respectively. In accordance with the NAGD, if the organic data are below LoR, half the LoR value will be used for normalisation purposes (CA 2009).

6.3.3 Calculation of 95% upper confidence limit

Concentrations of contaminants in sediment samples will be compared to the NAGD Screening Levels and Sediment Quality Guideline High Values, if required (CA 2009). Comparison of sediment contaminant concentrations to the NAGD Screening Levels requires calculation of the 95% Upper Confidence Limit (UCL) of the mean (CA 2009). The data will firstly be tested for normality using the software ProUCL 5.2 (USEPA 2022). This software determines the most appropriate method for calculating the 95% UCL depending on the distribution of the data and the size of the dataset, including the proportion of values below the LoR (which introduce statistical complexities into the analysis). These may include parametric (such as Student's t-UCL) or nonparametric (such as bootstrap) methods. A 95% UCL will then be calculated if there are enough replicate sediment samples.

The 95% UCL of the mean will not be calculated when more than 25% of the contaminant concentration data are below the LoR (Section 6.3.4). This is because bias can be introduced if a large proportion of data are below the LoR, leading to under-estimation of contamination at certain sites.

6.3.4 Analysis of analyte concentrations below the limit of reporting

Analyte concentrations that are too low to be detected using laboratory methods will be recorded as below the LoR. Generally, half the laboratory LoR value will be used as a substitute for data below the LoR, in accordance with the NAGD (CA 2009). However, a large proportion of the data below the LoR has the capacity to bias subsequent analyses. USEPA (2022) does not consider a 95% UCL of the mean calculated based upon few detected values to be reliable. Therefore, where the data contain values below the LoR, the following protocol will be applied (based on ANZECC & ARMCANZ 2000):

- Where >25% of values are below the LoR, descriptive statistics (means and percentiles) or inferential analysis (including the calculation of confidence limits) will not be calculated. Instead, individual results will be compared to the triggers and discussed accordingly.

- Where ≤25% but >0% of values are below the LoR, confidence limits will be calculated via two methods; once using the normalised estimate based on half the LoR as the replacement value and once using zero as a replacement value. This will then inform the interpretation of the results, in particular, whether the choice of replacement value affects the outcome of the analysis.

6.3.5 Quality assurance and quality control assessment

The results of the field QA/QC sampling will be analysed as described in the NAGD (CA 2009) by calculating the Relative Percent Difference (RPD) between two samples, and Relative Standard Deviation (RSD) between three samples. The results should agree within an RPD or RSD of ±50%, although the NAGD (CA 2009) notes that this may not always be the case where the sediments are very heterogeneous.

6.3.6 Data management procedures

All data will be validated prior to reporting (Annex A). Data will be checked for completeness and compared against the submitted CoC forms delivered to the laboratories. Data will be analysed for outliers and these will be processed as per page 35 of NAGD (CA 2009). All laboratory reports will be included in appendices to the SAP implementation report. This will include laboratory QA/QC data (blanks, laboratory duplicates, and spikes) and all original data received. All original field sediment grab log sheets will also be put in appendices along with appropriate photographs.

6.3.7 Systems

The data management system has the following components:

- procedures for recording results of analysis and field observations
- procedures for systematic screening and validation of data
- secure storage of information
- a data retrieval system
- data analysis protocols
- flexibility to accommodate additional information, e.g. metadata.

6.3.8 Data entry protocols

Appropriate protocols for entering data will be implemented to reduce error in data entry:

- templates for standardising datasheet formats (sediment field log, method statement) that are provided to field staff prior to sampling to ensure all information required will be collected.
- data are electronically transferred to the database where possible to prevent transcription errors.
- the collector(s) of the data to ensure that only correct and validated data are provided to the database manager for uploading into the database.

6.3.9 Responsibility for data management

A dedicated geographical information system (GIS) and Environmental Data Management (EDM) team are responsible for producing maps and managing spatial data, to ensure adherence to data management protocols and accurate mapping. The EDM team adhere to a QA/QC protocol, and any changes to the data and/or the database are appropriately implemented and tracked.

6.3.10 Archive and back-up data

Archives of all original data files and associated metadata are maintained for future reference. This includes archiving of:

- raw data sheets from field and laboratory measurements and analyses
- electronic copies of verified data files prior to uploading into the database.

Regular backing up of the monitoring database occurs so that data are not lost in the case of system or file failures.

6.4 Assessment of dredged material for ocean disposal

The suitability of the dredge material for unconfined ocean disposal will be determined by following the procedure as outlined within Figure 3 (p.12) of the NAGD (CA 2009).

6.4.1 Phase II assessment

The 95% UCL for COPC will be calculated for sediment samples, unless there are instances where the sample size is insufficient (i.e. $n \leq 6$), to yield statically robust results. In such cases, individual site data will be compared to NAGD Screening Levels (CA 2009).

Further sample analysis

If results for all analytes from each distinct sediment layer (sampling increment) fall below the NAGD Screening Levels (CA 2009), no further testing will be undertaken and the material in that area will be considered suitable for unconfined ocean disposal. Results may also be compared to ambient baseline levels for sediments of comparable grainsize, as per NAGD (CA 2009). If contaminant concentrations are found to be dissimilar to the concentrations occurring at the disposal area, then further sampling and testing will be required.

6.4.2 Phase III assessment

If contaminant concentrations still exceed NAGD Screening Levels (CA 2009), then elutriate and bioavailability analysis of the relevant analyte will be completed on samples collected at the site that exceeded the guideline to: 1) simulate the potential release of contaminants from the sediment during dredging and disposal; and 2) determine the bioavailability of the contaminant (CA 2009). If the bioavailable concentrations[5] still exceed relevant guidelines toxicity and bioaccumulation testing may be considered (as described in Section 4.2.3 of the NAGD; CA 2009). This will be done in consultation with the determining authority (DCCEEW).

Elutriate testing

If concentrations of metals are above the relevant NAGD Screening Levels (CA 2009) elutriate testing of the relevant sediment samples will be completed within 14 days to meet recommended holding times (Section 5.3.8). Given there are no guidelines for total nutrients in marine sediments, only elutriate nutrients will be analysed to assess potential eutrophication impacts. Selecting the samples from the sites that have exceeded the NAGD Screening Levels is consistent with the NAGD (CA 2009) protocols whereby a defined sub-area can be selected if the most contaminated locations are captured. The sites that have exceeded the NAGD Screening Levels (CA 2009) are assumed to be the most contaminated.

Elutriate testing[6] will be undertaken at a dilution ratio of 1:4 (CA 2009; p. 40). The results of the 1:4 dilutions will be compared directly with ANZECC/ARMCANZ (2000) or ANZG (2018) DGV's water quality trigger values for 90% and 99% species protection, with concentrations below the trigger values considered unlikely to adversely impact benthic organisms. If an exceedance occurs, the laboratory will apply a correction factor to the concentrations measured from the 1:4 dilution extraction, since this ratio greatly overestimates concentrations that will be present within the water column following disposal (NAGD; p. 40). These corrections factors will be calculated using initial dilution estimations based on disposal method and oceanographic data (where available). The corrected concentrations will then be compared against ANZG (2018) DGV for 90% and 99% species protection marine water quality, depending on the area of assessment (dredge/disposal).

Bioavailability testing

If concentrations of metals are above the relevant NAGD Screening Levels (CA 2009) bioavailable testing of the relevant sediment samples will be completed within 14 days to meet recommended holding times (Section 5.3.8). Further bioavailability testing of metals will be completed using a dilute acid extraction to estimate the bioavailable fraction. The bioavailable concentration (95% UCL) will then be compared to the NAGD Screening Levels (CA 2009) and, if exceeded, ecotoxicity testing may then be implemented or alternative design and/or disposal methods may be investigated.

6.4.3 Phase IV assessment

Toxicity

If elutriate concentrations of contaminants are below the ANZG (2018) DGV's, but the bioavailable fractions are above relevant criteria, toxicity testing is required. Toxicity and bioaccumulation testing will require fresh representative sediment samples to be collected. Acute and chronic toxicity and

[5] *Elutriate results may be used to estimate bioavailable concentrations where pore water samples can't be obtained (NAGD; CA 2009).*
[6] *Where guidelines for nutrients are not available in the revised ANZG (2018), ANZECC/ARMCANZ (2000) guidelines will be applied. Elutriate metals compared against ANZG (2018).*

bioaccumulation testing will be undertaken in accordance with the NAGD (CA 2009) in consultation with the determining authority (DCCEEW).

Bioaccumulation

If contaminants of concern prove to be bioavailable, a desktop study of the bioaccumulation potential will be undertaken for those contaminants. If a specific contaminant is identified as bioavailable and having a potential to bioaccumulate, a bioaccumulation study may be undertaken.

6.4.4 Phase V assessment

A Phase V 'weight-of-evidence' assessment will only be necessary if further testing is inconclusive. If necessary, all relevant data will be assessed, including field results/ecology, chemistry (bioavailability and desorption), laboratory ecotoxicity and bioaccumulation, to compile information to assist determination of the suitability for ocean disposal.

7 References

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Annex A Data Validation

Table 1 Field Data Quality Indicators

Indicator	Frequency	Acceptance Criteria
PRECISION (a quantitative measure of the data variability)		
Sampling methodologies	All samples	Appropriate and complied with
Intra-lab duplicates/splits	5% of samples	<+/- 50% RPD*
Inter-lab duplicates/splits	5% of samples	<+/- 50% RPD*
Trip blanks/spikes (volatiles only)	1 per sampling	</= LOR for blanks, as per lab spec for spikes
ACCURACY (a quantitative measure of the closeness of reported data to the true value)		
Collection of rinsate blanks for re-used sampling or subsampling equipment	Where equipment re-used, one sample per day per item of equipment	CoCs below detection limit
Sampling methodologies	All samples	Appropriate and complied with
REPRESENTATIVENESS (qualitative confidence that data obtained are representative of each sampled medium)		
Sampling, subsampling, sample handling and storage appropriate for the history and contamination status of the sediments, the study objectives and the media/analytes	All media & all analytes	All samples collected and handled according to SAQP
COMPARABILITY (qualitative confidence that data collected in separate sampling events is equivalent)		
SAQP for sample collection, subsampling and handling. Same methods used each day; same types of samples collected	All samples	All samples collected and handled in accordance with SAQP, by experienced professionals
COMPLETENESS (the amount of useable data, as a % of total data collected. Goal is 95% or more valid data)		
Chain-of-Custody forms (COCs), sample descriptions and sample location data complete	All samples	All samples
All critical locations sampled; all samples collected	All samples	All samples collected & analysed according to SAQP
Completeness objective met (ie percentage of data suitable for use, 95% of all data)	All data	Minimum 95% of all data on submitted samples validated as suitable for use
Methodologies	All samples	Sampling in accordance with NEPM, 2011 and/or NAGD, 2009, and other relevant standards for marine sampling, as appropriate

* Contaminant concentrations become increasingly uncertain as they approach the method detection limit, and therefore DQOs may not be met for analytical values close to LORs. Laboratories often use the following approach (or a variation of it) to assess replicates:

- Result < 5 times the LOR – no limit to RPD or RSD.
- Result > 5 times the LOR – RPD or RSD should be </= 50%.

Table 2 Laboratory Data Quality Indicators

Objective	Frequency	Acceptance Criteria
PRECISION (a quantitative measure of the data variability)		
Lab duplicates (separate subsamples from jar, not aliquot splits)	1 per batch or 20 samples	<5 x LOR = no limit on RPD. >5 x LOR = 0-50% RPD *
ACCURACY (a quantitative measure of the closeness of reported data to the true value)		
Matrix spikes Matrix spike duplicates	1 per lab batch or 20 samples 1 per lab batch or 20 samples	Recovery 70% - 130% for inorganics/metals, 60-140% for organics, or as per lab requirement## RPDs should be less than 35%
Surrogate spikes	All organic analyses	Recovery 70% - 130% for inorganics/metals, 60-140% for organics, or as for lab requirement##
Lab method and reagent blanks	1 each per batch	</= LOR
Control samples	1 per lab batch or 20 samples	Recovery 70% - 130% or as for lab requirement##
Analysis of CRMs (for metals) or in-house standards certified against CRMs	All sediment metal analyses, 1 per batch	<+/- 35% RPD, recovery 70% - 130% or as per lab requirement
REPRESENTATIVENESS (qualitative confidence that data obtained are representative of each medium sampled)		
Sample handling and storage appropriate for media/analytes	All media, all analytes	All samples
Holding times (HTs)	All samples	All samples extracted and analysed within HTs
COMPARABILITY (qualitative confidence that data collected in separate sampling events can be directly compared)		
Standard analysis methods	All samples	All samples subsampled, extracted/ digested & analysed at NATA-certified labs, by standard methods
LORs consistent between labs and batches	All samples	All samples
LORs met for all analytes**@	All samples	All samples
Outliers and inter-lab discrepancies resolved	Affected samples	Affected samples re-extracted and analysed in replicate.
COMPLETENESS (the amount of useable data, as a % of total data collected – minimum of 95%)		
All critical locations sampled, all required samples collected, and all samples analysed according to this SAQP	All samples	All required data obtained
Chain-of-Custody forms (COCs), field logs, sample descriptions and sample location data complete	All samples	All samples
Samples received at laboratory as specified on COC forms	All samples	All bottles and jars received and unbroken, seals intact and samples cool
QC samples sufficient, and acceptable results	All QC/QAs	100%
SENSITIVITY (ability of analysis methods to reliably determine the analytes at lowest environmental concentrations)		
Analysis methods and LORs appropriate for media, expected background levels of analytes and adopted site assessment criteria	All media, all analytes	All samples
SECONDARY DATA (quality assessment of any pre-existing data to be used in this project)		
All secondary data	All pre-existing data	Establish DQIs and assess data quality

Certain inhomogeneous samples, eg fine, clayey or organic-rich sediments, samples through mangrove root zones, algal mats etc, as well as samples for analysis of volatiles and semi-volatiles, must not be homogenised in the field prior to subsampling. Therefore, sample replicates are distinct samples rather than splits. Such replicates may not meet this DQI.

Lower recoveries may be recorded for some semi-volatile organics, such as phenols. Recoveries may also be lower, and the spread wider, on some sediments and soils due to matrix interference from high water content, high salinity, plant waxes, sterols, lipids etc.

* Contaminant concentrations become increasingly uncertain as they approach the method detection limit. Criteria:
  - Result < 5 times the LOR – no limit to RPD or RSD.
  - Result > 5 times the LOR – RPD or RSD should be </= 50% (or </= 35% for lab replicates).

** Occasionally, matrix effects may prevent this. Any such incidences must be documented by lab.

Annex C Jurien Bay Boat Harbour Sediment Sampling and Analysis Plan 2024 Implementation Report

PUBLIC

Jurien Bay Boat Harbour – Sampling and Analysis Plan Implementation Report

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1 Sediment Sampling and Analysis

1.1 Sediment sampling methods

Sediment samples were collected on the 8 May 2024 from the Jurien Bay Boat Harbour and entrance channel (hereafter; Boat Harbour) and the Offshore Disposal Area. Sediment sampling was conducted to characterise the physical and chemical properties of the proposed dredge and disposal area sediments to implement sediment monitoring under the Long-term Monitoring and Management Plan for maintenance dredging at the Boat Harbour over the period 2019–2029, in accordance with SD2019/3984 (BMT 2022) and Department of Transport's (DoT) Maintenance Dredging–Environmental Management Framework (EMF; BMT 2023).

Sampling was conducted in–line with the requirements of the National Assessment Guidelines for Dredging (NAGD; CA 2009), requirements of the LTTMP (BMT 2022) and Department of Transport's (DoT) Maintenance Dredging–Environmental Management Framework (EMF; BMT 2023). These methods are detailed the Sampling and Analysis Plan (SAP; BMT 2024).

Within the Boat Harbour, a cumulative dredge volume of ~550 000 m^3 is forecasted for the next 5 years that requires 30 sample sites (CA 2009). Where good quality data exists within the last 5 years, the Boat Harbour can be classified as 'probably clean' (BMT 2019) and sample sites can be halved as per the NAGD (CA 2009). Fifteen sites were proposed to be sampled within the Boat Harbour for characterisation of dredged material (Table 1.1). Three sites (JBBH_S6, JBBH_S8, JBBH_S10) had a large build–up of seagrass wrack on the seafloor resulting in equipment refusal and no sample could be retrieved at these sites. For further detail on sampling design and rationale, refer to the SAP (BMT 2024).

The Offshore Disposal Area has a low risk of potential contamination sources and seven sediment samples were collected to characterise the receiving environment for dredged material placement. (BMT 2019; BMT 2024).

All sampling sites were randomly distributed throughout the relevant areas, as required by NAGD (CA 2009), using ArcGIS 10 software. The coordinates of the sediment sampling sites are provided in (Table 1.1).

Table 1.1 Sediment sampling site coordinates at Jurien Bay Boat Harbour and Offshore Disposal Area

Sampling Area	Site[1]	Easting	Northing	Sampling Depth (m)
Boat Harbour	JBBH_S1	311544	6647746	~0.2
	JBBH_S2[3]	311509	6647644	~0.2
	JBBH_S3	311894	6647726	~0.2
	JBBH_S4[4]	311991	6647464	~0.2
	JBBH_S5	311855	6647577	~0.2
	JBBH_S7	311925	6647419	~0.2
	JBBH_S9	311847	6647414	~0.2
	JBBH_S11	311808	6647493	~0.2

Sampling Area	Site[1]	Easting	Northing	Sampling Depth (m)
	JBBH_S12	311537	6647936	~0.2
	JBBH_S13	311958	6647703	~0.2
	JBBH_S14	311736	6647691	~0.2
	JBBH_S15[3]	311614	6647508	~0.2
Offshore Disposal Area	JBDA_S1	310640	6648015	~0.2
	JBDA_S2	310963	6647992	~0.2
	JBDA_S3	310839	6647629	~0.2
	JBDA_S4	310704	6647833	~0.2
	JBDA_S5	310975	6647781	~0.2
	JBDA_S6	310980	6647579	~0.2
	JBDA_S7	310717	6647607	~0.2

Notes:

1. **Refer to Figure 1.1 for sampling sites and locations**
2. **'UTM' = Universal Transverse Mercator; 'GDA' = Geocentric Datum of Australia**
3. **Quality assurance and quality control triplicate (JBBH_S4 and JBBH_S15) and split (JBBH_S2) sampling sites (Section 1.1.2)**
4. **Sites JBBH_S6, JBBH_S8 and JBBH_S10 were not sampled due to large quantities of seagrass wrack present.**

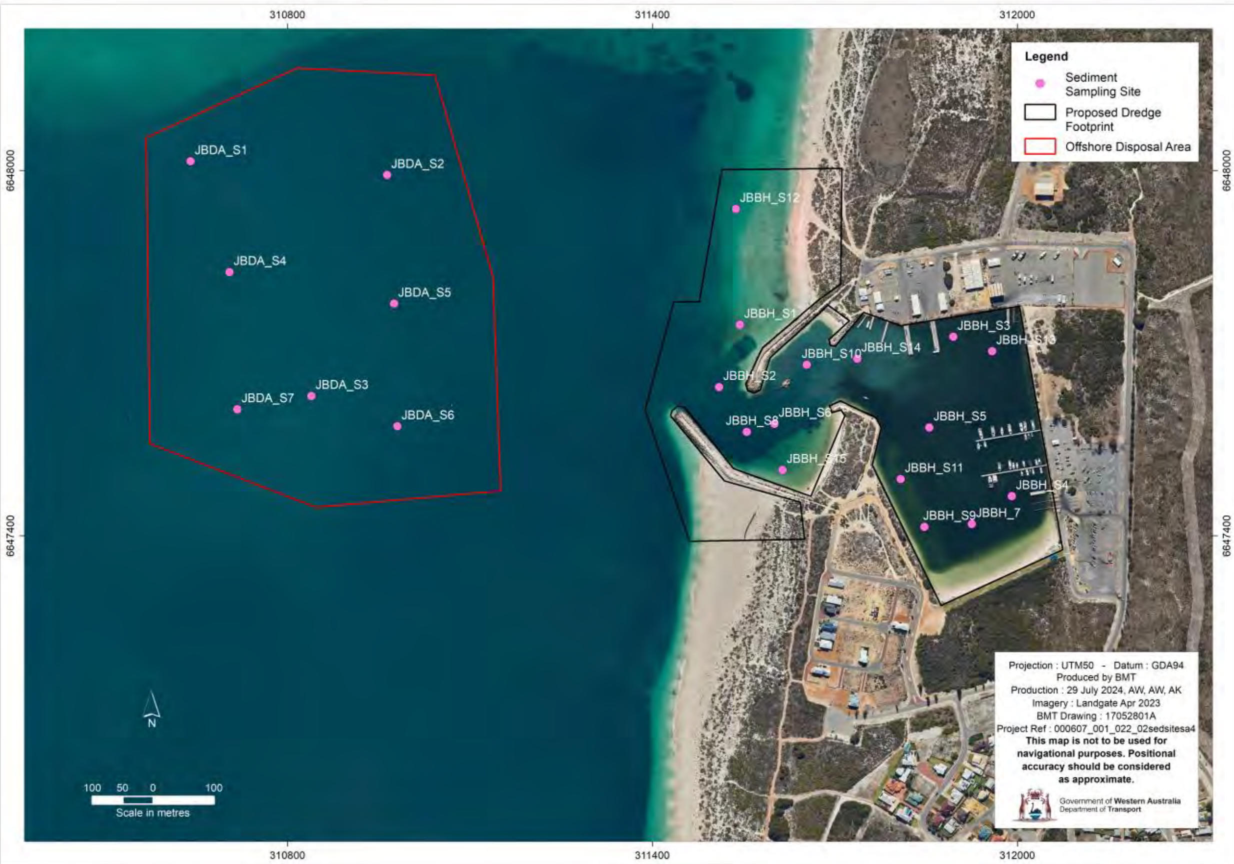


Figure 1.1 Sediment sites sampled within the Jurien Bay Boat Harbour dredge area and Offshore Disposal Area

1.1.2 Sampling quality assurance and quality control

The following quality assurance and quality control (QA/QC) samples were collected (CA 2009):

- Triplicates: at 10% of sampling sites, three separate samples were collected from the same site to determine the variability of the chemical sediment characteristics at the scale of sampling. Triplicate samples were collected at sites JBBH_S4 and JBBH_S15 (Table 1.1).
- Splits: at 5% of sampling sites, the sample was thoroughly mixed and split into three sub samples to assess laboratory variation. Two of the three sample splits were analysed by the primary laboratory (intra-laboratory splits) and the third sample split was analysed by a reference laboratory (inter-laboratory split). Split samples were collected at site JBBH_S2 (Table 1.1).
- One rinsate blank was completed of equipment reused during the day of sampling to assess if potential decontamination among samples meets relevant NAGD (CA 2009) data quality objectives.

All sampling equipment was washed with Decon 90 between sampling sites. Field personnel wore latex-free and powder-free gloves while handling sampling equipment, and changed gloves between sample collections at each site. Field personnel kept hands, clothing, and other objects from contacting the samples. Samples were stored and transported as per the SAP (BMT 2024) and NAGD (CA 2009) requirements.

1.2 Sediment analysis methods

1.2.1 Sediment analytes and rationale

Sediment samples collected in-field were sent to the relevant National Association of Testing Authorities (NATA) accredited laboratories for analysis (Table 1.2). For further information on the sampling regime, justification, analyses and laboratory methods, refer to the SAP (BMT 2024).

Table 1.2 Jurien Bay Boat Harbour dredge and disposal area sites and analytes

Area	Site[1],[2]	Metals[3]	Elutriate nutrients[4]	TOC[2,5]	TRHs/ TPHs[2]	PAHs[2]	BTEX[2]	PSD[2,7]
Boat Harbour	JBBH_S1	✓	✓	✓	✓	✓	✓	✓
	JBBH_S2[6]	✓	✓	✓	✓	✓	✓	✓
	JBBH_S3	✓	✓	✓	✓	✓	✓	✓
	JBBH_S4[6]	✓	✓	✓	✓	✓	✓	✓
	JBBH_S5	✓	✓	✓	✓	✓	✓	✓
	JBBH_S6							
	JBBH_S7	✓	✓	✓	✓	✓	✓	✓
	JBBH_S8							
	JBBH_S9	✓	✓	✓	✓	✓	✓	✓
	JBBH_S10							
	JBBH_S11	✓	✓	✓	✓	✓	✓	✓
	JBBH_S12	✓	✓	✓	✓	✓	✓	✓

Area	Site[1],[2]	Metals[3]	Elutriate nutrients[4]	TOC[2,5]	TRHs/ TPHs[2]	PAHs[2]	BTEX[2]	PSD[2,7]
	JBBH_S13	✓	✓	✓	✓	✓	✓	✓
	JBBH_S14	✓	✓	✓	✓	✓	✓	✓
	JBBH_S15[6]	✓	✓	✓	✓	✓	✓	✓
Offshore Disposal Area	JBDA_S1	✓		✓	✓	✓	✓	✓
	JBDA_S2	✓		✓	✓	✓	✓	✓
	JBDA_S3	✓		✓	✓	✓	✓	✓
	JBDA_S4	✓		✓	✓	✓	✓	✓
	JBDA_S5	✓		✓	✓	✓	✓	✓
	JBDA_S6	✓		✓	✓	✓	✓	✓
	JBDA_S7	✓		✓	✓	✓	✓	✓

Notes:

1. **Refer to 0 and Table 1.1 for sediment sampling site locations**
2. **'JBBH' = Jurien Bay Boat Harbour, 'JBDA' = Jurien Bay Disposal Area, 'TOC' = total organic carbon; 'TPHs' = total petroleum hydrocarbons, 'TRHs' = total recoverable hydrocarbons, 'PAHs' = polyaromatic hydrocarbons, 'BTEX' = benzene, toluene, ethylbenzene and xylene, 'PSD' = particle size distribution**
3. **Metals = arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc**
4. **Elutriate nutrients = total nitrogen, total phosphorus, total kjeldahl nitrogen, ammonia/ammonium, filterable reactive phosphorus and nitrate/nitrite**
5. **Analysis required for normalisation as a measure of bioavailability for organic contaminants**
6. **Quality assurance and quality control triplicate (JBBH_S4 and JBBH_S15) and split (JBBH_S2) sampling sites (Section 1.1.2)**
7. **Quality assurance and quality control were not sampled for particle size distribution.**

1.2.2 Particle size analysis

Sediment samples were analysed for particle size distribution (PSD) by laser diffraction to categorise particle sizes between 0.02 and 500 µm. The particle size distribution for particles >500 µm was measured by wet sieving.

1.2.3 Contaminant analysis

Concentrations of contaminants of potential concern (COPC) in sediment samples were determined using standard NATA accredited methods and laboratories. The primary laboratory used for contaminant analyses (except PSD) was ALS and the reference laboratory was MPL Laboratories. Murdoch University Marine Freshwater Research Laboratory was used as the primary laboratory for PSD, no reference laboratory was required for PSD.

1.2.4 Laboratory QA/QC

Laboratory reports of blanks, spikes, standards and duplicates testing as required by NATA and NAGD (CA 2009) can be provided on request.

1.3 Data analysis methods

1.3.1 Particle setting times

Stokes' Law was used to calculate the particle settling velocities of the time required for 50% and 90% of suspended particles to settle in 1 m of water for each sediment sample. Settling velocity was not calculated for sediment samples >45% silt and clay content as Stokes' Law is not applicable for material with high fines content.

1.3.2 Normalisation of organics

Total organic carbon (TOC) is the main binding constituent for organic substances in marine sediments. The NAGD (CA 2009) requires organics (total petroleum hydrocarbons [TPHs]) total recoverable hydrocarbons [TRHs], benzene, toluene, ethylbenzene and xylene [BTEX] and polyaromatic hydrocarbons [PAHs]) to be normalised to 1% TOC for appropriate comparison to Screening Levels (CA 2009). The normalised results allow for comparison of different sediment samples and provide an indication of the bioavailability of organic analytes. A TOC greater than 1% increases the binding capacity of organics to become less biologically available, therefore normalisation will reduce the measured value proportionally (the reverse also applies). Normalisation is appropriate over a TOC range of 0.2–10%. For TOC <0.2% or TOC >10%, the maximum and minimum values of 0.2 and 10% TOC are used for normalisation, respectively. Where the organic data were below the laboratory limit of reporting (LoR) normalisation was not completed.

1.3.3 Assessment against guidelines

NAGD Screening Levels

Contaminant concentrations in sediment samples were compared to the NAGD Screening Levels (CA 2009) that requires calculation of the 95% upper confidence limit (UCL) of the mean (CA 2009). The data was first tested for normality using the software ProUCL 5.2 (USEPA 2022). The software determines the appropriate method for calculating the 95% UCL depending on the distribution of the data and dataset size, including the proportion of values below the LoR (which introduces statistical complexities into analyses). These methods may include parametric (such as Student's t-UCL) or nonparametric (such as bootstrap) methods. Where there were insufficient samples to calculate the 95% UCL, individual sample concentrations were compared to the Screening Levels.

Australian & New Zealand Guidelines for Fresh and Marine Water Quality

Mean concentrations of elutriate nutrients as physical and chemical (PC) stressors were compared to the default guideline values (DGVs) of the Central West Coast Integrated Marine and Coastal Regionalisation of Australia (IMCRA) mesoscale bioregion (80^{th} percentile autumn reference site data in the surface top 20 m; ANZG 2018). Where marine PC stressors in the Central West Coast IMCRA mesoscale bioregion were not available, PC stressor DGVs for southwest marine inshore waters were applied (ANZECC/ARMCANZ 2000). The 95^{th} percentile elutriate nutrient concentrations were also compared to ANZG (2018) 90% and 99% species protection level for assessment of toxic effects.

1.3.4 Analysis of analyte concentrations below the limit of reporting

A large proportion of data below the LoR has the capacity to bias subsequent analyses leading to underestimation of contamination. USEPA (2022) does not consider a 95% UCL of the mean calculated based upon few detected values to provide reliable estimates. Therefore, where the data contain values below the LoR, the following protocol was applied (based on ANZG 2018):

- Where >25% of concentrations were below the LoR, descriptive statistics (means and percentiles) or inferential analysis (including the calculation of confidence limits) were not calculated. Instead, individual sample results were compared to the guidelines and discussed accordingly.
- Where ≤25% but >0% of concentrations were below the LoR, confidence limits were calculated via two methods; once using the normalised estimate based on half the LoR as the replacement value and once using zero as a replacement value. This information was used to inform the interpretation of results, in particular, whether the choice of replacement value affected the outcome of the analysis.

1.3.5 QA/QC data analysis

The accuracy of sediment analyses was determined by quantifying the differences between the concentrations of analytes in the QA/QC samples, using the methods outlined in NAGD (CA 2009). The relative percent difference (RPD) was calculated for the analyte concentrations in the split samples (both inter-laboratory and intra-laboratory splits) and the relative standard deviation (RSD) was calculated for analyte concentrations in the triplicate samples.

The RPD was calculated as follows:

$$RPD\ (\%) = \frac{(\text{differnce between sample splits})}{\text{average of sample splits}} \times\ 100$$

The acceptable RPD range of split samples depends upon the concentration levels detected relative to the LoR as follows (Australian Department of the Environment, pers. comm. 12 August 2014):

- 0–100% RPD when the average concentration is <5 times the LoR
- 0–75% RPD when the average concentration is 5 to 10 times the LoR
- 0–50% RPD when the average concentration is >10 times the LoR.

If the RPD for a measured analyte falls outside of these limits, the value of the measured analyte is flagged as an estimate rather than a precise value (CA 2009).

The RSD was calculated as follows:

$$RSD\ (\%) = \frac{(standard\ deviation\ of\ triplicate\ samples)}{\text{average of triplicate samples}} \times 100$$

The triplicate samples should agree within an RSD of ±50%. RSDs greater than 50% may indicate that the sediments are heterogeneous or greatly differ in grain size (CA 2009). The RPD and RSD was only calculated if all QA/QC sample concentrations were above the LoR. If one or more of the analyte concentrations were below the LoR, the individual concentrations were compared to assess the magnitude of the differences between them.

2 Sediment Analysis Results

2.1 Physical sediment characteristics

2.1.1 Visual and odour characterisation

Sediments from the Boat Harbour consisted of moderately–well sorted light grey/white coloured fine-grained sands. All samples apart from one (JBBH_S7) contained organic matter including wrack, and shell fragments. Three samples contained only wrack with no sediment present in the samples (JBBH_S6, JBBH_S8 and JBBH_S10). There was a slight sulfurous odour in two of the samples (JBBH_S3, JBBH_S13).

Sediments from the Offshore Disposal Area were characterised by well sorted fine-grained sands with white/yellow colouration. Wrack was present in all samples, with two samples (JBDA_S6, JBDA_S7) also containing fine shell fragments.

Table 2.1 Sediment description log of Jurien Bay Boat Harbour and Offshore Disposal Area sediment samples

Sampling area[1]	Sampling site[1,2,4]	Munsell colour[3]		Texture	Sorting	Sulfidic odour[4]	Organic matter	Other comments	Photograph
Boat Harbour	JBBH_S1	2.5Y 8/2		Fine sand	Well sorted	N	Wrack Fine shells		
	JBBH_S2[3]	2.5Y 7/2		Fine sand	Moderately sorted	N	Wrack		
	JBBH_S3	5Y 5/1		Fine sand	Well sorted	Y	Wrack		
	JBBH_S4[2]	2.5Y 7/2		Fine sand	Well sorted	N	Wrack		
	JBBH_S5	10YR 5/1		Fine sand	Moderately sorted	N	Wrack		
	JBBH_S6[5]						Wrack	No sediment sample collected	

Sampling area[1]	Sampling site[1,2,4]	Munsell colour[3]		Texture	Sorting	Sulfidic odour[4]	Organic matter	Other comments	Photograph
	JBBH_S7	2.5Y 5/1		Fine sand	Well sorted	N	None		
	JBBH_S8[5]						Wrack	No sediment sample collected	
	JBBH_S9	2.5Y 6/1		Fine sand	Well sorted	N	Wrack		
	JBBH_S10[5]						Wrack	No sediment sample collected	
	JBBH_S11	2.5Y 7/2		Fine sand	Well sorted	N	Wrack		
	JBBH_S12	7.5YR 8/1		Fine sand	Well sorted	N	Wrack Fine shells		
	JBBH_S13	2.5Y 5/1		Fine sand	Moderately sorted	Y	Wrack		

Sampling area[1]	Sampling site[1,2,4]	Munsell colour[3]		Texture	Sorting	Sulfidic odour[4]	Organic matter	Other comments	Photograph
	JBBH_S14	2.5Y 6/2		Fine sand	Well sorted	N	Wrack		
	JBBH_S15[2]	2.5Y 7/2		Fine sand	Well sorted	N	Wrack		
Offshore Disposal Area	JBDA_S1	5Y 8/1		Fine sand	Well sorted	N	Wrack Shells		
	JBDA_S2	5Y 8/1		Fine sand	Well sorted	N	Wrack		
	JBDA_S3	5Y 8/1		Fine sand	Well sorted	N	Wrack		
	JBDA_S4	5Y 8/3		Fine sand	Well sorted	N	Wrack		

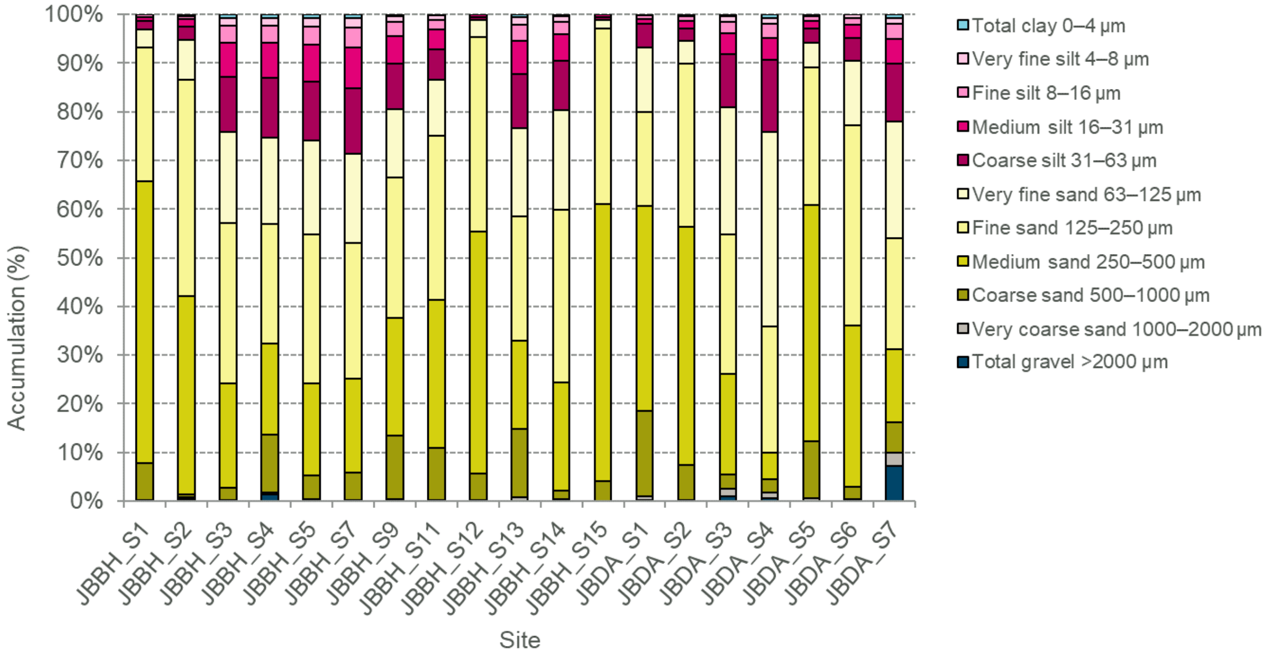
Sampling area[1]	Sampling site[1,2,4]	Munsell colour[3]		Texture	Sorting	Sulfidic odour[4]	Organic matter	Other comments	Photograph
	JBDA_S5	5Y 8/1		Fine sand	Well sorted	N	Wrack		
	JBDA_S6	5Y 8/1		Fine sand	Well sorted	N	Wrack Fine shells		
	JBDA_S7	7.5YR 8/1		Fine sand	Well sorted	N	Wrack Shells		

Notes:

1. Refer to Table 1.1 and 0 for explanation of sampling areas and sites.
2. Quality assurance and quality control triplicate (JBBH_S4 and JBBH_S15) and split (JBBH_S2) sampling sites (Section 1.1.2).
3. The colours presented in the table are intended to provide a visual RGB representation of the Munsell Soil Colour. Colours were determined using https://www.munsellcolourscienceforpainters.com/MunsellResources/Munsell-to-RGB-Tables.xlsm
4. 'JBBH' = Jurien Bay Boat Harbour, 'JBDA' = Jurien Bay Disposal Area, 'Y' = yes, 'N' = no
5. Sediment samples were not collected due to large build–up of wrack present (Section 1.1)
6. Sediment samples Munsell colour was amended post field due to incorrect categorisation in field for sites JBDA_S5, JBDA_S6 and JBDA_S7
7. Sediment sample sorting score was amended post field due to incorrect categorisation in field for site JBDA_S7.

2.1.2 Particle Size Distribution

Sediments from the Boat Harbour and Offshore Disposal Area were variable in composition. The samples were predominantly comprised of medium and fine sands (Figure 2.1, Table 2.2). Sites JBBH_S4, JBDA_S3 and JBDA_S7 recorded higher percentages of gravel (1.41%, 1.01% and 7.24%, respectively) with all other sites having a contribution of <0.55% (Table 2.2). Silt contribution was variable among Boat Harbour and Offshore Disposal Area sites ranging from 1.04% to 27.86% (samples JBBH_S12 and JBBH_S7, respectively) (Table 2.2). There was a very low percentage of total clay present across all samples.



Notes:

1. Refer to Table 1.1 and 0 for explanation of sampling areas and sites.
2. Quality assurance and quality control samples were not analysed for particle size distribution, only the primary sample was analysed.

Figure 2.1 Particle size distributions of the sediment samples from Jurien Bay Boat Harbour and Offshore Disposal Area.

Table 2.2 Particle size distributions of the sediment samples from Jurien Bay Boat Harbour and Offshore Disposal Area

Category	Size (µm)	Boat Harbour (%)												Offshore Disposal Area (%)						
		JBBH_S1	JBBH_S2[3]	JBBH_S3	JBBH_S4[3]	JBBH_S5	JBBH_S7	JBBH_S9	JBBH_S11	JBBH_S12	JBBH_S13	JBBH_S14	JBBH_S15	JBDA_S1	JBDA_S2	JBDA_S3	JBDA_S4	JBDA_S5	JBDA_S6	JBDA_S7
Total gravel	**<2000**	**0.00**	**0.44**	**0.06**	**1.41**	**0.04**	**0.00**	**0.00**	**0.00**	**0.02**	**0.03**	**0.21**	**0.01**	**0.10**	**0.03**	**1.01**	**0.54**	**0.03**	**0.10**	**7.24**
Very coarse sand	1000–2000	0.09	0.27	0.10	0.35	0.26	0.10	0.34	0.23	0.25	0.78	0.25	0.05	0.77	0.12	1.53	1.23	0.45	0.25	2.61
Coarse sand	500–1000	7.69	0.73	2.48	11.88	4.98	5.82	13.12	10.59	5.43	13.91	1.72	3.97	17.70	7.20	2.94	2.80	11.73	2.65	6.42
Medium sand	250–500	57.83	40.65	21.59	18.79	18.91	19.22	24.13	30.55	49.74	18.16	22.20	57.01	42.14	49.06	20.59	5.35	48.71	33.04	15.00
Fine sand	125–250	27.62	44.53	32.84	24.47	30.55	27.88	28.82	33.65	40.00	25.71	35.38	36.09	19.17	33.39	28.64	25.87	28.22	41.09	22.72
Very fine sand	63–125	3.70	8.13	18.71	17.80	19.30	18.34	14.05	11.54	3.52	18.02	20.59	1.75	13.28	4.69	26.14	40.00	5.09	13.32	24.03
Total sand	**63–2000**	**96.95**	**94.31**	**75.71**	**73.29**	**73.99**	**71.35**	**80.46**	**56.56**	**98.95**	**76.56**	**80.13**	**98.88**	**93.05**	**94.46**	**79.83**	**75.26**	**94.19**	**90.35**	**70.77**
Coarse silt	31–63	1.77	2.65	11.42	12.21	12.24	13.46	9.46	6.23	0.55	11.16	10.04	0.64	4.98	2.52	10.93	14.91	2.84	4.60	11.82
Medium silt	16–31	0.72	1.56	7.00	7.20	7.52	8.33	5.70	4.10	0.59	6.80	5.51	0.48	0.84	1.58	4.29	4.48	1.63	2.86	5.19
Fine silt	8–16	0.54	0.69	3.50	3.63	3.78	4.21	2.81	2.03	0.00	3.38	2.51	0.01	0.86	0.97	2.49	2.97	0.98	1.37	3.03
Very fine silt	4–8	0.03	0.35	1.63	1.60	1.72	1.86	1.24	0.92	0.00	1.48	1.16	0.00	0.17	0.43	1.04	1.17	0.33	0.67	1.29
Total silt	**4–63**	**3.05**	**5.25**	**23.55**	**24.64**	**25.27**	**27.86**	**19.21**	**13.28**	**1.04**	**22.82**	**19.23**	**1.12**	**6.84**	**5.50**	**18.75**	**23.53**	**5.78**	**9.50**	**21.33**
Total clay	**0–4**	**0.00**	**0.00**	**0.69**	**0.66**	**0.70**	**0.79**	**0.34**	**0.16**	**0.00**	**0.59**	**0.43**	**0.00**	**0.00**	**0.00**	**0.42**	**0.68**	**0.00**	**0.04**	**0.66**

Notes:

1. Refer to Table 1.1 and 0 for explanation of sampling areas and sites
2. Red text indicates the dominant size fraction in each sample
3. Quality assurance and quality control triplicate were not sampled for particle size distribution.

2.1.3 Settling times

The settling time for 50% of particles to settle though 1 m of water ranged between 0.24 and 1.08 minutes for the samples in the Boat Harbour. For the Offshore Disposal Area, the time for 50% of the particles to settle through 1 m of water ranged between 0.24 and 2.04 minutes (Table 2.3). For the Boat Harbour, the time for 90% of the particles to settle through 1 m of water ranged between 0.78 and 43.38 minutes (Table 2.3). The settling time for 90% of particles through 1 m of water for the Offshore Disposal Area samples ranged from 1.44 to 21.78 minutes (Table 2.3). Longer setting times in samples of JBBH_S3, JBBH_S4, JBBH_S7, JBBH_S5, and JBBH_S13 compared to all other samples are likely attributed to greater silt proportions in the samples (Table 2.3).

Table 2.3 Settling times of sediment samples from Jurien Bay Boat Harbour and Offshore Disposal Area sediment samples

Sampling area	Sampling site	Time for 50% of particles to settle through 1 m (mins)	Time for 90% of particles to settle through 1 m (mins)
Boat Harbour	JBBH_S1	0.24	0.90
	JBBH_S2[3]	0.42	1.68
	JBBH_S3	0.90	32.70
	JBBH_S4[3]	0.84	33.90
	JBBH_S5	1.02	36.72
	JBBH_S7	1.08	43.38
	JBBH_S9	0.54	21.36
	JBBH_S11	0.42	10.98
	JBBH_S12	0.30	0.90
	JBBH_S13	0.78	30.18
	JBBH_S14	0.84	19.62
	JBBH_S15[3]	0.24	0.78
Offshore Disposal Area	JBDA_S1	0.24	3.48
	JBDA_S2	0.30	1.32
	JBDA_S3	1.02	14.46
	JBDA_S4	2.04	18.00
	JBDA_S5	0.24	1.44
	JBDA_S6	0.48	4.56
	JBDA_S7	1.02	21.78

Notes:

1. **Refer to Table 1.1 and 0 for explanation of sampling areas and sites**
2. **Settling times for all samples were calculated using Stokes' Law which is not considered appropriate for use if material has >45% silt and clay content (Section 1.2.2)**
3. **Quality assurance and quality control triplicate (JBBH_S4 and JBBH_S15) and split (JBBH_S2) sampling sites (Section 1.1.2).**

2.2 Total organic carbon, cation exchange capacity and pH

The TOC content was generally low and ranged from 0.16–1.23% (samples JBBH_S12 and JBBH_S14, respectively) within the Boat Harbour and 0.22–1.95% (from samples JBDA_S2 and JBDA_S7, respectively) within the Offshore Disposal Area (Table 2.4).

CEC in the Boat Harbour ranged from 23.7–27.6 mEq/100 g, and pH ranged from 8.4–9 (Table 2.4). CEC in the Offshore Disposal Area ranged from 23.3–26 mEq/100 g, and pH ranging from 8.5–8.9 (Table 2.4). These were sampled to add contextual information to inform potential future onshore disposal.

Table 2.4 Total organic carbon content, cation exchange capacity and pH of Jurien Bay Boat Harbour and Offshore Disposal Area sediment samples

Sampling area	Sampling site	TOC (%)[2]	CEC (mEq/100 g)[2]	pH
Boat Harbour	JBBH_S1	0.18	24.5	8.8
	JBBH_S2[3]	0.38	24.9	8.7
	JBBH_S3	1.07	26.5	8.5
	JBBH_S4[3]	1.03	27.2	8.5
	JBBH_S5	1.01	27.5	8.6
	JBBH_S7	0.88	27.3	8.6
	JBBH_S9	0.43	25.4	8.6
	JBBH_S11	0.35	25.0	8.8
	JBBH_S12	0.16	23.7	8.7
	JBBH_S13	1.07	26.6	8.5
	JBBH_S14	1.23	27.6	8.4
	JBBH_S15[3]	0.18	23.7	8.9
Offshore Disposal Area	JBDA_S1	0.26	23.3	8.5
	JBDA_S2	0.22	26.0	8.9
	JBDA_S3	0.73	26.0	8.6
	JBDA_S4	0.7	25.9	8.5
	JBDA_S5	0.23	24.2	8.8
	JBDA_S6	0.34	24.7	8.8
	JBDA_S7	1.95	25.3	8.5

Notes:

1. **Refer to Table 1.1 and 0 for locations of sampling areas and sampling sites**
2. **'CEC' = cation exchange capacity; 'TOC' = total organic carbon (Section 1.1.2)**
3. **Quality assurance and quality control triplicate (JBBH_S4 and JBBH_S15) and split (JBBH_S2) sampling sites (Section 1.1.2)**
4. **Quality assurance and quality control sample; results of the split sample from JBBH_S2 analysed by the primary laboratory were averaged to provide a single value for the site. Results from triplicate samples collected at JBBH_S4 and JBBH_S15 were averaged to provide a single value for each site.**

2.3 Nutrients

2.3.1 Elutriate nutrients

Individual sample and mean concentrations of elutriate total phosphorous (TP), filterable reactive phosphorous (FRP), and total nitrogen (TN) from samples collected within the Boat Harbour exceeded the relevant ANZECC/ARMCANZ (2000) and ANZG (2018) DGVs for PC stressors (Table 2.5). Mean ammonia (NH_3) exceeded both the DGVs for PC stressors and for 90% species protection level (SPL) for toxicants, and the 95th percentile for NH_3 also exceeded the and 99% SPL for toxicants (ANZG 2018). Ammonium (NH_4) was not analysed by the laboratory due to unknown in-situ physical water characteristics requirements by the laboratory. The concentration of NH_3 has been assumed to be representative of the concentration of NH_4. Elutriate total kjedhal nitrogen (TKN) site concentrations ranged from below LoR (<500 µg/L) to 2900 µg/L with a mean concentration of 1196 µg/L.

Elutriate concentrations of nitrate and nitrate + nitrite (NO_x) were reported below LoR (<10 µg/L) for majority of sites, however the LoR is above the DVGs for PC stressors (ANZG 2018), therefore a comparison cannot be made (Table 2.5). Two individual site (JBBH_11 and JBBH_15) concentrations of elutriate NO_x and nitrate exceeded the DVGs for PC stressors (ANZG 2018) Nitrite concentrations were below LoR (10 µg/L) at all sites (Table 2.5).

It should be noted that in accordance with the NAGD elutriate data should be compared to water quality guidelines (ANZECC/ARMCANZ 2000 and subsequently ANZG 2018) following Initial Dilution (CA 2009) to estimate effects on organisms in the water column during disposal. See Section 3 for further explanation.

Table 2.5 Elutriate nutrient concentrations of sediment samples from Jurien Bay Boat Harbour

Sampling area[1]	Sediment sample[1]	Elutriate nutrients (µg/L)							
		TP[2]	FRP[2,11]	TN[2]	NO_x [2,10]	NH_3[1,]	Nitrite	Nitrate	TKN[2]
DGVs for PC stressors[3,4]		20	5	230	5	5	-	4	-
DGVs for 90% species protection level[3]		-	-	-	-	1200	-	-	-
DGVs for 99% species protection level[3]		-	-	-	-	500	-	-	-
Boat Harbour	JBBH_S1	70	5	700	<10	600	<10	<10	700
	JBBH_S2a[8]	1005	45	900	<10	650	<10	<10	900
	JBBH_S3	130	100	2900	<10	1730	<10	<10	2900
	JBBH_S4[8]	102	27	1400	<10	1097	<10	<10	1400
	JBBH_S5	140	60	1100	<10	860	<10	<10	1100
	JBBH_S7	80	60	1400	<10	1070	<10	<10	1400
	JBBH_S9	140	30	1100	<10	940	<10	<10	1100
	JBBH_S11	130	100	1400	10	900	<10	10	1400
	JBBH_S12	110	10	<500	<10	240	<10	<10	<500
	JBBH_S13	110	80	1600	<10	1280	<10	<10	1600
	JBBH_S14	150	10	800	<10	800	<10	<10	800
	JBBH_S15[8]	65	8	800	10	690	<10	10	800
Mean		**186**	**45**	**1196**	**n/d[2]**	**905**	**n/d[2]**	**n/d[2]**	**1196**
95th percentile[5]						**1099**			

Notes:

1. Refer to Table 1.1 and Figure 1.1 for locations of sampling areas and sampling sites
2. 'TP' = Total phosphorus, 'FRP' = filterable reactive phosphorus, 'TN' = total nitrogen, ' 'NOx' = nitrate + nitrite, 'NH3 = ammonia, ''DGVs' = default guideline values, 'PC' = physical and chemical, '-' = no guideline value available, 'n.d.' = statistic not determined because the dataset contains >25% of values below the laboratory limit of reporting
3. "DGV" = default guideline value as per the ANZG (2018) and ANZECC/ARMCANZ (2000). ANZECC/ARMCANZ (2000) DGVs were applied where no updates were made in ANZG (2018). Test statistics were compared to the DGV for 90% (applicable to the Boat Harbour) and 99% (applicable to the Offshore Disposal Area) species protection
4. DGVs for PC stressors were derived from ANZG (2018) Integrated Marine and Coastal Regionalisation of Australia (IMCRA) mesoscale bioregion surface water Central West Coast (Autumn; 80th percentile DGVs in µmol/L converted to µg/L); ANZECC/ARMCANZ (2000) DGVs for PC stressor for South-West Australian marine inshore waters, i.e., coastal lagoons (excluding estuaries), embayments, and water less than 20 metres deep for ammonia, NOx, TN and TP
5. For ammonia as a toxicant the 95^{th} percentile was used for comparison to the DGV
6. For ammonia, NOx, TN, phosphate and TP as physical chemical stressors, the mean concentration (CA 2009) was used for comparison to the DGV
7. Red text indicates exceedance of relevant guideline value
8. Quality assurance and quality control sample; results of the split sample from JBBH_S2 analysed by the primary laboratory were averaged to provide a single value for each site. Results from triplicate samples collected at JBBH_S4 and JBBH_S15 were averaged to provide a single value for each site
9. Mean calculated using the limit of reporting value
10. DGV for NOx could not be met by the laboratory
11. For FRP the phosphate ANZG (2018) DVG was applied .

2.4 Metals

2.4.1 Total metals

Test statistics (95% UCL, standard deviation and maximum) were calculated for total chromium, copper and zinc concentrations in Boat Harbour samples (Table 2.6). All other metals had 25% of samples below LoR, therefore test statistics could not be calculated, and individual sample concentrations were compared to the relevant guidelines (Section 1.3.4; Table 2.6). The 95% UCLs, maximums and individual site concentrations of total metals in Boat Harbour sediments were below the relevant NAGD Screening Levels (Table 2.6).

Concentrations of total mentals in Offshore Disposal Area sediments were mostly below LoR and were all below NAGD Screening Levels (Table 2.6).

Table 2.6 Total metal concentration of sediment samples from Jurien Bay Boat Harbour and Offshore Disposal Area

Sampling area[1]	Sediment sample[1]	Total metals (mg/kg)							
		Arsenic	Cadmium	Total chromium[2]	Copper	Lead	Mercury	Nickel	Zinc
NAGD Screening Level[2]		20	1.5	80	65	50	0.15	21	200
NAGD Sediment Quality High Values[2]		70	10	370	270	220	1	52	410
Boat Harbour	JBBH_S1	<5	<1	10	<5	<5	<0.1	<2	<5
	JBBH_S2[4]	<5	<1	9.25	<5	<5	<0.1	<2	<5
	JBBH_S3	<5	<1	11	30	<5	<0.1	<2	26
	JBBH_S4[4]	<5	<1	11	47	<5	<0.1	<2	41.33
	JBBH_S5	<5	<1	12	47	<5	<0.1	<2	38
	JBBH_S7	<5	<1	12	50	<5	<0.1	<2	38
	JBBH_S9	<5	<1	10	25	<5	<0.1	<2	15
	JBBH_S11	<5	<1	10	11	<5	<0.1	<2	9
	JBBH_S12	<5	<1	10	<5	<5	<0.1	<2	<5
	JBBH_S13	<5	<1	10	35	<5	<0.1	<2	26
	JBBH_S14	9	<1	11	30	<5	<0.1	<2	50
	JBBH_S15[4]	<5	<1	10	<5	<5	<0.1	<2	<5
Maximum				**12**					
95% UCL		**n/d**	**n/d**	**10.97**	**n/d**	**n/d**	**n/d**	**n/d**	**n/d**
Standard deviation				**0.84**					

Sampling area[1]	Sediment sample[1]	Total metals (mg/kg)							
		Arsenic	Cadmium	Total chromium[2]	Copper	Lead	Mercury	Nickel	Zinc
Offshore Disposal Area	JBDA_S1	<5	<1	10	<5	<5	<0.1	<2	<5
	JBDA_S2	<5	<1	10	<5	<5	<0.1	<2	<5
	JBDA_S3	<5	<1	9	<5	<5	<0.1	<2	<5
	JBDA_S4	<5	<1	8	<5	<5	<0.1	<2	<5
	JBDA_S5	<5	<1	9	<5	<5	<0.1	<2	<5
	JBDA_S6	<5	<1	9	<5	<5	<0.1	<2	<5
	JBDA_S7	<5	<1	8	<5	<5	<0.1	<2	<5

Notes:

1. **Refer to Table 1.1 and 0 for locations of sampling areas and sampling sites**
2. **NAGD = National Assessment Guideline for Dredging (CA 2009)**
3. **Quality assurance and quality control triplicate (JBBH_S4 and JBBH_S15) and split (JBBH_S2) sampling sites (Section 1.1.2)**
4. **'n/d' = statistic not determined because the dataset contains >25% of values below the laboratory limit of reporting (Section 1.3.4); 'UCL' = upper confidence limit; '< = below laboratory limit of reporting.**
5. **Quality assurance and quality control sample; results of the split samples from JBBH_S2 analysed by the primary laboratory were averaged to provide a single value for each site, and results from. Triplicate samples collected at JBBH_S4 and JBBH_S15 were averaged to provide a single value for each site.**

2.1 Hydrocarbons

Normalised (to 1% TOC) concentrations of hydrocarbons (PAHs, TRHs, and BTEX) in all sediment samples from the Boat Harbour and Offshore Disposal Area were below laboratory LoRs and the NAGD Screening Levels (CA 2009).

2.2 QA/QC Analysis

RPD statistics were calculated for split samples and RSD for triplicate samples. Acceptable RPD values were dependent upon the concentration of the analyte and were calculated using the following rules as outlined in Section 1.3.5. Acceptable RSD values were defined as those ≤50% (Section 1.3.5). The results of QA/QC analyses are summarised in Table 2.7. Analytes not included reported concentrations below the laboratory LoR in QA/QC samples and the calculation of RPD and RSD was not appropriate (refer to Section 1.3.5).

The RPD values for intra and inter–laboratory splits of TOC and elutriate nutrients exceeded assigned limits (Table 2.7). Inter–laboratory exceedances may be caused by sample variability between the laboratory methods for sample preparation and analysis. Exceedances may also be caused by sample heterogeneity for intra and inter–laboratory splits. The samples contained observable organic matter that varied among samples, and may attribute to heterogeny between samples, especially for the elutriate nutrients (Table 2.1). Therefore, the concentrations of analytes with RPD values exceeding assigned limits should be considered as estimates rather than precise measurements.

The RSD values for TRH >C16-C34, TP and FRP exceeded the ±50% limit recommended by NAGD (CA 2009) suggesting small-scale spatial variability in the distribution of these analytes.

The analysis laboratories completed the required testing of blanks, spikes and standards and laboratory duplicates as required by NAGD (CA 2009) and QA/QC issues reported. The rinsate blanks and trip blanks were below the LoR, indicating that there was no denomination among samples (Annex A). The results can be found in Annex A. The samples had water matrix spike outliers greater than four times the background level for the analytes of TPH C6–C9 fraction, TPH C6–C10 fraction, benzene and toluene. Quality control outliers were present for TRH and PAH. Laboratory LoR was raised for TKN and TP due to matrix interference. The recommended holding time for NO_2 and FRP for the rinsate was exceeded. Such exceedances should be taken into consideration when interpreting the results.

Table 2.7 Quality assurance and quality control data in the Boat Harbour and Offshore Disposal Area sediment samples

Analyte	QA/QC sample type	Sample splits			Field triplicates	
		Intra-laboratory splits	Inter-laboratory splits			
	Test statistic	RPD (%)	RPD (%)[2]		RSD (%)[2]	RSD (%)[2]
	Sediment site	JBBH_S2[1]			JBBH_S4[1]	JBBH_S15[1]
	QA/QC samples analysed	a,b	a,c	b,c	1,2,3	1,2,3
Carbon	TOC[2]	61.33	57.89	3.77	3.50	3.27
Metals	Copper	0.00	4.08	4.08	10.19	n/d
	Zinc	n/d	n/d	n/d	13.73	n/d

Analyte	QA/QC sample type	Sample splits			Field triplicates	
		Intra-laboratory splits	Inter-laboratory splits			
	Test statistic	RPD (%)	RPD (%)[2]		RSD (%)[2]	RSD (%)[2]
	Sediment site	JBBH_S2[1]			JBBH_S4[1]	JBBH_S15[1]
	QA/QC samples analysed	a,b	a,c	b,c	1,2,3	1,2,3
Hydrocarbons	TRH >C16-C34	n/d	n/d	n/d	65.82	66.99
	TRH >C34-C40	n/d	n/d	n/d	5.24	n/d
	Naphthalene	n/d	n/d	n/d	24.74	20.20
	Acenaphthylene	n/d	n/d	n/d	32.64	n/d
	Fluoranthene	n/d	n/d	n/d	38.57	n/d
Elutriate nutrients[2]	TP	184.08	170.37	63.48	72.16	43.83
	FRP	66.67	177.36	788.35	72.16	43.83
	TN	66.67	102.04	144.19	7.14	0.00
	NH_3	83.08	64.71	130.28	11.55	5.23
	TKN	66.67	102.04	144.19	7.14	12.50

Notes

1. Refer to Table 1.1 and 0 for locations of sampling areas and sampling sites
2. ‘TP’ = Total phosphorus, ‘FRP’ = filterable reactive phosphorus, ‘TN’ = total nitrogen, NH_3 = ammonia, ‘TKN’ = total kjeldahl nitrogen, ‘TOC’ = total organic carbon, ‘n/d’ = value not determined where one or more samples were below laboratory limit of reporting, ‘RSD’ = relative standard deviation, ‘RPD’ = relative percent difference
3. **Red text** indicates exceedances of RPD and RSD limits of ±50% as specified by NAGD (CA 2009)
4. Analytes not included reported concentrations below the laboratory limit of reporting (LoR) in QA/QC samples and the calculation of RPD and RSD was not appropriate (refer to Section 1.3.5).

3 Summary and Conclusion

The physical characterisation of sediment samples from the dredge area were similar to the offshore disposal area predominant characterised by fine well to moderately sorted fine sands. Concentrations of total metals and hydrocarbons from dredge area sediments were below NAGD Screening Levels (CA 2009). Mean concentrations of elutriate nutrients (TP, FRP, NO_x and NH_3) from dredge area exceeded the relevant ANZECC/ARMCANZ (2000) marine water quality trigger values. In accordance with the NAGD (CA 2009), elutriate concentrations should be scaled to account for initial dilution at the discharge area for appropriate assessment against the relevant ANZECC/ARMCANZ (2000) marine water quality trigger values; results of this additional requirement are to be presented in the next revision of the LTMMP. Based on the results presented in this report, dredge area sediments are considered suitable for unconfined ocean disposal under the EPSD Act.

4 References

ANZECC, ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1: The Guidelines. Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australian Capital Territory, October 2000

ANZG (2018) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available from www.waterquality.gov.au/anz-guidelines [Accessed 13 June 2024]

BMT (2019) Jurien Bay Boat Harbour – Long-term Maintenance Dredging Sediment Sampling and Analysis Plan Implementation Report. Prepared for Department of Transport by BMT Australia Pty Ltd, Report No R-1454_01-2, Perth, Western Australia, June 2019

BMT (2022) Jurien Bay Boat Harbour Maintenance Dredging Long Term Monitoring and Management Plan. Prepared for the Department of Transport by BMT Commercial Australia Pty Ltd, Report No. R-1454_01-3, Perth, Western Australia, June 2022

BMT (2023) Department of Transport Maintenance Dredging Environmental Management Framework. Prepared for Department of Transport by BMT Commercial Australia Pty Ltd, Report No. R-1755_02-6, Perth, Western Australia, February 2023

BMT (2024) Jurien Bay Boat Harbour – Long-term Maintenance Dredging Sediment Sampling and Analysis Plan. Prepared for Department of Transport by BMT Commercial Australia Pty Ltd, Report No. R-000607.001-22, Perth, Western Australia, May 2024

CA (2009) National Assessment Guidelines for Dredging. Commonwealth of Australia, Canberra, ACT

USEPA (2022) ProUCL: Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations, version 5.2. Available at: https://www.epa.gov/land-research/proucl-software

Annex A Primary Laboratory Reports (ALS)

CERTIFICATE OF ANALYSIS

Work Order	: **EP2406342**	Page	: 1 of 31
Client	: **BMT COMMERCIAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: Sophie Crochane	Contact	: Georgina Nearygrant
Address	: Level 4 20 Parkland Road Osborne Park 6017	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: +61 8 6163 4900	Telephone	: +61-8-9406 1301
Project	: Jurien Bay sediment sampling	Date Samples Received	: 08-May-2024 16:00
Order number	: 000607.001_022	Date Analysis Commenced	: 11-May-2024
C-O-C number	: ----	Issue Date	: 31-May-2024 13:37
Sampler	: ----		
Site	: Jurien Bay WA		
Quote number	: EP24BMTWBM0007		
No. of samples received	: 28		
No. of samples analysed	: 27		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Canhuang Ke	Inorganics Supervisor	Perth Inorganics, Wangara, WA
Chris Lemaitre	Laboratory Manager (Perth)	Perth Inorganics, Wangara, WA
Daniel Fisher	Inorganics Analyst	Perth Inorganics, Wangara, WA
Efua Wilson	Metals Chemist	Perth Inorganics, Wangara, WA
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Soil Preparation, Stafford, QLD
Thomas Donovan	Senior Organic Chemist	Perth Organics, Wangara, WA
Vincent Muller	Chemist - Inorganics	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EK061G (Total Kjeldahl Nitrogen as N) / EK067G (Total Phosphorous as P): Some samples were diluted due to matrix interference. LOR adjusted accordingly.
- EP075 (SIM): Where reported, Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- EP080-SD: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- EP075(SIM): Where reported, Total Cresol is the sum of the reported concentrations of 2-Methylphenol and 3- & 4-Methylphenol at or above the LOR.
- EP132B-SD: High surrogate recoveries for various samples due to possible matrix effects and interferences.
- Ammonium NH4 results could not be reported as field pH and temperature were not provided on the Chain of Custody. For future submissions where Ammonium is required, please provide the field pH and temperature for each sample.
- EK055G-NH4: Ammonium results could not be reported as field pH and temperature data were not available to process the Ammonium calculations.
- EN68: This analysis in accordance with National Ocean Disposal Guidelines, Commonwealth of Australia, 2002 - (modified). Results reported are those determined on a 1:4 sediment/seawater elutriate without blank correction.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: ELUTRIATE
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	JBBH_S1	JBBH_S2a	JBBH_S2b	JBBH_S3	JBBH_S5
Sampling date / time				08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
				EP2406342-001	EP2406342-002	EP2406342-003	EP2406342-004	EP2406342-006
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.84**	**7.77**	**7.75**	**7.77**	**7.83**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.60**	**0.92**	**0.38**	**1.73**	**0.86**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.7**	**1.2**	**0.6**	**2.9**	**1.1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.7**	**1.2**	**0.6**	**2.9**	**1.1**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.07**	**0.08**	**1.93**	**0.13**	**0.14**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	**0.06**	**0.03**	**0.10**	**0.06**

Analytical Results

Sub-Matrix: ELUTRIATE (Matrix: WATER)

Compound	CAS Number	LOR	Unit	JBBH_S4_1	JBBH_S4_2	JBBH_S4_3	JBBH_S7	JBBH_S9
Sampling date / time				08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
				EP2406342-007	EP2406342-008	EP2406342-009	EP2406342-010	EP2406342-011
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.82**	**7.83**	**7.83**	**7.85**	**7.71**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.96**	**1.12**	**1.21**	**1.07**	**0.94**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**1.3**	**1.4**	**1.5**	**1.4**	**1.1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**1.3**	**1.4**	**1.5**	**1.4**	**1.1**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.20**	**0.08**	<0.05	**0.08**	**0.14**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.03**	**0.02**	**0.03**	**0.06**	**0.03**

Analytical Results

Sub-Matrix: ELUTRIATE (Matrix: WATER)			Sample ID	JBBH_S15_1	JBBH_S15_2	JBBH_S15_3	JBBH_S11	JBBH_S12
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-012	EP2406342-013	EP2406342-014	EP2406342-015	EP2406342-016
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.87**	**7.89**	**7.88**	**7.82**	**7.90**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.65**	**0.70**	**0.72**	**0.90**	**0.24**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**0.01**	<0.01	**0.01**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	**0.01**	<0.01	**0.01**	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.7**	**0.8**	**0.9**	**1.4**	<0.5
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.7**	**0.8**	**0.9**	**1.4**	<0.5
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.06**	<0.05	**0.11**	**0.13**	**0.11**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.01**	<0.01	**0.01**	**0.10**	**0.01**

Analytical Results

Sub-Matrix: ELUTRIATE (Matrix: WATER)			Sample ID	JBBH_S13	JBBH_S14	Elutriate Water	----	----
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	----	----
Compound	CAS Number	LOR	Unit	EP2406342-017	EP2406342-018	EP2406342-028	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.77**	**7.77**	**7.97**	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**1.28**	**0.80**	**0.13**	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**1.6**	**0.8**	<0.5	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**1.6**	**0.8**	<0.5	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.11**	**0.15**	<0.05	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.08**	**0.01**	**0.01**	----	----

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S1	JBBH_S2a	JBBH_S2b	JBBH_S3	JBBH_S5
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-001	EP2406342-002	EP2406342-003	EP2406342-004	EP2406342-006
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.8**	**8.8**	**8.5**	**8.5**	**8.6**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**36.0**	**34.5**	**40.7**	**48.5**	**46.6**
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**21.8**	**22.2**	**21.8**	**21.8**	**22.1**
Exchangeable Magnesium	----	0.1	meq/100g	**2.1**	**2.3**	**2.5**	**4.0**	**4.5**
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	**0.5**	**0.5**	**0.4**	**0.6**	**0.7**
Cation Exchange Capacity	----	0.1	meq/100g	**24.5**	**25.0**	**24.8**	**26.5**	**27.5**
Exchangeable Sodium Percent	----	0.1	%	**2.1**	**1.8**	**1.8**	**2.4**	**2.7**
EG005(ED093)T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**10**	**10**	**9**	**11**	**12**
Copper	7440-50-8	5	mg/kg	<5	<5	<5	**30**	**47**
Lead	7439-92-1	5	mg/kg	<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg	<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg	<5	<5	<5	**26**	**38**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EN68: Seawater Elutriate Testing Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)								
Seawater Sampling Date	----	-	-	**14/05/2024**	**14/05/2024**	**14/05/2024**	**14/05/2024**	**14/05/2024**
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**0.18**	**0.49**	**0.26**	**1.07**	**1.01**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
>C16 - C34 Fraction	----	3	mg/kg	<3	<3	**18**	**34**	**20**

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S1	JBBH_S2a	JBBH_S2b	JBBH_S3	JBBH_S5
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-001	EP2406342-002	EP2406342-003	EP2406342-004	EP2406342-006
				Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued								
>C34 - C40 Fraction	----	5	mg/kg	<5	<5	<5	**10**	**8**
>C10 - C40 Fraction (sum)	----	3	mg/kg	<3	<3	**18**	**44**	**28**
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	<3	<3	<3	<3	<3
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C15 - C28 Fraction	----	3	mg/kg	<3	<3	**5**	**16**	**8**
C29 - C36 Fraction	----	5	mg/kg	<5	<5	**13**	**21**	**13**
^ C10 - C36 Fraction (sum)	----	3	mg/kg	<3	<3	**18**	**37**	**21**
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	<3	<3	<3
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	<3.0	<3.0	<3.0	<3.0	<3.0
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	<5	<5	<5	**7**	<5
2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	<5	<5	<5
Acenaphthylene	208-96-8	4	µg/kg	<4	<4	**6**	**5**	<4
Acenaphthene	83-32-9	4	µg/kg	<4	<4	<4	<4	<4

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S1	JBBH_S2a	JBBH_S2b	JBBH_S3	JBBH_S5
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-001	EP2406342-002	EP2406342-003	EP2406342-004	EP2406342-006
				Result	Result	Result	Result	Result
EP132B: Polynuclear Aromatic Hydrocarbons - Continued								
Fluorene	86-73-7	4	µg/kg	<4	<4	<4	<4	<4
Phenanthrene	85-01-8	4	µg/kg	<4	<4	<4	7	4
Anthracene	120-12-7	4	µg/kg	<4	<4	<4	<4	<4
Fluoranthene	206-44-0	4	µg/kg	<4	<4	<4	24	<4
Pyrene	129-00-0	4	µg/kg	<4	<4	<4	19	<4
Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	<4	11	<4
Chrysene	218-01-9	4	µg/kg	<4	<4	<4	11	<4
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	<4	13	<4
Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	<4	6	<4
Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	<4	6	<4
Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	<4	10	<4
Perylene	198-55-0	4	µg/kg	<4	<4	<4	<4	<4
Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	<4	7	<4
Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	<4	<4	<4
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	<4	6	<4
Coronene	191-07-1	5	µg/kg	<5	<5	<5	<5	<5
^ Sum of PAHs	----	4	µg/kg	<4	<4	6	132	4
^ Benzo(a)pyrene TEQ (zero)	----	4	µg/kg	<4	<4	<4	14	<4
^ Benzo(a)pyrene TEQ (half LOR)	----	4	µg/kg	5	5	5	16	5
^ Benzo(a)pyrene TEQ (LOR)	----	4	µg/kg	10	10	10	18	10
EP080-SD: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.2	%	93.1	99.4	96.6	93.1	93.9
Toluene-D8	2037-26-5	0.2	%	84.2	88.2	85.8	81.8	83.5
4-Bromofluorobenzene	460-00-4	0.2	%	101	104	104	95.3	98.1
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	10	%	97.6	107	118	120	112
Anthracene-d10	1719-06-8	10	%	121	123	126	123	137

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S1	JBBH_S2a	JBBH_S2b	JBBH_S3	JBBH_S5
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-001	EP2406342-002	EP2406342-003	EP2406342-004	EP2406342-006
				Result	Result	Result	Result	Result
EP132T: Base/Neutral Extractable Surrogates - Continued								
4-Terphenyl-d14	1718-51-0	10	%	**99.4**	**100**	**105**	**115**	**121**

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S4_1	JBBH_S4_2	JBBH_S4_3	JBBH_S7	JBBH_S9
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-007	EP2406342-008	EP2406342-009	EP2406342-010	EP2406342-011
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.5**	**8.5**	**8.6**	**8.6**	**8.6**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**48.7**	**47.7**	**49.0**	**47.9**	**40.8**
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**22.0**	**22.4**	**22.1**	**21.8**	**21.8**
Exchangeable Magnesium	----	0.1	meq/100g	**4.6**	**3.6**	**4.5**	**4.8**	**3.1**
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	**0.8**	**0.6**	**0.7**	**0.7**	**0.5**
Cation Exchange Capacity	----	0.1	meq/100g	**27.5**	**26.7**	**27.4**	**27.3**	**25.4**
Exchangeable Sodium Percent	----	0.1	%	**2.8**	**2.4**	**2.5**	**2.6**	**1.9**
EG005(ED093)T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**12**	**10**	**12**	**12**	**10**
Copper	7440-50-8	5	mg/kg	**54**	**44**	**48**	**50**	**25**
Lead	7439-92-1	5	mg/kg	<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg	<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg	**47**	**36**	**45**	**38**	**15**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EN68: Seawater Elutriate Testing Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)								
Seawater Sampling Date	----	-	-	**14/05/2024**	**14/05/2024**	**14/05/2024**	**14/05/2024**	**15/05/2024**
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**1.04**	**1.06**	**0.99**	**0.88**	**0.43**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
>C16 - C34 Fraction	----	3	mg/kg	**59**	**10**	**49**	**15**	**20**

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S4_1	JBBH_S4_2	JBBH_S4_3	JBBH_S7	JBBH_S9
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-007	EP2406342-008	EP2406342-009	EP2406342-010	EP2406342-011
				Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued								
>C34 - C40 Fraction	----	5	mg/kg	**14**	<5	**13**	**5**	**5**
>C10 - C40 Fraction (sum)	----	3	mg/kg	**73**	**10**	**62**	**20**	**25**
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	<3	<3	<3	<3	<3
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C15 - C28 Fraction	----	3	mg/kg	**31**	**4**	**24**	**7**	**8**
C29 - C36 Fraction	----	5	mg/kg	**32**	**6**	**29**	**9**	**13**
^ C10 - C36 Fraction (sum)	----	3	mg/kg	**63**	**10**	**53**	**16**	**21**
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	<3	<3	<3
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	<3.0	<3.0	<3.0	<3.0	<3.0
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	**8**	**5**	**8**	**8**	**10**
2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	<5	<5	<5
Acenaphthylene	208-96-8	4	µg/kg	**8**	<4	**5**	<4	**5**
Acenaphthene	83-32-9	4	µg/kg	<4	<4	<4	<4	<4

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S4_1	JBBH_S4_2	JBBH_S4_3	JBBH_S7	JBBH_S9
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-007	EP2406342-008	EP2406342-009	EP2406342-010	EP2406342-011
				Result	Result	Result	Result	Result
EP132B: Polynuclear Aromatic Hydrocarbons - Continued								
Fluorene	86-73-7	4	µg/kg	<4	<4	<4	<4	<4
Phenanthrene	85-01-8	4	µg/kg	5	<4	<4	<4	<4
Anthracene	120-12-7	4	µg/kg	5	<4	<4	<4	<4
Fluoranthene	206-44-0	4	µg/kg	4	<4	7	<4	<4
Pyrene	129-00-0	4	µg/kg	<4	<4	7	<4	<4
Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	<4	<4	<4
Chrysene	218-01-9	4	µg/kg	<4	<4	4	<4	<4
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	5	<4	<4
Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	<4	<4	<4
Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	<4	<4	<4
Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	<4	<4	<4
Perylene	198-55-0	4	µg/kg	<4	<4	<4	<4	<4
Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	4	<4	<4
Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	<4	<4	<4
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	<4	<4	<4
Coronene	191-07-1	5	µg/kg	<5	<5	<5	<5	<5
^ Sum of PAHs	----	4	µg/kg	30	5	40	8	15
^ Benzo(a)pyrene TEQ (zero)	----	4	µg/kg	<4	<4	<4	<4	<4
^ Benzo(a)pyrene TEQ (half LOR)	----	4	µg/kg	5	5	5	5	5
^ Benzo(a)pyrene TEQ (LOR)	----	4	µg/kg	10	10	10	10	10
EP080-SD: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.2	%	94.4	95.1	92.2	97.4	99.2
Toluene-D8	2037-26-5	0.2	%	84.8	83.8	81.1	84.8	87.7
4-Bromofluorobenzene	460-00-4	0.2	%	99.0	99.6	96.8	101	105
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	10	%	115	120	109	96.5	106
Anthracene-d10	1719-06-8	10	%	130	129	129	124	127

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S4_1	JBBH_S4_2	JBBH_S4_3	JBBH_S7	JBBH_S9
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-007	EP2406342-008	EP2406342-009	EP2406342-010	EP2406342-011
				Result	Result	Result	Result	Result
EP132T: Base/Neutral Extractable Surrogates - Continued								
4-Terphenyl-d14	1718-51-0	10	%	**121**	**113**	**127**	**101**	**108**

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S15_1	JBBH_S15_2	JBBH_S15_3	JBBH_S11	JBBH_S12
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-012	EP2406342-013	EP2406342-014	EP2406342-015	EP2406342-016
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.0**	**9.0**	**8.8**	**8.8**	**8.7**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**30.2**	**27.6**	**31.0**	**37.6**	**30.4**
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**21.1**	**21.2**	**21.4**	**21.8**	**21.2**
Exchangeable Magnesium	----	0.1	meq/100g	**2.0**	**2.0**	**2.0**	**2.7**	**2.0**
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	**0.4**	**0.4**	**0.4**	**0.5**	**0.5**
Cation Exchange Capacity	----	0.1	meq/100g	**23.5**	**23.7**	**23.9**	**25.0**	**23.7**
Exchangeable Sodium Percent	----	0.1	%	**1.7**	**1.9**	**1.9**	**2.1**	**2.1**
EG005(ED093)T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**11**	**10**	**10**	**10**	**10**
Copper	7440-50-8	5	mg/kg	<5	<5	<5	**11**	<5
Lead	7439-92-1	5	mg/kg	<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg	<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg	<5	<5	<5	**9**	<5
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EN68: Seawater Elutriate Testing Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)								
Seawater Sampling Date	----	-	-	**15/05/2024**	**15/05/2024**	**15/05/2024**	**15/05/2024**	**15/05/2024**
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**0.18**	**0.17**	**0.18**	**0.35**	**0.16**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
>C16 - C34 Fraction	----	3	mg/kg	**14**	<3	**5**	**9**	**4**

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S15_1	JBBH_S15_2	JBBH_S15_3	JBBH_S11	JBBH_S12
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-012	EP2406342-013	EP2406342-014	EP2406342-015	EP2406342-016
				Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued								
>C34 - C40 Fraction	----	5	mg/kg	**7**	<5	<5	<5	<5
>C10 - C40 Fraction (sum)	----	3	mg/kg	**21**	<3	**5**	**9**	**4**
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	<3	<3	<3	<3	<3
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C15 - C28 Fraction	----	3	mg/kg	**5**	<3	<3	**3**	<3
C29 - C36 Fraction	----	5	mg/kg	**11**	<5	<5	**6**	<5
^ C10 - C36 Fraction (sum)	----	3	mg/kg	**16**	<3	<3	**9**	<3
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	<3	<3	<3
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	<3.0	<3.0	<3.0	<3.0	<3.0
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	**6**	<5	**8**	**7**	**10**
2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	<5	<5	<5
Acenaphthylene	208-96-8	4	µg/kg	<4	<4	<4	<4	<4
Acenaphthene	83-32-9	4	µg/kg	<4	<4	<4	<4	<4

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S15_1	JBBH_S15_2	JBBH_S15_3	JBBH_S11	JBBH_S12
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-012	EP2406342-013	EP2406342-014	EP2406342-015	EP2406342-016
				Result	Result	Result	Result	Result
EP132B: Polynuclear Aromatic Hydrocarbons - Continued								
Fluorene	86-73-7	4	µg/kg	<4	<4	<4	<4	<4
Phenanthrene	85-01-8	4	µg/kg	<4	<4	<4	<4	<4
Anthracene	120-12-7	4	µg/kg	<4	<4	<4	<4	<4
Fluoranthene	206-44-0	4	µg/kg	<4	<4	<4	<4	<4
Pyrene	129-00-0	4	µg/kg	<4	<4	<4	<4	<4
Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	<4	<4	<4
Chrysene	218-01-9	4	µg/kg	<4	<4	<4	<4	<4
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	<4	<4	<4
Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	<4	<4	<4
Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	<4	<4	<4
Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	<4	<4	<4
Perylene	198-55-0	4	µg/kg	<4	<4	<4	<4	<4
Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	<4	<4	<4
Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	<4	<4	<4
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	<4	<4	<4
Coronene	191-07-1	5	µg/kg	<5	<5	<5	<5	<5
^ Sum of PAHs	----	4	µg/kg	**6**	<4	**8**	**7**	**10**
^ Benzo(a)pyrene TEQ (zero)	----	4	µg/kg	<4	<4	<4	<4	<4
^ Benzo(a)pyrene TEQ (half LOR)	----	4	µg/kg	**5**	**5**	**5**	**5**	**5**
^ Benzo(a)pyrene TEQ (LOR)	----	4	µg/kg	**10**	**10**	**10**	**10**	**10**
EP080-SD: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.2	%	**100**	**90.7**	**99.7**	**98.4**	**94.6**
Toluene-D8	2037-26-5	0.2	%	**90.2**	**86.7**	**86.2**	**88.2**	**85.7**
4-Bromofluorobenzene	460-00-4	0.2	%	**108**	**103**	**100**	**105**	**102**
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	10	%	**98.1**	**116**	**112**	**105**	**102**
Anthracene-d10	1719-06-8	10	%	**117**	**130**	**126**	**126**	**130**

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S15_1	JBBH_S15_2	JBBH_S15_3	JBBH_S11	JBBH_S12
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-012	EP2406342-013	EP2406342-014	EP2406342-015	EP2406342-016
				Result	Result	Result	Result	Result
EP132T: Base/Neutral Extractable Surrogates - Continued								
4-Terphenyl-d14	1718-51-0	10	%	**104**	**117**	**122**	**134**	**132**

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S13	JBBH_S14	JBDA_S1	JBDA_S2	JBDA_S3
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-017	EP2406342-018	EP2406342-019	EP2406342-020	EP2406342-021
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.5**	**8.4**	**8.5**	**8.9**	**8.6**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**46.6**	**53.0**	**30.6**	**34.6**	**40.0**
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**21.8**	**21.8**	**20.7**	**21.7**	**21.6**
Exchangeable Magnesium	----	0.1	meq/100g	**4.1**	**4.9**	**2.1**	**3.7**	**3.8**
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	**0.7**	**0.8**	**0.5**	**0.5**	**0.6**
Cation Exchange Capacity	----	0.1	meq/100g	**26.6**	**27.6**	**23.3**	**26.0**	**26.0**
Exchangeable Sodium Percent	----	0.1	%	**2.5**	**2.9**	**2.0**	**2.0**	**2.4**
EG005(ED093)T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	**9**	<5	<5	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**10**	**11**	**10**	**10**	**9**
Copper	7440-50-8	5	mg/kg	**35**	**30**	<5	<5	<5
Lead	7439-92-1	5	mg/kg	<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg	<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg	**26**	**50**	<5	<5	<5
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EN68: Seawater Elutriate Testing Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)								
Seawater Sampling Date	----	-	-	**15/05/2024**	**15/05/2024**	----	----	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**1.07**	**1.23**	**0.26**	**0.22**	**0.73**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
>C16 - C34 Fraction	----	3	mg/kg	**26**	**52**	**5**	<3	**19**

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S13	JBBH_S14	JBDA_S1	JBDA_S2	JBDA_S3
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-017	EP2406342-018	EP2406342-019	EP2406342-020	EP2406342-021
				Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued								
>C34 - C40 Fraction	----	5	mg/kg	**7**	**9**	<5	<5	**11**
>C10 - C40 Fraction (sum)	----	3	mg/kg	**33**	**61**	**5**	<3	**30**
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	<3	<3	<3	<3	<3
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C15 - C28 Fraction	----	3	mg/kg	**11**	**23**	<3	<3	**9**
C29 - C36 Fraction	----	5	mg/kg	**17**	**33**	<5	<5	**13**
^ C10 - C36 Fraction (sum)	----	3	mg/kg	**28**	**56**	<3	<3	**22**
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	<3	<3	<3
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	<3.0	<3.0	<3.0	<3.0	<3.0
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	**10**	**9**	**6**	**6**	<5
2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	<5	<5	<5
Acenaphthylene	208-96-8	4	µg/kg	<4	**7**	<4	<4	<4
Acenaphthene	83-32-9	4	µg/kg	<4	<4	<4	<4	<4

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S13	JBBH_S14	JBDA_S1	JBDA_S2	JBDA_S3
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-017	EP2406342-018	EP2406342-019	EP2406342-020	EP2406342-021
				Result	Result	Result	Result	Result
EP132B: Polynuclear Aromatic Hydrocarbons - Continued								
Fluorene	86-73-7	4	µg/kg	<4	<4	<4	<4	<4
Phenanthrene	85-01-8	4	µg/kg	<4	10	<4	<4	<4
Anthracene	120-12-7	4	µg/kg	<4	<4	<4	<4	<4
Fluoranthene	206-44-0	4	µg/kg	<4	16	<4	<4	<4
Pyrene	129-00-0	4	µg/kg	<4	12	<4	<4	<4
Benz(a)anthracene	56-55-3	4	µg/kg	<4	4	<4	<4	<4
Chrysene	218-01-9	4	µg/kg	<4	6	<4	<4	<4
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	7	<4	<4	<4
Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	<4	<4	<4
Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	<4	<4	<4
Benzo(a)pyrene	50-32-8	4	µg/kg	<4	5	<4	<4	<4
Perylene	198-55-0	4	µg/kg	<4	<4	<4	<4	<4
Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	4	<4	<4	<4
Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	<4	<4	<4
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	<4	<4	<4
Coronene	191-07-1	5	µg/kg	<5	<5	<5	<5	<5
^ Sum of PAHs	----	4	µg/kg	10	80	6	6	<4
^ Benzo(a)pyrene TEQ (zero)	----	4	µg/kg	<4	6	<4	<4	<4
^ Benzo(a)pyrene TEQ (half LOR)	----	4	µg/kg	5	9	5	5	5
^ Benzo(a)pyrene TEQ (LOR)	----	4	µg/kg	10	11	10	10	10
EP080-SD: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.2	%	93.2	90.3	97.0	105	96.9
Toluene-D8	2037-26-5	0.2	%	82.4	79.6	83.9	88.2	85.8
4-Bromofluorobenzene	460-00-4	0.2	%	98.2	95.6	102	104	99.1
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	10	%	94.3	86.6	89.3	99.6	85.2
Anthracene-d10	1719-06-8	10	%	116	114	122	127	87.2

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBBH_S13	JBBH_S14	JBDA_S1	JBDA_S2	JBDA_S3
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-017	EP2406342-018	EP2406342-019	EP2406342-020	EP2406342-021
				Result	Result	Result	Result	Result
EP132T: Base/Neutral Extractable Surrogates - Continued								
4-Terphenyl-d14	1718-51-0	10	%	**103**	**123**	**111**	**110**	**86.9**

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBDA_S4	JBDA_S5	JBDA_S6	JBDA_S7	Elutriate Water
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-022	EP2406342-023	EP2406342-024	EP2406342-025	EP2406342-028
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.5**	**8.8**	**8.8**	**8.5**	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**41.2**	**35.6**	**40.0**	**46.7**	----
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**21.6**	**21.3**	**21.6**	**20.8**	----
Exchangeable Magnesium	----	0.1	meq/100g	**3.7**	**2.3**	**2.5**	**3.9**	----
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	----
Exchangeable Sodium	----	0.1	meq/100g	**0.5**	**0.5**	**0.5**	**0.5**	----
Cation Exchange Capacity	----	0.1	meq/100g	**25.9**	**24.2**	**24.7**	**25.3**	----
Exchangeable Sodium Percent	----	0.1	%	**2.0**	**2.3**	**2.0**	**2.0**	----
EG005(ED093)T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	----
Chromium	7440-47-3	2	mg/kg	**8**	**9**	**9**	**8**	----
Copper	7440-50-8	5	mg/kg	<5	<5	<5	<5	----
Lead	7439-92-1	5	mg/kg	<5	<5	<5	<5	----
Nickel	7440-02-0	2	mg/kg	<2	<2	<2	<2	----
Zinc	7440-66-6	5	mg/kg	<5	<5	<5	<5	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
EN68: Seawater Elutriate Testing Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)								
Seawater Sampling Date	----	-	-	----	----	----	----	**15/05/2024**
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**0.70**	**0.23**	**0.34**	**1.95**	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	----
>C16 - C34 Fraction	----	3	mg/kg	**15**	<3	**10**	**82**	----

Analytical Results

Sub-Matrix: MARINE SEDIMENT
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	JBDA_S4	JBDA_S5	JBDA_S6	JBDA_S7	Elutriate Water
Sampling date / time				08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
				EP2406342-022	EP2406342-023	EP2406342-024	EP2406342-025	EP2406342-028
				Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued								
>C34 - C40 Fraction	----	5	mg/kg	**6**	<5	**5**	**11**	----
>C10 - C40 Fraction (sum)	----	3	mg/kg	**21**	<3	**15**	**93**	----
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	<3	<3	<3	<3	----
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	----
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	----
C15 - C28 Fraction	----	3	mg/kg	**8**	<3	**3**	**57**	----
C29 - C36 Fraction	----	5	mg/kg	**8**	<5	**8**	**30**	----
^ C10 - C36 Fraction (sum)	----	3	mg/kg	**16**	<3	**11**	**87**	----
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	<3	<3	----
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	<3.0	<3.0	<3.0	<3.0	----
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	<5	<5	<5	<5	----
2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	<5	<5	----
Acenaphthylene	208-96-8	4	µg/kg	<4	<4	<4	<4	----
Acenaphthene	83-32-9	4	µg/kg	<4	<4	<4	<4	----

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBDA_S4	JBDA_S5	JBDA_S6	JBDA_S7	Elutriate Water
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-022	EP2406342-023	EP2406342-024	EP2406342-025	EP2406342-028
				Result	Result	Result	Result	Result
EP132B: Polynuclear Aromatic Hydrocarbons - Continued								
Fluorene	86-73-7	4	µg/kg	<4	<4	<4	<4	----
Phenanthrene	85-01-8	4	µg/kg	<4	<4	<4	<4	----
Anthracene	120-12-7	4	µg/kg	<4	<4	<4	<4	----
Fluoranthene	206-44-0	4	µg/kg	<4	<4	<4	<4	----
Pyrene	129-00-0	4	µg/kg	<4	<4	<4	<4	----
Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	<4	<4	----
Chrysene	218-01-9	4	µg/kg	<4	<4	<4	<4	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	<4	<4	----
Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	<4	<4	----
Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	<4	<4	----
Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	<4	<4	----
Perylene	198-55-0	4	µg/kg	<4	<4	<4	<4	----
Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	<4	<4	----
Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	<4	<4	----
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	<4	<4	----
Coronene	191-07-1	5	µg/kg	<5	<5	<5	<5	----
^ Sum of PAHs	----	4	µg/kg	<4	<4	<4	<4	----
^ Benzo(a)pyrene TEQ (zero)	----	4	µg/kg	<4	<4	<4	<4	----
^ Benzo(a)pyrene TEQ (half LOR)	----	4	µg/kg	**5**	**5**	**5**	**5**	----
^ Benzo(a)pyrene TEQ (LOR)	----	4	µg/kg	**10**	**10**	**10**	**10**	----
EP080-SD: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.2	%	**88.4**	**95.9**	**91.9**	**95.6**	----
Toluene-D8	2037-26-5	0.2	%	**92.0**	**89.2**	**88.8**	**84.0**	----
4-Bromofluorobenzene	460-00-4	0.2	%	**108**	**105**	**105**	**101**	----
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	10	%	**93.5**	**82.8**	**81.7**	**96.1**	----
Anthracene-d10	1719-06-8	10	%	**98.5**	**90.3**	**106**	**95.3**	----

Analytical Results

Sub-Matrix: MARINE SEDIMENT (Matrix: SOIL)			Sample ID	JBDA_S4	JBDA_S5	JBDA_S6	JBDA_S7	Elutriate Water
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00	08-May-2024 00:00
Compound	CAS Number	LOR	Unit	EP2406342-022	EP2406342-023	EP2406342-024	EP2406342-025	EP2406342-028
				Result	Result	Result	Result	Result
EP132T: Base/Neutral Extractable Surrogates - Continued								
4-Terphenyl-d14	1718-51-0	10	%	**107**	**87.6**	**83.7**	**82.0**	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	Rinsate	Trip Blank	----	----	----
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EP2406342-026	EP2406342-027	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**5.56**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	<0.1	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	----	----	----	----
EP005: Total Organic Carbon (TOC)								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	Rinsate	Trip Blank	----	----	----
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EP2406342-026	EP2406342-027	--------	--------	--------
				Result	Result	----	----	----
EP005: Total Organic Carbon (TOC) - Continued								
Total Organic Carbon	----	1	mg/L	**6**	----	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	----	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	----	----	----	----
Acenaphthene	83-32-9	1.0	µg/L	<1.0	----	----	----	----
Fluorene	86-73-7	1.0	µg/L	<1.0	----	----	----	----
Phenanthrene	85-01-8	1.0	µg/L	<1.0	----	----	----	----
Anthracene	120-12-7	1.0	µg/L	<1.0	----	----	----	----
Fluoranthene	206-44-0	1.0	µg/L	<1.0	----	----	----	----
Pyrene	129-00-0	1.0	µg/L	<1.0	----	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	----	----	----	----
Chrysene	218-01-9	1.0	µg/L	<1.0	----	----	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	<1.0	----	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	----	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	----	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	----	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	----	----	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	----	----	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	----	----	----	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L	<0.5	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L	<50	----	----	----	----
C15 - C28 Fraction	----	100	µg/L	<100	----	----	----	----
C29 - C36 Fraction	----	50	µg/L	<50	----	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	Rinsate	Trip Blank	----	----	----
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EP2406342-026	EP2406342-027	--------	--------	--------
				Result	Result	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	----	----	----
>C10 - C16 Fraction	----	100	µg/L	<100	----	----	----	----
>C16 - C34 Fraction	----	100	µg/L	<100	----	----	----	----
>C34 - C40 Fraction	----	100	µg/L	<100	----	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	----	----	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	----	----	----	----
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	----	----	----
Toluene	108-88-3	2	µg/L	<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L	<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L	<2	<2	----	----	----
^ Total Xylenes	----	2	µg/L	<2	<2	----	----	----
^ Sum of BTEX	----	1	µg/L	<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L	<5	<5	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	1.0	%	**19.4**	----	----	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%	**44.0**	----	----	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%	**67.4**	----	----	----	----
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	1.0	%	**53.1**	----	----	----	----
Anthracene-d10	1719-06-8	1.0	%	**71.0**	----	----	----	----
4-Terphenyl-d14	1718-51-0	1.0	%	**79.2**	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**93.0**	**94.3**	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			*Sample ID*	Rinsate	Trip Blank	----	----	----
			Sampling date / time	08-May-2024 00:00	08-May-2024 00:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	EP2406342-026	EP2406342-027	--------	--------	--------
				Result	Result	----	----	----
EP080S: TPH(V)/BTEX Surrogates - Continued								
Toluene-D8	2037-26-5	2	%	**98.1**	**101**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%	**100**	**106**	----	----	----

Surrogate Control Limits

Sub-Matrix: **MARINE SEDIMENT**

Compound	CAS Number	Recovery Limits (%) Low	High
EP080-SD: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	70	130
Toluene-D8	2037-26-5	70	130
4-Bromofluorobenzene	460-00-4	70	130
EP132T: Base/Neutral Extractable Surrogates			
2-Fluorobiphenyl	321-60-8	70	130
Anthracene-d10	1719-06-8	70	130
4-Terphenyl-d14	1718-51-0	70	130

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	67
2-Chlorophenol-D4	93951-73-6	29	120
2.4.6-Tribromophenol	118-79-6	10	131
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	34	131
Anthracene-d10	1719-06-8	43	126
4-Terphenyl-d14	1718-51-0	41	142
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	61	141
Toluene-D8	2037-26-5	73	126
4-Bromofluorobenzene	460-00-4	60	125

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

(SOIL) EP003: Total Organic Carbon (TOC) in Soil

(SOIL) EN68: Seawater Elutriate Testing Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology). Only applies to samples EP2406342 (001, 002, 003, 004, 006, 007, 008, 009, 010, 011, 012, 013, 014, 015, 016, 017, 018, 028).

(WATER) EK055G: Ammonia as N by Discrete Analyser

(WATER) EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser

(WATER) EK057G: Nitrite as N by Discrete Analyser

(WATER) EK058G: Nitrate as N by Discrete Analyser

(WATER) EK071G: Reactive Phosphorus as P by discrete analyser

(WATER) EK067G: Total Phosphorus as P by Discrete Analyser

(WATER) EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser

(WATER) EK061G: Total Kjeldahl Nitrogen By Discrete Analyser

(WATER) EA005P: pH by PC Titrator

QUALITY CONTROL REPORT

Work Order	: **EP2406342**	Page	: 1 of 24
Client	: **BMT COMMERCIAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: Sophie Crochane	Contact	: Georgina Nearygrant
Address	: Level 4 20 Parkland Road Osborne Park 6017	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: +61 8 6163 4900	Telephone	: +61-8-9406 1301
Project	: Jurien Bay sediment sampling	Date Samples Received	: 08-May-2024
Order number	: 000607.001_022	Date Analysis Commenced	: 11-May-2024
C-O-C number	: ----	Issue Date	: 31-May-2024
Sampler	: ----		
Site	: Jurien Bay WA		
Quote number	: EP24BMTWBM0007		
No. of samples received	: 28		
No. of samples analysed	: 27		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Canhuang Ke	Inorganics Supervisor	Perth Inorganics, Wangara, WA
Chris Lemaitre	Laboratory Manager (Perth)	Perth Inorganics, Wangara, WA
Daniel Fisher	Inorganics Analyst	Perth Inorganics, Wangara, WA
Efua Wilson	Metals Chemist	Perth Inorganics, Wangara, WA
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Soil Preparation, Stafford, QLD
Thomas Donovan	Senior Organic Chemist	Perth Organics, Wangara, WA
Vincent Muller	Chemist - Inorganics	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key :
Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC
* = The final LOR has been raised due to dilution or other sample specific cause; adjusted LOR is shown in brackets. The duplicate ranges for Acceptable RPD% are applied to the final LOR where applicable.

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 5794133)									
EP2406342-001	JBBH_S1	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	10	10	0.0	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	<2	<2	0.0	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	<5	<5	0.0	No Limit
EP2406342-012	JBBH_S15_1	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	11	10	0.0	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	<2	<2	0.0	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	<5	<5	0.0	No Limit
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 5794222)									
EP2406526-001	Anonymous	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	38	38	0.0	0% - 50%
		EG005T: Nickel	7440-02-0	2	mg/kg	15	15	0.0	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	27	28	5.4	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	31	37	17.7	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
				Laboratory Duplicate (DUP) Report					
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 5794222) - continued									
EP2406526-001	Anonymous	EG005T: Zinc	7440-66-6	5	mg/kg	69	80	15.0	0% - 50%
EA002: pH 1:5 (Soils) (QC Lot: 5787543)									
EP2406342-001	JBBH_S1	EA002: pH Value	----	0.1	pH Unit	8.8	8.8	0.0	0% - 20%
EP2406342-011	JBBH_S9	EA002: pH Value	----	0.1	pH Unit	8.6	8.8	2.6	0% - 20%
EA002: pH 1:5 (Soils) (QC Lot: 5787544)									
EP2406342-022	JBDA_S4	EA002: pH Value	----	0.1	pH Unit	8.5	8.6	0.0	0% - 20%
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 5794137)									
EP2406342-001	JBBH_S1	EA055: Moisture Content	----	0.1 (1.0)*	%	36.0	36.4	1.2	0% - 20%
EP2406342-012	JBBH_S15_1	EA055: Moisture Content	----	0.1 (1.0)*	%	30.2	29.3	2.9	0% - 20%
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 5794228)									
EP2406342-022	JBDA_S4	EA055: Moisture Content	----	0.1 (1.0)*	%	41.2	42.1	1.9	0% - 20%
ED008: Exchangeable Cations (QC Lot: 5812452)									
EP2406256-001	Anonymous	ED008: Exchangeable Sodium Percent	----	0.1	%	18.6	18.5	0.6	0% - 20%
		ED008: Exchangeable Calcium	----	0.1	meq/100g	24.9	25.0	0.4	0% - 20%
		ED008: Exchangeable Magnesium	----	0.1	meq/100g	1.1	1.1	0.0	0% - 50%
		ED008: Exchangeable Potassium	----	0.1	meq/100g	8.7	8.8	1.3	0% - 20%
		ED008: Exchangeable Sodium	----	0.1	meq/100g	7.9	7.9	0.0	0% - 20%
		ED008: Cation Exchange Capacity	----	0.1	meq/100g	42.6	42.8	0.4	0% - 20%
EP2406342-001	JBBH_S1	ED008: Exchangeable Sodium Percent	----	0.1	%	2.1	2.0	0.0	0% - 20%
		ED008: Exchangeable Calcium	----	0.1	meq/100g	21.8	21.8	0.0	0% - 20%
		ED008: Exchangeable Magnesium	----	0.1	meq/100g	2.1	2.2	0.0	0% - 20%
		ED008: Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	0.0	No Limit
		ED008: Exchangeable Sodium	----	0.1	meq/100g	0.5	0.5	0.0	No Limit
		ED008: Cation Exchange Capacity	----	0.1	meq/100g	24.5	24.6	0.0	0% - 20%
ED008: Exchangeable Cations (QC Lot: 5812453)									
EP2406342-022	JBDA_S4	ED008: Exchangeable Sodium Percent	----	0.1	%	2.0	2.1	0.0	0% - 20%
		ED008: Exchangeable Calcium	----	0.1	meq/100g	21.6	21.7	0.6	0% - 20%
		ED008: Exchangeable Magnesium	----	0.1	meq/100g	3.7	3.8	0.0	0% - 20%
		ED008: Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	0.0	No Limit
		ED008: Exchangeable Sodium	----	0.1	meq/100g	0.5	0.5	0.0	No Limit
		ED008: Cation Exchange Capacity	----	0.1	meq/100g	25.9	26.1	0.8	0% - 20%
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 5794134)									
EP2406342-001	JBBH_S1	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EP2406342-012	JBBH_S15_1	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 5794225)									
EP2406526-001	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EP003: Total Organic Carbon (TOC) in Soil (QC Lot: 5810314)									
EP2406342-001	JBBH_S1	EP003: Total Organic Carbon	----	0.02	%	0.18	0.17	9.8	No Limit
EP2406342-012	JBBH_S15_1	EP003: Total Organic Carbon	----	0.02	%	0.18	0.15	19.9	No Limit
EP003: Total Organic Carbon (TOC) in Soil (QC Lot: 5810315)									
EP2406342-022	JBDA_S4	EP003: Total Organic Carbon	----	0.02	%	0.70	0.70	0.0	0% - 20%
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QC Lot: 5788162)									
EP2406340-001	Anonymous	EP080-SD: C6 - C9 Fraction	----	3	mg/kg	<3	<3	0.0	0% - 3%
EP2406340-006	Anonymous	EP080-SD: C6 - C9 Fraction	----	3	mg/kg	<3	<3	0.0	0% - 3%
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QC Lot: 5788163)									
EP2406340-001	Anonymous	EP071-SD: C10 - C14 Fraction	----	3	mg/kg	<3	<3	0.0	No Limit
		EP071-SD: C15 - C28 Fraction	----	3	mg/kg	15	18	16.6	No Limit
		EP071-SD: C10 - C36 Fraction (sum)	----	3	mg/kg	25	30	18.2	0% - 50%
		EP071-SD: C29 - C36 Fraction	----	5	mg/kg	10	12	25.5	No Limit
EP2406340-006	Anonymous	EP071-SD: C10 - C14 Fraction	----	3	mg/kg	<3	<3	0.0	No Limit
		EP071-SD: C15 - C28 Fraction	----	3	mg/kg	20	10	66.6	No Limit
		EP071-SD: C10 - C36 Fraction (sum)	----	3	mg/kg	29	20	36.7	No Limit
		EP071-SD: C29 - C36 Fraction	----	5	mg/kg	9	10	13.4	No Limit
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QC Lot: 5788165)									
EP2406342-001	JBBH_S1	EP080-SD: C6 - C9 Fraction	----	3	mg/kg	<3	<3	0.0	0% - 3%
EP2406342-012	JBBH_S15_1	EP080-SD: C6 - C9 Fraction	----	3	mg/kg	<3	<3	0.0	0% - 3%
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QC Lot: 5788166)									
EP2406342-001	JBBH_S1	EP071-SD: C10 - C14 Fraction	----	3	mg/kg	<3	<3	0.0	No Limit
		EP071-SD: C15 - C28 Fraction	----	3	mg/kg	<3	<3	0.0	No Limit
		EP071-SD: C10 - C36 Fraction (sum)	----	3	mg/kg	<3	<3	0.0	No Limit
		EP071-SD: C29 - C36 Fraction	----	5	mg/kg	<5	<5	0.0	No Limit
EP2406342-012	JBBH_S15_1	EP071-SD: C10 - C14 Fraction	----	3	mg/kg	<3	<3	0.0	No Limit
		EP071-SD: C15 - C28 Fraction	----	3	mg/kg	5	<3	48.2	No Limit
		EP071-SD: C10 - C36 Fraction (sum)	----	3	mg/kg	16	<3	137	No Limit
		EP071-SD: C29 - C36 Fraction	----	5	mg/kg	11	<5	76.7	No Limit
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QC Lot: 5788162)									
EP2406340-001	Anonymous	EP080-SD: C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	0.0	0% - 3%
EP2406340-006	Anonymous	EP080-SD: C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	0.0	0% - 3%
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QC Lot: 5788163)									
EP2406340-001	Anonymous	EP071-SD: >C10 - C16 Fraction	----	3	mg/kg	<3	<3	0.0	No Limit
		EP071-SD: >C16 - C34 Fraction	----	3	mg/kg	22	28	21.3	No Limit
		EP071-SD: >C10 - C40 Fraction (sum)	----	3	mg/kg	30	36	18.2	0% - 50%
		EP071-SD: >C34 - C40 Fraction	----	5	mg/kg	8	8	0.0	No Limit
EP2406340-006	Anonymous	EP071-SD: >C10 - C16 Fraction	----	3	mg/kg	<3	<3	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QC Lot: 5788163) - continued									
EP2406340-006	Anonymous	EP071-SD: >C16 - C34 Fraction	----	3	mg/kg	27	18	41.5	No Limit
		EP071-SD: >C10 - C40 Fraction (sum)	----	3	mg/kg	32	25	24.6	0% - 50%
		EP071-SD: >C34 - C40 Fraction	----	5	mg/kg	5	7	21.5	No Limit
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QC Lot: 5788165)									
EP2406342-001	JBBH_S1	EP080-SD: C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	0.0	0% - 3%
EP2406342-012	JBBH_S15_1	EP080-SD: C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	0.0	0% - 3%
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QC Lot: 5788166)									
EP2406342-001	JBBH_S1	EP071-SD: >C10 - C16 Fraction	----	3	mg/kg	<3	<3	0.0	No Limit
		EP071-SD: >C16 - C34 Fraction	----	3	mg/kg	<3	<3	0.0	No Limit
		EP071-SD: >C10 - C40 Fraction (sum)	----	3	mg/kg	<3	<3	0.0	No Limit
		EP071-SD: >C34 - C40 Fraction	----	5	mg/kg	<5	<5	0.0	No Limit
EP2406342-012	JBBH_S15_1	EP071-SD: >C10 - C16 Fraction	----	3	mg/kg	<3	<3	0.0	No Limit
		EP071-SD: >C16 - C34 Fraction	----	3	mg/kg	14	<3	130	No Limit
		EP071-SD: >C10 - C40 Fraction (sum)	----	3	mg/kg	21	<3	150	No Limit
		EP071-SD: >C34 - C40 Fraction	----	5	mg/kg	7	<5	35.8	No Limit
EP080-SD: BTEXN (QC Lot: 5788162)									
EP2406340-001	Anonymous	EP080-SD: Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Total Xylenes	----	0.2 (0.5)*	mg/kg	<0.5	<0.5	0.0	0% - .2%
		EP080-SD: Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
EP2406340-006	Anonymous	EP080-SD: Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Total Xylenes	----	0.2 (0.5)*	mg/kg	<0.5	<0.5	0.0	0% - .2%
		EP080-SD: Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
EP080-SD: BTEXN (QC Lot: 5788165)									
EP2406342-001	JBBH_S1	EP080-SD: Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EP080-SD: BTEXN (QC Lot: 5788165) - continued									
EP2406342-001	JBBH_S1	EP080-SD: Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Total Xylenes	----	0.2 (0.5)*	mg/kg	<0.5	<0.5	0.0	0% - .2%
		EP080-SD: Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
EP2406342-012	JBBH_S15_1	EP080-SD: Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Total Xylenes	----	0.2 (0.5)*	mg/kg	<0.5	<0.5	0.0	0% - .2%
		EP080-SD: Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
		EP080-SD: Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	0.0	0% - .2%
EP132B: Polynuclear Aromatic Hydrocarbons (QC Lot: 5788161)									
EP2406340-001	Anonymous	EP132B-SD: Acenaphthylene	208-96-8	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Acenaphthene	83-32-9	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Fluorene	86-73-7	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Phenanthrene	85-01-8	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Anthracene	120-12-7	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Fluoranthene	206-44-0	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Pyrene	129-00-0	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Chrysene	218-01-9	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Perylene	198-55-0	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Sum of PAHs	----	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Naphthalene	91-20-3	5	µg/kg	<5	<5	0.0	No Limit
		EP132B-SD: 2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	0.0	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
				Laboratory Duplicate (DUP) Report					
EP132B: Polynuclear Aromatic Hydrocarbons (QC Lot: 5788161) - continued									
EP2406340-001	Anonymous	EP132B-SD: Coronene	191-07-1	5	µg/kg	<5	<5	0.0	No Limit
EP2406340-006	Anonymous	EP132B-SD: Acenaphthylene	208-96-8	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Acenaphthene	83-32-9	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Fluorene	86-73-7	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Phenanthrene	85-01-8	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Anthracene	120-12-7	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Fluoranthene	206-44-0	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Pyrene	129-00-0	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Chrysene	218-01-9	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Perylene	198-55-0	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Sum of PAHs	----	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Naphthalene	91-20-3	5	µg/kg	<5	<5	0.0	No Limit
		EP132B-SD: 2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	0.0	No Limit
		EP132B-SD: Coronene	191-07-1	5	µg/kg	<5	<5	0.0	No Limit
EP132B: Polynuclear Aromatic Hydrocarbons (QC Lot: 5788164)									
EP2406342-001	JBBH_S1	EP132B-SD: Acenaphthylene	208-96-8	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Acenaphthene	83-32-9	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Fluorene	86-73-7	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Phenanthrene	85-01-8	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Anthracene	120-12-7	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Fluoranthene	206-44-0	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Pyrene	129-00-0	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Chrysene	218-01-9	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	0.0	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
				Laboratory Duplicate (DUP) Report					
EP132B: Polynuclear Aromatic Hydrocarbons (QC Lot: 5788164) - continued									
EP2406342-001	JBBH_S1	EP132B-SD: Perylene	198-55-0	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Sum of PAHs	----	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Naphthalene	91-20-3	5	µg/kg	<5	<5	0.0	No Limit
		EP132B-SD: 2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	0.0	No Limit
		EP132B-SD: Coronene	191-07-1	5	µg/kg	<5	<5	0.0	No Limit
EP2406342-012	JBBH_S15_1	EP132B-SD: Acenaphthylene	208-96-8	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Acenaphthene	83-32-9	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Fluorene	86-73-7	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Phenanthrene	85-01-8	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Anthracene	120-12-7	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Fluoranthene	206-44-0	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Pyrene	129-00-0	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Chrysene	218-01-9	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Perylene	198-55-0	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	0.0	No Limit
		EP132B-SD: Sum of PAHs	----	4	µg/kg	6	6	0.0	No Limit
		EP132B-SD: Naphthalene	91-20-3	5	µg/kg	6	6	0.0	No Limit
		EP132B-SD: 2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	0.0	No Limit
		EP132B-SD: Coronene	191-07-1	5	µg/kg	<5	<5	0.0	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
				Laboratory Duplicate (DUP) Report					
EA005P: pH by PC Titrator (QC Lot: 5790149)									
EB2416078-003	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.92	8.00	1.0	0% - 20%
EB2415603-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.11	7.16	0.7	0% - 20%
EA005P: pH by PC Titrator (QC Lot: 5790150)									
EP2406342-003	JBBH_S2b	EA005-P: pH Value	----	0.01	pH Unit	7.75	7.85	1.3	0% - 20%

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EA005P: pH by PC Titrator (QC Lot: 5792125)									
EP2406292-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.99	8.01	0.2	0% - 20%
EP2406422-004	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	5.14	5.13	0.2	0% - 20%
EA005P: pH by PC Titrator (QC Lot: 5793074)									
EB2416258-013	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	5.83	5.79	0.7	0% - 20%
EB2412338-003	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.36	7.37	0.1	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 5802573)									
EP2406342-026	Rinsate	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.0	No Limit
EP2406511-010	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.0	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 5802574)									
EP2406511-002	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EP2406511-011	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 5784020)									
EP2406342-026	Rinsate	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 5803772)									
EP2406342-001	JBBH_S1	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.60	0.60	0.0	0% - 20%
EP2406342-012	JBBH_S15_1	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.65	0.64	0.0	0% - 20%
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 5784018)									
EP2406342-026	Rinsate	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 5790015)									
EP2406342-006	JBBH_S5	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EB2415830-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01 (0.05)*	mg/L	<0.05	<0.05	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 5795202)									
EP2406342-016	JBBH_S12	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EB2416359-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 5784019)									
EP2406342-026	Rinsate	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 5803773)									
EP2406342-001	JBBH_S1	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EP2406342-012	JBBH_S15_1	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 5788614)									
EP2406216-022	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	9.5	9.1	4.7	0% - 20%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 5802102)									
EB2416349-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.0	No Limit
EB2416082-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 5802103)									
EP2406342-006	JBBH_S5	EK061G: Total Kjeldahl Nitrogen as N	----	0.1 (0.5)*	mg/L	1.1	1.1	0.0	No Limit
EP2406342-016	JBBH_S12	EK061G: Total Kjeldahl Nitrogen as N	----	0.1 (0.5)*	mg/L	<0.5	<0.5	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 5788613)									
EP2406216-022	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.06	0.07	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 5802101)									
EB2416362-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.06	0.03	80.8	No Limit
EB2416082-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 5802104)									
EP2406342-006	JBBH_S5	EK067G: Total Phosphorus as P	----	0.01 (0.05)*	mg/L	0.14	0.06	79.3	No Limit
EP2406342-016	JBBH_S12	EK067G: Total Phosphorus as P	----	0.01 (0.05)*	mg/L	0.11	<0.05	75.4	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 5784017)									
EP2406342-026	Rinsate	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 5790019)									
EP2406342-006	JBBH_S5	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.06	0.06	0.0	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 5795203)									
EP2406342-016	JBBH_S12	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.01	<0.01	0.0	No Limit
EB2416359-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.01	0.01	0.0	No Limit
EP005: Total Organic Carbon (TOC) (QC Lot: 5794049)									
EP2406216-025	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	<1	<1	0.0	No Limit
EP2406216-027	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	<1	<1	0.0	No Limit
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QC Lot: 5790739)									
EP2406323-006	Anonymous	EP075(SIM): Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Naphthalene	91-20-3	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Acenaphthylene	208-96-8	1	µg/L	<1.0	<1.0	0.0	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QC Lot: 5790739) - continued									
EP2406323-006	Anonymous	EP075(SIM): Acenaphthene	83-32-9	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Fluorene	86-73-7	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Phenanthrene	85-01-8	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Anthracene	120-12-7	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Fluoranthene	206-44-0	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Pyrene	129-00-0	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Benz(a)anthracene	56-55-3	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Chrysene	218-01-9	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Benzo(b+j)fluoranthene	205-99-2 205-82-3	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	<1.0	0.0	No Limit
EP2406322-001	Anonymous	EP075(SIM): Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Naphthalene	91-20-3	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Acenaphthylene	208-96-8	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Acenaphthene	83-32-9	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Fluorene	86-73-7	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Phenanthrene	85-01-8	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Anthracene	120-12-7	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Fluoranthene	206-44-0	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Pyrene	129-00-0	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Benz(a)anthracene	56-55-3	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Chrysene	218-01-9	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Benzo(b+j)fluoranthene	205-99-2 205-82-3	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	<1.0	0.0	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 5784618)									
EP2406331-001	Anonymous	EP080: C6 - C9 Fraction	----	20 (500)*	µg/L	38700	35100	9.6	0% - 20%
EP2406331-011	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.0	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 5790738)									
EP2406477-003	Anonymous	EP071: C15 - C28 Fraction	----	100	µg/L	<100	<100	0.0	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 5790738) - continued									
EP2406477-003	Anonymous	EP071: C10 - C14 Fraction	----	50	µg/L	<50	<50	0.0	No Limit
		EP071: C29 - C36 Fraction	----	50	µg/L	<50	<50	0.0	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 5784618)									
EP2406331-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20 (500)*	µg/L	39000	35400	9.6	0% - 20%
EP2406331-011	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.0	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 5790738)									
EP2406477-003	Anonymous	EP071: >C10 - C16 Fraction	----	100	µg/L	<100	<100	0.0	No Limit
		EP071: >C16 - C34 Fraction	----	100	µg/L	<100	<100	0.0	No Limit
		EP071: >C34 - C40 Fraction	----	100	µg/L	<100	<100	0.0	No Limit
EP080: BTEXN (QC Lot: 5784618)									
EP2406331-001	Anonymous	EP080: Benzene	71-43-2	1 (12)*	µg/L	4420	4120	7.0	0% - 20%
		EP080: Toluene	108-88-3	2 (12)*	µg/L	17200	15700	9.5	0% - 20%
		EP080: Ethylbenzene	100-41-4	2 (12)*	µg/L	2930	2640	10.4	0% - 20%
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2 (25)*	µg/L	5320	4850	9.2	0% - 20%
		EP080: ortho-Xylene	95-47-6	2 (12)*	µg/L	5060	4620	9.0	0% - 20%
		EP080: Naphthalene	91-20-3	5	µg/L	142	137	3.9	0% - 20%
EP2406331-011	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.0	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.0	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.0	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.0	No Limit

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 5794133)								
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	77.39 mg/kg	106	70.0	130
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	1.93 mg/kg	101	70.0	130
EG005T: Chromium	7440-47-3	2	mg/kg	<2	18.67 mg/kg	95.3	70.0	130
EG005T: Copper	7440-50-8	5	mg/kg	<5	46.13 mg/kg	103	70.0	130
EG005T: Lead	7439-92-1	5	mg/kg	<5	58.42 mg/kg	96.8	70.0	130
EG005T: Nickel	7440-02-0	2	mg/kg	<2	14.48 mg/kg	95.6	70.0	130
EG005T: Zinc	7440-66-6	5	mg/kg	<5	190.4 mg/kg	98.7	70.0	130
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 5794222)								
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	77.39 mg/kg	102	70.0	130
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	1.93 mg/kg	95.8	70.0	130
EG005T: Chromium	7440-47-3	2	mg/kg	<2	18.67 mg/kg	94.0	70.0	130
EG005T: Copper	7440-50-8	5	mg/kg	<5	46.13 mg/kg	98.0	70.0	130
EG005T: Lead	7439-92-1	5	mg/kg	<5	58.42 mg/kg	90.7	70.0	130
EG005T: Nickel	7440-02-0	2	mg/kg	<2	14.48 mg/kg	96.0	70.0	130
EG005T: Zinc	7440-66-6	5	mg/kg	<5	190.4 mg/kg	91.3	70.0	130
EN68: Seawater Elutriate Testing Procedure - Inorganics/Non-Volatile Organics (Glass Vessel) (QCLot: 5788765)								
EN68a-G: Seawater Sampling Date	----	----	-	14/05/2024	----	----	----	----
EN68: Seawater Elutriate Testing Procedure - Inorganics/Non-Volatile Organics (Glass Vessel) (QCLot: 5790168)								
EN68a-G: Seawater Sampling Date	----	----	-	15/05/2024	----	----	----	----
EA002: pH 1:5 (Soils) (QCLot: 5787543)								
EA002: pH Value	----	----	pH Unit	----	4 pH Unit	101	98.6	102
				----	7 pH Unit	100	98.6	102
EA002: pH 1:5 (Soils) (QCLot: 5787544)								
EA002: pH Value	----	----	pH Unit	----	4 pH Unit	101	98.6	102
				----	7 pH Unit	99.6	98.6	102
ED008: Exchangeable Cations (QCLot: 5812452)								
ED008: Exchangeable Calcium	----	0.1	meq/100g	<0.1	22.1 meq/100g	102	81.3	113
ED008: Exchangeable Magnesium	----	0.1	meq/100g	<0.1	1.56 meq/100g	91.5	78.5	106
ED008: Exchangeable Potassium	----	0.1	meq/100g	<0.1	0.91 meq/100g	105	86.8	115
ED008: Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.38 meq/100g	100	79.2	129

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Acceptable Limits (%) Low	Acceptable Limits (%) High
ED008: Exchangeable Cations (QCLot: 5812452) - continued								
ED008: Exchangeable Sodium Percent	----	0.1	%	<0.1	----	----	----	----
ED008: Cation Exchange Capacity	----	0.1	meq/100g	<0.1	24.95 meq/100g	102	81.8	113
ED008: Exchangeable Cations (QCLot: 5812453)								
ED008: Exchangeable Calcium	----	0.1	meq/100g	<0.1	22.1 meq/100g	98.2	81.3	113
ED008: Exchangeable Magnesium	----	0.1	meq/100g	<0.1	1.56 meq/100g	89.3	78.5	106
ED008: Exchangeable Potassium	----	0.1	meq/100g	<0.1	0.91 meq/100g	105	86.8	115
ED008: Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.38 meq/100g	97.4	79.2	129
ED008: Exchangeable Sodium Percent	----	0.1	%	<0.1	----	----	----	----
ED008: Cation Exchange Capacity	----	0.1	meq/100g	<0.1	24.95 meq/100g	97.9	81.8	113
EG035T: Total Recoverable Mercury by FIMS (QCLot: 5794134)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.115 mg/kg	88.8	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 5794225)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.115 mg/kg	90.0	70.0	130
EP003: Total Organic Carbon (TOC) in Soil (QCLot: 5810314)								
EP003: Total Organic Carbon	----	0.02	%	<0.02	0.55 %	97.0	80.0	120
				<0.02	32.3 %	97.7	80.0	120
EP003: Total Organic Carbon (TOC) in Soil (QCLot: 5810315)								
EP003: Total Organic Carbon	----	0.02	%	<0.02	0.55 %	92.9	80.0	120
				<0.02	32.3 %	98.8	80.0	120
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 5788162)								
EP080-SD: C6 - C9 Fraction	----	3	mg/kg	<3	35 mg/kg	104	70.0	130
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 5788163)								
EP071-SD: C10 - C14 Fraction	----	3	mg/kg	<3	277 mg/kg	128	75.9	145
EP071-SD: C15 - C28 Fraction	----	3	mg/kg	<3	490 mg/kg	124	70.9	140
EP071-SD: C29 - C36 Fraction	----	5	mg/kg	<5	80 mg/kg	108	60.2	132
EP071-SD: C10 - C36 Fraction (sum)	----	3	mg/kg	<3	----	----	----	----
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 5788165)								
EP080-SD: C6 - C9 Fraction	----	3	mg/kg	<3	35 mg/kg	117	70.0	130
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 5788166)								
EP071-SD: C10 - C14 Fraction	----	3	mg/kg	<3	277 mg/kg	124	75.9	145
EP071-SD: C15 - C28 Fraction	----	3	mg/kg	<3	490 mg/kg	114	70.9	140
EP071-SD: C29 - C36 Fraction	----	5	mg/kg	<5	80 mg/kg	93.5	60.2	132
EP071-SD: C10 - C36 Fraction (sum)	----	3	mg/kg	<3	----	----	----	----
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QCLot: 5788162)								

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QCLot: 5788162) - continued								
EP080-SD: C6 - C10 Fraction	C6_C10	3	mg/kg	<3	45 mg/kg	101	70.0	130
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QCLot: 5788163)								
EP071-SD: >C10 - C16 Fraction	----	3	mg/kg	<3	386 mg/kg	129	76.1	147
EP071-SD: >C16 - C34 Fraction	----	3	mg/kg	<3	432 mg/kg	118	63.4	132
EP071-SD: >C34 - C40 Fraction	----	5	mg/kg	<5	26 mg/kg	89.5	54.9	130
EP071-SD: >C10 - C40 Fraction (sum)	----	3	mg/kg	<3	----	----	----	----
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QCLot: 5788165)								
EP080-SD: C6 - C10 Fraction	C6_C10	3	mg/kg	<3	45 mg/kg	112	70.0	130
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QCLot: 5788166)								
EP071-SD: >C10 - C16 Fraction	----	3	mg/kg	<3	386 mg/kg	125	76.1	147
EP071-SD: >C16 - C34 Fraction	----	3	mg/kg	<3	432 mg/kg	106	63.4	132
EP071-SD: >C34 - C40 Fraction	----	5	mg/kg	<5	26 mg/kg	78.0	54.9	130
EP071-SD: >C10 - C40 Fraction (sum)	----	3	mg/kg	<3	----	----	----	----
EP080-SD: BTEXN (QCLot: 5788162)								
EP080-SD: Benzene	71-43-2	0.2	mg/kg	<0.2	2 mg/kg	114	70.0	130
EP080-SD: Toluene	108-88-3	0.2	mg/kg	<0.2	2 mg/kg	94.5	70.0	130
EP080-SD: Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	2 mg/kg	92.2	70.0	130
EP080-SD: meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	4 mg/kg	91.5	70.0	130
EP080-SD: ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	2 mg/kg	99.3	70.0	130
EP080-SD: Total Xylenes	----	0.2	mg/kg	<0.2	----	----	----	----
EP080-SD: Sum of BTEX	----	0.2	mg/kg	<0.2	----	----	----	----
EP080-SD: Naphthalene	91-20-3	0.2	mg/kg	<0.2	0.5 mg/kg	111	70.0	130
EP080-SD: BTEXN (QCLot: 5788165)								
EP080-SD: Benzene	71-43-2	0.2	mg/kg	<0.2	2 mg/kg	108	70.0	130
EP080-SD: Toluene	108-88-3	0.2	mg/kg	<0.2	2 mg/kg	104	70.0	130
EP080-SD: Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	2 mg/kg	109	70.0	130
EP080-SD: meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	4 mg/kg	112	70.0	130
EP080-SD: ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	2 mg/kg	111	70.0	130
EP080-SD: Total Xylenes	----	0.2	mg/kg	<0.2	----	----	----	----
EP080-SD: Sum of BTEX	----	0.2	mg/kg	<0.2	----	----	----	----
EP080-SD: Naphthalene	91-20-3	0.2	mg/kg	<0.2	0.5 mg/kg	113	70.0	130
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 5788161)								
EP132B-SD: Naphthalene	91-20-3	5	µg/kg	<5	25 µg/kg	90.3	55.0	131

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 5788161) - continued								
EP132B-SD: 2-Methylnaphthalene	91-57-6	5	µg/kg	<5	25 µg/kg	87.7	60.0	120
EP132B-SD: Acenaphthylene	208-96-8	4	µg/kg	<4	25 µg/kg	71.2	64.0	110
EP132B-SD: Acenaphthene	83-32-9	4	µg/kg	<4	25 µg/kg	93.2	62.0	112
EP132B-SD: Fluorene	86-73-7	4	µg/kg	<4	25 µg/kg	90.1	64.0	118
EP132B-SD: Phenanthrene	85-01-8	4	µg/kg	<4	25 µg/kg	96.8	59.0	117
EP132B-SD: Anthracene	120-12-7	4	µg/kg	<4	25 µg/kg	88.6	69.0	111
EP132B-SD: Fluoranthene	206-44-0	4	µg/kg	<4	25 µg/kg	87.4	66.0	118
EP132B-SD: Pyrene	129-00-0	4	µg/kg	<4	25 µg/kg	87.6	70.0	116
EP132B-SD: Benz(a)anthracene	56-55-3	4	µg/kg	<4	25 µg/kg	71.0	59.0	121
EP132B-SD: Chrysene	218-01-9	4	µg/kg	<4	25 µg/kg	105	68.0	116
EP132B-SD: Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	25 µg/kg	82.0	51.0	107
EP132B-SD: Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	25 µg/kg	95.7	52.0	118
EP132B-SD: Benzo(e)pyrene	192-97-2	4	µg/kg	<4	25 µg/kg	98.2	50.0	120
EP132B-SD: Benzo(a)pyrene	50-32-8	4	µg/kg	<4	25 µg/kg	83.0	55.0	111
EP132B-SD: Perylene	198-55-0	4	µg/kg	<4	25 µg/kg	88.3	50.0	120
EP132B-SD: Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	25 µg/kg	85.6	62.0	106
EP132B-SD: Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	25 µg/kg	78.2	35.0	141
EP132B-SD: Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	25 µg/kg	73.9	48.0	122
EP132B-SD: Coronene	191-07-1	5	µg/kg	<5	25 µg/kg	91.8	50.0	120
EP132B-SD: Sum of PAHs	----	4	µg/kg	<4	----	----	----	----
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 5788164)								
EP132B-SD: Naphthalene	91-20-3	5	µg/kg	<5	25 µg/kg	112	55.0	131
EP132B-SD: 2-Methylnaphthalene	91-57-6	5	µg/kg	<5	25 µg/kg	112	60.0	120
EP132B-SD: Acenaphthylene	208-96-8	4	µg/kg	<4	25 µg/kg	99.7	64.0	110
EP132B-SD: Acenaphthene	83-32-9	4	µg/kg	<4	25 µg/kg	109	62.0	112
EP132B-SD: Fluorene	86-73-7	4	µg/kg	<4	25 µg/kg	105	64.0	118
EP132B-SD: Phenanthrene	85-01-8	4	µg/kg	<4	25 µg/kg	114	59.0	117
EP132B-SD: Anthracene	120-12-7	4	µg/kg	<4	25 µg/kg	107	69.0	111
EP132B-SD: Fluoranthene	206-44-0	4	µg/kg	<4	25 µg/kg	108	66.0	118
EP132B-SD: Pyrene	129-00-0	4	µg/kg	<4	25 µg/kg	107	70.0	116
EP132B-SD: Benz(a)anthracene	56-55-3	4	µg/kg	<4	25 µg/kg	101	59.0	121
EP132B-SD: Chrysene	218-01-9	4	µg/kg	<4	25 µg/kg	113	68.0	116
EP132B-SD: Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	25 µg/kg	96.9	51.0	107

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Acceptable Limits (%) Low	Acceptable Limits (%) High
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 5788164) - continued								
EP132B-SD: Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	25 µg/kg	108	52.0	118
EP132B-SD: Benzo(e)pyrene	192-97-2	4	µg/kg	<4	25 µg/kg	104	50.0	120
EP132B-SD: Benzo(a)pyrene	50-32-8	4	µg/kg	<4	25 µg/kg	97.7	55.0	111
EP132B-SD: Perylene	198-55-0	4	µg/kg	<4	25 µg/kg	102	50.0	120
EP132B-SD: Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	25 µg/kg	96.2	62.0	106
EP132B-SD: Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	25 µg/kg	94.0	35.0	141
EP132B-SD: Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	25 µg/kg	95.6	48.0	122
EP132B-SD: Coronene	191-07-1	5	µg/kg	<5	25 µg/kg	83.5	50.0	120
EP132B-SD: Sum of PAHs	----	4	µg/kg	<4	----	----	----	----

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Acceptable Limits (%) Low	Acceptable Limits (%) High
EA005P: pH by PC Titrator (QCLot: 5790149)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	100	98.0	102
				----	7 pH Unit	100	98.0	102
EA005P: pH by PC Titrator (QCLot: 5790150)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	101	98.0	102
				----	7 pH Unit	100	98.0	102
EA005P: pH by PC Titrator (QCLot: 5792125)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	100	98.5	102
				----	7 pH Unit	100	98.5	102
EA005P: pH by PC Titrator (QCLot: 5793074)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	101	98.0	102
				----	7 pH Unit	100	98.0	102
EG020F: Dissolved Metals by ICP-MS (QCLot: 5802573)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.2	90.3	113
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	98.9	89.7	108
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	95.7	87.3	107
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	93.6	88.9	108
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	94.2	89.4	106
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	94.2	87.2	108
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	97.3	89.5	112
EG035F: Dissolved Mercury by FIMS (QCLot: 5802574)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.005 mg/L	106	85.6	120

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
				Result	Concentration	LCS	Low	High
EK055G: Ammonia as N by Discrete Analyser (QCLot: 5784020)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	96.4	86.2	111
EK055G: Ammonia as N by Discrete Analyser (QCLot: 5803772)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	91.0	83.5	114
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5784018)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	101	88.7	113
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5790015)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	99.1	90.0	110
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5795202)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	97.7	90.0	110
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 5784019)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	96.6	90.5	110
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 5803773)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	100.0	85.7	111
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 5788614)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	81.0	80.0	115
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 5802102)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	95.2	70.1	108
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 5802103)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	1 mg/L	98.2	70.1	108
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5788613)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	94.0	70.0	110
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5802101)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	98.2	84.7	106
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5802104)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	0.442 mg/L	102	84.7	106
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 5784017)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	102	89.4	109
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 5790019)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	104	81.7	117
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 5795203)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	98.4	81.7	117
EP005: Total Organic Carbon (TOC) (QCLot: 5794049)								
EP005: Total Organic Carbon	----	1	mg/L	<1	10 mg/L	101	87.2	116
				<1	100 mg/L	101	87.2	116

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Acceptable Limits (%) Low	Acceptable Limits (%) High
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 5790739)								
EP075(SIM): Naphthalene	91-20-3	1	µg/L	<1.0	10 µg/L	47.7	41.9	99.1
EP075(SIM): Acenaphthylene	208-96-8	1	µg/L	<1.0	10 µg/L	68.1	36.1	113
EP075(SIM): Acenaphthene	83-32-9	1	µg/L	<1.0	10 µg/L	49.5	35.8	102
EP075(SIM): Fluorene	86-73-7	1	µg/L	<1.0	10 µg/L	61.1	33.5	113
EP075(SIM): Phenanthrene	85-01-8	1	µg/L	<1.0	10 µg/L	63.6	36.5	115
EP075(SIM): Anthracene	120-12-7	1	µg/L	<1.0	10 µg/L	64.2	46.4	109
EP075(SIM): Fluoranthene	206-44-0	1	µg/L	<1.0	10 µg/L	73.6	40.4	124
EP075(SIM): Pyrene	129-00-0	1	µg/L	<1.0	10 µg/L	77.2	40.2	123
EP075(SIM): Benz(a)anthracene	56-55-3	1	µg/L	<1.0	10 µg/L	81.0	40.2	126
EP075(SIM): Chrysene	218-01-9	1	µg/L	<1.0	10 µg/L	72.7	45.6	121
EP075(SIM): Benzo(b+j)fluoranthene	205-99-2 205-82-3	1	µg/L	<1.0	10 µg/L	79.9	43.2	123
EP075(SIM): Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	10 µg/L	70.0	47.3	121
EP075(SIM): Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	10 µg/L	84.1	44.8	123
EP075(SIM): Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	10 µg/L	74.4	38.8	120
EP075(SIM): Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	10 µg/L	75.4	39.4	119
EP075(SIM): Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	10 µg/L	79.5	40.1	123
EP075(SIM): Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons (QCLot: 5784618)								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	360 µg/L	90.1	73.6	113
EP080/071: Total Petroleum Hydrocarbons (QCLot: 5790738)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	400 µg/L	62.6	39.3	103
EP071: C15 - C28 Fraction	----	100	µg/L	<100	600 µg/L	69.3	47.2	122
EP071: C29 - C36 Fraction	----	50	µg/L	<50	400 µg/L	72.3	42.5	119
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 5784618)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	450 µg/L	86.6	73.9	115
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 5790738)								
EP071: >C10 - C16 Fraction	----	100	µg/L	<100	500 µg/L	65.8	47.0	100
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	700 µg/L	71.1	46.2	116
EP071: >C34 - C40 Fraction	----	100	µg/L	<100	300 µg/L	73.2	24.7	137
EP080: BTEXN (QCLot: 5784618)								
EP080: Benzene	71-43-2	1	µg/L	<1	20 µg/L	104	84.1	114
EP080: Toluene	108-88-3	2	µg/L	<2	20 µg/L	98.0	81.0	115
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	20 µg/L	102	84.4	113

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Acceptable Limits (%) Low	High
EP080: BTEXN (QCLot: 5784618) - continued								
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	40 µg/L	100	84.3	114
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	20 µg/L	100	86.5	111
EP080: Naphthalene	91-20-3	5	µg/L	<5	5 µg/L	93.4	77.0	118

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Acceptable Limits (%) Low	High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 5794133)							
EP2406342-001	JBBH_S1	EG005T: Arsenic	7440-38-2	50 mg/kg	114	70.0	130
		EG005T: Cadmium	7440-43-9	12.5 mg/kg	88.4	70.0	130
		EG005T: Chromium	7440-47-3	50 mg/kg	93.0	70.0	130
		EG005T: Copper	7440-50-8	50 mg/kg	112	70.0	130
		EG005T: Lead	7439-92-1	50 mg/kg	93.7	70.0	130
		EG005T: Nickel	7440-02-0	50 mg/kg	89.4	70.0	130
		EG005T: Zinc	7440-66-6	50 mg/kg	85.8	70.0	130
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 5794222)							
EP2406526-001	Anonymous	EG005T: Arsenic	7440-38-2	50 mg/kg	95.5	70.0	130
		EG005T: Cadmium	7440-43-9	12.5 mg/kg	88.8	70.0	130
		EG005T: Chromium	7440-47-3	50 mg/kg	97.6	70.0	130
		EG005T: Copper	7440-50-8	50 mg/kg	105	70.0	130
		EG005T: Lead	7439-92-1	50 mg/kg	105	70.0	130
		EG005T: Nickel	7440-02-0	50 mg/kg	92.0	70.0	130
		EG005T: Zinc	7440-66-6	50 mg/kg	90.3	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 5794134)							
EP2406342-001	JBBH_S1	EG035T: Mercury	7439-97-6	1 mg/kg	110	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 5794225)							
EP2406526-001	Anonymous	EG035T: Mercury	7439-97-6	1 mg/kg	101	70.0	130
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 5788162)							
EP2406340-002	Anonymous	EP080-SD: C6 - C9 Fraction	----	24 mg/kg	98.2	70.0	130
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 5788163)							
EP2406340-002	Anonymous	EP071-SD: C10 - C14 Fraction	----	277 mg/kg	88.3	70.0	130
		EP071-SD: C15 - C28 Fraction	----	490 mg/kg	83.3	70.0	130

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Spike Concentration	SpikeRecovery(%) MS	Acceptable Limits (%) Low	Acceptable Limits (%) High
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 5788163) - continued							
EP2406340-002	Anonymous	EP071-SD: C29 - C36 Fraction	----	80 mg/kg	79.0	70.0	130
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 5788165)							
EP2406342-002	JBBH_S2a	EP080-SD: C6 - C9 Fraction	----	24 mg/kg	84.0	70.0	130
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 5788166)							
EP2406342-002	JBBH_S2a	EP071-SD: C10 - C14 Fraction	----	277 mg/kg	80.9	70.0	130
		EP071-SD: C15 - C28 Fraction	----	490 mg/kg	74.7	70.0	130
		EP071-SD: C29 - C36 Fraction	----	80 mg/kg	72.4	70.0	130
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QCLot: 5788162)							
EP2406340-002	Anonymous	EP080-SD: C6 - C10 Fraction	C6_C10	29 mg/kg	96.6	70.0	130
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QCLot: 5788163)							
EP2406340-002	Anonymous	EP071-SD: >C10 - C16 Fraction	----	386 mg/kg	86.9	70.0	130
		EP071-SD: >C16 - C34 Fraction	----	432 mg/kg	81.0	70.0	130
		EP071-SD: >C34 - C40 Fraction	----	26 mg/kg	81.9	70.0	130
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QCLot: 5788165)							
EP2406342-002	JBBH_S2a	EP080-SD: C6 - C10 Fraction	C6_C10	29 mg/kg	83.0	70.0	130
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QCLot: 5788166)							
EP2406342-002	JBBH_S2a	EP071-SD: >C10 - C16 Fraction	----	386 mg/kg	80.3	70.0	130
		EP071-SD: >C16 - C34 Fraction	----	432 mg/kg	72.0	70.0	130
		EP071-SD: >C34 - C40 Fraction	----	26 mg/kg	75.3	70.0	130
EP080-SD: BTEXN (QCLot: 5788162)							
EP2406340-002	Anonymous	EP080-SD: Benzene	71-43-2	2 mg/kg	97.9	70.0	130
		EP080-SD: Toluene	108-88-3	2 mg/kg	85.6	70.0	130
EP080-SD: BTEXN (QCLot: 5788165)							
EP2406342-002	JBBH_S2a	EP080-SD: Benzene	71-43-2	2 mg/kg	76.6	70.0	130
		EP080-SD: Toluene	108-88-3	2 mg/kg	73.0	70.0	130
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 5788161)							
EP2406340-002	Anonymous	EP132B-SD: Naphthalene	91-20-3	25 µg/kg	79.5	70.0	130
		EP132B-SD: 2-Methylnaphthalene	91-57-6	25 µg/kg	79.9	70.0	130
		EP132B-SD: Acenaphthylene	208-96-8	25 µg/kg	71.4	70.0	130
		EP132B-SD: Acenaphthene	83-32-9	25 µg/kg	83.1	70.0	130
		EP132B-SD: Fluorene	86-73-7	25 µg/kg	81.7	70.0	130
		EP132B-SD: Phenanthrene	85-01-8	25 µg/kg	86.1	70.0	130
		EP132B-SD: Anthracene	120-12-7	25 µg/kg	80.7	70.0	130
		EP132B-SD: Fluoranthene	206-44-0	25 µg/kg	81.1	70.0	130
		EP132B-SD: Pyrene	129-00-0	25 µg/kg	79.8	70.0	130
		EP132B-SD: Benz(a)anthracene	56-55-3	25 µg/kg	77.9	70.0	130

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Acceptable Limits (%) Low	High
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 5788161) - continued							
EP2406340-002	Anonymous	EP132B-SD: Chrysene	218-01-9	25 µg/kg	81.1	70.0	130
		EP132B-SD: Benzo(b+j)fluoranthene	205-99-2 205-82-3	25 µg/kg	76.9	70.0	130
		EP132B-SD: Benzo(k)fluoranthene	207-08-9	25 µg/kg	75.7	70.0	130
		EP132B-SD: Benzo(e)pyrene	192-97-2	25 µg/kg	76.8	70.0	130
		EP132B-SD: Benzo(a)pyrene	50-32-8	25 µg/kg	70.0	70.0	130
		EP132B-SD: Perylene	198-55-0	25 µg/kg	75.4	70.0	130
		EP132B-SD: Benzo(g.h.i)perylene	191-24-2	25 µg/kg	75.2	70.0	130
		EP132B-SD: Dibenz(a.h)anthracene	53-70-3	25 µg/kg	71.6	70.0	130
		EP132B-SD: Indeno(1.2.3.cd)pyrene	193-39-5	25 µg/kg	72.9	70.0	130
		EP132B-SD: Coronene	191-07-1	25 µg/kg	71.2	70.0	130
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 5788164)							
EP2406342-002	JBBH_S2a	EP132B-SD: Naphthalene	91-20-3	25 µg/kg	78.2	70.0	130
		EP132B-SD: 2-Methylnaphthalene	91-57-6	25 µg/kg	88.3	70.0	130
		EP132B-SD: Acenaphthylene	208-96-8	25 µg/kg	98.4	70.0	130
		EP132B-SD: Acenaphthene	83-32-9	25 µg/kg	109	70.0	130
		EP132B-SD: Fluorene	86-73-7	25 µg/kg	115	70.0	130
		EP132B-SD: Phenanthrene	85-01-8	25 µg/kg	116	70.0	130
		EP132B-SD: Anthracene	120-12-7	25 µg/kg	114	70.0	130
		EP132B-SD: Fluoranthene	206-44-0	25 µg/kg	117	70.0	130
		EP132B-SD: Pyrene	129-00-0	25 µg/kg	116	70.0	130
		EP132B-SD: Benz(a)anthracene	56-55-3	25 µg/kg	115	70.0	130
		EP132B-SD: Chrysene	218-01-9	25 µg/kg	111	70.0	130
		EP132B-SD: Benzo(b+j)fluoranthene	205-99-2 205-82-3	25 µg/kg	96.8	70.0	130
		EP132B-SD: Benzo(k)fluoranthene	207-08-9	25 µg/kg	104	70.0	130
		EP132B-SD: Benzo(e)pyrene	192-97-2	25 µg/kg	101	70.0	130
		EP132B-SD: Benzo(a)pyrene	50-32-8	25 µg/kg	96.8	70.0	130
		EP132B-SD: Perylene	198-55-0	25 µg/kg	102	70.0	130
		EP132B-SD: Benzo(g.h.i)perylene	191-24-2	25 µg/kg	100	70.0	130
		EP132B-SD: Dibenz(a.h)anthracene	53-70-3	25 µg/kg	96.1	70.0	130
		EP132B-SD: Indeno(1.2.3.cd)pyrene	193-39-5	25 µg/kg	98.1	70.0	130
		EP132B-SD: Coronene	191-07-1	25 µg/kg	86.1	70.0	130

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Acceptable Limits (%) Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 5802573)							
EP2406511-001	Anonymous	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	101	70.0	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 5802573) - continued							
EP2406511-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.05 mg/L	104	70.0	130
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	101	70.0	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	101	70.0	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	95.5	70.0	130
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	100	70.0	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	102	70.0	130
EG035F: Dissolved Mercury by FIMS (QCLot: 5802574)							
EP2406511-003	Anonymous	EG035F: Mercury	7439-97-6	0.005 mg/L	111	70.0	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 5784020)							
EP2406342-026	Rinsate	EK055G: Ammonia as N	7664-41-7	1 mg/L	112	70.0	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 5803772)							
EP2406342-002	JBBH_S2a	EK055G: Ammonia as N	7664-41-7	0.5 mg/L	90.4	70.0	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5784018)							
EP2406342-026	Rinsate	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	108	70.0	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5790015)							
EB2415941-001	Anonymous	EK057G: Nitrite as N	14797-65-0	2.5 mg/L	101	70.0	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5795202)							
EB2416362-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	97.6	70.0	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 5784019)							
EP2406342-026	Rinsate	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	102	70.0	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 5803773)							
EP2406342-002	JBBH_S2a	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	92.3	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 5788614)							
EP2406216-023	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	83.7	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 5802102)							
EB2416082-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	25 mg/L	96.0	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 5802103)							
EP2406342-007	JBBH_S4_1	EK061G: Total Kjeldahl Nitrogen as N	----	25 mg/L	82.8	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5788613)							
EP2406216-023	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	99.2	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5802101)							
EB2416082-002	Anonymous	EK067G: Total Phosphorus as P	----	5 mg/L	98.0	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5802104)							
EP2406342-007	JBBH_S4_1	EK067G: Total Phosphorus as P	----	5 mg/L	85.7	70.0	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 5784017)							
EP2406342-026	Rinsate	EK071G: Reactive Phosphorus as P	14265-44-2	0.5 mg/L	110	70.0	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 5790019)							
EP2406342-002	JBBH_S2a	EK071G: Reactive Phosphorus as P	14265-44-2	0.5 mg/L	102	70.0	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 5795203)							
EB2416362-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.5 mg/L	104	70.0	130
EP005: Total Organic Carbon (TOC) (QCLot: 5794049)							
EP2406216-026	Anonymous	EP005: Total Organic Carbon	----	100 mg/L	104	70.0	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 5784618)							
EP2406331-002	Anonymous	EP080: C6 - C9 Fraction	----	240 µg/L	# Not Determined	77.0	137
EP080/071: Total Petroleum Hydrocarbons (QCLot: 5790738)							
EP2406322-001	Anonymous	EP071: C10 - C14 Fraction	----	400 µg/L	70.1	44.5	122
		EP071: C15 - C28 Fraction	----	600 µg/L	86.1	55.1	143
		EP071: C29 - C36 Fraction	----	400 µg/L	92.5	53.6	128
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 5784618)							
EP2406331-002	Anonymous	EP080: C6 - C10 Fraction	C6_C10	290 µg/L	# Not Determined	77.0	137
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 5790738)							
EP2406322-001	Anonymous	EP071: >C10 - C16 Fraction	----	500 µg/L	74.6	44.5	122
		EP071: >C16 - C34 Fraction	----	700 µg/L	89.4	55.1	143
		EP071: >C34 - C40 Fraction	----	300 µg/L	104	53.6	128
EP080: BTEXN (QCLot: 5784618)							
EP2406331-002	Anonymous	EP080: Benzene	71-43-2	20 µg/L	# Not Determined	77.0	122
		EP080: Toluene	108-88-3	20 µg/L	# Not Determined	73.5	126

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP2406342**	Page	: 1 of 20
Client	: **BMT COMMERCIAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: Sophie Crochane	Telephone	: +61-8-9406 1301
Project	: Jurien Bay sediment sampling	Date Samples Received	: 08-May-2024
Site	: Jurien Bay WA	Issue Date	: 31-May-2024
Sampler	: ----	No. of samples received	: 28
Order number	: 000607.001_022	No. of samples analysed	: 27

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **Surrogate recovery outliers exist for all regular sample matrices - please see following pages for full details.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EP080/071: Total Petroleum Hydrocarbons	EP2406331--002	Anonymous	**C6 - C9 Fraction**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2	EP2406331--002	Anonymous	**C6 - C10 Fraction**	C6_C10	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EP080: BTEXN	EP2406331--002	Anonymous	**Benzene**	71-43-2	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EP080: BTEXN	EP2406331--002	Anonymous	**Toluene**	108-88-3	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Regular Sample Surrogates

Sub-Matrix: **MARINE SEDIMENT**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Samples Submitted							
EP132T: Base/Neutral Extractable Surrogates	EP2406342-006	JBBH_S5	**Anthracene-d10**	1719-06-8	137 %	70.0-130 %	**Recovery greater than upper data quality objective**
EP132T: Base/Neutral Extractable Surrogates	EP2406342-015	JBBH_S11	**4-Terphenyl-d14**	1718-51-0	134 %	70.0-130 %	**Recovery greater than upper data quality objective**
EP132T: Base/Neutral Extractable Surrogates	EP2406342-016	JBBH_S12	**4-Terphenyl-d14**	1718-51-0	132 %	70.0-130 %	**Recovery greater than upper data quality objective**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural Rinsate	----	----	----	16-May-2024	08-May-2024	**8**
Clear Plastic Bottle - Natural JBBH_S1, JBBH_S2a, JBBH_S2b, JBBH_S3, JBBH_S5, JBBH_S4_1, JBBH_S4_2, JBBH_S4_3, JBBH_S7	----	----	----	15-May-2024	14-May-2024	**1**

Matrix: **WATER**

Method	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
EA005P: pH by PC Titrator - Analysis Holding Time Compliance						
Clear Plastic Bottle - Natural						
JBBH_S9, JBBH_S15_1, JBBH_S15_2, JBBH_S15_3, JBBH_S11, JBBH_S12, JBBH_S13, JBBH_S14, Elutriate Water	----	----	----	16-May-2024	15-May-2024	**1**
EK057G: Nitrite as N by Discrete Analyser						
Clear Plastic Bottle - Natural						
Rinsate	----	----	----	11-May-2024	10-May-2024	**1**
EK071G: Reactive Phosphorus as P by discrete analyser						
Clear Plastic Bottle - Natural						
Rinsate	----	----	----	11-May-2024	10-May-2024	**1**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type		Count		Rate (%)		Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)						
TRH - Semivolatile Fraction	EP071	1	13	7.69	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)						
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	0	12	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA002: pH 1:5 (Soils)								
Soil Glass Jar - Unpreserved (EA002)								
JBBH_S1,	JBBH_S2a,	**08-May-2024**	**15-May-2024**	15-May-2024	✓	**15-May-2024**	15-May-2024	✓
JBBH_S2b,	JBBH_S3,							
JBBH_S5,	JBBH_S4_1,							
JBBH_S4_2,	JBBH_S4_3,							
JBBH_S7,	JBBH_S9,							
JBBH_S15_1,	JBBH_S15_2,							
JBBH_S15_3,	JBBH_S11,							
JBBH_S12,	JBBH_S13,							
JBBH_S14,	JBDA_S1,							
JBDA_S2,	JBDA_S3,							
JBDA_S4,	JBDA_S5,							
JBDA_S6,	JBDA_S7							
EA055: Moisture Content (Dried @ 105-110°C)								
Soil Glass Jar - Unpreserved (EA055)								
JBBH_S1,	JBBH_S2a,	**08-May-2024**	----	----	----	**16-May-2024**	22-May-2024	✓
JBBH_S2b,	JBBH_S3,							
JBBH_S5,	JBBH_S4_1,							
JBBH_S4_2,	JBBH_S4_3,							
JBBH_S7,	JBBH_S9,							
JBBH_S15_1,	JBBH_S15_2,							
JBBH_S15_3,	JBBH_S11,							
JBBH_S12,	JBBH_S13,							
JBBH_S14,	JBDA_S1,							
JBDA_S2,	JBDA_S3,							
JBDA_S4,	JBDA_S5,							
JBDA_S6,	JBDA_S7							
ED008: Exchangeable Cations								
Soil Glass Jar - Unpreserved (ED008)								
JBBH_S1,	JBBH_S2a,	**08-May-2024**	**24-May-2024**	05-Jun-2024	✓	**27-May-2024**	05-Jun-2024	✓
JBBH_S2b,	JBBH_S3,							
JBBH_S5,	JBBH_S4_1,							
JBBH_S4_2,	JBBH_S4_3,							
JBBH_S7,	JBBH_S9,							
JBBH_S15_1,	JBBH_S15_2,							
JBBH_S15_3,	JBBH_S11,							
JBBH_S12,	JBBH_S13,							
JBBH_S14,	JBDA_S1,							
JBDA_S2,	JBDA_S3,							
JBDA_S4,	JBDA_S5,							
JBDA_S6,	JBDA_S7							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG005(ED093)T: Total Metals by ICP-AES								
Soil Glass Jar - Unpreserved (EG005T)								
JBDA_S4,	JBDA_S5,	**08-May-2024**	**16-May-2024**	04-Nov-2024	✓	**22-May-2024**	04-Nov-2024	✓
JBDA_S6,	JBDA_S7							
Soil Glass Jar - Unpreserved (EG005T)								
JBBH_S1,	JBBH_S2a,	**08-May-2024**	**16-May-2024**	04-Nov-2024	✓	**28-May-2024**	04-Nov-2024	✓
JBBH_S2b,	JBBH_S3,							
JBBH_S5,	JBBH_S4_1,							
JBBH_S4_2,	JBBH_S4_3,							
JBBH_S7,	JBBH_S9,							
JBBH_S15_1,	JBBH_S15_2,							
JBBH_S15_3,	JBBH_S11,							
JBBH_S12,	JBBH_S13,							
JBBH_S14,	JBDA_S1,							
JBDA_S2,	JBDA_S3							
EG035T: Total Recoverable Mercury by FIMS								
Soil Glass Jar - Unpreserved (EG035T)								
JBBH_S1,	JBBH_S2a,	**08-May-2024**	**16-May-2024**	05-Jun-2024	✓	**17-May-2024**	05-Jun-2024	✓
JBBH_S2b,	JBBH_S3,							
JBBH_S5,	JBBH_S4_1,							
JBBH_S4_2,	JBBH_S4_3,							
JBBH_S7,	JBBH_S9,							
JBBH_S15_1,	JBBH_S15_2,							
JBBH_S15_3,	JBBH_S11,							
JBBH_S12,	JBBH_S13,							
JBBH_S14,	JBDA_S1,							
JBDA_S2,	JBDA_S3,							
JBDA_S4,	JBDA_S5,							
JBDA_S6,	JBDA_S7							
EN68: Seawater Elutriate Testing Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)								
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI) (EN68a-G)								
JBBH_S1,	JBBH_S2a,	**08-May-2024**	**14-May-2024**	05-Jun-2024	✓	----	----	----
JBBH_S2b,	JBBH_S3,							
JBBH_S5,	JBBH_S4_1,							
JBBH_S4_2,	JBBH_S4_3,							
JBBH_S7								
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI) (EN68a-G)								
JBBH_S9,	JBBH_S15_1,	**08-May-2024**	**15-May-2024**	05-Jun-2024	✓	----	----	----
JBBH_S15_2,	JBBH_S15_3,							
JBBH_S11,	JBBH_S12,							
JBBH_S13,	JBBH_S14,							
Elutriate Water								

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP003: Total Organic Carbon (TOC) in Soil								
Pulp Bag (EP003)								
JBBH_S1,	JBBH_S2a,	**08-May-2024**	**23-May-2024**	05-Jun-2024	✓	**23-May-2024**	05-Jun-2024	✓
JBBH_S2b,	JBBH_S3,							
JBBH_S5,	JBBH_S4_1,							
JBBH_S4_2,	JBBH_S4_3,							
JBBH_S7,	JBBH_S9,							
JBBH_S15_1,	JBBH_S15_2,							
JBBH_S15_3,	JBBH_S11,							
JBBH_S12,	JBBH_S13,							
JBBH_S14,	JBDA_S1,							
JBDA_S2,	JBDA_S3,							
JBDA_S4,	JBDA_S5,							
JBDA_S6,	JBDA_S7							
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
Soil Glass Jar - Unpreserved (EP071-SD)								
JBBH_S1,	JBBH_S2a,	**08-May-2024**	**14-May-2024**	22-May-2024	✓	**16-May-2024**	23-Jun-2024	✓
JBBH_S2b,	JBBH_S3,							
JBBH_S5,	JBBH_S4_1,							
JBBH_S4_2,	JBBH_S4_3,							
JBBH_S7,	JBBH_S9,							
JBBH_S15_1,	JBBH_S15_2,							
JBBH_S15_3,	JBBH_S11,							
JBDA_S3								
Soil Glass Jar - Unpreserved (EP071-SD)								
JBBH_S12,	JBBH_S13,	**08-May-2024**	**14-May-2024**	22-May-2024	✓	**17-May-2024**	23-Jun-2024	✓
JBBH_S14,	JBDA_S1,							
JBDA_S2,	JBDA_S4,							
JBDA_S5,	JBDA_S6,							
JBDA_S7								

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons							
Soil Glass Jar - Unpreserved (EP080-SD) JBBH_S1, JBBH_S2a, JBBH_S2b, JBBH_S3, JBBH_S5, JBBH_S4_1, JBBH_S4_2, JBBH_S4_3, JBBH_S7, JBBH_S9, JBBH_S15_1, JBBH_S15_2, JBBH_S15_3, JBBH_S11, JBBH_S12, JBBH_S13, JBBH_S14, JBDA_S1, JBDA_S2	08-May-2024	14-May-2024	22-May-2024	✓	14-May-2024	22-May-2024	✓
Soil Glass Jar - Unpreserved (EP080-SD) JBDA_S3, JBDA_S4, JBDA_S5, JBDA_S6, JBDA_S7	08-May-2024	14-May-2024	22-May-2024	✓	15-May-2024	22-May-2024	✓
Soil Glass Jar - Unpreserved (EP071-SD) JBBH_S1, JBBH_S2a, JBBH_S2b, JBBH_S3, JBBH_S5, JBBH_S4_1, JBBH_S4_2, JBBH_S4_3, JBBH_S7, JBBH_S9, JBBH_S15_1, JBBH_S15_2, JBBH_S15_3, JBBH_S11, JBDA_S3	08-May-2024	14-May-2024	22-May-2024	✓	16-May-2024	23-Jun-2024	✓
Soil Glass Jar - Unpreserved (EP071-SD) JBBH_S12, JBBH_S13, JBBH_S14, JBDA_S1, JBDA_S2, JBDA_S4, JBDA_S5, JBDA_S6, JBDA_S7	08-May-2024	14-May-2024	22-May-2024	✓	17-May-2024	23-Jun-2024	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons							
Soil Glass Jar - Unpreserved (EP080-SD) JBBH_S1, JBBH_S2a, JBBH_S2b, JBBH_S3, JBBH_S5, JBBH_S4_1, JBBH_S4_2, JBBH_S4_3, JBBH_S7, JBBH_S9, JBBH_S15_1, JBBH_S15_2, JBBH_S15_3, JBBH_S11, JBBH_S12, JBBH_S13, JBBH_S14, JBDA_S1, JBDA_S2	08-May-2024	14-May-2024	22-May-2024	✓	14-May-2024	22-May-2024	✓
Soil Glass Jar - Unpreserved (EP080-SD) JBDA_S3, JBDA_S4, JBDA_S5, JBDA_S6, JBDA_S7	08-May-2024	14-May-2024	22-May-2024	✓	15-May-2024	22-May-2024	✓
EP080-SD: BTEXN							
Soil Glass Jar - Unpreserved (EP080-SD) JBBH_S1, JBBH_S2a, JBBH_S2b, JBBH_S3, JBBH_S5, JBBH_S4_1, JBBH_S4_2, JBBH_S4_3, JBBH_S7, JBBH_S9, JBBH_S15_1, JBBH_S15_2, JBBH_S15_3, JBBH_S11, JBBH_S12, JBBH_S13, JBBH_S14, JBDA_S1, JBDA_S2	08-May-2024	14-May-2024	22-May-2024	✓	14-May-2024	22-May-2024	✓
Soil Glass Jar - Unpreserved (EP080-SD) JBDA_S3, JBDA_S4, JBDA_S5, JBDA_S6, JBDA_S7	08-May-2024	14-May-2024	22-May-2024	✓	15-May-2024	22-May-2024	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EP132B: Polynuclear Aromatic Hydrocarbons							
Soil Glass Jar - Unpreserved (EP132B-SD) JBBH_S1, JBBH_S2a, JBBH_S2b, JBBH_S3, JBBH_S5, JBBH_S4_1, JBBH_S4_2, JBBH_S4_3, JBBH_S7, JBBH_S9, JBBH_S15_1, JBBH_S15_2, JBBH_S15_3, JBBH_S11, JBBH_S12, JBBH_S13, JBBH_S14, JBDA_S1, JBDA_S2	**08-May-2024**	**14-May-2024**	22-May-2024	✓	**17-May-2024**	23-Jun-2024	✓
Soil Glass Jar - Unpreserved (EP132B-SD) JBDA_S3, JBDA_S4, JBDA_S5	**08-May-2024**	**16-May-2024**	22-May-2024	✓	**17-May-2024**	25-Jun-2024	✓
Soil Glass Jar - Unpreserved (EP132B-SD) JBDA_S6, JBDA_S7	**08-May-2024**	**16-May-2024**	22-May-2024	✓	**18-May-2024**	25-Jun-2024	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P) Rinsate	**08-May-2024**	----	----	----	**16-May-2024**	08-May-2024	×
Clear Plastic Bottle - Natural (EA005-P) JBBH_S1, JBBH_S2a, JBBH_S2b, JBBH_S3, JBBH_S5, JBBH_S4_1, JBBH_S4_2, JBBH_S4_3, JBBH_S7	**14-May-2024**	----	----	----	**15-May-2024**	14-May-2024	×
Clear Plastic Bottle - Natural (EA005-P) JBBH_S9, JBBH_S15_1, JBBH_S15_2, JBBH_S15_3, JBBH_S11, JBBH_S12, JBBH_S13, JBBH_S14, Elutriate Water	**15-May-2024**	----	----	----	**16-May-2024**	15-May-2024	×
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Filtered; Lab-acidified (EG020A-F) Rinsate	**08-May-2024**	----	----	----	**21-May-2024**	04-Nov-2024	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Filtered; Lab-acidified (EG035F) Rinsate	**08-May-2024**	----	----	----	**21-May-2024**	05-Jun-2024	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) Rinsate	**08-May-2024**	----	----	----	**29-May-2024**	05-Jun-2024	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) JBBH_S1, JBBH_S2a, JBBH_S2b, JBBH_S3, JBBH_S5, JBBH_S4_1, JBBH_S4_2, JBBH_S4_3, JBBH_S7	**14-May-2024**	----	----	----	**21-May-2024**	11-Jun-2024	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) JBBH_S9, JBBH_S15_1, JBBH_S15_2, JBBH_S15_3, JBBH_S11, JBBH_S12, JBBH_S13, JBBH_S14, Elutriate Water	**15-May-2024**	----	----	----	**21-May-2024**	12-Jun-2024	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) Rinsate	**08-May-2024**	----	----	----	**11-May-2024**	10-May-2024	×
Clear Plastic Bottle - Natural (EK057G) JBBH_S1, JBBH_S2a, JBBH_S2b, JBBH_S3, JBBH_S5, JBBH_S4_1, JBBH_S4_2, JBBH_S4_3, JBBH_S7	**14-May-2024**	----	----	----	**15-May-2024**	16-May-2024	✓
Clear Plastic Bottle - Natural (EK057G) JBBH_S9, JBBH_S15_1, JBBH_S15_2, JBBH_S15_3, JBBH_S11, JBBH_S12, JBBH_S13, JBBH_S14, Elutriate Water	**15-May-2024**	----	----	----	**17-May-2024**	17-May-2024	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) Rinsate	**08-May-2024**	----	----	----	**11-May-2024**	05-Jun-2024	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) JBBH_S1, JBBH_S2a, JBBH_S2b, JBBH_S3, JBBH_S5, JBBH_S4_1, JBBH_S4_2, JBBH_S4_3, JBBH_S7	**14-May-2024**	----	----	----	**21-May-2024**	11-Jun-2024	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) JBBH_S9, JBBH_S15_1, JBBH_S15_2, JBBH_S15_3, JBBH_S11, JBBH_S12, JBBH_S13, JBBH_S14, Elutriate Water	**15-May-2024**	----	----	----	**21-May-2024**	12-Jun-2024	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) Rinsate	**08-May-2024**	**23-May-2024**	05-Jun-2024	✓	**23-May-2024**	05-Jun-2024	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) JBBH_S1, JBBH_S2a, JBBH_S2b, JBBH_S3, JBBH_S5, JBBH_S4_1, JBBH_S4_2, JBBH_S4_3, JBBH_S7	**14-May-2024**	**20-May-2024**	11-Jun-2024	✓	**20-May-2024**	11-Jun-2024	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) JBBH_S9, JBBH_S15_1, JBBH_S15_2, JBBH_S15_3, JBBH_S11, JBBH_S12, JBBH_S13, JBBH_S14, Elutriate Water	**15-May-2024**	**20-May-2024**	12-Jun-2024	✓	**20-May-2024**	12-Jun-2024	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK067G: Total Phosphorus as P by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK067G) Rinsate		**08-May-2024**	**23-May-2024**	05-Jun-2024	✓	**23-May-2024**	05-Jun-2024	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) JBBH_S1, JBBH_S2b, JBBH_S5, JBBH_S4_2, JBBH_S7	JBBH_S2a, JBBH_S3, JBBH_S4_1, JBBH_S4_3,	**14-May-2024**	**20-May-2024**	11-Jun-2024	✓	**20-May-2024**	11-Jun-2024	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) JBBH_S9, JBBH_S15_2, JBBH_S11, JBBH_S13, Elutriate Water	JBBH_S15_1, JBBH_S15_3, JBBH_S12, JBBH_S14,	**15-May-2024**	**20-May-2024**	12-Jun-2024	✓	**20-May-2024**	12-Jun-2024	✓
EK071G: Reactive Phosphorus as P by discrete analyser								
Clear Plastic Bottle - Natural (EK071G) Rinsate		**08-May-2024**	----	----	----	**11-May-2024**	10-May-2024	×
Clear Plastic Bottle - Natural (EK071G) JBBH_S1, JBBH_S2b, JBBH_S5, JBBH_S4_2, JBBH_S7	JBBH_S2a, JBBH_S3, JBBH_S4_1, JBBH_S4_3,	**14-May-2024**	----	----	----	**15-May-2024**	16-May-2024	✓
Clear Plastic Bottle - Natural (EK071G) JBBH_S9, JBBH_S15_2, JBBH_S11, JBBH_S13, Elutriate Water	JBBH_S15_1, JBBH_S15_3, JBBH_S12, JBBH_S14,	**15-May-2024**	----	----	----	**17-May-2024**	17-May-2024	✓
EP005: Total Organic Carbon (TOC)								
Amber TOC Vial - Sulfuric Acid (EP005) Rinsate		**08-May-2024**	----	----	----	**16-May-2024**	05-Jun-2024	✓
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Amber Glass Bottle - Unpreserved (EP075(SIM)) Rinsate		**08-May-2024**	**15-May-2024**	15-May-2024	✓	**16-May-2024**	24-Jun-2024	✓
EP080/071: Total Petroleum Hydrocarbons								
Amber Glass Bottle - Unpreserved (EP071) Rinsate		**08-May-2024**	**15-May-2024**	15-May-2024	✓	**17-May-2024**	24-Jun-2024	✓
Amber VOC Vial - Sulfuric Acid (EP080) Rinsate,	Trip Blank	**08-May-2024**	**14-May-2024**	22-May-2024	✓	**15-May-2024**	22-May-2024	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		*Date extracted*	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved (EP071)							
Rinsate	**08-May-2024**	**15-May-2024**	15-May-2024	✓	**17-May-2024**	24-Jun-2024	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
Rinsate, Trip Blank	**08-May-2024**	**14-May-2024**	22-May-2024	✓	**15-May-2024**	22-May-2024	✓
EP080: BTEXN							
Amber VOC Vial - Sulfuric Acid (EP080)							
Rinsate, Trip Blank	**08-May-2024**	**14-May-2024**	22-May-2024	✓	**15-May-2024**	22-May-2024	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Exchangeable Cations with pre-treatment	ED008	3	26	**11.54**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Moisture Content	EA055	3	28	**10.71**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAHs in Sediments by GCMS(SIM)	EP132B-SD	4	30	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH (1:5)	EA002	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	3	26	**11.54**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	3	28	**10.71**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TPH - Semivolatile Fraction	EP071-SD	4	30	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX in Sediments	EP080-SD	4	30	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Exchangeable Cations with pre-treatment	ED008	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAHs in Sediments by GCMS(SIM)	EP132B-SD	2	30	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH (1:5)	EA002	4	24	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	28	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	4	24	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TPH - Semivolatile Fraction	EP071-SD	2	30	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX in Sediments	EP080-SD	2	30	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Exchangeable Cations with pre-treatment	ED008	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAHs in Sediments by GCMS(SIM)	EP132B-SD	2	30	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Seawater Elutriate Testing Procedure - Glass Leaching Vessel	EN68a-G	2	18	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	28	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TPH - Semivolatile Fraction	EP071-SD	2	30	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX in Sediments	EP080-SD	2	30	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
PAHs in Sediments by GCMS(SIM)	EP132B-SD	2	30	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	28	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TPH - Semivolatile Fraction	EP071-SD	2	30	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX in Sediments	EP080-SD	2	30	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	1	1	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	1	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	1	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by Auto Titrator	EA005-P	5	47	**10.64**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	1	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	9	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	9	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	13	**7.69**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by Auto Titrator	EA005-P	6	47	**12.77**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	0	12	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
pH (1:5)	EA002	SOIL	In house: Referenced to Rayment and Lyons 4A1 and APHA 4500H+. pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM Schedule B(3).
pH by Auto Titrator	EA005-P	SOIL	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM Schedule B(3)
Moisture Content	EA055	SOIL	In house: A gravimetric procedure based on weight loss over a 12 hour drying period at 105-110 degrees C. This method is compliant with NEPM Schedule B(3).
Exchangeable Cations with pre-treatment	ED008	SOIL	In house: Referenced to Rayment & Lyons Method 15A2. Soluble salts are removed from the sample prior to analysis. Cations are exchanged from the sample by contact with Ammonium Chloride. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil. This method is compliant with NEPM Schedule B(3).
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM Schedule B(3)
Total Mercury by FIMS	EG035T	SOIL	In house: Referenced to APHA 3112 Hg - B (Flow-injection (SnCl2) (Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	SOIL	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	SOIL	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	SOIL	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	SOIL	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	SOIL	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	SOIL	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM Schedule B(3)

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Total Phosphorus as P By Discrete Analyser	EK067G	SOIL	In house: Referenced to APHA 4500-P H, Jirka et al, Zhang et al. This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	SOIL	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Organic Carbon	EP003	SOIL	In house C-IR17. Dried and pulverised sample is reacted with acid to remove inorganic Carbonates, then combusted in a furnace in the presence of strong oxidants / catalysts. The evolved (Organic) Carbon (as CO2) is automatically measured by infra-red detector.
TPH - Semivolatile Fraction	EP071-SD	SOIL	In house: Referenced to USEPA SW 846 - 8270. Extracts are analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM Schedule B(3)
TRH Volatiles/BTEX in Sediments	EP080-SD	SOIL	In house: Referenced to USEPA SW 846 - 8260 Extracts are analysed by Purge and Trap, Capillary GC/MS. Quantification is by comparison against an established 5 point calibration curve.
PAHs in Sediments by GCMS(SIM)	EP132B-SD	SOIL	In house: Referenced to USEPA 8270 GCMS Capillary column, SIM mode using large volume programmed temperature vaporisation injection.
pH by Auto Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM Schedule B(3).
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al, Zhang et al. This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015 The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM Schedule B(3)
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	WATER	In house: Referenced to USEPA SW 846 - 8270 Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260 Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Exchangeable Cations Preparation Method	ED007PR	SOIL	In house: Referenced to Rayment & Lyons method 15A1. A 1M NH4Cl extraction by end over end tumbling at a ratio of 1:20. There is no pretreatment for soluble salts. Extracts can be run by ICP for cations.
TKN/TP Digestion	EK061/EK067	SOIL	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM Schedule B(3)
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of reagent grade water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.
Seawater Elutriate Testing Procedure - Glass Leaching Vessel	EN68a-G	SOIL	USEPA Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Guide, EPA-503/8-91/001, USEPA and US Army Corps of Engineers. ANZECC Interim Ocean Disposal Guidelines This Procedure outlines the preparation of leachate designed to simulate release of contaminants from sediment during the disposal of dredged material. Release can occur by physical processes or a variety of chemical changes such as oxidation of metal sulphides and release of contaminants adsorbed to particles or organic matter.

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	In house: Referenced to USEPA 200.2. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM Schedule B(3).
Dry and Pulverise (up to 100g)	GEO30	SOIL	#
Methanolic Extraction of Soils for Purge and Trap	ORG16	SOIL	In house: Referenced to USEPA SW 846 - 5030A. 5g of solid is shaken with surrogate and 10mL methanol prior to analysis by Purge and Trap - GC/MS.
Tumbler Extraction of Solids (Option A - Concentrating)	ORG17A	SOIL	In house: Mechanical agitation (tumbler). 20g of sample, Na2SO4 and surrogate are extracted with 150mL 1:1 DCM/Acetone by end over end tumble. The solvent is decanted, dehydrated and concentrated (by KD) to the desired volume for analysis.
Tumbler Extraction of Solids for LVI (Non-concentrating)	ORG17D	SOIL	In house: 10g of sample, Na2SO4 and surrogate are extracted with 50mL 1:1 DCM/Acetone by end over end tumbling. An aliquot is concentrated by nitrogen blowdown to a reduced volume for analysis if required.
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM Schedule B(3)
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for purging.

Annex D Jurien Bay Boat Harbour Benthic Habitat Mapping Study

Jurien Bay Benthic Habitat Mapping

444_07_001/1_Rev1

March 2018

Jurien Bay Benthic Habitat Mapping

Prepared for

Department of Transport

Prepared by

BMT

March 2018

Report No. 444_07_001/1_Rev1

Client: Department of Transport

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Distribution

Revision	Author	Recipients	Organisation	No. copies & format	Date
A	M Capill	B Davis	BMT	1 x .docm	17/01/18
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C	M Capill	M Bailey	BMT	1 x .docm	01/02/18
0	M Capill	L Clarke	BMT	1 x .pdf	02/02/18
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Review

Revision	Reviewer	Intent	Date
A	B Davis	Technical review	17/01/18
B	L Synnot	Client manager/editorial review	31/01/18
C	M Bailey	Director review	01/02/18
0	L Clarke	Project engineer	02/02/18

Quality Assurance

BMT Western Australia Pty Ltd (trading as BMT) has prepared this report in accordance with our Health Safety Environment Quality Management System, certified to OHSAS 18001, AS/NZS 4801, ISO 14001 and ISO 9001..

Status

This report is 'Draft' until approved for final release, as indicated below by inclusion of signatures from: (i) the author and (ii) a Director of BMT Western Australia Pty Ltd (trading as BMT) or their authorised delegate. A Draft report may be issued for review with intent to generate a 'Final' version, but must not be used for any other purpose.

Approved for final release:

Author
Date: 20/03/18

Director (or delegate)
Date: 20/03/18

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Acronyms

BPPH	Benthic primary producer habitat
DoT	Western Australian Department of Transport
ha	Hectares
km	Kilometres
m	Metres
m^2	Square metre
TCS	Towed camera system

1. Introduction

Jurien Bay Boat Harbour (hereafter, the Boat Harbour) is located north of the Jurien Bay town site, ~250 km north of Perth, Western Australia (Figure 1.1). The Boat Harbour services a range of government, recreational and commercial vessels and is managed by Department of Transport (DoT).

Wrack and marine sediments accumulate in the Boat Harbour on a frequent basis resulting in several negative impacts affecting the navigability, environment and aesthetic quality. To manage these impacts, routine maintenance dredging of the Boat Harbour is undertaken by DoT.

To inform future dredging requirements and marine environmental management of the Boat Harbour, BMT undertook benthic habitat mapping of Jurien Bay in November 2017. The specific objectives of the mapping project were to:

i. collect digital baseline data on the spatial extent and characteristics of benthic habitats in the mapping area, and
ii. qualitatively characterise the extent of benthic primary producer habitat (BPPH) surrounding the Boat Harbour, and develop a mapping product of suitable quality to meet multiple purposes (including informing dredging operations and potential future environmental approvals applications, if necessary).

This report provides an overview of the scope of work, methods and mapping products from the Jurien Bay benthic habitat mapping project.

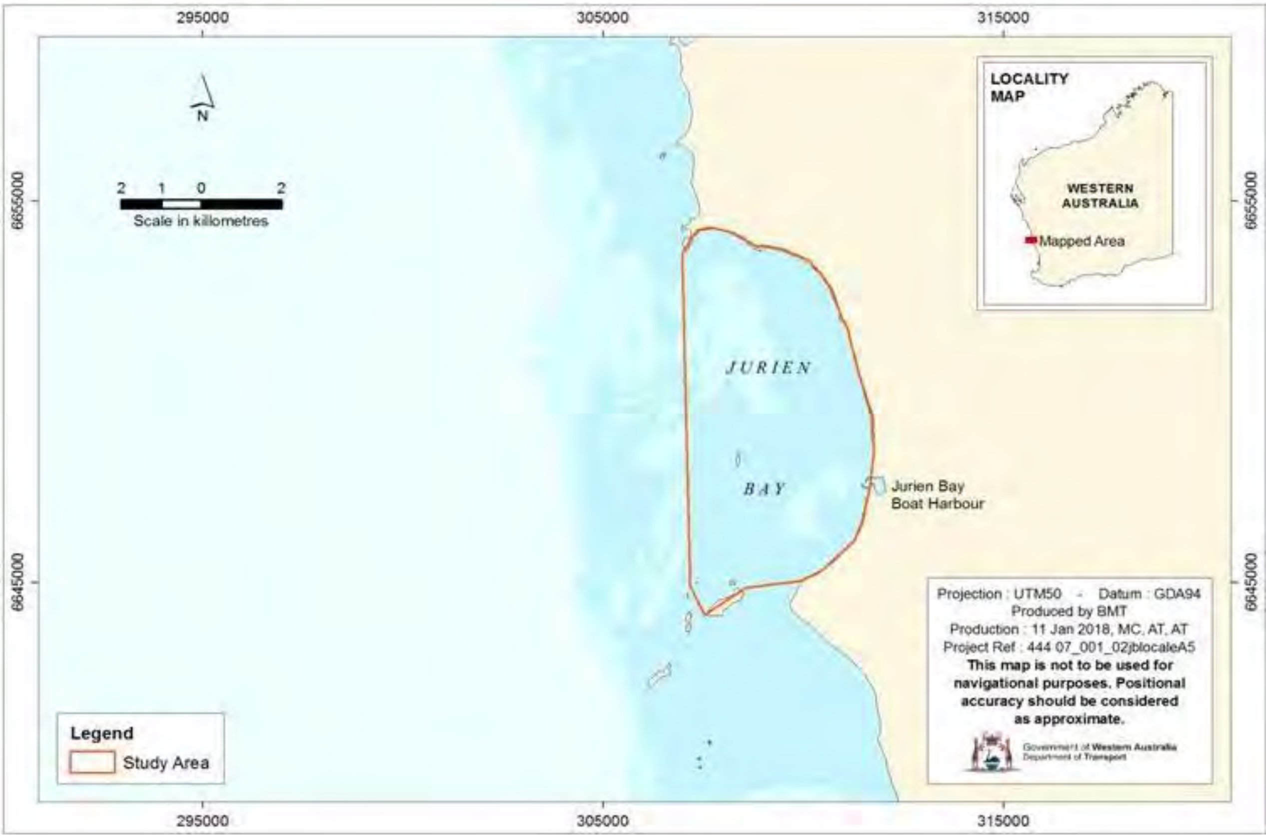


Figure 1.1 Location of the Jurien Bay Boat Harbour and study area

2. Description of the Marine Environment

2.1 General setting

The study area is located inside the Jurien Bay Marine Park (hereafter, the Marine Park) within the Central West Coast marine bioregion. The marine environment experiences a Mediterranean climate, low tidal range (maximum of ~0.7 m; Chua 2002), and predominantly wind driven currents (Holloway 2006). The marine flora and fauna of this region is comprised of a mixture of temperate and tropical species. Temperate species are transported north by the Capes Current from cool southern temperate waters, and tropical species are transported south by the Leeuwin Current from tropical northern waters (CALM 2005).

The near shore seabed topography of the region is complex, containing a series of shallow elongate limestone reefs that run parallel to shore. The numerous emergent rocks and islands associated with these reefs provide the coast with protection from swell waves, and result in the development of deep (>10 m depth) and shallow (<10 m depth) lagoonal environments. The shallow lagoons are interspersed with sandbars that run approximately perpendicular to shore (CALM 2005).

2.2 Marine flora and fauna

Marine Park waters are characterised by several BPPH types including (CALM 2005):

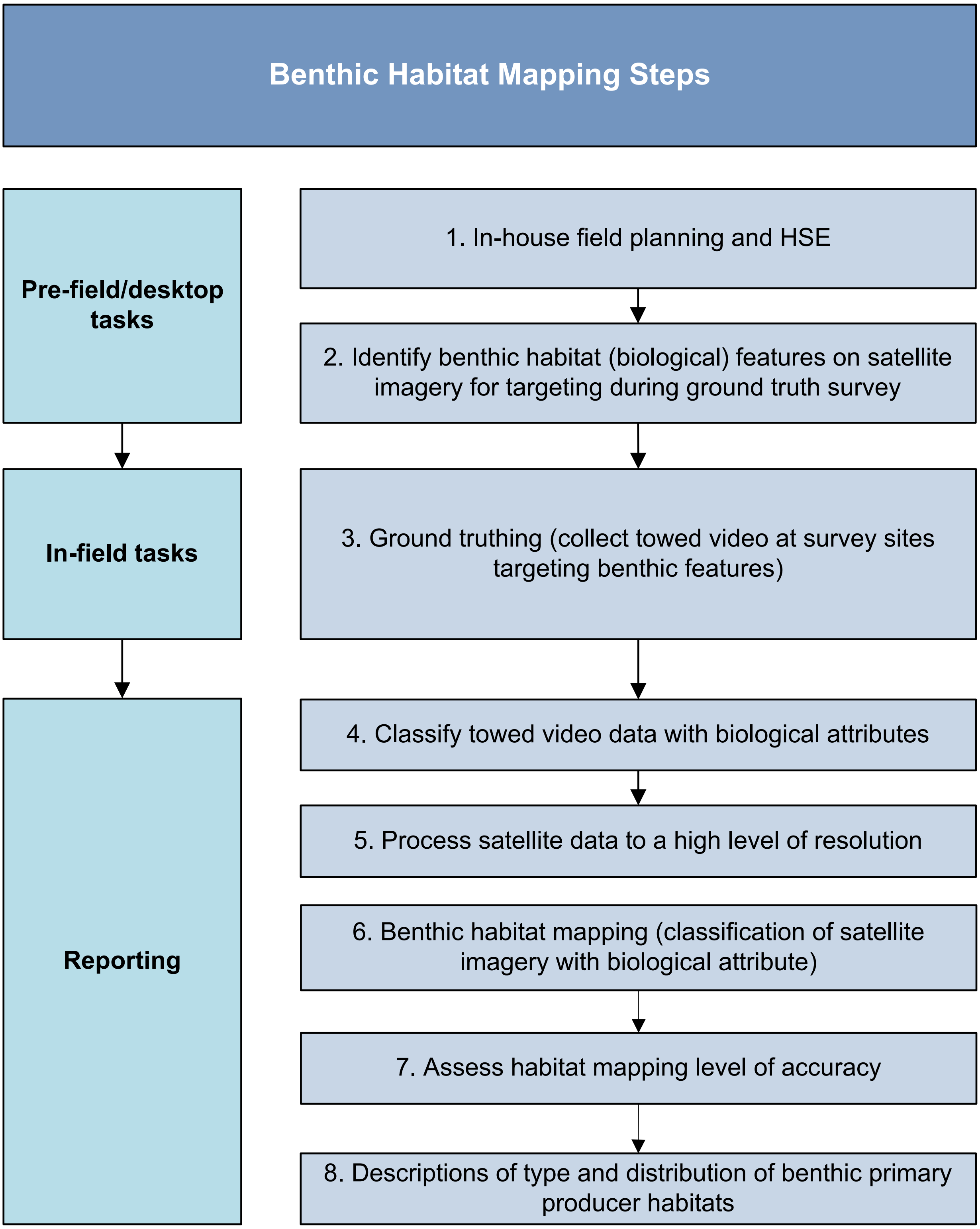
- seagrass meadows
- bare or sparsely vegetated mobile sand
- shoreline and offshore intertidal reef platforms
- subtidal limestone reefs
- reef pavement

These BPPH support diverse seagrass assemblages, with nine species of seagrass recorded in the Marine Park, and mixed macroalgal assemblages (CALM 2005). Although small coral communities are relatively common in the Jurien Bay region, there are no coral reefs (CALM 2005).

These local BPPHs in turn provide habitat and food for diverse fin-fish assemblages, with up to 127 species recorded in the Jurien Bay region (Atlas of Living Australia 2018). Examples include Western Australian dhufish (*Glaucosoma hebraicum*), pink snapper (*Chrysophrys auratus*) and baldchin groper (*Choerodon rubescens*). The commercially fished western rock lobster (*Panulirus cygnus*) is also common to the region and has the highest economic value of any single species commercial fishery in Australia. In addition, the Marine Park supports several species of marine mammals, including 14 species of cetaceans (five of which are listed as rare or likely to become extinct), and a large sea lion population (CALM 2005).

3. Benthic Habitat Mapping Methods

The steps involved to prepare the benthic habitat map are presented in Figure 3.1. In summary, satellite imagery was used to identify benthic habitat features to be ground truthed by towed video. Video footage was classified with biological attributes and combined with satellite imagery to create classified BPPH maps of an area offshore of the Boat Harbour.



Note:

1. HSE = Health, Safety and Environment

Figure 3.1 Steps undertaken to complete Jurien Bay benthic habitat mapping

3.1 Remote data collection

Satellite imagery collected over the study area in the last two years was assessed to determine the most suitable image for mapping. Multispectral satellite imagery from 24 August 2017 was used to identify benthic habitat assemblages for mapping the study area (Figure 3.2). Panchromatic (grey-scale) and multispectral (8 spectral bands) satellite imagery was acquired from the DigitalGlobe WorldView-2 sensor with a resolution of 2 m. The image selected had the clearest water and highest visibility of benthic features in the area of primary interest. Some turbidity was evident over the northern part of the image, but the visibility over these areas was considered sufficient to allow for spectral separation of habitat categories. Prior to commencing the habitat mapping, the satellite imagery was assessed for possible artefacts or sun-glint, but due to the high image quality, no corrections were required.

3.2 Ground truth survey

Ground truth data were collected using towed video camera surveys on 9 and 11 November 2017 and on 1 March 2018. The ground truth data were used to augment the spatial data from the satellite image analysis, and to enable definition of benthic habitat assemblages within the study area. The survey design, collection techniques and methods used to capture and classify video data are described below.

3.2.1 Survey design

In total, 60 transects were surveyed with towed video (Figure 3.2). Transect lengths varied from ~100 m to ~1.6 km, with a total survey transect distance of ~27.5 km. Transect positions were stratified to target areas of particular benthic features (sediments, reefs, seagrass, macroalgae habitats) prior to field mobilisation. Most video frames covered a ~1–2 m wide band of substrate, resulting in ~4.1 hectares (ha) (or 0.11% of the mapping area) of benthic habitat surveyed. Within this survey area, the video data analysis produced ~47 690 units of classified habitat data (with each unit corresponding to ~1.0 m^2 of mapping area).

3.2.2 Collection of towed video data

Towed video data were collected using a towed camera system (TCS). The TCS was configured for the project with two digital cameras (one standard definition and one high definition) mounted in a water proof sled/housing. The primary camera was mounted to a sled on a 45° angle, pointing forward. The system was connected to the vessel via an umbilical that could be let out to 50 m.

High definition footage from the camera was recorded onto the device's internal storage (128 GB) or external SD cards (up to 128 GB), while standard definition footage was used by the field team to navigate the sled. Footage was backed up at least daily throughout the survey.

During the towed video surveys, a track log was created in real-time within positioning software. The track log contained local date, local time, easting, northing, latitude and longitude, updated every 1 second. A single track log was generated for all towed video transects at the end of the survey.

3.2.3 Classification of video footage

Video footage was analysed and classified according to the benthic habitat categories outlined in Table 3.1. Analysis and classification of video footage was undertaken using TransectMeasure (SeaGIS 2013). The number of points from video tow that were classified for each benthic habitat category is provided in Table 3.2; each point represents ~1 m^2 of benthic habitat. Following classification, the time vs. classification log was merged with the position vs. time log to provide a single file with a classification for every position where valid video footage was obtained; this process was automated.

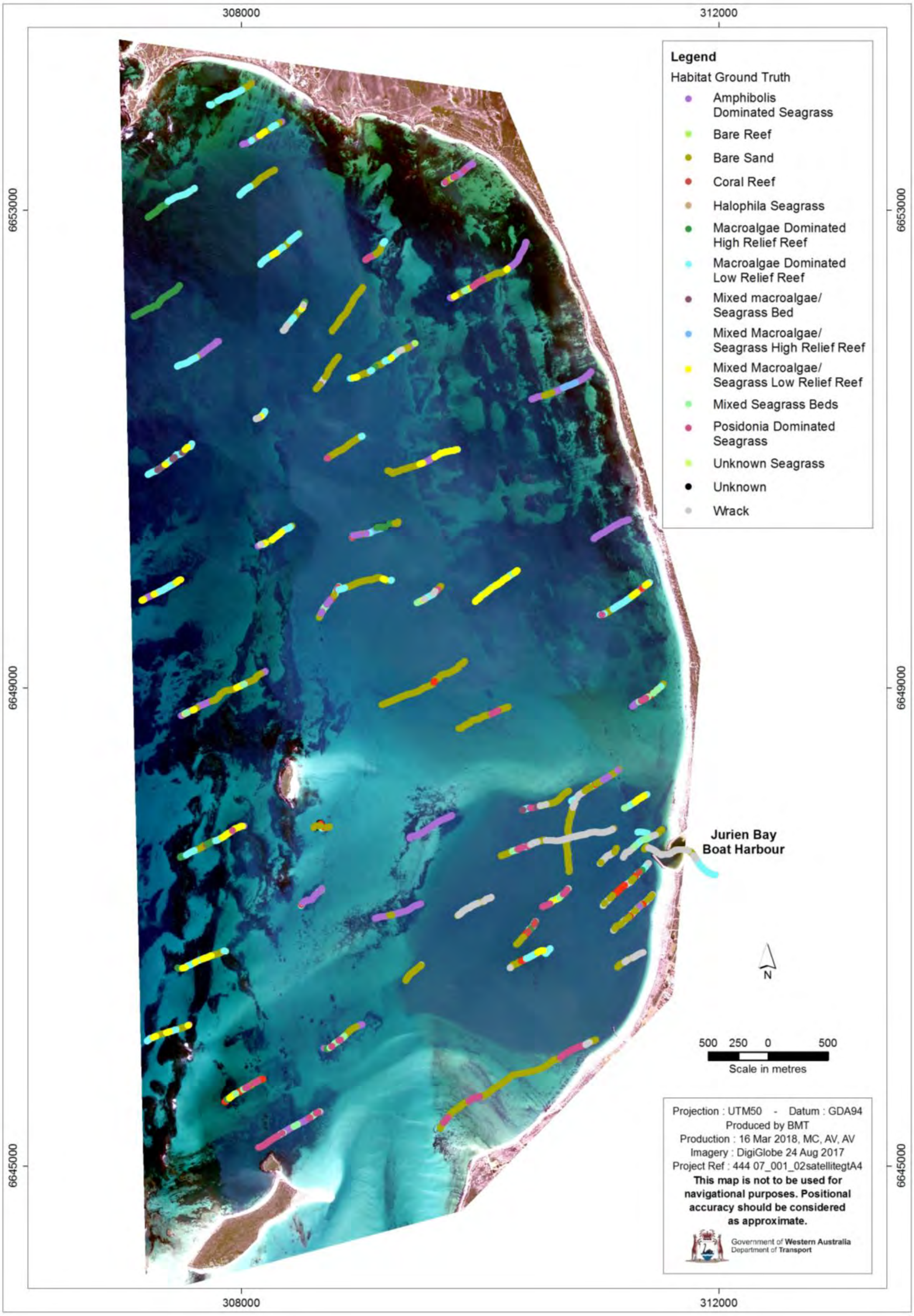
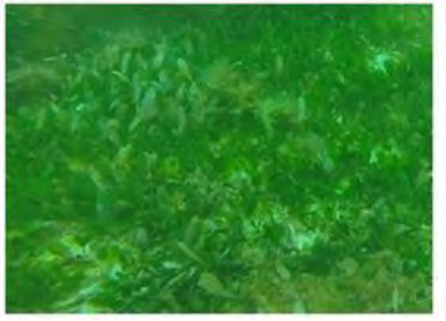
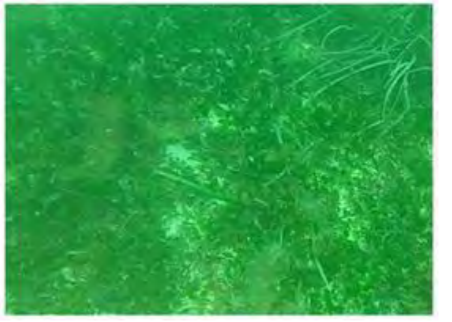


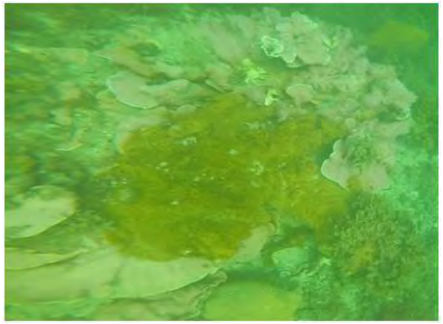
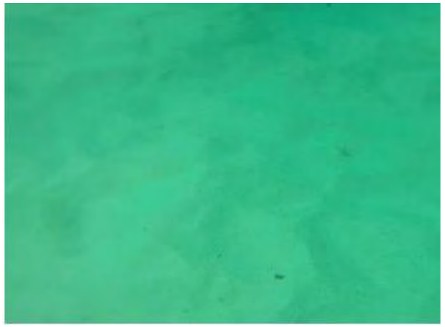
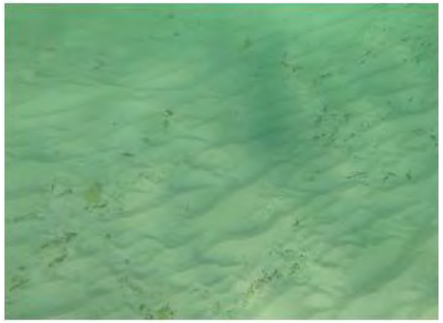
Figure 3.2 Jurien Bay benthic habitat mapping transect locations and habitat type

Table 3.1 Jurien Bay benthic habitat mapping categories and example images from video classification

Benthic habitat categories	Example images
Seagrass bed dominated by *Halophila* spp.	 
Seagrass bed dominated by *Amphibolis* spp.	  
Seagrass bed dominated by *Posidonia* spp.	 

Mixed seagrass bed	 
Macroalgae dominated low relief reef	  
Macroalgae dominated high relief reef	 

Mixed macroalgae/seagrass bed	  
Mixed macroalgae/seagrass low relief reef	 
Mixed macroalgae/seagrass high relief reef	  

Coral	 
Bare reef	 
Bare sand	 

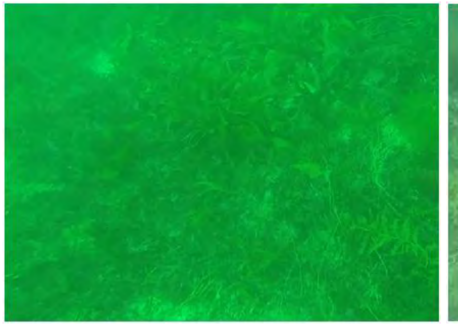
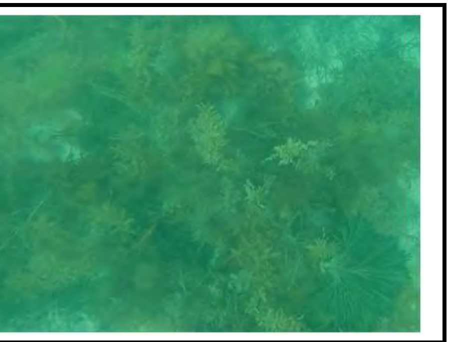
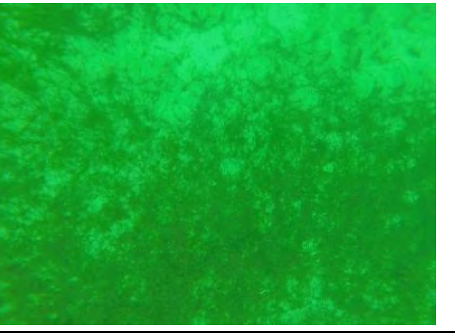
Wrack	  
Unknown seagrass	
Unknown	Feature does not fit into any of the above categories, and/or, cannot be determined.

Table 3.2 Benthic habitat categories points classified and proportion

Benthic habitat categories	Points classified	Proportion[1] (%)
Seagrass bed dominated by *Halophila* spp.	1094	2.3
Seagrass bed dominated by *Amphibolis* spp.	6108	12.8
Seagrass bed dominated by *Posidonia* spp.	1728	3.6
Mixed seagrass bed	1227	2.6
Macroalgae dominated low relief reef	8374	17.6
Macroalgae dominated high relief reef	1936	4.1
Mixed macroalgae/seagrass bed	332	0.7
Mixed macroalgae/seagrass low relief reef	3134	6.6
Mixed macroalgae/seagrass high relief reef	358	0.8
Coral	93	0.2
Bare reef	350	0.7
Bare sand	17154	36.0
Wrack	5645	11.8
Unknown seagrass	13	0.0
Unknown	144	0.3
Total	47690	100

Note:

1. Percentages do not add up to exactly 100 due to rounding.
2. Example images of classification categories are provided in Table 3.1.

3.3 Classification and mapping procedures

3.3.1 Classification procedures

Habitat mapping was performed using a supervised Maximum Likelihood classifier to classify the images using ERDAS IMAGINE 2015 (Hexagon Geospatial 2016). Training areas were based on ground truthing collected in the field using towed video (Section 3.2.3). A random split was applied to the ground truthing points to split them into classification (70%) and validation (30%) data. The 70% withheld classification ground truthing data were used to generate spectral signatures for the classification. Habitats could be reliably divided into vegetated cover of varying density, and non-vegetated areas, but could not be further classified into seagrass and reef categories as a result of high spectral similarity between seagrass and other vegetated areas (e.g. macroalgae, turfing algae). Therefore, the following categories were mapped:

- vegetated
- non-vegetated areas.

Vegetated areas included all regions with sparse to dense seagrass or macroalgal cover, while non-vegetated areas combined sand and bare rock pavement/reef. Seagrass and macroalgal categories were manually assigned at a later stage. Vegetated areas were defined as either dense (having no obvious gaps in the vegetation cover based on visual assessment of the imagery) or sparse vegetation (containing areas of bare sand or reef in between the vegetation cover). After the supervised classification had been performed, the classified images were visually assessed for consistency across the study area using ArcGIS 10.2. Bathymetric charts were also used to help delineate reef and non-reef areas based on visual assessment of the depth differences between features. The bathymetric information was then integrated with the habitat classification to allow for the separation of vegetated areas, according to reef or non-reef substrate.

3.3.2 Development of final habitat map

Ground truthing data (Figure 3.2) were used to manually define seagrass and macroalgal habitats over the vegetated reef and non-reef areas using ArcGIS 10.2, resulting in the categories described in (Table 3.1). Post-processing was then applied to improve the classification over areas of noise in the data, or misclassification resulting from spectral similarities between the categories, especially in more sparsely vegetated areas, and smooth the boundary between classified habitats. Areas affected by remaining turbidity were improved by applying additional image assessments and contrast stretches to maximise the visibility and confirm the extent of habitats. A minimum mapping unit of ~36 m^2 was considered suitable to remove small classified areas and merge with neighbouring polygons.

3.3.3 Assessment of accuracy

An accuracy assessment was performed on the habitat classification using the 30% withheld validation ground truthing data for the vegetated and non-vegetated categories. No accuracy assessment could be performed for the detailed habitat categories, as these were derived manually with no supervised classification approach and final categories deviated slightly from the final ground truth categories. However, a visual assessment showed good agreement between the detailed categories and the imagery and ground truthing.

The assessment of vegetated and non-vegetated categories achieved a very high overall accuracy of 93.40% and Kappa statistic of 0.87. The accuracies for the individual categories are reflected in Table 3.3. The Kappa value measures agreement between the classification of categorical data, and recognises the agreement that could occur by chance. Kappa values over 0.40 have been considered as representing moderate to strong agreement (Congalton 1991, 2001).

Table 3.3 Accuracy assessment of the benthic habitat classification

Habitat type		**Reference Data**			**User's accuracy[1]**
		Vegetated	**Non-vegetated**	**Total**	
Classified Data	Vegetated	58	5	63	**92.06%**
	Non-vegetated	2	41	43	**95.35%**
	Total	60	46	106	N/A
	Producer's accuracy[2]	**96.67%**	**89.13%**	N/A	N/A

Note:

1. User's accuracy, or reliability, indicates the probability that a pixel classified in the image actually represents that class on the ground (error of commission). It is calculated by dividing the total number of correct pixels in a class by the total number of pixels that were classified in that class (Congalton 1991).
2. Producer's accuracy indicates the probability of a reference pixel being correctly classified (error of omission). It is calculated by dividing the total number of correct pixels in a class by the total number of pixels of that class as derived from the reference data.

4. Distribution of Benthic Habitats

A total of 3667.2 ha of benthic habitat was mapped during the project (Table 4.1). Within this area, the dominant habitat types are (Table 4.1):

- bare sand (57.9%),
- sand inundated platform reef with macroalgae and mixed perennial seagrass (*Posidonia* spp. and *Amphibolis* spp.) (18.3%)
- sand inundated platform reef with macroalgae and perennial seagrass (*Amphibolis spp.*) (13.9%)
- reef dominated by macroalgae (6.1%)

Comparatively, a small proportion of mapped benthic habitat is inhabited by mixed perennial seagrass (*Amphibolis* spp. and *Posidonia* spp.) (2.6%) and even less by mono-specific perennial and ephemeral seagrass meadows (~1.0% for *Amphibolis* spp., *Posidonia* spp. and *Halophila* spp. combined). There is also little habitat within the mapping area occupied by filter feeders such as corals and sponges (0.3%). One area containing filter feeders was identified within a mixed assemblage of macroalgae and ephemeral seagrass (*Halophila* spp.) located south-west of the Boat Harbour approximately 750 m offshore (Figure 4.1).

The nearshore area north of the Boat Harbour is mostly comprised of a mixed assemblage of macroalgae and mixed perennial seagrass (*Posidonia* spp. and *Amphibolis* spp.). This occurred on sand inundated platform reef, extending ~500 m to 1 km offshore (Figure 4.1). South of the Boat Harbour, benthic habitat is less vegetated and is dominated by mobile sands with small scattered meadows of perennial seagrass (mixed assemblages of *Posidonia* spp. and *Amphibolis* spp. and mono-specific assemblages of *Posidonia* spp.) and ephemeral seagrass (*Halophila* spp.; Figure 4.1). This predominantly sandy area surrounding the Boat Harbour extends ~3 km offshore.

Further offshore, benthic habitat is dominated by a mixed assemblage of macroalgae and perennial seagrass (*Amphibolis* spp.) on sand inundated platform reef (Figure 4.1). Next to the dominant offshore benthic habitat, areas containing a mixed assemblage of macroalgae and mixed perennial seagrass (*Amphibolis* spp. and *Posidonia* spp.) also occur (Figure 4.1). In the north-west offshore region of the mapping area, there is an expansive area of reef dominated by macroalgae (Figure 4.1).

Inside the Boat Harbour Entrance Channel, benthic habitat is predominantly characterised by wrack overlying bare sand. Directly adjacent to the Boat Harbour Entrance Channel, wrack and sparse meadows of seagrass (*Posidonia* spp.) covered in sand and epiphytic growth by calcareous algae was observed. These seagrass meadows appeared partially dead and flattened on the seafloor, and therefore were classified as wrack for the purpose of the mapping project. It is noted that areas which comprised wrack have been classified as bare sand in Figure 4.1.

Table 4.1 Area and proportion occupied by benthic habitat categories

Benthic habitat type	Area (ha)	Proportion1 (%)
Ephemeral seagrass (Halophila spp.)	2.6	0.1
Perennial seagrass (Amphibolis spp.)	23.4	0.6
Perennial seagrass (Posidonia spp.)	12.2	0.3
Mixed perennial seagrass (Amphibolis spp. and Posidonia spp.)	94.5	2.6
Reef dominated by macroalgae	222.1	6.1
Sand inundated platform reef with macroalgae and perennial seagrass (Amphibolis spp.)	508.2	13.9
Sand inundated platform reef with macroalgae and mixed perennial seagrass (Posidonia spp. and Amphibolis spp.)	670.2	18.3
Platform reef with macroalgae, filter feeders (corals and sponges) and ephemeral seagrass (Halophila spp.)	11.5	0.3
Bare sand	2122.5	57.9
Total	3667.2	100

Note:

1. Percentages do not add up to exactly 100 due to rounding.

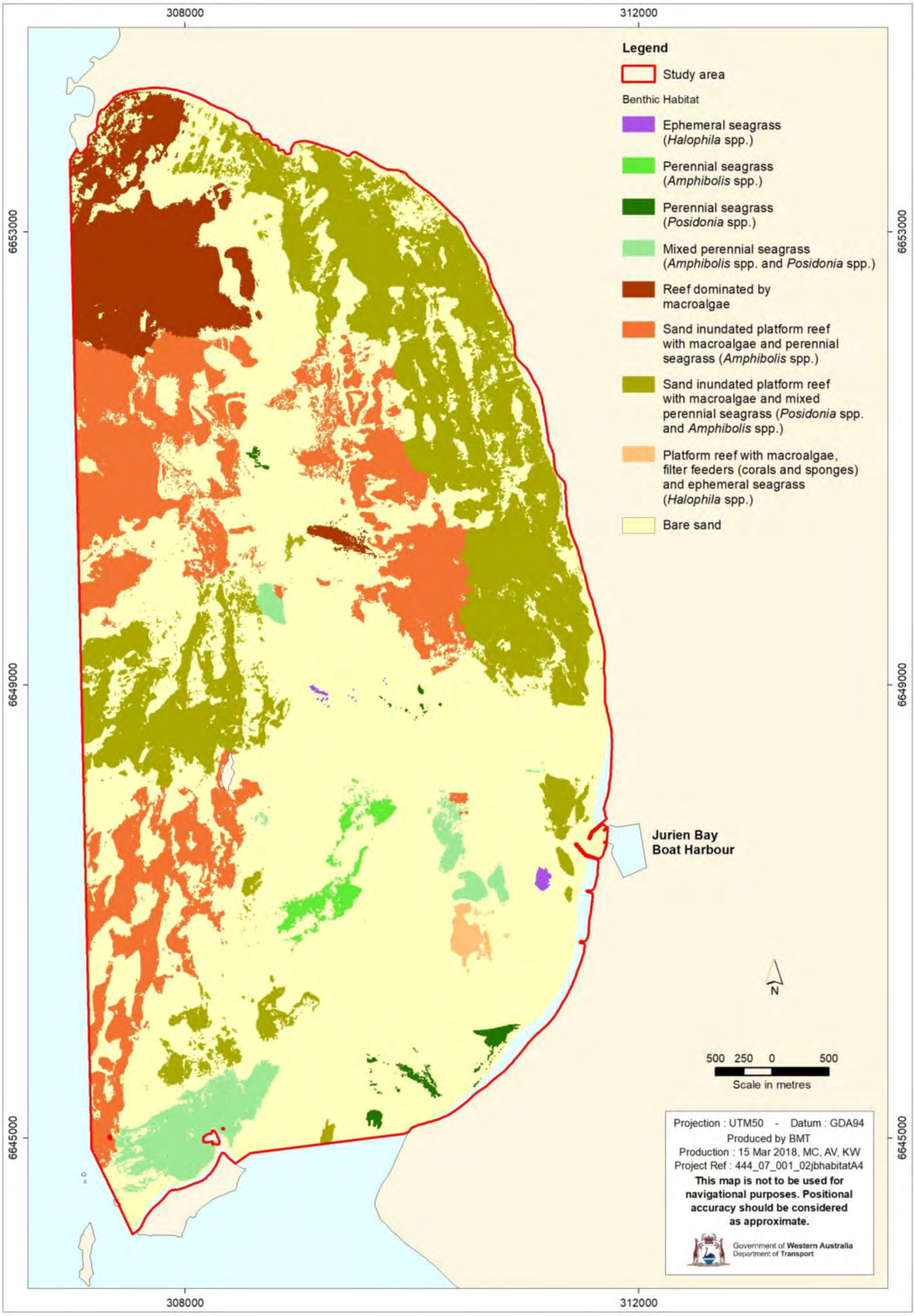


Figure 4.1 Classification of Jurien Bay benthic primary producer habitat extent and distribution

5. Conclusions

Benthic habitats of Jurien Bay were successfully mapped using satellite images and ground truthing data. The survey methods and approaches used to generate the benthic habitat map employed accepted scientific techniques that are repeatable.

Habitats primarily consisted of bare sand, sand inundated platform reef with macroalgae and mixed perennial seagrass (*Posidonia* spp. and *Amphibolis* spp.), sand inundated platform reef with macroalgae and perennial seagrass (*Amphibolis* spp.) and reef dominated by macroalgae. The mapped benthic habitats were representative of known regional and local habitats, and no new BPPH assemblages were observed.

This report and associated mapping products provide a high quality representation of the benthic habitats within the mapping area. All maps are suitable for environmental approvals processes with State and Federal regulatory authorities, and for facilitating future monitoring and management in the region.

6. References

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Hexagon Geospatial (2016) ERDAS Imagine Classification Supervised Classification. Available at <https://hexagongeospatial.fluidtopics.net/reader/~P7L4c0T_d3papuwS98oGQ/r3McCpL65xdeQ0Mcu5SfzA > [Accessed on 11 October 2017]

Holloway K (2006) Characterizing the Hydrodynamics of Jurien Bay, Western Australia. University of Western Australia, Perth, Western Australia

SeaGIS (2013) Transect Measure – single camera biological analysis tool. SeaGIS Pty Ltd, Bacchus Marsh, Victoria, Australia. Available at http://www.seagis.com.au/transect.html [Accessed 15 May 2013]

Appendix A

Electronic data

The following data were supplied electronically to Department of Transport for the Jurien Bay mapping project:

- Towed video
- Transect locations and time stamp data
- TransectMeasure classifications – raw data
- Raw satellite imagery (2017)
- Ground truth video overlay
- Mapping products – final BPPH map

Annex E EPBC Act Protected Matter Search Tool Report – October 2024

Australian Government
Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 02-Oct-2024

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	2
Listed Threatened Species:	48
Listed Migratory Species:	48

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	75
Whales and Other Cetaceans:	11
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	4
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	3
Key Ecological Features (Marine):	None
Biologically Important Areas:	9
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text	Buffer Status
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community may occur within area	In feature area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community may occur within area	In feature area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Anous tenuirostris melanops			
Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris acuminata			
Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris canutus			
Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area	In feature area
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area	In feature area
Charadrius leschenaultii			
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area	In feature area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area	In feature area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In feature area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Endangered	Species or species habitat known to occur within area	In feature area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area	In feature area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Phaethon rubricauda westralis Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird [91824]	Endangered	Species or species habitat may occur within area	In feature area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area	In feature area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Rostratula australis			
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area	In feature area
Sternula nereis nereis			
Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
Thalassarche carteri			
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Thalassarche cauta			
Shy Albatross [89224]	Endangered	Species or species habitat may occur within area	In feature area
Thalassarche impavida			
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area	In feature area
Thalassarche melanophris			
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In feature area
Thalassarche steadi			
White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area	In feature area
Tringa nebularia			
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Zanda latirostris listed as Calyptorhynchus latirostris			
Carnaby's Black Cockatoo, Short-billed Black-cockatoo [87737]	Endangered	Species or species habitat likely to occur within area	In feature area
MAMMAL			
Balaenoptera musculus			
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area	In feature area
Dasyurus geoffroii			
Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area	In feature area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat may occur within area	In feature area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat known to occur within area	In feature area
Parantechinus apicalis Dibbler [313]	Endangered	Species or species habitat known to occur within area	In buffer area only
PLANT			
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area	In feature area
Caleana dixonii listed as Paracaleana dixonii Sandplain Duck Orchid [87944]	Endangered	Species or species habitat may occur within area	In buffer area only
Eucalyptus argutifolia Yanchep Mallee, Wabling Hill Mallee [24263]	Vulnerable	Species or species habitat may occur within area	In feature area
Hemiandra gardneri Red Snakebush [7945]	Endangered	Species or species habitat likely to occur within area	In feature area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat may occur within area	In buffer area only
REPTILE			
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Chelonia mydas			
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
Ctenotus lancelini			
Lancelin Island Skink [1482]	Vulnerable	Translocated population known to occur within area	In buffer area only
Dermochelys coriacea			
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area	In feature area
Egernia stokesii badia			
Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483]	Endangered	Species or species habitat may occur within area	In feature area
Liopholis pulchra longicauda			
Jurien Bay Skink, Jurien Bay Rock-skink [83162]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Natator depressus			
Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
SHARK			
Carcharias taurus (west coast population)			
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Carcharodon carcharias			
White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
Pristis pristis			
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area	In feature area
Rhincodon typus			
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Sphyrna lewini			
Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area	In feature area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Anous stolidus			
Common Noddy [825]		Species or species habitat likely to occur within area	In feature area
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Ardenna carneipes			
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area	In feature area
Ardenna pacifica			
Wedge-tailed Shearwater [84292]		Breeding known to occur within area	In buffer area only
Diomedea amsterdamensis			
Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area	In feature area
Diomedea epomophora			
Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area	In feature area
Diomedea exulans			
Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In feature area
Hydroprogne caspia			
Caspian Tern [808]		Breeding known to occur within area	In feature area
Macronectes giganteus			
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In feature area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area	In buffer area only
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area	In feature area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area	In feature area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area	In feature area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area	In feature area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area	In feature area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In feature area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area	In feature area
Migratory Marine Species			
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Balaenoptera musculus			
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area	In feature area
Carcharhinus longimanus			
Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area	In feature area
Carcharias taurus			
Grey Nurse Shark [64469]		Species or species habitat likely to occur within area	In feature area
Carcharodon carcharias			
White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
Caretta caretta			
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area	In feature area
Chelonia mydas			
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
Dermochelys coriacea			
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area	In feature area
Eubalaena australis as Balaena glacialis australis			
Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area	In feature area
Lamna nasus			
Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area	In feature area
Megaptera novaeangliae			
Humpback Whale [38]		Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat known to occur within area	In feature area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat may occur within area	In feature area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area	In feature area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area	In feature area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area	In feature area
Migratory Terrestrial Species			
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area	In feature area
Migratory Wetlands Species			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris melanotos			
Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
Charadrius leschenaultii			
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat may occur within area	In feature area
Limosa lapponica			
Bar-tailed Godwit [844]		Species or species habitat known to occur within area	In feature area
Numenius madagascariensis			
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Pandion haliaetus			
Osprey [952]		Breeding known to occur within area	In feature area
Thalasseus bergii			
Greater Crested Tern [83000]		Breeding known to occur within area	In buffer area only
Tringa nebularia			
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area	In buffer area only

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State	Buffer Status
Unknown		
Commonwealth Land - [51481]	WA	In buffer area only

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area	In feature area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area	In feature area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area	In feature area
Ardenna pacifica as Puffinus pacificus Wedge-tailed Shearwater [84292]		Breeding known to occur within area	In buffer area only
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area overfly marine area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Chalcites osculans as Chrysococcyx osculans			
Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area	In feature area
Charadrius leschenaultii			
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat may occur within area	In feature area
Chroicocephalus novaehollandiae as Larus novaehollandiae			
Silver Gull [82326]		Breeding known to occur within area	In buffer area only
Diomedea amsterdamensis			
Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area	In feature area
Diomedea epomophora			
Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area	In feature area
Diomedea exulans			
Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In feature area
Haliaeetus leucogaster			
White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area	In feature area
Hydroprogne caspia as Sterna caspia			
Caspian Tern [808]		Breeding known to occur within area	In feature area
Larus pacificus			
Pacific Gull [811]		Breeding known to occur within area	In feature area
Limosa lapponica			
Bar-tailed Godwit [844]		Species or species habitat known to occur within area	In feature area
Macronectes giganteus			
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In feature area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Onychoprion anaethetus as Sterna anaethetus Bridled Tern [82845]		Breeding known to occur within area	In buffer area only
Onychoprion fuscatus as Sterna fuscata Sooty Tern [90682]		Breeding known to occur within area	In buffer area only
Pandion haliaetus Osprey [952]		Breeding known to occur within area	In feature area
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area	In buffer area only
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area	In feature area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Puffinus assimilis Little Shearwater [59363]		Breeding known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Rostratula australis as Rostratula benghalensis (sensu lato)			
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area
Stercorarius antarcticus as Catharacta skua			
Brown Skua [85039]		Species or species habitat may occur within area	In buffer area only
Sterna dougallii			
Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area	In feature area
Sternula albifrons as Sterna albifrons			
Little Tern [82849]		Species or species habitat may occur within area	In feature area
Sternula nereis as Sterna nereis			
Fairy Tern [82949]		Breeding known to occur within area	In buffer area only
Thalassarche carteri			
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Thalassarche cauta			
Shy Albatross [89224]	Endangered	Species or species habitat may occur within area	In feature area
Thalassarche impavida			
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area	In feature area
Thalassarche melanophris			
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In feature area
Thalassarche steadi			
White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area	In feature area
Thalasseus bergii as Sterna bergii			
Greater Crested Tern [83000]		Breeding known to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Thinornis cucullatus as Thinornis rubricollis			
Hooded Plover, Hooded Dotterel [87735]		Species or species habitat known to occur within area overfly marine area	In feature area
Tringa nebularia			
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area overfly marine area	In buffer area only
Fish			
Acentronura australe			
Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area	In feature area
Campichthys galei			
Gale's Pipefish [66191]		Species or species habitat may occur within area	In feature area
Choeroichthys suillus			
Pig-snouted Pipefish [66198]		Species or species habitat may occur within area	In feature area
Halicampus brocki			
Brock's Pipefish [66219]		Species or species habitat may occur within area	In feature area
Hippocampus angustus			
Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area	In feature area
Hippocampus breviceps			
Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area	In feature area
Hippocampus subelongatus			
West Australian Seahorse [66722]		Species or species habitat may occur within area	In feature area
Lissocampus fatiloquus			
Prophet's Pipefish [66250]		Species or species habitat may occur within area	In feature area
Maroubra perserrata			
Sawtooth Pipefish [66252]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area	In feature area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area	In feature area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area	In feature area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area	In feature area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area	In feature area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area	In feature area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area	In feature area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area	In feature area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area	In feature area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area	In feature area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area	In feature area
Mammal			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area	In feature area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat known to occur within area	In feature area
Reptile			
Aipysurus pooleorum Shark Bay Sea Snake [66061]		Species or species habitat may occur within area	In feature area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area	In feature area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area	In feature area
Hydrophis kingii as Disteira kingii Spectacled Sea Snake [93511]		Species or species habitat may occur within area	In feature area
Hydrophis platura as Pelamis platurus Yellow-bellied Sea Snake [93746]		Species or species habitat may occur within area	In feature area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area

Whales and Other Cetaceans

[Resource Information]

Current Scientific Name	Status	Type of Presence	Buffer Status
Mammal			

Current Scientific Name	Status	Type of Presence	Buffer Status
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area	In feature area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area	In feature area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area	In feature area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area	In feature area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area	In feature area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area	In feature area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area	In feature area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area	In feature area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area	In feature area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area	In feature area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area	In feature area

Extra Information

State and Territory Reserves			[Resource Information]
Protected Area Name	Reserve Type	State	Buffer Status
Beekeepers	Nature Reserve	WA	In buffer area only
Boullanger, Whitlock, Favourite, Tern And Osprey Islands	Nature Reserve	WA	In buffer area only
Drovers Cave	National Park	WA	In buffer area only
Jurien Bay	Marine Park	WA	In feature area

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Jurien East Road Upgrade, 3 km NNE Jurien Bay, WA	2020/8740		Post-Approval	In buffer area only
Not controlled action				
Construction of several passing lanes between Lancelin and Jurien Bay, WA	2015/7509	Not Controlled Action	Completed	In buffer area only
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area

Biologically Important Areas			[Resource Information]
Scientific Name	Behaviour	Presence	Buffer Status
Seabirds			
Ardenna pacifica Wedge-tailed Shearwater [84292]	Foraging (in high numbers)	Known to occur	In feature area
Hydroprogne caspia Caspian Tern [808]	Foraging (provisioning young)	Known to occur	In feature area

Scientific Name	Behaviour	Presence	Buffer Status
Larus pacificus Pacific Gull [811]	Foraging (in high numbers)	Known to occur	In feature area
Puffinus assimilis tunneyi Little Shearwater [59363]	Foraging (in high numbers)	Known to occur	In feature area
Sterna dougallii Roseate Tern [817]	Foraging	Known to occur	In feature area
Sternula nereis Fairy Tern [82949]	Foraging (in high numbers)	Known to occur	In feature area
Seals			
Neophoca cinerea Australian Sea Lion [22]	Foraging (male and female)	Known to occur	In feature area
Sharks			
Carcharodon carcharias White Shark [64470]	Foraging	Known to occur	In feature area
Whales			
Megaptera novaeangliae Humpback Whale [38]	Migration (north and south)	Known to occur	In feature area

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

Annex F Jurien Bay Boat Harbour Marine Fauna Log Sheets

Marine fauna observation log (to be completed after any observations of marine fauna within 300 m from the dredge)

Date:		**Observer name:**		**Dredge operator name:**	
Were there any marine fauna interactions during this shift?	☐ Yes ☐ No	**If yes, how many interaction logs were completed?**			
Were any injured or dead marine fauna sighted during this shift?	☐ Yes ☐ No	**If yes, was notification provided to BMT?**	☐ Yes ☐ No	**If yes, was the notification record completed?**	☐ Yes ☐ No

Time of observation	Operation in progress during the observation*	Dredge position		Pod information							Weather Conditions				Outcome of observation and management*
		Latitude	Longitude	Marine fauna type*	Number of marine fauna	Relative bearing from dredge bow (°)*	Distance from dredge (m)	Actual swim direction*	Interaction with dredge/equipment (Y/N)	Marine fauna condition*	Wind speed (km/h)	Wind direction	Waves (0–4)*	Visibility (0–3)*	

***Key**

Operation in progress during observation: DO = dredge in operation; DNO = dredge not in operation

Marine fauna type: W = whale; D = dolphin; P = pinniped; T = turtle; U = unknown; O = other

Relative bearing from dredge bow: assume bow of the dredge is 0°

Actual swim direction: where the fauna is heading based on true north (e.g. N, S, E, W)

Marine fauna condition: N = normal; I = injured; D = dead; U = unknown

Waves: 0 = flat to ripples with crest; 1 = small wavelets; 2 = large wavelets; 3 = small waves; 4 = moderate to long waves

Visibility: 0 = no visibility; 1 = limited visibility; 2 = visibility ok; 3 = visibility perfect

Outcome of observation and management:
Scenario 1 = not able to resight marine fauna – suspended dredging until 20 minutes after the last marine fauna was observed in the monitoring zone (within 300 m from the dredge)
Scenario 2 = marine fauna moved outside of the monitoring zone (within 300 m from the dredge) – dredging continued afterwards
Scenario 3 = dredge moved to another position where a minimum distance of 300 m between the dredge and marine fauna could be maintained – dredging continued afterwards
Scenario 4 = other (provide further comments to explain)

Notification record (to be completed after any observations or interactions with injured/dead marine fauna)

Date and time of notification:	
Name of person providing the notification:	
Name of BMT person notified:	
Instructions received from BMT:	

Marine Fauna Observer – Interaction Log

Marine fauna interaction log (to be completed after any interaction between marine fauna and dredge or dredge equipment)

Date/time of interaction:		**Observer name:**		**Dredge operator name:**	
Location of dredge during interaction:					
Marine fauna type:	☐ Whale ☐ Dolphin ☐ Pinniped ☐ Turtle ☐ Unknown ☐ Other:				
Marine fauna species/notable features:					
Operation in progress during interaction:	☐ Dredge in operation ☐ Dredge not in operation ☐ Other:				
Type of interaction:	☐ Interaction with dredge ☐ Interaction with dredge equipment ☐ Other:				
Detailed comments for type of interaction:					
Outcome of interaction and management:	☐ No injury apparent for marine fauna – not able to resight marine fauna – suspended dredging until 20 minutes after the last marine fauna was observed in the monitoring zone (within 300 m from the dredge) ☐ No injury apparent for marine fauna – marine fauna moved outside of the monitoring zone (within 300 m from the dredge) – dredging continued afterwards ☐ No injury apparent for marine fauna – dredge moved to another position where a minimum distance of 300 m between the dredge and marine fauna could be maintained – dredging continued afterwards ☐ Injured marine fauna – suspended dredging and notified BMT of the injured marine fauna ☐ Dead marine fauna – suspended dredging and notified BMT of the dead marine fauna ☐ Other (provide further comments to explain):				
Detailed comments for outcome of interaction and management:					

Annex G Jurien Bay Boat Harbour Plume Sketch Template

DREDGE AREA

OBSERVATIONS (within the past 24 hours)

	Y	N	N/A
• Evidence of excessive algal growth?	☐	☐	☐
• Evidence of oil or other films on water surface?	☐	☐	☐
• Evidence of litter or other debris in water?	☐	☐	☐
• Observations of marine fauna within 300m from dredge while operating (if yes, marine fauna observation log to be completed)?	☐	☐	☐
• Interaction (e.g. collision) with marine fauna and dredge while operating (if yes, marine fauna interaction log to be completed)?	☐	☐	☐

(Note that "marine fauna" includes whales, dolphins, pinnipeds and turtles).

(Photos to be taken of any items reported)

Notes & Comments: ....

....

DREDGE AREA

Maintenance Dredging Plume Sketch

Use Black Felt Tip Pen

Date: ....

Time: ....

Observer Name: ....

Dredge Operator Name: ....

	Y	N	N/A
Dredging Area Plume Sketched	☐	☐	☐
Dredging Area Photo(s) Taken	☐	☐	☐

Draw Wind Direction (From): N / W / E / S

WIND SPEED (kn)	WAVE	
<1 - 2	Flat - Ripples with Crests	☐
3 - 6	Small Wavelets	☐
7 - 10	Large Wavelets	☐
11 - 15	Small Waves	☐
16 - 26	Moderate to Long Waves	☐

TIDE High ☐ Mid ☐ Low ☐ Flood ☐ Slack ☐ Ebb ☐

Notes & Comments: ....

....

DISPOSAL PIPELINE OUTLET

	Latitude	Longitude	Dip	Tide	RL
A					
B					
C					
D					
E					

DISPOSAL AREA

OBSERVATIONS (within the past 24 hours)

	Y	N	N/A
• Evidence of excessive algal growth?	☐	☐	☐
• Evidence of oil or other films on water surface?	☐	☐	☐
• Evidence of litter or other debris in water?	☐	☐	☐

(Photos to be taken of any items reported)

Notes & Comments: ....

....

DISPOSAL AREA

Maintenance Dredging Plume Sketch

Use Black Felt Tip Pen

Date: ....

Time: ....

Observer Name: ....

Dredge Operator Name: ....

	Y	N	N/A
Disposal Area Plume Sketched	☐	☐	☐
Disposal Area Photo(s) Taken	☐	☐	☐

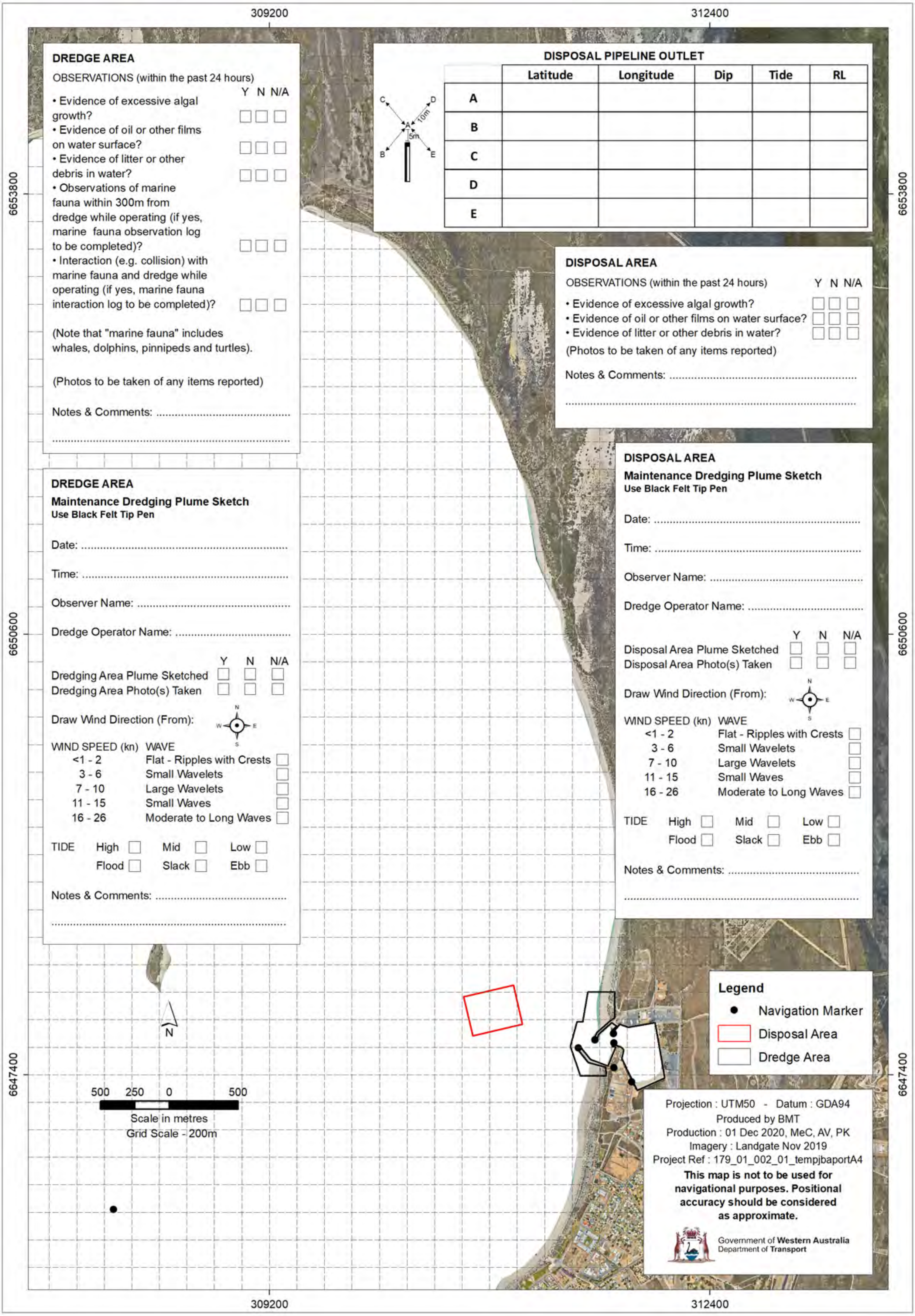
Draw Wind Direction (From): N / W / E / S

WIND SPEED (kn)	WAVE	
<1 - 2	Flat - Ripples with Crests	☐
3 - 6	Small Wavelets	☐
7 - 10	Large Wavelets	☐
11 - 15	Small Waves	☐
16 - 26	Moderate to Long Waves	☐

TIDE High ☐ Mid ☐ Low ☐ Flood ☐ Slack ☐ Ebb ☐

Notes & Comments: ....

....



Annex H Jurien Bay Boat Harbour Weekly Environmental Checklist Template

BMT Commercial Australia Pty Ltd
Level 4, 20 Parkland Road, Osborne Park, WA, 6017
Australia

ABN: 54 010 830 421

Weekly environmental monitoring Jurien Bay Boat Harbour 20XX Maintenance Dredging Campaign – Week X

Environmental monitoring of the 20XX Jurien Bay Boat Harbour Maintenance Dredging Campaign was conducted between XX-XX XX 20XX and was completed in accordance with the Jurien Bay Boat Harbour Maintenance Dredging Long Term Monitoring Management Plan (LTMMP; BMT 2025). See table and comments below for results of the required environmental monitoring tasks (Table 1.1).

Table 1.1 Environmental Monitoring Checklist

Monitoring Task	Monday (dd/mm/yy)		Tuesday (dd/mm/yy)		Wednesday (dd/mm/yy)		Thursday (dd/mm/yy)		Friday (dd/mm/yy)		Saturday (dd/mm/yy)		Sunday (dd/mm/yy)	
	Received?	Correct?	Received?	Correct?	Received?	Correct?	Received?	Correct?	Received?	Correct?	Received?	Correct?	Received?	Correct?
Plume Sketch (Dredge Area)														
Plume Sketch (Disposal Area)														
Remote imagery (Boat Harbour)														
Remote imagery (Dredge Vessel)														
Site photograph (Disposal Area)														
Site photograph (Dredge Area)														
Disposal area depth														
Marine mammal observation log														
Marine mammal interaction log														
Dredge vessel track log														
Disposal pipe track log														

Notes:

1. **Red text** indicates a nonconformance with conditions outlined in the LTMMP (BMT 2025)
2. ***Red italicised text*** indicates partial non-conformance with conditions outlined in the LTMMP (BMT 2025)
3. **Black bold text** indicates that data was collected but not yet provided and/or no data was collected for a valid reason e.g. non-operational machinery, poor weather
4. 'N/A' indicates there was no requirement for data to be collected in accordance with the LTMMP (BMT 2025)
5. '-' indicates no data was collected as no maintenance dredging was undertaken on those days.

BMT Commercial Australia Pty Ltd
Level 4, 20 Parkland Road,
Osborne Park, WA, 6017
Australia

ABN: 54 010 830 421

Relevant SharePoint link(s):

https://apacbmt.sharepoint.com/sites/DataSharepointDoT/SitePages/Jurien-Bay-Boat-Harbour.aspx

Comments on environmental monitoring:

Comments on environmental monitoring non-conformances:

Comments on other environmental issues:

Environmental monitoring data still to be received

References

BMT (2025) Jurien Bay Boat Harbour Maintenance Dredging – Long Term Monitoring and Management Plan. Prepared for the Department of Transport by BMT Commercial Australia Pty Ltd. Report No. R-000607.002-31. Perth, Western Australia. June 2025.

Annex I Summary of Stakeholder Consultation

PO Box 2305 Churchlands
WA 6018 Australia
Tel: +61 8 6163 4900
www.bmt.org

Date	Stakeholder type	Stakeholder comment	DoT comment
20/08/2019	Resident	In todays business world all projects revolve around MONEY. This ongoing contamination issue within Jurien marina has cost the tax payer an enormous amount of money, while the problem continues year after year. In short, an extremely expensive band aid. Another reason dredging may not be the wisest idea is that any natural depressions in the marine environment may well be there for a reason, and messing with nature may well come back and bite you on the rear end, and then we are back into the money outlay - again! Not to mention the scourge of any government - the Green "people". And still the marina problem exists. Surely the most positive solution to the problem has to be one that is effective, permanent and cost effective. This would be to either protect the current entrance from the W/NW weather by a means to be determined by people smarter than me, or to completely alter access to the marina by way of a W/SW orientated entrance. Either way the solution is final, as is the money outlay.	The comment received does not relate to offshore disposal of dredged material. Long-term planning and/or engineering solutions for the future of Jurien Bay Boat Harbour is beyond the scope of this report and stakeholder consultation process. DoT notes that sediments tested in both 2014 and 2019 are not contaminated and are suitable for unconfined offshore disposal under the NAGD (CA 2009) framework.
23/08/2019	Resident	Thanks for the opportunity to comment on this problem . Perhaps now it is a good time to stand back and assess design and cost for future management of this infrastructure, a forward twenty year plan might be a good plan . The current design is best suited to a stable shoreline and perhaps because it's initial cost ,was given approval for its	The comment received does not relate to offshore disposal of dredged material. Long-term planning and/or engineering solutions for the future of Jurien Bay Boat Harbour is beyond the scope of this report and stakeholder consultation process

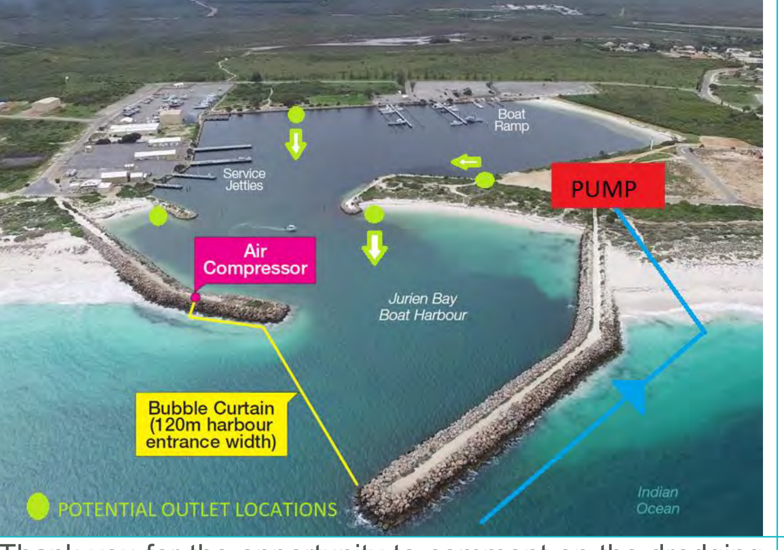
Date	Stakeholder type	Stakeholder comment	DoT comment
		construction, but without delving back in historical evidence , the first jetty built is some distance inland now. This dynamic ,has of recent times , accelerated , causing the problem of silting in the marina . This can be attributed to the rapid erosion of the south point of Jurien Bay . This erosion , driven by the predominant prevailing wind , the southerly , has caused the distance between the point and Long Island to get greater and so the volume of water driven by the wind carries greater volumes of sand into the bay which is evidenced by beach accretion and problems in the marina . Solutions may involve a groin at the point to arrest the water flow or looking further ahead , designing a marina , using the current groins , to establish the marina in the ocean with a bridge for access so that foreshore dynamics could occur naturally without ending up in an inland marina like now . No cheap option seems likely but I believe good engineering and cost benefit analysis could have a good chance for long term success . Otherwise continual costs will make expenses blow out to mind blowing numbers in the current situation.	
24/08/2019	Pen Holder Resident	Being a keen surfer, amateur fisherman, scuba diver & generally interested in all things related to the ocean & foreshore, I am surprised there is not a plan in place to fix the seaweed build up problem!	Long-term planning and/or engineering solutions for the future of Jurien Bay Boat Harbour is beyond the scope of this report and stakeholder consultation process

PO Box 2305 Churchlands
WA 6018 Australia
Tel: +61 8 6163 4900
www.bmt.org

Date	Stakeholder type	Stakeholder comment	DoT comment
		My visual observations over the past 7 years tell me the bay flushes from north to south, this is evident by the build-up of beach wrack on the north side of the marina breakwater & a clean wrack free beach on the south side. Extension of the north breakwater wall will prevent the sea grass/weed from entering the marina after a storm or large swell event. My comments are not meant to offend anyone or discredit any studies undertaken but I feel there is no substitution for practical experience & observation. Conversations with local professional fishermen seem to back my assessment of the seaweed issue. Dumping the dredging spoil back into the ocean is not a good idea, fix the problem & you most likely won't need to dredge.	Offshore disposal has been identified and assessed as the most ecologically sustainable solution for disposal of dredged material at Jurien Bay. Capital works to prevent further incursion of sand and wrack into the harbour will not remove the requirement to dredge in the short-medium term.
24/08/2018	MAG member Resident	As a long time advocate of the Jurien Bay Marine Park, me being the diving supervisor for the initial CALM benthic survey of the Marine Park in the 1990's and then a member of the JBMP consultative committee that established the Marine Park afterwards, I see no impediment with placing dredge spoil from the Jurien Marina into the natural depression just offshore. Having dived that area I have found nothing of significance on the seabed there. I believe that decreasing the depth of water in the depression it will reduce the cost of a groyne that will	DoT appreciates the support for proposed offshore placement of dredged material.

Date	Stakeholder type	Stakeholder comment	DoT comment
		eventually be installed to protect the entrance of the Jurien Marina.	
27/08/2019	Resident	I admit I am not an engineer and can't back this suggestion with scientific evidence but why not pump water into the marina to create an outflow of water and material that would prevent the build up. The principal is similar to the bubble curtain. Create eddies and currents that prevent the seagrass from entering the marina. By pumping water into the marina, oxygen levels would increase and overall health would be improved. Just like a fish tank, by circulating the water, the tank remains healthy. The benefit of this is by pumping sufficient quantities of water into the marina, there would be an outflow through the mouth. When water is flowing out through the mouth it would seem to prevent seagrass and weed from flowing inward. It is a simple suggestion and there would need to be a fair bit of scientific research to assess viability. As with the bubble curtain there would need to be several trial locations for the outlet, to ensure effective outflow. Ideally the outlet would be in the back of the marina to maximise the outflow potential, however erosion and deposits of sand will need to be considered through some sort of initial modelling to investigate this. Consideration would need to be given to the swimming areas and the impact currents would have on these. There	The comment received does not relate to offshore disposal of dredged material. Pumping of water into the Boat Harbour has been previously assessed by DoT as a solution to reduced dissolved oxygen levels, however; proved economically un-viable. Bubble curtain trials proved ineffective at preventing wrack from entering the Boat Harbour. Long-term planning for the future of Jurien Bay Boat Harbour is beyond the scope of this report and stakeholder consultation process.

PO Box 2305 Churchlands
WA 6018 Australia
Tel: +61 8 6163 4900
www.bmt.org

Date	Stakeholder type	Stakeholder comment	DoT comment
		would be the potential to only run the pumps overnight or during storms so currents would not impact the swimming and boating activities 	
02/04/2019	Department of Water and Environmental Regulation (DWER) mid-west Gascoyne office	Thank you for the opportunity to comment on the dredging operation at Jurien Bay Boat Harbour. The Mid West Gascoyne office will not be providing a response direct to Department of Transport, feedback and comments will be directed through the departments head office.	DoT has provided project information to the DWER EPA Services Division on 02/08/2019 and no reply has been received to date (04/09/2019)

Jurien Bay Boat Harbour

The Department of Transport (DoT) is researching how it can improve the harbour environment in the Jurien Bay Boat Harbour.

With on-going data collection methods and trialing practical options, DoT is currently using computer modelling, which simulates the floating seagrass and seaweed (wrack) transported into the harbour from Jurien Bay.

The collection of oceanographic data as part of ongoing investigations into environmental issues in the local area also continues.

During winter 2018, a trial saw two separate deployments of a bubble curtain:

1. Across the harbour entrance in an effort to exclude wrack from the harbour.
2. Inside the harbour in an effort to improve oxygen levels in the water.

Results from the deployments will be compiled and provided to DoT for review.

Have your say: Jurien Bay Boat Harbour maintenance dredging campaigns

The Department of Transport (DoT) is seeking feedback from the community and users of Jurien Bay Boat Harbour in relation to an offshore placement area for future maintenance dredging campaigns.

Sand and seaweed from the offshore marine environment are transported into Jurien Bay Boat Harbour via natural coastal processes and accumulate within the entrance channel and basin. Maintenance dredging is the process undertaken to manage and redistribute accumulated marine sand and seaweed in order to:

- restore navigable depths for vessels;
- provide ongoing access and operational use of the harbour
- remove decomposing seaweed and maintain harbour water quality; and,
- restore natural tidal flushing.

Offshore placement

Jurien Bay Boat Harbour maintenance dredging campaigns are completed approximately every two years and previously material generated has been placed in the dune system north of the harbour. DoT is seeking a long-term sustainable solution with the material now proposed to be returned to the offshore marine environment into a natural seabed depression.

The proposed offshore area is preferred due to its close proximity to the harbour, and because it has fewer marine flora and fauna compared with the surrounding areas. Water quality and marine flora and fauna around the proposed placement area will be closely managed to ensure there are no long-term impacts.

Have your say

DoT is working closely with Department of Biodiversity, Conservation and Attractions to obtain the required environmental approvals for the proposed campaigns and is committed to minimising its environmental impact.

DoT values community input in project planning and feedback on the proposed offshore material placement area is being sought until 4 September 2019. Feedback can be provided via the contact details below.

Street address	Postal address	Telephone	Fax	Email
		(08) 9435 7604		Email

Jurien Bay Boat Harbour maintenance dredging offshore placement 907 Kb

Project status

About the project

History of the project

Investigative study and data collection

Next steps

Jurien Bay Boat Harbour project related links

Coastal infrastructure project contact list

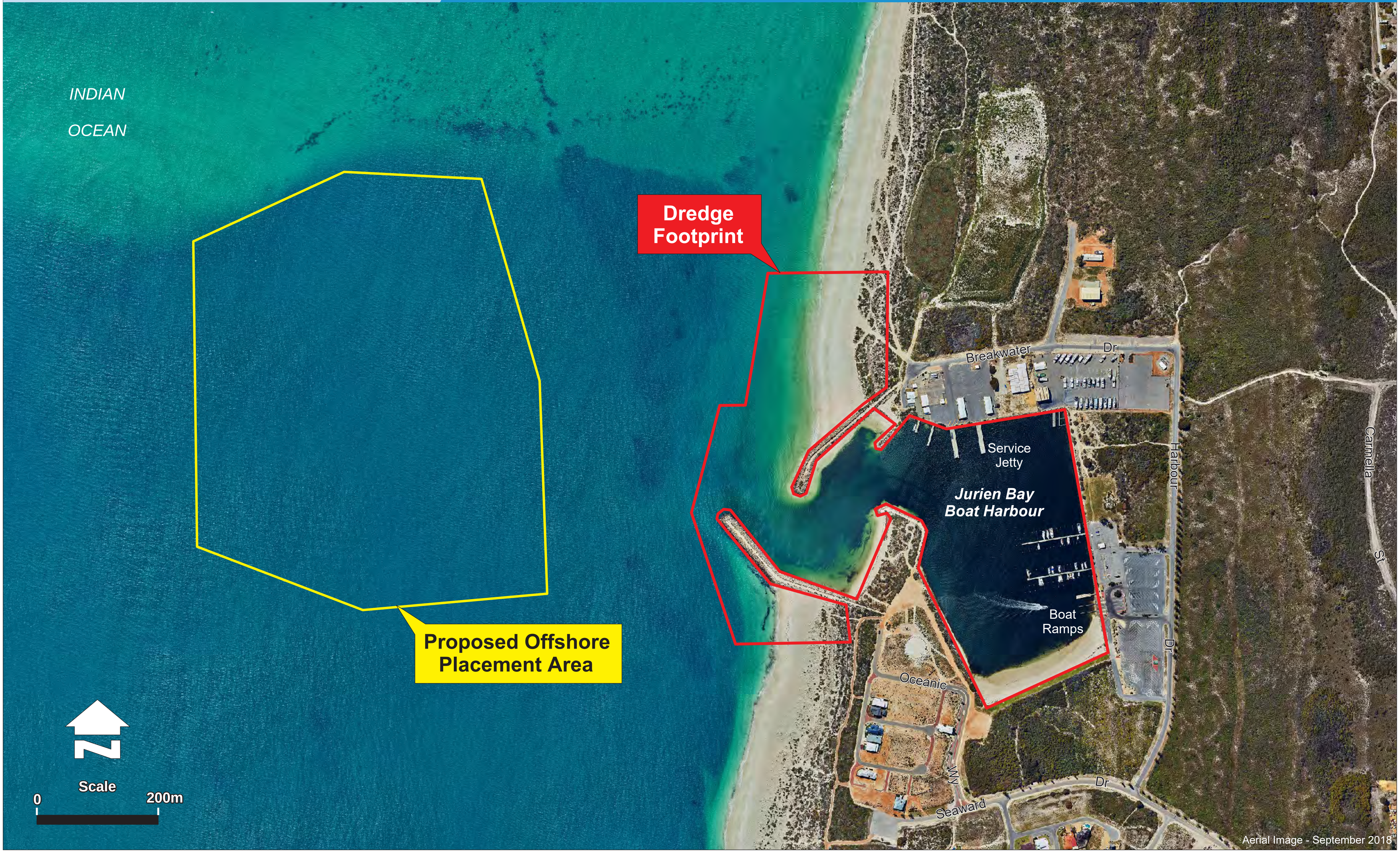
Jurien Bay Boat Harbour project: Documents

Page last updated: Fri Aug 16 2019 8:25:34 AM

Jurien Bay Boat Harbour

Maintenance Dredging Offshore Placement

Department of Transport



projectmapping@transport.wa.gov.au

8 July 2019; Plan No: 6330401

Ben Davis

From: Synnot, Louise <Louise.Synnot@transport.wa.gov.au>
Sent: Friday, 23 August 2019 8:49 AM
To: Ben Davis
Subject: [External] Fw: Have your say - Jurien Bay Boat Harbour Maintenance Dredging Campaigns

---

From: Mills, Jackie
Sent: Friday, 23 August 2019 8:42 AM
To: Synnot, Louise
Cc: Newnham, Joyce
Subject: FW: Have your say - Jurien Bay Boat Harbour Maintenance Dredging Campaigns

Hi Louise,

The email below was sent to all Jurien Bay penholders on Monday 19th August 2019.

Regards,

Jackie Mills
Regional Officer | Regional Services | Department of Transport
65 Chapman Road, Geraldton WA 6530
Tel: (08) 9216 8191 | Fax: 9216 8004
Email: Jackie.Mills@transport.wa.gov.au | Web: www.transport.wa.gov.au

---

From: MidWest
Sent: Monday, 19 August 2019 2:13 PM
Subject: Have your say - Jurien Bay Boat Harbour Maintenance Dredging Campaigns

Dear Penholder,

Have your say - Jurien Bay Boat Harbour Maintenance Dredging Campaigns

The Department of Transport (DoT) is seeking feedback from the community and users of Jurien Bay Boat Harbour in relation to an offshore placement area for future maintenance dredging campaigns.

Sand and seaweed from the offshore marine environment are transported into Jurien Bay Boat Harbour via natural coastal processes and accumulate within the entrance channel and basin. Maintenance dredging is the process undertaken to manage and redistribute accumulated marine sands and seaweed in order to restore safe water depth for navigation, maintain water quality and provide ongoing access and operational use of the harbour.

Material generated from Jurien Bay Boat Harbour maintenance dredging campaigns has historically been placed into the dune system north of the harbour. DoT is seeking a long-term sustainable solution with the material now proposed to be returned to an offshore placement area into a natural seabed depression within the marine environment.

DoT is working to obtain the required environmental approvals for the maintenance dredging campaigns and feedback on the proposed offshore material placement area is being sought until 04 September 2019.

People wanting more information can visit https://www.transport.wa.gov.au/projects/jurien-bay-boat-harbour.asp and feedback can be provided by emailing dredging@transport.wa.gov.au or contact the project team on 9435 7604.

Media contact: media@transport.wa.gov.au"

Jackie Mills
Regional Officer | Regional Services | Department of Transport
65 Chapman Road, Geraldton WA 6530
Tel: (08) 9216 8191 | Fax: 9216 8004
Email: Jackie.Mills@transport.wa.gov.au | Web: www.transport.wa.gov.au

» CLEAR DIRECTION » FRESH THINKING » EXCELLENT SERVICE » GREAT PEOPLE

Ben Davis

From: Synnot, Louise <Louise.Synnot@transport.wa.gov.au>
Sent: Friday, 23 August 2019 12:28 PM
To: Ben Davis
Subject: [External] Fw: Have your say - Jurien Bay Boat Harbour Maintenance Dredging Campaigns

---

From: Mills, Jackie
Sent: Friday, 23 August 2019 10:36 AM
To: Synnot, Louise
Subject: FW: Have your say - Jurien Bay Boat Harbour Maintenance Dredging Campaigns

Hi Louise,

The email below has been sent to Jurien MAG members.

Regards,

Jackie Mills
Regional Officer | Regional Services | Department of Transport
65 Chapman Road, Geraldton WA 6530
Tel: (08) 9216 8191 | Fax: 9216 8004
Email: Jackie.Mills@transport.wa.gov.au | Web: www.transport.wa.gov.au

Department of Transport | We're working for Western Australia.

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From: Mills, Jackie
Sent: Friday, 23 August 2019 10:35 AM
Subject: FW: Have your say - Jurien Bay Boat Harbour Maintenance Dredging Campaigns

Dear MAG members,

Have your say - Jurien Bay Boat Harbour Maintenance Dredging Campaigns

The Department of Transport (DoT) is seeking feedback from the community and users of Jurien Bay Boat Harbour in relation to an offshore placement area for future maintenance dredging campaigns.

Sand and seaweed from the offshore marine environment are transported into Jurien Bay Boat Harbour via natural coastal processes and accumulate within the entrance channel and basin. Maintenance dredging is the process undertaken to manage and redistribute accumulated marine sands and seaweed in order to restore safe water depth for navigation, maintain water quality and provide ongoing access and operational use of the harbour.

Material generated from Jurien Bay Boat Harbour maintenance dredging campaigns has historically been placed into the dune system north of the harbour. DoT is seeking a long-term sustainable solution with the material now proposed to be returned to an offshore placement area into a natural seabed depression within the marine environment.

DoT is working to obtain the required environmental approvals for the maintenance dredging campaigns and feedback on the proposed offshore material placement area is being sought until 04 September 2019. People wanting more information can visit https://www.transport.wa.gov.au/projects/jurien-bay-boat-harbour.asp and feedback can be provided by emailing dredging@transport.wa.gov.au or contact the project team on 9435 7604.
Media contact: media@transport.wa.gov.au"

Jackie Mills
Regional Officer | Regional Services | Department of Transport
65 Chapman Road, Geraldton WA 6530
Tel: (08) 9216 8191 | Fax: 9216 8004
Email: Jackie.Mills@transport.wa.gov.au | Web: www.transport.wa.gov.au

HAVE YOUR SAY - JURIEN BAY BOAT HARBOUR MAINTENANCE DREDGING CAMPAIGNS

The Department of Transport (DoT) is seeking feedback from the community and users of Jurien Bay Boat Harbour in relation to an offshore placement area for future maintenance dredging campaigns.

Sand and seaweed from the offshore marine environment are transported into Jurien Bay Boat Harbour via natural coastal processes and accumulate within the entrance channel and basin. Maintenance dredging is the process undertaken to manage and redistribute accumulated marine sands and seaweed in order to restore safe water depth for navigation, maintain water quality and provide ongoing access and operational use of the harbour.

Material generated from Jurien Bay Boat Harbour maintenance dredging campaigns has historically been placed into the dune system north of the harbour. DoT is seeking a long-term sustainable solution with the material now proposed to be returned to an offshore placement area into a natural seabed depression within the marine environment. DoT is working to obtain the required environmental approvals for the maintenance dredging campaigns and feedback on the proposed offshore material placement area is being sought until 04 September 2019.

People wanting more information can visit https://www.transport.wa.gov.au/projects/jurien-bay-boat-harbour.asp and feedback can be provided by emailing dredging@transport.wa.gov.au or contact the project team on 9435 7604.

ONE IN FOUR RETIREES HAS LOST MORE THAN $1,000 IN CREDIT CARD FRAUD

One in four retirees has lost more than $1,000 in credit card fraud, according to new research that has also identified the two most common scams affecting over-65s. The research, conducted by Compare the Market, reveals that scammers most commonly target over-65s and that baby boomers aged 55-64 were the next in line with 22 per cent reporting scams

Younger people seem savvy about being scammed, with just 11 per cent of cardholders under 25 registering fraudulent activity on their credit card. The Australian Competition and Consumer Commission (ACCC) says that 3,452 fraud reports involving credit cards have been lodged this year alone, with almost half (47 per cent) marked as online shopping scams.

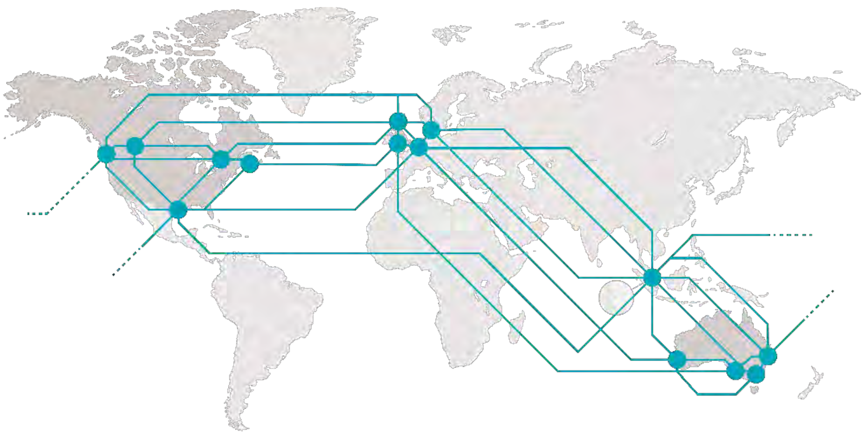
Bank of Queensland money expert Rod Attrill said older Australians were especially prone to online shopping and credit card cons as many weren't up to speed with a cashless, and often cardless, society. "Those heading into the later years of their life are having to keep up with the fast-paced nature of a cashless society, which can prove both difficult and costly," said Mr Attrill.

"Especially for scammers online, this particular demographic is also perceived as having more accumulated wealth, which makes them an attractive target when grabbing card details."

The two main methods scammers are using to fleece older Australians are phishing and identity theft.

"Phishing is where consumers are tricked into giving out their personal information, such as credit card numbers, either online or over the phone," said Mr Attrill, going on to explain how identity theft "is particularly prevalent [as a threat] for those wanting to regularly use card details".

"If you suspect your financial details were stolen, you should alert your bank immediately for a better chance at recovering your money," he said.



BMT is a leading design, engineering, science and management consultancy with a reputation for engineering excellence. We are driven by a belief that things can always be better, safer, faster and more efficient. BMT is an independent organisation held in trust for its employees.

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Registered office
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Brisbane QLD 4000 Australia

For your local BMT office visit www.bmt.org

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