



DAMPIER PORT AUTHORITY

# **Benthic Habitat Report**

# **Dampier Marine Service Facility**

301012-01121

22-Dec-09



#### Infrastructure & Environment

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# **EXECUTIVE SUMMARY**

Dampier Port Authority (DPA) is seeking approval for the Dampier Marine Services facility (DMSF). This will require the dredging of approximately 2.2 Mm3 of material near reclamation, with a balance of cut and fill. Excess water from the reclamation area will be discharged from weir boxes to manage water quality in the discharge water. The proposed dredging operations will create an associated plume that will affect the turbidity of surrounding waters and sedimentation processes resulting in the potential disturbance or loss of subtidal Benthic Primary Producers (BPPs) in the affected area. In accordance with the Environmental Protection Act 1986 (EP Act), all proposals that may result in potential disturbance or loss of marine benthic primary producer communities or habitats, should apply the principles outlined in EPA Guidance Statement No. 3.

In the areas surveyed, live corals were restricted to depths ranging between 1 m and 5 m below chart datum. Coral communities, ranging from sparse cover (1-10%), moderate cover (10-50%) and limited areas of dense cover (>50%) occur as a thin veneer of living coral growing on a substratum of bedrock outcrop and large boulders. Hard coral cover is moderate in the areas surveyed, ranging from almost 25% to just over 40%

The previously dredged area of the proposed DMSF has very low benthic habitat diversity, and is generally similar to the bare sediment area. As the area is significantly deeper and more turbid, very little light penetrates to the seabed. Benthic primary producers (such as seagrass and corals) are absent from this zone.

The risk of increased turbidity having long-term significant impacts on benthic ecosystems in the harbour will be buffered by the natural resilience of the biota to turbidity. If the physical processes which favoured the colonising of the communities are maintained, these communities are likely to recover and colonise suitable substrates i.e. the rock wall and fish communities will utilse fauna on the piles.





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# 1. INTRODUCTION

#### 1.1 **Project Overview**

The Dampier Port Authority (DPA) is proposing to construct and operate an expanded Dampier Marine Services Facility (DMSF) to serve as a centralised Port on the Burrup Peninsula, in the northwest of Western Australia. The DMSF will be constructed for the loading and unloading of large vessels for major industry operating in the surrounding Pilbara region, and will include expansion of the Dampier Cargo Wharf (DCW) which the DPA currently own and operate. Figure 1 shows the location and proposed construction footprint.

The works will include the dredging of 2.2 million m<sup>3</sup> to remove sediment from the seafloor area adjoining the proposed extension of the existing cargo berth and new wharf, and a new land-backed wharf structure. The footprint of the reclamation area is about 22ha, but this will only create some 17ha of land.

The dredging operations will directly impact the benthic substrate, and will also result in the production of a turbid plume that may have indirect effects on the surrounding marine environment. This will result in disturbance and loss of local Benthic Primary Producers (BPP) and their Habitats (BPPH).

Under the *Environmental Protection Act 1986* (EP Act) all proposals that have the potential to result in loss of, or serious damage to, BPPH in (the Western Australian) marine environment should adhere to the guidelines recommended in the EPA Environmental Assessment Guideline No. 3 (formerly Guidance Statement No. 29) which provides a framework for management of BPPH. The Guideline states that the distribution of existing marine habitat must be quantified in order to assess any negative impacts associated with the dredging activity.

This report outlines the data compilation, survey and mapping of marine benthic habitats in the zones of influence using video transects and previously collected data, to create a high resolution benthic habitat map of the area.





Figure 1: Location and footprint of proposed Dampier Marine Services Facility.

#### 1.2 Background

The Dampier Port is bounded by the western coastline of the Burrup Peninsular to the east and Dampier Archipelago to the west. The marine waters between these boundaries are shallow in bathymetry, with depths ranging from 5-20 m LAT (lowest astronomical tide). The channel between these two boundaries is known as Mermaid Sound (Semeniuk et al., 1982).

The area is described as a drowned coastal embayment which is interspersed by a number of small islands often fringed by limestone rock platforms. The seabed generally comprises silt/sand sediments of mixed terrestrial and marine origin, with occasional limestone reef outcrops (Stoddart and Anstee, 2005). These sediments become coarser with increasing wave exposure, and are typically relatively fine in the southern region of Mermaid Sound adjacent to the proposed development (Figure 2).

The marine environment supports of variety of subtidal habitats including coral, limited seagrasses, macroalgae and unconsolidated sediment benthic communities (CALM, 2005). The fringing and subtidal coral communities provide habitat for a range of species including diverse corals, fish and invertebrates. Intertidal areas generally feature mudflats, sand/gravel beaches and rocky shores (CALM, 2005).

The following basic habitats were identified through the Dampier Archipelago by Morrison (2004):



- Eight coral habitats (branching *Acropora*, corymbose *Acropora*, digitate *Acropora*, encrusting non-*Acropora*, massive non-*Acropora* and mushroom coral);
- Three soft coral habitats (alcyoniids, nephtheids and gorgonians);
- Three abiotic habitats (sand, rubble and rock);
- Macroalgae; and
- Five additional habitats (sponge, anemone, mollusc, echinoderm, ascidian).

These are in general agreement with the findings of a later survey by WorleyParsons (2009) studying a *Comparison of the Dampier Port Fringing Reef Benthic Community with Nearby Reef Areas.* The study found twelve basic benthic cover types in the Port and reference locations, namely:

- Algae;
- Sponges;
- Nine hard coral (Acroporidae, Agariciidae, Fungiidae, Pectiniidae, Merulinidae, Dendrophylliidae, Mussidae, Faviidae and Poritidae); and
- Soft coral

#### 1.3 Scope of Work

DPA commissioned WorleyParsons Pty Ltd (WP) to conduct surveys to acquire baseline data on the distribution of BPPHs, and compile existing information in order to create a benthic habitat map for the marine environment adjacent to the development area.

The study and resultant benthic habitat map were commissioned following feedback from EPASU regarding the key factors for assessment. The specific feedback was:

The proponent will need to undertake an assessment of BPPH loss consistent with Environmental Protection Authority (EPA) Guidance Statement No. 29: Benthic Primary Producer Habitat Protection for Western Australia's Marine Environment.

Further comment:

The proponent needs to provide a detailed benthic habitat map that includes all benthic habitats, not just BPPH.

In addition to this:



It is necessary for the proponent to assess/survey the distribution of seagrass within the zone of influence of the development on a seasonal basis. (Seagrass has a seasonal distribution in this area and is generally not present throughout the year.)

The survey findings will be used to guide the management decisions required to satisfy the requirements of the EPA Environmental Assessment Guideline No. 3 (formerly Guidance Statement No. 29) (EPA, 2009).



# 2. LEGAL REQUIREMENTS AND RELEVANT GUIDELINES

#### 2.1 Environmental Assessment Guidelines

The EPA Environmental Assessment Guideline (No. 3) defines Benthic Primary Producer Habitats (BPPH) as seabed communities within which algae (e.g. macroalgae, turf and benthic microalgae), seagrass, mangroves, corals or mixtures of these groups are prominent components (EPA, 2009). The EPA recognises the fundamental ecological importance of BPPHs and the potential consequences of their loss. They also acknowledge that almost all marine development proposals will result in the loss of some of these important habitats (EPA, 2009).

For the purposes of this study, the following definitions were adopted:

- Benthic Primary Producers (BPP) are primarily marine plants such as seaweeds, seagrasses, mangroves, turf algae, and benthic microalgae, but also includes the scleractinian corals (which gain a large proportion of their energy from internal symbiotic microalgae).
- BPPHs are a combination of the BPPs and the substrata that can support them. BPPHs include not only areas of existing BPPs, but also areas which previously supported them or which may be colonised by BBPs in the future. Examples of BPPHs include coral reefs, seagrass meadows, mangrove forests, intertidal mud flats and seabed where macroalgal, coral or seagrass communities have grown and could grow.
- Other benthic habitats such as those dominated by sessile animals that have light requiring
  organisms associated with them (e.g. soft corals, sponges and ascidians) are recognised as
  being important but the loss of or damage to these habitats would be treated separately in the
  Environmental Impact Assessment process.

This report groups distinct benthic communities into broad biotic groups based on the primary biota types.



### 3. METHODS

#### 3.1 Literature Review

All available scientific and technical studies regarding the Dampier Archipelago were reviewed in order to identify and integrate all relevant existing habitat distribution data, and provide a basis for survey design and habitat classification schemes. Compilation of existing data also included the acquisition, reprocessing and presentation of aerial photography, satellite imagery, existing habitat maps (created through a range of techniques), bathymetric charts and detailed bathymetric sounding information.

Multiple coral monitoring/mapping methodologies have been used within the Archipelago since Wilson (1974) who surveyed 30x30m grids for the species composition of Acanthaster populations. Generally all involved some form of transect to analyse and interpret coral health/mortality and/or abundance/diversity.

The majority of researchers in the Archipelago use the AIMS methodology or variations of it. Table 1 lists the variety of methods used in the Archipelago. Recent studies by Mscience (2004b, 2005b, 2005a, 2006a, 2006e, 2006b, 2007a, 2007b, 2008, 2009) in the Archipelago uses 5 x 10 m fixed transects to define a site. Benthic cover is estimated by scoring the benthic category beneath 50 points in each of 10 still photos taken at metre intervals along each transect. The photos are taken from a height of about a metre and measure about 50 x 70 cm (Stoddart et al., 2005).



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Table 1         Review of previou	Review of previous studies methodologies within the Archipelago					
Author/year	Title	Methodology				
Wilson, B. R. and L. M. Marsh (1974)	Acanthaster studies on a western Australian coral reef	30 x 30m Grids				
Marsh. L.M (1978)	Report on the corals and some associated invertebrates of the Dampier Archipelago	Line intersect method				
Paling, E. I. (1986)	Analysis of coral community data using multivariate techniques, and their application to other community data	Line intersect method				
Hilliard, R. W. and P. N. Chalmer (1992)	Incidence of Drupella on coral monitoring transects between Serrurier Island and Mermaid Sound. Drupella cornus: A synopsis.	Line intersect method				
Ecos Consulting (1996)	Marine monitoring of dredging operations in Mermaid Sound.	Line intersect method – 50m transects				
LeProvost Dames & Moore (1999)	Chemical and Ecological Monitoring of Mermaid Sound.	Line intersect method - 60m transects – represents the results of 1994, 1995, 1996, 1997 and 1998 dredge program for Woodside				
MScience (2003)	Dampier Port Authority Dredging Project Benthic Coral Community Monitoring Baseline Data Report.	5 x 10 m transects, 1 photo taken every metre and processed (50 random points)				
Hutchins, J. B., S. M. Slack- Smith, et al. (2004)	Methodology	Line intersect method – 25m transects				

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Author/year	Title	Methodology		
MScience (2004) Dampier Port Upgrade Project: Coral Studies		5 x 10 m transects, 1 photo taken every metre and processed (50 random points)		
MScience (2004)	Bulk Liquids Berth Project: Species-specific assessment of coral mortality during dredging: July 2004	5 x 10 m transects, 1 photo taken every metre and processed (50 random points)		
Blakeway, D. R. and B. Radford (2005)	Scleractinian Corals of the Dampier Port and inner Mermaid Sound: species list, community composition and distributional data.	5 x 10 m transects, 1 photo taken every metre and processed (50 random points)		
Stoddart, J. A., D. R. Blakeway, et al. (2005)	Rapid high-precision monitoring of coral communities to support reactive management of dredging in Mermaid Sound, Dampier, Western Australia.	5 x 10 m transects, 1 photo taken every metre and processed (50 random points)		
Mscience (2005)	Coral Distribution in the Port of Dampier.	Drop down video camera over a videoed transect of varying lengths		
Mscience (2005)	Woodside Dredging Program: Coral Monitoring Baseline.	5 x 10 m transects, 1 photo taken every metre and processed (50 random points)		
Mscience (2006)	Woodside Dredging Program: Post Dredging Coral Monitoring Report November 2006	5 x 10 m transects, 1 photo taken every metre and processed (50 random points)		
Mscience (2006)	Pluto LNG Development: Coral Loss Estimate	5 x 10 m transects, 1 photo taken every metre and processed (50 random points)		
Mscience (2006)	Pluto LNG Development: Baseline Studies for Coral and Sediments.	5 x 10 m transects, 1 photo taken every metre and processed (50 random points)		
Mscience (2006)	Pluto LNG Development: Coral Loss Assessment - Model	5 x 10 m transects, 1 photo taken every metre and processed (50		





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Author/year	Title	Methodology		
	Two.	random points)		
Mscience (2007)	Dampier Cargo Wharf Habitat Survey	Drop camera every 20m on transect and 10m line intersect transects		
Mscience (2007)	Pluto LNG Development: Coral Habitat Survey	Drop camera		





# 3.2 Survey Design

A conservative model of the potential extent of the sediment plume was created by APASA (2009) based on bathymetric and oceanographic conditions such as the tidal currents, prevailing winds and continental shelf waves. Using the modeled plume extent and assessment of the distribution of existing data, an underwater video and SCUBA survey was designed. Transects and survey sites were proposed to acquire sufficient data from both the reclamation footprint and the areas exposed to dredge plumes, of the benthic habitat in the affected areas.

### 3.3 Underwater Video Surveys

A drop-camera and towed video survey was conducted in October 2009, followed by a SCUBA survey in November 2009 (WorleyParsons, 2009a). The survey covered the direct footprint area and predicted plume extent. The use of remote underwater video allows multiple sites to be rapidly and safely surveyed, providing basic information about the distribution and structure of benthic habitats. A series of GPS coordinates representing the start and finish location of each transect were generated, enabling the vessel to navigate along each transect line. Similarly, the planned drop camera survey points were also uploaded into the GPS for accurate location during the field survey.

A Splash Cam *Delta Vision Industrial* underwater video recorder and acquisition equipment was deployed for the purposes of this survey. Incoming video information was monitored on a small viewing screen during the survey to ensure video quality, and that an adequate view of the substrate was being recorded at all times. Spatial and temporal positioning data were recorded using a handheld Garmin GPS unit (76CSx), which continually recorded accurate time and GPS coordinates (every second) for all transects. This enabled the accurate matching of seabed features observed in the video with position using a common time stamp. Key changes in the benthic habitat type as observed in the field were also recorded as GPS waypoints during the survey.

# 3.4 Video Data Analysis and Classification

All video results for each transect line and drop camera site were analysed and classified in the office by a trained specialist to determine key habitat types. Benthic habitats were classified into 8 key types:

- High relief reef.
- Low relief reef.
- Mixed reef and sediment.





- Scattered rock on sediment.
- Seagrass.
- Bare sediment.
- Algae.
- Mixed algae and seagrass.

Benthic habitat type was classified as per the key types above on approximately 30-second intervals during the video interpretation. The time of each benthic habitat change was then correlated with the continuously monitored GPS position, and Geographical Information Systems (GIS) software was used to plot the benthic habitat types by location in shape file format. The location of key benthic habitat changes was then validated using GPS locations taken during the field survey (see above).

### 3.5 Habitat Map Production

A benthic habitat map was compiled from a variety of data sources in order to quantify the spatial distribution of the main intertidal and subtidal environments within the zone of influence (Table 2). The various habitats in the Archipelago were characterised using detailed observation methods (e.g. diving, underwater video and review of previous investigations) at a series of spatially limited sites. For map production, a series of broad scale geophysical datasets (bathymetry, charts, aerial photography) were used to place the observational data into a broader context. Habitat boundaries, as defined by the broad-scale datasets, were then manually digitised in a GIS environment. No automated habitat classification techniques were used due to the highly inconsistent coverage and resolution of base data layers (Table 2).

Data Source	Useable Scale	Region	Source	Description
Existing bathymetric data	1:10,000- 1:25,000	Whole region, resolution highly variable.	WP, DPA	High resolution multi- beam and single-beam sonar sufficient to delineate geomorphic features.
Bathymetric charts	1:25,000	Whole region.	Australian Hydrographic Service (AHS)	Delineates broad depth contours and known reefs/shoals where no other information is





Data Source	Useable Scale	Region	Source	Description
				present.
Aerial photography mosaics	1:5000	Whole region.	DPA, 2007	Intertidal and shallow subtidal areas only, where water clarity is adequate.
Broad scale satellite imagery (Landsat ETM7)	1:25,000	Whole region.	WP	Coarse resolution; intertidal and shallow subtidal areas only, where water clarity is adequate.
LiDAR Altimetry Survey	1:5000	Whole region.	DPA	Terrestrial laser altimetry data; covers shallow areas to a depth of -4 m CD.
Towed underwater video transects (WP)	1:5000	Linear transect lines at selected locations.	WP, October 2009	High resolution observational habitat information for linear transects where water clarity permits.
Drop camera sites (WP)	1:5000	Point sites in the DMSF zone.	WP, October 2009	High resolution observational habitat information where water clarity permits.
Coral habitat dive surveys (WP)	Point locations	Various sites around the Archipelago.	WP, November 2009	Very high detail, quantitative data for selected sites.
Existing habitat survey sites (points)	Point locations	Various sites around the Archipelago.	DPA	Over 50 field trips of survey data





# 4. RESULTS

# 4.1 Literature Review Results

#### 4.1.1 Seagrass

Nine species of seagrasses occur in the Dampier Archipelago, but whilst they are diverse they tend to have reduced biomass compared to the dense meadows that form in southern Western Australia (Wells and Walker, 2003). The seagrass species found within the Archipelago and their distributions are as follows:

- Cymodocea angustata (perennial) has been found to occur at between depths of 1-17m on sandy bottoms, growing together with or near patches of *Syringodium isoetifolium*, *Halophila ovalis* and *Halodule uninervis* (McMillan, 1983). It grows in currents of 0-1 knots (Walker et al., 1988).
- *Enhalus acoroides* (perennial) is found in coarse sediments on top and around the edges of raised reef platforms and near tidal channels where the plants are subjected to fast currents. It can also form meadows on sandy and muddy bottoms, where it traps fine particulates (Walker D.I., 1987).
- *Halophila decipiens* (perennial) is widespread on the Western Australian coastline, and has frequently been found mixed with *Halophila ovalis* on rock with a thin sediment veneer or in pools. It is found at depths of up to 35m, and also in rock pools at the mid-tide level (Walker D.I., 1987). It grows in currents of 0-1 knots (Walker et al., 1988).
- *Halophila minor* (perennial) grows in sand and mud on intertidal areas and mud flats (Western Australian Herbarium, 2009).
- *Halophila ovalis* (perennial) is dominant in intertidal systems, where it is often associated with mangroves. It has a very wide ecological tolerance and a high turnover rate, and is important for dugong grazing (Walker D.I., 1987). It can grow in white sand and mud, and is found in tidal pools, reefs and intertidal areas (Western Australian Herbarium, 2009). It grows in currents of 0-1 knots (Walker et al., 1988).
- *Halophila spinulosa* (perennial) is a deep-water species (up to 45m depth), but has also been found at 8-15m depth in coarse sediment in areas away from direct tidal streams. In shallower water in areas of rapid tidal movement, it occurs in patches between larger species or as





sparse populations (Walker D.I., 1987). *H. spinulosa* was reported growing at depths of 3-14m and in currents of 0-1 knots in Shark Bay (Walker et al., 1988).

- *Halodule uninervis* (perennial) is found on sand or mud substrate in tidal pools and reef flats (Western Australian Herbarium, 2009).
- *Syringodium isoetifolium* (perennial) grows in sand and forms sparse colonies on reefs (Western Australian Herbarium, 2009), and grows to depths of 0-14m in Shark Bay (Walker, Kendrick & McComb 1988). It grows in currents of 0-1 knots (Walker et al., 1988).
- *Thalassia hemprichii* (perennial) has been found in reef-associated habitats and is common around coral rubble with *Halophila ovalis* or *Halodule uninervis*. It accumulates sediment on raised reefs, as well as at depth (Walker D.I., 1987).

The key threats to seagrass communities are identified as habitat alteration, increasing turbidity and lower light regimes primarily as a result of increasing dredging. Species such as *Halophila sp.* and *Halodule sp.*, occur within the macroalgal meadows, and are the dominant plants of some shallow sand flat areas near the coast. Seagrass is the principal food of Dugongs (*Dugong dugon*). They are also consumed by other herbivores such as the Green Turtle (*Chelonia mydas*), which also grazes on the macroalgae beds found in the region.

Whilst the literature suggests these species are perennial, experience in similar projects has shown seagrass species are ephemeral and seasonal senescence occurs in some species The field survey subsequently investigated further the potential distribution of seagrass, the survey was timed to be at the growing season for seagrasses in the area to capture the largest areal coverage of seagrass communities. A concurrent study being undertaken by WorleyParsons (WorleyParsons, 2009b) identified a silty habitat which is typical in the south of Mermaid Sound and less preferential habitat for seagrasses (Figure 2)..

A study undertaken by Bertolino (2006) further indicated seagrass species in the Dampier Archipelago are distributed in the coarser more compact sediments. In general, sites with sediments dominated by the larger grainsize fractions supported a larger biomass of seagrass than those dominated by clays and silts fractions (Figure 3). It is suggested that in the coarser, compact sediments resuspension is less likely to occur; therefore the water column is less likely to be turbid where light limitation and smothering of seagrasses could occur. Regardless, the sediments identified in the zones of influence were devoid of seagrass and appeared unsuitable for rhizome settlement.

Of further note was that BPPH<6mLAT was primarily rocky boulders unsuitable for seagrass. A study by Bertollino (2006) concluded that depths greater than 6m LAT (typically rocky BPPH in zones of impact) are not suitable for seagrass growth within the Dampier Archipelago. This current study was executed in October or spring. Tropical species typically exhibit a 'bimodal' growth pattern, where the





majority of their growth occurs during spring and autumn when the water temperatures are within their optimal growth range (Lee et al., 2007).

Based on the arguments above that geology, depth, habitat and the complete absence of seagrass (that was expected to be at its most abundant time of year if present) during this survey would indicate that seagrass does not occur in the impact zone.







Figure 2 Surface sediment grain size Mermaid Sound



Figure 3 Diagrammatic representation of approximate seagrass distribution (maximum and minimum depth (CD) where seagrasses were found during survey, diagram not to scale with approximated depth of high (HT) and low (LT) tides) (Bertolino, 2006).





### 4.1.2 Coral Communities

Coral communities of the Dampier Archipelago provide habitat for diverse communities of fish and marine invertebrates. The majority of corals in the Archipelago occur at depths between 0-10 m (Jones, 2004). A total of 229 scleractinian coral species from 57 genera had been recorded in the Dampier Archipelago. Coral reef communities fringe the islands and coastline of Mermaid Sound and vary in their structure with increasing distance from the mainland as water quality improves (EPA, 2003).

It is widely recognised that coral communities provide high ecological value to the marine environment. As such coral communities within the Dampier Archipelago have been researched to identify community structure and ecology and minimise and mitigate impacts associated with port development and other anthropogenic impacts. Historically, taxonomic surveys and ecological research have concentrated on the outer Archipelago (Griffith, 2004), while studies associated with monitoring potential impacts on coral from industrial development and port expansion have focused on nearshore areas (Blakeway and Radford, 2005).

The coral reefs found fringing the industrial developments along the western Burrup Peninsula experience elevated levels of natural turbidity and suspended sediment almost all year, and coral communities appear to be relatively resilient in terms of there persistence (Blakeway and Radford, 2005). The *Turbinaria* and mixed coral assemblages found in this area are considered less sensitive to turbidity and sedimentation compared with the *Pavona*, *Porites* and *Acropora*-dominated assemblages found further offshore (Blakeway and Radford, 2005).

Coral reefs have been recorded in the vicinity of King Bay, and between Phillip Point and Dampier Public Wharf. The majority of coral habitat identified within the Dampier Port Boundary occurs in the immediate subtidal area – between approximately Spring Low Water and -4m LAT (MScience, 2005a).

Coral communities located within 2 km of the proposed development are generally representative of nearshore coral communities found throughout the Dampier Archipelago and those identified within the proposed reclamation footprint. Densities are generally low to medium (10-25% cover) and consist predominantly of sediment tolerant species such as faviid/turbinaria and porites species (MScience, 2005a).

#### 4.2 Survey Results

A total of 29 towed underwater video transects (Figure 4; Figure 5 and Figure 6) and 20 drop camera sites (Figure 4) were completed during October, 2009. Fourteen transects covered the direct dredging and reclamation footprint ("Footprint Transects") and fifteen transects were undertaken in the predicted impact zone of the dredge plume ( "Plume Transects"). All transects commenced as close to the shoreline as possible.



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Figure 4: Underwater video transects and drop camera sites acquired near the proposed DMSF development during the October 2009 survey.



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# Classification





Figure 5: Underwater video transects for the broader area of influence (North), acquired during the October 2009 survey.



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Figure 6: Underwater video transects for the broader area of influence (South), acquired during the October 2009 survey.





Transects were typically 15-20 minutes in total. Transects were terminated after 5 minutes of the same benthos (bare sediment only benthos type) and the depth stratum was >10m. This approach of shorter transects allowed coverage of a greater length of seabed during the available sampling time without compromising the quality of transects. Transect length was also constrained by turbidity. The turbidity levels meant the camera had to be lowered to within 0.30m of the bottom. Consequently, the small field of view meant the transects took significantly more time than expected.,







Figure 7: Images taken from the video footage (clockwise from top left: coral community (including *Turbinaria* and *Lobophyllia* corals), mixed coral and algal community, sparse seagrass (*Halophila*), brown algae on bare sediment, sparse algae on muddy sand, bare sand).





# 4.3 Spatial Distribution of Benthic Habitats

Using the data collected during the drop-camera video survey, and previously collected data sets outlined in Section 3.4, a benthic habitat map of the potential zone of influence within the Dampier Archipelago was created. The map is presented in Figure 8, Figure 9 and Figure 10.

The primary benthic habitats which occur in the DMSF area (Figure 8) include intertidal and shallow subtidal rocky shore, bare sediment and high to moderate profile reef colonised by coral and macroalgal communities. In the broader region of influence (Figure 9; Figure 10), the shoreline comprises intermittent rock platforms with relatively short, wide sand/gravel beach systems. Coral and rocky reefs tend to occur seawards of the rocky shoreline areas, and are typically restricted to <100 m distance from the shoreline. A small number of rocky shoals, some of which are known to support corals, occur throughout the region. The unconsolidated benthic substrate typically comprises fine sediments in the south of Mermaid Sound, which become coarser and more dominated by calcium carbonate toward the north. (Figure 2).

# 4.4 Spatial Distribution of Seagrass

Seagrasses were only found in the north-east section of the Dampier Archipelago. In general the survey area appeared to be unsuitable for seagrass habitat due to low light availability and the majority of substrate consisting of silt. This result was expected based on the results of the literature review (Section 4.1.1).







Figure 8: Benthic habitat map for the region adjacent to the proposed DMSF footprint.

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Figure 9: Broader scale benthic habitat map for the southern region of the zone of influence.







Figure 10: Broader scale benthic habitat map for the northern region of the zone of influence.





# 5. DISCUSSION

# 5.1 Coral Communities in the Dampier Archipelago

In the areas surveyed, live corals were restricted to depths ranging between 1 m and 5 m below chart datum. Coral communities, ranging from sparse cover (1-10%), moderate cover (10-50%) and limited areas of dense cover (>50%) occur as a thin veneer of living coral growing on a substratum of bedrock outcrop and large boulders. Hard coral cover is moderate in the areas surveyed, ranging from almost 25% to just over 40%. Massive faviid corals were the dominant hard coral group closely followed by *Turbinaria* spp. corals (family: Dentrophylliidae) and poritid corals. These three families made up 70% of all recorded hard corals. Agariciids (predominately the species *Pavona decussata*), pectiniids and mussids (mainly *Lobophyllia hemprichii*) were also present (WorleyParsons, 2009a). Fast-growing acroporid and pocilloporid corals that often dominate coral reefs (and are susceptible to bleaching impacts) were rare or absent on these reefs covering a combined mean of less than 0.4% of the substratum. The coral assemblage in the DMSF footprint was therefore very similar to other inshore assemblages in Dampier Port; however the areas of coral and hard substrate surveyed in this zone were impacted by sedimentation.

# 5.2 Benthic Habitat Impacts in the Broader Zone of Influence

The impact zone overwhelmingly comprises bare sediment, which ranges in depth from intertidal to a maximum of approximately 8 m below chart datum. The bare sediment ranges in composition from mud to sand fraction sediment, with sparse shell fragments and gravel/rubble occurring in some locations. The intertidal environment is typically rocky reef between small areas of beach. Rocky reef is also a common shallow water environment, and typically supports sparse to moderate coral communities of varying species composition (Section 4.1.2). Sponges were moderately common on these reefs, covering a mean of 3.4% of the substratum but algae and soft corals were rare. A significant area of previously disturbed or modified seabed also occurs in the region, including dredged shipping channels which are typically 5-10 m deeper than the surrounding seabed, and also physical structures such as pipelines and vessel moorings.

# 5.3 Benthic Habitats in the DMSF Footprint

The intertidal foreshore and shallow subtidal zone of the proposed DMSF reclamation area comprises rocky platforms, interspersed by gravel/boulder beach areas. With the exception of oysters within the lower tidal zone, the intertidal area is largely devoid of encrusting or surface dwelling marine flora and fauna, due to the wide range of tidal inundation (~4.5 m) and associated impacts from exposure and desiccation. The occurrence of live corals in this zone is extremely patchy and is generally around 1%. Various common macroalgal species occur in the shallow subtidal zone.





The largest area of habitat directly impacted by the development consists of bare sediment, which is dominated by either mud or sand with sparse shell fragments. The region is highly turbid due to a combination of natural and anthropogenic impacts. The area is relatively devoid of features, supporting only very sparse filamentous green algae and polychaete burrows in some areas. No seagrass or coral has been detected in this area.

The previously dredged area of the proposed DMSF has very low benthic habitat diversity, and is generally similar to the bare sediment area. As the area is significantly deeper and more turbid, very little light penetrates to the seabed. Benthic primary producers (such as seagrass and corals) are absent from this zone.





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