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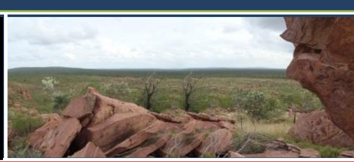
Western Desert
RESOURCES

Chapter 5
Marine

Western Desert Resources Limited
Roper Bar Iron Ore Project



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5.1 Introduction and Background

The following section describes the coastal and marine environments within and directly adjacent to the proposed Western Desert Resources Limited (WDRL) project infrastructure, including characterisation of the physical and biological environment.

WDRL propose to export iron ore out of an existing port (Bing Bong Port) in the south-western Gulf of Carpentaria east of Borroloola. The Bing Bong Port Facility is a single user port facility owned and operated by Xstrata to service its McArthur River Mine (MRM) operation. WDRL propose to construct a separate barge loading facility within the Port to enable transhipment of Direct Shipping Ore to markets in Asia.

The intent of this section is to describe the extant coastal and marine environments including social and economic resources and values, potential threatening processes arising as a result of the proposed mining operation, and measures required to mitigate any impacts.

The study area which has been used to describe baseline conditions of the marine environments includes the coastal zone and marine waters in proximity to the existing Bing Bong loading facility: situated on the south-western coast of the Gulf of Carpentaria near the Sir Edward Pellew group of islands. The marine environment at the mouth of the Towns River has not been considered in detail because all mining infrastructure and activity is located a considerable distance (approximately 80 kilometres upstream) from the mouth of the Towns River and surrounding waters. Even in the event of catastrophic failures at the proposed mine, it is extremely unlikely that marine environments at the mouth of the Towns River will be impacted, and furthermore all coastal and marine infrastructure is located at the Bing Bong Barge Loading Facility over 120 km to the south-east.

However, a discussion of ecological values of the marine environment in proximity of the Towns River Mouth has been included within this chapter as part of the regional context and a discussion of potential impacts upon the Towns River marine environments is provided in this context.

Note that a discussion of potential impacts upon aquatic, terrestrial and estuarine environments of the Towns River is provided in Chapter 4 Terrestrial and Aquatic Biodiversity.

For the purpose of this report, the marine environment in this instance is inclusive of the intertidal zone and both Northern Territory waters (three nautical miles seaward of the MLWS and offshore islands) and Commonwealth marine waters (three to 200 nautical miles from the coast). Chapter 3.7 (Biodiversity) addresses terrestrial and coastal flora and fauna present above the Highest Astronomical Tide (HAT).

The study area includes all marine components of the proposal, specifically the barge loading facility, transhipment anchorages, and existing Port facilities.

The description of the study area includes the results of previous research carried out in the vicinity of the subject site and specifically studies undertaken for the McArthur River Mine Bing Bong loading facility, and other environmental investigations in the region.

A limited number of scientific studies have been carried out within the region in which the proposed marine and coastal infrastructure will be located, predominantly associated with Environmental Impact Assessments carried out for the Bing Bong loading facility.

Studies of the marine environment for the McArthur River mine commenced in 1992 by Charles Darwin University (CDU), and later the Australian Institute of Marine Science (AIMS) and have included sampling of fish assemblages, seagrass, benthic invertebrates and seagrass, sediment and water quality. Where relevant, the results of these studies are summarised.

Impacts to coastal and marine flora and fauna assemblages are described, including their likelihood, consequences, mitigation measures and cross references to other sections of the EIS where appropriate.

5.2 Project Description (Marine Components)

A detailed description of all project operations and infrastructure is provided in Chapters 2.1 - 2.6 Project Planning and Project Components. This section summarises components of the project located in the coastal and marine environments only.

5.2.1 Overview

WDRL proposes to mine iron ore reserves within existing Mining Leases under Application (MLA 28264 and 28963) in the Roper Bar Region of the Northern Territory (the Roper Bar Iron Ore Project). WDRL hold a number of Exploration Leases (ELs) and currently have (Five) Mineral Lease Applications (MLAs) lodged with the Northern Territory Government. WDRL has identified a number of deposits within the MLAs and hope to commence mining these resources once approvals are granted.

The predominant land uses in the region are the existing McArthur River Mine and ancillary infrastructure, pastoral leases, Aboriginal lands and outstations and large areas of undeveloped lands and coastline including the proposed Limmen National Park. There are no significant coastal townships, with the town of Borroloola located approximately 40 km inland from the Bing Bong loading facility, and the Bing Bong Station homestead located approximately 5 km to the west.

The proposal includes a 165km Haul Road between the mine site and an existing facility at Bing Bong. Iron ore will be transported to the existing Bing Bong loading facility via the proposed Haul Road, where it will be deposited and stockpiled inland at a Stockyard Facility approximately 300 m from the coast.

The ore will then be transported to a barge loading facility (described further below) at the Bing Bong loading facility via conveyor where it will be loaded onto a bulk carrier to be conveyed to Ocean Going Vessels (OGV) moored approximately 20-30km offshore in accordance with existing operations at Bing Bong. The existing Bing Bong loading facilities are described briefly below.

5.2.2 Existing Bing Bong Load Out Facilities

The existing Bing Bong load out facility was constructed in 1994 by Xstrata to service the McArthur River Mine, previously owned by Mt Isa Mines Limited, and is located on the south-western coast of Gulf of Carpentaria at 15° 28' S, 136° 14.8' E.

Shore-based facilities at the port include access roads, stockpile area, concentrate storage sheds, site runoff pond, onshore dredge spoil disposal and an administration office and worker accommodation facilities. The port includes a loading wharf, swing basin, rock revetment and dredged 3.5km access channel. Appropriate navigational and safety lighting is provided for the channel, wharf, and bulk carrier for safe night loading and transhipment operations.

Xstrata propose to substantially increase their output of bulk lead-zinc-silver concentrate for export, which has required the preparation of an Environmental Impact Statement. The Environmental Impact Statement is currently under review for approval against the provisions of the NT Environmental Assessment Act (EA Act).

The proposed expansion will require an increased storage capacity. No additional onshore or offshore infrastructure expansions are required, and neither the bulk carrier or transit routes require modification for the proposed expansion (McArthur River Mining Pty Ltd. 2012). Maintenance dredging is currently undertaken approximately every four years, and the proposed expansion is not expected to increase the rate or quantity of dredging.

The port currently exports 375,000 tonnes per annum (tpa) of bulk lead-zinc-silver concentrate with a planned increase up to 800,000tpa by 2014 using a dedicated self-unloading barge for transhipment to an OGV. The proposed expansion of the McArthur River mine will correspondingly increase the number of return barge trips, resulting in an increase from 110 to 250 return trips per year (or 500 total trips).

Figure 5-1 shows the location of current Port of Bing Bong Infrastructure and Figure 5-2 shows the position of the Loading Wharf and Bulk Carrier.

5.2.3 Proposed Bing Bong Barge Loading Facility

The proposed facility, to be known as the 'Bing Bong Barge Loading Facility', will be required to handle bulk DSO initially at a rate of up to 1.5 million tonnes per annum (Mtpa) in its first two years (Phase 1) with a planned increase to 3 Mtpa by the start of the third year of export to the eighth year of operation.

It is proposed the DSO would be transported from the Roper Bar Mine site by covered road trains on a dedicated haul road to the Stockyard or load out facility (approximately 300 m inland from the Port) where it would be stockpiled into shipment size stockpiles. The DSO would subsequently be reclaimed and conveyed to the proposed Bing Bong barge loading facility via an long overland conveyor.

Figure 5-1 Loading Wharf and Bulk Carrier

The area for the barge loader and transfer station is to be constructed on reclaimed land approximately 2m above the HAT. The area for the barge loader will be hardstand and completely sealed and bunded. The berth deck will also be sealed and bunded and will slope landwards to a collection sump, which will capture any material and/or contaminated storm water which will be pumped back to settlement ponds.

The proposed barge loading facility will be comprised of a barge loader and a barge loading berth located in the existing Bing Bong loading facility, to the west of the Xstrata Loading Wharf.

The barge loader would be mounted at the end of the causeway arrangement and the covered export conveyor will travel from the stockpiles directly feed to the barge loader.

The transfer chute to the barge loader would have sufficient capacity to store material from the overland conveyor during stopping sequences if required.

The ore would be loaded onto self-propelled barges that would travel to nominated transhipment anchorages and transferred to OGV's either by floating crane or using ships gear.

Barges will be refuelled by a service truck as per current practice for the MRM operation with a bunded area for the truck and refuelling point.

Additional excavation of the port basin will be required to construct the combi-pile wall: this design has been chosen to minimise excavations which may expose acid sulphate soils (ASS). Berthing piles and mooring bollards will also be required to be constructed in the marine environment.

The facility would be developed in two phases, in line with the capacity requirements. The design life of the barge loading facility is at this stage assumed to be 10 years.

WDRL proposes that the existing Xstrata accommodation village be expanded to accommodate the WDRL personnel. It is estimated that an additional 30 rooms would be required, along with commensurate increases in laundry, dining, communications, power and sewage. The proposed location of the barge loading facility and loading conveyor are illustrated in Figure 5-3 and Figure 5-4.

Figure 5-2 Port of Bing Bong Existing Infrastructure (McArthur River Mining Pty Ltd. 2012).

Figure 5-3 Facing South-East Toward Proposed Barge Landing Facility and Existing Xstrata Facility

Figure 5-4 Facing South Toward Proposed Barge Landing Facility and Existing Xstrata Facility

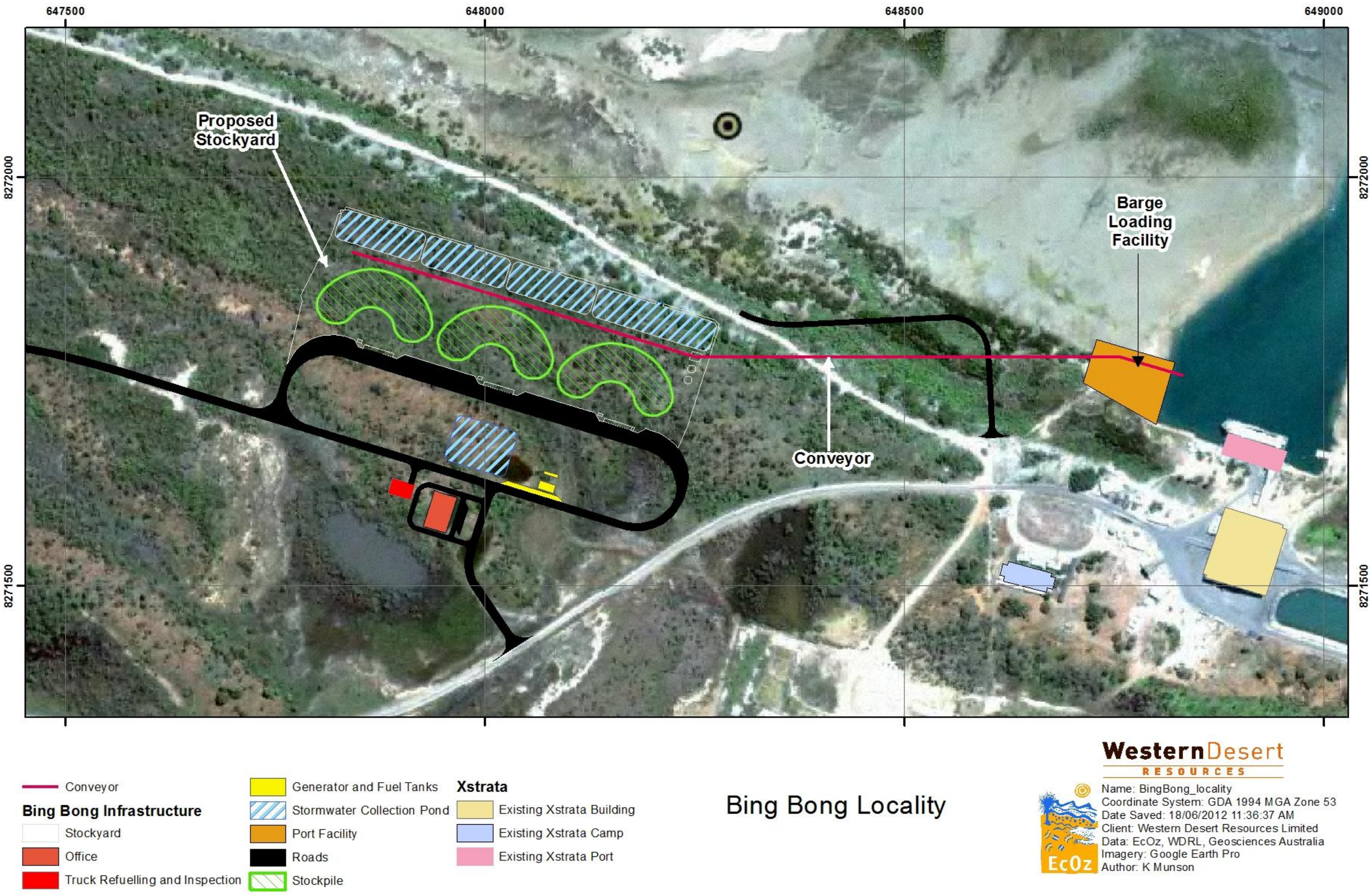

Figure 5-5 Proposed Location of WDRL Barge Loading Facility and Loading Conveyor

5.3 Shipping Operations

Two self-propelled (electrical propulsion) 6300 dead weight tonnage (DWT) barges would transport the DSO from the port to the transhipping point initially for the 1.5Mtpa operations during Phase 1, increasing to three self-propelled barges for the 3Mtpa operations during Phase 2.

During Phase 1, ore will be transferred to a Supramax OGV (65,000 DWT) resulting in an average number of 240 return barge trips per annum (or 480 total trips). During Phase 2, ore will be transferred to a Panamax OGV (90,000 DWT) requiring an average of 480 return barge trips per annum or 960 total trips. This represents a significant increase from the 110 return barge trips per annum Xstrata currently require for their operations, and the planned 250 return barge trips that are planned to commence in 2014 to accommodate the planned expansion of McArthur River Mine operations. Commute trip times and proposed channel utilisation including cumulative shipping rates are presented in Chapter 2 of this EIS (Project Description).

It is proposed that the WDRL barges would utilise the existing port access channel, which is 65m in width and which is currently maintained to a of 3.5m water depth at Mean Low Water Springs (MLWS).

Phase 1, for operations up to 1.5Mtpa, would see the transhipment anchorage location located further inshore (approximately 19NM offshore) due to the shallower draft of the Supramax vessels (minimum depth required approximately 14m).

Further development of the Stockyard (identified in this EIS) would see the transhipment anchorage location relocated to approximately 21NM offshore from the Port to accommodate larger Panamax sized vessels requiring a minimum water depth of 17m. A 32T floating crane would be used to transfer the material from the barges to Panamax-sized OGV during Phase 2 only. The crane would be electrically controlled and would not require the use of hydraulics, minimising the risk of pollution posed by oil leaks and split hoses.

The location of the transhipment anchorages is shown in Figure 5-6

Permanent swing moorings would be required at the transhipment anchorage locations for: the OGV's, grab crane barges, transfer barges, assist tug and tow tug.

Typical and proven moorings will be established. Tow tugs are to have anchor handling capability.

Once loaded, the product will be shipped on OGV's to Asia. The shipping route will not pass through any declared World Heritage Areas or Marine Parks.

The timely transfer of the barges to cyclone moorings in the event of a cyclone warning requires consideration. Cyclone moorings are therefore proposed to be provided at either West or Centre Island. Swing moorings similar to those at the transhipment moorings would be required.

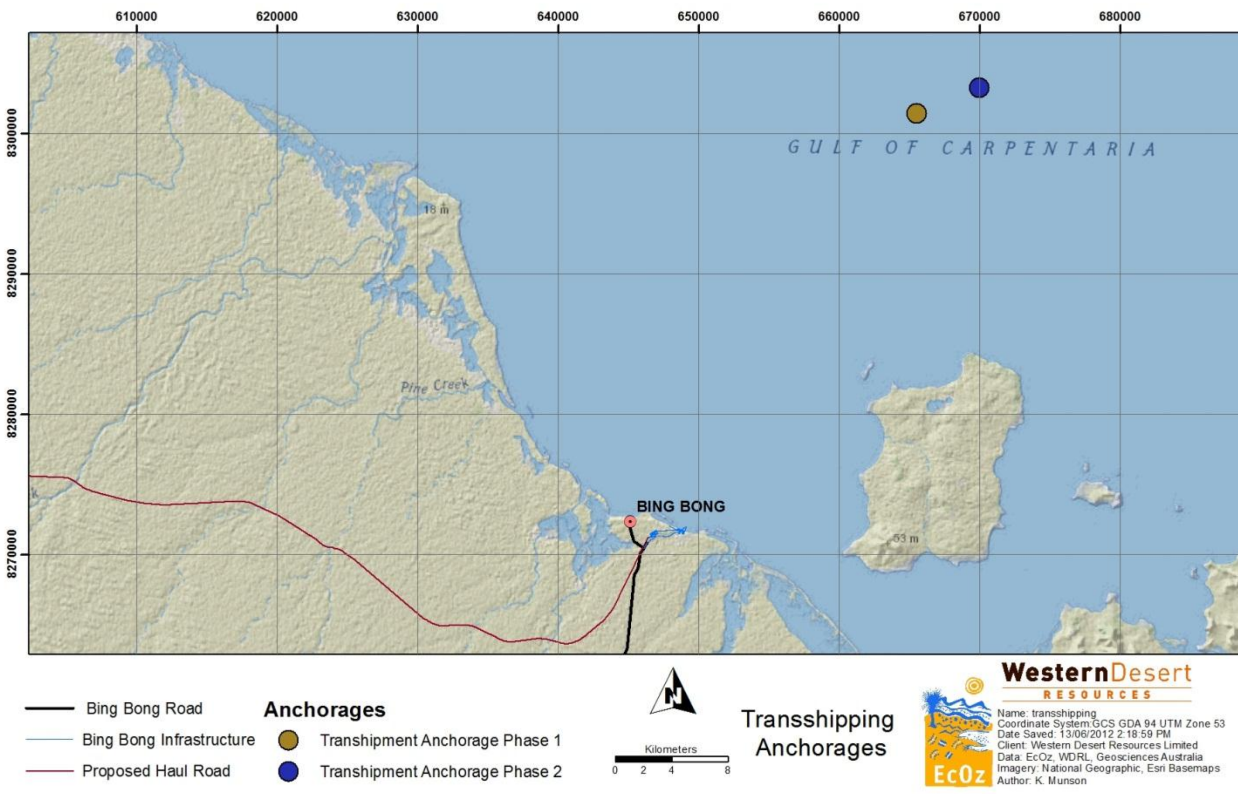

Figure 5-6 Proposed Transhipment Anchorages Phases I and II.

5.4 Physical Environment and Processes

The physical coastal environment and processes are described in the following section, predominantly using pre-existing data for the study area. No numerical hydrodynamic modelling was undertaken with respect to currents, plumes and sediment transport as this information has been provided in support of the original Xstrata Port; and the potential impacts of the WDRL proposal are considered to be negligible with respect to coastal processes (i.e. limited tidal structures and no further dredging are proposed).

5.4.1 Coastal Morphology and Bathymetry

The Gulf of Carpentaria is a shallow and protected body of water occupying 370,000km2 on the continental shelf of Northern Australia (Elliott 1993). The sediment types differ across the gulf however inshore sediments are generally composed of sandy muds in the western gulf, and muddy sands in the eastern gulf, with large expanses of relatively featureless sandy and muddy substrates present in the central basin (DEWHA 2008).

The South Western Gulf of Carpentaria is typified by relatively shallow depths with a coastline dominated by alluvial plains, tidal channels and estuaries of river systems over clays and muds.

The coastline from the Towns River mouth south to Bing Bong follows a north-westerly to south-easterly alignment. Bing Bong is relatively sheltered from prevailing winds and waves by West Island (part of the Sir Edward Pellew Group of Islands), which is located approximately 5km offshore from the coast. The other islands in this group are located further to the east.

The coastline is characterised by low topographic relief, formed by deposition of quaternary marine deposits resulting in tidal inlets, beach flats and low beach ridges. The extant Bing Bong loading facility is located adjacent to a narrow beach berm, with low frontal and hind dune formation and extensive tidal mud flats, in a typical chenier formation. At higher elevations within the coastal zone, low, partially stabilised sand dunes are present, intersected in several locations by tidal channels.

The existing Xstrata barge loading wharf at Bing Bong is located in the swing basin which has a depth of 4.5m, and is dredged by the operators of the Bing Bong facility. The proposed WDRL wharf mooring arrangement would also be located in a minimum depth profile of 4 to 4.5m. Engineered revetment has been constructed at the southern end of the basin, whilst the remaining edges are untreated. Limited bathymetric and topographic survey is available however shallow tidal flats extend to the east and west of the existing basin and access channel, with greater depths (5m) attained approximately 3-5km offshore.

Depths exceeding 18m are reached approximately 40km offshore. Bathymetric survey will be confirmed in the detailed design stage.

5.4.2 Climate

The Gulf of Carpentaria climate exhibits marked seasonality in temperature, rainfall, salinity and wind regimes. The region has a tropical, humid climate with distinct wet and dry seasons, during which temperature, wind and rainfall patterns exhibit marked seasonality. The monsoonal climate results in mild, dry winters, and humid, wet summers (from October to March) during which tropical cyclones cross the Gulf of Carpentaria. Over 100 estuaries, (Saenger 1989) along with associated fresh and salt water wetlands, provide significant inputs into the Gulf marine system during and immediately after the monsoon season.

The average annual rainfall as recorded from the Centre Island station is in excess of 1000mm with average daily temperatures during the wet season ranging from 25-35°C, and 18-33°C during the dry season (Bureau of Meteorology 2012).

The Bing Bong loading facility falls within a Category C rated cyclone area and consequently all facilities will be designed to withstand cyclones, and cyclone moorings for all barges and floating plant provided.

5.4.3 Wind and Wave Climate

Wind data from the Bureau of Meteorology Centre Island station (approximately 40km away) indicate that the prevailing winds are from the south and south-east in the morning and east and north-east in the afternoon, with around 10% of records over 30 km/hour (Mintrex 2012).

The proposed Stockyard Facility is proposed to the west/south-west of the existing Xstrata Facility approximately 300 m landward of the HAT; as the Stockyard is similarly positioned to existing facilities it is therefore assumed to be set-back appropriately.

Bing Bong Harbour faces north/north-east and worst case winds for wave generation would likely be afternoon north-east winds. The Bing Bong loading facility has been located in a sheltered location and consequently the wave climate is considered to be mild (Mintrex 2012).

The offshore anchorage locations are expected to be more exposed to waves from the east, north-east and north-west.

Insufficient bathymetric data is available at this point to accurately hindcast the wave climate for the offshore anchorages and cyclone moorings; however this will be undertaken at detailed design stage.

The wind and wave climate in the Towns River has not been subject to consideration given that no infrastructure is proposed to be located in this area.

5.4.4 Extreme Weather Events

Cyclones in the south-western Gulf are most often experienced from November to April and Bureau of Meteorology (BOM) data indicates that numerous tropical cyclones have made landfall in close proximity to the Bing Bong loading facility (McArthur River Mining 2012).

One of the most severe on record for the region was Cyclone Kathy in 1984, during which trawlers sheltering in the Pellew Islands were damaged and sunk, and sea turtles were stranded up to 7km inland (National Oceans Office 2003).

The BOM has predicted an average of 0.2-0.4 cyclones annually for the Bing Bong region (McArthur River Mine 2012). This would equate to an average of 0.4-0.8 cyclones during a 2 year planning period, and 2-4 cyclones during a 10 year planning period (the maximum life of the project).

Severe meteorological events such as tropical cyclones are often accompanied by a temporary local rise in sea level known as storm surge (OzCoasts 2008). This surge is usually caused by strong onshore winds exerting a stress on the sea surface, which causes water to accumulate adjacent to the coast. Additionally, the low atmospheric pressure within a cyclone can allow a small rise in water level (OzCoasts 2008). As a cyclone moves into shallow coastal waters, the nearshore seabed and coastline shape modify the surge and may result in a substantial amplification of its height.

Tropical cyclones are predicted to increase in frequency and duration in a warming climate (Webster *et al.* 2005), and hence storm surge is an important factor which is required to be taken into account in the planning of coastal infrastructure. Given that the proposed barge landing facility is to be located within an existing loading facility, it is assumed that storm surge levels have been considered in the loading facility design. A 2m storm surge allowance has been included for concept designs, and the Stockyard facility is located at a similar setback distance to existing Xstrata facilities, so is not expected to be impacted by storm surge.

Given the short term nature of the project however (i.e. 10 years), longer term predicted effects of climate change have not been considered in the project design.

5.4.5 Tides and Currents

The interaction between prevailing dry south-east trade winds from May to October, and moister north-westerlies during the wet season combined with tidal flows result in a slow, clockwise movement of water around the coastal margins of the Gulf of Carpentaria (DEWHA 2008).

Tides in the region are diurnal with a range of approximately 2-3 metres. An average of 30 days per year have low tides less than 0.5 m (Louis Dreyfus Ports and Logistics 2012).

Tidal planes are listed in Table 5-1 below derived from Mintrex (2012):

Table 5-1 Tidal Planes (Bureau of Meteorology Centre Island Station)

Tidal Datum	**Level (m AHD)**
Highest Astronomical Tide (HAT)	3.1 m
Mean Higher High Water (MHHW)	3.0 m
Mean Lower High Water (MLHW)	2.2 m
Mean Sea Level (MSL)	1.8 m
Mean High Low Water (MHLW)	1.4 m
Mean Lower Low Water (MLLW)	0.6 m
Indian Spring Low Water (ISLW)	0.5 m

The Australian Standard AS4997 requires that sea level rise be taken into account for structures with a significant design life (i.e. for structures with a design life of 50 years the recommended allowance for sea level rise is 0.2m). Given the relatively short design life of the structure (10 years), no allowance for sea level rise has currently been adopted however this may be subject to review if the project life is expected to extend beyond ten years. Given the well-sheltered nature of the Bing Bong loading facility, currents within the harbour are assumed to be relatively weak and tidal in origin.

5.4.6 Sediment Quality

Sediment samples collected from tidal flats approximately 60m seaward of the existing loading facility (prior to its construction) contain a mixture of sand, silt and shell with an average grain size of about 0.25mm (Mount Isa Mines Limited 1992).

Contemporary monitoring of sediment quality is undertaken by both MRM and the Australian Institute of Marine Science (AIMS) and the results of these investigations are found in the latest version of the *McArthur River Mine: Annual Marine Monitoring Program* (AIMS, 2012).

In general, lead and zinc results for sediments recorded higher concentrations in the swing basin site as opposed to the control sites; indicating that Xstrata operations are causing a measurable impact. Lead isotope analysis undertaken on sediment at a beach site west of the Bing Bong facility also revealed an MRM ore impact. This sample also recorded high concentrations of zinc, arsenic and cadmium. Although all results are below the ANZECC/ARMCANZ (2000) ISQG-Low threshold, zinc, lead and cadmium have shown a trend of increasing concentrations since 2008.

AIMS have also investigated indicated seafloor sediments in the trans-shipment area. Results have indicated elevated lead and zinc concentrations, most likely due to enrichment from fugitive MRM ore concentrate. Contaminated dust present in marine waters and sediments associated with the concentrate storage shed has also been previously identified by independent monitoring of the Bing Bong loading facility operations (Environmental Earth Sciences 2011).

Analysis indicates however that lead and zinc sediment concentrations would not be expected to impact upon sediment quality in the area as they are below the ANZECC/ARMCANZ (2000) ISQG-Low threshold values. MRM have also implemented upgrades to storage facilities and procedures to minimise fugitive ore concentrate. The results of this investigation in full are presented in the report *Metal concentrations and Pb isotope ratios in seafloor sediments from the Xstrata Zinc MRM Trans-shipment area* (AIMS 2010).

5.4.7 Sediment Transport

Sediment transport is driven by a combination of wind, waves, currents and tides. Modern sedimentation in the Gulf of Carpentaria is restricted to water depths of less than 50m and is driven by propinquity to sediment sources as well as exposure to wind and wave activity and tidal regimes (Jones 1987). In the Gulf two distinct zones occur: a shallow, turbid inshore zone in which most sediments are received (at depths of 15-20m), and a deeper offshore zone which is separated by a boundary current (Wolanski and Ridd 1990).

Within tropical estuaries of northern Australia, variation in terrigenous sediment export is extreme between seasons and is controlled by periods of heavy monsoonal rainfall and cyclone activity (Bryce *et al.* 1998). The dispersal of this terrigenous sediment is thought to be controlled by coastline orientation relative to onshore winds, and in the Gulf is distributed seaward (Bryce *et al.* 1998). Shallow depths in the Gulf (<70m) in combination with high tidal energy results in high levels of tidal and wind mixing, and limited mixing with waters external to the Gulf in the adjacent Arafura and Coral Seas (Burford *et al.* 2009).

Examination of wind and wave data indicates that wave-driven longshore transport of sediment is unlikely to be a dominant process in the region due to the low energy environment, with sediment transport likely to be significant during storms or cyclones only.

At the local scale, the major sources of terrigenous sediment within close proximity to the site are likely to be local tidal channels; however these are likely to supply only small amounts of sediment to the coast. Deposition of sediments driven by tidal currents is likely to be occurring in lower sections of the site where mangrove stands are present. Offshore marine sediments are also likely to be lesser contributing sediment sources.

5.4.8 Estuarine and Marine Water Quality

The major inputs of fine sediments from river systems during the wet season result in naturally high turbidity in the Gulf of Carpentaria. The deposition of sediment forms sand bars and mudflats which in themselves are a source of high turbidity throughout the year as sediments are resuspended by wind action and tidal movements. Consequently high turbidity levels are expected year-round. The lack of development or major population centres in the region however suggests that marine water quality in the region should generally be of a high standard.

Monitoring of the Xstrata Bing Bong loading operation is undertaken by both CDU and AIMS and the results of these investigations are found in the latest version of the *McArthur River Mine: Annual Marine Monitoring Program* (AIMS 2012).

A number of marine water quality sites are sampled on a monthly basis including sites around the Sir Edward Pellew Islands. This includes two sampling sites in the swing basin, three in the dredged navigation channel, and three control sites. The monitoring results show that the majority of sites were below the nominated ANZECC/ARMCANZ (2000) threshold for protection of 95% of species, with the exception of the site closest to the swing basin which showed elevated concentrations of lead and zinc, indicating that Port operations are causing a detectable impact (Environmental Earth Sciences 2011).

An Independent Monitors Report has noted that the Bing Bong dredge spoil ponds spoon drain is directing saline, possibly acid leachate from the ponds to the marine environment (Environmental Earth Sciences 2011), which may also be causing localised declines in water quality.

5.5 Marine Ecology

The following sections describe coastal and marine ecological communities of the defined study area and broader region. Subtidal surveys (i.e. soft sediment sampling or inshore fish surveys) have not been undertaken by EcOz Ecologists given that the majority of marine infrastructure is to be located within an existing operational port. Studies of coastal zone communities undertaken in the vicinity of the load out facility by EcOz Ecologists have been undertaken, including terrestrial vegetation mapping, bird surveys, trapping and opportunistic observations. These are described in detail in Chapter 3.7 (Biodiversity) and therefore are not presented in this chapter.

Where relevant, studies undertaken by others in the vicinity of the project site are described.

5.5.1 Marine Protected Areas

Commonwealth marine areas are defined as any part of the sea, including the waters, seabed, and airspace, within Australia's exclusive economic zone and/or over the continental shelf of Australia, that is not in State or Northern Territory waters.

The Commonwealth marine area stretches from three to 200 nautical miles from the coast. The OGV transhipping anchorages are proposed to be located approximately 19-21NM offshore and therefore are to be located within the Commonwealth marine area. Proposed cyclone moorings will be located in the lee of the Sir Edward Pellew Island group within Northern Territory waters.

Marine protected areas are marine areas which are recognised to have high conservation value.

No Commonwealth marine protected areas were identified in the Protected Matters Database Search. No Marine Protected Areas (i.e. Marine Parks administered by the State or Commonwealth) are located within the waters adjacent to the subject site or within the greater south-western Gulf.

The Commonwealth Government is currently developing Marine bioregional plans for Australia's marine regions as part of the marine bioregional planning process. The North Marine Region encapsulates the Commonwealth waters and seabed of the Arafura and Timor seas, and the Gulf of Carpentaria from Cape York Peninsula to the Northern Territory-Western Australia border. This region does not include coastal waters (i.e. from HAT to three nautical miles offshore) and consequently does not include the inshore waters in which the Bing Bong loading facility and navigation channel are located.

A draft Marine Bioregional Plan and a Commonwealth marine reserve network proposal for the North Marine Region has been released for public consultation, and includes proposals for the Limmen Marine Reserve, located offshore from the Limmen Bight, some 100km to the north of the Bing Bong loading facility, and the Gulf of Carpentaria marine reserve to the north and the west of the Wellesley Islands in the southern Gulf approximately 200km south-east of the Port.

As part of the Marine Bioregional planning process Bioregional Profiles have been prepared which detail the ecosystems of each marine region, their conservation values and the Goals and Principles that guide the identification and design of new Commonwealth marine reserves. Relevant information from the North Marine Bioregional Plan Bioregional Profile (DEWHA 2008) has been summarised where relevant.

The Northern Territory Government have also very recently proposed the declaration of a Marine Park in the Limmen Bight, which will extend southward from the mouth of the Roper River to Wuraliwuntya Creek in the Gulf. The Marine Park is subject to a sixty day consultation period ending on the 18 May 2012. It features inshore waters from the mean low water mark, extending three nautical miles and includes waters off Maria Island (NRETAS 2012). The proposed Limmen Bight Marine Park will cover 88,000 hectares comprising 1.2% of the Territory's coastline, and will be approximately one-third the size of the Territory's only extant Marine Park: Garig Gunak Barlu National Park (Parks and Wildlife Commission of the Northern Territory 2012). The Marine Park does not encompass the Bing Bong loading facility, access channel, or Sir Edward Pellew Group with the proposed boundaries located to the north of the Port. The zoning of the Marine Park is yet to be finalised and it is expected that this will evolve through the consultation process. The proposed boundaries are shown in Figure 5-7 below.

The Sir Edward Pellew Island Group have also previously been identified by NRETAS as a proposed Marine Conservation Area however this has not been gazetted (NRETAS 2007a).

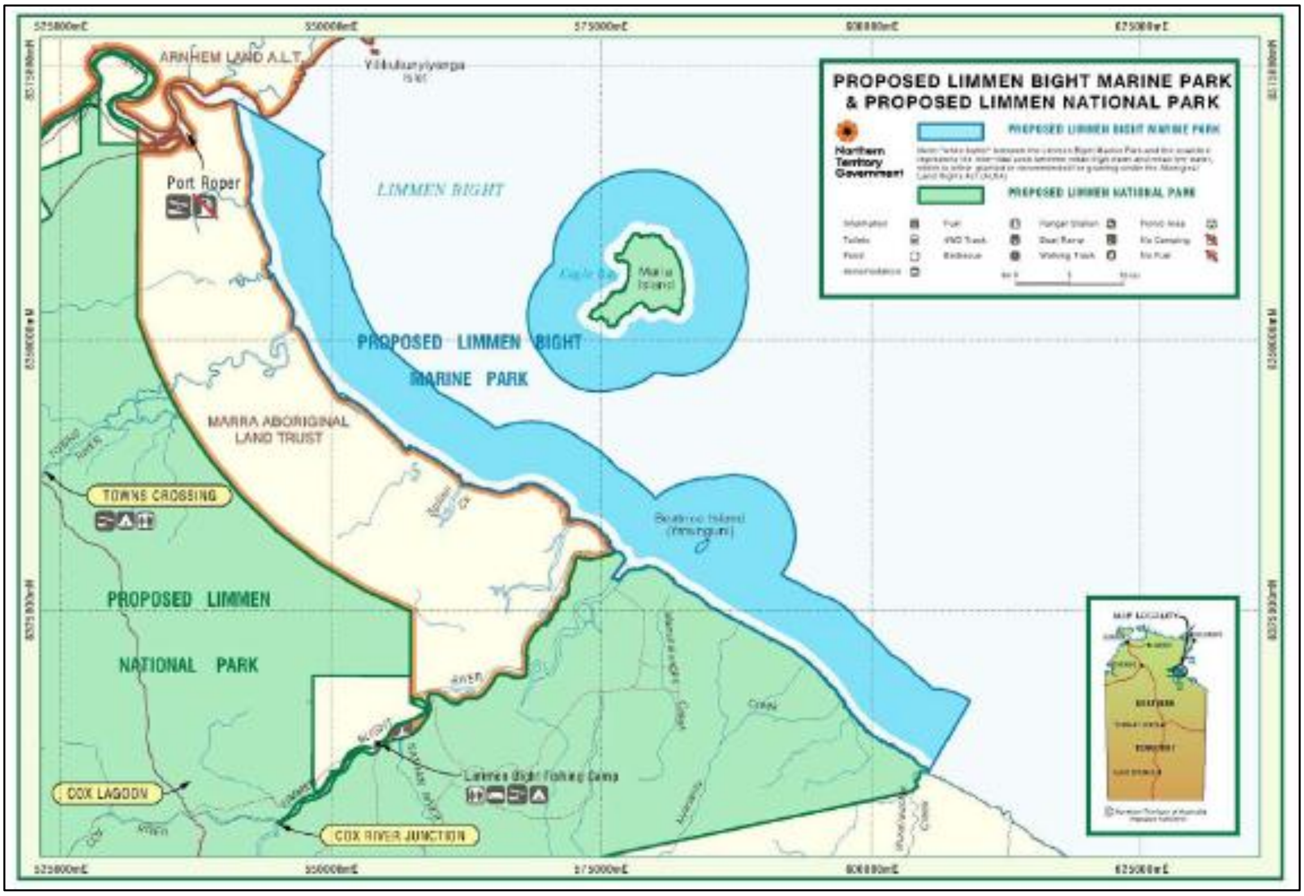

Figure 5-7 Proposed Limmen Bight Marine Park Boundaries (Source: NRETAS, 2012).

5.5.2 Conservation and Biodiversity Values – Regional Overview

The Interim Biogeographic Regionalisation for Australia (IBRA) mapping defines Australia by units of broadly similar landform, geology and biodiversity (Baker *et al.* 2005). There are 12 bioregions wholly within the Territory, and another 13 that are located partially with neighbouring states. The project area is situated across the Gulf Fall and Upland and Gulf Coastal bioregions, with the proposed Barge Landing and Stockyard facility located within the Gulf Coastal Bioregion.

The Gulf Coastal bioregion is considered generally to be in good condition, but threatened by changed fire regimes, feral animals, weeds and also potentially by commercial fishing and/or impacts associated with mining (NRETAS 2007b).

The Gulf Coastal bioregion is recognised for its significant refugial values, nationally significant sites including two wetlands, 36 marine turtle nesting sites, 22 seabird nesting sites, 33 shorebird feeding/nesting sites and 7 waterbird feeding/nesting sites. Nine significant plant species and 16 significant vertebrate species occur within the Gulf Coastal Bioregion.

The Northern Territory Sites of Conservation Significance for Biodiversity Values Inventory further refines the IBRA through the classification of 67 sites of International and National conservation significance for biodiversity values in the NT (Harrison *et al*. 2009). Whilst recognition of sites in this inventory by NRETAS does not provide any new regulatory or legislative protection above what exists, the inventory is intended to be used as a tool to ensure targeted conservation outcomes are achieved at these sites.

Two Sites of Conservation Significance (SOCS) are located within the immediate vicinity of the barge landing area and offshore transhipping and cyclone anchorages; the McArthur River Flood Plain (Site of Primary Conservation Significance) and the Sir Edward Pellew Island Group (Site of Secondary Conservation Significance). The Limmen Bight and associated coastal floodplains Site of Conservation Significance is located to the east of the mining lease however no project infrastructure is located within this SOC. These SOCS are described briefly below.

McArthur River Flood Plain SOC

The McArthur River Flood Plain site is a site of recognised International Significance, which broadly coincides with the Port McArthur Tidal Wetlands Systems which are listed in the Directory of Important Wetlands of Australia (DIWA). The floodplain is located approximately 30km north-east of Borroloola and covers a considerable expanse of open saline flats that are amongst the largest in the NT (NRETAS 2007b). The flats support low chenopod shrubland, which provides habitat for very large aggregations of migratory shorebirds, some of which are considered internationally significant (NRETAS 2007b). Large aggregations of waterbirds and seabirds are also known to occur in coastal habitats including sand spits, mangroves and tidal flats and wetlands (NRETAS 2007b).

Sir Edward Pellew Island Group SOC

The Indigenous owned Sir Edward Pellew Island group are located immediately adjacent to the McArthur River Coastal Floodplain SOC at the mouth of a major tropical river system (the McArthur River) and comprise five large islands and over 50 sandy islets, reefs and rocks (NRETAS 2007a). The islands are notable for both their large range of coastal habitats which include vine thickets, open forests and woodlands, heaths, mudflats, mangroves and sand dunes and their role as an important refuge for species that are subject to threatening processes on the mainland of coastal Australia (NRETAS 2007a).

The Sir Edward Pellew Island Group is also of international significance for nesting marine turtles and colonial seabirds, including Green and Flatback turtles, and crested and roseate terns.

Limmen Bight and associated coastal floodplains SOC

This Limmen Bight and associated coastal floodplain SOCS includes the coastal floodplains and extensive tidal flats of the Roper, Towns and Limmen Bight Rivers, and other coastal habitats between the Roper and Limmen River Mouths, and also includes Maria Island as well as Low Rock and Sandy Island (NRETAS 2012). The marine and coastal environments of this SOC are rated as internationally significant owing to the presence of extensive seagrass beds, intertidal sand and mud flats and other coastal and marine ecological communities (NRETAS, 2012). These environments provide habitat for internationally significant dugong populations, a number of threatened species including marine turtles, shorebirds, seabirds and a diversity of other coastal and marine life.

The lower reaches of the Towns River and adjacent marine and estuarine environments are located within this SOCS. Aerial surveys of this region revealed extensive mangrove communities, salt pans, and extensive sandflats and mudflats. The mainland coast of the Towns River mouth region is dominated by inter-tidal mudflats and consequently is considered sub-optimal habitat for nesting marine turtles.

Areas of seagrass are known to be present in all the inshore areas from the Roper River south-east to the Pellews, however extensive seagrass meadows were not observed during aerial surveys in the immediate vicinity of the Towns River Mouth. Seagrass beds in this region are thought to be patchy, extending east to Maria Island and further offshore (NRETAS, 2012).

Nesting Flatback sea turtle and dugong records are located to the south of the Towns River (NRETAS, 2012) however the region around the Towns River mouth is not thought to be a significant for either species. Significant numbers of Flatback turtles are known however to nest on nearby Maria Island (NRETAS 2007b; 2012). Maria Island also provides foraging areas for one of the Territory's largest breeding colonies of silver gulls (NRETAS, 2012).

Important shorebird records have been documented to the north of the Towns River mouth (NRETAS 2007b), correlating with the presence of extensive sandflats and mudflats in this region.

The location and extent of Sites of Conservation Significance and project mining leases and infrastructure is shown in Figure 5-8 below.

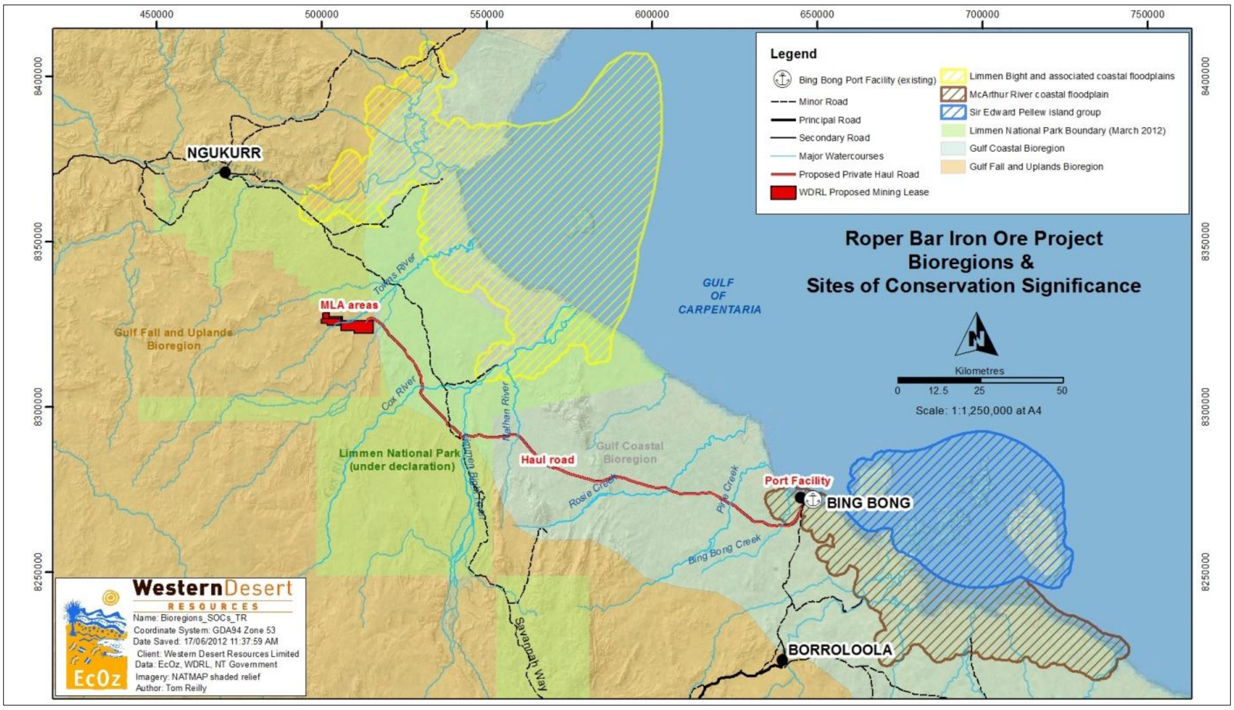

Figure 5-8 WDRL Project and NT Sites of Conservation Significance

Commonwealth and Territory waters adjacent to the McArthur River coastal floodplain and Sir Edward Pellew Islands are also of importance for several marine ecological communities and conservation-dependent species.

These waters support high biological productivity and for several protected species they are significant feeding, resting, breeding and nursery areas, or are important parts of species ranges or migratory pathways. Abundant subtidal seagrass meadows are important for green turtles and dugong, and soft substrates and the inshore coral reefs provide important feeding habitat for Olive Ridley and Flatback

Turtles (DEWHA, 2008). These species and seabirds feed in the highly productive coastal shelf and inshore waters, moving ashore to breeding, nesting and roosting sites (DEWHA, 2008).

The shallow sea front at the boundaries of mixed inshore shallow coastal waters and stratified offshore deeper waters (generally the 20-30m contour) is also known to be a productive region that attracts aggregations of fish and sharks. Upwellings around islands and offshore reefs are also known to be highly productive regions for several species.

Inshore and estuarine waters are also significant for several higher order trophic consumers in the southern Gulf, including Sharks (e.g. Bull Shark and Blacktip Shark), Sawfish, and dolphins [e.g. Bottlenose, Australian Snubfin, and Indo-Pacific Humpback (DEWHA 2008)].

The following sections provide further information on the coastal and marine ecology of the project area with particular reference to ecological communities and species that are likely to be affected by the proposal.

5.5.3 Coastal and Marine Ecological Communities

The extensive intertidal sand and mud flats and shallow subtidal areas of the Gulf of Carpentaria and its associated estuaries contain significant and extensive coastal habitats including seagrass and macro-algal communities, intertidal banks, sandy beaches, mangrove forests, salt flats, open waters, inshore rocky reefs, and freshwater wetlands.

The south western part of the Gulf is dominated by tidal plains which provide significant habitat for several migratory bird species.

Coastal habitats in proximity to the Bing Bong loading facility and the wider project area include beaches, dune communities, salt flats, extensive intertidal mudflats and mangroves. Extensive coastal plains, woodlands, vine thickets and wetlands are also present. These communities are moderately to highly disturbed from grazing, weed incursion, previous fires and cyclones, and the presence of the Bing Bong loading facility and operational facilities, and are described in further detail in Chapter 3.7 (Biodiversity).

Significant marine communities immediately adjacent to the Port include extensive seagrass beds, found along the coast between the Roper and McArthur Rivers, and other subtidal soft sediment communities. Coral reefs are sparse and have not been documented from the immediate area (Chatto and Baker 2008), with high levels of turbidity and significant freshwater inflows likely precluding their development, however rocky reefs are known to be present around the Sir Edward Pellew Islands.

This freshwater inundation is the catalyst for growth, migration and other life cycle changes for aquatic animals within the neritic biosphere (Elliott 1993).

Coastal and marine habitats in proximity to the proposed Stockyard facility, covered conveyor and barge loading facility are discussed below. Coastal habitats and marine ecological communities in the vicinity of the Towns River mouth are as described above in Section 5.5.2 under the Limmen Bight and associated coastal floodplain SOCS.

Beach Dune Community

The frontal dune communities adjacent to Bing Bong form discontinuous habitat in locations where mangroves have not established, and on the crest of dunes located landward of areas formerly colonised by mangroves. The calcareous sands support typical beach dune species, including Beach Sheoak (*Casuarina equisitifolia*), the grasses Beach Spinifex (*Spinifex longifolius*) and *Veteveria elongata*, as well as several low shrubs and ground covers typical of these communities. Some environmental weeds are also present. This community is known to provide regional nesting habitat for Flatback Turtles (see below). The proposed conveyor system will traverse this community where it terminates at the barge loading facility.

Intertidal Flats

Extensive intertidal mud flats and shallow sand banks are present immediately adjacent to the Port to the north and south of the access channel. These support extensive soft sediment communities, and small, patchy stands of mangroves (see below). The proposed barge landing area will be located adjacent to extensive intertidal flats north of the existing dredged channel.

Mangroves

This area is not considered to be significant for mangroves, and mangroves are relatively absent from much of the foreshore adjacent to the Port. Some mangroves stands are present in the mud flats to the west of the proposed barge landing area however, and in some locations have been historically present but destroyed by cyclones. Species known to occur in this area include Grey Mangrove (*Avicennia marina*), Stilt-rooted Mangrove (*Rhizophora stylosa*), and Yellow Mangrove (*Ceriops tagal*). Mangroves form more extensive forests on some of the banks of tidal creeks and waterways in the locality of the Port.

Mangroves in the region are known to provide important habitat for a diverse range of fauna including prawns, fish, birds and estuarine crocodiles (*Crocodylus porosus*). The elevated conveyor system will traverse adjacent to the mangroves present immediately west of the barge loading facility however the construction of the conveyor is not expected to require the removal of mangroves.

Soft Sediment Communities

Shallow water soft sediment habitats are extensive and are the defining and prominent feature of the seabed in the region. Sedimentary soft bottom habitats (sand and mud), despite lacking conspicuous vegetation communities, are responsible for high rates of primary production from benthic microalgae and bacteria in the upper surface sediments. Deposit feeders (i.e. Heart Urchins) are dependent on and recycle these nutrients, and the sediments support important assemblages of infauna (i.e. polychaetes, crustaceans, and bivalves) and epifauna (i.e. brittle stars, sea cucucmbers) as well as sponges, ascidians, and some corals.

Production in the high-light environment of these shallow banks is now considered to be important in sustaining trophic food webs. Several animals (i.e. fish, shorebirds) also forage on sandbanks as the incoming and outgoing tides expose food items, and prawns, crabs, and a number of commercially important fish species are dependent on soft sediment habitats.

Soft sediment communities in the swing basin, navigation channel and offshore transhipment mooring may be affected by localised increases in turbidity during construction and operation, and sustained minor or major pollution events.

Seagrass

The ecological importance of seagrass has been well documented. Seagrass helps to trap and reprocess nutrients, stabilise coastal sediments, provide food and shelter for many marine species, as well as providing a nursery for commercially important fish and prawn species (Coles *et al*. 2004).

Expansive intertidal banks along the Gulf of Carpentaria contain seagrass meadows with *Syringodium isoetifolium* and *Cymodocea serrulata* common subtidally and *Halophila ovalis* and *Halophila spinulosa* further offshore (Coles *et al*. 2004). Recent records from the central Gulf report seagrass at depths of 20m, emphasising the lack of data below 15m (Coles *et al*. 2004).

Intertidal seagrass meadows in the region were most recently surveyed in 2004 which showed a concentration of meadows from Limmen Bight River south-east to the Sir Edward Pellew Island Group (Roelofs *et al.* cited in Delaney 2012). A recent aerial dugong survey is considered to provide a more representative distribution of seagrass based on dugong presence, which indicates patchy seagrass is present in all inshore areas from the Roper river south-east to the Sir Edward Pellew Island Group (Delaney 2012). Meadows with aggregated patches are known to support abundant dugong and turtle populations from Limmen Bight to the Sir Edward Pellew Island Group (Roelofs cited in McKenzie 2008).

Seagrass surveys in the region have previously identified eight seagrass species: *Cymodocea serrulata, Cymodocea rotundata, Enhalus acoroides, Halodule uninervis, Halophila ovalis, Halophila spinulosa, Syringodium isoetifolium* and *Thalassia hemprichii* (McKenzie 2008).

Bi-annual monitoring of seagrass distribution, density and species richness of the seagrass beds adjacent to the east and west of the Bing Bong loading facility has been undertaken as part of the marine monitoring program (Environmental Earth Sciences 2011). The most recent results suggest that overall distribution, density, and species richness has increased since the previous 2009 survey, but has not returned to pre-existing levels in 2007 (Environmental Earth Sciences 2011). The Independent Monitors report (Environmental Earth Sciences 2011) has recommended that this monitoring be continued.

The three dominant species in the Port region are: *Syringodium isoetifolium, Halodule uninervis* and *Halophila ovalis.* Monitoring undertaken by MRM in the vicinity of Bing Bong has demonstrated an increase in species richness since the 2009 survey, and that seagrass assemblages are recovering from severe impacts associated with cyclones in 2000-2001 (Xstrata Zinc 2010).

At least two threatened species known to be present in the waters adjacent to Bing Bong feed directly on seagrass – Dugong (*Dugong dugon*) and Green Turtle (*Chelonia mydas*), and seagrass beds in the region are known to be significant habitat for Tiger Prawns which are of commercial importance.

Laboratory analysis on seagrass in the Port region is carried out on behalf of MRM by Charles Darwin University. Results suggest that MRM operations are not having a significant impact upon seagrass tissue concentrations of heavy metals (Xstrata Zinc 2008).

Seagrass communities are not expected to be directly affected by the proposal, given that maintenance dredging in the swing basin and navigation channel is likely to preclude the sustained presence of seagrass. However, seagrass may potentially be affected by localised increases in turbidity from shipping movements, sustained minor or major pollution events, and if deep water communities are present at the transhipment or cyclone moorings, some minor removal of seagrass will be required. The indicative locations of seagrass in the region based on the aerial imagery is provided in Figure 5-9 (Marine Megafauna Records and Indicative Seagrass Distribution) however the presence of several dugong records from locations outside of mapped seagrass meadows indicates that the actual extent of seagrass in the region around Bing Bong is likely to be far greater than that indicated.

Coral Reefs

Reefs have been documented as present in the subtidal areas adjacent to Sir Edward Pellew Islands. The reefs are likely to be marginal systems, consisting of a relatively thin veneer of corals growing over rocky substrates, rather than true coral reefs (i.e. the corals forming the reef structure).

Nonetheless, the inshore reefs associated with islands in the Sir Edward Pellew group support relatively diverse assemblages of corals, sponges, and other sessile invertebrates, as well as feeding areas for several fish species, marine turtles and other marine biota (DEWHA 2008).

Submerged ‘patch’ or barrier reefs are also known to be present in the Southern Gulf at depths of around 30-50m and are known to support significant aggregations of marine life (DEWHA 2008).

5.5.4 Significant Coastal and Marine Flora Species

Desktop reviews have identified a number of significant flora species which may persist on the subject site; however none of these species are considered to be specifically coastal or marine in their habitat requirements.

Seagrass and mangroves are considered significant in the context of regional conservation values and habitat provision and are described above. No seagrass or mangrove communities are expected to be directly affected by the proposal.

5.5.5 Avifauna (Seabirds and Shorebirds)

The Gulf of Carpentaria is recognised as an extremely important area for shorebirds, seabirds and waterbirds owing to the highly productive coastal and marine systems of the bioregion (DEWHA 2008).

The region is known to host a number of migratory waders and seabirds listed under the EPBC Act which utilise the East Asian - Australasian Flyway, and are listed under bilateral International Agreements such as JAMBA (Japan Australia Migratory Bird Agreement), CAMBA (China Australia Migratory Bird Agreement), and ROKAMBA (Republic of Korea Australia Migratory Bird Agreement).

The region is considered a high quality habitat for seabirds and waders, and is extensively utilised by migratory species (Chatto and Baker 2008). The extensive intertidal mudflats of the McArthur River floodplain (which includes the Bing Bong loading facility) are among the most important areas for migratory shorebirds in the NT. This is due to the high biomass of epifauna and infauna in the extensive soft sediment habitats including polychaete worms, molluscs, and crustaceans which provide an abundant food source.

Large concentrations of shorebirds (>5000) have been counted from near the mouth of the McArthur River and islands in the Sir Edward Pellew Group are known feeding and roosting sites for several migratory seabirds (Mount Isa Mines Limited 1992). The mouth of the McArthur River is an important staging area for migratory bird species (DEWHA 2008).

The Sir Edward Pellew Island Group is listed on the Register of the National Estate for its significance to migratory seabirds. Pearce, Urquhart, and Hervey Islands in the Sir Edward Pellew Group are also listed as an Important Bird Area (IBA) by BirdLife Australia, as these islands supports more than 1% of the global population of crested and roseate terns. Shorebirds are also present in the mudflats around the islands however not in the numbers reported from the mainland (NRETAS 2007a).

Chatto (2003) undertook targeted shorebird surveys along the coast of the NT. Within the survey ‘block’ that incorporated the Bing Bong loading facility the five most abundant shorebirds were the Black-tailed Godwit (*Limosa limosa*), Great Knot (*Calidris canutus*), Red-necked Stint (*Calidris ruficollis*), Curlew Sandpiper (*Calidris ferruginea*), and the Bar-tailed Godwit (*Limosa lapponica*) all listed as ‘Least Concern’ under the NT TWPC Act.

A Little Tern breeding colony has been previously documented from offshore sandbanks of Bing Bong Creek (approximately 14km from the Port) (Chatto 2001), and a breeding site for these species at Pine Creek/Little Creek is listed as an indicative place on the Register of the National Estate.

There are no declared Ramsar Wetlands in the region of the proposed action however wetlands in the region are likely to satisfy Ramsar criteria. Wetland systems near the coast are important sites for migration stop-over area for shorebirds such as the Brolga (*Grus rubicundus*) and the Straw-necked Ibis (*Threskiornis spinicollis*) and an important seabird (Tern) breeding area (NRETAS 2007b).

Consultants acting on behalf of McArthur River Mine have undertaken migratory bird surveys, and documented a significant increase in migratory shorebirds in the most recent survey in comparison with previous counts in 2008 and 2003 (EMS cited in Xstrata Zinc 2010). The surveys were noted to highlight “*the importance of the Port McArthur area, east of Bing Bong, as a nationally and globally significant migratory bird staging area and indicated that the Bing Bong Port area is not used by a large number of birds*” (Xstrata Zinc 2010).

Surveys undertaken by EcOz Ecologists in the vicinity of the Bing Bong loading facility detected a number of common shorebirds and seabirds (i.e. listed Least Concern under the TWPC Act). These are presented in Chapter 3.7 (Biodiversity). The majority of these species are concurrently listed ‘Marine’ and/or ‘Migratory’ under the *EPBC Act* and included White-bellied Sea Eagle (*Haliaeetus leucogaster*), Beach Stone-curlew (*Esacus magnirostris*), , and the Red-necked Stint (*Calidris ruficollis*).

5.5.6 Marine Reptiles

Of the seven species of marine turtle in existence, six of these are found in northern Australian waters including the Gulf of Carpentaria, and all of which are listed as Vulnerable, Endangered, or Critically Endangered under the EPBC Act, NC Act, or IUCN Red List.

The Northern Shelf province, in which the project coastal and marine infrastructure is proposed to be located, contains significant migratory and dispersal pathways, and breeding, nesting and feeding areas for marine turtles (DEWHA 2008).

Chatto and Baker (2008) have undertaken comprehensive surveys for nesting marine turtles including aerial and ground surveys over the Northern Territory coastline, including islands. They recorded four species as regularly nesting in the NT: Flatback Turtle (*Natator depressus*), Green Turtle (*Chelonia mydas*), Hawksbill Turtle (*Eretmochelys imbricata*) and Olive Ridley Turtle (*Lepidochelys olivacea*). Of these four species, Flatback Turtles were found to be the most widespread nesting species.

Surveys undertaken by these authors in the Sir Edward Pellew Islands indicated that this area is very important for marine turtle nesting, with track density reported at >100 tracks per 1km in some locations (2008). Nesting is dominated by Flatback and Green Turtles in this location (Chatto and Baker 2008).

Surveys undertaken in the region between Nyinpinti Point and Bing Bong however showed that the mainland coastline in this location was generally sub-optimal for turtle nesting, with large expanses of intertidal mudflats adjacent to saline mudflats and/or mangroves, with narrow, shallow beach berms in other locations. Where sandy beaches are present, low densities of Flatback Turtle nests have been documented, with most nesting located to the north of Bing Bong in the Limmen Bight (Chatto and Baker 2008).

Green Turtle tracks have also been confirmed in the vicinity of the Port though no nesting has been recorded for this species. Green Turtles are considered likely to be present in high densities in the waters adjacent the Port given the abundance of favoured seagrass species in the region. Earlier studies have identified a significant population near the Sir Edward Pellew Islands (Limpus cited in Elliott 1993).

Results of ongoing surveys indicate that there is only a short seasonal nesting period on this section of coastline, predominantly during the months of July, September, and October (Chatto and Baker 2008). Egg harvest by humans was noted by the authors as having occurred in the vicinity of Bing Bong, with no predation by animals noted in the limited number of nests which were checked in this area (Chatto and Baker 2008).

Estuarine crocodiles (*Crocodylus porosus*) are known to be present in low densities in the Port region including estuarine waterways and offshore in proximity to the Sir Edward Pellew Island Group.

Records for this species, as well as Green and Flatback Turtles in propinquity to Bing Bong are shown in Figure 5-9 (Marine Megafauna Records and Indicative Seagrass Distribution).

A review of these (and other species listed in desktop searches) in the context of the proposal is included below.

<u>Green Turtles</u>

Green Turtles (*Chelonia mydas*) are present in the waters across tropical northern Australia. They usually occur between the 20°C isotherms although individuals can stray into temperate waters (Cogger *et al*. 1993). This species spends its first five to ten years drifting on ocean currents (DSEWPC 2011a). Once individuals reach a curved carapace length of 30 to 40cm, they migrate to shallow benthic foraging habitats such as tropical tidal and sub-tropical coral and rocky reef habitat or inshore seagrass beds (DSEWPC 2011a). These shallows are their primary feeding areas (DSEWPC 2011a), indicating both the importance of inshore habitats for younger turtles and the susceptibility of this age class to coastal impacts.

Adults primarily feed on seagrass and algae, although they have been recorded to eat other items such as mangroves, fish-egg cases, jellyfish and sponges (Limpus 2008; DSEWPC 2011a).

In the Gulf of Carpentaria, nesting occurs year-round but peaks mid-year (Limpus 2008). Breeding males and females move from their feeding grounds to areas near nesting beaches for mating (DSEWPC 2011a). The males then return to their feeding grounds, and the females come up onto the beach to lay their eggs, usually on several different nights (DSEWPC 2011a). Females usually remain in shallow water within 5–10 km of the beach between nesting episodes (DSEWPC 2011l).

As described above, green turtles are known to be nesting in significant numbers the Sir Edward Pellew Islands, and in low densities on the coast to the north and south of Bing Bong, and are likely present in the waters adjacent to the loading facility.

Flatback Turtles

Natator depressus occurs in the tropical waters of Papua New Guinea, Irian Jaya and northern Australia (DSEWPC 2011b). Unlike other species of sea turtles, hatchling *Natator depressus* do not have an oceanic phase (DSEWPC 2011b). Instead, they remain in the surface waters of the continental shelf, feeding on macroplankton (DSEWPC 2011b). Once this life stage is complete, the turtles transition to sub-tidal soft bottomed habitats (DSEWPC 2011l). The diet of *Natator depressus* is poorly understood, although juveniles are known to eat gastropod molluscs, squid and siphonophores (DSEWPC 2011b).

Nesting for *Natator depressus* has only been recorded on Australian beaches, from the Pilbara region in Western Australia, to Mon Repos in southern Queensland (Chatto and Baker 2008; DSEWPC 2011b). The species requires sandy beaches in the tropics and subtropics with sand temperatures between 25 °C and 33°C at nest depth (DSEWPC 2011b).

As described previously, Flatback Turtles are known to nest in significant numbers in the Sir Edward Pellew Islands, and on the mainland to the north of the Port, as well as in the waters adjacent to the Port.

Hawksbill Turtles

Eretmochelys imbricata are found in tropical, subtropical and temperate waters in all the oceans of the world (DSEWPC 2011c). In Australia, the species is found along the tropical coasts from mid-western West Australia to southern Queensland (Cogger 2000).

Eretmochelys imbricata is omnivorous, feeding primarily on sponges and algae, but also known to eat a variety of animals and plants including cephalopods, gastropods, and cnidarians (DSEWPC 2011c). During their pelagic phase, juveniles feed on plankton (DSEWPC 2011c).

Eretmochelys imbricata requires tropical beaches for breeding and nesting. Nesting has been recorded from the Western Cape York Peninsula (DSEWPC 2011l).

This species spends the first five to ten years of life in a pelagic phase, drifting on ocean currents (DSEWPC 2011c). After reaching a 30 to 40cm curved carapace length, *Eretmochelys imbricata* generally settle and forage in tropical tidal and sub-tidal coral and rocky reef habitat. The species has also less frequently been recorded within seagrass habitats of coastal waters, and deeper waters associated with trawl fisheries (DSEWPC 2011c).

No nesting has been recorded in the vicinity of the Port for this species. Its presence is considered likely in seagrass and rocky reef habitats in the region.

Olive Ridley Turtles

Lepidochelys olivacea occurs in tropical waters worldwide, and is found in the tropical waters of the northern Australian coast from northern Western Australia to south-east Queensland (Cogger 2000; DSEWPC 2011d). In Australia, both juveniles and adults most commonly forage in shallow benthic habitats, although larger juvenile and adults have also been recorded pelagic foraging habitats.

Lepidochelys olivacea is known to forage in waters ranging from several metres to over 100m in depth (DSEWPC 2011d). The species feeds on crabs, shrimp, tunicates, jellyfish, salps and algae (DSEWPC 2011d).

Although no concentrated areas of nesting have been recorded, scattered and low density nesting has been observed in the Sir Edward Pellew group, including West Island immediately west of the Port (Chatto and Baker 2008).

Estuarine Crocodiles

Estuarine Crocodiles (*Crocodylus porosus*) are known to be present in low densities in the Port region, in coastal creeks and the McArthur River, where nesting is also known to occur, however habitat in the region of the Port is considered sub-optimal for this species.

Sea Snakes

A number of sea snake records (at least 19 species) have been confirmed from the Gulf of Carpentaria (predominantly from prawn trawl bycatch records) including the Elegant Seasnake (*Hydrophis elegans*), Ornate Sea Snake (*Hydrophis ornatus*), Olive-headed Sea snake (*Disteira major*) and Stoke's Sea snake (*Astrotia stokesii*) (DEWHA 2008). Sea snakes generally inhabit waters around the 30 m depth contour, and large aggregations have been recorded in the southern Gulf (Elliott 1993).

5.5.7 Marine and Estuarine Fish (Teleosts and Cartilaginous Fishes)

Given the low likelihood of significant impacts on marine assemblages, subtidal assemblages were not surveyed by EcOz Ecologists. There is limited information on marine and estuarine fauna assemblages in the region, and surveys of vertebrate marine fauna were not carried out in support of the Environmental Impact Statement for the Bing Bong loading facility. However, both target species and bycatch associated with commercial fisheries in particular the Northern Prawn Fishery and the Gulf of Carpentaria Inshore Finfish Fishery have been subject to significant survey effort.

Furthermore, whilst baseline data for fish assemblages in the Port locality is not available, it is possible to predict which species may be present in the waters adjacent to the subject site based on general distributions and habitat requirements, and studies undertaken in other regions of the Gulf. Additionally, with the exception of species which are dependent on estuarine or coral reef habitats for all or part of their life cycle, the majority of demersal fish species are found throughout the Gulf (Elliott 1993).

The ten most abundant (predominantly marine) fish families by biomass and overall catch rates as described in the *Marine Biota Atlas for the Gulf of Carpentaria* (Elliot, 1993) are Sweetlips (Haemulidae), Threadfin Bream (Nemipteridae), Snapper (Lutjanidae), Goatfish (Mullidae), Pony Fish (Leiognathidae), Whiptail Stingrays (Dasyatidae), Whaler Sharks (Carcharinidae), Emperors (Lethrinidae) and Silver Biddies (Gerreidae).

Delaney (2012) reports on species known from the proposed Limmen Bight region based on previous studies of coastal and estuarine fish of the Roper River and adjacent waterways. These include threatened sharks (freshwater sawfish), Pipefish (see below), and several species of recreational or commercial importance including Barramundi, Golden Snapper, Blue Salmon and Northern Whiting.

Biannual sampling of the freshwater reaches of the McArthur River undertaken on behalf of MRM (URS 2012), has identified approximately 27 estuarine and marine species in addition to targeted freshwater species. Species which spend some or part of their life cycle in estuarine and marine waters and for which records exist from these surveys include Bull Shark (*Carcharhinus leucas*), Freshwater Whipray (*Himantura dalyensis*); and Barramundi (*Lates calcarifer*).

Barramundi are a locally abundant species and an important commercial fishery. Samples have been taken from barramundi and submitted to a lab for analysis for heavy metal concentrations in order to detect ecological effects on higher order consumers as part of the MRM monitoring program. Results were not available at the time of report publication.

Freshwater Sawfish (*Pristis microdon,* listed as Vulnerable under the TWPC and EPBC Acts) have also been recorded from the MRM surveys.

This species is likely present in estuarine and coastal areas in proximity to the port as well as the freshwater reaches of the McArthur River. Freshwater Sawfish are known to occur in the lower reaches of the McArthur River, and McArthur River Mine is actively monitoring the population, in order to detect any impact from the mines operations. A total of 28 records (including 19 captures) of Freshwater Sawfish have been collected over a five year period up to June 2011 (McArthur River Mine 2012).

The Gulf of Carpentaria is believed to be one of the last strongholds in the world for sawfish (Roelofs 2009) and two other sawfish species are listed in the EPBC Protected Matters Search Report: Dwarf Sawfish (*Pristis clavata*), and Green Sawfish (*Pristis zijsron*).

Pristis microdon is mainly confined to the main channels of large rivers (Larson *et al.* 2006b; DSEWPC 2011e). It spends its first three–four years in freshwater, with juveniles and sub-adults predominantly occurring in rivers and estuaries (Larson *et al.* 2006b; DSEWPC 2011e). Large mature animals occur more often in coastal and offshore waters up to 25m depth (DSEWPC 2011e).

The Green Sawfish is most commonly observed in the Gulf of Carpentaria in Queensland whereby it has been recorded in low numbers with a patchy distribution (Stirrat *et al*. 2006; DSEWPC 2011n). It is often found in shallow water; however it has been recorded offshore at depths over 70m (Stirrat *et al*. 2006; DSEWPC 2011n). *Pristis zijsron* is known to be responsive to tidal influence, and has been reported to inhabit marine inshore waters, estuaries, lagoons and freshwater although most records are from marine estuarine areas (Larson *et al.* 2006). This species has not been recorded from the south-western Gulf in proximity to the Bing Bong loading facility.

The Dwarf Sawfish (*Pristis clavata*) has only been recorded from the western Gulf of Carpentaria (DSEWPC 2011f) however suitable habitat for the species i.e. inshore marine waters, estuaries, river mouths, and in waters adjacent to sandy and muddy beaches, is present near Bing Bong. Furthermore, a number of authors have suggested that the Dwarf Sawfish is likely to be encountered in the same habitat as the Freshwater Sawfish (DSEWPC 2011f) and Green Sawfish.

Shark fauna is dominated by whaler sharks of the family: Carcharhinidae (Elliott 1993). Common shark species in the region based on records from other parts of the Gulf (Salini *et al*. 1992) are expected to include Bull Shark (*Carcharhinus leucas*), Nervous Shark (*C. cautus*), Whitecheek Shark (*C. dussumieri*), Spot Tail Shark (*C. sorrah*), and Blacktip Shark (*C. tilstoni*).

Whale Sharks (*Rhincodon typus*) are listed on the EPBC Protected Matters Search (refer to Desktop review); however no known aggregations have been recorded from waters surrounding the project area, and suitable habitat is not considered to be present.

The likelihood of these species occurring in the waters adjacent to the project site is discussed further in Chapter 3.7 (Biodiversity).

5.5.8 Syngnathids and Solenostomids (Seahorses, Seadragons, Pipefish and Ghost Pipefish)

The family Syngnathidae comprises a group of bony fish including Seahorses, Pipefish, Pipehorses and Sea Dragons. All syngnathids and solenostomids in Australia are listed as 'marine species' under Section 248 of the EPBC Act and are protected. Most syngnathids diets are dominated by small invertebrates and feeding takes place on or near the substrate or in the water column (DSEWPC 2011g).

Approximately 28 species of syngnathids and 2 species of solenostomids are known to occur in the North Marine Region with a further 35 species potentially present (DSEWPC 2011g). Twenty-one species were listed as potentially occurring within 10km of the Bing Bong loading facility in the EPBC Act Protected Matters Report.

The majority of these listed in the EPBC Protected Matters Report are associated with seagrass and macroalgal beds, coral reefs, mangroves and sponge gardens. Macroalgal beds, coral reefs, and mangroves do not form extensive habitats in close proximity to the Port however extensive seagrass beds are likely to provide important habitat for some species, and three pipefish species associated with seagrass habitats have been previously recorded from the Limmen Bight area including *Hippichthys cyanospilus, H. parvicarinatus*, and *H. penicillus* (Delaney 2012).

Biologically important areas have not yet been identified for seahorse and pipefish species in the North Marine Region (DSEWPC 2011g).

5.5.9 Cetaceans

There is a relative dearth of published information on the distribution and abundance of cetaceans in the south-western gulf. According to NRETAS (2012) there have been no targeted surveys for dolphins or any other cetacean species in the Limmen Bight; with the few records that exist either anecdotal or opportunistic observations from dugong surveys undertaken in 1997 and 2007.

However, it is considered likely that inshore species such as *Orcaella heinsohni* (Australian Snubfin Dolphins – formerly Irrawaddy River Dolphins), Indo-Pacific Humpback Dolphins (*Sousa chinensis*), and the Indian Ocean Bottlenose Dolphin (*Tursiops aduncus*) inhabit the coastal and estuarine areas within the waters surrounding the port on a migratory or more permanent basis (i.e. are resident for a significant part of the year). All of these species have been reported from Gulf of Carpentaria waters, including records from the waters adjacent to Bing Bong (Elliott 1993). Resident populations are also known to exist in the waters adjacent to the Sir Edward Pellew Islands (DEWHA 2008). Records for both *Tursiops aduncus* and *Sousa chinensis* are shown in Figure 5-9 (Marine Megafauna Records and Indicative Seagrass Distribution).

Other small cetaceans which are predominantly offshore in nature and may be found in the waters of the access channel and transit routes may include the Common Dolphin (*Delphinus delphis*), Risso's Dolphin (*Grampus griseus*), and Spotted Dolphin (*Stenella attenuata*).

Oceanic whale species which have been documented from shallow waters in the northern Gulf include the False Killer Whale (*Pseudorca crassidens*) and Short-finned Pilot Whales (*Globicephala macrorhynchus*).

Both Blue Whales (*Balaenoptera musculus*) and Humpback Whales (*Megaptera novaeangliae*) are listed in the EPBC Protected Matters Search however Blue Whales are more oceanic in nature and are usually present in deeper waters of the continental slope, and given the site is outside of known Humpback Whale migratory routes and aggregation areas, the site is not thought to be significant for either of these species.

Bryde's Whale (*Balaenoptera edeni*) and Killer Whales (*Orcinus orca*) were also listed in the EPBC Protected Matters Report. Whilst records for these species are not thought to exist near the Bing Bong loading facility, it is possible that these species are transitory in offshore waters of the Gulf.

No whale species are however considered likely to inhabit coastal nearshore waters on a regular basis, and it is further considered unlikely that significant populations of any other cetacean species apart from those identified below are present in the Limmen Bight (NRETAS, 2012).

The cetacean species which are considered to be most significant in the context of the proposal are discussed further below.

<u>Australian Snubfin Dolphins</u>

Records indicate that *Orcaella heinsohni* occur only in waters off the northern half of Australia, from approximately Broome (17° 57´S) on the west coast to the Brisbane River (27° 32´S) on the east coast. The large area of shallow water on the northern Sahul Shelf, plus records of sightings out to 23 km offshore, suggests that even though the known distribution is limited, its occurrence probably exceeds 20,000 km² (DSEWPC 2011h).

Orcaella heinsohni have been recorded mostly from coastal and estuarine waters in protected shallow waters less than 20m deep. This species exhibits a marked preference for shallower waters and seagrass meadows, and are thought to occur closer to river mouths than Indo-Pacific Humpback Dolphins (Parra *et al*. 2006).

Concentrating their activities in these areas, animals spend most of their time foraging and travelling, and to a lesser extent socialising. The predominance of foraging activities in coastal areas indicates that these areas represent important feeding habitats for these species (DSEWPC 2011h).

A study by Parra *et al.* (2006) in Cleveland Bay, Queensland, showed that whilst there is high site fidelity and residence patterns for this species, there was also a substantial movement of animals in and out of the study area, following a model of emigration and remigration. Studies from other regions in Queensland however indicate that this species may be present year round, with little seasonal variation (Cagnazzi cited in (Gladstone Ports Corporation, 2011).

Prey includes fish from the families *Engraulidae, Clupeidae, Chirocentridae, Anguillidae, Hemirhampidae, Leiognathidae, Apogonidae, Pomadasydae, Terapontidae* and *Sillaginidae.* These fishes are typically associated with shallow coastal waters and estuaries in tropical regions (DSEWPC 2011h).

Australian Snubfin Dolphins are thought to have relatively small population sizes of <100, indicating they may be vulnerable to anthropogenic pressures. In Australia, Snubfin and Humpback Dolphins occur in broad sympatry throughout most of their range including in the NT (Parra *et al*. 2006)

Indo-Pacific Humpback Dolphin

In Australia, the Indo-Pacific Humpback Dolphin (*Sousa chinensis*) is known to occur along the northern coastline, extending to Exmouth Gulf on the west coast (25°S), and the Queensland/NSW border region on the east coast (34°S). Off the east Australian coast their distribution appears to be continuous and whilst there are only a few records between the Gulf of Carpentaria in the north and Exmouth Gulf in the west, this is probably due to a lack of research effort.

The extent of occurrence is calculated in coastal waters 5.5km (3NM) seawards throughout the known distribution (DSEWPC 2011i). In these areas, resident populations generally occur in water less than 10m deep, and offshore to 6km. They display no apparent preference for clear or turbid waters, and have been reported in a variety of coastal habitats, from coastal lagoons and enclosed bays with mangrove forests and seagrass beds through to open coastal waters with rock and/or coral reefs. Although the choice of key habitats varies between different geographic regions, the choice of habitat is well defined and persistent at each location (DSEWPC 2011i).

This species is thought to be an opportunistic-generalist feeder, with a wide variety of coastal and estuarine associated fish species forming the main component of their diet, though reef, littoral and demersal fish, as well as cephalopods and crustaceans have also been recorded as prey (Gladstone Ports Corporation, 2011). Feeding is thought to occur mainly in shallow water less than 20 m depth.

Studies by Parra *et al*. (2006; 2011) of this species in Queensland indicate that this species shows less site fidelity than the Snubfin Dolphin, with a large proportion of the study population either spending most of their time outside of the study area in inshore or offshore waters. Again, studies from elsewhere in Queensland indicated that as per the Australian Snub-fin, this species may also be present year round, with little seasonal variation (Cagnazzi cited in (Gladstone Ports Corporation, 2011).

Indian Ocean Bottlenose Dolphin

All Bottlenose Dolphins (*Tursiops spp*.) are a cosmopolitan species found throughout tropical and temperate seas and oceans worldwide (Fury 2009). Bottlenose Dolphins are present in waters around the Australian mainland continuously however the taxonomic status of many populations is unknown (DSEWPC 2011m).

Historically, only one Bottlenose Dolphin was recognised: *Tursiops truncatus* (Bottlenose Dolphin), however more recent morphological and genetic investigations have proven the existence of at least two genetically distinct Tursiops species, *T. truncatus* and *T. aduncus. T. truncatus* is considered to be a larger species adapted to cooler, offshore waters, whilst *T. aduncus* is distributed largely throughout warmer coastal waters (Fury 2009).

Indian Ocean Bottlenose Dolphins are known to occur in four main regions around Australia: the eastern Indian Ocean, Tasman Sea, Coral Sea, and Arafura/Timor Seas (DSEWPC 2011m).

The total population size of Indian Ocean Bottlenose Dolphins is unknown although it is likely that this species is common in inshore and nearshore waters of eastern, western and northern Australia (Ross 2006). Estimates suggest that populations range from 102 individuals in Jervis Bay, 140 in Port Stephens, about 350 in Moreton Bay 900 in coastal waters off North Stradbroke Island and about 1800–2400 in Shark Bay, Western Australia (DSEWPC 2011m). Small populations may be somewhat isolated from neighbouring populations as a result of high levels of site fidelity and philopatry (remaining in their area of birth) (DSEWPC 2011m).

The species is found in warm shallow waters of less than 30m depth, and prefers more sheltered coastal and estuarine environments including tidal sand banks, adjacent to deeper channels at the entrances of canals, creeks or artificial breakwalls, and in some locations in eastern Australia are associated with seagrass beds (Fury 2009).

This species feeds on a variety of fish and cephalopods however in specific locations abundant prey items may form the major component of their diet (DSEWPC 2011 j).

This species is known to be resident in the waters adjacent to the Sir Edward Pellew Islands Group (DEWHA 2008).

5.5.10 Dugong

The dugong is a migratory species listed as Near Threatened under the TWPC Act. The current range of *Dugong dugon* spans tropical and subtropical waters in 40 countries and territories from the Red Sea to the Western Pacific Ocean between 26 and 27 degrees north and south of the equator (Gillespie 2005). In Australia, their general distribution extends along most of the northern coastline from the latitude of Moreton Bay in the east to the latitude of Perth in the west (Whiting 2008). Coastal habitats around northern Australia are generally accepted as the last stronghold for the dugong (Gales *et al*. 2004).

Dugongs generally inhabit calm, shallow, coastal waters such as broad bays and banks (Bertram and Ricardo Bertram 1973). Consequently they are threatened by a number of anthropogenic impacts including habitat loss and degradation, incidental drowning in nets, vessel strike and hunting (Preen and Marsh 1995).

The dugong diet essentially comprises seagrass species in the genera *Zostera, Posidonia, Thalassia, Enhalus, Cymodocea, Halodule, Syringodium*, and *Halophila* (Yamamuro and Chirapart 2005). Generally dugongs preferentially feed on faster growing species i.e. *Halophila ovalis* and H*alodule uninervis* over slower-growing species such as *Zostera capricorni* and *Thalassia hemprichii* (Preen 1995). Dugongs also feed on algae, particularly if seagrass resources are scarce, however most often do so inadvertently (Marsh and Channells 1982).

The waters of northern Australia support globally significant populations of dugong (DSEWPC 2011k), with the most recent aerial surveys undertaken in 2007 indicating that some 5000 dugong were present from the Sir Edward Pellew Islands through to Groote Eylandt (Marsh *et al*. cited in DSEWPC 2011k). High concentrations of dugongs on the Northern Territory side of the Gulf have been attributed to expansive and luxuriant seagrass meadows (DEWHA 2008).

Saalfeld and Marsh suggest that the distribution of dugongs along the Western Gulf of Carpentaria is continuous, with dugongs present along the entire length of this section of coastline at medium to high densities (2004). The area of coastline from the Limmen Bight to the Sir Edward Pellew Group in the western Gulf is known to support 183km^2 of seagrass and correspondingly the largest population of dugongs in the NT (DWEHA 2008), ranking it in the top four populations in Australia (Saalfeld and Marsh 2002). The waters around the Sir Edward Pellew Group are known to be one of the most important areas for feeding, breeding and calving aggregations of dugongs in Australia (DEWHA 2008).

At least three of the seagrass species known to be present in the waters adjacent to Bing Bong are favoured food species and several dugongs have been caught from this region during a satellite tracking program (Marsh 2002) including between the Islands and the mainland (Marsh cited in Mount Isa Mines Limted 1992).

Dugongs have also been recorded from deeper offshore waters more than 10m deep including in Queensland up to 37m depth and 60km offshore, reflecting the distribution of deeper water seagrass species including *Halophila spinulosa* (Saalfeld and Marsh 2002). Dugongs are also known to undertake long-range movements, particularly in response to loss of seagrass habitats from events such as floods, cyclones and coastal development. The presence of dugong is considered likely in the vicinity of the existing Port and transit routes given the known abundance of this species in the region. Regional Dugong records are shown in Figure 5-9 (Marine Megafauna Records and Indicative Seagrass Distribution).

5.5.11 Benthic Communities

The soft sediment substrates present in the intertidal and subtidal zones fringing the subject site are expected to provide habitat for a moderately diverse assemblage of invertebrates, including polychaete worms, bivalves, crustaceans and echinoderms. One study of benthic invertebrates in the sediments adjacent to the Bing Bong barge-loading site found 452 species (DEWHA 2008).

Infaunal communities in the Gulf are thought to be regulated by sediment grain size and depth, with lower abundances and species diversity reported for the western Gulf in comparison to the east (Long and Poiner 1990; 1994). Scavengers/carnivores (44%) and deposit feeders (43%) were numerically dominant throughout the Gulf (Long and Poiner 1994).

Based on the substrates and ecological communities present near Bing Bong, other invertebrates likely to be present include numerous species of gastropods, barnacles, limpets, crabs, sea squirts, encrusting broyozoans, anemones and isopods. Mobile epibenthos are likely to include jellyfish, shrimps, crabs, shrimps and penaeid prawn species.

Marine benthic biota monitoring specifically heavy metal contamination analysis has been undertaken for two gastropods (*Telescopium telescopium* and *Terebralia semistriata*) and two bivalve molluscs (*Saccostrea cucullata* and *Saccostrea mordax*); all of which were below ANZ Food Standard Guidelines for molluscs (Environmental Earth Sciences 2011).

5.5.12 Migratory Species

Several coastal and marine migratory species were listed in the EPBC Protected Matters Search Report some of which are concurrently listed as threatened. These have been discussed in preceding sections and include birds, cetaceans, dugong, marine turtles, and elasmobranchs.

5.5.13 Marine Fauna of Conservation Significance

In order to assess whether any matters of National Environmental Significance (NES) are present, or potentially present on the subject site, a search of the EPBC Act online Protected Matters Search Tool was undertaken. This database is maintained by the Federal Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPC). It helps members of the public to understand the EPBC Act, and their rights, obligations and requirements under the Act. The database holds mapped locations of World Heritage properties, Ramsar wetlands, threatened species, migratory species, marine species, threatened ecological communities and protected areas. It is used to determine whether development is likely to affect a matter of NES and consequently require referral for assessment and approval under the EPBC Act.

An EPBC Act Protected Matters report around the mining lease applications and proposed haul road was generated on 08/03/2012. This search covered a 10km radius from the Bing Bong loading facility and included coastal and marine habitats (See Appendix D).

Additionally, an EPBC Act Protected Matters report around the Towns River mouth was generated on 11/06/2012, which also included coastal and marine habitats. The EPBC Protected Matters Reports for the 10 km areas around Bing Bong and the Towns River mouth list an identical suite of estuarine, marine and migratory species, including: 18 threatened species, 33 migratory species, 62 marine species and 11 whales and other cetaceans. A list and details of the relevant species found in the EPBC Protected Matters Reports that have the potential to occur in the area is presented in Chapter 4 (Terrestrial and Aquatic Biodiversity).

The NT NRM Infonet online mapping tool was also used to generate a list of threatened species for which records exist within the Bing Bong study area, however this report did not generate any new species to those included in the EPBC Protected Matters Report or other desktop studies.

These species (and/or broader taxonomic groups) listed in desktop searches have been described in detail in the preceding sections, and also in Chapter 3.7 (Biodiversity). The reader is directed to this chapter for the EPBC Act Significance of Impact Assessments for Threatened, Migratory and Marine Fauna.

As described above a number of species of conservation concern are known to inhabit the littoral and sublittoral environments of the study area. Where known records exist these have are shown in Figure 5-9 (Marine Megafauna Records and Indicative Seagrass Distribution).

Sections below discuss the likelihood of impacts upon these species.

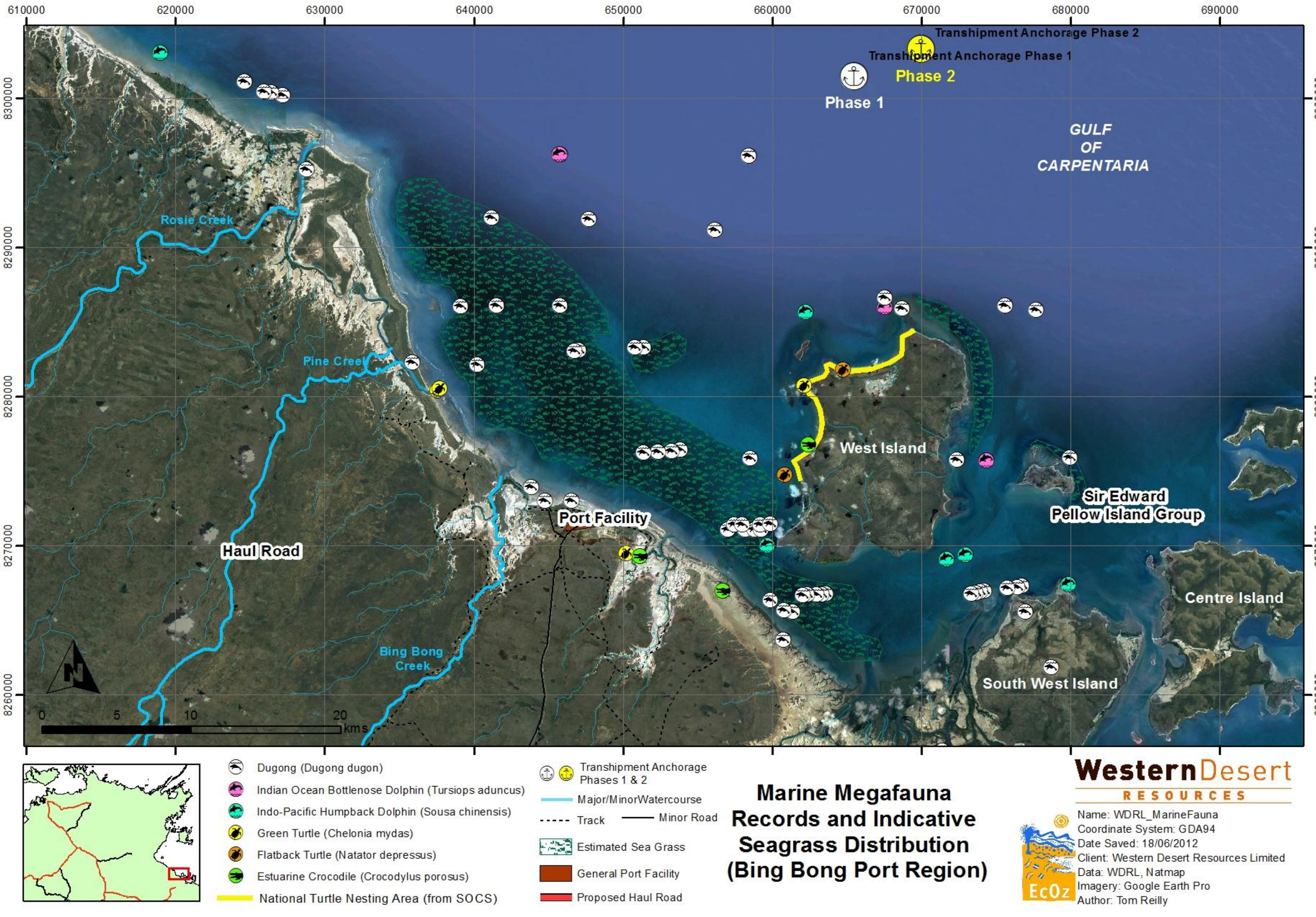

Figure 5-9 Marine Megafauna Records and Indicative Seagrass Distribution

5.5.14 Invasive Marine Species

There is a potential for exotic marine species to be introduced to waters adjacent to the subject site through ballast water or on ship hulls from the substantial increase in shipping activity associated with both the expansion of Xstrata's operation and the WDRL proposal.

Two incursions of invasive marine species have been recorded from Northern Australian waters: the Black Striped Mussel (*Mytilopsis sallei*), and Tube Worm (*Hydroides santaecrucis)* which were introduced from ship's hulls (DEWHA 2008). The Black Striped Mussel was effectively controlled through a poisoning program, and the NT Government actively monitors other ports throughout the NT to prevent further introductions, including eradication programs as required.

5.6 Socio-Economic Values

A Social Impact Assessment (Appendix G of the EIS) has identified potential social risks resulting from the mine and associated infrastructure, including appropriate mitigation strategies where required. The following section provides a summary of socio-economic values associated with the marine and coastal environments of the project area.

5.6.1 Fisheries Resources

Commercial fisheries in the south-western Gulf target prawns, mackerel, sharks and snapper amongst other species (DEWHA 2008).

The south-western Gulf of Carpentaria forms a significant component of Australia's federally-managed and extremely productive Northern Prawn Fishery (NPF), which extends from the low water mark to the outer edge of the Australian Fishing Zone (AFZ) in the area between Cape York in Queensland and Cape Londonderry in Western Australia (Baker and Sheppard 2006).

Six of the nine target species for the NPF are found in south-western Gulf waters including Banana Prawns (*Penaeus semisulcatus*), and two Tiger Prawn species (*Penaeus spp*.). Seagrass meadows and mangrove-lined estuaries are particularly important juvenile nursery habitats for commercially important penaeid prawn species including Tiger and Banana Prawns, as well as other species of fisheries significance (Baker and Sheppard 2006).

Northern Territory managed fisheries that are or have recently been operational in the south-western Gulf include: the N3 Inshore Gillnet Fishery that operates within Gulf rivers, creeks and coastal waters and targets Barramundi and King Salmon; the N9 Offshore Net Fishery that operates between 7 and 25NM targeting Barramundi, Tropical Shark and Grey and Spanish Mackerel; and the L4 and L5 line fisheries that target Spanish Mackerel within Gulf Waters from the shore to 25NM offshore (Hart 2002).

The Mud Crab (*Scylla serrata*) fishery is also important in the NT and several licences are operational in the south-western Gulf. This species is present in estuarine and coastal mangrove systems, and moves offshore to spawn, with settlement occurring on substrates in coastal mangrove habitats.

An unloading facility on the Roper River is used to transship seafood products from the Gulf.

Recreational fishers were commonly observed during field surveys in the proposed barge landing area, fishing the access channel for salmon, bream and other recreational species. Other popular recreational species in the NT include Barramundi, Mud Crab and snapper (DEWHA 2008). There is limited data on recreational catch rates from the Gulf however of the estimated 100,000 visitors to the Gulf annually, 99% of these state recreational fishing as one of the main reasons for their visit (Kehoe cited in Hart 2002). Recreational fishers were also observed within the mouth of the Towns River during aerial surveys of this region.

The majority of tourists in the region are thought to be visiting from the Top End and Queensland, and visitation is thought to be increasing (Parks and Wildlife Commission of the Northern Territory 2012).

Indigenous fisheries are discussed below.

5.6.2 Indigenous Cultural and Social Values

No Indigenous heritage values have been listed on the Register of the National Estate in the vicinity of Bing Bong. Indigenous heritage values of the Commonwealth marine area and broader project site have been considered in Chapter 8 (Social Aspects). The reader is directed to this chapter which outlines Indigenous and non-Indigenous cultural values of the subject site.

Data on Indigenous hunting and harvesting of coastal and marine resources in the region is largely undocumented. Catches of between eight and 16 dugong per year between 1980 and 1993 have been previously reported and traditional hunting of turtle and harvesting of their eggs are known to continue in the region.

The proposed Project Area does not contain any significant heritage sites or any other areas of interest that are either registered with NRETAS and the archaeological survey did not detect any sites of interest, heritage places or artefacts in the vicinity of the Stockyard or proposed Barge Loading Area.

A detailed survey of the proposed transhipping route has not been undertaken given that shipping is unlikely to impact substantially upon heritage values.

Natural resources of the coastal and marine environments that support the economic and cultural systems of Aboriginal people who live in the vicinity of the project site include economic plants (with documented or orally reported Aboriginal uses), and native animals which are used for food and other purposes (i.e. dugong and turtle). None of these resources are likely to be substantially affected by the project.

The value of a site for economic gain, including capitalist enterprises such as mining operations, is often recognised by the Traditional Owners, with the value of place or country for many Aborigines often being concurrently economic and cultural (Solomon *et al*. 2008). Although it is acknowledged that for some Aboriginal people the importance of place is mostly cultural.

Given the existing land use (the Port) there is unlikely to be any significant impact to the current land resource and use, such as Indigenous hunting and harvesting uses, recreation and tourism activities should the proposal proceed. Impacts from mining activities some 80 km upstream are also considered highly unlikely to affect the marine resources adjacent to the Towns River (see Section 5.7.1 below).

5.6.3 Other Coastal and Marine Resources and Values

No offshore oil, gas and mineral exploration permits are located in the immediate area including Commonwealth waters, and the NT Government has recently placed a three year moratorium on seabed mining.

Some tourism operators are known to operate in the region including fishing charters (DEWHA 2008) and there is potential for other tourism development in the area including Aboriginal cultural tours particularly given the proximity of Borroloola to the Port.

No non-Indigenous heritage places or artefacts were located on the project site during the archaeological survey. As described earlier in this chapter, the site is known to be used by residents for a number of recreational activities such as fishing.

Other values of the region are likely to relate to its geographically remote location and relatively unspoilt nature and visual amenity.

Additionally, the project lease area may hold less quantifiable social values, such as spiritual, historical, aesthetic, educational, artistic, epistemological, therapeutic and character building values for sections of the population (Schuster *et al.* 2003).

5.7 Potential Impacts and Mitigation Measures

The following section presents an assessment of possible impacts arising from the proposed operations. Potential impacts to coastal and marine values are generally associated with increased shipping activity in this location, and the construction of additional facilities at Bing Bong.

Cumulative impacts from the expansion of Xstrata operations have been considered.

For example, consequences of increased shipping activity include both the potential for higher rates of interactions between vessels and marine megafauna and increased likelihood of threats such as the introduction of invasive marine species from ships hulls or ballast water.

Impacts can be either direct localised impacts (i.e. increased turbidity associated with increased shipping activity), or indirect such as water quality impacts on seagrass (particularly sediment re-suspension and light attenuation).

Impacts have been presented under four broad themes: habitat degradation, species level impacts, coastal and marine processes, and socio-economic impacts.

Consequences of the impact occurring, as well as a summary of appropriate mitigation measures are included. The assessment has focused on potential impacts to conservation-dependent and migratory marine species in particular, in accordance with the requirements of the EIS guidelines.

A number of anticipated impacts on coastal habitats and assemblages have also been covered in detail in separate chapters of the EIS. Where relevant, readers are referred to these chapters which provide more detail on the mitigation measures or additional background information.

5.7.1 Coastal and Marine Habitat Degradation

Potential impacts on coastal and marine habitats and proposed mitigation measures are detailed below.

Failure of Towns River Tributary Realignment

Potential Impacts

The location of the Area F ore bodies necessitates the realignment of three sections of the Towns River (totalling approximately 2.3km) to facilitate open-cut mining. Chapter 2 provides further detail regarding the proposed realignment.

A potential failure of the proposed Towns River Tributary realignment may involve one or more of the following:

- potential increase in Towns River flood levels and flood extent;
- potential to inundate the open cut pits;
- potential erosion and failure of the banks (slumping) during a flood or high flow event;
- potential increase in erosion of the Towns River channel and floodplain; and
- potential erosion of the Towns River tributary diversions.

This may lead to a number of impacts including the introduction of large volumes of sediment into the diversion channel and Towns River, temporary localised or extensive reductions in water quality through increased sediment loads and potentially pollutants from mine activities, loss of habitat for aquatic and riparian species, reductions in macroinvertebrate diversity and abundance and subsequent impacts on higher trophic level consumers.

In order to ensure that any of the above failure scenarios do not eventuate, a number of technical reports relating to hydrology and flood modelling, water management, and water quality assessment that have been undertaken as part of the Environmental Impact Assessment. These have been used to inform the conceptual design of the proposed re-alignment. The conceptual overview of the proposed re-alignment reflects the geometry of the existing watercourse. The exact design will be confirmed upon completion of more detailed hydraulic analysis, which is currently being undertaken.

In general, a permanent and sustainable re-alignment is preferable to the use of temporary infrastructure. The flood protection measures considered most likely to be sustainable over the long term is to re-align the stream channel with a trapezoidal cross section (30m wide and 3m deep) with uniform slopes (no steeper than 1 in 1) and embankments to direct the flood waters around and downstream of the mine. The entrance and exit to the channel will have a bell shape to intake and discharge flood waters. This option will require minimum maintenance and allow the stream to re-settle and establish its own morphology within the channel provided.

Estimated flow velocities, both within the channel and in the overbank regions, are relatively low and below 2.0m/s, the velocity at which erosion protection measures are required. This is to be expected, given the low gradient across the area.

Erosion protection and sediment control are to be achieved by providing a 0.5m thick rock armour cladding in the base and along the embankments to some 0.5m above the 100-year ARI flood level. This cladding will be allowed to silt and establish vegetation naturally, and through active planting, once the re-aligned channel has settled. Vegetation will contribute to erosion control through roots providing reinforcement and stability to the bed and bank, through shielding by providing protection from the erosive action of water, and reducing water velocity by contributing to the ‘roughness’ of a watercourse.

It is considered that the design controls and management measures outlined above will ensure that there is no increase in the Towns River flood levels and extent, nor will open cut pits or mine infrastructure be subject to inundation. Significant erosion or slumping events are also considered unlikely, given the relatively low flows and erosion protection and sediment controls which are to be implemented. It is acknowledged that some erosion of alluvial channels such as the Towns River is likely to continue, which is a natural phenomenon, albeit a slow one. The diversion has also been designed to allow the stream to adopt a natural morphology, which may result in some minor sedimentation.

It is considered that whilst temporary reductions in water quality due to higher sediment loads and consequently elevated levels of turbidity may occur, these are likely to be short lived in duration and relatively localised. The introduction of chemical wastes or potential acid forming (PAF) materials into the diversion is also considered highly unlikely given the controls which will be implemented for the handling, storage, use and disposal of chemicals, and with respect to the extraction, handling and storage of PAF materials and acid mine drainage (AMD).

An example of a potential ‘worst-case scenario’ in relation to downstream impacts of AMD is the former Rum Jungle mine in the NT, where significant ecological impairment was recorded for a distance of up to 15 km downstream (Edwards 2001) and a measurable effect for a distance of up to 30km downstream (Jeffree and Williams 1975). It should be noted that as previously described, all mining infrastructure and activity is located approximately 80 kilometres upstream from the mouth of the Towns River and surrounding waters. Even in the event of catastrophic failures at the proposed mine, such as overtopping of the banks of the diversion channel and the release of acid mine drainage into the Towns River system, it is extremely unlikely that marine environments at the mouth of the Towns River will be impacted.

Furthermore, whilst the aquatic fauna of the channel is unlikely to recover to pre-diversion states for a number of years, the impacts of temporary reductions in aquatic invertebrate diversity and abundance, and subsequent impacts upon higher trophic orders are considered unlikely to impact upon marine ecological communities some 80 km downstream.

Mitigation Measures

No mitigation measures required. Refer to Chapter 2 which describes in detail the proposed Towns River tributary diversion.

For further details of the Towns River hydrology in the vicinity of the mine site, please refer to Chapter 6 and Appendix N.

Seabed Disturbance – Construction and Operation

Potential Impacts

Some relatively minor disturbance of the seabed will be required to facilitate the construction of coastal and maritime infrastructure and operational shipping phases. During construction, some disturbance within the existing swing basin will be required to install the combi-pile wall, barge landing structure, cyclone moorings and transhipment anchorages.

The construction of the Barge Loading Facility will require reclamation works adjacent to the swing basin.

To maximise the available berthing area and swing basin within the port confines it is proposed to construct a combi-pile wall along the line of the top of dredge batter on the western side of the basin. The dredge batter in front of the wall would be required to be excavated to provide a berth pocket to accommodate the loaded barge at all states of the tide. The quantity of dredge requiring to be cleared for the berth pocket is approximately $9000m^3$. This will be a one-off dredging exercise during construction.

A combi-pile wall has been chosen over a conventional sheet piled wall to avoid excavations associated with installing tie backs and the potential exposure of acid sulphate soils. In a combi-pile wall, piles act as the load bearing structure with sheet piles installed in between using a combination of steel tubular and sheet piles, which forms a retaining wall structure. Anchoring, bracing, and props are also installed as required.

Installation of the transhipment anchorages and cyclone moorings, and the movement of anchor chains when in use are likely to produce some minor disturbance.

The remobilisation of sediments into the water column from shipping activity (i.e. propeller wash from barge, tug and other support vessel movements) is also likely to occur within the shallow depths of the swing basin and navigation channel. The remobilisation of sediments associated with failure of sediment control devices during reclamation works may also result in temporary increases in turbidity.

During the operational phase there is not expected to be further seabed disturbance above that which is expected with vessel activity, with the exception of the movement of the transhipment anchorage further offshore, and the eventual removal of the transhipment anchorages and cyclone mooring. This will involve the removal of the anchor and chains and will result in some localised seabed disturbance in the anchorage location.

Disturbance of sediments may temporarily reduce light availability (i.e. increase turbidity), potentially release contaminants into the water column, increasing bioavailability and toxicity to marine organisms, and may result in some localised effects on benthic infauna i.e. smothering, removal, or mortality. However, these impacts would occur over a relatively small temporal and spatial scale and are unlikely to be significant given the scale of the proposed infrastructure and the implementation of mitigation measures.

Generally the primary mechanisms that govern natural turbidity are the resuspension, deposition and advection of sediment. The waters of the Gulf are frequently reported as being naturally turbid particularly during the wet season, when the surrounding estuaries and waterways discharge plumes of brackish, turbid water into the Gulf.

Furthermore, the swing basin and navigation channel adjacent to the barge landing area is dredged frequently, so mobile fauna assemblages are already exposed to elevated turbidity during dredging and extreme weather events. Mobile fauna can also move away from the source of disturbance.

Soft sediment communities are also highly resilient to disturbance (Lenihan and Micheli 2001) and while a temporary reduction in water quality associated with the resuspension of fine sediments is expected, impacts are expected to be minor. When infrastructure is removed during the decommissioning phase benthic fauna is expected to return to its original composition within a relatively short time period.

Seagrass communities within the region are subject to naturally high turbidity levels therefore the temporary decreases in water quality (i.e. turbidity) arising from the proposal are unlikely to impact significantly on meadows to the east and west.

Short-term construction impacts are not anticipated to result in a significant net loss or gain of seagrass habitat adjacent to the swing basin as no direct removal of seagrass is anticipated, and water quality impacts are considered to be localised (and subject to mitigation measures). However, there is a possibility that seagrass has recolonised the swing basin since the last dredging event, and that seagrass is also present at the cyclone mooring location and transhipment anchorages given that seagrass in this region is known to occur beyond depths of 15m.

Should this be the case, then a minor area of seagrass will be required to be removed to facilitate construction of the combi-pile wall and/or installation of the transhipment anchorage and cyclone moorings. As the presence/absence of seagrass in these locations have not been confirmed, it is impossible to quantify the exact area of seagrass that would require removal as a result of the project. However even in the most conservative estimate (in which seagrass is present in every location subject to disturbance), the total area of seagrass lost in the disturbance footprint would be <1ha.

Therefore, potential minor loss of habitat for species that may utilise seagrass habitats in the region (i.e. green turtle, dugong) is considered to be negligible, particularly given the extensive areas of seagrass present in the region.

Other marine species, including inshore dolphin species which are present in small resident populations, may be particularly vulnerable to habitat degradation and displacement. Species with high levels of site fidelity are of particular concern. Dugong, marine turtles, and Australian Snub-fin and Indo-Pacific Humpback Dolphins are known to be present regionally. Some of these species, particularly the Australian Snub-fin and Indo-Pacific Humpback Dolphins have been observed to undertake small-scale movements only (Cagnazzi cited in Gladstone Ports Authority 2011) thereby increasing the risk of impacting upon important habitat for a population.

However, given that the majority of the infrastructure is to be located within an existing operational port, such impacts are considered unlikely to arise as a direct consequence of seabed disturbance and associated impacts.

Indeed, many inshore cetacean species are known to be able to continue normal behaviour in turbid waters due to their habitat generally being located in shallow, turbid inshore locations such as river mouths, estuaries and mangroves. Species such as sea snakes, crocodiles and some syngnathids also inhabit areas that are naturally turbid and therefore are also expected to also tolerate temporary increases in turbidity levels (Inpex 2011). Other species including dugongs and Green Turtles, may alter their behaviour to avoid turbidity plumes by moving to adjacent, unaffected habitats (Inpex 2011).

Mitigation Measures

Impacts on soft sediment assemblages associated with construction and installation of maritime infrastructure are also likely to be both minor and localised in nature. Soft sediment assemblages have generally been demonstrated to be highly dynamic and resilient communities, with rapid recolonisation of disturbed areas generally occurring once the disturbance ceases. Seagrass communities are also unlikely to be greatly affected.

However, in order to contain and minimise the potential area affected by turbidity plumes, a silt curtain and floating boom will be used during construction of the combi-pile wall and barge loading area, and reclamation and terrestrial works are to utilise best practice sediment and erosion controls.

A delegate is to be responsible for observing for marine megafauna each half hour during construction using binoculars when the silt curtain is in use. The delegate is to suspend construction operations immediately if a turtle, dugong, dolphin or other cetacean is observed within the sediment curtain bounds of the construction area. Operations may only recommence when the animal is outside of the silt curtain bounds. Note that construction of maritime infrastructure will be undertaken during daylight hours only both for safety requirements and to ensure optimal visibility of marine mega-fauna.

It is recommended that reclamation works and construction of the barge loading facility be timed for the dry season, and during optimal tidal conditions i.e. low tides if possible to avoid increasing the potential for heavy sediment loads during construction.

Maintenance Dredging

Potential Impacts

Dredging for construction of the present Bing Bong loading facility is thought to have had a minor impact on seagrass in the region, destroying an estimated 0.1km^2 (Marsh 2002). Currently, maintenance dredging of the swing basin and channel is undertaken approximately every 4 years. The proponent has initiated discussions with Xstrata regarding the frequency of dredging required with respect to the expansion of Xstrata's operations, and the WDRL's proposal to conduct shipping operations from the port. Xstrata have confirmed that an increase in dredging frequency will not be required and therefore no impacts beyond that which already occur with the current regime are expected.

Nonetheless, it is recognised that maintenance dredging within the Port may have a number of impacts.

Sediment plumes from dredging may potentially impact on seagrass in adjacent waters causing smothering and potential mortality. Seagrass in the region is known to be significant for marine turtles (Green Turtles), dugong, and juvenile prawn species of commercial importance (i.e. Tiger Prawns).

During dredging, a loss of invertebrate food sources may occur, and dredging would regularly remove recovering communities (i.e. seagrass) within the swing basin and navigation channel sediments. The removal of surface layer sediments to reinstate deeper channels may encourage aggregation of some fish species as well as providing potential resting habitat for marine turtles (Gladstone Ports Authority 2011). Dolphins are also repeatedly observed frequenting deeper channels however the intensification of use may eventually discourage this association.

Sawfish and turtles may be present around the swing basin and could potentially become entrained in dredging equipment (however noise and turbid plumes may discourage their presence away from the dredge head). Other species, such as cetaceans, may approach the dredger out of curiosity however impacts are unlikely to be biologically significant.

Dredging is also expected to have a positive impact upon levels of metals in sediments (i.e. a reduction) (MRM, 2012).

Mitigation Measures

Given that there is no planned increase in dredging frequency there is no requirement to implement mitigation measures. However, a number of best practice methodologies with respect to dredging are recommended:

- The use of cutter-suction dredges to minimise both the potential for megafauna to be injured through contact with the dredge head, and sediment disturbance (cutter-suction dredges generate the least turbidity);
- The use of a silt curtain where practical to further minimise generation of turbidity plumes;
- Observation for and removal of marine fauna from within the silt curtain prior to closure to avoid mortalities or other negative impacts; and
- Timing of dredging (i.e. early winter) to avoid impacts on postlarvae and juvenile prawns which utilise the seagrass and are most likely to be affected.

Introduction of Artificial Habitat

Potential Impacts

The presence of project infrastructure including the combi-pile wall, mooring lines and anchors and other supporting infrastructure/structures provides a number of hard substrates for settlement of marine organisms. Generally, marine structures will develop a fouling community similar to a ship hull, where growth of marine organisms occurs on immersed surfaces of vessels and structures (known as biofouling).

The development of a fouling community is of concern from a marine engineering perspective as it increases static and hydrodynamic loading, and also affects corrosion rates as well as hindering underwater inspection and maintenance (Callow and Edyvean, 1990).

Communities that develop at shallow depths typically include marine algae and other invertebrates including sponges, bryozoans, ascidians, barnacles, crustaceans and brittle stars. Deep water transhipping anchorages are likely to have different assemblages due to less light penetration and lower temperatures.

Fish are also often attracted to artificial structures through a combination of prey availability, and the cover provided from the structure itself from higher order predators.

Mitigation Measures

Surface structures are to be treated with antifouling paints or other treatments that don't contain tributylin (TBT) compounds, in accordance with legislative requirements and current best practice. When infrastructure is removed during the decommissioning phase epibenthic biota is expected to return to its original composition within a relatively short time period.

Hydrocarbon Spill

Potential Impacts

There is the potential for spillages of hydrocarbons during construction of the combi-pile wall, refuelling, and normal barge and support vessel loading and unloading procedures both in the Barge Loading Facility and at sea, and in a worst case scenario equipment failure, grounding or collision. In the event of a spill, diesel fuel and engine and other vessel oils would be the major hydrocarbons of concern.

A minor release of fuel or oil in the marine environment would not be considered to be a considerable impact; however a significant release of oil or fuel in the swing basin or navigation channel could result in reductions to water quality, impacts on benthic ecology and marine assemblages within proximity to the spill.

Diesel is composed of volatile and semi-persistent hydrocarbons, with around 60-75% of mass predicted to evaporate within the first two days following a spill (dependent on prevailing conditions) with the remainder entrained in the upper water column. Engine and other oils commonly used in shipping applications are generally composed of a number of hydrocarbons, among which polycyclic aromatic hydrocarbons (PAH) account for around 20% and are the most biologically toxic (Haynes 2001).

Hydrocarbon spills therefore potentially contain a mix of several hydrocarbons, all with differing effects on the marine environment. Effects on marine assemblages can include direct mortality through physical coating and asphyxiation, or sub-lethal effects including disruption of physiological or behavioural processes such as cell mutagen and carcinogen (Haynes 2001). Effects can be acute (i.e. short lived and severe), or chronic (i.e. persistent over time but reduced acuity).

The most significant impacts associated with a hydrocarbon spill are thought to be experienced by larvae and organisms with sessile or low motility life stages that cannot avoid or leave the spill area, and as a result experience significant mortality, reductions in fecundity and consequently reduced population sizes. Once PAH's have settled from the water column into sediment, significant uptake by filter feeders and other benthic invertebrate fauna occurs, resulting in the bioaccumulation of toxic compounds into their tissues. This can impact upon both the benthic fauna, for example genetic mutations and cell degeneration (Haynes 2001), as well as higher up the trophic chain, with bioaccumulation in birds, fish and cetaceans.

Direct impacts upon marine vertebrates are varied and may include negative physiological responses including immunosuppression, hepatoxicity, carcinogenesis, reproductive and developmental toxicity, dermal toxicity, and neurotoxicity which can result in depressed fertility and increased mortality (DSEWPC 2011j).

Fish mortalities have been recorded from sheltered bays with low levels of water exchange, however rarely from open waters (Inpex 2011). Both bony and cartilaginous fish would be expected to demonstrate avoidance behaviour if exposed to hydrocarbons in the water column.

Oil spills reduce or remove the water repellent properties from seabirds feathers and ingestion of hydrocarbons through feather preening or feeding on contaminated prey may result in development abnormalities and reduced reproductive output and egg viability (Inpex 2011).

Sea snakes are also vulnerable to oil spills both on the ocean surface and benthic sediments, as they are air breathers and also obligate bottom feeders which can result in the inhalation or ingestion of hydrocarbons and associated dispersants (Gagnon cited in DSEWPC, 2011l).

Marine megafauna, particularly inshore cetaceans such as the Indo-Pacific humpback and bottlenose dolphins and dugongs, may also be vulnerable to the impacts of oil spills. Both cetaceans and dugongs are obligate surface breathers and damage to their respiratory and nervous systems from short term inhalations would be expected in surface oil spills.

Experiments conducted on bottlenose dolphins however, found that this species could detect and avoid a surface slick following the primary exposure (Smith *et al*. cited in Inpex 2010) and it is likely that for most cetaceans and potentially dugongs, exposure to oil spills would lead to avoidance behaviour.

Marine turtles are considered to be vulnerable to impacts of oil spills during all life stages. If a ship collision or grounding resulted in a significant hydrocarbon spill, oil could potentially wash up on nesting beaches if coincident with the nesting season, resulting in potential avoidance of the beach for nesting, impacts upon egg viability and hatchling mortality. Documented impacts of oil spills on green turtles have included impacts upon eyes, nasal, and other body cavities, increases to white cell blood counts, sloughing (shedding) of skin and reduced salt gland function (Inpex 2010).

Mitigation Measures

A fuel farm comprising self bunded tanks providing a total of approximately 1,000,000L of diesel fuel would be provided at the Stockyard Facility, approximately 300 m inland from the Bing Bong loading facility. Refuelling of the barges would be by a service truck that would refuel from the fuel farm.

The barges and any support vessels would be refuelled at the Barge Loading Facility. The barge would also carry fuel and refuel the floating crane at the transhipment location.

The berth deck will be sealed and bunded and will slope landwards to a collection sump, which will capture any material and/or contaminated storm water which will be pumped back to settlement ponds at the Stockyard Facility. Visual inspection of berth decks for cracks or seal damage will be undertaken routinely.

The fuel pipeline will have an automatic cut-off valve to prevent large spills, however it is acknowledged that small spills may occur infrequently. No refuelling will be undertaken during inclement weather conditions to minimise the chance of a spill.

The crane would be electrically controlled and would not require the use of hydraulics, minimising the risk of pollution posed by oil leaks and spilt hoses.

Standard operating procedures including appropriate training, visual monitoring of hoses and the sea surface, initial shutdown, and spill response procedures will be implemented.

An emergency response plan will be developed and equipment supplied to deal with any spill that occurs and this will further detail how offshore and inshore spill risks will be minimised, including appropriate reporting under the *International Convention for the Prevention of Pollution from Ships* (known as MARPOL 73/78) and NT Marine Pollution Act (oils, noxious liquids, or other harmful substance). This will describe the fuel handling and storage procedures in greater detail and will include specifications for oil spill kits including booms and absorption materials on board barges and tugs at all times. The transport, storage, recycling and disposal of any hydrocarbon waste, and regular servicing and inspection of vessels and machinery to identify and address any leaks, will be addressed in standard operating procedures to be developed by WDRL.

Spill of Direct Shipping Ore

Potential Impacts

Spill of Direct Shipping Ore (DSO) material or dust emissions generated during barge loading or transhipping processes or an accident or equipment failure could potentially impact upon the marine environment. This may result in sedimentation and smothering, and potentially increased productivity of microorganisms.

Iron ore is not toxic to marine organisms in most circumstances, given that iron ore is virtually insoluble in sea water. If fugitive dust emissions occur, the dust would likely settle on the substrate which may lead to physical effects of smothering and change in substrate type. Such an impact in theory would lead to increased metal levels in benthic biota and subsequent uptake in higher order level consumers.

However, such an impact is likely to be negligible given the dust and other procedural controls that are proposed (see Mitigation Measures below). Under normal operating procedures the potential for spillage of material is considered to be low, given that spill safeguards and processes will be in place.

In the event of equipment failure or human error, then there is potential for a spill of DSO. Again, such a scenario is considered unlikely given that design, proecdural and operational safeguards will be in place.

The composition of DSO is haematite, the mineral form of iron (III) oxide (Fe_2O_3), which means that given the density and gravity of this mineral any spills of the DSO itself are likely to settle on the seabed rapidly and unlikely to affect water clarity in a significant or extended way.

Dissolved iron in water could in theory result in heterotrophic growth of algal blooms where enrichment exceeds the capacity for assimilation, given iron's importance as a trace element supporting primary production in the marine environment (Gobler *et al*. cited in SKM 2009). Loss of seagrass could also in theory occur, or alternatively low levels of iron input may enhance primary productivity and seagrass and algal growth.

Dugongs are an important food source for Traditional Owners in Borroloola and concern has previously been expressed regarding the potential for ore spills to cause contamination of marine sediments and subsequent uptake by dugongs.

However, haematite and other iron oxides are relatively stable compounds, as such separation of the iron from its ores necessitates high energy requirements and strongly reducing conditions (Ussher, cited in SKM 2009). Furthermore, haematite ore is virtually insoluble in water (University of South Australia, cited in SKM 2009) and has a reasonably high density and consequently the bio-availability of iron oxide for uptake by marine organisms is expected to be negligible.

Based on the likely scenario of a small mass of haematite being deposited on the sea floor, impacts are expected to be minor.

Mitigation Measures

Proposed dust and spillage prevention and containment measures are outlined below.

Dust Control will be achieved through pre-conditioning to the Dust Extinction Moisture Level prior to loading, and conveyor transfers, long reclaim and overland conveyors will be fully enclosed, preventing dust migration into tidal waterways and subsequent inputs into the marine environment.

Equipment will be regularly maintained and tested, and standard operating procedures and training will be employed, with visual inspections in barge loading areas and transhipment anchorages with remediation measures implemented as required. Clean up procedures will be established and enforced.

Spillage containment will be achieved through complete enclosure of the overland and barge loading conveyors, which will be designed and constructed to relevant Australian Standards and best practice to pull away under a blocked chute and loaded condition.

Transfer stations and the barge loading and refuelling area will be fully enclosed and sheeted, with floors of transfer stations fully sealed and bunded. During heavy rain/high wind events the loading of the barges will cease until conditions improve.

Routine visual inspections to ensure that loads are fully contained and that no material is escaping during loading, will take place at the Barge Loading Facility and the transhipment anchorages.

Slurry will not be released into receiving waters as all reclaim conveyors, where practicable, will be covered to prevent collection of rainwater build up inside the conveyor; transport barges will have open decks that are sealed and bunded with runoff and rainwater collected in a series of sumps and, when berthed, any water and slurry collected will be piped back to the transfer station sump, then on to the Stockyard to the collection ponds. Stormwater from the stockpile area will also be contained by a perimeter bund and directed through open drains and sediment traps, then settlement and collection ponds (designed for a 1 in 10 year event). Water will be reused in the Stockyard for ore conditioning and dust control.

Introduction of Invasive Marine Species

Potential Impacts

Barges, Ocean Going Vessels, and other vessels have the potential to introduce marine pests through fouling of ship's hulls or ballast water. The introduction of marine pests can result in ecological effects including competition with native species, predation, parasitisation, and through disruption of trophic pathways. Other impacts can include the extension of a pest species range, including to other Australian Ports, and impacts upon local fisheries. The likelihood of introductions is correlated with the increase in shipping activity in the Port.

Mitigation Measures

The *Australian Ballast Water Management Requirements* (DAFF 2008) details the requirements to prevent the introduction of invasive or pest marine species into Australian waters, which are implemented through the *Quarantine Act 1908* and administered by the Australian Quarantine Inspection Service (AQIS). Ships from International ports are currently required to exchange ballast water outside of Australia's territorial sea under the *Quarantine Act 1908* which is believed to be somewhat effective in preventing outbreaks in coastal areas.

It will be a mandatory requirement that all ships comply with AQIS requirements with respect to the management of ballast water. Any vessels originating from foreign ports will be subject to best practice Quarantine Management to ensure the continued protection of Australia's native flora and fauna from introduced pest species and diseases. Where vessels are from outside of Australia, a hull inspection is required, and vessels that have been outside of Australian waters in the previous 12 months may also necessitate inspection.

Improved methods that treat ballast water to destroy entrained organisms will be adopted in accordance with best practice and current legislation.

It is understood that Xstrata conduct monitoring for invasive/pest marine species however the frequency and methodology of this monitoring program are unknown. It is recommended that this monitoring continue, and consideration should be given to increasing the monitoring frequency and intensity given the significant expansion of activities within the Port (see Marine Ecological Monitoring Program).

Marine Debris (Pollution)

Potential Impacts

Solid materials, typically rubbish and waste that has entered the marine environment are called marine debris. It has been estimated that approximately 80% of marine debris globally originates from land-based sources and the remaining 20% is ocean based in origin (Allsopp *et al*. 2006).

Rubbish and waste materials could potentially enter the marine environment as a result of poor housekeeping in the Port and Stockyard Facility, and from vessels transiting the access channel and transit routes. Rubbish could potentially be blown off the site and into surrounding waters during strong winds or cyclonic conditions, or deliberately dumped from ships. This could potentially result in localised habitat degradation, and potential marine fauna mortality through entanglement and ingestion.

Ingestion of or entanglement in marine debris has been listed under the EPBC Act as a key threatening process causing injury and fatality to marine vertebrates. Entanglement in debris can result in restricted mobility, starvation, infection, amputation, drowning and smothering (DEWHA 2008). Ingestion of plastic marine debris can lead to physical blockages, and subsequent asphyxiation, starvation, or injuries to the digestive system resulting in infection or death (DEWHA 2008).

The impacts of ingestion or entanglement in marine debris on different marine taxa have been subject to a number of studies. At least 267 marine species have been documented by Allsopp *et al.* (2006) as having suffered from entanglement or ingestion of marine debris.

The most significant and pervasive type of marine debris are plastic and synthetic materials (Allsopp *et al*. 2006). Ingestion of or entanglement in marine debris is known to be a significant problem for many species of sea birds, dolphins and whales, dugongs, and turtles, in particular the potential for entanglement in discarded fishing gear, i.e. ghost nets, hooks, etc. and subsequent injury or drowning, and the ingestion of plastic materials. Ingestion is also documented for several species of bony fish, sharks and rays, squid, and marine invertebrates.

Marine debris is assessed as of potential concern for dugongs, marine turtles and inshore cetacean species in the North Marine Region (DEWHA 2008). Plastic bags in particular are a problem in the coastal zone as marine turtles often mistake them for jellyfish, a key prey species, and the ingestion of which often leads to leaked gases and toxins which cause animals to float and die (DSEWPC 2011l).

Marine debris washed up onto turtle nesting beaches may also negatively impact upon nesting turtles and inhibit hatchlings from entering the sea.

White (2004) undertook a study of marine debris in Northern Territory Waters which included a survey site at Bing Bong. The majority of items found at the Bing Bong site were Australian in origin which was due to a disproportionate amount of aluminium beer and soft drink cans, indicating that improper disposal of waste in the region is an issue. Indigenous Rangers also conduct regular patrols to collect marine debris along the McArthur River floodplain (NRETAS 2007b)

Mitigation Measures

Appropriate waste management and storage controls are outlined in Chapter 2.10 (Waste Management), and it is expected that WDRL will comply with Xstrata waste management practices within the Port. A regular litter collection program (targeting anthropogenic items) will be undertaken within the area of the Barge Loading Facility and Stockyard area. It is understood that recreational fishers regularly use a site adjacent to the access channel to fish. Given the sites popularity and the problems associated with discarded fishing gear and associated plastic debris, it is suggested that interpretive signage regarding the impacts of debris on the marine environment be installed at an appropriate location, as well as a rubbish bin in a publicly accessible location to ensure the proper disposal of waste.

The disposal of plastics into the sea is prohibited world-wide under MARPOL Convention. It is expected that all WDRL operational vessels will comply with this convention. Marine pollution is also regulated in the NT under the *Marine Pollution Act.*

Cyclone procedures are to be detailed as part of the Emergency Procedures Plan (EPP) prepared for the site, to ensure that no waste or other materials enter the marine environment during heavy storms or cyclones.

Sewage Disposal

Potential Impacts

The discharge of sewage from vessels can result in a number of impacts including reductions in local water quality, human health risks associated with swimming, fishing, and the collection of shellfish, and increased nutrient and pathogen loads. Increased nutrient loads can result in the growth of epiphytic algae which can affect tropical seagrasses and macroalgal communities, consequently reducing the amount of food available for species dependent on these resources i.e. turtle and dugong, and increased oxygen demand. Pathogens present in sewage may also potentially result in disease and other sub-lethal effects amongst marine vertebrates.

Such impacts are typically more pronounced in areas which are poorly flushed i.e. bays and lagoons. Sewage disposal in coastal areas which may cause serious environmental harm are prohibited under the *Marine Pollution Act.*

Mitigation Measures

All sewage waste form the barges and support vessels will be disposed of at the licenced sewage waste facility at Bing Bong.

Acoustic Disturbance (Marine)

Potential Impacts

The marine acoustic environment is a complex setting in which multiple natural and anthropogenic sound sources are often present. Natural sound sources may be biotic in origin for example fish, marine mammals, and some invertebrates; whereas abiotic sound sources may include waves and other sources (Scholik and Southall 2009). Anthropogenic sound sources may generate sound as a consequence of their operation (shipping) or intentionally for a set purpose (marine sonar and other hydro-acoustic devices).

The potential for anthropogenic noise to disturb marine fauna, particularly marine mammals has been known for some time; however it is generally accepted that anthropogenic noise sources have been steadily increasing over the last few decades through expanding industries such as commercial shipping, offshore oil and gas exploration and drilling, and widespread use of sonar.

Whilst several investigations and reviews have sought to measure and quantify sound sources and their relative occurrence in the marine environment, as well as impacts upon marine assemblages, in general terms this field remains an area of uncertainty, particularly with respect to disturbance and impacts (Scholik and Southall 2009).

Most marine vertebrates rely on the generation, detection and processing of auditory cues for several critical biological functions including communication, mating, foraging, predator avoidance, and navigation, in particular toothed whales, large baleen whales and many fish species. The introduction of anthropogenic noise sources into the marine environment can potentially affect the capacity of marine fauna to detect and generate sound by impacting upon behaviour i.e. avoidance and reduction of critical behaviours, reduction of communication ranges, and physical impacts such as physiological stress responses, injury to auditory systems and mortality. This may be particularly important in waters with high turbidity levels, such as those in the Gulf of Carpentaria, where marine fauna are particularly reliant on their auditory ability to forage, socialise, and detect and avoid threats.

The response of animals to acoustic stimuli is strongly dependent upon previous experience, season, reproductive condition, seabed bathymetry, group size, age, sex, reproductive state (Bowles cited in Miksis-Olds and Wagner 2010), as well as the sound duration and frequency. Mothers and attendant calves may be particularly vulnerable to acoustic disturbance, with increased risk of stress, disrupted birthing or suckling, increased risk of injury and predation or other mortality for calves. Noise may potentially disrupt mate selection, courtship, and mating, and therefore reduce reproductive success for a given population (URS 2009). However, it is very difficult to determine when impacts of noise exposure become biologically significant (i.e. population level impacts for a species or greater ecosystem impacts) particularly with respect to behavioural responses (Scholik and Southall 2009).

Low frequency sounds are least absorbed by sea water and as such are the principal source of ambient background noise levels in the marine environment (URS 2009). Shipping is the dominant source of ambient noise in the low frequency range. Propeller cavitation, main diesel engines and auxillary diesel engines are important components of shipping noise, and hull induced vibration (generated by operating machinery) is the dominant noise source at lower vessel speeds (International Maritime Organisation

2009). Factors such as size, speed, load, condition, age and engine type all contribute to the generation of sound from a vessel (Scholik and Southall 2009). Other major noise sources in the marine environment include dredging, drilling, pile driving, explosives, sonars, and low flying aircraft (URS 2009).

Sound propagation is influenced by the following variables: frequency of sound and absorption losses, sound velocity profile, bathymetry, substrate composition of the seabed and nature of the sea surface (URS 2009). Noise levels are amplified where reflective, rock or hard substrates are present, and decrease where absorptive layers of fine sediments and muds are present (URS 2009).

An acoustic model was developed to detect the distance at which activities associated with the Western Basin Dredging and Disposal Project in Queensland, including pile driving and bulk carrier noise became lower than ambient noise levels (Gladstone Ports Corporation 2011). These distances were over 4 km for pile pulses (though the authors note actual distances are likely to be further) while for bulk carrier-generated noise this was predicted to be between 1.3 and 4 km (Gladstone Ports Corporation 2011). It should be noted however that these distances represent the point at which noise has been modelled as attenuating to background levels, rather than a defined zone of impact.

Within the waters of the Port and access channel, noise is expected to be attenuated significantly within tens of metres due to the shallow depths, soft substrates and expected high ambient noise levels. For example, noise from a 200dB source is estimated to drop to approximately 170dB within 100m, with attenuation of sound levels expected to further decrease with distance from the source.

Furthermore, the distance the animal is located from the noise source will determine whether the animal is within a zone in which discomfort, injury or mortality may occur, a zone of behavioural response (such as movement away from the source), or a zone of audibility (in which the noise is detected but does not elicit a behavioural response). The noise duration, frequency and origin (i.e. stationary, approaching, or departing) all have a bearing on the extent of noise impacts in the underwater environment.

Importantly, it is also critical to understand that behavioural responses are strongly influenced by the animals experience and habituation and context of exposure, ambient noise characteristics and habitat setting (URS 2009).

The main source of sound during construction is likely to be pile driving for construction of the combi-pile wall (no blasting is required or proposed). Noise source levels (the level measured one metre from the sound source) for pile driving have been measured as 180-215dB (all measurements in dB referenced to one micropascal or 1µPa) and 131dB at a range of 1km (URS 2009). During operations, the Ocean Going Vessels, barges and supply vessels will be the most significant sound sources and are all expected to be in the range of 180-190dB (re 1µPa), and tug boats in the range of 145-171dB when operational at the source level (as opposed to the received level, which is the level experienced by the organism of interest).

Maintenance dredging using a cutter suction dredge (which is not expected to increase in frequency as a result of the WDRL proposal or Xstrata expansion) has been calculated to be 180dB (re 1µPa) at the source, and 100dB at 1km (Henderson, cited in URS 2009).

The predominantly low frequency sounds produced by large vessels is thought to be similar to the auditory sensitivity of large whales and several fish species, whereas commercial sonar may overlap with the hearing of dolphins and porpoises (Scholik and Southall 2009). Sounds between 120-190dB (re 1µPa) have been demonstrated to result in avoidance and other behavioural impacts upon baleen whales and dolphins, and noises of 175dB have been reported to result in avoidance behaviour in green turtles (URS 2009). Southall (cited in URS 2009) provided a criterion of 230dB at which pulsed noise can cause physical injury in cetaceans (irreversible hearing loss), and 190 dB re 1uPa as resulting in avoidance behaviour.

Whilst there is an overlap between the likely noise sources generated from the proposal and the frequencies used by marine fauna likely to be present within proximity to the Port, the potential impacts of these sounds with reference to auditory reception and ‘masking’ is critically dependent upon the relative frequency between the sounds animals produce and detect and the noise source in question (Scholik and Southall 2009).

Marine mammals may be displaced from their habitat when the "cumulative effects of boat traffic produce *a greater cost than the benefits of the resources in the area*" (Hodgson 2004). If animals are able to travel to other, less affected locations to avoid the source of the noise disturbance the effect is likely to be less than on animals that are forced, by way of lack of other available habitat, to remain and tolerate the disturbance.

Potential impacts upon marine taxa likely to be present within or adjacent to the Port are discussed further below.

<u>Cetaceans</u>

Noise pollution from shipping and onshore and offshore construction including activities such as pile driving is described of potential concern (DSEWPC 2011j) for the three dolphin species known to be present in the Northern Marine region: Orcaella heinsohni (Snubfin Dolphins – formerly Irrawaddy River Dolphins), Indo-Pacific Humpback Dolphins (Sousa chinensis), and Bottlenose Dolphins (Tursiops spp).

Whilst there is a lack of data relating specifically to the impacts of noise pollution on dolphins in the North Marine Region, impacts from anthropogenic noise on cetaceans have been well studied, more so than any other broad taxonomic group, and noise pollution is known to potentially result in adverse effects on cetaceans (Nowacek et al. 2007).

In particular, the response of cetaceans to boats has been subject to several investigations. Short term documented responses have included changes in swim direction, increased swimming speed, shortened surface intervals, and reduced resting times (Hodgson and Marsh 2007). Inshore dolphins are reliant on acoustic signals to maintain contact with conspecifics, and vessel noise can disrupt or mask such communication.

A study of acoustic communication and group cohesion of Indo-Pacific Humpback Dolphins in Queensland showed that boat traffic affected both communication and subsequently cohesion (Van Parijs and Corkeron 2001). Bottlenose Dolphins have also been demonstrated to change the frequency and volume of whistles and echolocation clicks in noisy localities and embayments (URS 2009).

Whilst short term behavioural responses have been relatively well-studied for cetaceans, studies attempting to investigate and quantify the effects of long term traffic are rare. Documented examples are generally from the northern hemisphere and include: the movement of Beluga Whales from a river to a nearby bay in Alaska when disturbed by persistent boating noise (Stewart *et al*., cited in Hodgson 2004); the possible disappearance of Belugas in another location in Alaska (Speckmann and Piat, cited in Hodgson 2004); observed movement of Bottlenose Dolphins to deeper channels during weekend periods of heavier boat traffic, in preference to their usual, shallower foraging habitats (Allen and Read, cited in Hodgson 2004); and a possible change to migration routes of Bairds Whales in response to vessel traffic (Nishiwaki and Sasao, cited in Hodgson 2004).

Other studies have shown no observable difference in behaviours such as surface resting behaviour and swimming speed in Sperm Whales in response to merchant ships in a busy shipping lane (Madsen 2003, cited in URS 2009). Animals are thought to be more tolerant of boats travelling at consistent speed, and the greater the level of traffic and proximity of passing vessels, the more significant the behavioural response (Hodgson and Marsh 2007).

Whilst noise generated during the operational phase of the project is of greatest concern with respect to this project, noise related construction impacts are also of concern. Construction activities have the potential to produce loud noises, such as those generated by pile driving, which at close range can physically injure animals or cause temporary or permanent damage to hearing thresholds (Nowacek *et al.* 2007) i.e. Kent *et al*. cited in DSEWPC (2011j) found that the higher frequencies of pile driving overlaps with the most sensitive frequencies of marine mammals.

Elevated noise levels associated with the construction of the barge landing area can also 'mask' communication signals and disturb normal behaviour. Noise from dredgers during maintenance dredging of the channel may also be within the hearing frequencies of larger cetaceans, however trends appear to indicate that dredge-associated noise does not cause undue interference or stress to cetaceans (Gladstone Ports Authority 2011).

Given the known acoustic sensitivity of cetaceans and documented impacts of underwater noise on behaviour, it is likely that increased shipping and construction activities will result in at least temporary disturbance and displacement of coastal cetacean species. Of the three cetacean species known to be present in the region, both the Australian Snubfin Dolphin and the Indo-Pacific Humpback Dolphin are likely to be affected due to their inshore nature.

Sustained interruptions of important behaviours including resting, feeding and courtship and mating can be costly, and reduce the reproductive rate of a population, and eventual displacement.

It should be noted however that given that the proposal represents the intensification of an existing use, that most marine mammals, including cetaceans, are likely to be habituated to some degree to activities within the Port. Furthermore, given the extensive areas of suitable habitat to the north and south of the Port, displacement and relocation of animals from the Port region owing to increased shipping traffic would, whilst being far from optimal, represent a worst case scenario in this instance.

The intensification of use is not considered to be occurring in an area of critical habitat for any cetacean species, nor is it expected to prevent migration of populations, disrupt feeding on seasonally restricted prey, or have the potential to mask the calls of great whales given that such species are unlikely to be present within auditory range of the Port and transhipment anchorages.

Similarly, the proposed transhipment anchorage locations are not located in a critical breeding, feeding, or aggregation area for any delphinids or baleen whales, and therefore impacts on cetaceans in these deep water locations are not considered to be significant.

It should also be noted that it may not be possible to accurately determine the impacts of the proposed intensification of operations on cetaceans, given that baseline cetacean surveys do not appear to have been undertaken in the vicinity of the Port, either prior to its construction, or during current operations.

<u>Dugongs</u>

Information pertaining to the auditory systems of sirenians (dugongs and manatees) and in particular dugongs is scarce. The auditory range of dugongs is thought to be in the middle frequencies (URS 2009). Like cetaceans, the response of sirenians is dependent on degree of previous exposure, season, age/sex class, weather and other factors (Miskis-Olds and Wagner, 2011).

Studies undertaken on manatees demonstrate that this species may not immediately abandon feeding in high noise level environments, suggesting that habitat type and behavioural state may influence the reaction of manatees to environmental signals such as approaching vessels (Miskis-Olds and Wagner 2011). Similar results were found by Hodgson and Marsh (2007) who assessed the risk of disturbance and displacement on dugongs from boat traffic in Moreton Bay in Queensland. Whilst short term, low distance movements were observed in response to boats passing within 50 m, it was considered that boating activity was unlikely to substantially impact upon the energy intake of dugongs due to the abundant seagrass beds available in the Bay (Hodgson and Marsh 2007). However, where dugongs are feeding on small or marginal patches of seagrass, continual disturbance by vessels may result in reduced feeding times, and possible displacement.

It is considered that dugongs may have a limited perception of dredger noises due to the low frequencies (URS cited in Gladstone Ports Authority 2011), however the impact of noises associated with construction activities such as pile driving is unknown. Anecdotal evidence suggests that dugongs may vacate an area following blasting (URS 2009) and may also be sensitive to drilling noise. Noise from nearshore construction activities is likely to have similar effects to inshore cetaceans resulting in short term potential disruption to behaviours and possible short to medium term displacement, and in the case of sudden start-ups of drilling or pile-driving machinery; potential injury.

It is therefore considered likely that, given the extent of seagrass meadows in the region, dugongs may move further away from the Port to avoid chronic or temporary noise exposure again however, this is considered a worst case scenario.

Again, the intensification of use is not considered to be occurring in an area of critical habitat for dugongs, nor is it expected to prevent migration of populations, or disrupt feeding on seasonally restricted seagrass species.

Turtles

As turtles do not have an external hearing organ, auditory perception is thought to be a function of bone and water conduction (URS 2009). Hearing range in turtles is thought to range from about 100-700Hz for Green Turtles (McCauley, cited in URS, 2009), with auditory sensitivity thought to correspond with low frequency noise generated by vessels.

Studies of noise impacts on marine turtles are scarce, however a trial on caged Loggerhead and Green Turtles using an air gun indicated that at a level of 166dB (re 1µPa) both species increased their swim speed noticeably, and above 175dB their behaviour became erratic, which was interpreted to be the point at which turtles may demonstrate active avoidance behaviour (McCauley, cited in URS 2009).

Nesting turtles near the Port of Hay Point in Queensland were monitored before, during and after a pile driving event of several months duration (Dames and Moore, cited in URS 2009). No significant trend was observed however one study does not enable definitive conclusions to be made with respect to the impact of pile driving on nesting female turtles.

Again, turtles may actively avoid the Port area during construction in the event that noise levels are within the range that may cause pain, injury or disturbance to normal behaviours. Juvenile Green Turtles are known to persist in areas subject to high levels of boating activity such as the Gold Coast seaway in Queensland, where macroalgae is abundant and therefore may continue to use the access channel and swing basin in between dredging events despite the increase in vessel traffic.

Fish

Variation in bony fish with respect to sensitivity to sound is very large, and some species may be sensitive to sound levels as low as 60dB (re 1µPa), particularly fish that have morphological adaptations that connect otilithic hearing organs to gas filled bullae or swim bladders (URS 2011).

Studies have shown that bony fish will avoid approaching vessels when noise levels exceed hearing thresholds by 30dB or greater by swimming down or horizontally away from the vessels path (URS 2009). Therefore some fish species may be affected by vessel movement in the Port, however, conversely, the aggregation of some species next to operational infrastructure such as oil/gas production platforms, wharves, ship-loaders etc. indicates that habituation to sustained noise can occur over time (URS 2009).

Hearing sensitivities in sharks are not particularly well documented however audiograms have been performed for some cartilaginous fish species including the Bull Shark (*Carcharinchus leucas*), and sharks and rays are thought to be able to distinguish sound, determine direction and detect relevant biological auditory cues (URS 2011). Hearing sensitivity of sharks lies within a low frequency range that is sufficient to detect sounds at 120-180dB typical of most vessel noise.

Syngnathid species are not thought to be affected significantly by noise below 180dB (re 1µPa) with hearing sensitivity thought to be greatest in higher frequency ranges based on studies of seahorse vocalisations (URS 2011).

Continued disturbance in the vicinity of the swing basin and access channel may result in permanent avoidance of that location by some fish species, or animals may move off temporarily if disturbed.

Pile driving and dredging during construction has the potential to cause injury or mortality, particularly for fish located in close proximity to the noise source (i.e. within 30m).

Whilst some fish species may be temporarily disturbed by construction and shipping activities, such impacts are not expected to be significant given background levels of shipping activity in the region. It is expected that most animals would move off or cross-shore in response to approaches from small or large vessels.

Mitigation Measures

During construction, a trained marine fauna observer is to make regular inspections (suggested frequency every half hour) both prior to start up and during construction within an observation zone 200 m from the construction area. Note that construction of maritime infrastructure will be undertaken during daylight hours only both for safety requirements and to ensure optimal visibility of marine mega-fauna.

In addition to visual observation, the potential to use passive/active detection acoustic detection methods will be investigated. As silt curtains will be utilised as is practical to do so, it will be necessary to ensure that no marine megafauna is trapped within the curtain bounds prior to start-up, specifically cetaceans, dugongs, turtles and crocodiles.

Piles can be installed using a leader rig with vibrator, but may also be pressed in where silent vibrationless piling is required. If piles are able to be pressed in (subject to engineering considerations and prevailing conditions) then this method should be utilised to minimise noise emissions. Alternatively, soft-start procedures for pile driving using a leader rig are to be utilised (i.e. gradually increasing the power of the leader rig) so that the potential for startle responses and injury or death is minimised.

It is recognised that marine megafauna are mobile and can generally avoid impacted areas for the duration of disturbance. However, if a cetacean, dugong, or turtle is sighted within the 200m radius observation area during construction, then operations are to cease until the animal has left the observation zone.

To further minimise potential noise emissions associated with vessel movements, a go slow zone (suggested 4 knots) is suggested for the access channel and swing basin. Barges will have operational maximum of approximately 6 knots empty and 4 knots loaded. Vessels are to avoid interactions with marine mammals where possible – noting the limitations imposed by the lack of manoeuvrability of barges.

Acoustic and Physical Disturbance (Coastal)

Potential Impacts

In addition to underwater acoustic disturbance, shore-based disturbance associated with the construction and operation of the barge loading facility will likely result in acoustic and physical disturbance to seabirds or shorebirds (i.e. migratory waders) that are utilising the intertidal zone adjacent to the facility.

Given the existing levels of background noise and disturbance associated with the Port, and that important shorebird and seabird aggregation areas are not located within the immediate vicinity of the Port, impacts are considered to be minor. The intensification of use at the Port and construction of the Barge Landing Facility is expected to result in a very minor loss of foraging or breeding habitat that is considered insignificant in the context of the southern Gulf coastline and nearby Sir Edward Pellew Island Group. Furthermore, whilst several listed migratory and marine species were sighted within the general Port area, none of these are listed as conservation dependent under either the TWPC or EPBC Acts. It is worth noting that the conservation status of several species under the TWPC Act is currently under review.

Mitigation Measures

None required.

5.7.2 Species Level Impacts

A number of species are known to be at particular risk of impacts associated with discrete components of the proposal. In some cases, the risk may apply to a number of species (i.e. boat strike). These potential impacts are discussed further below.

Boat Strike

Potential Impacts

There is a potential for increased incidence of boat strikes on marine megafauna, notably turtles, dugong and cetaceans (Hazel *et al*. 2007) given the cumulative increase in shipping which will arise as a result of the Xstrata expansion and WDRL proposal. The proposed development would require multiple trips over the life of the project, transporting iron ore from the Bing Bong Facility to Ocean Going Vessels (OGVs) moored approximately 20km offshore, and then to market.

Boat strike is known to be a threat to several marine megafauna species given their requirement to surface to breathe, and feeding habits in shallow coastal zones.

Marine megafauna can also be disturbed when boat noise elicits a response to a perceived risk of boat strike, which can result in other effects including energy costs of disruption to feeding and social behaviours, and failure to detect auditory or other cues from conspecifics (Hodgson, 2004).

No data exists for boat strike injuries or mortalities in NT waters of the southern Gulf; however records exist from the Queensland side of the Gulf (Greenland and Limpus 2007; Biddle *et al*. 2010; Biddle and Limpus 2011).

Boat speed is considered to be the causative factor influencing the outcome of boat strikes to marine mammals, and as with any vehicle collision, the higher the speed, the less chance the animal has to take evasive or avoidance action. Risk of boat strike is also thought to be correlated with the density of vessels, with vessel size and bathymetry also influencing the level of risk (Gladstone Ports Authority 2011). High levels of background noise may also reduce the ability of marine fauna to detect oncoming vessels, with speed also documented as influencing the ability of animals to detect approaching vessels (Hodgson, 2007). The vast majority of documented boat strikes for marine megafauna are for smaller vessels (i.e. recreational speedboats) travelling at high speeds i.e. > 20 knots.

The boat speed for the self-propelled barge will be 4 knots fully laden, and 6 knots empty, which is considered to be a low speed operation. The technical crane will travel at speeds of up to 8 knots outside the access channel and swing basin, also considered to be relatively slow-moving. The OGV's associated with transport of the product offshore are also expected to be large and slow, reducing the overall threat of vessels striking and injuring cetaceans or marine mammals.

Any increases in injury or mortality would potentially be expected within the access channel and transit routes as vessel activity will be concentrated within these designated areas. In deeper open waters outside of the access channel and at the transhipment anchorages, the probability of boat strike is reduced as animals are less likely to be crushed between the boat and the substrate; however individuals may still be struck when surfacing to breathe. Overall however, given the large size and slow speeds associated with project vessels, the risk is considered to be low.

The risk of boat strike for specific taxa is discussed below.

<u>Cetaceans</u>

Studies from other parts of the world indicate that shipping may be a major cause of mortality for some cetacean species (Knowlton and Kraus, cited in DEWHA 2008). Within the northern marine region, potential boat strikes are likely to be more prevalent for smaller cetacean species (i.e. dolphins) than for larger species such as whales, as these seldom occur in the region. As with impacts associated with underwater noise, Australian Snubfin Dolphin and Indo-Pacific Humpback Dolphins are thought to be particularly susceptible due to their coastal inshore nature. These species have been observed in areas of moderate to heavy vessel traffic including commercial fishing boats, ferries, and larger, slow vessels in the Port of Gladstone, Hinchinbrook and Darwin Harbour regions (Gladstone Ports Corporation, 2011).

Bottlenose Dolphins may be also susceptible due to known behaviours such as actively approaching smaller vessels and bow-riding. Studies have also indicated that depth or availability of complex depth structure, as present in the majority of ports may be an indicator of dolphin presence and/or prevalence (Gladstone Ports Corporation, 2011).

Dolphins are thought to be less vulnerable to boat strike than other taxa however, due to their greater mobility (than turtles and whales), and for whales, their greater size means they are also less likely to be struck by boats (URS 2009). This is reflected in data from Queensland, where cetacean mortality from boat strike has averaged at only two per annum (Greenland and Limpus 2007) since monitoring commenced in 1998.

Furthermore, noise associated with vessels is known to often deter many cetacean species and result in active avoidance behaviour.

Dugong

Boat strikes are thought to have resulted in a relatively small number of anthropogenic-related dugong mortalities in Australia; however boat strike is thought to be a global problem affecting this species throughout its range (Marsh cited in Hodgson, 2004).

The most recent statistics from Queensland show that during the year 2009-2010, there were eight dugong mortalities as a result of boat strike, of which only one was in the Gulf (Karumba), and the remaining mortalities were from the Moreton Bay Marine Park, which is subject to much higher rates of vessel traffic.

Both dugongs and turtles are thought to exhibit a delayed response to vessels travelling at high speed, and therefore may be particularly vulnerable to smaller vessels (i.e. tug boats and support vessels) travelling at greater speeds outside of the swing basin and access channel.

Larger vessels such as the self-propelled barges and OGV’s may also pose a risk of boat strike as opportunities to escape are more limited from the large draft and width of the vessels. It should be noted however, that the majority of documented incidences relate to smaller pleasure-craft travelling at higher speeds.

Potential changes in dugong movements and distribution patterns may also increase the risk i.e. in the event a cyclone destroys large areas of seagrass, large numbers of dugongs may be forced to travel through the Port region to find food resources.

Noise associated with increased vessel activity may also result in dugongs attempting to avoid the busy Port, given the abundance of food resources to the north and south.

Green Turtles

Boat strike accounted for 63 deaths of marine turtles over the period 2005-2010 in Queensland, which is substantially higher than comparable rates of dugong and cetacean deaths from vessel strike extrapolated over a five year period (Biddle and Limpus, 2011).

Field experiments conducted by Hazel *et al*. (2007) on behavioural responses of Green Turtles to approaches from research vessels showed that as vessel speed increased; the proportion of turtles that fled to avoid the vessel decreased, and that turtles that fled from moderate and fast approaches, did so for a shorter distance than slow approaches. This implies that turtles may not actively avoid vessels approaching at speed; which may explain the higher incidence of boat strike related mortality, however behavioural response to larger vessels (i.e. barges) is unknown, with the majority of studies (and documented mortalities) again focused on smaller recreational and commercial vessels.

Green and Flatback Turtles are likely to be present in the waters around the Port. Juvenile Green Turtles are most likely to come into the Port access channel and swing basin to feed on algal growth.

Sea Snakes

Sea snakes are also thought to be vulnerable to boat strike particularly fast moving vessels given that they are air breathers, and are unable to hear and rely on vision and vibration to detect approaching vessels (Hibbard, cited in DSEWPC 2011d). However, actual mortality rates of sea snakes as a direct result of boat strike are unknown. Given that most sea snake species are found at depths of around 30 m, they are unlikely to be subject to greatly increased risk, given that the Port, transhipment anchorages and cyclone moorings are all located within depths of less than 20m.

Mitigation Measures

It is reasonable to assume that dolphins and turtles may frequent the navigation channel and swing basin at times dependent on the prevailing levels of disturbance. Dugongs may also pass en route to other seagrass beds in the region depending on conditions, therefore speed restrictions are considered reasonable within the access channel and swing basin (suggested speed of 4 knots). It is acknowledged that Xstrata have likely implemented speed restrictions at Bing Bong loading facility. No important habitat areas are known to occur within the proposed route to the transhipment anchorages, therefore reduction of boat speeds external to the entrance channel and basin (which are already slow at 4 knots) is not considered necessary.

Furthermore, strict marine megafauna interaction procedures are to be implemented (assuming that these do not presently exist for current Port operations), suggested approach distances are 50m (dolphins and turtles) and 100m (whales and dugongs) i.e. no vessel must approach closer than these distances.

Personnel aboard all vessels will be responsible for remaining vigilant and avoiding cetaceans, dugong and turtles. Barges and OGV's carrying iron ore are slow moving vessels, which have lower potential risk of boat strike to marine fauna than faster moving vessels.

The workforce is to be educated on the importance of compliance with speed restrictions and the need to be vigilant whilst operating vessels, to reduce the potential for negative vessel/fauna interactions.

All incidents of boat strike and associated injury/mortality are to be maintained in a register and reported to the Parks and Wildlife Commission of the NT.

Artificial Lighting

Potential Impacts

Lighting of the Barge Landing Facility and ancillary structures has the potential to disrupt critical behaviours of adult female nesting turtles and hatchlings, such as nest selection and sea-finding behaviour, through disorientation from bright light sources. The likely consequences are an increased rate of hatchling mortality and reduced nesting rates.

Less documented are impacts of light pollution associated with shipping. Shipping is likely to increase greatly in volume and where ships are anchored (i.e. the transhipping anchorage points) anecdotal evidence suggests that hatchlings are drawn to the lights of anchored vessels (DSEWPC 2011d). Hatchlings may become trapped along the hulls, subsequently exposing them to higher rates of predation.

Nesting or roosting seabirds and shorebirds may also become disoriented from bright lights associated with lighting of coastal and marine infrastructure.

Marine turtles frequent the waters adjacent to the project site and are known to nest in the nearby Sir Edward Pellew Islands to the east of the shipping channel that the barges will use to transport OGVs.

No turtle nesting beaches are known from the project site or close proximity. Low density nesting has been recorded further to the north and south of the Port. Low density nesting is in theory possible on the narrow beach berms approximately 1km to the north and south of the existing Port although has not been previously recorded. The closest known nesting beach is approximately 10 km from the barge loading facility on West Island.

No major rookeries or nesting areas for shorebirds or seabirds are known to be present in the immediate vicinity of the Port, the presence of which is likely precluding the use of this area for some species. Impacts of artificial lighting on avian species are not well documented, and may range from attraction to avoidance. Industrial lighting which serves to light coastal waters may also serve to attract some fish animals and consequently higher order predators.

Impacts from the Barge Loading Facility are expected to be minimal given the distance to the closest area where nesting potentially occurs (estimated to be a minimum of 10km to the north and south, and to

West Island). Disorientation of nesting Flatback Turtles has however been documented in Queensland associated with brightly illuminated salt spray above an alumina refinery in Queensland, some 18 km from the nesting beach (Hodge *et al*. cited in Gladstone Port Authority 2011).

Therefore, a number of recommendations are provided under mitigation measures in order to minimise cumulative light emissions from Bing Bong. The proposed transhipping anchorages are approximately 19 and 21NM offshore and are not expected to attract hatchlings given the distance offshore from the closest nesting area (Sir Edward Pellew Islands), nor disorientate seabirds or shorebirds. Cyclone moorings may however be located in close proximity to the Sir Edward Pellew Group, and lighting of these moorings may potentially disorientate adult females approaching the islands for nesting. Consequently, mitigation measures for cyclone moorings are listed below.

Mitigation Measures

Turtle nesting is not thought to be occurring adjacent to or within close proximity to the loading facility, however, cumulative light emissions may still serve to disorientate nesting females, as well as acting as a form of habitat degradation to nesting beaches in the nearby Pellew Island group. Consequently, in order to minimise cumulative light emissions from the Bing Bong Barge Loading Facility, the following is recommended:

- Use of orange and red lights, or yellow low pressure sodium vapour lamps for external lighting of buildings;
- Where white and other lights are required, install shades or modify light orientation to minimise light spill;
- Position lights low to the ground wherever possible; and
- Use reflective tape to reduce the amount of ambient light required.

It is further recommended that consideration be given to the positioning and lighting of cyclone moorings. The use of orange and red lights or preferably reflective tape is to be utilised in preference of white lights.

Impacts on Coastal and Marine Processes

Potential Impacts

Potential impacts of coastal infrastructure and related activities, for example groyne construction and large-scale dredging have the potential to cause refracted wave patterns and longshore sediment transport, and subsequent changes to coastal morphology through altered patterns of erosion and accretion.

The detailed design of Port Infrastructure is not complete however the Barge Loading Facility is to be located on reclaimed land approximately 2m above the HAT level and unlikely to interfere significantly with active sediment transport given the low energy environment of the site. A causeway structure may potentially cause accretion on the updrift side and erosion on the downdrift side however given the low net rates of sediment transport; this is likely only in storm events.

Furthermore, shallow excavation in the swing basin is unlikely to have any significant effect on the wave climate of the port or sediment regimes and therefore should not result in any significant effect on the existing port or surrounding shoreline.

Mitigation Measures

None proposed. Coastal process modelling will be undertaken if required at the detailed design stage to ensure that the proposed Barge Loading Facility does not impact upon coastal processes.

5.7.3 Socio-economic Impacts

Restriction of Access to Recreational Fishing Areas

Potential Impacts

The Bing Bong channel is known as an excellent recreational fishing spot and popular with local and visiting recreational visitors, as well as school groups.

The presence of the new Barge Loading Facility is expected to result in a small reduction in the amount of shoreline adjacent to the access channel that is available for recreational fisherman to fish. However, this represents a very small reduction to the overall area available to fishermen. Open waters and the surrounding coastline will remain unaffected. The existing viewing platform, access track and informal car parking area may require relocation subject to detailed design of the conveyor and Barge Loading Facility.

Fishing is also popular on the Towns River, with boat ramps provided for this purpose. Given that no infrastructure is to be located in the lower Towns River, no impacts upon fishing opportunities are expected. Furthermore, mine activities are not expected to impact significantly upon water quality or fish stocks in the region.

Mitigation Measures

The existing viewing platform, access track and informal car parking area will be relocated, with appropriate signage installed as required as determined appropriate by Xstrata.

Interactions with Commercial and Indigenous Fisheries

Potential Impacts

The proposed transit routes from the Port to the transhipment anchorages may traverse important fishing grounds and disrupt commercial operators or Indigenous fishing and hunting practices through the increase in shipping traffic.

The marine environment in proximity to the Towns River is expected to remain unaffected by the mine given that no infrastructure is proposed to be located in this region.

Mitigation Measures

No significant fishing grounds have been identified within the proposed navigation route through consultation with affected parties. It is expected that potential disruptions to commercial and Indigenous fishers would be relatively minor on a temporal and spatial scale. Ongoing consultation with both Traditional Owners and the fishing industry will take place to ensure that any potential negative interactions can be prevented.

Cyclone and Heavy Storms

Potential Impacts

Cyclones and heavy storms have the potential to damage or destroy coastal and maritime infrastructure, cause injury or mortality to mine personnel and visitors, and result in physical damage to marine ecological communities as well as resulting in the potential release of contaminants/pollutants and hard debris into the marine environment. Potential impacts associated with tidal and nearshore structures include the potential for erosion and slumping as a result of coastal hazards such as storm bite.

Mitigation Measures

The Bing Bong loading facility falls within a Category C rated cyclone area and consequently all facilities will be designed to withstand cyclones, and cyclone moorings for all barges and floating plant provided.

Extreme event design criteria (i.e. wave height, storm surge) will be considered at the detailed design stage so that existing infrastructure is designed to withstand any future event, with modelling undertaken as required.

It is anticipated that even in the case of a storm event, that erosion is unlikely to be extensive, and any erosion scarps may be backfilled from the zone of accretion, using conventional earthmoving equipment.

Cyclone moorings would be provided for the barges and floating crane at West and/or Centre Island subject to further investigations.

A cyclone tie-down and maintenance area would be provided at one end of the stacker travel to lock the stacker in position during a cyclone and allow access for maintenance.

The concentrate storage facility at Bing Bong will be constructed to withstand the impacts of cyclones and flooding and all buildings containing hazardous materials and fuels will be fully bunded.

The barge crews would be transferred to shore and to a cyclone shelter, or evacuated from site in the event of a cyclone. A cyclone bunker will be provided either at the accommodation or Stockyard site for use by all WDRL personnel including barge crews. The bunker will be designed and constructed to all relevant Australian Standards for cyclone prone areas and have a sufficient capacity for both WDRL personnel and contractors.

Barge Collisions and Groundings

Potential Impacts

There is a risk of barge collisions particularly given the proposed intensification of use in the Port. This could potentially result in spill of hazardous materials (i.e. hydrocarbons) and DSO. Groundings are considered unlikely provided transit routes are adhered to and given no known reefs are present in shallow waters of the transit routes.

Possible interactions between the existing Xstrata operation and the proposed WDRL operations have been assessed by an external consultant who concluded that WDRL and Xstrata barging operations can run independently with no disruption to each other if proper operational rules are implemented.

Mitigation Measures

With the increase in shipping planned within the Bing Bong loading facility a Shipping Officer may be required to monitor and co-ordinate the movement of barges with the port and those passing through the access channel.

To ensure the ability of Xstrata to conduct their operations without disruption from WDRL it is proposed that that an operational and risk assessment workshop be conducted between the between WDRL and Xstrata to develop a Port Operations Manual which would include items such as:

- A set of Port Operating rules;
- Emergency response procedures;
- Safety and security procedures; and
- Detailed contact information required to ensure 24 hour coverage during operations.

The risk of collisions and groundings is expected to be reduced through joint Xstrata Operational procedures, good illumination of the Barge Loading Facility, enforced speed limits, correct docking procedures, operational restrictions during unsuitable conditions and standard operating procedures and training for all personnel involved in Port operations.

WDRL also proposes that a combined emergency response team and equipment be provided for incidents that occur within the barge loading facility. WDRL will provide equipment, personnel and training required to this end.

5.8 Conclusions

This section has assessed the potential risks posed by the intensification of an existing use in the Bing Bong loading facility, including cumulative impacts from the expansion of Xstrata operations. Whilst the intensification of use will undoubtedly result in increased risk of potential impacts in this location, it is considered that an intensification of use at an existing Port facility is far preferable to the construction and operation of an additional port facility in another location, which would greatly expand the temporal and spatial impacts associated with the WDRL proposal.

To this end, WDRL has been discussing options for the sharing of infrastructure, most notably the port facilities. These discussions will continue to ensure that opportunities to reduce cumulative impacts are explored and managed effectively.

Based on the above impact assessment a number of potential risks have been identified including habitat degradation, species level impacts, impacts on coastal and marine processes, and socio-economic impacts.

The most significant potential impacts associated with the project are considered to be the potential for displacement and disruptions to normal behaviour for marine fauna associated with acoustic and other disturbance arising from the increase in shipping. This has been reported from port developments in Queensland where a reduced presence of marine turtle, dugong, and dolphin species were reported in proximity to recently developed facilities including a bund wall and barge landing facility (Gladstone Ports Corporation, 2011). Boat strike is also considered to be a potential risk, however can be mitigated with speed restrictions.

Other potential impacts, such as spillages, introduction of marine pests, and other mentioned impacts for both the construction and operation phases are considered to be low risk activities given the mitigation measures proposed.

The most significant areas in proximity to the Port are considered to be the extensive seagrass meadows to the north and south of the Port, and the Sir Edward Pellew Islands group. The most significant risk to these areas are considered to be a hydrocarbon spill, which could potentially reach the shore in the unlikely event of a collision or accident during a cyclone, given that a cyclone mooring will be located near the Islands. However, a significant hydrocarbon spill is considered unlikely to occur given mitigation measures proposed.

Matters of National Environmental Significance associated with near shore environments include threatened and migratory marine species, including cetaceans, dugongs, birds, turtles, sharks, seahorses and migratory birds.

Whilst coastal dolphins, dugongs, marine turtles, and sawfish are known to occur in the immediate area, the most significant breeding and feeding grounds are found to the south-east in the Sir Edward Pellew Islands, and to the north in the Limmen Bight. It should also be noted that no critical breeding, aggregation, feeding or foraging areas for cetaceans, dugongs, turtles or other conservation dependent species are known to exist in proximity to the Port or transhipment anchorages, and a large number of vessels already utilise the region.

Based on the above impact assessment, it is apparent that risks to fisheries activities, fish stocks, migratory species, benthic species or species utilising the littoral or sub-littoral environment are generally minor, with the exception of the likely displacement of some species from the immediate vicinity of the access channel and navigation route. It is expected that species sensitive to acoustic and other disturbance associated with the intensification of operations will migrate to other less disturbed locations, of which there is suitably undisturbed areas of habitat to the north and south.

The development is not expected to impact upon a matter of National Environmental Significance, thus triggering assessment under the EPBC Act, and is considered to be compliant with the requirements of the Northern Territory *Fisheries Act 1998* and *Territory Parks and Wildlife Conservation Act 2000*.

In order to ensure that the project does not cause adverse environmental impacts, a marine ecological monitoring program is proposed.

5.8.1 Marine Ecological Monitoring Program

WDRL propose to contribute towards the existing Xstrata Marine Monitoring program. The Xstrata program is understood to include the following (MRM 2005a,b):

- Monthly sampling of seawater sample sites including in the swing basin, dredge channel, control site and Sir Edward Pellew Islands;
- Seawater sampling locations using the diffusive gradients in thin-film (DGT) technique, which are deployed for a period of four to six days every month;
- Bi-annual marine sediment monitoring at seven locations including sites in the swing basin and dredge channel, and a reference site located at a distance away from the Bing Bong loading facility; and
- Seagrass, gastropods, oysters and other bivalve sampling and heavy metal concentration analysis at Bing Bong and Sir Edward Pellew Islands.

It is understood MRM is proposing to broaden the scope of its marine monitoring program to include regular sampling of fish and other biota.

Seagrass monitoring is also currently undertaken by Xstrata at the end of the dry season to avoid confounding results with seasonal variations.

As part of the Port Marine Environment Monitoring program, WDRL propose to implement complementary environmental monitoring elements specific to its operations at the Port of Bing Bong Operations, in particular additional dust monitoring, and inclusion of additional parameters of interest (i.e. dissolved iron levels) for analysis of seawater and sediment samples from existing Xstrata sampling sites.

It is recommended that this monitoring continue, and consideration will be given to increasing the monitoring scope, frequency and intensity given the significant expansion of activities within the Port.

The current Xstrata marine monitoring program will be reviewed in the context of both Xstrata and WDRL operations by relevant experts including Charles Darwin University Personnel and AIMS staff whom are currently undertaking monitoring activities.

For example, the inclusion of monitoring of marine invertebrates and macroalgal assemblages may be considered as part of the expanded scope. Marine invertebrate and macroalgal assemblages are important components of trophic food webs that support higher level consumers, and are therefore important bio-indicators. A number of parameters can influence diversity and abundance of macroalgal and invertebrate communities including ambient contaminant concentrations, temperature, nutrients, and light availability. Sampling of macroalgal and invertebrate assemblages that have colonised settlement devices (nets) deployed at a number of sites (preferably the sites currently sampled for seawater and sediment monitoring as part of Xstrata's monitoring program) and analysis of species richness and diversity, biomass and other relevant parameters of interest may therefore be a useful inclusion.

Settlement plates are also suggested as a monitoring tool for invasive marine species if these are not already being utilised, given the risks posed by diving in this location.

Whilst the increase in shipping is expected to substantially increase underwater noise levels in proximity to the Port, baseline and predictive underwater noise propagation modelling is considered ineffective as modelling would be confounded by a large number of variables including variable depths of water owing to the large tidal range, and variable background levels of shipping.

Baseline cetacean and dugong surveys do not appear to have been undertaken prior to or following the Ports construction. Given this, and current levels of background activity, the current state of the marine environment should not be regarded as a baseline reference. Very little is known about the ecology of the Australian Snubfin and Indo-Pacific Humpback Dolphin in Australian waters and because of their population size and movement patterns, these species are particularly vulnerable to extinction (Parra *et al*. 2006).

Pending the results of the strategic review, consideration may be given to the inclusion of aerial and boat-based surveys of marine mega-fauna to be undertaken as part of the scope of the marine monitoring program at both regional and finer spatial scales. Telemetry and passive acoustic studies may be used to further detect the presence and ecological responses of marine fauna.

Alternatively, WDRL and Xstrata may consider making a financial contribution to any scientific studies on marine vertebrates of conservation importance that are undertaken in the region of the Port and Sir Edward Pellew Islands, in particular population and site fidelity studies of Australian Snubfin and Indo-Pacific Humpback Dolphins, and marine turtle nesting on nearby beaches and in the nearby Sir Edward Pellew Island group.

Regardless, studies should commence prior to both WDRL commencing construction at Bing Bong and Xstrata's expansion of shipping activity at the Port, and should include at least two sampling periods to account for seasonal variation.

Studies should seek to develop an understanding of marine megafauna populations movements and habitat utilisation in the vicinity of Bing Bong, so that appropriate indicators to monitor changes to populations can be developed.

5.8.2 Commitments

WDRL commits to best practice marine environmental management to ensure its impacts upon the marine environment can be minimised.

To this end, WDRL commit to undertaking a strategic assessment of proposed mitigation measures and the current Xstrata marine monitoring program to ensure that the cumulative impacts of both Xstrata's expansion and WDRL's proposal may be appropriately mitigated and monitored.

WDRL commits to reviewing the current Xstrata Marine Monitoring program with relevant Xstrata, AIMS, Charles Darwin University, and other relevant technical personnel.

The outcomes of this strategic assessment will be used to verify the proposed mitigation measures within this document (or provide alternative measures), and to determine an appropriate scope of works to be included within the monitoring regime at the Port.

WDRL further commits to undertaking any further monitoring of parameters of interest that arise from this review, including any required mitigation measures. This includes a contribution to the current Xstrata Marine Monitoring program, including financial, personnel or in-kind support.

Regardless of the outcomes of the review, WDRL commits to the following mitigation measures:

- Timing of construction works to take into account seasonal variation and optimal tides as determined by the Strategic Review;
- The use of physical mitigation measures including sediment and erosion control barriers onshore and floating booms and silt curtains in the marine environment for the construction of the Barge Loading Structure;
- Acoustic controls including observers prior to and during construction, engineering alternatives for pile installation or soft start procedures, and speed restrictions in the Port;
- Marine megafauna approach/interaction procedures and mandatory speed restrictions within the access channel (assuming that these do not presently exist for current operations) are to be implemented – suggested maximum speed within the channel of 4 knots. Barges will have operational maximum of approximately 6 knots empty and 4 knots loaded. Vessels are to avoid interactions with marine mammals where possible – noting the limitations imposed by the lack of manoeuvrability of barges;

- Dust suppression measures;
- Design controls to prevent spills including covered conveyors and loading chutes, automatic cut-off valves on fuel hoses, standard operating procedures and clean up procedures;
- Management of rubbish and waste including regular rubbish inspections around the Port;
- Monitoring of water and sediment quality, presence of invasive marine pest species and other marine biota as determined by the strategic assessment;
- The existing viewing platform, access track and informal car parking area will be relocated, with appropriate signage installed as required as determined appropriate by Xstrata; and
- Coastal process modelling (if required) will be undertaken at the detailed design stage to ensure that the proposed Barge Loading Facility does not impact upon coastal processes. Extreme event design criteria (i.e. wave height, storm surge) will be taken into account at the detailed design stage so that existing infrastructure is designed to withstand any future event.