



Notice of Intent

AUSTRALIA



East Arm Marine Industry Park Notice of Intent

20 August 2014
42214014/NOI/0

Prepared for:
Land Development Corporation

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East Arm Marine Industry Park
Notice of Intent

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42214014/NOI/0

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Appendix E	EPBC Act Protected Matters Report
Appendix F	AAPA certificates for East Arm

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ABBREVIATIONS AND UNITS

Abbreviation/Unit	Description
%	percentage
µg/m ³	micrograms per cubic metre
µm	micrometres
AAPA	Aboriginal Areas Protection Authority
ABS	Australian Bureau of Statistics
AHD	Australian Height Datum
ARI	average recurrence interval
ASS	acid sulphate soils
BIMOS	Biodiversity Impact Mitigation and Offset Strategy
BoM	Bureau of Metrology
CBD	Central Business District
CD	Chart Datum
CEMP	Construction Environmental Management Plan
CN	Conservation
CUA	Common User Area
DHAC	Darwin Harbour Advisory Committee
DLP	(former) NT Department of Lands and Planning
DLPE	NT Department of Lands, Planning and the Environment
DLRM	NT Department of Land Resource Management
DDSPMP	Dredging and Dredge Spoil Placement Management Plan
DPA	Darwin Port Authority
DPC	Darwin Port Corporation
DoE	Commonwealth Department of Environment
DV	Development
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EMS	Environment Management Services
EPA	Environment Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act</i>
FD	Future Development
GI	General Industry
ha	hectares
HAA	heavy anti-aircraft
km	kilometres
km/h	kilometres per hour
L/s	litres per second
LAT	lowest astronomical tide

Abbreviation/Unit	Description
LDC	Land Development Corporation
LNG	liquefied natural gas
m	metres
m/s	metres per second
m ³	cubic metres
mm	millimetres
MNES	Matters of national significance
NAGD	National Assessment Guidelines for Dredging
NEPM	National Environment Protection Measures
NOI	Notice of Intent
NRETAS	(former) NT Department of Natural Resources, Environment, the Arts and Sport
NT	Northern Territory
NT EPA	Northern Territory Environment Protection Authority
NTG	Northern Territory Government
°C	degrees Celsius
PASS	potential acid sulphate soils
PM	Proposed Main Road
RW	Railway
SAP	Sampling and Analysis Plan
TPWC Act	<i>Territory Parks and Wildlife Conservation Act</i>
U	Utilities
UXO	Un-Exploded Ordinance
URS	URS Australia Pty Ltd
WWII	World War 2

The East Arm Logistics Precinct is at the forefront of the Northern Territory's (NT) major projects in a region that is rapidly expanding into the resources and logistics industries area. The precinct covers more than 300 hectares and is strategically located close to the Port of Darwin's East Arm Wharf, the Marine Supply Base, the AustralAsia railway and major road and air transport connections (Land Development Corporation [LDC], 2013a).

In 2011, the (former) Department of Lands and Planning (DLP), (now the Department of Lands, Planning and the Environment [DLPE]), prioritised the continued development and availability of industrial land at the East Arm Wharf and the development of industrial land suitable for use by industries associated with oil and gas, including fabrication and offshore supply facilities, as well as those that support the Darwin Port and the AustralAsia Railway.

Accordingly, the Northern Territory Government's (NTG) primary industrial land developer, the LDC, is master planning the 'East Arm Marine Industry Park' (the 'Project') as part of the wider East Arm Logistics Precinct to accommodate the future growth and demand of the industrial marine and support sectors (LDC, 2013b). The Project will include a mix of existing privately owned service industries, a new waterfront development, commercial activities and areas proposed for marine maintenance, servicing and logistics facilities (LDC, 2012a). The Project will be located on parcels of land in the Hundred of Bagot, including portions of sections¹ 6117, 6289, 6238 and 4337, and sections 6115 and 6116.

The Project will be developed in stages, anticipated to be over a long timeframe of up to 50 years. The development and timing will be influenced by many factors over this period. Construction of the first stage, subject to the approvals process, is estimated to commence as early as 2016 and take five years. It is likely that some dredging of channels and berth pockets will be undertaken during the initial stages of development, however this will be subject to industry demand and operational requirements.

An alternative option regarding dredging is also under consideration. Under this alternative option, businesses that locate to the site will initially work on the tides, with some small berth pockets to potentially be dredged. Under both options, further dredging of access channels and more extensive berth pockets will be staged to accommodate additional businesses / foundation tenants as the Project expands.

1.1 Scope of Notice of Intent

The overall objective of the Notice of Intent (NOI) is to provide formal notification to the NTG and the NT Environment Protection Authority (EPA) of the LDC's intention to develop the East Arm Marine Industry Park.

It should be noted that this NOI does not incorporate the entire area of the proposed Marine Industry Park; the 'Project' for the purpose of this NOI is shown on **Figure 2.1**. Other sections of the Marine Industry Park are incorporated into existing approved developments or will be managed under future development applications.

¹ All portions or section referenced in this report refer to Hundred of Bagot, NT. e.g. Sections 6117, 6289, 6238 and 4337 of the Hundred of Bagot, NT.

The adopted Marine Industry Park NOI boundary incorporates an extended zone within Darwin Harbour, within which dredged access channel(s) and other dredge zones required for the development will be investigated during the Environmental Impact Assessment (EIA) process.

This NOI presents and discusses the Project by:

- Describing the scope and timeframe of works for the Project;
- Identifying the existing environment of the site;
- Identifying the environmental and related impacts that could potentially occur as a result of the Project and associated works; and
- Presenting management strategies that could be employed to manage and mitigate these potential environmental impacts.

This NOI assumes the scope of works as discussed under **Section 2.3**.

This NOI is the first step in the EIA process for this development. It is considered highly likely that a full Environmental Impact Statement (EIS) will be required for the Project for which further investigations will be required.

Accordingly, the LDC is scheduling a suite of studies to be initiated during the latter half of 2014 to support the EIS. The LDC will also refer to previous investigations undertaken for the East Arm Wharf Expansion Project.

1.2 Proponent Details

The proponent is the LDC, which was established under the *Land Development Corporation Act* through an Advisory Board and reports to the NT Minister for Economic Development & Major Projects.

The proponent can be contacted via:

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Project Director
Land Development Corporation
18 – 20 Cavenagh Street
Darwin, NT 0800
[GPO Box 353, Darwin, NT 0801]
Tel (08) 8944 0900

1.3 Relevant Legislation and Other Obligations

1.3.1 Legislation

The Commonwealth and NTG have jurisdiction over environmental and other legislation relating to the location, construction and operation of infrastructure proposed under the Proposal. The LDC recognises its legislative obligations under **Appendix A**, which provides a summary of legislation that may be relevant to the Project and activities undertaken as part of the Proposal.

This NOI has been prepared in accordance with the requirements of the *Environmental Assessment Act 1982* and the *Environmental Assessment Administration Procedures 1984*, including subsequent variations.

Following submission of the NOI, the Minister of Lands, Planning and the Environment will determine the appropriate level of environmental assessment.

Approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is required for actions that are likely to have a significant impact on matters of national environmental significance (MNES). A referral under the EPBC Act will be submitted concurrently with this NOI. In the case that a formal assessment is required at both the Territory and Commonwealth level, it is envisaged a joint assessment will be undertaken in accordance with the Bilateral Agreement.

1.3.2 Other Obligations

Other approvals and licensing requirements relevant to this Project include, but may not be limited to, the following:

- Development Permit under the NT *Planning Act 2008* for activities proposed to take place in areas that are subject to this NOI;
- Ministerial consent for any development covered by the East Arm Control Plan from the Minister for Lands, Planning and the Environment;
- Darwin Port Corporation (DPC) consent for any coastal development below high tide in Darwin Harbour;
- Marine Safety Branch, Department of Transport consent for any coastal development above low tide in NT Coastal Waters;
- The International Maritime Dangerous Goods (IMDG) Code, which was developed as a uniform international code for the transport of dangerous goods by sea, covering such matters as packing, container traffic and stowage, with particular reference to the segregation of incompatible substances;
- Commonwealth Department of the Environment (DoE) and NT EPA consent for any dredging operations;
- Approval to disturb heritage items and archaeological artefacts, as located, through the *Heritage Act 2011*; and
- Aboriginal Areas Protection Authority (AAPA) certificate(s), which provide legal indemnities for works carried out in accordance with Certificate conditions.

1.4 Structure of the Notice of Intent

This NOI comprises the following sections:

Section 1 Introduction

This section introduces the Project and the scope of the NOI. It includes the proponent contact details and a summary of legislative requirements and obligations.

Section 2 Description of the Proposal

A description of the Proposal is summarised under Section 2, including background information for the development, descriptions of the location, existing infrastructure, land use zoning, site selection justification and objectives and benefits of the Project, followed by prior investigations then the concept plan including a description of the Project elements and timeframes.

Section 3 Existing Environment

A description of environmental factors including climate, geology, landforms and soils, oceanic processes, hydrology, terrestrial ecology (including flora, fauna, introduced species and biting insects), marine ecology and habitats, air quality and greenhouse gases, historic and cultural heritage, and social environment.

Section 4 Potential Impacts and Mitigation Measures

Brief descriptions of the potential environmental and associated impacts and suggested mitigation measures, including environmental commitments, safeguards, monitoring, management systems and suggested additional studies relevant to the environmental assessment of the Project are provided under this section.

Section 5 References

Presents references and sources used in the development of the NOI.

Appendices

Appropriate attachments listed in the report.

2 DESCRIPTION OF THE PROPOSAL

This section presents a description of the Proposal under the following headings:

- Description of the Project location;
- Prior investigations and design; and
- Concept plan, including timeframes.

The LDC brochures (2014) featuring the East Arm Logistics Precinct and Marine Industry Park (concept image and plans) are attached as **Appendix B.1** and **Appendix B.2** respectively.

It should be noted this NOI is not for the entire Marine Industry Park as presented in **Appendix B.2**, as some sections and access channels are incorporated into existing approved developments or will be managed under development applications.

2.1 Description of Project Location

The Project is situated approximately 7 kilometres (km) east of the Darwin Central Business District (CBD), on the East Arm Peninsula within Darwin Harbour. The Project is situated east north-east of the East Arm Wharf and its western portion will adjoin the proposed Multi User Barge Ramp Facility and existing Common User Area (CUA). The Marine Industry Park is bordered to the north by Berrimah Road to Casey Street, then Hamaura Road, and continues east to Muramats Road.

The Project location and the adjoining components of the East Arm Logistics Precinct are detailed in **Figure 2.1**.

2.1.1 Site Access

Terrestrial

The location of the site is strategically close to the East Arm Wharf, rail freight terminal and Darwin Business Park. Berrimah Road (northbound) provides a direct link to Berrimah and links to Darwin International Airport.

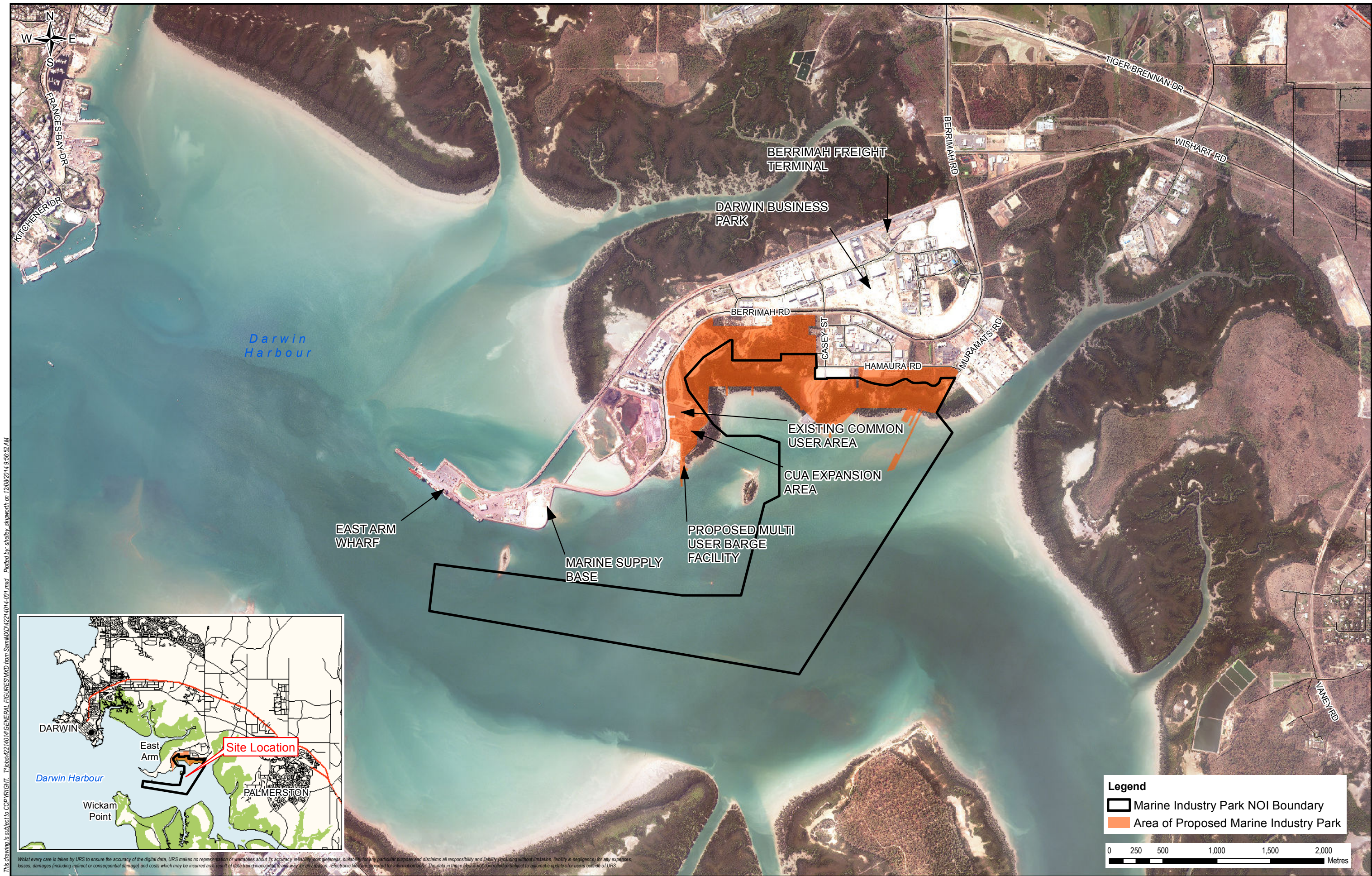
Tiger Brennan Drive (westbound) provides a major road link to the Darwin CBD and the industrial area of Winnellie. Tiger Brennan Drive (eastbound) provides access to Pinelands and Palmerston, with an alternative route to Palmerston via Kirkland Drive.

The Stuart Highway can be accessed either by Berrimah Road or Tiger Brennan Drive.

Access onto the Project site is currently limited, with a small network of unmaintained, unsealed bush tracks exiting off Berrimah Road and Casey Street.

Marine

Marine access is via Darwin Harbour, with tides and water depth dictating accessibility. The NOI boundary (**Figure 2.1**) has been designed to incorporate all concept access routes, with final design dredged channels to be located within this boundary.



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NOTICE OF INTENT FOR THE EAST ARM MARINE INDUSTRY PARK

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2.1.2 Existing Infrastructure

Section 6238 (59.7 ha), 6289 (43.2 ha) and 6117 (13.7 ha) are owned by the LDC. The majority of these sections to be incorporated into the Project are undeveloped, with existing infrastructure comprising a number of open unlined stormwater drainage lines.

Fill material has been stockpiled on the north-west portion of sections 6117 and 6289, adjacent Berrimah Road. The origin of this material, which appears to be good quality fill material, is believed to be from cut and fill works from surrounding industrial and business site development.

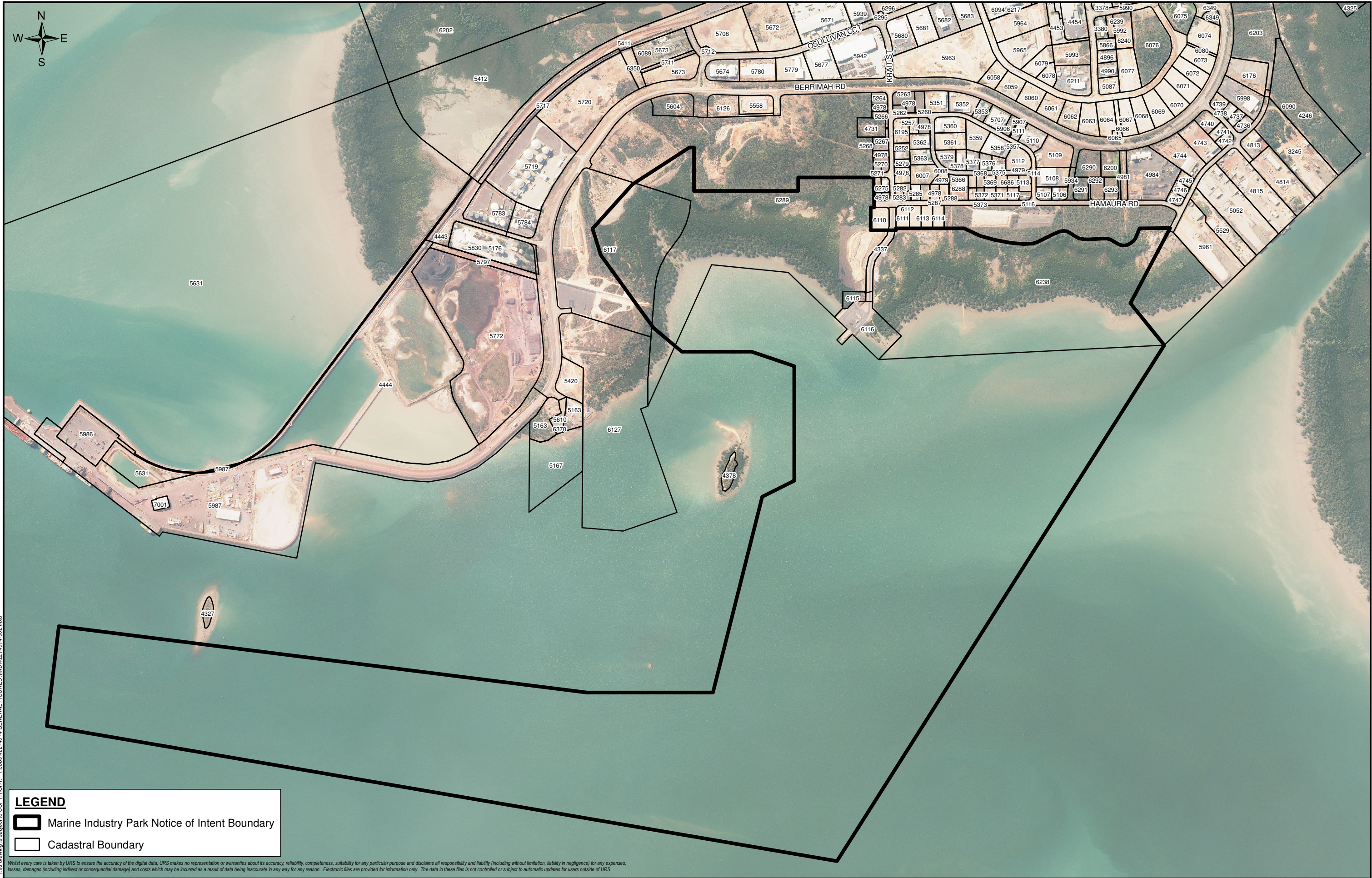
Sections 6116 (3.9 ha) and 4337 (0.9 ha) contain the East Arm Public Boat Ramp and access road.

Adjacent to the boat ramp and access road, Section 6115 (0.5 ha) and a westerly portion of Section 6289 are being used to temporarily stockpile rock, with the material to be used to protect the INPEX Ichthys LNG Project gas export pipeline (INPEX, 2014).

Portions of the Project area were utilised during World War 2 (WWII) with historic photographs depicting a variety of buildings, infrastructure and tracks, of which some remnants remain.

Figure 2.2 shows current infrastructure and Lot / Section numbers (under the NT Planning Act).

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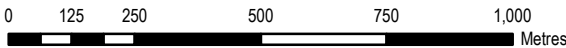
LEGEND

 Marine Industry Park Notice of Intent Boundary

 Cadastral Boundary

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**CURRENT INFRASTRUCTURE
AND LOT NUMBERS**

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NOTICE OF INTENT FOR THE EAST ARM MARINE INDUSTRY PARK

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2.1.3 Land Use Zoning

The East Arm Peninsula has been earmarked for port / industrial related development since the late 1970's, with the intent formalised in the *Darwin Regional Structure Plan 1984*, and subsequent *Darwin Regional Land Use Structure Plan 1990*, and *East Arm/Middle Arm Peninsulas Masterplan 2008*. The 1990 and 2008 plans are included as **Appendix C**.

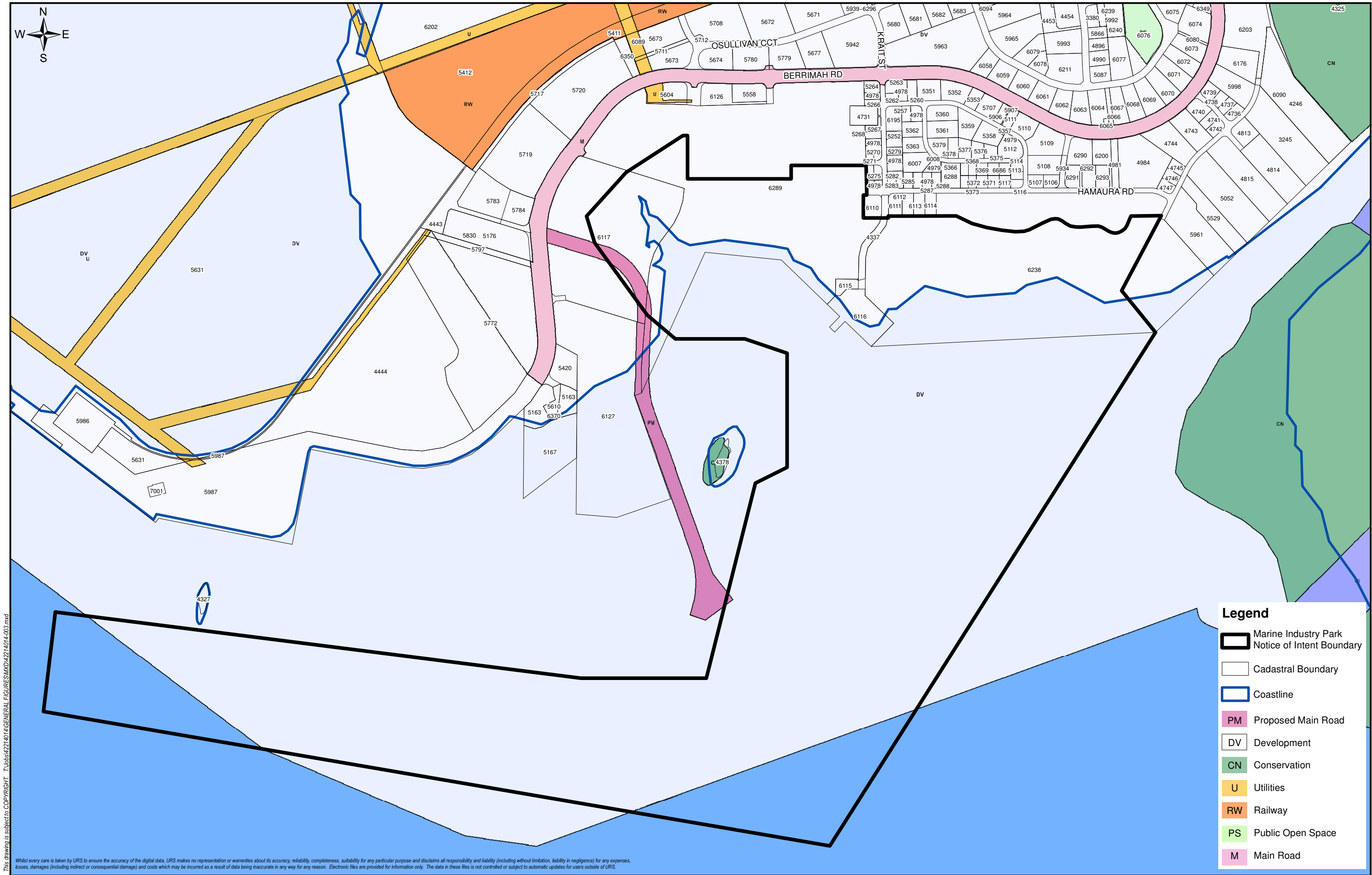
The Project site was designated as Zone DV (Development) when the current NT Planning Scheme was gazetted in 2007. Zone DV allows for the development of major strategic industries including gas based, road, rail or port industries, and provides land for major industrial developments that are of strategic importance to the future economic development of the NT (NTG, 2013).

Existing land-use, zoning and future planning / land use information for the surrounding land is detailed in **Table 2-1**. Zoning for the Project site and surrounds is depicted on **Figure 2.3**.

Table 2-1 Land Use and Zoning surrounding the Project Site

Direction	Existing Land Use	Zoning*	Future Planning / Land Use
Northwest and North	Undeveloped land;	DV	East Arm Marine Industry Park.
	Industrial land and Darwin Business Park;	DV	Increased industrial and business occupancy.
	Railway corridor;	RW	No change currently forecast.
	Utility corridors;	DV, U	Infill of the undeveloped upper mangrove fringes for light industrial use.
Northeast	Undeveloped mangrove fringes of Bleasers Creek.		
	Light Industrial blocks on reclaimed land;	DV	Increased industrial occupancy, including Wishart Road Subdivision and infill of a portion of the undeveloped upper mangrove fringes for light industrial use.
	Hudson Creek substation;	U	
East	Hudson Creek and upper mangrove fringes.	DV, CN	
	Light Industrial blocks reclaimed land;	DV	No change currently forecast.
Southeast	Hudson Creek and lower mangrove fringes.	DV, CN, GI	
	Darwin Harbour and mangrove fringes	DV, CN, GI	No change currently forecast.
South	East Arm Boat Ramp;	DV	May be incorporated into the Project.
	Catalina Island;	CN	No change currently forecast.
	Darwin Harbour;		
Southwest	Bladin Point Ichthys Liquefied Natural Gas (LNG) Development.	DV	Operating LNG Plant.
	Common User Area and East Arm Wharf.	DV	East Arm Wharf Expansion Project, including expansion of the CUA.
West	Common User Area, access to East Arm Wharf;	DV, RW	East Arm Wharf Expansion Project.
	Mineral laydown areas, cement plant, fuel terminal.	PM	Former proposed road for harbour bridge to Middle Arm.
		DV	Increased industrial occupancy in DV zone.

*CN conservation; DV development; GI general industry; PM proposed main road; RW railway; U utilities.



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2.1.4 Justification of Site Selection

As stated in **Section 2.1.3**, the whole of the East Arm Peninsula has been earmarked for port related development for several decades.

The Project is located approximately 7 km east of Darwin, and forms part of the East Arm Logistics Precinct on the East Arm Peninsula. Strategic developments are in close proximity including industrial developments, Darwin Business Park, East Arm Wharf and the AustralAsia Railway. The site is bordered by, or close to, an existing major road network, providing easy road access to Darwin CBD, Palmerston, Darwin International Airport and surrounding general and light industrial areas detailed previously (**Table 2-1**).

As the Project site is located adjacent to the East Arm Wharf and existing commercial and light industrial infrastructure, companies locating to the site will likely be in close proximity to both customers and suppliers.

2.1.5 Objectives and Benefits of the Project

The Project will provide additional land for industrial development, specifically those industries servicing the marine sector. With the increase of trade and development in the greater Darwin area over the last twenty years, increase of trade through the port, current and future construction projects, ongoing LNG plant operation and increased offshore oil and gas development, additional coastal industrial land, especially land with ocean access, is required. Increased affordable industrial/commercial land will enable continued growth and positive effects on the local and regional economy.

2.2 Prior Investigations and Design

A number of previous investigations and studies have been undertaken to inform the Project and surrounds. A summary of the key findings from each of the principal reports reviewed is provided in **Table 2-2**.

Table 2-2 Prior Investigations

Prior Investigation	Summary
Darwin Regional Structure Plan (NTG, 1984)	This plan earmarked the East Arm area for port related development.
Darwin Regional Land Use Structure Plan (NTG, 1990) (plan attached in Appendix C)	This report plans to incorporate the Project site into industrial usage. It identified the East Arm Peninsula (including the Project site) as a 'future major industrial area'.
East Arm Peninsula Earthworks Characterisation and Trunk Drainage Study (GHD, 1997)	Department of Lands, Planning and Environment (DLPE) commissioned a drainage and earthworks investigation for the East Arm Peninsula, including the Project site. This report presents the results of a desktop study carried out to set site development levels, identify fill requirements and sources of fill, and to prepare a drainage master plan.
Wishart Road Land Use Issues and Precinct Study (Irwin, 2006)	An initial conceptual development study for the Wishart Road Subdivision (located to the north north-east of the Project site) was commissioned for Sections 3085, 4240 to 4243, 4807 to 4812

Prior Investigation	Summary
	and Portions 1142, 1168 and 2207 of Hundred of Bagot, NT. The report presented: • A concept plan for a new access road and intersection with Wishart Road; • Concept subdivision plans, including stormwater drainage layout and finished surface levels subsequent to maximum soil excavation (for filling elsewhere); • Alternative concepts for subdivision excluding all or part of Section 3085; and • Concept plans of access alternatives to Section 4243. Subsequent to this study, some land has been developed in the area, adjacent to Berrimah Road and Wishart Road.
Draft Report for East Arm Peninsular Earth Works Characterisation and Trunk Drainage Study Review and Update (GHD, 2009)	This draft report reflects developments and changes to planning concepts that occurred since the original East Arm Peninsula Earthworks Characterisation and Trunk Drainage Study was prepared in 1997. The outcome of this report was to provide an updated ultimate trunk drainage plan and design levels, including the resulting cut and fill volumes.
Pre-Feasibility Study for the Marine Services Precinct (HYDER, 2010)	Pre-Feasibility Study for the Project
Feasibility Study and Baseline Case for East Arm Waterfront (HYDER, 2012)	Feasibility Study for the Project
Industrial Land Supply Report, Greater Darwin LI, SC, DV, FD, GI and Specific Use Zones, Final Phase 4 Consolidated Report (Master Plan, 2012)	The Industrial Land Supply Report has been developed to assist the LDC with the timing and design of Government-owned industrial land releases. The purpose of this report is to provide a review of the demand and supply of all industrial zoned land in order to inform the Government's overall strategy for industrial land release.
Land Development Corporation Development Guidelines Version 2 – June 2012 (LDC, 2012b)	These guidelines provide guidance to proponents in designing buildings and associated facilities. It makes provision for: • Suitability of Locations and Sites • Access • Siting of Buildings and Boundary Setbacks • Car Parking • Loading Bays • Heavy Vehicle Manoeuvring • Outdoor Storage • Ancillary Structures • Landscaping • Public Health, Safety and Security • Compatibility of Land Uses • Impact on Environment and Heritage • Sustainability in Design.
Proposed Marine Industry Park Modelling Report, Task 1 – Dredge Channel and Shoreline	This report documents a hydrodynamic and sediment transport modelling investigation undertaken for Task 1 of the Marine Industry Park at East Arm (building the shoreline out from

Prior Investigation	Summary
Development (Patterson and Williams, 2013) (attached as Appendix D.1)	intertidal mangroves to a rock wall and include a ship turning area and dredge channel). It concluded: • Little change will occur in and around South Shell and Catalina islands; • The proposed dredge channel has been placed in an appropriate location from a physical point of view, avoiding large sand banks at the minimum depth required; • Bed deposition is predicted to occur in the area of the proposed dredged ship turn area and shoreline structure development; and • The frequency of maintenance dredging cannot be predicted, however, given that deposition has occurred at areas surrounding the East Arm Wharf coastline historically, this could be an indication that this may occur similarly near the proposed development and dredged ship turn area. Several assumptions were made during the development of the models. Severe weather events were not taken into account for the modelling. In the event of severe weather, currents will be greater than the modelling results predicted in the report. This may contribute to unforeseen scour and/or sediment deposition.
Proposed Marine Industry Park Modelling Report, Sediment transport and bed material testing to support the Darwin Harbour sediment transport model (Patterson and Williams, 2014) (attached as Appendix D.2)	AIMS Darwin undertook targeted sediment transport research in order to improve the AIMS sediment transport models in support of industry works at East Arm. Previously the model were based on assumptions for key parameters in which various literature and 'default' values have been used. Best modelling practices make use of data that have been measured <i>in situ</i>. This report describes the six separate field studies (carried out in late January and mid-February to mid-March 2014), four laboratory experiments and five desktop analyses undertaken to achieve these data for the East Arm environment. The data collected have quantified the sediment fall velocity, bulk density of the bed surface, bed material type, thickness and distribution, and the variation and concentration of suspended sediment in the water column. AIMS also used the data to verify that of the wind waves generated by storms during the study period, there was no effect of the waves on the sediment transport. AIMS highlighted the need for this data to be collected and the model coefficients to be calibrated in the Task 1 Proposed Marine Park Development Modelling report (Patterson and Williams, 2013). The report included further modelling to test the changes made. Reasonable results were achieved in the cohesive sediment model, which was the model that benefited most from the collection and analysis of these data. The deposition/erosion rates and locations have been predicted with confidence and could be used for estimating dredge intervals. Dredge plumes have also been modelled with confidence. The non-cohesive (sand) model could be improved further with the use of better laboratory equipment such as a flume. Although these models are calibrated and values documented to a high standard, further verification should always be sought should the opportunity arise. Modelling of erosion and deposition in the East Arm area was

Prior Investigation	Summary
	carried out in addition to requested dredge plume modelling.
Notice of Intent for the Wishart Road Subdivision (URS, 2013)	The Notice of Intent provided formal notification to the NTG of the LDC's proposed subdivision of land at Wishart Road for light industrial use. The NT EPA advised that the proposal did not require formal assessment under the <i>Environmental Assessment Act</i> .

2.3 Concept Plan

The latest concept plan (**Figure 2.4**) for the Project was prepared in 2014, comprising six parcels of land (Portions of section 6117, 6289, 6238 and 4337, and sections 6115 and 6116, ranging between 0.5 ha to 59.7 ha). The total area of the Project (onshore) is approximately 92.4 ha.

The concept plan incorporates the following elements which will occur in a series of stages:

- Subdivision of land for commercial and industrial allotments, including waterfront allotments for marine maintenance, servicing and logistics facilities;
- Provision of required utilities and infrastructure;
- Land reclamation and seawall establishment; and
- Dredged access channels and ship turning area to provide access for increasingly larger vessels (if required). Areas to be dredged are to be determined during the design process, but will be located within the NOI Boundary depicted within **Figure 2.4** and other figures within this NOI.

The concept plan in **Figure 2.4** will be updated as part of consultancy development designs.

2.3.1 Timeframes

The Project will be developed in stages, anticipated to be over a long timeframe of up to 50 years. The development and timing will be influenced by many factors over this period. Construction of the first stage, subject to the approvals process, is estimated to commence as early as 2016 and take five years.

It is likely that some dredging of channels and berth pockets will be undertaken during the initial stages of development, however this will be subject to industry demand and operational requirements.

An alternative option regarding dredging is also under consideration. Under this alternative option, businesses that locate to the site will initially work on the tides, with some small berth pockets to potentially be dredged. Under both options, further dredging of access channels and more extensive berth pockets will be staged to accommodate additional businesses / foundation tenants as the Project expands.

2.3.2 Project Elements

The following description is based on the concept plan and provides an overview of the anticipated site works for the Project. As detailed above, the Project may be staged over a significant timeframe.

The concept plan is subject to outcomes of various consultancy development designs.

2.3.2.1 Onshore Activities

A development application will be submitted for each stage of the onshore activities, including clearing, earth works and land subdivision.

Clearing and Earthwork

The various stages of development will involve the gradual clearance of approximately 79.4 ha of vegetation over the life of the plan. Due to site topography, development would include significant cut and fill operations to increase the land relative levels to 5.5 – 6 metres (m) Australian Height Datum (AHD) in the vicinity of the proposed seawall. Project design would need to consider storm surge and rising sea levels in calculating final design elevation.

Land subdivision

The land will be subdivided for commercial and industrial allotments, and associated facilities (headworks/ internal works).

Table 2-3 summarises the potential businesses and associated facilities / activities the Project could support.

Table 2-3 Potential Businesses and Associated Facilities / Activities

Type of business	Potential Business Activities	Potential Business Facilities
Marine Services	Base for fleet of vessels to support offshore industry.	Fully serviced office facilities; Workshops; Yard storage, laydown area; Dry dock; Berthing facilities; and Barge ramp facilities.
Marine and Offshore Logistics	Coastal cargo transfer; Vessel maintenance.	Fully serviced office facility; Yard storage; Berthing facilities; and Barge ramp facilities.
Marine maintenance	Shipwright work; Boiler making/engineering; Abrasive blasting; Painting above and below the waterline; Diesel refuelling; Engine / hull maintenance.	Fully serviced office facilities; Workshops; Yard storage; Vessel hauling and lifting, rigging and servicing facilities; Dry and wet docks; and Diving and marine plant.

There is potential for other relevant commercial business and industries, not limited to those mentioned in **Table 2-3**, to be located within the Project. Consideration of the occupants to be housed within the development will be undertaken by the LDC to ensure an appropriate mix of facilities within the industrial area. However, waterfront allotments will be retained for businesses which require marine access as part of their core business activities.

A range of services and facilities will be provided for the subdivisions including power, telecommunications, water, sewerage, road works and stormwater drainage.

Land reclamation and seawall establishment

The development of the Project will require land reclamation from intertidal mangroves to a sea wall, as shown in **Figure 2.4**.

The reclaimed area is likely to be constructed by establishing a sea wall bund, and then backfilling inside the bund using suitable dredged material sourced from onsite dredging, and dredged and excavated materials from offsite projects. Current plans expect the final sea wall bund to be approximately 2,400 m long and at an elevation of approximately 5.5 – 6 m AHD. As with other aspects of the Project, these activities will occur within stages over a considerable timeframe.

The seawall will be constructed using suitable material sourced from LDC projects in the Darwin area (Hidden Valley and Wishart Road Business Precinct). Seawall protection will be provided by natural stone from quarries or using tetrapods. Backfilling inside the bunded area will be undertaken using dredged material and suitable terrestrial fill in an engineered fill sequence, which may involve vertical and horizontal drainage pipework. The filled area may be surcharged to ensure that the area can be used after the shortest consolidation time.

2.3.2.2 Offshore Activities

Dredging and dredge spoil disposal

The development of navigation channels and dredged berth pockets represent a significant infrastructure requirement both in capital expenditure (dredging and disposal of spoil) and maintenance (some items). Dredging will be contained within the NOI Boundary shown within **Figure 2.4**.

As stated earlier, it is likely that some dredging of channels and berth pockets will be undertaken during the initial stages of development, subject to industry demand and operational requirements. As more business is generated, additional access may be required, and subsequent stages may see an increase in the depth of the access channel and / or additional channels may be developed.

Existing waterfront blocks in the East Arm Logistics Precinct (at the mouth of Hudson Creek) currently access their blocks according to the tides. Therefore, it is possible that businesses that locate to the site could initially work on the tides, with some small berth pockets to potentially be dredged.

Under both options, further dredging of access channels and more extensive berth pockets will be staged to accommodate additional businesses / foundation tenants as the Project expands.

Channel location and alignment will be designed in accordance with geotechnical investigations which will include sidescan and seismic surveys as well as waves and currents.

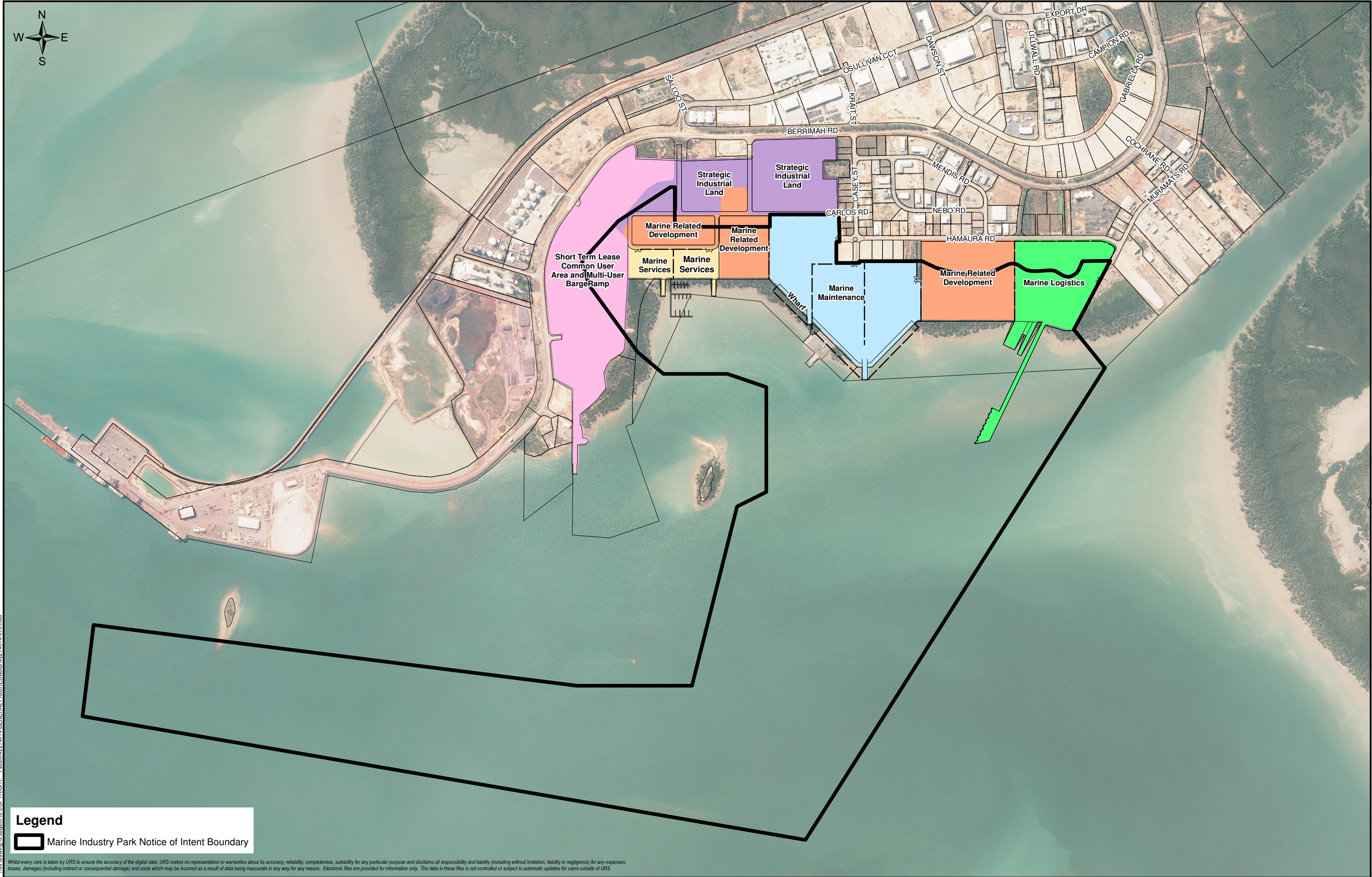
The spoil produced during each dredging stage is expected to be used in reclamation work at the Project site if suitable. Initial marine sediment studies will be undertaken to indicate the suitability of dredged material across the potential development / dredge zones to be used for this purpose. Alternatively, existing or future reclamation ponds at East Arm Wharf or adjacent the Project area may be utilised or developed if the dredged material is suitable for reclamation and there is a requirement to further increase the land area. Should geochemical and/or geotechnical testing deem the dredge spoil unsuitable for reclamation purposes, it will be appropriately disposed of under the required approvals (onshore and offshore options will be considered).

During operations, maintenance dredging will most likely be required to preserve appropriate water depths within the shipping channel and turning basins/berth pockets; this will also require dredge spoil disposal (onshore and offshore options will be considered).

Other activities

Channel markers and lighting will be installed using piling, to provide guided access for vessels.

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Legend

Marine Industry Park Notice of Intent Boundary

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CONCEPT PLAN (LDC, 2014)

URS

NOTICE OF INTENT FOR THE EAST ARM MARINE INDUSTRY PARK

File No: 42214014-013.mxd

Drawn: JD

Approved: KT

Date: 24/07/2014

Figure: **2.4**

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2.3.3 Anticipated Waste

Waste associated with the construction and operations of the Project include:

- Dredge spoil;
- Listed wastes under Schedule 2 of the Waste Management and Pollution Control (Administration) Regulations (NT):
 - tyres;
 - batteries;
 - hydrocarbon-impacted materials, including rags, contaminated soils and used spill response equipment, and oily water;
 - greases, waste oils, and lubricants; and
 - sewage and sewage sludge.
- Non-listed wastes;
- Quarantined waste;
- Hazardous wastes, including excess or spent chemicals, contaminated scrap metals or drums, oily rags and absorbents, solvents, batteries, fluorescent tubes, oily sludge, paints and paint drums, oil filters, sewage and contaminated soil;
- Non-hazardous wastes, which may include inert solids, including paper, food waste, domestic waste, scrap metal, plastics, wood, glass, concrete and cardboard; and
- Recyclable or recoverable waste, including paper and cardboard, plastics, glass, metal, wood, tyres and vegetation and organic matter.

In terms of volume, dredge spoil is anticipated to be the largest waste product resulting from the Project. However, this product is anticipated to be used in reclamation work at the Project site or East Arm Wharf if suitable (as discussed in **Section 2.3.1.2**). Alternatively, if the material (or portions of) is unsuitable for reclamation, other onshore and offshore disposal options will be investigated. At this early stage, the quantity of spoil expected to be dredged has not been estimated as this will depend on the final dimensions of the dredging works, and is expected to be undertaken in a staged approach.

Refuelling facilities for vehicles and plant will likely be incorporated into the Project, and appropriate bunding of facilities and tanks will be required, with spill kits provided to manage any spills.

Wastes generated during construction and operation of the Project, which cannot be practicably recycled or reused, will be transported offsite to a licenced waste management facility.

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EXISTING ENVIRONMENT

There is a large suite of studies and information available for the existing surrounding environment including data gathered for previous development in Darwin Harbour, such as the various stages of the East Arm Wharf development and other construction projects such as the ConocoPhillips and INPEX Ichthys LNG Plants and redevelopment of the Darwin Waterfront. Information relevant to the Project is summarised or included in this section.

The LDC appreciates that further investigations will be required to better develop knowledge and understanding of the Project site, inform the EIA and assist with environmental management during development, and hence is scheduling a number of studies to commence in the latter part of 2014 to 2015.

3.1**Climate**

Darwin is located 12 ° south of the equator in the seasonally wet/dry monsoon tropics. Rainfall seasonality and intense tropical storm activity are the most distinguishing features of the local and regional climatic pattern. The wet season brought on by the northwest monsoon weather pattern runs between November and March. The dry season brought on by the southeast trade-winds weather pattern across the Australian continent runs between May and September. April and October are transitional months between the wet and dry seasons, characterised by localised thunderstorms.

General monsoonal rain associated with the monsoon trough (intertropical convergence zone) falls across the Top End region between December and March. Large low pressure systems associated with the monsoon trough can produce severe tropical cyclones that lead to significant damage to above ground structures, in addition to storm surges and prolonged rainfall.

Climatic observations are recorded by the Bureau of Meteorology (BoM) at Darwin Airport (BoM station 014015), located approximately 6 km northwest of the East Arm Marine Industry Park.

Long term averages for the period 1941 to 2013 (unless otherwise stated) based on BoM data for Darwin Airport (BoM, 2014) are described and presented in the following sections and charts. The major climatic observations include information on temperature, rainfall, wind speed and direction, humidity and evaporation.

3.1.1 Temperature

Based on the Darwin Airport historical data, November (transition to the wet season) is the hottest month with a mean temperature range of 25.3 °C minimum to 33.3 °C maximum. July (mid dry season) is the coolest month with a mean temperature range of 19.3 °C minimum to 30.5 °C maximum. The highest temperature on record is 38.9 °C (recorded on 18 October 1982) and the lowest temperature is 10.4 °C (recorded on 29 July 1942).

The monthly mean minimum and maximum and monthly highest and lowest temperatures are displayed in **Chart 3-1**.

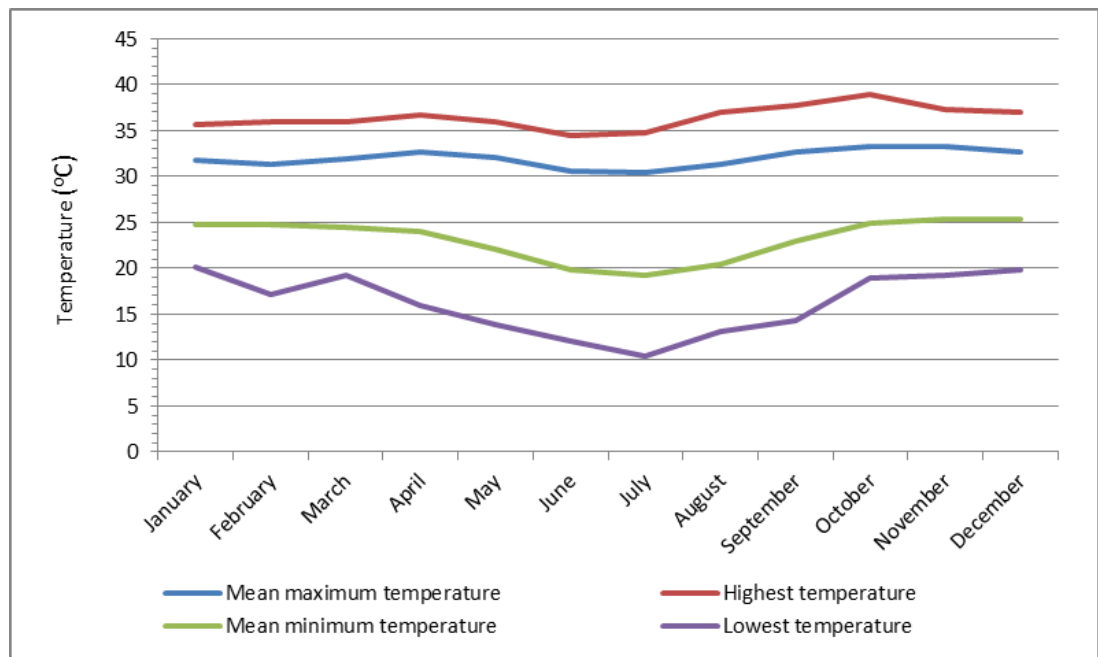


Chart 3-1 Mean Monthly Maximum and Minimum, and Highest and Lowest Recorded Temperatures (BoM, 2014)

3.1.2 Rainfall

Darwin has a mean annual rainfall of 1729.7 millimetres (mm), with rain falling on an average of 94 days, mainly during the wet season months of December to March. The highest monthly rainfall recorded was 1110.2 mm in February 2011. Zero rainfall has been recorded for all months between May and October. July is the driest month, returning the lowest mean rainfall of 1.2 mm.

The monthly mean, and highest and lowest monthly rainfall recorded between 1941 and 2013 are displayed in **Chart 3-2**. This chart also displays the highest daily rainfall recorded within each month for the same period.

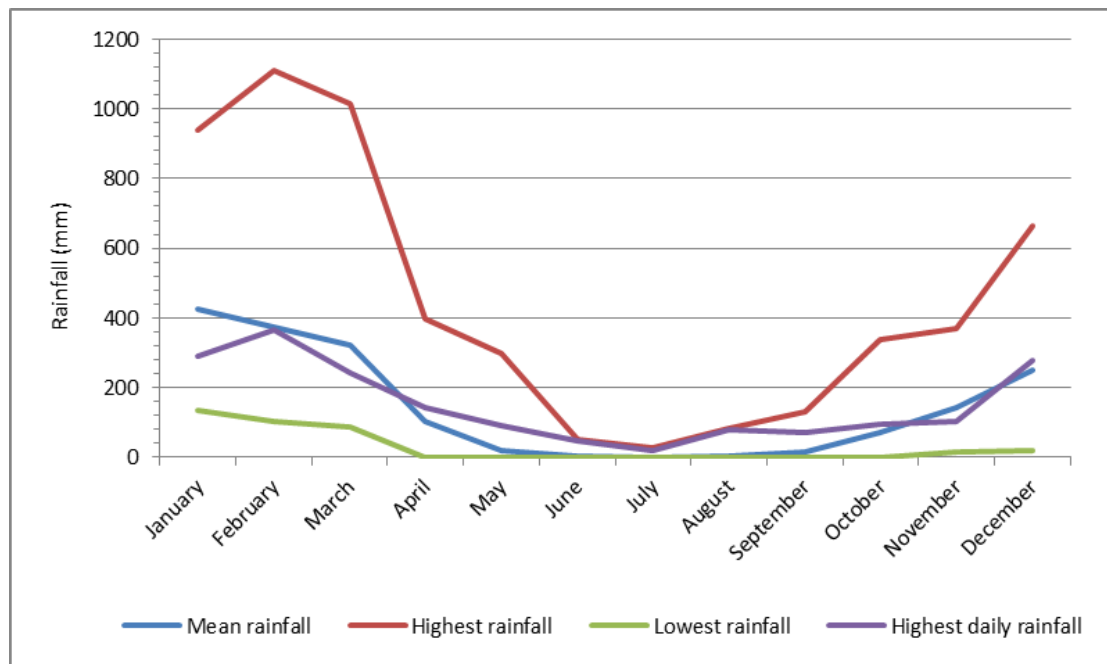


Chart 3-2 Mean, Highest and Lowest Monthly Rainfall, and Highest Daily Rainfall (BoM, 2014)

3.1.3 Wind Direction and Speed

Wind direction generally displays seasonal trends with winds tending from the east/southeast in the dry season and from the west/northwest in the wet season (BoM, 2014). Wind speed also displays a daily trend, with mean afternoon wind speeds always stronger than morning wind speeds. Morning wind speed is stronger during the dry season, whereas the afternoon wind speed increases during the late dry, build up and wet season periods (likely due to the mid-late afternoon storms that are common during this period). Gusty conditions can be experienced throughout the year.

Chart 3-3 displays the mean 9 am and 3 pm wind speed for years 1941 to 2010 (BoM, 2014).

Maximum recorded wind gust speeds are detailed in **Chart 3-4**. The maximum recorded wind speed of 217 kilometres per hour (km/h) recorded was on 25 December 1974, associated with the direct hit on Darwin by Cyclone Tracy, before the wind recorder was destroyed. The January and October maxima were both recorded in 2008, and the February maximum in 2010.

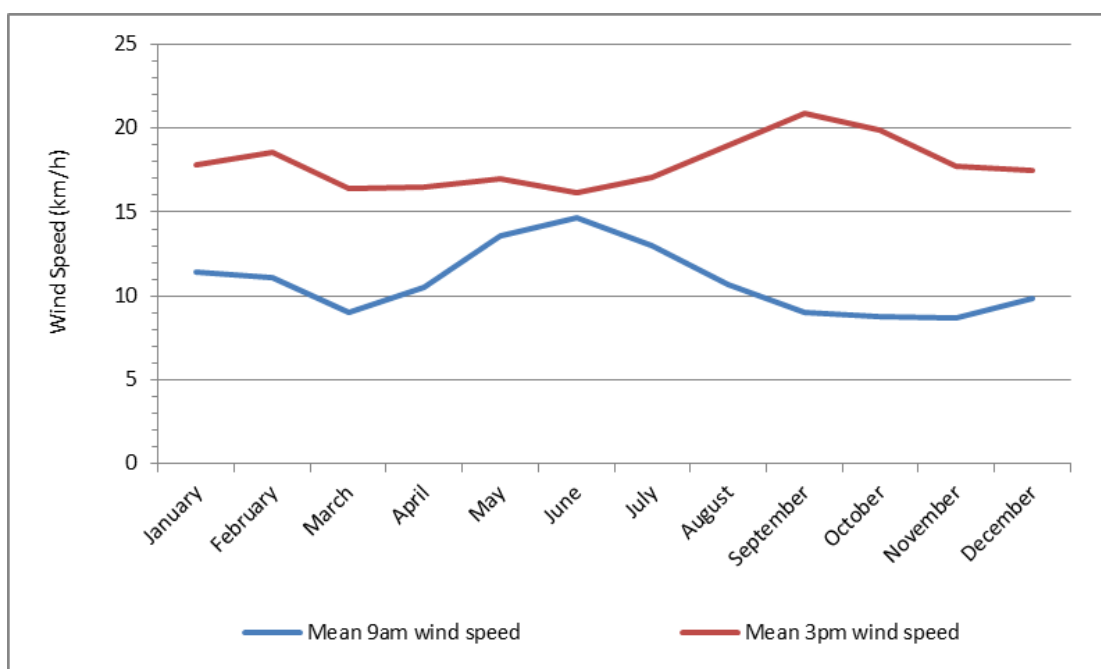


Chart 3-3 Mean 9 am and 3 pm Wind Speed for Years 1941 to 2010 (BoM, 2014)

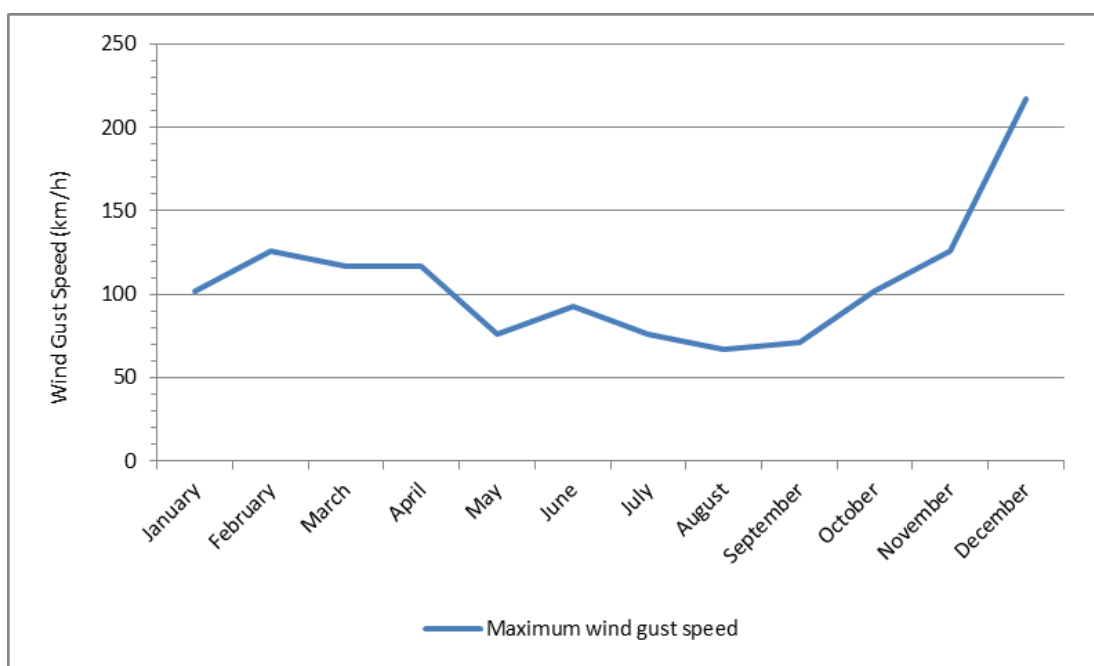


Chart 3-4 Maximum Wind Gust Speed for Years 1947 to 2013 (BoM, 2014)

3.1.4 Humidity and Evaporation

With its tropical location, Darwin experiences relatively high levels of humidity, with the mean 9 am level consistently higher than the mean 3 pm level. Mean humidity is lower in the dry season months of May to August, increasing during the build-up period to reach maximum levels during the wet season months of January to March.

Daily evaporation rates reach a mean minimum of 5.7 mm during February and March to a mean maximum of 8 mm in October.

Chart 3-5 displays the mean monthly humidity levels (9 am and 3 pm) for years 1954 to 2010, and mean daily evaporation rates for the period 1957 to 2013.

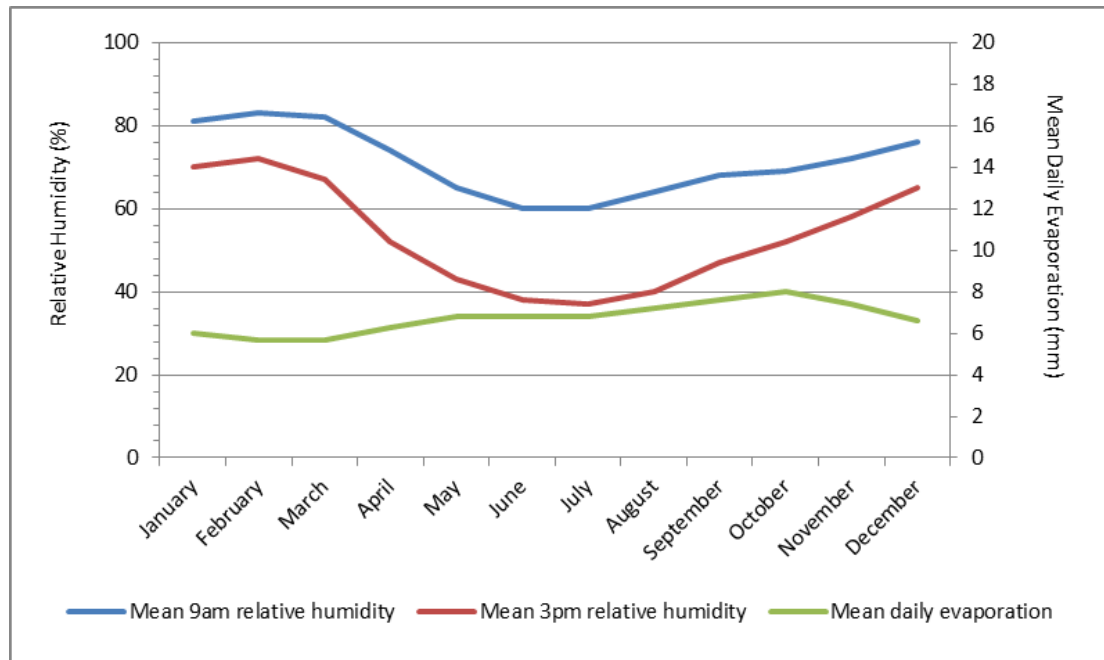


Chart 3-5 Mean Monthly Relative Humidity for Years 1954 to 2010, and Mean Daily Evaporation For Years 1957 to 2010 (BoM, 2014)

3.1.5 Cyclone Activity

Darwin and the NT coastline, being located close to the equator, are in a region where cyclones tend to form. There are on average 7.7 days per season when a cyclone exists in the northern region of Australia. The Gulf of Carpentaria averages two cyclones a year, while the Arafura and Timor Seas average one a year (BoM, 2014).

3.2 Geology, Landforms and Soils

3.2.1 Geology

Reference to the 1:100,000 scale geological maps (Darwin 5073) for the area indicates the presence of metasediments belonging to the Burrell Creek formation, which is typically described as siltstone, shale, sandstone and quartz pebble conglomerate metamorphosed to lower greenschist facies. The coastal fringes of the area are underlain by Quaternary intertidal marine deposits of mud, clay and silt.

The Northern Territory Geological Survey map for the area indicates the northern portion of the site consists predominantly of unconsolidated sand, ferruginous and clayey, sandy and gravelly soils, pisolitic and mottled laterite and kaolinitic claystone. The northern western section of the site consists of shale, siltstone, phyllite, in places coloured banded; fine to very coarse sandstone (quartz arenite, sublitharenite), pebble conglomerate and minor graphitic phyllite. The south and eastern portion of the site consists of a silt clay mud.

Based on the inspection of previous reports, it would appear that bedrock occurs at a depth of 0-4 m across most of the site. Bedrock generally consists of interbedded siltstones, greywacke and conglomerate (GHD, 2009). Low lying areas of the site are expected to display a deeper soil profile.

Tidal areas and areas below mean sea level are overlain by unconsolidated estuarine mud sediments generally up to 5 m in thickness, consisting of an upper sandy zone and a lower clayey zone. A zone of clayey sand and sandy to gravelly clay overlies the bedrock, consisting mainly of weathered siltstone (GHD, 2009).

The geology of the site and surrounding region is shown in **Figure 3.1**.

3.2.2 Landforms and Soils

The general landform of the Project area is plains areas (0 m to 9 m relative to AHD, rises (9 to 10 m), drainage systems and marine areas, with slopes ranging from 0.5% to 15%.

Land units associated with the on-shore Project area are summarised in **Table 3-1** and presented in **Figure 3.2**.

Table 3-1 Land Unit Code and Descriptions

LU Code	Landform Description	Slope	Soil Description	Vegetation Range
1c	Rises and short steep slopes	5 – 15%	Leptic Rudosols	Woodland
2b2	Side slopes	2 – 5%	Brown Kandosols	Low open to open woodland
4c	Gentle lower slopes	0.5 – 1.5%	Kandosolic Redoxic Hydrosols	Open forest
6b	Broad lowland plains	<1.5%	Tenosolic Redoxic Hydrosols	Tall shrubland to low open woodland
9b	Estuarine fringes	<0.5%	Intertidal Hydrosols	Low closed forest
9c	Dunes and Beach Ridges	2-8%	Tenosols	Grassland

The general landform in the coastal area of the Project site (marine areas) comprises a combination of the following:

- Lower intertidal areas of marine alluvium consisting of wet clays and silts with variable sand content.
- Upper intertidal areas of mixed marine colluvium and alluvium consisting mainly of silty sand and gravelly sand.

Generalised soil and soil drainage classification for the Project area indicates that the majority of the site comprises seasonally or permanently wet soils, which in terms of soil drainage classification are poorly or very poorly drained. The north-eastern portion of the Project site includes minimum soil development and soils without structure (earths); these are described as rapidly, well or moderately well drained soils.

The Project will likely include both reclamation and dredging works. Bed levels are up to 3 m Chart Datum (CD) in the north with areas as low as -9 m CD in the south. Chart Datum is based on lowest astronomical tide (LAT)².

The sediments of Darwin Harbour have been divided into four types (Michie, 1988):

- Terrigenous gravels, which occur primarily in the main channel
- Calcareous sands with greater than 50% biogenic carbonate, which are among or close to the small coral communities at East Point, Lee Point and Channel Island. Carbonate sediments, largely derived from molluscan shell fragments, also occur in spits and shoals close to the Harbour mouth
- Terrigenous sands on beaches and spits, with 10–50% carbonate, largely derived from molluscs. This type of sediment is predominantly quartz and clay
- Mud and fine sand on broad, gently inclined intertidal mudflats that occur in areas characterised by low current and tidal velocities, such as in Kitchener Bay (prior to the construction of the Darwin City Waterfront).

It is estimated that 60% of the Harbour's sediments originate from offshore. The remainder is deposited by rivers and creeks, derived predominantly from erosion of channel walls. Direct contribution to the Harbour from sheet erosion is likely to be limited because of the very low hillslope gradients adjacent to the Harbour (Darwin Harbour Advisory Committee [DHAC], 2006).

Soft surfaces consisting of muds and fine sand are estimated to cover approximately 80% of the seafloor (Acer Vaughan Consulting Engineers, 1993). Soft surfaces with varying amounts of gravel and sand are found in the main channels around reefs, on beaches and on spits and shoals near the mouth of the Harbour. However, the spatial extent of these surfaces is sometimes difficult to determine because of the gradual transition between muddy, sandy and coarser sediments and sediment movement associated with large tidal influences (Fortune, 2006).

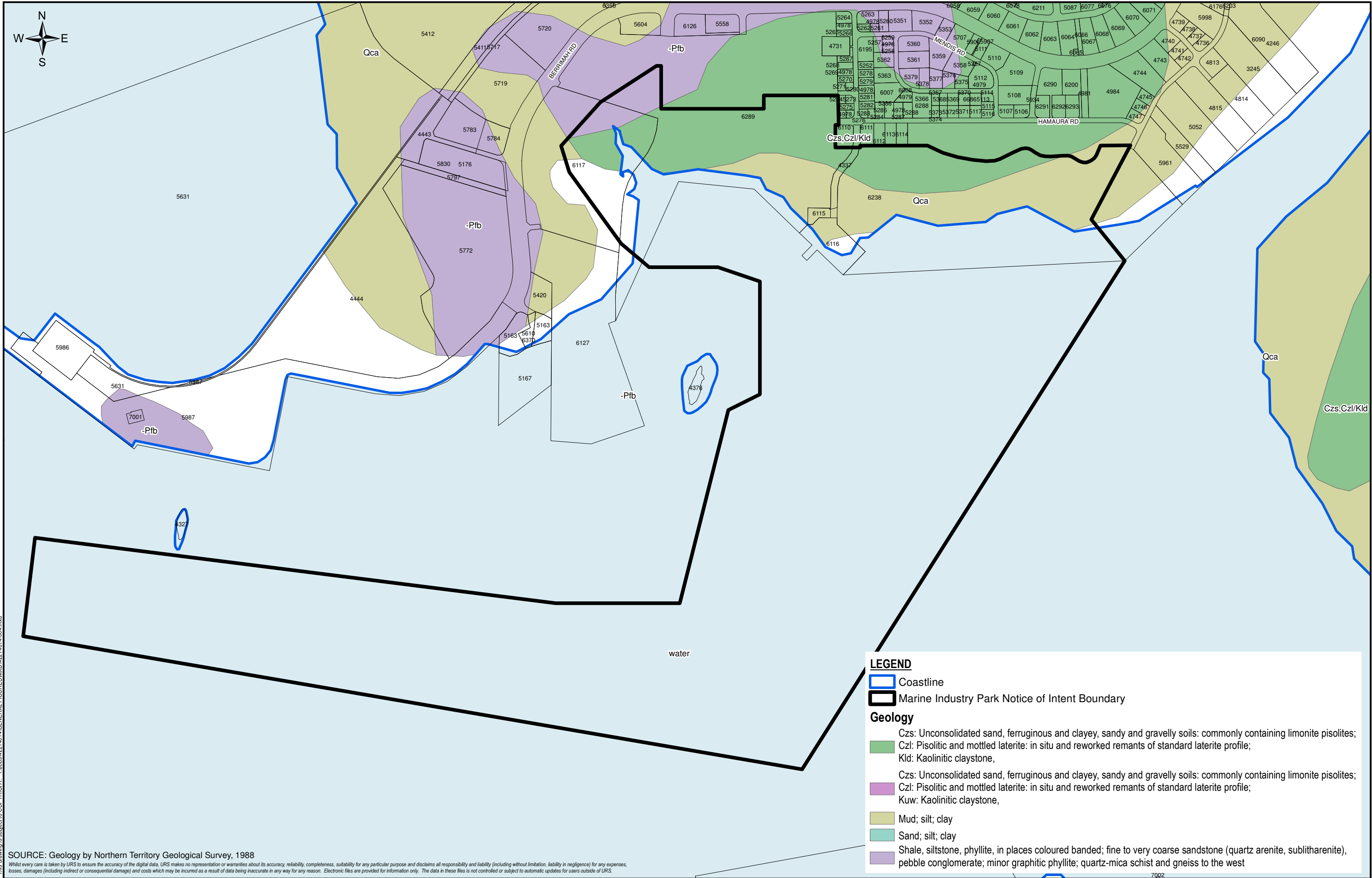
Coarser material appears to be located in the central channels of tributaries and the main body of the Harbour, as opposed to the landward margins, demonstrating the influence of tidal movement, bathymetry and potential transport capacity in these regions (Fortune, 2006).

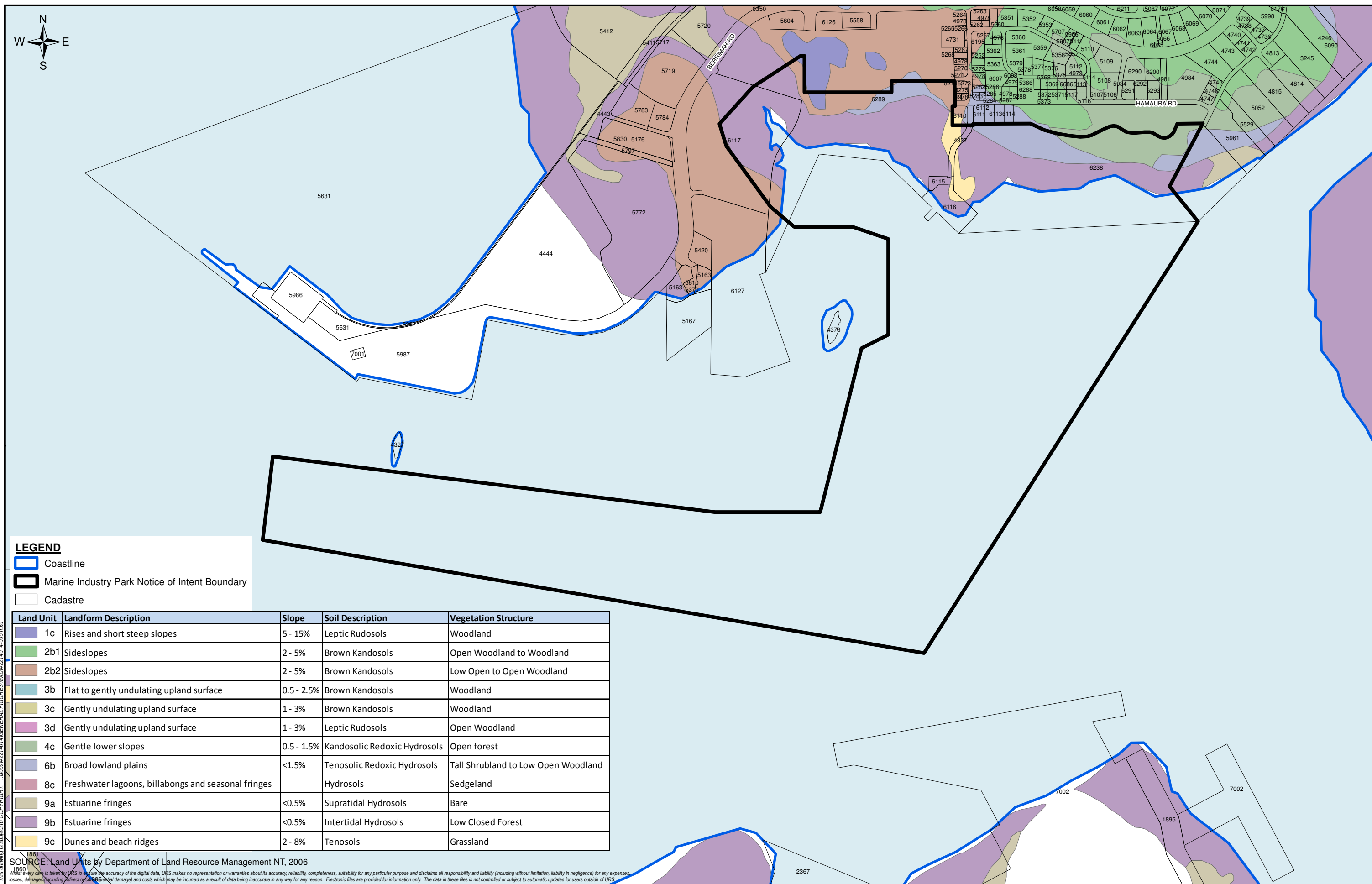
3.2.3 *Acid Sulphate Soils*

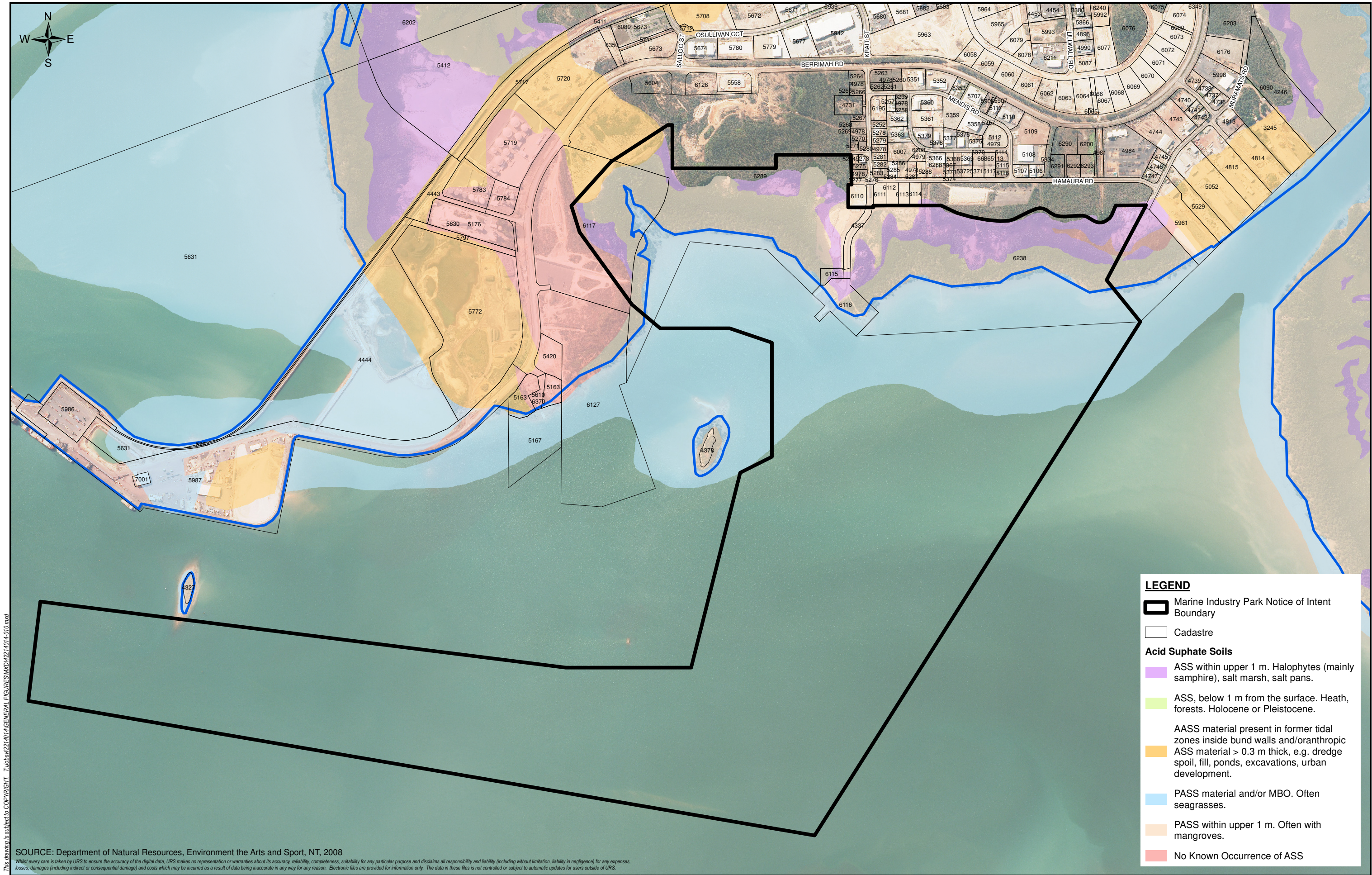
Acid sulphate soils (ASS) are formed by natural processes and can be found in intertidal areas and marine, wetland, estuarine or river settings. They occur predominantly in low-lying areas near the coast. Coastal estuarine and mangrove swamp environments develop ASS due to the waterlogged and anaerobic soil environments.

Previous investigations (Fogarty et. al., 1984) indicate the presence of potential acid sulphate soils (PASS) and ASS within the proposed development area. ASS zones are detailed within **Figure 3.3**.

² For Darwin harbour, 0 CD is equal to 3.975 m AHD. The AHD is used as a reference for terrestrial elevations / depths. The CD references lowest astronomical tide (LAT) and is used for marine elevation / depth measurements.







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3.3 Oceanic Processes and Natural Features

Darwin Harbour is a large ria system, or drowned river valley, formed by post-glacial marine flooding of a dissected plateau. The Harbour was formed by rising sea levels about 6,000 - 8,000 years ago. The Harbour has a surface area of about 500 km².

In its southern and south-eastern portions, the Harbour has three main components: East, West and Middle Arms, which merge into a single unit, along with the smaller Woods Inlet, before opening into Beagle Gulf to the north. The harbour extends for more than 30 km along this north-north-west – south-south-easterly oriented axis. The Elizabeth River flows into East Arm, while the Darwin and Blackmore rivers flow into Middle Arm. Freshwater inflow into the Harbour occurs from January to April, when estuarine conditions prevail in all areas (Hanley, 1988).

The main channel of the Harbour is around 15-25 m deep, with a maximum depth of 36 m. The channel favours the eastern side of the Harbour, with broader shallower areas occurring on the west side. Intertidal flats and shoals are generally more extensive on the western side than on the eastern side. The channel continues into East Arm, towards Bladin Point, at water depths of more than 10 m below LAT. The bathymetry in this area has been already previously modified by dredging for the development of the East Arm Wharf and for the INPEX Ichthys LNG project.

Darwin Harbour is characterised by a macro-tidal regime with a maximum range of 8.1 m (e.g. Harper, 2010). The mean neap tidal range is 1.9 m, while spring tides have an average range of 5.5 m. Tides are predominantly semidiurnal (two highs and two lows per day), with a slight inequality between the successive tides during a single day. Nearly diurnal tides occur for a two day period during the neaps. The lowest spring tides of the year occur during October, November and December, while the highest spring tides take place in June and July.

Cyclonic storm surge within the Greater Darwin area was mapped by the NTG (2011b) and shows the estimated inundation at the highest astronomical tide for a primary storm surge zone (100 year average recurrence interval [ARI]) and a secondary storm surge zone (1000 year ARI). The storm surge zones are depicted on **Figure 3.4**. Sea-level rise may further contribute to storm surge levels, which increase by up to 3.2 mm per year around Australia (BoM, 2013).

Storm tide predictions – which take into account cyclone storm surges together with the effects of frequent waves (“wave set-up”) and the influence of astronomical tide - indicate that temporary increases in sea level would occur during cyclone conditions at sites around Middle Arm and East Arm.

Due to the above-mentioned macro-tidal regime of the Harbour, prevailing currents are of tidal origin. Tidal excursions range from 8 to 15 km during springs and 2 to 8 km during neaps (Semeniuk, 1985; Hanley & Caswell, 1995). Williams et al. (2006) indicate that speeds can peak at 2–2.5 metres per second (m/s) during spring tides. Modelling financed by INPEX for the Ichthys Gas Field Development Project (INPEX, 2010a, 2010b) produced results consistent with collected current records and reported maximum flood current speeds near the entrance to the Harbour varied from 0.3 m/s (neaps) to 1 m/s (springs), while the maximum ebb speeds varied from 0.5 m/s (neaps) to 1.6 m/s (springs). At inner-harbour locations, maximum spring current speeds varied from 0.7 to 1.3 m/s, and maximum neap speeds from 0.1 to 0.4 m/s, depending on the bathymetry and proximity to the shore (INPEX, 2010b).

Darwin Harbour is well sheltered from long period tsunami and ocean swell waves by the Tiwi (Melville and Bathurst) Islands. Several wave measurement (e.g. INPEX, 2010a) and wave modelling (e.g. GHD MacKnight, 1997) studies consistently demonstrated that waves within the Harbour are generally of short mean periods with heights well below 1.0 m. Due to the harbour orientation, bathymetry and coastline configuration, energy of long period waves entering the Harbour quickly dissipates and thus wave heights decrease dramatically.

3.4 Hydrology

3.4.1.1 *Surface Hydrology*

It is expected that surface water at the Project site would drain according to local topography, or into existing drainage channels, southwards towards the Harbour. Culverts under Berrimah and Hamaura Road direct stormwater runoff and overland flow into a number of open unlined stormwater drainage lines running across the site to the Harbour. These water courses appear to be intermittent in nature, and likely only carry flow within the wet season.

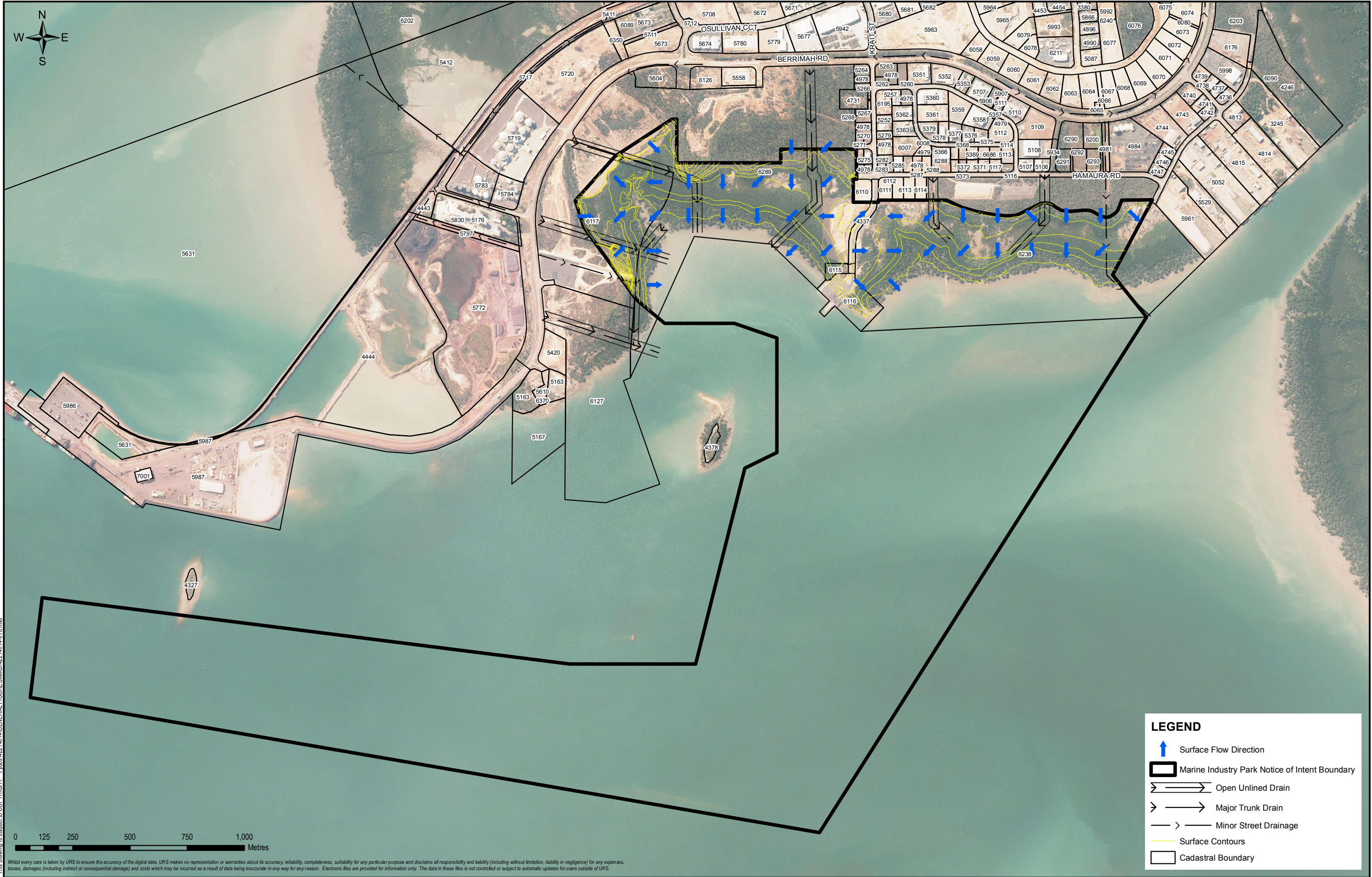
Figure 3.5 indicates the existing catchment boundaries, natural and engineered drainage across the site.

3.4.1.2 *Hydrogeology*

Groundwater information within the area (1:250 000 Hydrogeological Map of Darwin) indicates that groundwater may be encountered within unconfined quaternary sediments (sand, silt and clay) and fractured, weathered bedrock. The groundwater resources in the area are classified as minor with generally low yields (less than 0.5 litres per second [L/s]); however relatively higher yields with low storage may be available from sand lenses within the quaternary sediments, gravel layers that may be present at the interface of the sediments and bedrocks and fractures within the bedrock (quartz veins).

The groundwater hydraulic gradient would be expected to follow ground surface topography with flow toward the Harbour from areas of elevation. The topography and mangrove vegetation in the southern portion of the site suggests that the groundwater level remains relatively close to, or at, the surface year round, with a progressive lowering of the water table expected throughout the dry season (May to October). Near-shore groundwater levels are likely to be influenced by tides, which range up to 8 m.

A search of the DLPE's website (DLPE, 2014) provided information on bores located to the west of the site. One bore was installed to 128 m in 1944 and 14 bores were installed between 2005 and 2006 to depths of 8 to 10 m. No water quality data are attached to the bore logs for these bores. Based on available groundwater data from the monitoring bores, groundwater is generally expected to be within approximately 5 m of ground surface and may vary between 3 and 8 m depending on the season (NTG, 2011a).



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A review of existing geological information from geotechnical boreholes in the study area (NTG, 2011a) identified three main hydrogeological units:

- Quaternary sediments (sand, silt, clay and shells) and fill (marine dredge) material,
- Weathered zone above relatively fresh bedrock, and
- Fresh bedrock and fractures within fresh bedrock.

3.4.1.3 *Water and Marine Sediment Quality*

Water quality in Darwin Harbour is described as generally high, although naturally turbid most of the time. Water quality parameters vary greatly with the tide (spring versus neap), location of sampling point (inner versus outer harbour), and with the season (wet season versus dry season). The Darwin wet season, extending from November to March, affects Harbour water quality due to high surface runoff from the land and can last until April or May, depending on rainfall.

To assess the overall health of Darwin Harbour, the Department of Land Resource Management (DLRM) has, since 2008, annually collated water quality data from a range of monitoring conducted by the DLRM, other government agencies and the private sector. The 2013 Darwin Harbour Report Cards (DLRM, 2013) described East Arm as having very good water quality.

There is no evidence of widespread water or sediment pollution in the Harbour, although there is some localised pollution (Padovan, 2003). Potential sources of pollution in the harbour include storm water runoff from rural, urban and industrial catchment diffuse sources during the wet season, sewage treatment plant wastewater discharges and other licensed waste water discharges (DLRM, 2013). There is no evidence of hydrocarbon or pesticide pollution in the Harbour (DHAC, 2007).

Pollutants specific to East Arm include treated wastewater discharge to Bleesers Creek and high sediment, nutrient and other pollutant loads received from wet season runoff from urbanised areas (DLRM, 2013). In addition, the Darwin Correctional Centre's Sewage Treatment Plant overflows to Hudson Creek during the wet season. East Arm Wharf has the potential to affect water and marine sediment quality with regards to import and exports at the wharf, including live cattle, minerals, chemicals, petroleum and ores. These have historically influenced the sediment quality in the East Arm Wharf area, most notably after copper concentrate spills occurred while loading in 2010 (AIMS 2010).

However, sediments of East Arm have generally been shown to have low levels of contamination (URS, 2008b, URS, 2012; URS, 2014). Based on the results of construction monitoring studies for East Arm Port, the ConocoPhillips Darwin LNG plant and Darwin City Waterfront projects, disturbance of the sediments by dredging and other construction activities is not expected to result in release of contaminants at concentrations likely to exceed water quality guideline values for other water quality parameters (DO, pH and toxicants) or, in the case of substances occurring at naturally elevated levels, such as arsenic (confirmed by testing to have low bioavailability), to exceed natural background concentrations for Darwin Harbour.

3.5 Ecology

3.5.1 Terrestrial Ecology

A number of ecological assessments have been conducted in the East Arm Peninsula and surrounding region. Most recently, a terrestrial flora and fauna survey was conducted in the East Arm area as part of the East Arm Wharf Expansion Project by Environment Management Services (EMS) (NTG, 2011a). The survey targeted species identified in a review of previous ecological studies undertaken in the East Arm area and other data sources, and species listed in threatened categories under Commonwealth and NT legislation, as well as migratory / marine bird species listed under Commonwealth legislation that potentially occur in the vicinity of the survey areas (EMS, 2011).

The findings of this more recent survey, and previous ecological assessments, where relevant to the Project area, are summarised herein.

In preparation for an EIS, further investigations will be undertaken to document native flora and fauna, specifically the presence and distribution of critical habitats (*TPWC Act*) and listed ecological communities / species (*TPWC Act* and *EPBC Act*) within and adjacent the Project site, with particular attention to species identified in previous ecological studies undertaken in the area.

3.5.1.1 Flora

The vegetation in the Project area is dominated by mangroves, with terrestrial vegetation situated on the higher ground (northern portion of the site). Vegetation communities located at the Project site are presented on **Figure 3.6**.

Mangrove communities of Darwin Harbour, including areas within and adjacent to the Project area, have been mapped by Brocklehurst & Edmeades (1996). Three broad categories were recognised, which are divided into twelve map units or communities. Mangrove communities located at the Project site include mangrove closed forests, open forests, woodlands and samphire / salt flats.

Mangrove communities are classified as sensitive or significant according to the Northern Territory Land Clearing Guidelines ([former] Department of Natural Resources, Environment, the Arts and Sport [NRETAS], 2010a). They are not listed as threatened under the *EPBC Act* 1999.

The EMS (2011) terrestrial flora and fauna survey focused on terrestrial vegetation situated on the higher ground of East Arm Peninsula; tidal mangrove communities were not surveyed during this investigation. Three of the EMS (2011) flora survey locations (locations 2, 3 and 5) were within 50 m of the north eastern NOI Project boundary (refer to **Figure 3.6**). The other survey locations were located in the undeveloped northern portion of the East Arm Peninsula (adjacent to the railway corridor).

The vegetation communities at the three survey locations in close proximity to the Project site (locations 2, 3 and 5) comprised of Low-Mixed to High Mixed Species Open Woodland to Woodland (EMS, 2011). Recent filling and clearing were observed in the area, and EMS (2011) reported in some areas reclamation works impacted on the condition of both the mangrove and terrestrial vegetation types.

The vegetation community Low-Mixed to High Mixed Species Open Woodland to Woodland is not recognised as significant vegetation under the Land Clearing Guidelines (NRETAS 2010), and is not listed under the *EPBC Act 1999*.

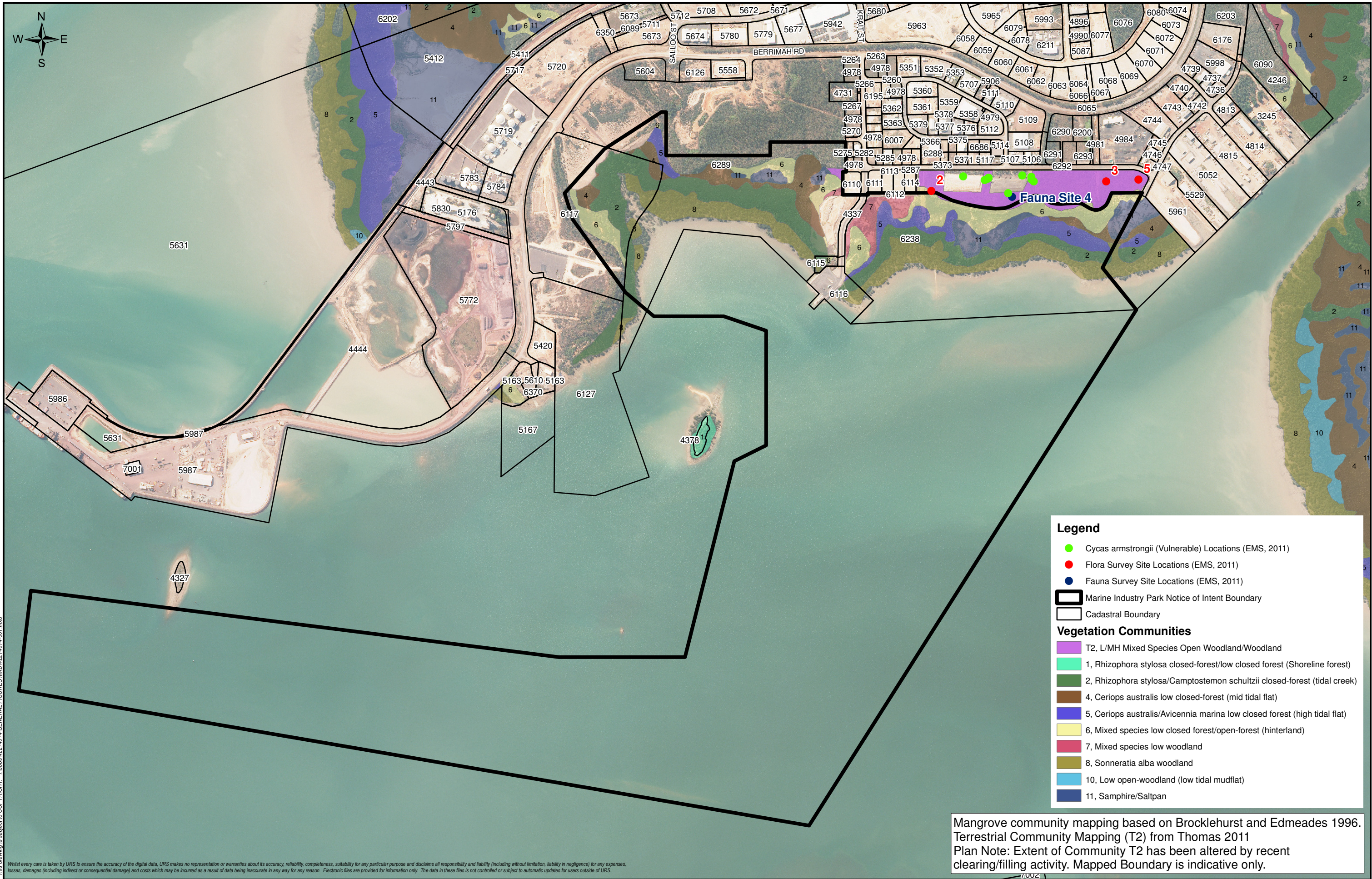
The EMS (2011) flora survey recorded a total of 46 native flora species within the Low-Mixed to High Mixed Species Open Woodland to Woodland communities surveyed (inclusive of surveyed communities in the undeveloped northern portion of the East Arm Peninsula). Overall, the EMS (2011) flora survey recorded a total of 11 naturalised flora species and five 'Declared Weeds' (*Weeds Management Act 2001*); however, none of these species were recorded at the three study sites located in close proximity to the Project site (locations 2, 3 and 5).

A NT National Resource Management Infonet report for the Project area classified the vegetation communities on the northern perimeter of the western portion of the site as woodland (NTG, 2014).

During an inspection of the Project site conducted on 18 March 2014, vegetation was observed to consist of disturbed / regrowth and remnant vegetation types.

Species recorded within proximity to the Project site listed in the threatened species and/or migratory schedules of the *EPBC Act 1999* and the *Territory Parks and Wildlife Conservation (TPWC) Act 2000* are summarised in **Section 3.5.3**.

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3.5.1.2 Fauna

One of the four fauna sites in the EMS (2011) survey (fauna site 4) was located within 50 m of the north eastern NOI Project boundary (refer to **Figure 3.6**), in woodland and mangrove habitat. In addition, shore birds were counted on tidal mudflats within the eastern portion of the NOI Project area on two occasions. The other EMS (2011) fauna sites were located in the undeveloped northern portion of the East Arm Peninsula (adjacent to the railway corridor), and shore bird counts were conducted at a number of locations adjacent the East Arm Wharf Expansion Project area and dredge spoil ponds. The fauna surveys were conducted during early wet season conditions in 2010/2011.

A total of 59 species of native terrestrial vertebrate were recorded in close proximity to the Project site (fauna site 4), including seven amphibian, eight reptile, 38 birds and six mammal species. Additionally, a further 17 bird species were identified on the tidal mud flats within the eastern portion of the Project area. A high tide survey of creeks and mangrove areas within and adjacent the eastern portion of the Project area recorded small mixed flocks of migratory waders roosting at these sites. At low tide groups of shorebirds were feeding on the tidal mudflats (EMS, 2011).

None of the fauna species recorded within the study area are listed as endemic to the Darwin Coastal bioregion or the NT in the *Northern Territory Assessment of Key Biodiversity Values and Threats for Bioregions* (Baker et al., 2005; EMS, 2011).

Species recorded within proximity to the Project site listed in the threatened species and/or migratory schedules of the *EPBC Act 1999* and the *TPWC Act 2000* are summarised in **Section 3.5.3**.

3.5.1.3 Weeds and Feral Animals

An *EPBC Act* Protected Matters Report (**Appendix E**) for the Project site lists a range of weed and pest species that potentially occur within the proposed development area.

Five 'Declared Weeds' (*Weeds Management Act 2001*) were recorded during the 2011 EMS survey works, although not present in survey sites in proximity to the Project area:

- *Andropogon gayanus* (Gamba Grass);
- *Jatropha gossypifolia* (Bellyache Bush);
- *Pennisetum polystachion* (Mission Grass);
- *Lantana camara* (Common Lantana); and,
- *Sida cordifolia* (Flannel Weed) (EMS 2011).

These species are categorised as Class B/C within the NT *Weeds Management Act* and land holders must take appropriate measures to contain and reduce the spread of these species. Bellyache Bush is now categorised as Class A in the Darwin region and therefore targeted for eradication.

EMS (2011) recorded the Cane Toad (*Rhinella marina*) and the Asian House Gecko (*Hemidactylus frenatus*) during survey works.

3.5.2 Marine Ecology

3.5.2.1 Marine Communities

Several types of ecological communities have been recorded in Darwin Harbour: rocky shore communities, filter feeders (sponges and soft corals), hard coral communities, seagrass and macroalgal beds, soft sediment communities, mangrove communities and fish communities. Benthic habitat classes within the Project site are presented in **Figure 3.7**.

There are few natural intertidal rocky shores in the vicinity of the Project area. However, the benthic communities on the artificial hard substrates (rock walls, wharf structures, piles, etc.) provided by the existing Hudson Creek facilities would be expected to be similar (in composition, abundance and diversity) to those inhabiting natural rocky shores elsewhere within Darwin Harbour.

Most of the Project area is surrounded by bare substrate (**Figure 3.7**). Further offshore (in the vicinity of the potential dredge channel) there are some filter feeder communities around South Shell Island and Old Man Rock (BMT WBM, 2010; Geo Oceans, 2012). It should be noted that the habitat distributions displayed in **Figure 3.7** are based upon BMT WBM (2010), but these have been substantially refined through subsequent surveys by Geo Oceans (2012), especially in the vicinity of South Shell Island and Old Man Rock. It is intended that, as part of the EIS studies, similar refinement of the BMT WBM habitat distributions will be undertaken within the marine portion of the Project area.

Hard coral communities have been recorded around South Shell Island (south of East Arm Point) and at Old Man Rock (URS, 2009; BMT WBM, 2010; Geo Oceans, 2012). Around South Shell Island, hard coral cover is highest (15-20%) at 0-1.5 m below LAT and declines with increasing depth. The community is comprised of at least 21 species, predominantly faviids, with numerous *Turbinaria* colonies also present. The dominant fauna on the lower slope (deeper than 1.5 m LAT) surrounding South Shell Island were numerous sponges, soft corals (including gorgonians [sea fans and sea whips]), crinoids (feather stars) and hydroids (URS, 2009). Coral cover at Old Man Rock is lower (<10% cover) and more limited in distribution than at South Shell Island; the community is predominantly comprised of faviids [primarily *Goniastrea*] and *Goniopora* species (URS, 2009).

Other sites surveyed by divers and remote operated vehicles in East Arm revealed a moderate to low diversity of benthos, with the exception of the south side of Old Man Rock and at Walker Shoal³ which had numerous soft corals and a high diversity of sponge species. No substantial macro-algae beds, and no seagrasses, were recorded within the vicinity of the Project area by BMT WBM (2010) or by Geo Oceans (2012).

Monitoring at South Shell Island, one of the original control sites for monitoring since the first stage of the East Arm Wharf was constructed in the 1990's, is currently ongoing to observe any effects on coral communities potentially related to recent dredging occurring in the Harbour for infrastructure projects at East Arm and Bladin Point.

Mud and sand flats are exposed at low tide at the southern portion of the Project area, seaward of the mangrove shoreline. In Darwin Harbour, shorebirds forage on the extensive

³ Walker Shoal has recently been removed by dredging associated with the INPEX Ichthys LNG construction project.

areas of low tidal mud and sand flats. These areas can provide an abundant source of intertidal invertebrate fauna for shorebirds to feed on.

Mangroves form a valuable part of the marine ecosystem by producing large amounts of organic matter and nutrients that are utilised by animals such as crustaceans and fish. Many fish and prawns utilise mangroves as spawning grounds and nursery habitat (Water Monitoring Branch, 2005).

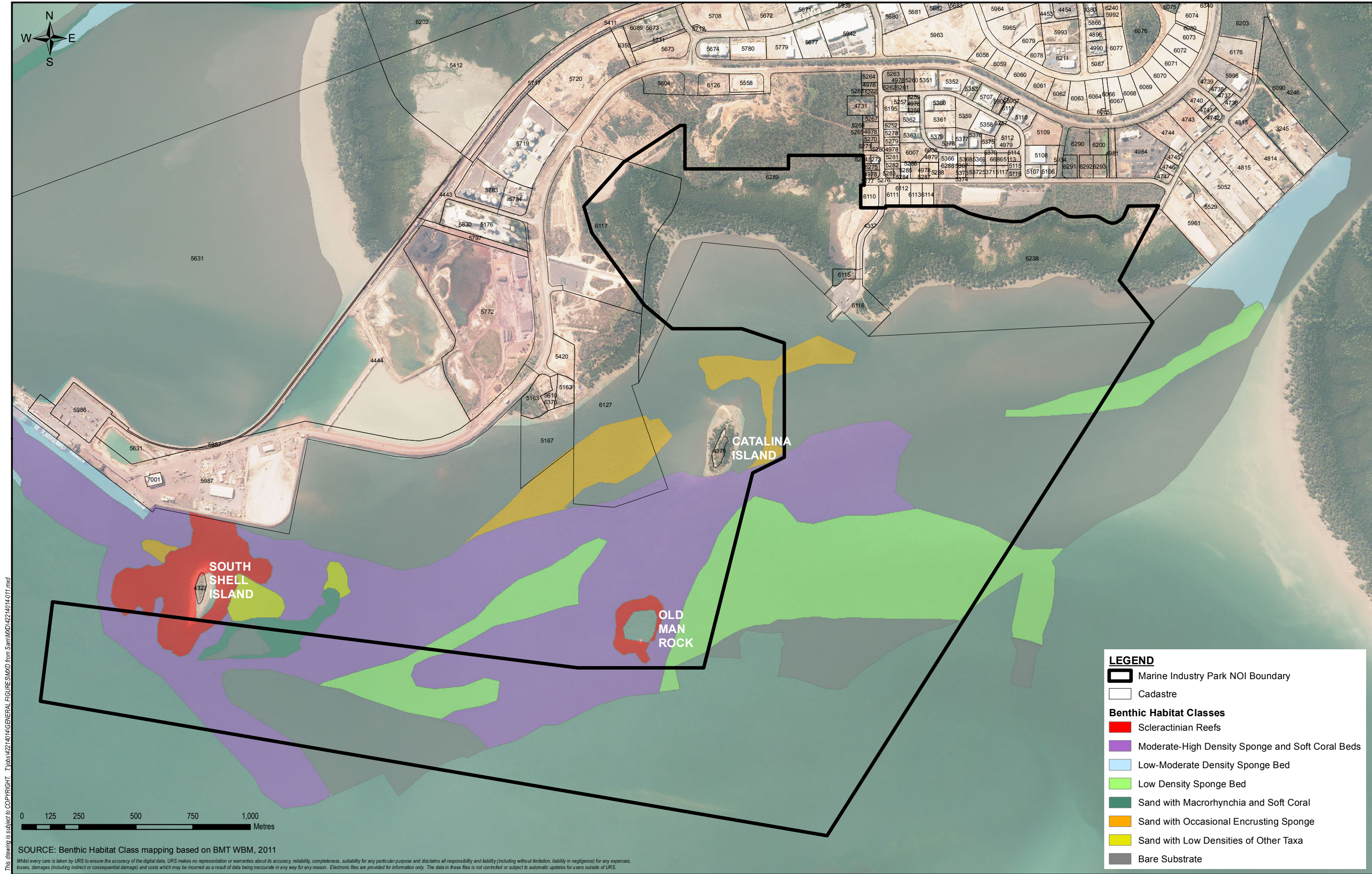
URS (2009) considered pelagic fish life within East Arm to be moderate to abundant relative to other areas surveyed within Darwin Harbour. The following species were noted: *Protonibea diacanthus* (jewfish), *Platycephalus* sp. (flathead), *Synanceja verrucosa* (stonefish), Urolophidae (rays), as well as a number of sharks. Surgeon fish (Acanthuridae) and butterfly fish (Chaetodontidae) were noted at Old Man Rock (URS, 2009).

URS recognises that dredging and associated monitoring is occurring within Darwin Harbour; details of these monitoring programs and findings will be incorporated into subsequent documents as part of the EIA process.

3.5.2.2 *Marine Pests*

The Port of Darwin Harbour is considered free of introduced marine pest species, based on the outcome of a baseline study conducted by the CSIRO Centre for Research on Introduced Marine Pests and the Museums and Art Galleries of the Northern Territory in 1999 and 2000; no suspect species were found (Russell & Hewitt, 2000). This is despite detection of the Caribbean black striped mussel, *Mytilopsis sallei*, in three Darwin marinas in 1999 (Russell & Hewitt, 2000), which was successfully eradicated within a month. Annual marine pest monitoring programs are currently undertaken within Darwin Harbour.

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3.5.3 Listed Species Review

3.5.3.1 Listed Threatened Species

A species database was identified through generation of an *EPBC Act* Protected Matters Report (**Appendix E**) for the Project site (including a 1km buffer) which listed potentially occurring species within the proposed development area. In addition, threatened species under the *TPWC Act* were reviewed with findings detailed below.

Threatened and endangered terrestrial and marine species listed by the *EPBC Act* Protected Matters Report as potentially occurring at the site are summarised under **Table 3-2**.

Table 3-2 Listed Threatened Species

Listed Threatened Species	Status	Type of Presence
Birds		
<i>Erythrotriorchis radiatus</i> Red Goshawk	Vulnerable	Species or species habitat known to occur within area
<i>Erythrura gouldiae</i> Gouldian Finch	Endangered	Species or species habitat known to occur within area
<i>Geophaps smithii smithii</i> Partridge Pigeon [eastern]	Vulnerable	Species or species habitat likely to occur within area
<i>Rostratula australis</i> Australian Painted Snipe	Endangered	Species or species habitat may occur within area
<i>Tyto noahollandiae kimberli</i> Masked Owl [northern]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
<i>Conilurus penicillatus</i> Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma	Vulnerable	Species or species habitat may occur within area
<i>Dasyurus hallucatus</i> Northern Quoll	Endangered	Species or species habitat known to occur within area
<i>Phascogale pirata</i> Northern Brush-tailed Phascogale	Vulnerable	Species or species habitat likely to occur within area
<i>Saccolaimus saccolaimus nudiclunatus</i> Bare-rumped Sheath-tail Bat	Critically Endangered	Species or species habitat likely to occur within area
<i>Xeromys myoides</i> Water Mouse, False Water Rat, Yirrkoo	Vulnerable	Species or species habitat likely to occur within area
<i>Megaptera novaeangliae</i> Humpback Whale	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
<i>Acanthophsis hawkei</i> Plains Death Adder	Vulnerable	Species or species habitat known to occur within area
<i>Caretta caretta</i> Loggerhead Turtle	Endangered	Foraging, feeding or related behaviour known to occur within the area
<i>Chelonia mydas</i> Green turtle	Vulnerable	Foraging, feeding or related behaviour known to occur within the area

Listed Threatened Species	Status	Type of Presence
Reptiles (continued)		
<i>Dermochelys coriacea</i> Leatherback Turtle,	Endangered	Foraging, feeding or related behaviour likely to occur within area
<i>Eretmochelys imbricata</i> Hawksbill Turtle	Vulnerable	Species or species habitat known to occur within area
<i>Lepidochelys olivacea</i> , Pacific Ridley Turtle	Endangered	Foraging, feeding or related behaviour known to occur within the area
<i>Natator depressus</i> Flatback Turtle	Vulnerable	Foraging, feeding or related behaviour known to occur within the area
Sharks		
<i>Carcharodon carcharias</i> Great White Shark	Vulnerable	Species or species habitat may occur within area
<i>Glyphis garricki</i> Northern River Shark	Endangered	Species or species habitat may occur within area
<i>Pristis clavata</i> Dwarf Sawfish	Vulnerable	Species or species habitat likely to occur within area
<i>Pristis microdon</i> Freshwater Sawfish	Vulnerable	Species or species habitat likely to occur within area
<i>Pristis zijsron</i> Green Sawfish	Vulnerable	Species or species habitat may occur within area
<i>Rhincodon typus</i> Whale Shark	Vulnerable	Species or species habitat may occur within area

During the EMS (2011) terrestrial flora and fauna study conducted in the East Arm area as part of the East Arm Wharf Expansion Project, the following significant threatened species were recorded within proximity to the Project site:

- One plant species, *Cycas armstrongii*, which is listed as vulnerable under the *TPWC Act 2000*.
- One fauna species, the Bush Stone-curlew (*Burhinus grallarius*) which is listed as near threatened under the *TPWC Act 2000*;

EMS (2011) found *Cycas armstrongii* to be common in the narrow strip of remnant vegetation along the edge of Hamaura Road (**Figure 3.6**). *Cycas armstrongii* is locally abundant in the Darwin region (NRETAS, 2006b).

The Bush Stone-curlew (*Burhinus grallarius*) is relatively common in the Darwin region and the small numbers of pairs that were present in the EMS (2011) study area were unlikely to represent a significant population. The individuals observed within the bushland and regrowth remnants within the study area were also observed moving into adjacent areas of cleared land, railway yards and parkland (EMS, 2011).

The EMS (2011) survey identified an additional fauna species within the East Arm area, the Mitchell's Water Monitor (*Varanus mitchelli*), which has since been classified as vulnerable under the *TPWC Act*.

Previous flora and fauna studies in the area have identified a number of additional threatened fauna species within the area, including the Northern Quoll (*Dasyurus hallucatus*) which is now classified as endangered under the *EPBC Act* and critically endangered under the *TPWC Act*,

and the Yellow Spotted Monitor (*Varanus panoptes*), which is now classified as vulnerable under the *TPWC Act*.

The Northern Quoll was detected from tracks in the study area and reported to be common during surveys conducted in 1990 (Acer Vaughan Consulting Engineers, 1993). Northern Quoll populations in the Darwin region declined rapidly following the arrival of cane toads in 2004 to 2005; however there had been documented declines in the NT prior to the arrival of toads, possibly due to inappropriate fire regimes or other factors (Hill and Ward, 2010). Cane toads are currently considered the main threat to Northern Quoll populations in parts of their range within Australia (Hill and Ward, 2010).

Despite adequate survey efforts, the Northern Quoll was not detected within the 2011 study area during the EMS survey (EMS 2011). It was considered possible that the Northern Quoll no longer occurs in the local area, however if they do persist they are likely to be present at significantly lower density than observations in 1990 indicate, due to the influx of cane toads since that time (EMS 2011).

It should be noted, the EMS (2011) study did not incorporate all of the area for the proposed Marine Industry Park, and there is potential for suitable habitat for threatened species to exist within the western portion of the Project area.

The known distribution of the marine species listed in **Table 3-2** is as follows:

- Humpback whales: Migrate to northern Australia from June to August but rarely venture as far northeast as the NT.
- Turtles: Green, hawksbill and flatback turtles are seen foraging for food in Darwin Harbour. Green and hawksbill turtles feed primarily on rocky reefs and in sponge and soft coral areas. There are no known turtle nesting sites in Darwin Harbour as the mangroves and mudflats do not provide suitable nesting grounds. Other turtle species (Ridley and loggerhead) are thought to be infrequent users of Darwin Harbour. Leatherback turtles are typically oceanic and unlikely to occur within the Harbour (INPEX, 2010c).
- Sawfish: Dwarf sawfish, freshwater sawfish and green sawfish have not been recorded in Darwin Harbour.
- Great white shark and whale shark: These species are not known to occur within Darwin Harbour.

3.5.3.2 *Listed Migratory Species*

In addition to the species in **Table 3-2**, several other species are listed as migratory species under the *EPBC Act* and are included in **Table 3-3**.

Table 3-3 Listed Migratory Species

Listed Migratory Species	Type of Presence
Marine Birds	
<i>Apus pacificus</i> Fork-tailed Swift	Species or species habitat likely to occur within area
<i>Sternula albifrons</i> Little Tern	Species or species habitat may occur within area
Terrestrial Species	
<i>Haliaeetus leucogaster</i> White-bellied Sea-Eagle	Species or species habitat known to occur within area
<i>Hirundo rustica</i> Barn Swallow	Species or species habitat may occur within area
<i>Merops ornatus</i> Rainbow Bee-eater	Species or species habitat may occur within area
<i>Rhipidura rufifrons</i> Rufous Fantail	Species or species habitat likely to occur within area
Wetlands Species	
<i>Actitis hypoleucos</i> Common Sandpiper	Foraging, feeding or related behaviour known to occur within area
<i>Ardea alba</i> White Egret	Species or species habitat known to occur within area
<i>Ardea ibis</i> Cattle Egret	Species or species habitat likely to occur within area
<i>Arenaria interpres</i> Ruddy Turnstone	Foraging, feeding or related behaviour known to occur within area
<i>Calidris acuminata</i> Sharp-tailed Sandpiper	Foraging, feeding or related behaviour known to occur within area
<i>Calidris alba</i> Sanderling	Foraging, feeding or related behaviour known to occur within area
<i>Calidris canutus</i> Red Knot	Foraging, feeding or related behaviour known to occur within area
<i>Calidris ferruginea</i> Curlew Sandpiper	Foraging, feeding or related behaviour known to occur within area
<i>Calidris ruficollis</i> Red-necked Stint	Foraging, feeding or related behaviour known to occur within area
<i>Calidris tenuirostris</i> Great Knot	Foraging, feeding or related behaviour likely to occur within area
<i>Charadrius leschenaultii</i> Greater Sand Plover	Foraging, feeding or related behaviour known to occur within area
<i>Charadrius mongolus</i> Lesser Sand Plover	Foraging, feeding or related behaviour known to occur within area
<i>Charadrius veredus</i> Oriental Plover	Foraging, feeding or related behaviour may occur within area
<i>Glareola maldivarum</i> Oriental Pratincole	Foraging, feeding or related behaviour may occur within area

Listed Migratory Species	Type of Presence
Wetlands Species (continued)	
<i>Heteroscelus brevipes</i> Grey-tailed Tattler	Foraging, feeding or related behaviour known to occur within area
<i>Limosa lapponica</i> Bar-tailed Godwit	Foraging, feeding or related behaviour known to occur within area
<i>Limosa limosa</i> Black-tailed Godwit	Foraging, feeding or related behaviour likely to occur within area
<i>Numenius madagascariensis</i> Eastern Curlew	Foraging, feeding or related behaviour known to occur within area
<i>Numenius minutus</i> Little Curlew	Foraging, feeding or related behaviour likely to occur within area
<i>Numenius phaeopus</i> Whimbrel	Foraging, feeding or related behaviour known to occur within area
<i>Pluvialis fulva</i> Pacific Golden Plover	Foraging, feeding or related behaviour known to occur within area
<i>Pluvialis squatarola</i> Grey Plover	Foraging, feeding or related behaviour known to occur within area
<i>Xenus cinereus</i> Terek Sandpiper	Foraging, feeding or related behaviour known to occur within area
Marine Species	
<i>Crocodylus porosus</i> Salt-water Crocodile	Species or species habitat likely to occur within area
<i>Balaenoptera edeni</i> Bryde's whale	Species or species habitat may occur within area
<i>Dugong dugon</i> Dugong	Species or species habitat known to occur within area
<i>Manta birostris</i> Giant Manta Ray	Species or species habitat may occur within area
<i>Orcaella heinsohni</i> Australian snubfin dolphin	Species or species habitat likely to occur within area
<i>Orcinus orca</i> Killer whale	Species or species habitat may occur within area
<i>Sousa chinensis</i> Indo-Pacific humpback dolphin	Breeding known to occur within area
<i>Tursiops aduncus</i> Spotted bottlenose dolphin	Species or species habitat likely to occur within area

During the EMS (2011) terrestrial flora and fauna study conducted in the East Arm area as part of the East Arm Wharf Expansion Project, migratory species (*EPBC Act*) recorded within the overall EMS (2011) study area were predominantly within the mangroves, saline wetlands (including samphire and salt flat habitat) and East Arm Wharf dredge spoil ponds. It should be noted the dredge spoil ponds are not within the Marine Industry Park Project area.

The following migratory/marine species were recorded at the fauna survey site adjacent the north eastern boundary of the Marine Industry Park Project area (refer to **Figure 3.6**) and adjacent tidal mud flats:

- One bird species listed as a migratory terrestrial species under the *EPBC Act*;
- 12 bird species listed as migratory wetland or marine species under the *EPBC Act*; and,
- 17 bird species classified as marine species under the *EPBC Act* (EMS, 2011).

Migratory shorebird studies undertaken as part of the East Arm Wharf Expansion Project (EPBC 2010/5304) in 2013/2014 do not identify the Marine Industry Park Project area as either a known or potential roost site for migratory shorebirds (Lilleyman, Lawes and Garnett 2013). Monitoring of shorebirds known to roost in the East Arm Wharf dredge spoil Pond D is currently ongoing through 2014 (Lilleyman, Lawes and Garnett 2014).

Dugongs have been observed in Darwin Harbour, including at Channel Island in Middle Arm, where they were thought to be feeding on macroalgae (Whiting, 2002). Dugongs could potentially utilise algal communities within East Arm (such as those around Old Man Rock) as a food source.

Three coastal dolphins, the Australian snubfin (*Orcaella heinsohni*), the Indo-Pacific humpback (*Sousa chinensis*) and the Indo-Pacific bottlenose (*Tursiops aduncus*) are the most common cetaceans in Darwin Harbour (Palmer, 2008). The false killer whale (*Pseudorca crassidensis*) has also been recorded in the Harbour (Palmer et al., 2009).

Four additional dolphin species or species habitat known or likely to occur within the area are listed under the *EPBC Act*, Common dolphin (*Delphinus delphis*), Risso's dolphin (*Grampus griseus*), Spotted dolphin (*Stenella attenuata*) and Bottlenose dolphin (*Tursiops truncatus*).

The saltwater crocodile (*Crocodylus porosus*) occurs in Darwin Harbour, although its abundance is controlled by a trapping and removal program for public safety. Because only limited nesting sites for the saltwater crocodile are available inside Darwin Harbour, the area is not considered critical habitat for crocodile survival in the NT (Whiting, 2003).

It should be noted, a Biodiversity Impact Mitigation and Offset Strategy (BIMOS) to address the consequential and residual impacts on *EPBC Act* listed dolphins, migratory birds, dugongs and marine turtles associated with the neighbouring East Arm Wharf Expansion Project has been developed and approved as part of DoE conditions of approval (EPBC 2010/5304). This BIMOS includes three plans, a Coastal Offset Plan, Migratory Birds Management Plan, and the Port Environmental Protection Plan. The latter two plans have been developed and approved by DoE, and the Coastal Offset Plan is currently with DoE for approval.

3.5.4 Biting Insects

Medical Entomology undertook an assessment of the potential for the creation of new biting insect breeding sites from impact of construction in or adjacent to tidal areas at the adjacent East Arm Wharf Expansion.

3.5.4.1 Mosquitoes

The report prepared by Medical Entomology indicates that the East Arm area has been an appreciable mosquito breeding area since the development of the wharf, with major mosquito breeding associated with hill removal, borrow pits and scrapes, cut-off upper tidal mangrove areas, mud ponds and sediment ponds, constructed drainage lines, and shallow ponding on reclaimed land. All of these are artificially created breeding sites. Natural breeding sites at

East Arm were previously limited to isolated upper tidal depressions (Warchot and Whelan, 2011).

The presence of very appreciable and productive mosquito breeding sites created by the first stage of development at East Arm Wharf indicates future development has the very high potential to create new mosquito breeding sites. Future development also has the opportunity to rectify existing mosquito breeding sites. Rectification of existing mosquito breeding sites will be of benefit to workers in the East Arm Area, by reducing pest problems and the risk of mosquito borne disease transmission (Warchot and Whelan, 2011).

The most important mosquito species collected of public health importance at East Arm were the northern salt marsh mosquito *Aedes vigilax* and the common banded mosquito *Culex annulirostris*. Both species are known vectors of Ross River virus and Barmah Forest virus, with the latter a known vector of the potentially fatal Murray Valley encephalitis virus and other arboviruses. Other mosquito species of potential significance, either as disease vectors or pest mosquitoes, included the receptacle mosquito *Aedes notoscriptus*, the golden mosquito *Coquillettidia xanthogaster*, the brackish water mosquito *Verrallina funereal*, the salt water *Culex* mosquito *Culex sitiens* and *Anopheles* mosquitoes. *Anopheles* mosquitoes include some species that are potential malaria vectors (Warchot and Whelan, 2011).

3.5.4.2 Midges

The East Arm area is subject to very high seasonal biting midge pest problems, caused by the mangrove biting midge *Culicoides ornatus* (Warchot & Whelan 2006). The mangrove biting midge *C. ornatus* accounted for the majority of biting midges collected during trapping at East Arm. All other biting midge species were recorded in low numbers only, or were not of any appreciable human pest significance (Warchot and Whelan, 2011). *C. ornatus* is considered the most significant human pest biting midge species around coastal areas of the NT (Shivas 1999, Shivas & Whelan 2001), and is also the most common biting midge pest around coastal areas of the NT (Whelan 2003). Whilst biting midges are considered appreciable human pests, they are not known to transmit disease to humans in Australia.

The mangrove biting midge *C. ornatus* breeds in mud adjacent to and under dense mangrove canopies (Warchot and Whelan, 2011). Breeding sites are associated with the nearby Bleasers Creek and Hudson Creek, which surround the East Arm Port Area (Warchot and Whelan, 2011).

Very high pest problems will be encountered in all areas of East Arm within 1.5 km of the nearest mangrove margin. Peak season problems will occur from August to November, with appreciable pest problems expected during all other months.

Trapping indicated that biting midge numbers inland of areas of industrial development were lower compared to areas adjacent to the mangroves, and subsequently outer areas facing mangroves are likely to experience the greatest pest problems.

3.6 Air Quality and Greenhouse Gases

3.6.1 Air Quality

Background air quality monitoring data for the Darwin region was collected and investigated in the East Arm area in order to establish background concentrations of air pollutants as part of the East Arm Wharf Expansion Project (NTG, 2011a). Key air pollutants investigated were PM₁₀ (particulate matter with an average aerodynamic diameter of 10 micrometres [10µm] and less), oxides of nitrogen (NO_x [sum of NO and NO₂, reported as NO₂]) and sulphur dioxide (SO₂). These data provide an indication of the quality of the existing air environment and the capacity of the local airshed for future increases associated with new developments.

Studies conducted on PM₁₀ (CSIRO [2001] and NRETAS [2006a, 2008]) showed dust levels in the Darwin airshed were generally within the National Environment Protection Measures (NEPM) criterion, however elevated dust levels were often associated with bushfires or firework displays. Oxides of Nitrogen (NO₂) and sulphur dioxide (SO₂), usually a product of combustion, are present in low concentrations in the Darwin airshed owing to the comparatively low numbers of cars and industrial areas when compared with other urban centres of Australia. Peak concentrations of both these pollutants were below the NEPM criteria.

The measured peak background concentrations of NO_x in Darwin (in the CBD and at Middle Arm Peninsula) in a study by URS in 2008 were 138 micrograms per cubic metre (µg/m³) (1 hour averaging period) and 9.7 µg/m³ (24 hour averaging period) (URS, 2008a). These peak concentrations were within the NEPM criteria of 246 µg/m³ (1 hour averaging period) and 62 µg/m³ for 24 hour averaging period.

Sulphur dioxide (SO₂) is an air pollutant emitted mainly from smelting of sulphide ores, sulphuric acid production and also in combustion of fuels containing sulphur. There is no sulphide ore smelting or sulphuric acid manufacture in Darwin, and Darwin has comparatively low numbers of vehicles and small light industrial areas; also fuel standards have been introduced that limit the concentration of sulphur in diesel fuel.

SO₂ was monitored in Darwin and Middle Arm in two URS studies (2005, 2008a). The background concentrations calculated from these studies were well within the NEPM criteria of 570 µg/m³ (one hour averaging period), 228 µg/m³ (24 hour averaging period) and 60 µg/m³ (annual averaging period).

Thus SO₂ is present in the Darwin airshed in low concentrations, when compared to other urban centres of Australia (NTG, 2011a).

3.6.2 Greenhouse Gases

Greenhouse gases (GHG) are naturally occurring gases in the Earth's atmosphere that absorb and radiate infrared radiation (heat) reflected from the Earth's surface. The most abundant of these gases are carbon dioxide (CO₂) and water (H₂O). Other naturally occurring greenhouse gases such as methane (CH₄) and nitrous oxide (N₂O) are present in much smaller amounts in the atmosphere.

Previous accounting for GHG emissions by activity sector for the NT shows that agriculture and stationary energy (power generation plant) are the prime contributors to GHG emissions in 1990 and 2008 (NTG 2011b).

Existing sources of GHG within the East Arm Wharf and surrounding areas comprise the following:

- Fuel combustion for energy supply, industrial processes and transportation (including importing and exporting by marine vessels) and other combustion sources;
- Waste;
- Fugitive emissions from industrial processes or similar; and
- Loss of vegetation through land use changes (NTG 2011a).

3.7 Historic and Cultural Heritage

A heritage assessment was undertaken that included the Project area as part of the East Arm Wharf Expansion Project (NTG, 2011a). This included a desktop study and field survey conducted by Earth Sea Heritage Surveys (2011).

The assessment resulted in the identification of the following indigenous, historic and maritime archaeological places:

- Indigenous Site 1 - shell midden;
- Indigenous Site 2 - stone artefact scatter;
- Three WWII historic features relating to refuse dumps;
- One WWII historic refuse incinerator complex;
- Maritime wreck sites consisting of RAAF Catalinas A24-69 (Catalina 2) and A24-206 (Catalina 3); and
- Other maritime wreck sites.

Locations of these historic and cultural sites are provided on **Figure 3.8**.

3.7.1 Historic WWII Archaeological Sites

Of the previously recorded WWII sites located in the East Arm area, one is located in close proximity to the Project site; the Quarantine heavy anti-aircraft (HAA) (defence air static). The Quarantine HAA is considered of significant value.

It is unlikely that there will be an impact on this WWII historic site as it is outside the Project area.

3.7.2 Maritime Wreck Sites

There are three registered shipwrecks within the Project area. These wrecks include two Vietnamese refugee boats (ID3429 and ID3430) and a two part barge (ID3428). There is also one registered shipwreck within close proximity to the Project area (approximately 250m south of the offshore Project area), Vietnamese refugee boat Con Dao 3 (ID3408). Of the above listed registered shipwrecks, none have been placed on the NT Heritage Register.

There are two maritime wreck sites within the Project area. These wrecks include Catalina 2 (RAAF Catalina A24-69) and Catalina 3 (RAAF Catalina A24-206). There are also three maritime wreck sites within close vicinity of the Project area, located within one kilometre to the south of the Project area, including Catalina 4 (United States (US) Navy Patrol Wing 10 28-5MNE) and Catalina 5 and 6 (US Navy Patrol Wing 10 PBV-4). The Catalina wreck sites are not protected under the *Shipwrecks Act*.

These five Catalinas, along with Catalina 1 (located in Darwin Harbour off the eastern shore of Bladin Point, south of the Project site), were nominated for inclusion on the NT Heritage Register in 1998.

A decision was made in October 2013 by the NT Heritage Council not to recommend to the Minister to include the RAAF wrecks on the register. However a renomination was accepted on 6 December 2013, and the wrecks are currently in the process of being assessed. Ownership of the RAAF Catalina aircraft is still believed to be by the Commonwealth.

The US Navy Catalinas are owned by the US Navy. No agreement on NT heritage listing was reached with current US parties so nominations for the US Catalinas were allowed to lapse as of 1 October 2013. However a renomination was accepted on 6 December 2013 and the wrecks are currently in the process of being assessed by the NT Heritage Council. Furthermore a nomination is currently in place for the National Heritage List.

It is noted that none of the sites are war graves.

3.7.3 **Indigenous Cultural Heritage**

The NT Archaeological Site Database indicated there were three Aboriginal shell middens sites within the surrounding area (East Arm Scatters 1, 2 and 3 on **Figure 3.8**) (NTG, 2011a). The East Arm 3 site has been destroyed by the current development of the East Arm Wharf and no longer exists as an archaeological site.

The Earth Sea Heritage Survey (2011) located two Indigenous cultural heritage places, identified as Indigenous Site 1 and 2 on **Figure 3.8**. These consisted of:

- A shell midden located on the mangrove mudflats adjacent to the existing railway, approximately 0.75 km to the west of the Project boundary. The midden consisted of a discrete mound primarily of *Anadara granosa* (granular mud ark), coupled with a relatively high density of quartz flakes. A diversity of other shell species was also noted. Based on the underlying geomorphology it is likely that the mound continues sub-surface below the mangrove mudflat. A low density background scatter of quartz stone artefacts surrounded the shell midden.
- A stone artefact scatter located towards the mouth of Hudson Creek, located in close proximity to the Project boundary. This consists of a low density scatter of quartz flakes, retouched flakes and cores. The quartz artefacts are located on a stony laterite bench surface, which is unlikely to present any depth of deposit.

The Indigenous archaeological sites located in this survey are believed to have been afforded interim protection under the previous *Heritage Conservation Act*. These archaeological sites contain a representative sample of the significant archaeological features of the general Darwin Harbour area.

Two existing AAPA certificates, signed in 2009, cover the onshore and portions of the offshore components of the proposed Marine Industry Park. These certificates are attached within **Appendix F**; both identify Catalina Island and surrounds as a restricted area. This restricted area has been, and will continue to be, incorporated into the Project design.

It is intended for a new application to be submitted to the AAPA to include the entire proposed Marine Industry Park, including the offshore zone, on one certificate.

3.8 Social Environment

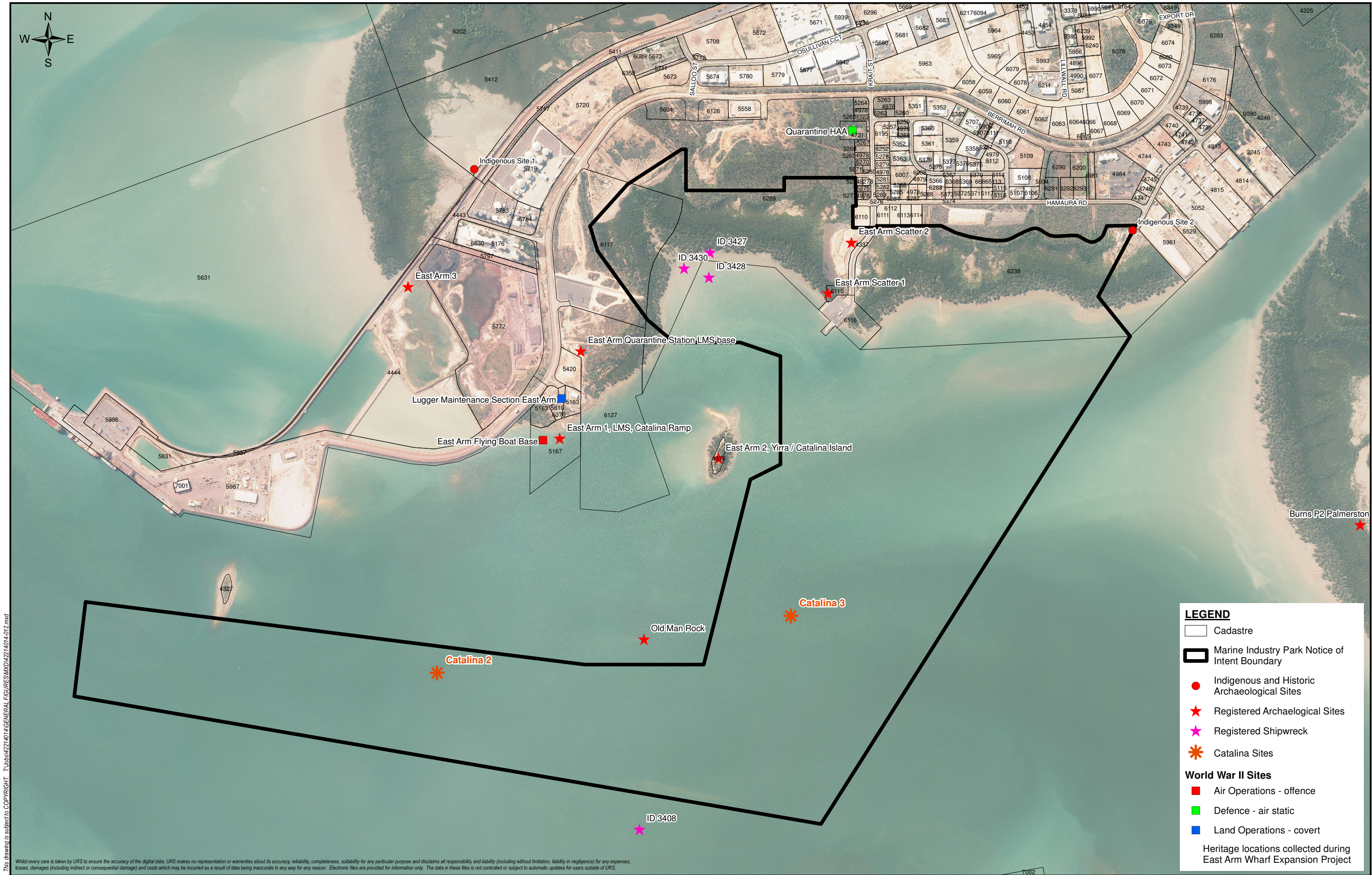
The Project area is located within an industrial area located between the City of Darwin and the City of Palmerston, which are the two main settlements in the Darwin Region. Both the cities have a youthful and multicultural population, and have a reputation for having an above national average transient population.

As the capital of the NT, Darwin is the commercial and administrative centre for the region. Darwin was established as Palmerston in 1869 then renamed as Darwin in 1911. The main Indigenous group within the area are the Larrakia people, also known as “salt-water people”, who traditionally and currently occupy the coastal area around Darwin.

Darwin has seen a number of significant events during its history, including bombings by the Japanese during WWII, and destruction by Cyclone Tracy in 1974. Darwin’s economy has been based on the Australian Defence Force, administration, mining and tourism. Darwin is also home to a thriving pearl farm industry, and occupies a strategic location for domestic and international trade.

Unemployment levels tend to be below the national average, and incomes above the national average (Australian Bureau of Statistics [ABS], 2012).

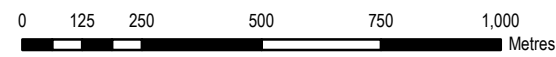
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LEGEND

- Cadastral
- Marine Industry Park Notice of Intent Boundary
- Indigenous and Historic Archaeological Sites
- Registered Archaeological Sites
- Registered Shipwreck
- Catalina Sites
- World War II Sites**
 - Air Operations - offence
 - Defence - air static
 - Land Operations - covert
- Heritage locations collected during East Arm Wharf Expansion Project

**HISTORIC AND CULTURAL
HERITAGE LOCATIONS**

4 POTENTIAL IMPACTS AND MITIGATION MEASURES

This section identifies the potential environmental and social impacts associated with the development of the Marine Industry Park, as presented under **Section 2**. This high level assessment is based primarily on desktop information as available to, and believed to be current and accurate by, URS at the time of writing.

Potential impacts are presented in **Section 4.1** for each environmental aspect in the same order as discussed in **Section 3**.

It is considered highly likely that a full EIS may be required for the Project for which further investigations will be undertaken; the likely required investigations are detailed at the end of each environmental aspect. Accordingly, the LDC has identified certain environmental baseline studies and long-lead item investigations with the intent these commence during the latter half of 2014.

The outcomes of all investigations, if deemed required and once completed, will inform the risk assessment within the EIS.

Proposed mitigation measures are then discussed in **Section 4.2**.

4.1 Potential Impacts

4.1.1 *Climate Change and Severe Weather*

Darwin has the tropical, wet - dry seasonal climate typical of northern Australia. The wet season occurs from late November through to April and is generally warm and wet with more than 90% of the annual rainfall falling in this period. There is potential for formation of monsoon troughs, tropical lows and cyclones during the wet season, which can produce gale force winds, prolonged heavy rainfall and storm surges.

Storm surge is a major cause of erosion, sediment mobilisation and property damage. Storm surge zones are depicted on **Figure 3.4**. Based on **Figure 3.4** the majority of the Project site at its current elevation would be inundated during a storm surge event, with the exception of the northern portion of section 6289.

Due to the harbour orientation, bathymetry and coastline configuration, energy of long period waves entering the Harbour quickly dissipates and thus wave heights decrease dramatically.

Project design would need to consider storm surge and rising sea levels in calculating final design elevation.

4.1.2 *Land and Soil*

4.1.2.1 *Erosion and Sedimentation Control*

Project construction activities, such as land clearance and bulk earthworks, create potential for erosion and sedimentation. Erosion can be caused by direct rainfall onto disturbed areas or by runoff from external catchments which may flow over the disturbed areas.

Sediment generation by construction activities can potentially lead to:

- Increased nutrient, sediment and other contaminant concentrations in receiving waters;
- Deterioration of receiving waterways' water quality and aquatic environmental health;
- Deterioration of soil quality and fertility due to increased erosion; and
- Sedimentation impacts on retained terrestrial and marine vegetation.

Figure 4.1 shows the existing topography and highlights areas of moderate erosion risk (i.e. with a slope between 2% and 5%) and high erosion risk (i.e. greater than 5% slope).

Erosion potential will increase, including on areas of less than 2% slope, when vegetation is cleared during bulk earthworks and the binding properties of root systems on the soil is removed. Construction works will alter the topography of the Project site, as will reclamation of land within the intertidal areas. All these factors may increase the erosion potential across the Project site during construction activities.

Once earthworks are completed, the resulting platform would be 0.1% to 1.0% slope, with a seawall bund extending approximately 2,400 m long and approximately 5.5 – 6 m AHD (however the final elevation would consider storm surge and rising sea levels); hence lowering erosion potential.

The potential impacts from wind erosion leading to suspended soil particles in the air, i.e. dust, causing potential air quality issues are described in **Section 4.6**.

4.1.2.2 *Acid Sulphate Soil*

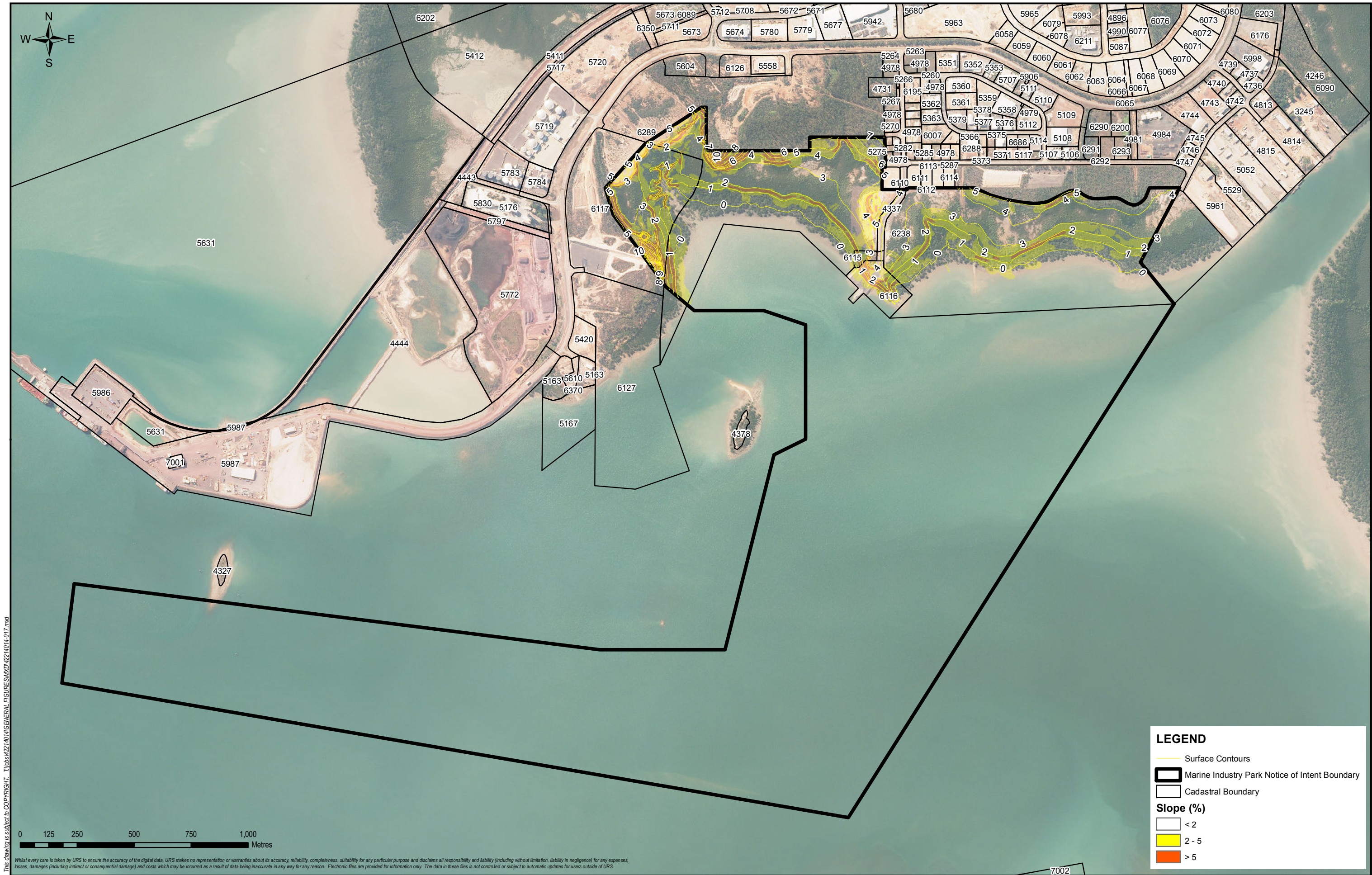
Earthworks, dredging and reclamation activities at the site have the potential to disturb ASS and PASS by:

- Excavating soil horizons above ASS and exposing ASS to the atmosphere;
- Excavating ASS and stockpiling/relocating the soil, exposing it to the atmosphere;
- Dredging of PASS and placement of PASS onshore, exposing it to the atmosphere; and
- Dewatering activities and/or alterations to groundwater flow regimes (e.g. dredging and land reclamation increasing groundwater flow and discharge mechanisms) drawing groundwater below its usual level potentially exposing ASS that would otherwise be waterlogged to oxygen.

When exposed to oxygen, these soils have the potential to produce sulphuric acid which can decrease the pH of the soil and mobilise metals within the soil and on-site water, leading to potential localised and downstream effects on terrestrial and marine flora and fauna if the water is discharged off site or percolates into groundwater.

As presented in **Figure 3.3**, previous investigations (Fogarty et. al., 1984) indicate the presence of ASS and PASS within the proposed NOI Project area. Areas situated on the higher ground (northern-most portion of the site) are not expected to consist of ASS, and therefore earthworks undertaken here are not anticipated to disturb ASS.

An ASS risk investigation will likely be conducted as part of the EIA. Any potential ASS issues would be addressed in an Acid Sulphate Soil Management Plan.



4.1.3 Oceanic Processes

Dredging and land reclamation, as well as dredge spoil disposal (if required), have the potential to modify coastal and hydrodynamic processes within Darwin Harbour, including water circulation patterns, wave regime, bed shear stress, and sediment transport patterns, which may lead to changes in surrounding shorelines and bathymetry.

Patterson and Williams (2013) conducted baseline and development hydrodynamic and cohesive sediment modelling for the shoreline development from intertidal mangroves to a seawall, ship turning area and dredge channel, associated with the then proposed first phase of the Project (report attached as **Appendix D.1**).

The modelling results, combined with known sediment distribution, show that little change is expected to occur in and around South Shell and Catalina Islands. The proposed dredge channel has been placed in an appropriate location from a physical point of view. It avoids large sand banks at the minimum depth required (-3.4 m CD). Bed deposition is predicted to occur in the area of the proposed dredged ship turn area and shoreline structure development. This may occur due to the low current velocities in that area and the characteristics of the bed material being fine sediment and sand. The frequency of maintenance dredging cannot be predicted, however given that deposition has occurred at areas surrounding the East Arm Wharf coastline (near the southern edge of ponds C and K) in the past, this could indicate that sedimentation may occur similarly near the proposed shoreline development and dredged ship turn area (Patterson and Williams, 2013).

Several assumptions have been made during the development of the models described above. Severe weather events have not been taken into account for the modelling. In the event of severe weather, currents will be greater than the modelling results predicted in this report. This may contribute to unforeseen scour and/or sediment deposition (Patterson and Williams, 2013).

Patterson and Williams (2014) undertook targeted sediment transport research in order to improve the AIMS sediment transport models in support of industry works at East Arm (report attached as **Appendix D.2**). Previously the model outputs have been based on assumptions for key parameters in which various literature and 'default' values have been used. The data collected as part of the targeted sediment transport research have quantified the sediment fall velocity, bulk density of the bed surface, bed material type, thickness and distribution, and the variation and concentration of suspended sediment in the water column. AIMS also used the data to verify that of the wind waves generated by storms during the study period, there was no effect of the waves on the sediment transport (Patterson and Williams, 2014).

AIMS highlighted the need for this data to be collected and the model coefficients to be calibrated in the 'Task 1 Proposed Marine Park Development Modelling Report' (Patterson and Williams, 2013). Patterson and Williams (2014) included further modelling to test the changes made. Reasonable results were achieved in the cohesive sediment model, which was the model that benefited most from the collection and analysis of these data. The deposition/erosion rates and locations have been predicted with confidence and could be used for estimating dredge intervals. Dredge plumes have also been modelled with confidence. The authors noted the non-cohesive (sand) model could be improved further and further verification should always be sought should the opportunity arise.

Modelling of erosion and deposition in the East Arm area was carried out in addition to requested dredge plume modelling. The model predicts a low rate of cohesive bed erosion. Deposition occurs mainly in the dredged areas close to the shore. The model shows that for sand deposition under the conditions described in Patterson and Williams (2013) the maximum deposition rate is around 1m per year while the maximum potential erosion rate is approximately 5.5m per year in isolated areas. The sand model indicates a large amount of sand erosion and deposition at the East Arm sand bar. For further details on the modelling results refer to **Appendix D.2**.

To assist with Project design, including dredge channel placement, and the EIA process, additional sediment sampling and verification of currents and bed surface characteristics in the Project vicinity will be required to further support the model calibration and verification process.

4.1.4 Hydrology

4.1.4.1 Terrestrial Water

Modification of natural flow velocities, surface / ground water interchange and water quality could be expected as a result of the Project's development activities, which are expected to include:

- Vegetation clearing and soil stockpiling;
- Ground compaction and sealing of the ground surface; and
- Dredging, sea wall construction and land reclamation.

Within the Project site, engineered and natural water courses direct stormwater runoff from surrounding areas and overland flow into the Harbour. These water courses appear to be intermittent in nature, and likely only carry flows within the wet season.

Potential impacts to surface water from the Project include:

- Interruption to or reduction of natural drainage flows;
- Increase of suspended sediment loads in surface water systems/marine environment during construction;
- Release of metals by disturbance of ASS/PASS materials via surface water systems;
- Exceedances of the water quality objectives for Darwin Harbour or relevant standards; and,
- Contamination from leaks and spills of fuels, lubricants, solvents or other products.

Potential impacts to groundwater from the Project are:

- Increased groundwater flow and discharge mechanisms, particularly where fractured bedrock is intersected, due to changes in bathymetry as a result of dredging and/or reclamation. This may reduce terrestrial groundwater levels and limit the availability of groundwater to dependent ecosystems. Terrestrial seawater intrusion (if present), could also progress further inland under this scenario;

- Modification of the groundwater flow regime, particularly if the hydraulic conductivity of the deposited sediments is significantly different to that of the natural soil profile of the shoreline;
- Reduction of groundwater discharge mechanisms, particularly where fractured bedrock is intersected, due to reclamation of land. This may increase terrestrial groundwater levels and limit terrestrial seawater intrusion (if present);
- Acidification of groundwater and release of heavy metals due to disturbance of ASS and PASS during land reclamation or groundwater dewatering activities;
- Reduction in groundwater recharge to aquifers as a result of compaction and sealing of ground surfaces during construction of roads, buildings and hardstands. This can also lead to a reduction in groundwater levels, flow and discharge mechanisms; and,
- Contamination from leaks and spills of fuels, lubricants, solvents or other products.

Development would involve the design of drainage infrastructure, potentially including a retention basin to reduce the effects of surface water runoff, especially during peak rainfall periods, and provide improved water quality discharge to the receiving environment.

In preparation for an EIS, baseline terrestrial surface water and groundwater investigations are proposed to commence later in 2014 to inform water management strategies. These will include studies and monitoring programs that require a period of investigation encompassing at least one wet dry season cycle.

4.1.4.2 *Marine Water*

Construction and associated activities may result in temporary impacts on water quality in and about the Project area, and more generally in East Arm.

The major potential impacts on water quality during construction are related to the disturbance of sediments and release of particulates into the water column associated with the following activities:

- Dredging and spoil disposal operations;
- Sea wall construction and reclamation;
- Excavation of the shallow sediments;
- Pile driving; and
- Propeller wash from vessels.

During construction, marine water quality may also be impacted by contamination from leaks and spills of fuels, lubricants, solvents or other products, and mobilisation of sediments, nutrients, toxicants, acid sulphate soils or other pollutants into the Harbour via surface water and groundwater systems (as discussed in **Section 4.1.4.1**).

During operations, marine water quality may be impacted by leaks and spills or by the release of toxins (most likely copper-based) during over-water maintenance of steel structures and vessels involving abrasive blasting or grinding/sanding.

In preparation for an EIS, baseline marine surface water and sediment quality investigations may be undertaken to inform environmental management strategies. Any sediment to be dredged will need to be characterised via sampling.

4.1.5 Ecology

4.1.5.1 Terrestrial Flora and Fauna

The proposed development will result in clearing of approximately 79.4 ha of vegetation. The vegetation in the Project area is dominated by mangroves (70.9 ha), with areas of terrestrial vegetation (8.5 ha) situated on the higher ground (northern and north western portions of the site). Previous investigations and an inspection of the Project site conducted on 18 March 2014 indicate the terrestrial vegetation consists of disturbed / regrowth and remnant vegetation types.

Project construction activities, such as land clearance, bulk earthworks, land reclamation, dredging and vehicle movements, represent the greatest threat to local flora and fauna within the Project area. In addition, unplanned fires from construction activities or uncontrolled events also pose a threat to local flora and fauna.

Potential impacts to native flora and fauna, including those protected under the *EPBC Act* and *TPWC Act* (refer **Section 3.5.3**) from the Project include:

- Loss of native fauna (or injury), flora and habitats;
- Disturbance or displacement of native local fauna species (e.g. night lighting, noise, human access etc.);
- Introduction and spread of weeds outcompeting and depleting native vegetation;
- Introduction and spread of pests, damaging native flora and fauna;
- Decline of retained and surrounding native flora health due to dust generation, erosion or sedimentation, disturbance of ASS and modification of surface water, groundwater and tidal systems; and
- Loss of individual flora and fauna species from the broader regional population, which may potentially impact the genetic diversity of flora and fauna species populations within the surrounding area.

The Project will be developed in stages, anticipated to be over a long timeframe of up to 50 years. Hence, vegetation clearance is expected to be conducted in stages during the construction phase of the project.

In preparation for an EIS, further investigations may need to be undertaken to document native flora and fauna, specifically the presence and distribution of critical habitats (*TPWC Act*) and listed ecological communities, threatened species (*TPWC Act* and *EPBC Act*) and migratory species (*EPBC Act*) within and adjacent the Project site, with particular attention to species identified in previous ecological studies undertaken in the area.

A relocation (salvage) program will be undertaken for *Cycas armstrongii* prior to woodland vegetation clearing activities.

4.1.5.2 Marine Communities

Most of the Project area is surrounded by bare substrate. Further offshore (in the vicinity of potential dredge channel/s) there are some coral and filter feeder communities around South Shell Island and Old Man Rock (refer to **Section 3.5.2**).

Nearshore construction activities associated with the Project site that have potential to impact on marine communities include:

- Land clearing, sea wall construction and land reclamation;
- Dredging and the associated deposition of dredge spoil;
- Excavation of the shallow sediments;
- Pile driving;
- Increases to general shipping/ vessel traffic; and
- Propeller wash from vessels.

Mangroves will be impacted directly (by removal) and, potentially, indirectly (through changes to tidal exchange, sediment deposition, hydraulic loading effects [e.g. development of mud waves]). The maximum extent of potential mangrove loss from the Project footprint is 70.9 ha. The mangrove tracts around the Darwin Harbour shoreline are extensive and the potential 70.9 ha mangrove loss associated with the Project represents 0.3% of the 27,000 ha of mangroves that currently exist. In this context, the mangrove loss could not be considered as having a potentially significant impact upon mangrove ecosystems at the broader regional scale.

Approximately 97 ha of low tidal mud flat habitat will be either reclaimed or substantially disturbed during construction of the Project. These areas can provide an abundant source of intertidal invertebrate fauna for shorebirds to feed on. In the context of the extensive areas of tidal flats within Darwin Harbour (222 km² / 222,000 ha [NRETAS, 2008b]), the area (97 ha) to be impacted by the Project is small (0.04%) and hence it is unlikely to present any significant threat to shorebird populations in the Harbour.

Dredging will impact upon the surrounding benthic environments directly (physical removal by the dredging process or burial) and, potentially, indirectly (impacts from light attenuation by turbid plumes and settlement of suspended sediments on areas outside of the dredging footprint). Additionally, offshore dredge spoil disposal (if required) may cause mortality, through smothering, of benthic fauna at the disposal ground. All of the benthic communities found near the Project area are well represented elsewhere in Darwin Harbour.

Turbidity may clog the feeding apparatus of filter-feeders and deposit feeders, and gills of fish, although fish would be expected to move away from areas of temporary disturbance. Fish eggs and larvae will be more susceptible to suspended sediments than juveniles and adults, with the larvae of some species being adversely affected by concentrations as low as 100 mg/L in a period of 96 hours. These levels will also affect invertebrates such as bivalves and sea urchins. Levels greater than 500 mg/L are likely to produce measurable effects on larvae of most species (Jenkins and McKinnon, 2006).

Potential impacts from the Project on species protected under the *EPBC Act 1999* or the *TPWC Act* include direct (e.g. boat strike, noise and vibration) and indirect (e.g. habitat loss)

impacts upon migratory animal species, including cetaceans, dugongs, birds, turtles and sharks or migratory birds that could occur in the area. Coastal dolphins, dugongs and turtles are known to occur in Darwin Harbour, but there are no known habitats of particular significance to these species in the immediate Project area. Habitats for these species are widespread across the Harbour.

Lastly, marine pests could be introduced to the Project area through the increased vessel movements. The two main vectors of marine pests in commercial vessels are ballast water and biofouling. There are existing NTG monitoring programs in place within Darwin Harbour to detect any instances of marine pests.

In preparation for an EIS, more detailed mapping of the benthic habitats is planned to be undertaken. The results from this mapping, in consideration with early side scan and seismic studies, will assist with access channel mapping and dredge planning. Sediment transport modelling has already been undertaken (**Appendix D**) and potential impacts upon ecosystem function will be assessed for the EIS.

4.1.5.3 *Biting Insects*

Biting insects have the potential to affect the health of workers and members of the public through the transmission of mosquito-borne diseases or reactions to bites.

The Project has the potential to lead to the creation of new breeding sites for pest and disease carrying mosquito species through the inappropriate carriage, storage or dispersal of water, in particular dry season flows. In addition, blockage of surface water flows by roads, embankments and sediment control infrastructure could create new mosquito and biting midge habitats.

In contrast, the proposed development could potentially decrease mosquito and biting midge populations due to removal of their breeding habitat.

In preparation for an EIS, a biting insect study will likely be undertaken.

4.1.6 *Air Quality and Greenhouse Gas Emissions*

4.1.6.1 *Air Quality*

The NT EPA requires that air contaminant levels for human health meet the National Environmental Protection Measures (NEPM) guidelines for air quality criteria.

Particulate levels in the Darwin airshed vary according to season, with dry season PM₁₀ levels up to 20 µg/m³ (over a 24 hour period) greater than wet-season levels (around 10 µg/m³). Climatic factors and dust from dry season bush fires across the Top End contribute to these variations. Previous background air quality monitoring for the Darwin region concluded that carbon monoxide (CO), nitrogen oxides (NO_x) and sulphur dioxide (SO₂), all occur at very low levels in the Darwin airshed compared to the large cities in other parts of Australia.

The Project would not be expected to cause a significant increase in carbon monoxide (CO), nitrogen oxides (NO_x) and sulphur dioxide (SO₂), although combustion of fuels will occur during both construction and operations phases, from construction and operational equipment, and from power utilised during operations.

Emissions of volatile organic compounds (VOCs) and odour emissions would be expected to be minor, although VOCs would likely be produced from light industry, for example paint spraying operations, which may have an odour impact.

The issue of concern during construction activities would be fugitive dust. Construction activities that may generate dust on a variable and intermittent basis are clearing, earthworks, cut and fill activities, vehicle movements on unsealed roads, and the loading and unloading of loose materials. In addition, wind erosion of stockpiles and unsealed surfaces contribute to dust generation and the significance of dust impacts.

Impacts may include:

- Nuisance, amenity and health impacts to surrounding communities;
- Effects on ecosystems from dust deposition; and
- Relatively minor increased levels of atmospheric pollution (NO_x and particulates PM₁₀ & PM_{2.5});

Possible human receptors sensitive to dust may include the construction workforce, those driving on surrounding roads, employees at nearby commercial and industrial developments and employees / passengers at the Ghan passenger train terminal.

In preparation for an EIS, further investigation and air modelling may be required.

4.1.6.2 *Greenhouse Gases*

The Project would not be expected to create impacts in regards to ozone production and photochemical smog, and is not anticipated to create notable greenhouse gas pollution.

The principle GHG expected to be produced would be carbon dioxide (CO₂), produced by the combustion of fuels during Project construction and operations.

The other direct GHG impact from the Project would be the removal of vegetation during land and mangrove clearance and the resulting loss of carbon sink capacity.

Impacts therefore may be summarised as:

- Increasing levels of greenhouse gases, primarily CO₂;
- Removal of carbon sink from clearance of vegetation; and
- Production of gases from the cleared vegetation (the gases produced and relative proportions would depend on the method(s) used to dispose of the material).

In preparation for an EIS, further investigations and GHG modelling may be required.

4.1.7 *Historic and Cultural Heritage*

The following indigenous, historic and maritime archaeological places have been identified within the Project area:

- Indigenous Site 1 - shell midden;

- Maritime shipwreck sites, consisting of two Vietnamese refugee boats (ID3429 and ID3430) and a two part barge (ID3428).
- Maritime wreck sites, consisting of RAAF Catalinas A24-69 (Catalina 2), and A24-206 (Catalina 3).

The following historic and maritime archaeological places have been identified within close proximity of the Project area:

- Quarantine heavy anti-aircraft (HAA) (defence air static); and
- Maritime wreck sites consisting of US Navy Catalinas Navy Patrol Wing 10 28-5MNE (Catalina 4), and 10 PBV-4 (Catalina 5 and 6).

Locations of these historic and cultural sites are provided on **Figure 3.8**.

Project construction activities, such as land clearance, bulk earthworks, vehicle movements, dredging and land reclamation may potentially damage, disturb or result in the loss of historic and cultural heritage sites within the Project area. Additionally, there is a potential risk that damage, disturbance or loss of previously unidentified historic and cultural heritage sites may occur.

In preparation for an EIS, a heritage assessment for the Project area and discussions with the Heritage Branch of the DLPE may be required.

As detailed in **Section 3.7.3**, it is intended for a new application to be submitted to the AAPA to include the entire Marine Industry Park on one AAPA certificate.

4.1.8 Social Environment

The proposed Project is increasing the availability of industrial land in the East Arm Precinct. This is expected to bring increased employment opportunities and assist in creating further growth for the NT.

The Project may require the re-siting the public East Arm Recreational Boat Ramp and the dredging and associated changes to the coastline may impact on some recreational use of the area as the Project expands. This will likely be a requirement to separate recreational users from the marine industrial activities.

Noise associated with the Project construction and operation is not anticipated to be an issue due the surrounding land zoning (refer **Section 2.1.3**) and that there are no adjacent or nearby residential areas and the area is already an industrial area and working port.

Social impact assessments and stakeholder consultation will form part of the EIS process.

4.2 Proposed Mitigation Measures

4.2.1 Consideration of Existing Environment in Project Design

The existing environment and potential impacts will be considered as the Project design develops. This includes the consideration of options and scenarios to enable potential impacts to be accurately predicted and, where possible, modifications to the design made to avoid or

minimise impacts. Design measures will be further investigated and refined as part of the EIS process.

4.2.2 Environmental Management Plans and Monitoring

Site specific Construction Environmental Management Plans (CEMPs) and Operations Environmental Management Plans (OEMPs) will be developed for the construction and operational stages of the Project, respectively. Responsibility for these plans will be held by the LDC for the development of the Project.

The scope of the plans will be informed by the EIA process and current legislation, and will likely be inclusive of potential impacts discussed in **Section 4.1**, as well as waste and hazardous materials management.

The CEMPs and OEMPs will establish an environmental monitoring program for each relevant stage of the Project. The scope of the program will be informed by the EIA process.

4.2.3 Dredging and Dredge Spoil Placement Management Plan

A Dredging and Dredge Spoil Placement Management Plan (DDSPMP), and other associated EMPs, will be developed as required by the NT and Commonwealth legislation current at the time of dredging. The purpose of a DDSPMP is to provide a general framework for planning and implementation of dredging and spoil management activities in relation to the Project.

DDSPMPs are currently required to address:

- The probable dredging methods (capital and maintenance work), including type of dredge and timelines;
- The quantity and characteristics of material to be dredged;
- The reuse and / or disposal of dredged material, whether on or offshore; and,
- The environmental management framework for the proposed dredging work, comprising the environmental management objectives, performance criteria, mitigation measures and reporting and monitoring requirements.

As the Project is likely to occur in stages, there may be the requirement for the DDSPMP to be updated / revised as the different phases occur.

Prior to the development of the DDSPMP, a sediment Sampling and Analysis Plan (SAP) is required to characterise the sediments to be dredged. The SAP must comply with the National Assessment Guidelines for Dredging (NAGD) 2009 and Guidelines for the Environmental Assessment of Marine Dredging in the Northern Territory (NT EPA, 2013a).

A Waste Discharge License is an expected requirement to manage tailwater discharge when placing dredge spoil onshore, and licenses will be progressively staged according to dredging and onshore placement programs.

There is a risk in the Darwin Harbour area, both on and offshore, of disturbing Un-Exploded Ordinance (UXO) and dredging operations would be required to undertake appropriate due diligence with respect to UXO (NT EPA, 2013a).

4.2.4 *Residual Impacts and Environmental Offsets*

Following the environmental management hierarchy, where impacts cannot be ‘designed out’, best practice management and mitigation strategies will be applied to minimise the potential for such environmental impacts. However, where such strategies are unable to account for the residual impacts, consideration may be given to appropriate offsets in accordance with the *Guidelines on environmental offsets and associated approval conditions* (NT EPA, 2013b) and *EPBC Act 1999 Environmental Offsets Policy* ([former] Department of Sustainability, Environment, Water, Population and Communities [DSEWPC], 2012), where applicable.

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