East Arm Wharf Expansion Project

DRAFT ENVIRONMENTAL IMPACT STATEMENT

VOLUME 1 OF 4 | Executive Summary

MAY 2011

Prepared for Northern Territory Department of Lands and Planning

Northern Territory Government

Table of Contents

1 Executive Summary 1
1.1 Introduction 1
1.2 Background 2
1.2.1 Location of the Port 3
1.3 Existing and Surrounding Land Uses 6
1.4 Description of Proposal 7
1.4.1 Barge Ramp and Hardstand Area 7
1.4.2 Marine Supply Base 8
1.4.3 Construction of Tug Pens and Small Vessels Berths 9
1.4.4 Rail Loop and Spur 12
1.5 Construction Methods 13
1.5.1 Barge Ramp and Hardstand Area 13
1.5.2 Marine Supply Base 13
1.5.3 Berths for Tugs and Small Vessels 15
1.5.4 Rail Loop and Spur 15
1.5.5 Laydown Areas 15
1.6 Ongoing Maintenance 16
1.7 Employment 16
1.8 Justification and Alternatives Considered 16
1.8.1 Project Location 17
1.8.2 Port Facilities 17
1.8.3 Dredging Methods and Dredge Spoil Reuse / Disposal 17
1.8.4 Sources of Raw Materials 18
1.8.5 Alternative Management Techniques for Moderate to High Impacts 18
1.9 Timeframes Schedules and Staging 19
1.10 Environmental Impact Assessment Process 19
1.11 Relationship to Other Actions 22
1.12 Environmental Issues and Management Controls 23
1.12.1 Climate 23
1.12.2 Geology Landforms and Soils 24
1.12.3 Oceanic Processes and Natural Features 29
1.12.4 Marine Water 33
1.12.5 Terrestrial Water 36

1.12.6 Air Quality 39
1.12.7 Greenhouse Gas Emissions 41
1.12.8 Marine Noise 43
1.12.9 Terrestrial Noise 44
1.12.10 Marine Ecology 47
1.12.11 Terrestrial Ecology 49
1.12.12 Visual Amenity 54
1.12.13 Historical and Cultural Heritage Values 56
1.12.14 Social Environment 60
1.12.15 Economics 62
1.12.16 Biting Insects 65
1.12.17 Fire 67
1.12.18 Waste and Hazardous Material Management 69
1.13 Stakeholder Consultation 70
1.14 Risk assessment 72
1.15 Environmental Management System and Environmental Management Plans 75
2 References 78
3 Glossary 83

Tables

Table ES-1 Noise Sensitive Locations 45
Table ES-2 Cultural Heritage Places located in the Vicinity of EAW 57
Table ES-3 Darwin Ports – Cargo by Type 2009/10 63

Figures

Figure ES-1 Location of East Arm Wharf within the Northern Territory 4
Figure ES-2 General Arrangement of the Proposed EAW Expansion 5
Figure ES-3 Marine Supply Base and Barge Ramp, and Hard Stand Area 10
Figure ES-4 Marine Supply Base and Barge Ramp, and Hard Stand Area 11
Figure ES-5 NT Environmental Impact Assessment Process (Adapted from NRETAS, 2011) 21
Figure ES-6 East Arm Wharf – Landform 26
Figure ES-7 East Arm Wharf – Acid Sulphate Soils 27
Figure ES-8 Colour Coded Bathymetry of Darwin Harbour; Depths are Positive, Relative to LAT 30
Figure ES-9 Viewpoints Considered in the Visual Impact Assessment 54
Figure ES-10 Overview of ISO 31000 Risk Management Process 72
Figure ES-11 Environmental Management Process Flow 76

Plates

Plate ES-1 Cycas Armstrongii (Vulnerable TPWC Act 2000) Area 4 50
Plate ES-2 Australian Pelican (*Pelecanus conspicillatus*) Pond B East Arm Wharf 52

Units, Symbols and Abbreviations

Units

The technical units of measurement in this report are based on the International System of Units (SI) wherever possible. These technical units may be broadly grouped as prefixes and units.

A prefix applies to the unit of measurement that immediately follows it—for example, milligram is abbreviated as mg.

Superscripts ^{2} and ^{3} following a linear unit indicate area and volume respectively—for example, m^2 (square metres) and m^3 (cubic metres).

Different units are combined by a full stop (.) to differentiate units of the same exponential sign, and a solidus (/) to indicate 'per'. For example, a kilometre per hour is abbreviated as km/h, while megalitres per day per square kilometre are $ML/d.km^2$.

Prefixes

M	mega	1,000,000	m	milli	0.001
k	kilo	1,000	µ	micro	0.000001

Units

a	year (annum)	L	litre
ºC	degrees Celsius	m	metre
d	day	t	tonne
g	gram	hr	hour
ha	hectare		

Chemical Symbols and Formulae

CO_2	Carbon dioxide	NO_2	Nitrogen dioxide
CO_2-e	CO_2 equivalent	SO_2	Sulphur dioxide

Abbreviations

Abbreviation	Description
>	Greater than
<	Less than
AAPA	Aboriginal Areas Protection Authority
AAQ NEPM	National Environment Protection (Ambient Air Quality)Measure)
AHD	Australian Height Datum
AQIS	Australian Quarantine and Inspection Service
AQMP	Air Quality Management Plan
ASS	Acid Sulphate Soils
CBD	Central Business District
CD	Chart Datum
CEMP	Construction Environmental Management Plan
CHMP	Cultural Heritage Management Plan
$CO_{2\text{-}e}$	Carbon Dioxide Equivalent
CSD	Cutter Suction Dredge
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CWMP	Construction Waste Management Plan
DCM	Department of the Chief Minister
DCCEE	Department of Climate Change and Energy Efficiency
DEC	NSW Department of Environment and Conservation
DECC	NSW Department of Environment and Climate Change
DECCW	NSW Department of Environment, Climate Change and Water
Defence	Department of Defence
DEIS	Draft Environmental Impact Statement
DHAC	Darwin Harbour Advisory Committee
DLP	Northern Territory Department of Lands and Planning
DMP	Dredge Management Plan
DoH	Department of Health
DPA	The Darwin Port Authority
DPA Act	*Darwin Port Authority Act 1983*
DPC	Darwin Port Corporation
DPI	Department of Planning and Infrastructure
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities
EAW	East Arm Wharf
EIS	Environmental Impact Statement
EMP	Environment Management Plan
EMS	Environment Management System
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ERA	Emergency Response Area
FMP	Fire Management Plan
GHG	Greenhouse Gas
GWI	Genesee and Wyoming Incorporated
HAT	Highest Astronomical Tide

Abbreviation	Description
IUCN	International Union for Conservation of Nature
LAT	Lowest Astronomical Tide
LDC	Land Development Corporation
LNG	Liquefied Natural Gas
MSB	Marine Supply Base
MVF	Monsoon Vine Forest
NCOS	National Carbon Offset Standard
NEPC	National Environmental Protection Council
NEPM	National Environmental Protection Measure
NOI	Notice of Intent
NPI	National Pollutant Inventory
NRETAS	Department of Natural Resources, Environment, The Arts and Sport
NT	Northern Territory of Australia
NTFRS	Northern Territory Fire and Rescue Service
NTG	Northern Territory Government
OH&S	Occupational Health and Safety
PASS	Potential Acid Sulphate Soils
PM	Particulate Matter
PM_{10}	Particulate Matter with an Average Aerodynamic Diameter of 10 μm and Less
RFP	Request for Proposal
RISQUE	Risk Identification and Strategy Using Quantitative Evaluation
RLO	Rock Loadout
SEDMP	Soil Erosion and Drainage Management Plan
the Minister	Northern Territory Minister of Natural Resources, the Environment and Heritage
TPWC Act	*Territory Parks and Wildlife Conservation Act*
WMB	Water Monitoring Branch
WWII	World War II

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Chemical Symbols and Formulae

CO_2	Carbon dioxide	NO_2	Nitrogen dioxide
CO_2-e	CO_2 equivalent	SO_2	Sulphur dioxide

1

Executive Summary

1.1 Introduction

The Northern Territory Government (NTG) proposes to expand existing facilities at the East Arm Wharf (EAW) to address increased demands on the wharf for export of bulk minerals, storage, the Department of Defence (Defence) and other industries (SKM, 2009; AECOM, 2009a).

The proposed EAW Expansion (the Project) includes:

- Developing a Marine Supply Base (MSB) adjacent to EAW, primarily to service the existing and developing oil and gas industries in the Timor Sea, Browse Basin and adjacent areas.
- Constructing a barge ramp and hardstand area, including berthing for barges and facilities for loading and unloading.
- Establishing a rail loop enabling rakes of rail wagons carrying bulk material to be manoeuvred through the port, and unloading material through a proposed rail dump facility to the adjacent stockpile areas.
- Extending the EAW quay, and construction of moorings to accommodate tugs, customs boats and other smaller vessels.

This Draft Environmental Impact Statement (DEIS) was prepared to identify the environmental and related impacts that could potentially occur as a result of the proposed expansion. It also describes management strategies and plans that will be employed to manage and mitigate those impacts.

This DEIS is based on the Department of Natural Resources, Environment, The Arts and Sport (NRETAS) *Guidelines for Preparation of a Draft Environmental Impact Statement for the Expansion works at East Arm, Northern Territory* (NT), Department of Planning and Infrastructure (DPI) December 2009 (the Guidelines).

Although listed as part of the proposal in the Notice of Intent (NOI) and the Guidelines, this DEIS does not include the Land Development Corporation (LDC) subdivisional works and filling proposed for the area adjacent to the new East Arm Boat Ramp and Muramats Road. The NOI also indicated that the entire area north of the wharf, up to approximate alignment with Bleesers Creek, will be filled; however the only works north of the wharf within the scope of this DEIS will be associated with the proposed rail loop spur.

The proponent formally advised NRETAS of the alteration to the proposed action, consistent with the requirements of the Northern Territory Environmental Assessment Administrative Procedures, clause 14A (2003) in May 2011.

The proponent of the proposed EAW Expansion Project is the NT Department of Lands and Planning (DLP), which is responsible for developing and providing the strategic planning, growth frameworks and infrastructure plans required to sustainably develop the NT.

DLP is acting on behalf of the:

- Darwin Port Corporation (DPC), a NTG body responsible for the control and management of the land, waterways and facilities within the Port of Darwin; and
- Department of the Chief Minister (DCM) who are seeking to collaborate with a single operator or an operator-led consortium with experience in developing and operating a MSB to service the offshore oil and gas exploration and production industries.

The LDC is the NTG's primary industrial land developer and has an integral role in the development of the EAW area. The LDC has been involved with the East Arm Marine Services Precinct, Common User Area and Darwin Business Park.

1.2 Background

EAW is located approximately 4.5 km south east of the Darwin Central Business District (CBD). The existing wharf has a continuous 754 m berth face located parallel to the main shipping channel, and incorporates a dry bulk materials handling facility featuring a ship loader designed to load Panamax class vessels.

EAW occupies a land area of approximately 18 ha of sealed hand stand surface with 4,000 m^2 of undercover cargo handling facility, and a further 18 ha of bunded area for future reclamation. A single rail spur from the AustralAsia Railway runs over a 16 m wide railway causeway, linking to three rail lines to the wharf (including a 4 ha intermodal container terminal), with road access provided over the causeway from Berrimah Road.

The Darwin Port Authority (DPA) was established under the *Darwin Port Authority Act 1983* (*DPA Act*). The Authority's role was to control, develop and manage all waters and land within the port (including EAW) and to facilitate marine related activities and industries. In 1998 the *DPA Act* was amended to see the establishment of the DPC and the adoption of a greater commercial focus for the port operations and management (DPC, 2010a).

The expansion of the Port of Darwin (the Port) was announced by the NTG in the early 1990's as a strategic development for the NT, and approval for the development of a wharf at the East Arm Peninsula was gained via a DEIS and Supplement prepared by Acer Vaughan in 1993 (Acer Vaughan, 1993a, 1993b; SKM, 2009).

EAW was designed to make provision for the long-planned Darwin to Alice Springs railway line, establishing Darwin as a significant transport and logistics centre for trade between Australia and the Asia Pacific region (Acer Vaughan, 1993a). The proposed expansion of the port is designed to meet the requirements of, and be consistent with, a number strategic plans developed or commissioned by the NTG, including:

- Territory 2030 Strategic Plan (NTG, 2009a).
- Growing International Trade Priority Action Plan (NTG, 2009b).
- Darwin Harbour Strategy 2010 (NTG, 2010a).
- East Arm Wharf Facilities Masterplan 2030 Land Use Report (GHD, 2009).

The primary role of EAW is to facilitate the movement of goods via rail, road and shipping to international markets. EAW currently services vessels handling general cargoes, live cattle exports, dry bulk imports, containerised / break bulk and specialised heavy lift cargoes, plus offshore rig tender service vessels (AECOM, 2009a). It is utilised by oil and gas, mining, agriculture, horticulture and construction industries (DPC, 2010a).

Bulk solids have turned out to be the major driver for expansion. This is emphasised by the addition of a bulk loader and the development of a first stage minerals stockpile area. With the installation of the bulk ship loader and associated conveyors, more hardstand space is being consumed by the rail extension for mineral concentrate exports to China and India. This in turn has reduced hardstand and berth space for the Port's traditional trades. Consequently, adequate available land space for the traditional trades is limited (DPC, 2010a).

Executive Summary

Demand for an additional barge ramp, including covered, secure storage areas with power supplied, has been identified by DPC. It is proposed that this should consist of a boat ramp-type facility for landing craft and a storage area that is accessible on a 24 hour, seven day a week basis. This facility will be utilised by private barge operators to transfer goods to islands and communities in the NT, and also by Defence. Defence requires a loading area, preferably at EAW. It is proposed that as part of this expansion an equivalent area to that currently available for Defence at Fort Hill Wharf will be found at EAW (DPC, 2010a).

The proposed MSB will be able to service over 400 vessel calls per annum. These vessels support activities such as oil and gas exploration in Northern Australian waters from the Arafura Basin in the east, to the Browse Basin in the west. The MSB will support the operation of drilling platforms and operational platforms including those in the Bayu Undan field, which supplies the liquefied natural gas (LNG) production facility at Wickham Point (DPC, 2010a).

It is noted that the transfer of commercial port activities to EAW from the Darwin City Wharf located in the Darwin CBD has allowed for the Darwin City Waterfront redevelopment. The Darwin City Waterfront redevelopment provides for significant public space, community facilities, plus commercial, residential and tourism development, the centrepiece of which is the Convention and Exhibition Centre (DPC, 2010b). Although the city wharves remain as working facilities for visiting international cruise and naval vessels, as well as alternative berths for some commercial shipping, the transfer of other commercial activities has greatly reduced traffic associated with transportation of cargo and materials, including live (cattle) exports, through the Darwin CBD (DPC, 2010b).

The proposed expansion of the existing facilities at EAW is consistent with the existing industrialised character of the Port of Darwin (SKM, 2009); the original DEIS and Supplement for the Expansion of the Port of Darwin (Acer Vaughan, 1993a; Acer Vaughan 1993b); and the EAW Masterplans (Acer Vaughan, 1995; GHD, 2009).

1.2.1 Location of the Port

EAW is situated on the East Arm Peninsula, within Darwin Harbour. The Peninsula has been developed to form the EAW and associated wharf related industries. The EAW extends into the Darwin Harbour and is bounded by Bleesers Creek to the north and Hudson Creek to the east. Two small islands lie directly south and east of the project area; South Shell Island and Catalina Island (AECOM, 2009a).

The location of EAW within the Northern Territory and in relation to the city of Darwin is illustrated in Figure ES-1and the layout of the proposed development is shown in Figure ES-2.

Figure ES-1 Location of East Arm Wharf within the Northern Territory

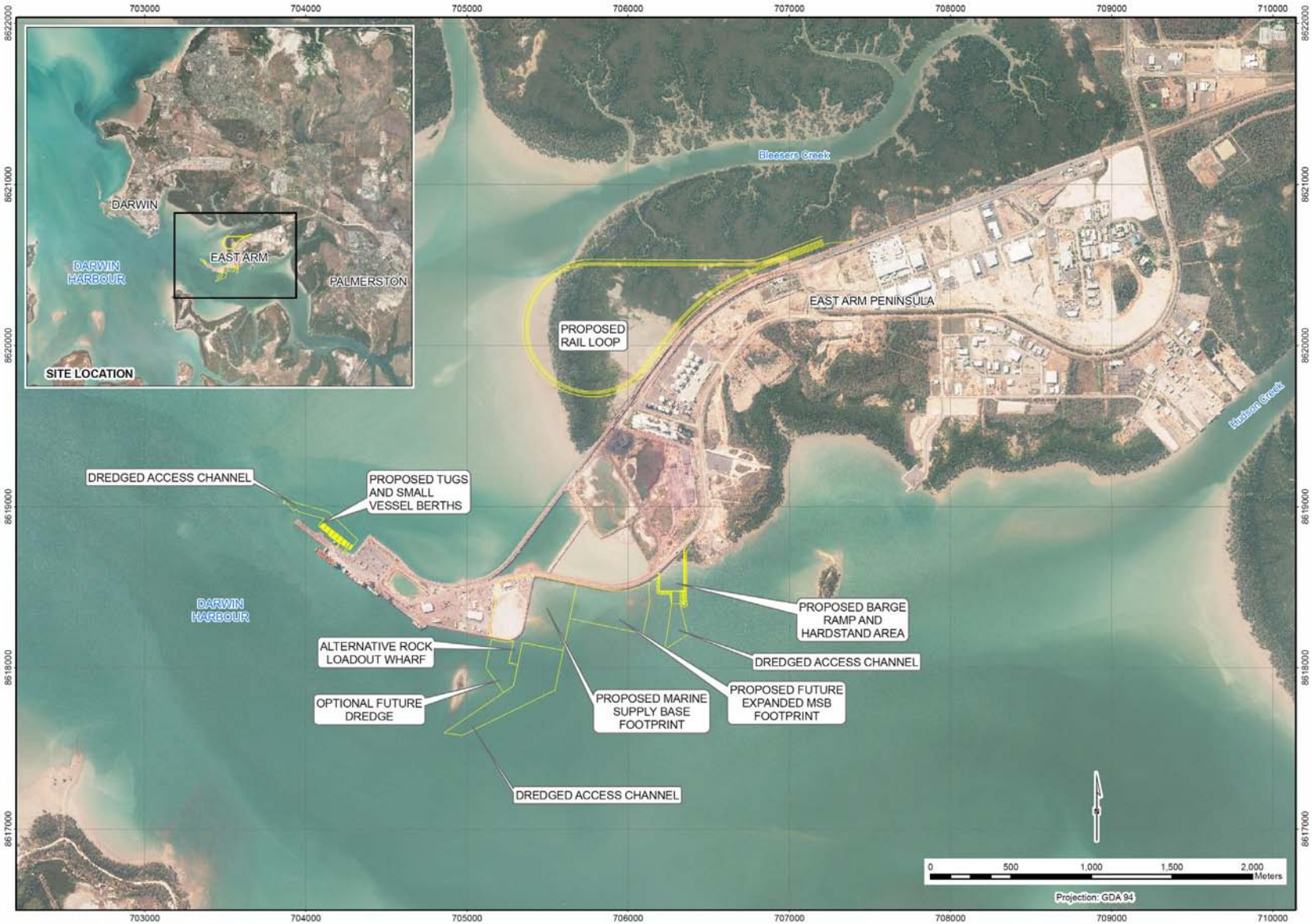


Figure ES-2 General Arrangement of the Proposed EAW Expansion

1.3 Existing and Surrounding Land Uses

Infrastructure at EAW has been progressively developed over the past twenty years, and the site currently features the following key facilities:

- Purpose built multi berth wharf.
- Intermodal container terminal (rail and road).
- Hardstand areas.
- Open stockpile, bulk ship loading and conveyor infrastructure.
- Haulage rail (AustralAsia) and road corridor.
- Industrial allotments (including the Darwin Business Park) (AECOM, 2009a).

A summary of EAW throughput for the financial year 2009/10 (most recent data available) is as follows (note that figures are for the whole of DPC activities, but the overwhelming majority is associated with EAW (David McMaster pers. comm., 3 February 2011):

- Total throughput of 4,577,532 t
- Total exports of 3,396,264 t
- Dry bulk exports of 3,023,581 t
- Iron ore exports of 2,010,045 t
- Manganese concentrate exports of 768,313 t
- Copper concentrate exports of 223,710 t
- Livestock exports totalled 360,127 head
- Exports on rig tender vessels totalled 199,694 t

The above trade involved 1,642 total trading vessel visits to DPC.

Territory Resources Limited produces the iron ore products exported from EAW (Territory Resources Limited, 2009). Copper concentrate for export is currently delivered to EAW from the OZ Minerals mine at Prominent Hill, SA (OZ Minerals, 2011). Manganese concentrate export product comes from the OM (Manganese) Ltd Bootu Creek project, approximately 110 km north of Tenant Creek, NT (OM Holdings Ltd, 2009). In addition, approximately 30 per cent of the uranium oxide concentrate produced at BHP's Olympic Dam mine has been exported from EAW since 2005 (BHP Billiton, 2009).

As part of the expanded use of EAW, BHP Billiton are also proposing to store and handle copper concentrate and uranium oxide from the expanded Olympic Dam project at the EAW prior to export (BHP Billiton, 2009). It is expected that additional land reclamation would occur as part of the Port's ongoing development at EAW, and that this land would support the new infrastructure to be built either by or for BHP Billiton, including a new storage shed and bulk materials loading facility (BHP Billiton, 2009).

The Darwin Business Park is situated to the east of the EAW facilities and comprises 130 ha of industrially zoned land designated for additional port-related export based industries. The Darwin Business Park provides direct links with berth, rail and road services for:

- Cold storage facilities.
- Food processing and packaging.
- Pre-retail preparation facilities.
- Light assembly and manufacturing.
- Pick and pack distribution..

There are several large Australian companies which have established operations in the Darwin Business Park, including, Toll Holding's major distribution and consolidation centre, Vopak's Darwin Industry Fuel Terminal and the Natural Fuel / Babcock and Brown bio-desalination production facility.

New Investments proposed or under way within the Darwin Business Park include:

- Gwelo Development 7,000 m^2 distribution facility for the import of building products from Asia.
- Top Class Fruit Supply warehouse/cold storage facility for importing and exporting NT produce to Australian capital cities and Asian markets.
- Amcor Packaging warehouse.
- Dawson's Diesel 2 ha warehouse for the repair and maintenance of mining equipment, imported and re-exported over the EAW.
- Metcash (Independent Grocers) warehouse/distribution facility.
- Extended Toll Holdings facilities.
- Shaw's Transport facilities.
- Glimmer Pty Ltd industrial development.
- Andarwin Pty Ltd distribution and warehouse development (BHP Billiton, 2009).

1.4 Description of Proposal

The proposed expansion of EAW broadly comprises four separate developments within the EAW precinct which are outlined below:

1. Hardstand area and barge ramp.
2. Marine supply base.
3. Additional rail loop spur into the bulk stockpile area.
4. Tug and small vessel berths.

Area 4 of the development as described in the NOI is no longer within the footprint of the proposed development.

1.4.1 Barge Ramp and Hardstand Area

This facility will be used by barge operators including Defence for the berthing of barges and loading or unloading of cargo and Defence equipment. Private barges are utilised to transfer goods to islands and communities in the NT. Defence typically transfer loads to a barge at a ramp, which then transfers the load to a larger ship anchored offshore. Demand for an additional barge ramp, including covered, secure storage areas with power supplied, has been identified by DPC.

This component of the proposed development includes the establishment of a hardstand area and barge ramp on the southern side of the peninsula, located adjacent to and west of the Paspaley lease and east of the Wharf (refer Figure ES-2 and Figure ES-3). A shed will be constructed to temporarily house loads for each barge operator. It is anticipated that one or two barge operators would typically be operating from the barge ramp at any given time, and loads would be stored on site for up to 48 hours (prior to transfer to a barge).

An existing power line runs along the northern boundary of the proposed hardstand site. The shed will be connected to power via this line, and will be able to hold refrigerated containers. The first flush of stormwater from the hardstand will be collected in pipework along the southern edge of the reclamation, and passed through an oil interceptor before being discharged to the sea.

Access to the EAW is restricted to the general public for security purposes, and access to the barge ramp and hardstand would be further restricted within the greater EAW precinct, with additional security fencing and lockable gates to be installed.

The hardstand area, barge ramp, and channel will encompass an area of approximately 7.12 ha:

- Hardstand: 2.94 ha
- Barge ramp: 0.4 ha
- Access channel: 2.32 ha
- Bunds and batters: 1.46 ha

1.4.2 Marine Supply Base

The construction and operation of the proposed MSB is a strategically important development for the NT and Australia, as the oil and gas industry is a major contributor to the Australian economy. The Oil and Gas Production industry is expected to generate revenue of about $34.58 billion in 2010-11, compared with $29.44 billion five years earlier.

Oil and gas industry support ships presently dock at the EAW, where they are refuelled and loaded with supplies. These support ships then deliver supplies to the various oil rigs, exploration vessels, and other associated craft located in the Timor Sea. Approximately 185,000 tonnes of rig tender supplies were handled by the EAW in 2007/08, and forecasts indicate strong growth in offshore oil and gas rig services through the EAW until at least 2030 (GHD, 2009). The EAW is nearing the limit of its capacity to serve this support function.

Initially the MSB wharf will be used for rock loadout (RLO) to specifically service the rock armouring requirements of the forthcoming INPEX Icthys LNG project (INPEX Browse, 2009). The RLO facility is expected to operate for approximately 133 days. A secondary purpose of the MSB will be for refuelling of tugs.

The proposed MSB will be located east of the existing reclamation at East Arm, and to the west of the proposed barge ramp and hardstand (refer Figure ES-2 and Figure ES-3). A request for proposals (RFP) has been issued to pre-qualified proponents to design and construct the MSB. The final configuration of the proposed MSB is at this stage unconfirmed, and the final design and construction of the MSB would be determined through the RFP process. The NTG has specified that the Operator will provide the services appropriate for the facility, and will not otherwise be involved in the final design.

The MSB concept design shown in Figure ES-3 incorporates the following features:

- Dredged channel to -7.7 m Chart Datum (CD) to provide access for deep-draft vessels
- A large hardstand area on existing reclaimed land. This area will be used for storage of supplies, and will also include an administrative building. A RLO facility (stockpile and wharf) of approximately 1 ha will be provided at the southern end, and a truck path will run along the seaward edge of the hardstand. The RLO wharf will be adjacent to the southern end of the hardstand, with one deep water (-7.7 m CD) berth for a vessel to take on rock for offshore use (e.g. undersea pipeline armouring). The truck path extends from the hardstand on to the rock loadout wharf, and has been designed such that a Custom-Mafi type vehicle (a cargo trailer with a tractor 20.7 m length) can access the wharf, turn around, and exit the wharf.

- A wharf adjacent to northern end of the hardstand for the accommodation of drilling mud and brine tanks and supply systems, potable water supply services, and fuel storage and supply systems. This wharf includes deep water (-7.7 m CD) berths for up to four vessels to take on supplies.
- Services provided across the entire facility will include power and fire-fighting water systems, which will be designed and constructed to the appropriate Australian Standards. The fire fighting system will comprise either hydrants connected to the mains water supply, or pumps, pipes and hoses connected to sea water in the harbour.
- Suitable bins will be installed for disposal of the various waste streams. Bins will collected by a licensed waste contractor/s.

It is expected that the wharf structures will comprise reinforced concrete wharf decks supported by steel piles, or sheet piles with land backed structures, to provide berths for offshore platform supply vessels (rig tenders). The hardstand area will be bitumen paved. Hazardous chemicals and other will be stored in dedicated covered, bunded storage areas. The refuelling infrastructure will also be covered and bunded. Stormwater treatment infrastructure will be constructed and the facility designed such that the first flush of runoff (during rainfall events) is captured and treated prior to release. The MSB will be designed and constructed to withstand a 1 in 100 year return event storm.

The ultimate footprint of this project component will be approximately 49 ha. On the configuration shown in Figure ES-3, this includes:

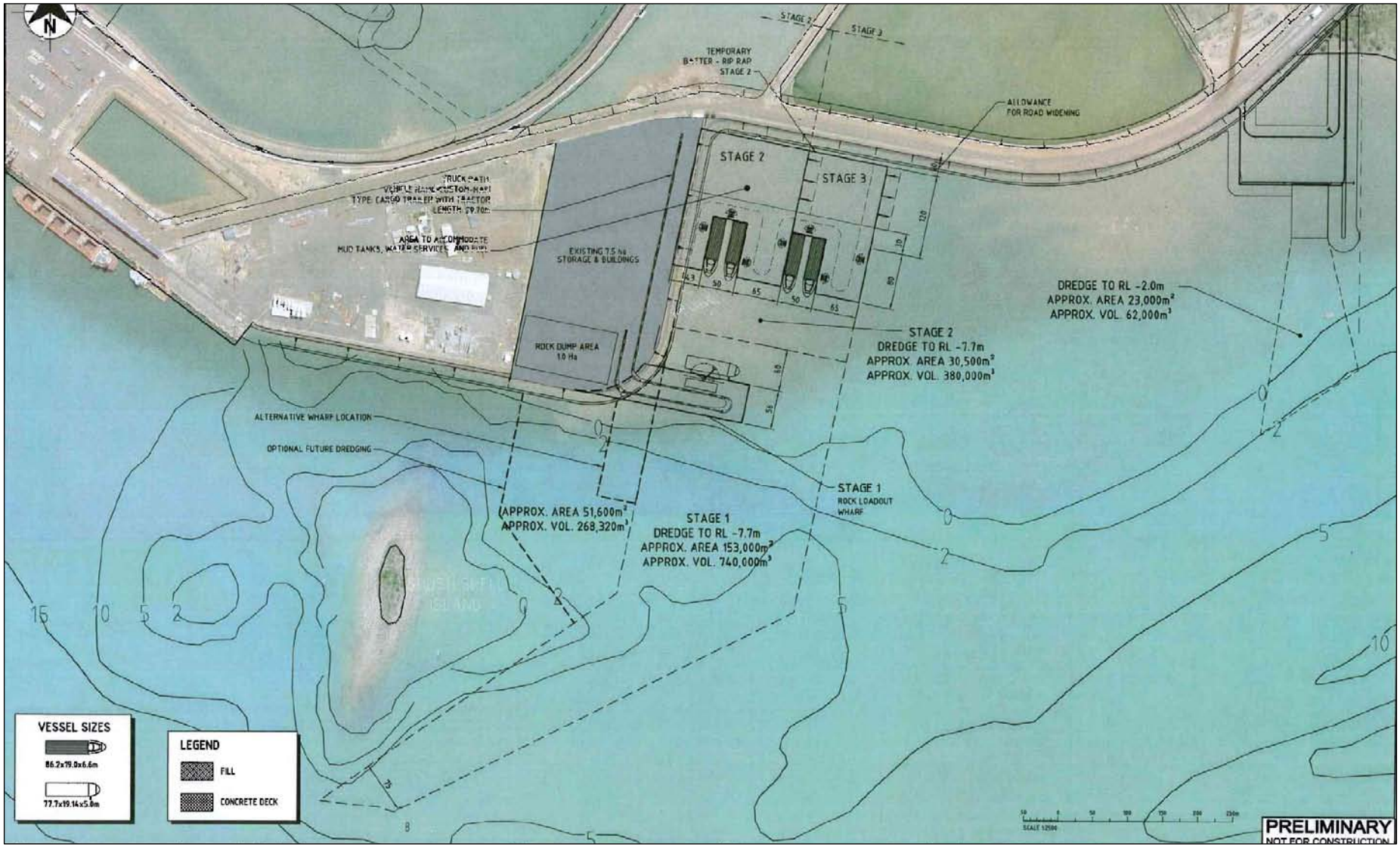
- Hardstand (including storage, buildings, and truck path): approximately 8 ha
- Wharf for mud tanks, water services, and fuel storage: approximately 5 ha
- Potential Extension to Wharf for mud tanks, water services, and fuel storage: approximately 11 ha
- Rock Loadout wharf (option 1): approximately 1 ha
- Rock Loadout wharf (option 2): approximately 1 ha
- Dredged channel: approximately 18.5 ha, with optional future dredging of another 4.5 ha.

1.4.3 Construction of Tug Pens and Small Vessels Berths

The current wharf has a capacity of four trade berths, all located on the southern side of the wharf. The existing four berths include a fuel berth, a container loading / unloading berth, and two dry bulk berths. There are currently dedicated berths for two tug boats adjacent and to the east of the four main ‘trade’ berths. Tug boats currently berth at Stokes Hill wharf, and there are no dedicated berths for other smaller craft at EAW.

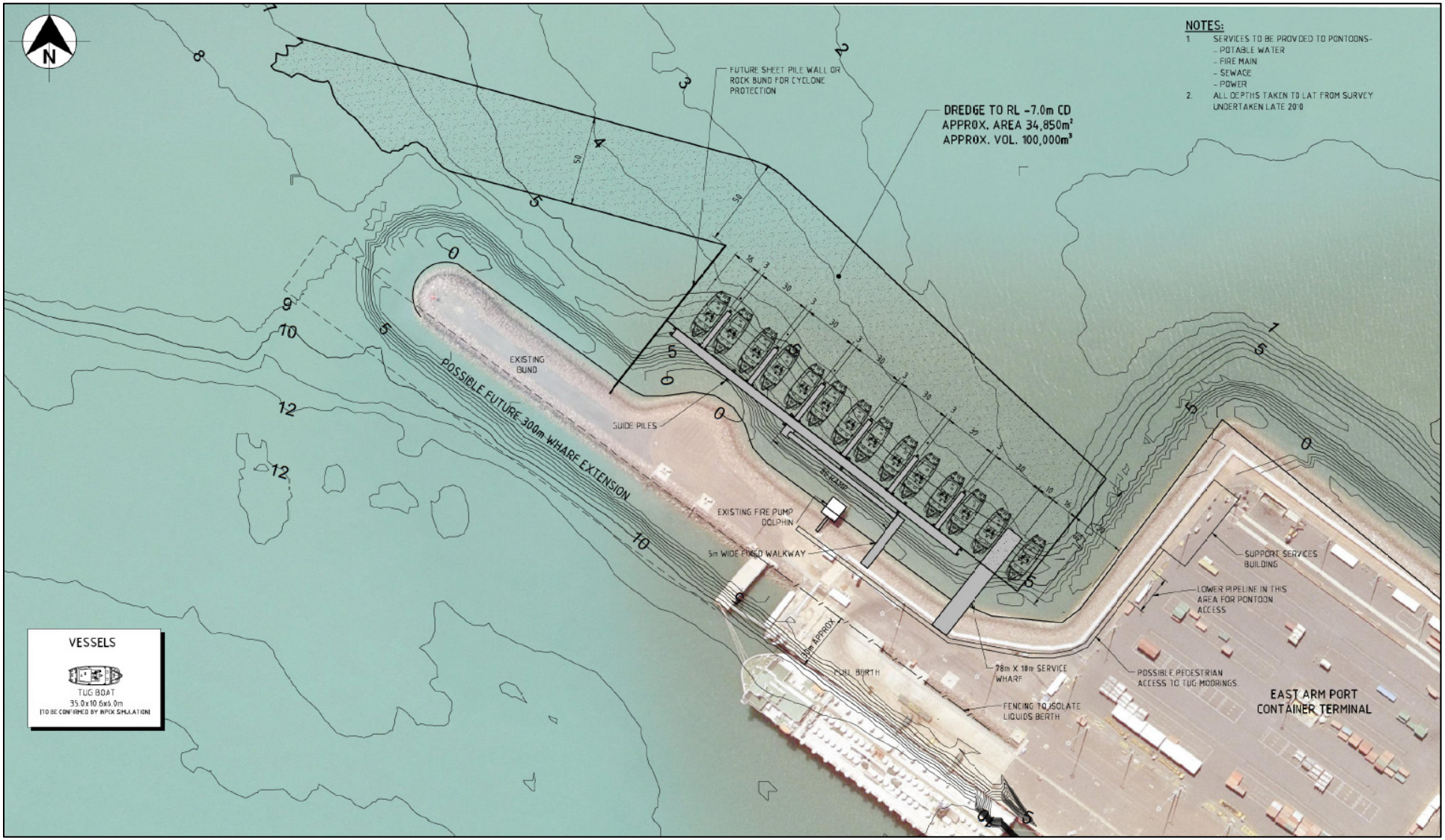
Increased traffic at East Arm is necessitating a greater number of tug boats and other small vessels, requiring the construction of a dedicated mooring facility suitable for tug and other small craft. The proposed facility will be situated north-west of the liquids berth (at the western end of East Arm wharf), created by extending the existing quay line (refer Figure ES-2 and Figure ES-3) and will accommodate up to 12 tugs (35 m length, 10.6 m beam and 6 m draft).

A dredged access channel to -7 m CD will provide all-tide access to the moorings for the tugs. Lower draft vessels will be similarly accommodated at another pontoon mooring facility in shallower water, to the east of the moorings for the tugs. Access to these moorings will be by an extension of the dredging for tugs of -3.5m CD.



Source: Aurecon, 2010

Figure ES-3 Marine Supply Base and Barge Ramp, and Hard Stand Area



Source: Aurecon, 2010

Figure ES-4 Marine Supply Base and Barge Ramp, and Hard Stand Area

The following features are proposed to be included at the proposed small vessel berths:

- Dredged channel to -7 m CD to provide access for deep-draft vessels
- Extension of channel dredged to -3.5 m CD to provide access to the eastern side of the mooring area for shallow drafted vessels only
- Extension of the existing wharf bund to provide a sheltered berthing facility for smaller vessels.
- Pontoon type mooring pontoons for tug, DPC, police, and other small vessels
- 10 m wide service wharf, 5 m wide fixed walkway, and 3 m wide ramp
- Possible future 300 m wharf extension
- A fire protection pump system (this is existing, but may need upgrading).

The total footprint of this project component will be approximately 9.37 ha. This includes:

- Dredged channel: 5.88 ha
- Wharf bund extension: 0.66 ha
- Anchorage: 2.83 ha.

1.4.4 Rail Loop and Spur

The Adelaide-Darwin railway was opened in 2004, and is utilised for both freight and passenger transport services. The physical asset is owned by Genesee and Wyoming Incorporated (GWI). The passenger service (the 'Ghan'), which is operated by Great Southern Rail, presently runs twice a week, originating / terminating at the Darwin Railway Station, which is outside of the EAW precinct. Six Darwin-Adelaide freight services per week are presently operated by GWI.

Current rail freight volumes on the Darwin-Adelaide line are approximately 870,000 t/a (800,000 t/a of intermodal freight and 70,000 t/a of bulk liquids). In addition to Adelaide-Darwin freight, GWI also currently operates 24 bulk trains per week between various mine sites and the Port of Darwin (Genesee & Wyoming, 2010). These include the OM Manganese Bootu Creek mine, Territory Resources Frances Creek iron ore mine, and the OZ Minerals Prominent Hill copper and gold mine in South Australia. Export of ores and concentrates is expected to increase from these mines as well as from other mines.

Under the existing EAW infrastructure arrangements, some trains are being forced to perform shunting manoeuvres across the Berrimah Road rail crossing. This activity is potentially unsafe (as the Berrimah Road rail closing may be blocked for extended periods) and is also inefficient (as Berrimah Road provides the only road access to the EAW precinct). Road access to other enterprises located at East Arm peninsula, such as Northern Cement Limited, the Darwin Railway Station, and the East Arm fuel storage facility, is also impeded when shunting activities across the Berrimah Road rail crossing are occurring.

To improve operational efficiency of rail activities at EAW a rail loop is proposed to the west of the fuel storage facility. The proposed rail loop will provide additional standing and manoeuvring space for trains within the EAW precinct and will incorporate an additional rail dump facility which will enable two trains to unload dry bulk concurrently. It will also allow trains to enter and exit the EAW precinct concurrently, meaning that a train entering the precinct to unload at the berths will be able to pass a train already unloading at the dry bulk dumps. Following completion, shunting outside of the EAW precinct will be required only occasionally and loading and unloading of trains will be faster.

The construction of the rail loop is expected to commence in 5-10 years, so designs are only conceptual at this stage. However, the approximate location and the basic infrastructure required is as described, so the likely environmental impacts of the development can be assessed.

The total footprint of this project component will be approximately 30.49 ha.

1.5 Construction Methods

1.5.1 Barge Ramp and Hardstand Area

The hardstand area (Figure ES-2 and Figure ES-3) will comprise a land-based section and an offshore section, and will be constructed on a combination of disturbed land, backfilled bunded ponds, and harbour foreshore. The on-shore and off-shore sections will be constructed by linking the sections with a harbour facing sea wall, and then backfilling the enclosed space with suitable materials.

The proposed construction methodology for the hardstand area and ramp is as follows:

- Construct a bund 330m long with an 8 m wide access road at the top from imported fill, probably phyllite, delivered by truck and dumped directly in position, starting from the existing port access road. A fleet of side tippers or rear dump trucks would be used and a bulldozer would push the material into position.
- A second bund 110 m long with a 5 m wide emergency escape road at the top will be placed in a similar manner parallel to and 150m west of the first bund
- A third bund 150 m long will connect the two bunds.
- The seaward battered slopes of all bunds will be armoured with two layers of rock (600 kg) on an underlayer of 60 kg rock with geotextile. Sidetippers or rear dump trucks would deliver the rock and long reach excavators would place the rock in position on the face of the bunds.
- The inner area between the three bunds will be filled with imported fill until an area of 2.5 ha is achieved. The area will be drained into pipes along the southern edge of the reclamation with the stormwater passing through an oil interceptor before discharge into the sea. The internal battered slopes will be protected with rip-rap dumped by trucks and placed in position by long reach excavators.
- A barge ramp 50 m wide and approximately 79 m long will be constructed from concrete, sloped at a maximum of 10 degrees. Concrete will be transported to the site from local concrete batching plants in Darwin.
- A channel dredged to -2 m CD using a small cutter section dredge (CSD) will provide all tide access to the ramp. The dredged volume will be approximately 62,000 m^3, which would be disposed of to sea at the dredge spoil disposal ground utilised by INPEX for the Icthys Gas Field Development Project (INPEX Browse, 2009).

1.5.2 Marine Supply Base

The MSB (Figure ES-2 and Figure ES-3) will be established on a combination of disturbed land, backfilled bunded ponds, and harbour foreshore. It will comprise reinforced concrete wharf decks supported by steel piles to provide berths for platform supply vessels (PSV) (rig tenders). Construction methodology will depend on the final configuration selected, but one possible methodology for a suspended concrete deck on driven piles could be:

Executive Summary

- Dredge to -7.7m CD using a medium size CSD which will discharge the spoil into available ponds (unless offshore dumping is adopted).
- Drive steel piles using a barge mounted pile driver. A crane would lift the tubular steel piles from the land out to a barge. Some drilling of sockets to house the pile toes may be required in the higher strength rock which may be encountered.
- Construct reinforced concrete decks. After the piles have been driven, precast concrete headstocks would be lifted by crane onto the piles. Precast slabs would then be lifted into position spanning between headstocks. Concrete would be lifted in skips to the areas to be concreted on the deck and deposited in situ onto the slabs to form an integral deck. Alternatively concrete pumps could avoid the use of cranes for this latter operation.
- Fit fenders and bollards using a crane.
- After construction of the concrete decks to the berths, services will be installed. Usually this would be from an underground supply connected to existing services. At the wharf, these would be installed by crane in service trenches precast into the concrete deck. At appropriate locations, take-off points would be provided along the wharf face for electrical power outlets, valves for potable water, and hydrant connections.

An alternative construction methodology could use a retaining wall with some elements of land backing and areas of potential reclamation using dredged / imported material with competent engineering properties. This would entail the following:

- If the existing reclamation is to be utilised as a berth face, a retaining wall would be installed through or landward of the existing armoured revetment. “King piles” such as tubular steel or universal column sections could be used to penetrate medium to high strength rock beneath this area. Predrilling of holes to socket the piles may be necessary if driving conditions are too difficult. Sheet piles would then be connected to clutches on each side of the king piles and driven to a higher level than the king piles.
- A concrete capping beam (with deck behind) would then be cast onto the line of king and sheet piles.
- When the wall is complete, the material seaward of it (rock armour and fill) could be removed by crane and grab onto the shore behind the wall.
- Dredge to provide a clear berth for vessels.
- Fit fenders and bollards using a crane.
- After construction of the concrete decks behind the wall, the services would be installed. This would likely be from an underground supply connected to existing services. At the berths, these would be installed by crane in service trenches precast into the deck. At appropriate locations, take off points would be provided along the wharf face for electrical power outlets, valves for potable water, and hydrant connections for fire.

Another alternative construction methodology could involve the construction of earth bunds protected with rock armour. On one side of the bunds could be constructed concrete wharf decks. Further developments could include tidal regulation structures comprising concrete walls with gated access at each end. Anticipated dredge spoil volume for the first stage is approximately 950,000 m^3.

1.5.3 Berths for Tugs and Small Vessels

The extension of the quay line and berths for tug boats and other smaller vessels is shown in Figure ES-2 and **Figure ES-3**. Deeper draft tugs will be moored to finger pontoons connected to a series of main pontoons 200 m long. The pontoons will be restrained in position by vertical steel piles along which the pontoons can rise and fall with the tide. A ramp will connect the pontoons to a fixed walkway to provide access to the tugs. The construction methodology for the extension of the EAW quay line will be as follows:

- A small CSD will dredge a channel to -7.0 m CD for tug boats, and -3.5 m CD for other small vessels. Dredging of the -7 m CD section of the channel will create 106,000 m^3 of spoil, and dredging the -3.5 m CD section will create 75,000 m^3 of spoil. The total of 181,000 m^3 of spoil would be disposed of to sea at the dredge spoil disposal ground utilised by INPEX for the Ichthys LNG Project (INPEX Browse, 2009).
- Steel piles for the location of the floating pontoons will be driven into the sea floor using a pile driver. Concrete will be delivered by concrete delivery trucks and the pile footings formed using concrete pumps.
- A steel walkway, which will be fixed to the piles, will then be erected. A transportable crane will be utilised to lower the walkway sections into place.
- Prefabricated pontoons will then be installed, and attached to the piles such that they can move vertically with the tides
- Hinged steel ramps would be installed to provide access to the floating pontoons from the fixed walkway.

1.5.4 Rail Loop and Spur

The proposed rail loop (Figure ES-2) will be constructed to the west of the fuel storage facility, and will extend (westward) beyond the current East Arm peninsula shore line: thus reclamation of an area of land will be required. The reclaimed area will be constructed by establishing a sea wall bund. The bund will be approximately 3,000 m long. The seaward faces of the bund will be armoured using 600 kg rock, and the inner faces will be protected with riprap. The proposed construction methodology for the rail loop and spur is as follows:

- Mud from the rail loop alignment will be excavated using a small CSD.
- The sea wall bund will be constructed by dumping fill using trucks on two fronts, from where the arms of the loop diverge, until the bund loop is completed.
- Road trains will deliver clean fill and rock, and dump the material directly along the rail loop and pond wall alignments to form the bund cores. Bulldozers will shape the fill and rock core, and rollers will compact the material.
- Road trains will deliver rock armour and riprap to stockpiles in the vicinity of the work zones. Excavators will place the armour rock on to the rail loop bund seaward slope, and riprap on the rail loop inner slope.

1.5.5 Laydown Areas

Construction laydown areas will be utilised to service the various project components. Some of the laydown facilities are already in place for the existing EAW, including Laydown 1, which is fully paved, including stormwater infrastructure. Laydowns 2 and 3 are also in place and currently consist of

earthen, ungraded surfaces. Their surfaces will be graded, compacted, and covered with loose gravel to minimise dust generation and erosion. The surfaces of Laydowns 2 and 3 will each be graded towards sediment traps and oil separators for stormwater treatment. Once treated, stormwater from the laydown areas will be disposed of into the existing stormwater system at the EAW.

Security fencing will be installed around each laydown area, with a lockable gate to provide access. Road access to Laydown 1 is already available using Berrimah Road, which extends to the western tip of EAW. Access to Laydown 2 will be via a compacted gravel surfaced access road to be constructed off Berrimah Road. It will necessarily cross the Adelaide-Darwin rail line at a temporary level crossing. The proposed Laydown 3 is directly adjacent to Berrimah Road, and so an access road will not be necessary. The compacted gravel surface of laydown 3 will extend to Berrimah Road.

Facilities to be provided at the laydown areas will include:

- Portable office / crib buildings (with power supply connected to EAW precinct mains supply)
- Security flood lighting
- Portable toilets
- Covered, bunded, storage facilities for fuels, lubricants, and other hazardous materials.

1.6 Ongoing Maintenance

Each component of the proposed development will require maintenance over the life of the project. Maintenance programs and their execution will be the responsibility of the operators of the various project components.

All project components will require regular cleaning and rust proofing (as the project will be developed in a marine environment). The Rail Loop will require regular inspection for subsidence, and possibly reinstatement of ballast if subsidence is observed.

All channels and berths will be regularly surveyed to assess silting. It is proposed that maintenance dredging will be undertaken every ten years, or as indicated from the marine surveys. Marine surveys would also be undertaken prior to and after any maintenance dredging program.

1.7 Employment

The workforce required for the construction of the various project components will depend on the construction methodologies selected by the contractors. It is estimated that a workforce of up to 200 would be required during construction; an update on this should be available in the Environmental Impact Statement (EIS) Supplement.

A maximum of 20 full time equivalent (FTE) staff would be employed once the proposed development is operational.

1.8 Justification and Alternatives Considered

Trade and traffic at EAW has increased since the development was approved in 1993, with the wharf handling a total trade of nearly 4.57 Mt in 2009/10, and exports of 3.39 Mt during the same period (DPC, 2010c). Trade is forecast to continue to increase to between 6.5 Mt in 2011 and 45 Mt in 2016, with the most likely scenario a trade of almost 15 million tonnes in 2012 (GHD, 2009).

Executive Summary

The over-arching objective of the proposed expansion of the EAW is to facilitate efficient operation of the port into the future, as trade and vessel traffic continue to grow. Deepening of channels accessing the EAW will facilitate access by larger ships, which will have a positive effect on the NT economy.

A number of alternatives to various aspects of the proposed development were considered during concept development. These included locations for the development, locations of various components within the favoured project location, scenarios for port facilities development, alternatives to foreshore reclamation, dredge methodology and dredge spoil management, sources of raw materials, and environmental management techniques for moderate or higher risk impacts.

1.8.1 Project Location

The number of sites suitable for large scale deep water port development in the vicinity of Darwin is limited. East Arm was selected for the location of the expanded port facility because of the existing deep water port infrastructure present at the site. The EAW is classified as DV (Development) Zone in the NT Planning Scheme (NTG, 2010b) and was designated for this type and scale of development prior to the development of the current wharf facility (Acer Vaughan, 1993a).

The environmental and social impacts of further developing an existing industrial site are considerably less than for a 'greenfields' (i.e. previously undeveloped) site. If the EAW was replaced by a facility in a new location, there would also be significant impacts and costs associated with decommissioning of the existing site, as well as impacts associated with the new site.

A site at Glyde Point on the Gunn Point Peninsula has previously been assessed for potential large scale industrial development including a deep water port facility (KBR, 2003). Relative to Glyde Point, the impacts of a deep water port at East Arm are smaller in scale, as the site is already disturbed. East Arm is also well placed between Darwin and Palmerston. Access to East Arm is considerably easier, and necessary ancillary infrastructure is already in place.

1.8.2 Port Facilities

With the existing East Arm site confirmed as the optimum location for the proposed development, various design permutations were investigated and assessed. The locations of the MSB, barge ramp, and tug / small vessel berths were selected primarily because of access to water of sufficient depth, access to road infrastructure, and sufficient space for hardstand and storage areas.

The location of the rail loop was originally proposed to be adjacent to the container berth and storage area of the wharf structure, on reclaimed land to the south of Northern Cement and west of Berrimah Road. However, the proposed rail loop was subsequently relocated to existing land to the north of Berrimah Road to minimise dredging requirements.

An alternative to the proposed rail loop, namely a single rail spur adjacent to the existing track, was also considered. This option was discounted, however, due to infrastructure constraints. If a spur is constructed instead of a loop, trains would be required to reverse out of the EAW, based on the current development scenario. A spur arrangement would therefore be less efficient than a rail loop.

1.8.3 Dredging Methods and Dredge Spoil Reuse / Disposal

Locations of project components and related channels have been selected with the objective of minimising the volume of dredging required. This objective limits alternative dredging locations, as

any realistic alternatives would involve greater dredging volumes. The duration of the dredging program could be reduced, however, by increasing the size of the dredging fleet mobilised.

Reuse and disposal of dredged material will be undertaken in accordance with the Dredging and Spoil Management Framework for Darwin Harbour (AECOM, 2009b). Dredge spoil reuse / disposal strategies will also incorporate practical considerations such as the quantity and characteristics of dredged material, location of dredging relative to reuse / disposal sites, accessibility of the dredging sites to various dredging equipment, and the availability of alternative fill materials.

A draft Dredge Management Plan (DMP) has been developed and is included in the DEIS. The draft DMP details the size of the dredge fleet, the types of dredging equipment most suitable for this project, and reuse / disposal of dredged material for the currently preferred scenario; the proponent may however investigate other alternatives to the dredging processes described within.

One option that may be further investigated is dredging with a CSD and then temporary storage of the spoil into Darwin Harbour prior to disposal at the INPEX Icthys Gas Field Development Project dredge spoil disposal ground (INPEX Browse, 2009). Further exploration of this strategy will be dependent on timing requirements, specifically whether dredging of channels must be undertaken prior to the commencement of other project components. Under this scenario, spoil would be temporarily deposited at a relatively deep section of Darwin Harbour, where it is less likely for the material to be reincorporated into currents. It would later be reclaimed and disposed of offshore after other works have been completed.

Any further investigation of the alternative dredging scenario described would include modelling. This work, if undertaken, would be included in the Supplement to the DEIS.

1.8.4 Sources of Raw Materials

A RLO Study conducted by Aurecon (2011) found that efficient and practicable options for sources of raw materials within the vicinity of Darwin, specifically materials for filling, reclamation, and bund construction, are limited. Quarry material for armouring of bunds is likely to be sourced from the quarries utilised for the recent INPEX wharf development at Middle Arm. Fill material will be sourced from onsite as much as is practicable, particularly from dredging activities where possible.

The Phyllite material expected to occur within the EAW expansion areas is considered unlikely to be an ideal reclamation filling material (AECOM, 2010a). This is because Phyllite in the Darwin harbour is typically weathered, weak and friable (URS, 2004). It is noted by AECOM (2010a), however, that Phyllite material from Darwin Harbour has previously been used as fill for the EAW Stage 1 development. It may be possible to utilise excavated Phyllite for some filling / reclamation purposes, but the extent to which it is possible will not be confirmed until construction is underway.

Construction / demolition waste from the Darwin area will also be utilised for filling and / or armouring where possible, depending on the chemical and physical suitability of the material. Final sources of material will be determined by the contractors responsible for construction of the proposed development.

1.8.5 Alternative Management Techniques for Moderate to High Impacts

All potential environmental and social aspects associated with the project have been subject to a risk assessment process, in order to identify key aspects. The risk assessment process has identified the key environmental and social impacts associated with those aspects.

Alternative management techniques have been considered for moderate to high impacts, adopting the following hierarchy of impact mitigation strategies:

- Avoidance.
- Minimisation.
- Mitigation.
- Procedures and management.

Consequences of Adopting the "No Development" Option

The objective of the proposed development is to facilitate growth and operational efficiency of EAW as trade and traffic grow in the future. The increased operational efficiency associated with the proposed EAW expansion, and associated facilitation of increased trade volumes, will have positive effects on the local, regional and national economy. If the proposed development does not go ahead, the opportunity of these positive effects on the local, regional and national economy will be lost. Defence demand for an additional ramp associated with the introduction of new amphibious vehicles has also been identified.

For the above reasons, the 'do nothing' option is not considered a viable alternative.

1.9 Timeframes Schedules and Staging

The first component of the development to commence construction will be the MSB. It is anticipated that dredging will commence in the first quarter of 2012. Completion of stage 1 of the MSB, comprising three berths (of 6 planned berths), is projected for the fourth quarter of 2013. Operations will commence in the first quarter of 2014, under a 25+5 year leasing arrangement. The RLO elements of the MSB are projected to operate for 133 days (after which time the supply of rock for the INPEX Icthys LNG project will be complete).

The dredging program for the proposed development will be sequentially staged. Dredging for the barge ramp will commence once MSB dredging is complete, currently planned for the second quarter of 2012, with dredging for the tug and small vessel berths projected to commence in the third quarter of 2012. The proposed dredging program is detailed in a draft DMP.

Pile driving for the tug berths will take approximately three months, and pontoon / deck / walkway construction an additional 12 months. Construction of the tug berths will not commence until 2014 as operation of the facility is planned to commence in 2016.

A construction schedule for the rail loop has not been devised at this stage. Construction of this project component is likely to commence in 5-10 years, subject to demand from future mining projects.

1.10 Environmental Impact Assessment Process

This project will be assessed under both Commonwealth and NT environmental legislation. The NTG has a bilateral agreement with the Commonwealth, which accredits the NTG for conducting environmental assessments on the Commonwealth's behalf. In accordance with this agreement the NTG will liaise with Commonwealth through the approval process to ensure that both agencies are satisfied that all matters are being satisfactorily addressed throughout the process. An overview of the EIA process for this project is shown in Figure ES-5.

Executive Summary

The NT environmental assessment process is administered under the *Environmental Assessment Act 1982*. The object of the Act is to ensure that matters affecting the environment to a significant extent are fully examined and taken into account in decisions by the NTG (NRETAS, 2011).

The NOI outlining the proposed expansion of the EAW was submitted to the NT Minister of Natural Resources, the Environment and Heritage (the Minister) in July 2009. Similarly, a Referral under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was submitted to the Commonwealth's Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) on 11 January 2010, advising the department of the proposed activity.

The information contained within the NOI and Referral, together with consultation with relevant agencies, assisted in the preparation of EIS Guidelines which outline the matters to be addressed during the environmental assessment process.

In December 2009 the NT Minister responded to the NOI with the determination that the action warrants formal assessment under the EA Act at the level of an EIS. The following reasons were given (NRETAS, 2009):

- Visual amenity and public interest.
- The project area is over 500 ha with large-scale land reclamation required.
- 220 ha of mangrove forest would be cleared with consequent ecological impacts and greenhouse gas emissions.
- The project is in the immediate vicinity of the mangrove forests of Charles Darwin National Park, the implications of which are unclear.
- Changes to the hydrodynamics in the East Arm area could have flow-on effects to adjacent tidal creeks.
- Catalina Island, which is of significance to the Larrakia people, may be impacted by increased sedimentation.
- Acid sulphate soils are likely to be present within the area effected by the proposal.
- Submerged heritage (known Catalina wrecks and the wreck of the Kelat) has the potential to be impacted.
- Threatened, marine and migratory species listed under the EPBC Act may be impacted.
- Significant dredging is required with associated water quality and ecological impacts.

DSEWPC advised on 8 February 2010 that the project is a controlled action, having the potential to impact on the following Matters of National Environmental Significance that are protected under Part 3 of the EPBC Act:

- Listed threatened species and communities (sections 18 and 18A)
- Listed migratory species (section 20 and 20A).

The response from DSEWPC also advised that this project will be assessed under the bilateral agreement.

Draft Guidelines covering issues to be addressed in the EIS were released for public comment on 14 November 2009, for a 14 day public comment period. On 11 December 2009, Final EIS Guidelines were issued taking into account comments received from the community and Government agencies.

Executive Summary

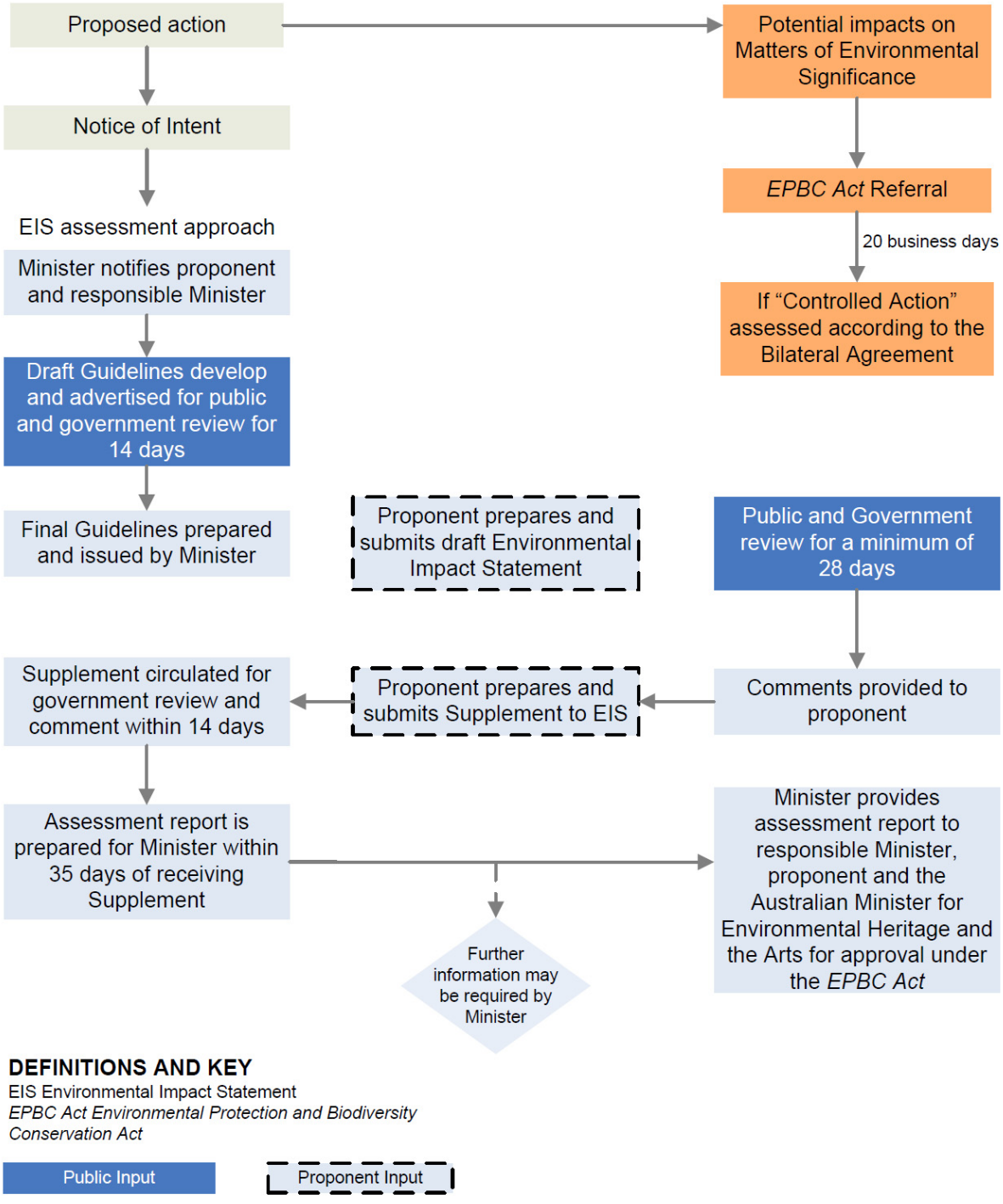


Figure ES-5 NT Environmental Impact Assessment Process (Adapted from NRETAS, 2011)

Work began on the preparation of this DEIS in September 2010. This DEIS contains data gathered by DLP during the NOI process; subsequent data gathered during supporting studies and stakeholder consultation; and proposed management measures to fulfil the requirements of the EIS Guidelines issued by the Minister. This DEIS has been released for review to enable the public and government agencies to comment on the project. Notification of the display centres, submission procedures, and purchasing details have been advertised in local newspapers.

The public and government agencies have a minimum review period of 28 days from the date of submission of the DEIS to submit comment to NRETAS or via the website to be established by Elton Consulting Group Pty Ltd (Elton Consulting), to elicit comments from interested parties on the project. Any comments received by the close of the public review period will be addressed in an EIS Supplement which will be prepared by DLP and submitted to NRETAS. The Draft EIS together with the Supplement (the 'Final EIS') will be reviewed by NRETAS.

Once assessment is completed to the satisfaction of the NT Minister, NRETAS will prepare an Environmental Assessment Report and Recommendations on the project's acceptability for the Minister's consideration in consultation with DSEPWC. Following this, the Minister will make a recommendation to the Minister for Lands and Planning regarding the project's environmental acceptability and its compliance with the requirements of the EA Act.

Approval (if granted) would be given by the Minister for Lands and Planning under the *East Arm Control Plan 1998, Northern Territory Planning Act 2008*.

Other approvals and licensing requirements relevant to this project include, but may not be limited to, the following (AECOM, 2009a):

- Ministerial consent for any development covered by the East Arm Control Plan from the Minster for Lands and Planning
- Darwin Port Authority consent for any coastal development below high tide in Darwin Harbour
- Marine Branch, DPI consent for any coastal development above low tide in NT Coastal Waters
- NRETAS and Environment Protection Authority (EPA) consent for any dredging operations
- Aboriginal Areas Protection Authority (AAPA) Authority Certificate for Sacred Site clearance
- Approval to disturb heritage items and archaeological artefacts, as located, through the Heritage Conservation Division of NRETAS.

It should be noted that all future development at the EAW including the construction of individual facilities will require separate approval under the relevant NT planning legislation and a Development Permit under the *NT Planning Act 2008* may also be required for activities proposed to take place in the areas that are subject to this DEIS, dependent on the nature of the proposed activity. These developments will therefore be the subject of separate applications in future years.

1.11 Relationship to Other Actions

The proposed expansion of EAW is a response to the current and forecast expansion of trade in Darwin, the NT, and Australia, and the associated traffic increase at EAW (and the Port of Darwin in general), as well as changes in Defence activities. As such, the proposed development relates indirectly to a wide range of actions.

The barge ramp and hardstand is a response to private and government demand for such a facility, including the planned acquisition of new amphibious craft by Defence, which will necessitate the development of a dedicated amphibious craft berth additional to facilities at Larrakeyah.

The requirement to develop the MSB relates to the increasing activities of the offshore oil and gas industry, specifically in the Timor Sea. Oil and gas industry support ships currently dock at the main berths of the EAW. The EAW is nearing the limit of its capacity to serve this support function.

The most immediate offshore industry service requirement is for a RLO facility to support the Ichthys LNG Project, which would be the first stage of the MSB. The RLO structure would be subsequently converted into MSB berths, and when complete the MSB will be capable of supporting projects in locations ranging from the Browse Basin to Papua New Guinea.

Although not directly related to any one action, the proposed rail loop will increase the capacity of EAW to efficiently accept rail freight, including mined ore. In particular the export of ores and concentrates from both existing and other mines via EAW is expected to increase, including ores that will be transported via the Adelaide-Darwin rail line from the proposed Olympic Dam expansion (BHP Billiton, 2009).

The proposed extension of the wharf quay line and construction of small vessel berths is not directly related to any other activities, other than general increased demand and the benefit of additional berthing tugs associated with the normal operation of the expanded EAW.

1.12 Environmental Issues and Management Controls

1.12.1 Climate

The EAW precinct lies within the monsoonal tropics of northern Australia and experiences two distinct seasons: a hot, wet season from November to March and a warm, dry season from May to September.

Darwin has a mean annual rainfall of 1,711 mm (111 rain days), most of which falls within the wet season. Humidity over this period averages 70–80%. In the dry season humidity is often below 35-55% and there is virtually no rainfall. Monthly mean evaporation ranges from 167 mm in February to 259 mm in October. The mean annual evaporation is 2,630 mm (BoM, 2011a).

While the maximum temperatures are defined as hot all year round, November is the hottest month with a range of 25°C (mean minimum) to 33°C (mean maximum). June and July normally experience the lowest monthly minima with a range of 20°C (mean minimum) to 30°C (mean maximum) (BoM, 2011a).

The strongest winds and heaviest rainfall are associated with the passage of tropical cyclones, which can occur in the region at any time during the period November to April, and occur on average once every two years (BoM, 2011b). Australian Standard AS 1170 Part 2-1989 specifies likely maximum gusts during cyclonic events in Darwin for purposes of structural designs.

Storm surge is a raised mass of water, generally 2–5 m higher than normal tide levels, which results from strong onshore winds and reduced atmospheric pressure (BoM, 2011c). An individual storm surge is measured relative to the tide level at the time. Storm surge is often associated with cyclones and can cause flooding and damage through raised tides and waves. The height of storm surge is

influenced by many factors, including the intensity and speed of an associated cyclone, the angle at which the cyclone crosses the coast and the topography of the affected area.

Cyclonic tidal surges are associated with the passage of intense tropical cyclones on particularly critical paths, combined with a high state of the astronomical tide. Surge levels significantly above the predicted levels are possible. Cyclonic storm surge within the Greater Darwin area has been evaluated by VIPAC (1994). The study indicated that peak combined sea level predictions at East Arm Port of 10, 100, 1,000 and 10,000 year return periods were 3.7, 4.9, 6.0 and 7.0 m relative to the Australian Height Datum (AHD), respectively.

The study of climate change in Australia conducted by Commonwealth Scientific and Industrial Research Organisation (CSIRO) and BoM (2007) indicated that the likely changes in climate variables for Darwin Region appear to be consistent with the observed trends over the last half century. These include:

- Increase in maximum and minimum temperatures.
- Increase in relative humidity and dew point in the wet season with increasing rainfall.
- Likely increase in dry season potential evaporation and a possible decrease in potential evaporation in the wet season with increasing rainfall.
- Likely decrease in dry season rainfall and increase in wet season rainfall frequency and intensity.
- Tropical cyclone frequency may remain relatively stable with maximum intensity likely to increase.
- Sea-level rise may accelerate.

1.12.2 Geology Landforms and Soils

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.

Darwin is in an area of generally low seismic activity, despite the relative proximity to the tectonic plates of South East Asia. Design procedures for earthquake loadings are outlined in the Australian Standard AS1170.4. Proposed buildings would be designed for earthquake loading in accordance with the requirement of this standard.

The general landform of the EAW area is shown in Figure ES-6. The figure shows plains areas (0 to 9 m AHD), rises (9 to 30 m AHD), swamp areas, drainage systems and marine areas.

Currently, the existing level along the wharf structure is of the order of 2.5-3.5 m AHD and the bed level shown on the bathymetric survey is between 3 m CD in the north with areas as low as -2 m CD in the south[1]. The levels along the existing rail line are of the order of 5-7 m AHD. The extension of the quay line to the west will be protected by a sea wall and significant dredging and reclamation will be required to cover the area of approximately 9 ha. The bathymetry in this area of the development ranges from around 3 m AHD to as low -9 m CD in the south west.

Generalised soil and soil drainage classification for EAW indicates that the northern part of the area (the area comprising the current rail line and the coastal fringe to the north of the rail line) comprises seasonally or permanently wet soils, which in terms of soil drainage classification are poorly or very

[1] The Australian Height Datum (AHD) is used as a reference for terrestrial elevations / depths. Chart Datum (CD) references lowest astronomical tide (LAT) and is used for marine elevation / depth measurements.

poorly drained. The area of EAW to the south of the rail line includes similar soils and drainage characteristics, but also includes a significant area of soils without structure (earths); these are described as rapidly, well or moderately well drained soils. A number of smaller areas with minimal soil development are also indicated to be present within the area to the south of the rail line.

The soils in the area are known to have various levels of acid sulphate soils (ASS) and potential acid sulphate soils (PASS). These are shown in Figure ES-7.

A number of previous geotechnical or soils investigations have been undertaken. A review of these investigations identified the key soil, landform and geotechnical issues to be addressed as part of the EAW development. These are summarised below.

Soil Erosion and Disturbance

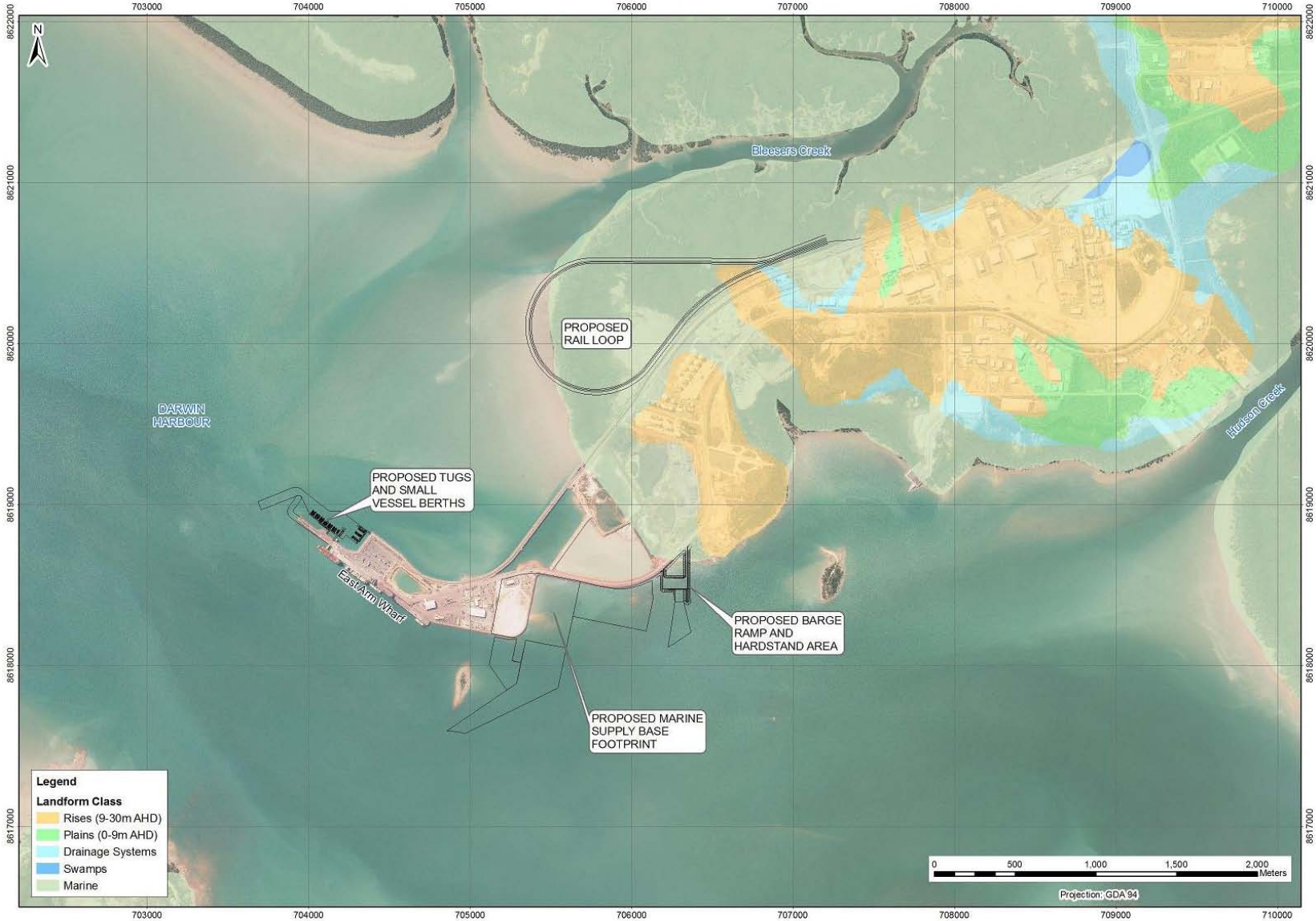
The proposed rail loop will be the main land-based activity where soil erosion is a potential issue. Cut and fill earthworks will be required and, if embankments are required to form the new rail loop, erosion could be an issue during heavy rainfall events. Consequently, soil erosion and sedimentation control and management measures will be implemented during construction. The dredging and reclamation activities associated with the other components of the development will also require soil erosion and sedimentation management measures in place during construction.

A Soil Erosion and Drainage Management Plan (SEDMP) would be prepared for the construction activities at the site. This Plan will address items as such as stabilisation and rehabilitation of exposed soils, and provision of silt fences and other such controls during construction.

Acid Sulphate Soils

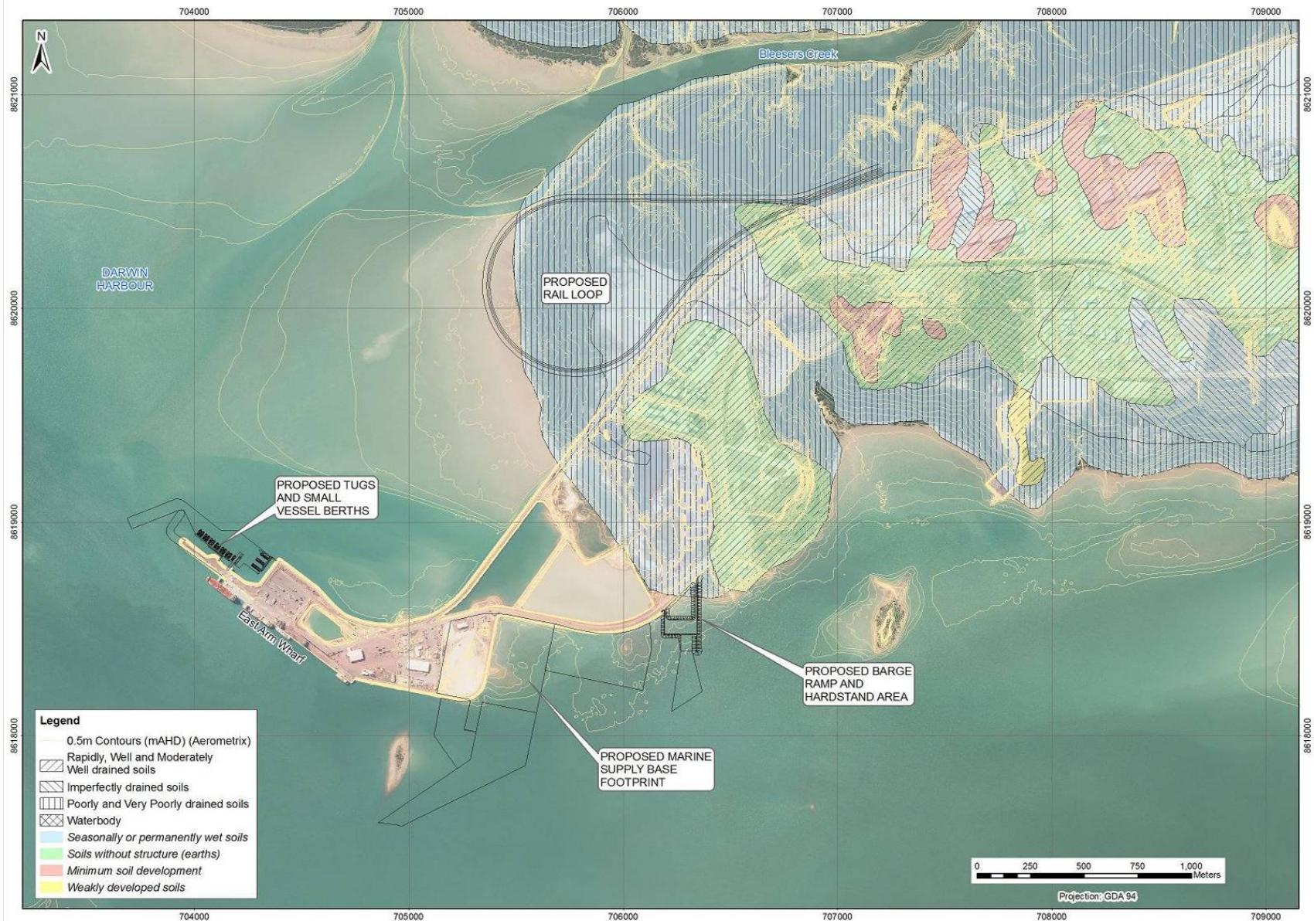
ASS generate sulphuric acid when exposed to oxygen and can also mobilise metals. Earthworks, dredging and reclamation activities are likely to result in material being exposed to oxygen and this is considered to be a potential risk. Previous investigations indicate the presence of PASS and possible ASS in the area. Thus, given that significant amounts of dredging and earthworks required there is the risk that ASS could be encountered.

An ASS Management Plan would be prepared for the construction activities at the site.



Source: Fogarty, Lynch and Wood, 1984

Figure ES-6 East Arm Wharf – Landform



Source: Fogarty, Lynch and Wood, 1984

Figure ES-7 East Arm Wharf – Acid Sulphate Soils

Executive Summary

Sourcing of Fill

Final design for the site is not available as yet and therefore volumes of cut and fill, the types of materials required and their potential sources are not finalised. Fill material will be mainly required for construction of bunds and infilling of reclaimed areas, although fill material may be required in other areas. It is likely that a select rock fill will be required for construction of the bunds, and larger rock will be required for use as rock armour.

Previous investigations indicate that in general a layer of marine sediments of variable thickness overlies weathered rock at the site. The marine sediments are described as either very soft to soft clay or mud or clayey sand or sand. In some locations thin layers of residual soils, consisting of either stiff clay or sand and gravels, were also encountered underlying the soft marine mud.

The underlying weathered rock is typically described as very low to low strength phyllite (or meta-siltstone) with interbedded sandstones and quartzites. The phyllite is described as being rippable; it is unlikely to be suitable for use as rock armour or rip-rap, however, due to its relatively low strength and susceptibility to slaking and deterioration. It is possible that the phyllite could be used in reclamation as a general fill.

The presence of sandstone and particularly high strength quartzite bands may result in ripping of the rock not being possible. However, if this type of material can be recovered on site, it may be suitable for use as select rock fill.

An Earthworks Plan (or separate Plans for each of the individual development areas) that details cut and fill volumes, finished site levels, excavation or formation levels and specifications for fill materials will be prepared. The Earthworks Plan will be used to determine the net quantities required from external sources, following which potential borrow sources can be identified and investigated.

Further geotechnical investigation will be undertaken in the three areas to be dredged, as well as along the alignment of the proposed rail loop. This investigation has been commissioned; however the results are not available for inclusion in this DEIS.

Foundations and Geotechnical Matters

A significant length of bund wall is to be constructed by end-tipping rock fill. Based on the anticipated sub-surface soil profiles at the sites, establishment of a suitable foundation layer will be a key issue. Weak marine sediments, present from bed level to underlying rock, are unlikely to be suitable as a foundation and if feasible the weak material would be removed to ensure that the foundation has adequate bearing capacity to prevent failure of the bund and to minimise settlement.

Alternatively, if the weak material is left in place and the bund wall is constructed by end tipping, it is likely that select rock fill would be placed directly onto the seabed sediments, followed by mud waving. Mud waving refers to refers to the lateral squeezing of soft foundation soil that occurs due to the surcharging effect of dumped embankment fill. These construction issues would be addressed during the detail design stage of the project.

The extension of the quay line and construction of the MSB will involve sheet pile installation. Design details are not known at this stage; it is anticipated that the following will need to be addressed in design and installation of the sheet piles, however:

- The presence of weak marine sediments will likely mean that the piles will need to be embedded into the underlying weathered rock to give an adequate factor of safety for stability of the sheet pile wall. Refusal could be met before the target toe level, when driving sheet piles into underlying weathered rock and it is possible that pre boring may be necessary. Pile installation will be addressed as part of the design process. Cathodic protection will be designed and included to expand life of piles.
- Long-term corrosion of the sheet piles will be addressed as part of the design process to ensure that the bending stresses in the pile can be catered for by the potential loss of section thickness.

It is noted that it is possible that other foundation and geotechnical matters will be encountered and addressed during the detail design process, and other marine investigations may be required. The EIS Supplement will provide an update on any investigations undertaken.

Geology Landform and Soils
A SEDMP would be prepared.
An ASS Management Plan would be prepared.
Adequate occupational health and safety (OH&S) measures for dealing with ASS soils will be incorporated into the Construction OH&S Plan.
An Earthworks Plan (or separate Plans for the individual development areas) would be prepared that details cut and fill volumes, finished site levels, excavation or formation levels and specifications for fill materials.
Specific site geotechnical land and marine investigations will be undertaken as required; the EIS Supplement will provide an update on any investigations undertaken.

1.12.3 Oceanic Processes and Natural Features

Darwin Harbour (refer Figure ES-8) 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 6000-8000 years ago. The Harbour has a surface area of about 500 km^2. 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-east – south-south-westerly 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).

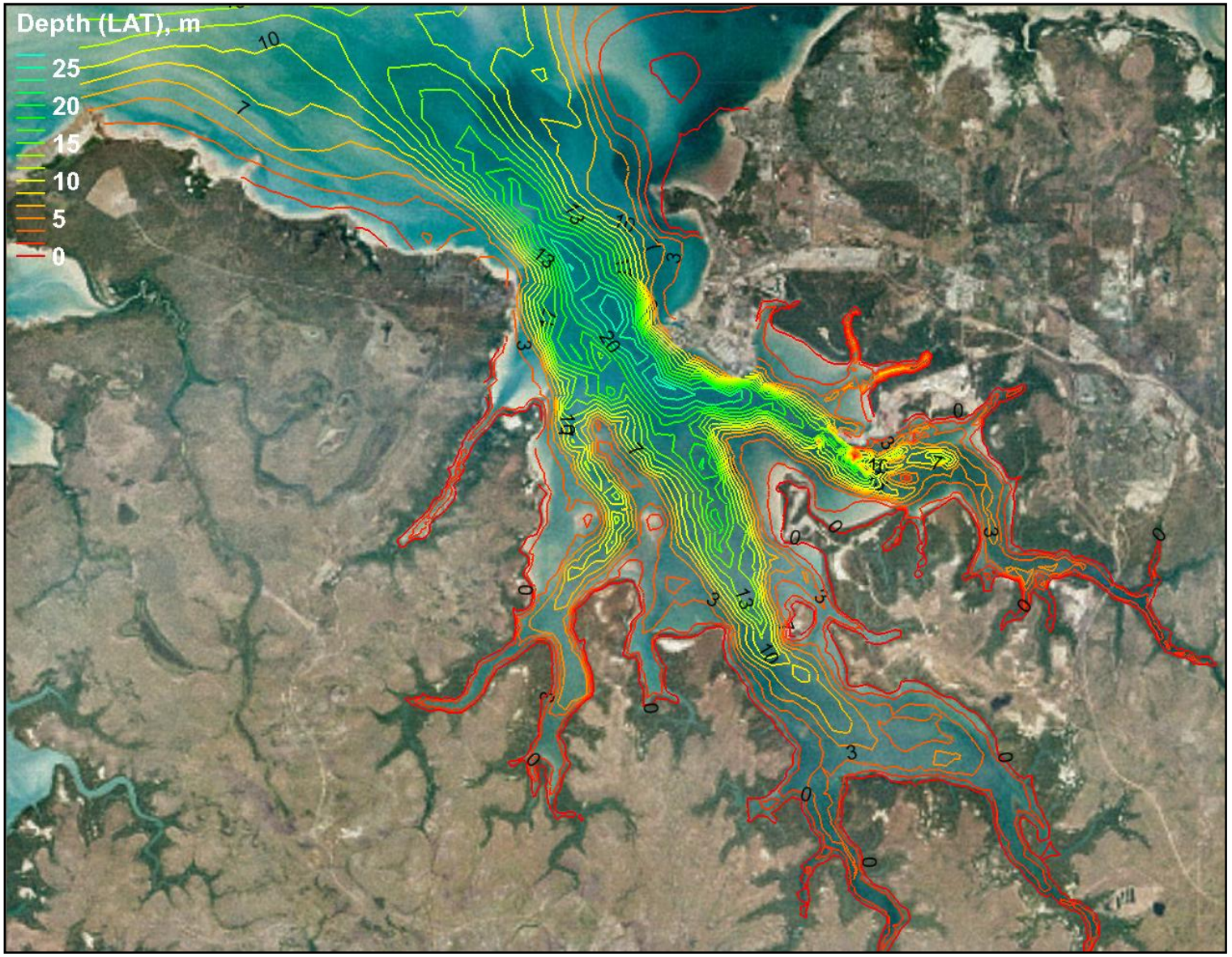


Figure ES-8 Colour Coded Bathymetry of Darwin Harbour; Depths are Positive, Relative to LAT

Executive Summary

The Darwin region is in general characterised by low, flat plateaus with an average elevation of 15 m AHD and occasional rises of up to 45 m AHD. Since the Harbour formation, surface erosion from the adjoining flat terrestrial environment has carried substantial quantities of sediment into the Harbour. This sediment now forms much of the intertidal flats that veneer the bedrock.

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 Blaydin Point, at water depths of more than 10 m below Lowest Astronomical Tide (LAT).

The bathymetry in this area has been already previously modified by dredging for the development of the EAW. A slightly deeper channel extends into Middle Arm, up to the western side of Channel Island. A shallower channel (about 10-15 m below LAT) separates Wickham Point from Channel Island.

The proposed development area is situated at the eastern side of the Harbour, forming the southern limit to Frances Bay and the northern entrance to East Arm.

Darwin Harbour is characterised by a macro-tidal regime with a maximum range of 8.1 m (Harper, 2010). The highest expected tidal level at any location is termed Highest Astronomical Tide (HAT), it is 4.0 m AHD in Darwin Harbour. Depending on the super-position of the Sun's and Moon's gravitational attractions, HAT occurs once each 18.6 year period, although at some sites tide levels similar to HAT may occur several times a year. The mean neap tidal range is 1.9 m, while spring tides have an average range of 5.5 m.

Prevailing currents are of tidal origin. Recent studies of currents in Darwin Harbour indicated that 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) (Inpex Browse 2010a, 2010b). Williams, Wolanski, and Spagnol (2006) indicate that speeds can peak at 2–2.5 m/s during spring tides.

Darwin Harbour is well sheltered from long period tsunami and ocean swell waves by the Tiwi (Melville and Bathurst) Islands. Several wave measurement (INPEX 2010a) and wave modelling (GHD-Macknight, 1997) studies consistently demonstrated that waves within the Harbour are generally of short (3-5 s) mean periods with heights well below 1.0 m.

Using Cyclone Tracy winds, extreme wave conditions were modelled by GHD-Macknight (1997). Waves with the significant wave height of 4.5 m and mean wave period of 7.5 s at the harbour entrance were reducing in height down to 0.7 m inside the Harbour.

A quantitative assessment of the potential current, wave and bed shear stress modifications as a result of the proposed development, over both the wider (Darwin Harbour) and more localised (East Arm) scales were conducted through a numerical modelling using ADCIRC and STWAVE from the SMS modelling package as well as Mud Transport Module from the MIKE modelling package. The results suggest the current velocities and directions would be modified to a different degree at eight comparison sites within the proposed developments: at some sites, there might be a decrease in maximum current velocities by as much as 45% (0.15 m/s at the site of concern), while at the others there might be an increase of up to 9% (0.07 m/s at the site of concern).

Executive Summary

The wave modelling results suggest that both short and long waves entering the harbour decay significantly before the waves reach the East Arm area, and that the proposed developments would lead to wave energy attenuation.

An analysis of the possible change in bed shear stress was conducted to predict the cumulative effect of changes in the tidally driven currents and the wave energy over the entire domain. The results indicated there would be areas of both decreased and increased bed shear stress around the East Arm Port with the differences ranging from -0.05 N/m^2 to +0.05 N/m^2. The positive differences imply higher than present day deposition rates/possible sediment accretion, while the negative differences indicate areas of increased re-suspension and erosion rates. The magnitudes of the differences are below the deposition and erosion thresholds used for Darwin Harbour in several recent sediment transport studies (Wasko et al., 2010).

The potential impacts of dredging activities in terms of elevated suspended sediment concentration and deposition of unconsolidated silt were evaluated. As a result of Marine Supply Base dredging operations, the highest levels of suspended sediment would occur around the dredge location and along EAW, with the 95th percentile concentrations of 2.0-5.0 mg/l. Deposition of suspended sediments would occur to the north of EAW, with the unconsolidated thickness of 1.0-5.0 mm; it would be less than 1.0 mm elsewhere.

Defence Hardstand dredging operations would produce a suspended sediment plume with the 95th percentile values of 1.0-2.0 mg/l, which drop to 0.2 mg/l within a distance of 100 m from the dredging plant; unconsolidated deposition would not exceed 0.5-1.0 mm.

Dredging operations at the Tug and Small Craft Mooring would contribute 2.0-5.0 mg/l of suspended sediment concentration on top of the background concentrations, and up to 0.1-0.5 mm bottom deposition on top of the existing bottom sediments.

The simulated values suggest that suspended sediment concentrations due to the dredging operations would stay below the average values measured in the harbour (~14.0 mg/l), while unconsolidated deposition would be of order of few millimetres, which would be hardly noticeable in the harbour energetic environment.

The spoil disposal operations would lead to small, quickly dispersing, plumes of suspended sediments transported by the prevailing tidal current. Outside of Darwin Harbour, in Beagle Gulf, current velocities and resulting bed shear stress are sufficient to prevent deposition and encourage dispersion of the suspended sediment. Therefore sediment would be dispersed at low concentrations with the 95th percentile value less than 3.0 mg/l. This again suggests that suspended sediment concentrations due to these operations would stay below the average values measured in the harbour (~14.0 mg/l).

The deposition area would be sensitive to wave conditions during the dumping operations, with the waves encouraging sediment re-suspension and thus slightly increasing local suspended sediment concentrations. Thickness of the deposited unconsolidated sediment resulting from the spoil disposal operations would not exceed 0.1-0.5 mm, which again would be hardly noticeable in the gulf energetic environment.

Management of potential impacts during dredging and construction phases will be addressed separately as part of dredging and construction environmental management plans. Management of potential impacts post construction will be addressed in future operational environmental management plans.

Executive Summary

Monitoring of current, wave, suspended sediment and bottom sediment should be undertaken near the proposed dredging locations during dredging operations. The data should be analysed to assist in implementing and assessing compliance with management strategies and plans. Annual reporting on monitoring performance should be aligned to existing and future construction and operational environmental management plans.

Oceanic Processes and Natural Features Commitments
Implement preventative actions as in relevant environmental management plans, i.e. the DMP and the Construction Environmental Management Plan (CEMP).
Review routine and scheduled monitoring data and findings to determine need for corrective action.
Undertake annual reporting on monitoring performance.
Management of potential oceanographic processes impacts will be in accordance to relevant standards.

1.12.4 Marine Water

The Project will aim to conform to the existing water quality objectives for Darwin Harbour. These are included in a Water Quality Protection Plan initiated as part of the National Water Quality Management Strategy. Water quality guidelines and objectives are based on the "declared beneficial uses" under the NT *Water Act (1991*), which are defined for the Harbour as "protection of aquatic ecosystems, recreational water quality and aesthetics" (NRETAS, 2007).

Potential sources of impact on marine water quality during construction and operation of the port expansion include pile driving, dredging activities and general vessel traffic, including waste emissions and potential spills of fuel and product.

At present there is no information available on actual suspended sediment or turbidity levels likely to be generated from this project, or the exact frequency and duration of these activities, as well as the time of year these activities are likely to occur. An assessment of the potential impacts of dredging and other construction activities on the water quality of Darwin Harbour was therefore undertaken based on studies of previous construction related activities as literature on water quality in Darwin Harbour.

The dredging proposed for the three proposed port development projects comprises a total volume of approximately 1.36 Mm^3, of which it is estimated that approximately 1% or 14,000 m^3 will be lost into the water column at the dredge head over the period of dredging.

URS has undertaken sediment fate modelling to predict the dispersal of turbid plumes from dredging activities, and to predict the areas in which suspended sediments will accumulate. Modelling of the dispersion and resettlement of this volume of suspended sediment predicts that suspended sediment concentrations will rise during dredging by 5-10 mg/L in the vicinity of the dredging operation, falling to <2 mg/L outside of the immediate port area, against a background range of 6-10 mg/L (URS, 2004).

The deposition of unconsolidated fine sediments is expected to be similarly small, with thicknesses of 5 mm occurring in a number of the embayments either side of the port, and lesser thicknesses (0.1-1.0 mm) accreting onshore. Depending on the management of the spoil further losses may be experienced during transfer to barges for disposal offshore, or through the return of decant water from spoil disposed of onshore.

Executive Summary

The spoil from the dredging operations is proposed to be disposed of at the offshore spoil ground, i.e. outside of Darwin Harbour in Beagle Gulf. The dumping of each barge load of spoil, at a rate of approximately one barge load every three hours, is predicted to give rise to an instantaneous suspended sediment concentration of 10.0-20.0 mg/L within a plume 50-100 m in diameter.

The plume will then disperse following the prevailing current direction, increasing in diameter and reducing in concentration to generally less than 5.0 mg/L. Modelling results show that suspended sediment concentrations remain below 3.0 mg/L in Beagle Gulf over the period of dredging. Subsequent accretion of fine sediment is predicted to occur only at the entrance to Darwin Harbour, however, the thickness of sediment deposition is again predicted to be less than 0.5 mm over the dredging period.

The sediments of East Arm have been shown to have low levels of contamination and disturbance. Dredging is not expected to result in release at concentrations likely to adversely impact on water quality. Similarly, the disturbance of sediments due to dredging, when considering the high levels of mixing which occur through tidal exchange, is considered highly unlikely to result in the presence of nutrients at concentrations leading to the development of nuisance phytoplankton blooms.

Marine and estuarine sediments containing significant amounts of sulphur, present as sulphides, have the potential to generate acidity when exposed to oxygen. Dredging and disposal of the sediments offshore will not result in release of significant acidity as any acid which is generated will be neutralised by seawater.

Sediment disposed on land has the potential to release acidity, which may need to be neutralised (typically with lime) if there is insufficient natural acid neutralisation capacity present in the dredged sediment. This will be determined by monitoring the acidity of sediment held within any reclamation ponds and neutralising the decant water, as required, prior to discharge.

Management of potential impacts from the dredging and reclamation works are addressed in the AECOM (2011) draft DMP. An ASS Management Plan would also be prepared for the construction activities at the site.

The operation of construction vessels (tugs, workboats, survey vessels, anchor handling boats, etc.) in the comparatively shallow water of the construction area, particularly at low tide, can be expected to resuspend sediment due to the turbulence created by propellers, known as propeller wash. This typically results in localised redistribution of sediment, raises the concentration of suspended sediments in the water column and causes increased levels of turbidity in the immediate vicinity of the vessel.

As for construction, the operation of additional vessels in the port area can be expected to result in more frequent re-suspension of sediment due to propeller wash. This is expected to result in more frequent increases in the concentration of suspended sediments in the water column and increased levels of turbidity in the port area.

There may be a requirement to undertake periodic maintenance dredging to maintain the navigable depth of the channels and berthing basins; the required frequency is yet to be determined, however. The impacts would be similar in nature to those previously discussed under construction impacts, but the volumes of material to be dredged and the resultant suspended sediment loads and resettlement depths would be much smaller. Maintenance dredging will be undertaken under separate environmental approvals to be sought when the requirements are more fully understood.

Executive Summary

Over-water maintenance of steel structures will be periodically required for corrosion control. This typically involves abrasive blasting or grinding / sanding of surfaces to remove paint and anti-fouling residues and corrosion (rust). The majority of this material will comprise inert particulates (paint chips, rust flakes, blasting grit, etc.) but there may be a release of toxins (most likely copper-based) from anti-fouling. Procedures have previously been developed for use in Darwin Harbour to minimise the quantity of particulates entering the water during such operations.

The main discharge from the port area to the harbour will be stormwater and this will increase as a result of the development due to the additional hard stand area created. The discharge of the stormwater in itself poses no threat to water quality however there is a need to manage potential contaminants including solids, hydrocarbons from grease or oil spills and leaks, and any material from vessel repair / maintenance that may accumulate on the hard stand between rainfall events.

Sewage will be transported offsite and will not be discharged to the harbour.

Accidental spills to the marine environment during construction and operations may result from:

- Refuelling spills.
- Fractured hoses (diesel fuel/hydraulic oil) or as a result of rupture of a fuel tank due to a collision between vessels or between a vessel and a wharf or other solid structure.
- Contaminated stormwater (e.g. from oily surfaces or where product spills may have occurred).
- Waste handling spills.
- Sewage pump-out spills.

The potential for such spills occurs across all areas of port operations, and will be addressed in specific procedures under the Port's Environmental Management Plan and Oil Spill Contingency Plan.

It is noted that the Marine Supply Base may in future handle a significant volume of waste from offshore rigs and platforms, including potentially hazardous wastes. Additional specific procedures may be required under the Port environment management plan (EMP) to ensure safe handling of such materials and avoid spillage during unloading or while stored on the hardstand, with subsequent potential to wash off into the harbour.

As described above, management plans will be developed for the Project. These will describe the proposed management controls to be undertaken to reduce the risk of adverse environmental impacts resulting from the Project. The provisional plans will form the basis for more detailed plans as the Project proceeds and will be addressed in specific procedures under the Port's Environmental Management Plan.

The provisional plans will include measures to manage the impacts of the Project on water and sediment quality from:

- Dredging and dredge spoil disposal and other sediment disturbing activities (Dredging Management Plan).
- Fuel leaks and spills (Oil Spill Contingency Plan).
- Stormwater disposal (Port Environmental Management Plan).

Marine Water Quality Commitments
The Project will aim to conform to the existing water quality objectives and guidelines for Darwin Harbour. *Provisional plans will be developed to manage:* • *Dredging and dredge spoil disposal and other sediment disturbing activities (DMP).* • *Fuel leaks and spills (Oil Spill Contingency Plan).* • *Stormwater disposal (Port Environmental Management Plan).* *The provisional plans will form the basis for more detailed plans as the Project proceeds.*

1.12.5 Terrestrial Water

Due to the limited amount of surface water and groundwater data available, a drilling and testing programme was instigated to obtain lithological samples and groundwater quality data. Similarly, surface water samples were collected to characterise existing surface drainages.

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 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).

There is no historical groundwater level data from the project locality. Groundwater levels in the project locality are likely to follow ground surface topography with flow toward the sea from elevation areas. Near-shore groundwater levels are likely to be influenced by tides that range up to 8 m. Based on available groundwater data from monitoring bores, groundwater is generally expected to be within about 5 m of ground surface and vary between 3 and 8 m depending on the season.

The topography of the development areas and the earth-worked areas (fills and hardstands) are designed to drain as overland flow to detention/sediment basins and to the ocean. Currently surface water runoff for most of the EAW hardstand areas is collected into stormwater collection pits that passively seep into the harbour.

Stormwater collection pits that drain from the ship loader catchment and the hardstand east of the bulk loader have recently been diverted to discharge to Pond F. There are further plans underway to improve stormwater management which includes:

- Implementation of stormwater contaminant capture such as gross pollutant traps.
- Developing a “cut off drain” along the wharf berth in front on the Bulk Loader.

Potential impacts to surface water from the proposed expansion are:

- Interruption or reduction to natural drainage flows.
- Increase suspended sediment loads in surface water systems/marine environment during construction.
- Release of metals and nutrients by disturbance of ASS / PASS materials via surface water systems.

Executive Summary

- Surface runoff / pond seepage may exceed water quality objectives for Darwin Harbour or relevant standards.

Potential impacts to groundwater from the proposed expansion are:

- Changes in bathymetry as result of dredging and/or reclamation may increase groundwater flow and discharge mechanisms, particularly where fractured bedrock is intersected. 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 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.
- Reclamation of land may reduce groundwater discharge mechanisms, particularly where fractured bedrock is intersected. This may increase terrestrial groundwater levels and limit terrestrial seawater intrusion (if present).
- Disturbance ASS and PASS during land reclamation or groundwater dewatering activities could lead to contamination of groundwater by acidification of groundwater, release of heavy metals and nutrients.
- Contamination from leaks and spills of fuels, lubricants, solvents or other products from operating equipment.
- Reduction in groundwater recharge to aquifers as results of compaction and sealing of ground surfaces during construction of roads, railways, buildings and hardstands. This can also lead to a reduction in groundwater levels, flow and discharge mechanisms.

A number of mitigation and control measures could be implemented during both construction and operations to minimise impacts on surface and groundwater. These include:

- Storing Oils, hydrocarbons and other hazardous materials in designated locations with specific measures to prevent leakage and release of their contents, including the location of the storage areas away from surface water drains, and on an impermeable base that has no outflow and is of adequate capacity to contain more than 100% of the contents.
- Reduce or eliminate rainfall infiltration to storage stockpiles in unsealed hardstand areas.
- Provision of spill response equipment to contain and clean-up spills.
- Installing and maintaining waste management structures appropriately around the maintenance workshop, vehicle washdown bays and refuelling depots. Waste management structures may include, but are not limited to: protective bunding, skimmers, silt traps, fuel and oil traps, drains and sealed collection sumps. These measures could be used to recover spills, and allow treatment to remove contaminants within impervious containment structures prior to discharge.
- Minimising the amount of run-off entering oily wastewater and wastewater treatment systems through appropriate grading, drainage designs and other means.
- Installing and maintaining sediment retention ponds, vegetated buffer strips or other effective measures at all potential off-site stormwater discharge points.
- Engineering water pollution retention ponds to mitigate seepage to groundwater.
- Controlling overland drainage to prevent channelling and sediment transport by diverting flows away from areas that are exposed.
- Collecting all stormwater from areas through surface drainage channels and directing them into sedimentation structures before flowing off-site.
- Designing and implementing sediment control measures within drainage lines downstream of active work areas and other disturbance areas.

Executive Summary

Management of potential groundwater and surface water impacts will be in accordance to relevant standards. These include:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australia and New Zealand Environment Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), 2000)
- Darwin Harbour Strategy (Darwin Harbour Advisory Committee (DHAC), 2010)
- Darwin Port Corporation Environmental Management Plan
- Draft Stormwater Management Strategy for the Darwin Harbour Catchment
- Water Quality Objectives for the Darwin Harbour Region

Both groundwater and surface water monitoring network will be required for long-term monitoring program to comply with objectives and standards.

Drilling, logging and installation of groundwater monitoring bores will allow understanding of site groundwater hydrology and hydraulics. Groundwater monitoring bores should be located in unsealed hardstand areas (over reclaimed and natural land surface) to determine if seepages from the areas meet water quality objects. Bores should also be located near existing pollution and sedimentation ponds to determine seepage quality.

The surface water monitoring program should monitor both sediment and water quality at collection points throughout the surface water management system. These will include; drains, pollution retention ponds, sediment retention ponds, and other area of potentially contaminated surface water run-off.

Annual water quality reporting on monitoring performance will be aligned to existing and future construction and operational environmental management plans.

Terrestrial Water Commitments
Mitigation and control measures would be implemented as required to ensure that relevant groundwater and surface water standards are met. *Interim measures for stormwater management will be integrated into the design of the drainage system for the proposed EAW extension.* *A surface and groundwater monitoring program would be implemented, which would be periodically reviewed for the number and frequency of analyses, and also amended in accordance with future operational environmental management plans.* *Groundwater and surface water monitoring performance would be reported to NRETAS annually.* *A drainage strategy is being developed for East Arm Wharf for existing and new areas. Existing areas will have management improved to further reduce contaminants that can enter the stormwater system, drainage will be altered to collect stormwater and various retention and treatment systems are to be installed to ensure stormwater discharged off the site will be of acceptable quality.This strategy identifies "management actions" to prevent contaminants finding their way into stormwater. This will be applied to new areas to ensure the design and daily operations minimise stormwater contamination. Final detailed design is to ensure such management actions can be undertaken and Environmental Management Plans and operational procedures will also be developed. Areas such as General Cargo will have Gross Pollutant Traps (GPT) that remove some heavier sediment, litter and oil. Whereas areas vulnerable to greater volumes of contaminants, or more difficult to capture*

contaminants (such as bulk minerals) will have sediment ponds. Stormwater discharges are also to be monitored to verify the systems in place are adequately treating stormwater to an acceptable standard. Stormwater found not to be of acceptable quality will have management actions reviewed and stormwater treatment infrastructure modified where required.

1.12.6 Air Quality

An air quality and noise assessment has been undertaken for the EAW expansion project. The assessment focussed on particulate matter emissions associated the construction phase of the Project, particulate matter emissions from the expected dry bulk operational areas and combustion emissions from vessels at port.

Background air quality monitoring data for the local region has been collected and investigated in order to provide an indication of the quality of the existing air environment and the capacity within the local air sheds for future emission increases associated with new developments. The key air pollutants investigated were particulate matter (PM_{10}), oxides of nitrogen (NO_X) and sulphur dioxide (SO_2).

Whilst specific air quality guidelines are not available for the NT, the DPC EMP considers the following regulations and guidelines:

- *National Environment Protection Measure (Ambient Air Quality)* (AAQ NEPM) (National Environment Protection Council (NEPC), 2003).
- *National Environment Protection Measure (Air Toxics)* (NEPC, 2004).
- *State Environment Protection Policy (Air Quality Management) (Victoria)*
- *NOHSC:1003 Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment (1995)*
- *Other State and Territory Guidelines that DPC determines are relevant.*

Particulate matter (dust) measurements generally showed dust levels in the Darwin Air Shed were low and below National Environmental Protection Measure (NEPM) Standards, however, elevated dust levels were often associated with bushfires or firework displays.

Oxides of Nitrogen (NO_2) and sulphur dioxide (SO_2), which are generally a product of combustion, are also present in low concentrations in the Darwin Air Shed due to comparatively low numbers of cars and industrial areas, when compared with other urban centres of Australia. Peak concentrations of both of these pollutants were below the NEPM criteria.

Assessments considered emissions of dust, combustion products, odours and Volatile Organic Compounds and indicated that generally air emissions associated with construction and operational activities would be minor, however, certain construction and operational activities were identified which required further (quantitative) assessment using dispersion modelling. These investigations included modelling potential concentrations of PM_{10}, NO_2 and SO_2 using AUSPLUME and published emission estimates (National Pollutant Inventory (NPI), 2001; Air Resources Board, 2002) and meteorological data (using the TAPM model suite).

The predicted concentrations were shown to be below the adopted criteria. However mitigation measures have been provided to ensure the emissions of air pollutants during the construction phase are contained to minimise adverse air quality impacts.

Executive Summary

Assessments of operational air quality impacts have been provided as based on current information. Further consideration to the emissions associated with marine vessels and the additional wharf operation areas should be considered upon finalisation of the detailed design of the facility.

An Air Quality Management Plan (AQMP) detailing requirements for the construction phase of the project would be incorporated within plans and procedures included within the CEMP. Key management controls for construction include:

- Access paths or roads would be sealed as soon as practicable after clearing in order to minimise dust emissions from vehicle movements.
- Multiple handling of material will be avoided where possible.
- Dust suppression techniques will be applied where necessary. Specifically water sprays, water trucks or dust suppression additives may be utilised.
- Vehicle control measures. This may include minimising vehicle speeds (maximum 20 km/hr) and movements on unsealed roads, the use of water sprays on vehicle access paths, and wheel wash areas.
- Covering of trucks carrying construction material to prevent dust releases.
- A vegetation and soil erosion control plan incorporating erosion protection measures.
- A dredging and dredge spoil disposal management plan which would incorporate mitigation measures for controlling odour and dust releases particularly from dewatered and stored spoil.

Operational management is currently covered by the EAW EMP and includes the following management principles (Coffey Environments, 2010):

- Enclosure of dust generating activities where operationally practical and efficient.
- Implementation of appropriate dust suppression or capture technology where enclosure is not practical.
- Efficient operational of machinery, equipment and vehicles to minimise exhaust emissions.
- Clean up of residues and spills in a timely manner.
- Adherence to the activity specific EMP.
- Regular review of the efficiency of air quality and greenhouse gas management measures to ensure implementation of continuous improvement.

Monitoring activities would be conducted throughout the construction phase of the project in order to meet key targets. Proposed monitoring activities that would be incorporated into the CEMP include:

- Visual inspections of dust deposition on surrounding areas will be undertaken on a periodic basis during activities likely to cause dust releases (i.e. vegetation clearing, earthworks) to assess the effectiveness of mitigation measures.
- An incident-reporting and complaint handling mechanism for dust incidents to be monitored and logged, and corrective and/or preventative actions to be implemented.
- Auditing of particulate management practices, including a review of objectives and targets.

The following measures, which are currently contained in the EAW EMP, would continue after the development is complete:

- Environmental incident reporting including incident investigation and the inclusion of corrective and preventative actions.
- Environmental monitoring of air quality (amongst others), with sampling to be undertaken on a quarterly basis at sites on or around EAW, EAW Stockpile, Fort Hill Wharf, Fishermans Wharf and the centre of the harbour.

- External and internal audits of the EMP biennially.

Air Quality Commitments
A CEMP would be detailed outlining the AQMP prior to construction.
Inspections of dust releases and associated control measures would be conducted on a regular basis.
Where appropriate, a speed limit of 20 km/hr is to be enforced for all vehicles onsite to reduce dust releases from vehicle movements.
All truck deliveries in and out of the construction area would have their loads covered to prevent dust releases.
All stockpiled materials would be kept to a reasonable size and controlled via wet suppression and/or covers where deemed appropriate.
Vehicle movements on unsealed roads would be kept to a minimum.
A vehicle inspection and maintenance program for all on site construction vehicles.
Adherence to the DPC operational EMP for the EAW facility.

1.12.7 Greenhouse Gas Emissions

The NTG aims to minimise greenhouse gas (GHG) emissions from new and expanding operations to a level that is as low as practical (NRETAS, 2009). Accordingly, a GHG assessment was completed for the project.

GHG accounts provided by the Department of Climate Change and Energy Efficiency (DCCEE) show a contribution of approximately 575 Mt carbon dioxide equivalent (CO_2-e) by Australia for the 2007-08 financial year (DCCEE, 2010a). Breakdowns of the individual state and territory contributions show that the NT contributes 16.3 Mt CO_2-e or approximately 2.8% of the national inventory. This is an increase from from 10 Mt CO_2-e from 1990. The prime contributions to these figures are agriculture and stationary energy.

Existing sources of GHG within the EAW and surrounding areas include:

- 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.
- Loss of vegetation through land use change.

GHG emissions associated with the construction phase of the project are predominantly associated with combustion of diesel fuel in construction equipment with some emissions from land clearing (loss of vegetation) for the rail loop. It is estimated that the total greenhouse gas emissions associated with the construction phase represents approximately 0.26 % of the NT Inventory for 2008 (DCCEE, 2010b), or approximately 41,872 t $CO_{2\text{-}e}$. Annual greenhouse gas emissions for the construction phase are estimated at 10,468 t $CO_{2\text{-}e}$, based on a four year construction timetable. This represents a small account of the NT inventory and a negligible quantity of the national accounts.

Specific emissions associated with the operation of the wharf are expected to include:

- Electricity use and or supply (i.e. equipment, lighting etc).

Executive Summary

- Maintenance and equipment supply.
- Waste generation.
- Fuel use (i.e. site vehicles or equipment, vessels associated with each industry).

Actual greenhouse gas quantities for the operational phase is difficult to account at this stage given operational uncertainties, however, these can be incorporated into the accounting and reporting mechanisms described within the DPC EAW EMP.

The objective of managing greenhouse gas emissions during construction and operation would focus on efficient use of energy. The CEMP will consider areas where GHG emissions can be reduced. The EMP will consider requirements for GHG reductions, including energy efficiency initiatives, and requirements for reporting in accordance with the *National Greenhouse and Energy Reporting Act 2007*.

Opportunities for management of greenhouse gases include:

- Reducing fuel use through fitting equipment with efficient engines, utilising local materials, minimising equipment idle times, using appropriately sized equipment, and efficient planning of activities.
- Reducing office energy consumption in accordance with the Energy Smart Buildings Policy, and to look for additional energy savings elsewhere in its operations.
- Monitoring energy and water consumption to determine current usage and efficiency.
- Minimising the consumption of resources through good operational practices and making environmentally sound choices where procuring new equipment and infrastructure.
- Reducing the amount of cleared land where practicable, for example reducing the vegetation clearing within the railway loop.
- Reusing dredge spoil where feasible.
- Recycling waste where possible.

Consideration should also be given to the purchase of Green power and offsetting greenhouse gas emissions from National Carbon Offset Standard (NCOS) compliant offsets, through the operational phase of the EAW. In addition the prospect of carbon sequestration through vegetation planting will be fully investigated, however this would be limited at the site given that the site is entirely hardstand. Vegetation planting could be investigated in the Greater Darwin Area.

Greenhouse Gas Emissions Commitments
A CEMP would be developed incorporating greenhouse gas saving initiates using mechanisms described within the GHG assessment (i.e. regular vehicle engine inspections)
The CEMP would incorporate areas where greenhouse gas emissions can be reduced and detail requirements for GHG and energy efficiency reporting. .
An EMP will be prepared (or an update to existing EMP) by DPC that will consider requirements for GHG reductions, including energy efficiency initiatives and requirements for reporting.

1.12.8 Marine Noise

In-water noise will unavoidably be generated during the development of the proposed port expansion, and as a consequence of ongoing operations at both the new and existing facilities. Potential sources of noise during construction and operation of the port expansion can include pile driving, dredging activities, rock armouring and general vessel traffic. All of these activities may disturb marine fauna to varying degrees. As a result a detailed literature review of underwater sound propagation, natural and anthropogenic sources of marine noise, and the potential vulnerabilities of marine fauna of interest was undertaken to assess the potential impacts of noise on marine fauna.

The review focuses principally on the known and potential physiological and behavioural responses of fauna to noise in the marine environment, with emphasis given to Darwin Harbour. At present there is no information available on actual noise levels likely to be generated by the project, the regularity and duration of noise generating activities, or the time of year they are likely to occur. Therefore, representative data from similar projects have been drawn from available literature.

It is difficult to predict which species may be most vulnerable to anthropogenic noise because of the wide range of individual and population sensitivities and differences in wariness, motivation or degree of habituation. Currently, it is only possible to make generalisations about the vulnerability of species groups based on behavioural observations of responses to man-made sounds, habits and what is known about a species auditory sensitivity or vocal range.

Some auditory masking (which may prevent animals from hearing social communications or other acoustic cues) may occur from dredging noise in Darwin Harbour. However, masking will only occur in the low frequencies (below approximately 5 kHz, with most noise below 1 kHz) and will be generally confined to a zone in close proximity to the dredging. Dredging noise is not likely to occur at the higher frequencies used by toothed cetaceans in echolocation.

The intense pulses of pile driving have been observed to injure swim bladders and sometimes kill fishes in limited circumstances, and they have the potential to elicit a startle response from cetaceans, particularly if the hammering operation is commenced without any form of soft-start procedure. Thresholds above which physical injury to marine mammals could occur are unlikely to be exceeded, other than in the immediate vicinity of pile-driving activities.

As shipping and vessel noise is a continuous noise source of relatively low intensity, thresholds above which injury to marine mammal hearing could occur will not be exceeded. Any impacts from vessel noise will be limited to behavioural disturbance and/or masking of other biologically important sounds.

It may be concluded that noise intensive activities at EAW is generally unlikely to trigger any long-term, persistent, deleterious impact upon marine fauna. This conclusion is founded upon several key points, namely:

- The relatively low levels of noise expected to be generated and their attenuated propagation.
- The temporary nature of the predicted acoustic disturbance.
- The absence of any identified critical or important habitat in the project area for significant marine fauna.

It is possible that construction activities, particularly pile driving, will elicit some short-term behavioural changes in some fauna. These are likely to be confined to startle responses, and possibly to changes

to feeding patterns and temporary avoidance of the project area. None of these are considered likely to result in long-term harm to either individuals or populations of any of the marine fauna considered.

Results of recent modelling compared to established noise exposure criteria have been used to establish proposed safety for marine mammals and turtles during piling, dredging and other noise intensive activities. For sources of generally low acoustic disturbance (e.g. dredging, trenching) a safety range of 500 m is considered adequate for marine mammals and turtles to avoid the onset of physical injury. For sources of potentially elevated acoustic disturbance (e.g. pile driving) a safety range of 1,000 m is proposed for marine mammals and turtles to avoid the onset of physical injury.

From one hour prior to the commencement of any noise-intensive activity, vessel and/or land-based observers should monitor the exclusion zone to check for the presence of any important marine fauna species. Activities may commence if no important marine fauna have been sighted within the exclusion zone 30 minutes prior to the commencement of the activity. If any such species are observed within the exclusion zone, noise-intensive activities should not commence until the animal is observed to leave the exclusion zone, or until 30 minutes of observations have passed since the last sighting and no more important marine fauna have been sighted.

To enhance the effectiveness of surveillance:

- Activities should preferably be commenced in appropriate sea conditions so that observers have a reasonable probability of sighting important marine fauna. In the case of pile driving, activities should only be conducted in daylight hours.
- Where practicable, suitably experienced personnel should continuously maintain an adequate look-out for the presence of important marine fauna within the exclusion zone during noise-intensive activities.

In respect of potential impact to marine fauna, there are advantages to conducting activities during elevated sea conditions (e.g. times of rough sea and increased wind (sea state 3 or above)). The reason for this is that elevated sea states limit acoustic propagation ranges (especially in shallow coastal waters) and the increased background noise masks other noises, thus effectively reducing noise levels perceived by marine fauna. Noting this, such conditions should actually be exploited as a means of mitigating potential impacts.

If practicable, soft start procedures for pile driving should be used each time pile driving is commenced for the day, gradually increasing power over a 30 minute period. During daylight hours, visual observations should be maintained continuously during soft starts to identify any marine fauna within the precaution zones.

If important marine fauna are sighted within the exclusion zone at any time noise activities should cease. Noise-intensive activities should only resume after the animal has been observed to move outside the exclusion zone, or when 30 minutes have lapsed since the last sighting.

1.12.9 Terrestrial Noise

A construction and operational terrestrial noise and vibration impact assessment was undertaken for the proposed expansion works at EAW.

EAW is part of an operating port zoned DV (Development) under the NT Planning Scheme. The land surrounding EAW is unconstrained with respect to land use conflicts as there are no adjacent or nearby residential areas. The closest residential area to EAW is in the Darwin CBD, approximately

Executive Summary

4.2 km to the northwest. EAW is also well located in comparison to other Australian ports as its location is strategically placed to avoid the need for buffers from incompatible land uses.

In the absence of specific environmental noise and vibration policies / guidelines for the NT, noise and vibration impacts associated with the Project's proposed construction and operations have been assessed in accordance with the following guidelines and standards:

- NSW *Interim Construction Noise Guideline* (DECC (Department of Environment and Climate Change), 2009).
- NSW *Assessing Vibration – A Technical Guideline* (Department of Environment and Conservation (DEC), 2006).
- NSW *Industrial Noise Policy* (NSW EPA, 2000).
- *Guideline for Community Noise* (World Health Organisation, 1999)
- *Environmental Criteria for Road Traffic Noise* (NSW EPA, 1999)
- NSW *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects* (DECCW, 2007).

A review of aerial photographs of the study area has identified six noise sensitive residential receptor groups and a school which are considered to be the worst potentially affected by noise from the proposed activities at the subject site (refer Table ES-1). DLP has flagged the nearby Berrimah Farm for residential development. This site is located to the north-east of the intersection of Berrimah Road and Tiger Brennan Drive. It is set back from the wharf by approximately 6 km and by 1.4 km from the DV zoned land on the north-west corner of the railway line and Berrimah Road.

Table ES-1 Noise Sensitive Locations

Location and Land Use	Approx Distance from EAW	Direction from EAW
A - Darwin (Government House)[1]	4 km	WNW
B - Darwin (Waterfront Precinct)[1]	4 km	WNW
C - East Darwin, Stuart Park[2]	5 km	NW
D – Bayview[2]	6 km	NNW
E - Kormilda College[3]	4 km	NNE
F - Berrimah Farm[2]	4 km	NNE
G – Palmerston[2]	6 km	E
Notes: 1. Considered as Urban Receptor 2. Considered as Suburban Receptor 3. School		

Noise levels from the assumed construction and operation have been predicted using an acoustic computer model created in SoundPLAN Version 7.0. Details of the area's topography, receptor locations and sound power levels of the noise sources have been incorporated into the noise model. 'Worst-case' scenarios have been taken into consideration throughout the noise modelling.

Noise modelling indicates that the proposed construction and operational activities would comply with the established noise criteria at all the identified receptor locations without the requirement for any specific noise mitigation measures. Piling has the potential to generate exceedances of the

nominated night-time noise limit at the closest receptors. This activity would, however, be expected to be constrained to the daytime period.

With consideration to future traffic growth, traffic volumes increases from operation and development of EAW would be expected to be less than five percent of the total traffic already present along the main arterial route to the wharf. Therefore negligible influence on existing road traffic noise levels is expected.

At the closest receptors to the rail alignment (considering only those within the study area), there is potential for existing rail movements associated with East Arm Wharf to cause exceedances of the nominated rail noise criteria, WHO sleep disturbance criteria and vibration criteria. The extent of the impacts that may occur, if any, will be dependent on a number of factors that are presently unknown.

Measures to mitigate any vibration impact, if necessary, include track maintenance, inclusion of resilient elements beneath the rails in local areas and/or operational controls such as limiting night-time movements and restricting speed in residential areas. A detailed assessment would be required to determine likely rail noise and vibration impacts due to the expansion of the wharf once more detailed information is available.

Key management controls proposed for construction and operation include:

- Where practicable carrying out all construction works using noisiest equipment or plant items within the day-time period. Piling should not be carried out after 6pm.
- Scheduling construction to minimise multiple use of the noisiest equipment or plant items where practicable.
- Strategic positioning of plant items and maintenance work areas to reduce the noise emission to noise sensitive receptors, where possible.
- Ensuring machinery engine covers are closed, equipment is well maintained and silencers/mufflers are used. Maintenance for major items of construction equipment that are significant contributors to construction noise levels.
- Ensuring noise generating plant complies with the applicable noise criteria at all nearby residential receptor locations.
- Awareness training for staff and contractors in environmental noise issues including:
  - minimising the use of horn signals and maintaining to a low volume. Alternative methods of communication should be considered
  - avoiding any unnecessary noise when carrying out manual operations and when operating plant
  - switching off any equipment not in use for extended periods during construction work.
- Restricting heavy vehicles' entry to site and departure from site to the nominated construction hours.
- Developing a noise monitoring program in accordance with relevant standards and make results of this monitoring available to the relevant authority upon request.
- Community consultation with local residents and building owners to assist in the alleviation of community concerns.
- Monitor any adverse impact from site going vehicles movements on the public road network through on-going consultation with neighbouring residents. In the event of off-site vehicle noise adversely impacting neighbouring residents, opportunities to reduce the impact through management controls will be investigated.

- Maintaining a suitable complaints register and complaints handling protocol. Should noise complaints be received, undertake noise monitoring at the locations concerned. Reasonable and feasible measures would need to be implemented to reduce noise impacts.
- In the event of any exceedance of the established noise criteria, the proponent will take immediate action to investigate and remedy the situation.

In the event of a community member registering a complaint regarding excessive noise levels, a two-phase response regime will be implemented:

- First complaint: EAW personnel will visit complainant's property to carry out subjective evaluation of the noise and undertake a preliminary noise monitoring assessment, in order to determine if an exceedance of the construction noise criteria had occurred.
- Second complaint: Site Response - An acoustic professional will visit the area where the complaint was registered for a 48-hour period to undertake a robust noise monitoring assessment to appropriately assess any impacts.

Terrestrial Noise Commitments
A CEMP would be outline the Construction Noise Management Plan prior to construction
Noise monitoring will be carried out in accordance with the requirements of the NSW Industrial Noise Policy (EPA 2000) and AS1055:1997 "Acoustics – Description and Measurement of Environmental Noise".
The project will investigate all substantiated noise and vibration related complaints.
The project will implement corrective action resulting from complaints investigations as required.

1.12.10 Marine Ecology

Several types of ecological communities have been recorded in Darwin Harbour: rocky shore communities, hard coral communities, filter feeder communities (primarily soft corals and sponges), macroalgae communities, seagrass beds, soft sediment communities, mangrove communities and fish communities.

Most of the project area is surrounded by bare substrate, however, on the south side of EAW there are some moderate to high densities of sponge and soft coral beds and some scleractinian ("hard") coral communities around South Shell Island and Old Man Rock.

Nearshore construction activities associated with the proposed expansion of EAW that have potential to impact on the marine environment include land clearing and land reclamation, dredging and the associated deposition of dredge spoil, and noise generation. Impacts associated with accidental occurrences during either construction or operations include hydrocarbon spills and the introduction of marine pests.

The risks of these events occurring and their possible consequences was assessed by analysis of hydrodynamic modelling undertaken for the project, and reviewing information on similar projects in Darwin Harbour, particularly those studies associated with the original development of EAW.

Potential impacts from the proposed expansion on species protected under the *EPBC Act 1999* of the *Territory Parks and Wildlife Conservation Act 2001* (TPWC Act) include impacts upon migratory animal species, including cetaceans, dugongs, birds, turtles, sharks and seahorses or migratory birds that

Executive Summary

could occur in the area of EAW. Coastal dolphins, dugongs and sawfish are known to occur in Darwin Harbour, but there are no known habitats of significance to these species in the immediate Project area.

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 (WMB), 2005). Most mangrove tracts surrounding Darwin Harbour are zoned for "conservation" under the Northern Territory Planning Scheme (AECOM, 2009a), and are classified as "significant vegetation" under NT clearing guidelines. However, the mangroves in the EAW Project area are within the EAW Area Development Zone and are not zoned for conservation.

Mangroves will be impacted directly (by removal) and indirectly (e.g. through changes to tidal exchange). The maximum extent of potential mangrove loss from the project footprint, is 74 ha, this being comprised of 22 ha from the placement of the rail corridor and loop (i.e. direct clearing of mangroves) and 52 ha from the impoundment of mangrove habitat within the rail loop (potential indirect loss). Engineering options such as installing culverts are being considered to mitigate the potential loss of mangroves inside the rail loop.

The mangrove tracts around the Darwin harbour shoreline are extensive and the potential 74 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 24 ha of low tidal mud flat habitat will be either reclaimed or substantially disturbed during construction of the project. In Darwin Harbour shorebirds forage on the extensive areas of low tidal mud and sand flats (when exposed during low tides) that are located seaward of the mangrove shoreline. These areas can provide an abundant source of intertidal invertebrate fauna for shorebirds to feed on. In the context of these extensive areas of tidal flats, the area (24 ha) to be impacted by the EAW project is small and hence it is unlikely to present any significant threat to shorebird populations in Darwin Harbour.

Limited dredging is required to construct the berthing areas and channels from these areas to existing channels within Darwin Harbour. The primary effect of the proposed dredging during the construction phase will be to remove soft bottom communities and some hard substrate areas that support filter feeder communities. All of the benthic communities found near EAW are well represented elsewhere in Darwin Harbour.

Potential effects of the dredging plumes include a reduction in light reaching benthic species on the seafloor, which could affect the hard coral community at South Shell Island. No substantial macroalgae communities or seagrass meadows have been recorded within the areas that will be potentially influenced by the turbid plumes.

Modelling shows turbidity caused by the dredging will vary with tidal currents. Suspended sediment levels in the water column in many areas of East Arm will decrease to near background levels as the sediment settles to the bottom during slack water periods. Some of the settled material will be resuspended as the tidal flow resumes. It is predicted from modelling that sediment is not expected to accumulate to any substantial extent in areas where mangrove, coral or filter feeder communities are present.

Dredging may release nutrients from the sediments; these will be rapidly dispersed within the water column. It is highly unlikely that they will be sufficiently concentrated to cause any measurable increase in primary productivity, either on the surface of the seabed or in the water column.

Management of potential impacts from the dredging and reclamation works are addressed in the draft DMP. Monitoring of the health of mangroves in the vicinity of the Project area will be undertaken during the port expansion construction and dredging works. The monitoring programme will include parameters related to both mangrove health and habitat condition.

Marine pest risks associated with the Project need to be carefully considered. Marine pests tend to be concentrated in shallow, disturbed areas, so the risks of their being introduced are greater in these areas. The risks of introducing a marine pest will be greater during the construction phase because of the types of vessels used and their work patterns. The risk is heightened in nearshore areas by the presence of susceptible areas such as infrastructure, disturbed environments, and aquaculture facilities. The use of large, slow moving vessels such as dredges and barges during the construction phase presents the greatest risk for distributing marine pests, particularly from overseas ports.

A provisional Marine Pest Management plan will be developed for the Project before vessel arrivals commence. The plan will include requirements of the various regulatory agencies, including the Australian Quarantine and Inspection Service (AQIS) and NT Fisheries.

A marine pest monitoring program has been established for Darwin Harbour by NRETAS. Discussions will be held with NRETAS to determine whether the existing program sufficiently covers EAW, or if additional monitoring is required by the Project at EAW.

1.12.11 Terrestrial Ecology

Ecological Management Services Pty Ltd was commissioned by URS to prepare a terrestrial flora and fauna assessment for the proposed expansion area. The target species included flora and fauna 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 study area (Ecological Management Services, 2011).

The vegetation in the study area is dominated by mangroves, with several smaller areas of terrestrial vegetation situated on the higher ground. The majority of the terrestrial vegetation is a disturbed / regrowth type and the remainder is comprised of remnant vegetation types. In some areas reclamation works have impacted on the condition of both the mangrove and terrestrial vegetation types (Ecological Management Services, 2011).

The flora survey recorded a total of one hundred and five (105) flora species, including ninety four (94) native flora species, eleven (11) naturalised flora species and five (5) 'Declared Weeds' (*Weeds Management Act 2001*). Four vegetation communities were recorded within the study area two (2) of which are classified as sensitive or significant according to the Northern Territory Land Clearing Guidelines (NRETAS, 2010a), the Monsoon Vine Forest (MVF) and the Mangrove Communities (Ecological Management Services, 2011). The remaining were classified as Low to Mid High, Mixed Species Open Woodland to Woodland and Disturbed Areas with Regrowth.

A total of one-hundred and forty-one (141) species of native terrestrial vertebrate species were recorded within the study area, including seven (7) amphibian, eleven (11) reptile, one-hundred and nine (109) birds and fourteen (14) mammal species. Two introduced species, the Cane Toad

Executive Summary

(*Rhinella marina*) and the Asian House Gecko (*Hemidactylus frenatus*), were recorded within the study area. An additional marine mammal, the Indo-pacific Hump-back Dolphin (*Sousa chinensis*), was also observed in offshore habitat adjacent to the study area (Ecological Management Services, 2011).

Significant threatened species in the context of this review are those which are listed in the higher categories of critically endangered, endangered, vulnerable or near threatened under Commonwealth or NT legislation (Ecological Management Services, 2011). The field surveys undertaken to advise this assessment recorded:

- One plant species, *Cycas armstrongii*, which is listed as vulnerable under the TPWC Act.
- One fauna species, the Bush Stone-curlew (*Burhinus grallarius*), which is listed as near threatened under the TPWC Act.
- Thirty-one (31) species of birds listed as migratory wetland or marine species under the EPBC Act.
- Fifty-nine (59) bird species classified as marine species under the EPBC Act.

Cycas amstrongii is endemic to the Northern Territory and is known to occur from Gunn Point to Hayes Creek, west to within 50 km of the coast and east to the Wildman River catchment, and also occurs on the Tiwi Islands and Cobourg Peninsula (Kerrigan, Cowie and Liddle, 2006) (refer Plate ES-1). Threatening processes include land clearing for development projects in the Darwin region and forestry operations on the Tiwi islands (Kerrigan, Cowie and Liddle, 2006). This species was not found within the footprint of the proposed development however it was reported in adjacent habitats during field surveys that were undertaken to advise this assessment.

Source: Ecological Management Services, 2011

Plate ES-1 Cycas Armstrongii (Vulnerable TPWC Act 2000) Area 4

The Bush Stone-curlew (*Burhinus grallarius*) qualifies as near threatened under the TPWC Act, but is close to qualifying for or is likely to qualify for a threatened category in the near future (International Union for Conservation of Nature (IUCN), 2001). This species is relatively common in the Darwin region and the small numbers of pairs that are present in the study area are unlikely to represent a

Executive Summary

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 (Ecological Management Services, 2011).

Previous flora and fauna studies identified two additional threatened fauna species within the study area, the Northern Quoll (*Dasyurus hallucatus)* which is classified as endangered under the EPBC Act and critically endangered under the TPWC Act, and the Yellow Spotted Monitor *(Varanus panoptes)* which is classified as vulnerable under the TPWC Act *(*Acer Vaughn, 1993a).

The Northern Quoll was not detected within the study area during the 2010-2011 survey. At sites in the NT where Northern Quoll populations persist and animals are present in reasonable numbers they are generally detected by the standard trapping and survey techniques applied during the current survey, including trapping, spotlighting, hair funnels and camera traps. As recent trapping and other surveys within the project area have failed to locate this species, it is possible that 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. There is a very small area of fragmented suitable habitat for the Northern Quoll present within the study area (Ecological Management Services, 2011).

The Yellow-spotted Monitor (*Varanus panoptes*) is classified as vulnerable under the TPWC Act. Declines of the Yellow Yellow-spotted Monitor (*Varanus panoptes*) have been associated with the invasion of the Cane Toad. This species has persisted in the Darwin region following the arrival of the Cane Toad (Smith and Firth, 2003), however it is likely to be present at lower population densities. It is potentially still present in the local area, however as for the Northern Quoll there is a limited area of fragmented suitable habitat for the Yellow-spotted Monitor present within the study area (Ecological Management Services, 2011).

Migratory species (EPBC Act) recorded within the study area, were predominantly within the mangroves, saline wetlands (including samphire and salt flat habitat) and the dredge spoil ponds (Ecological Management Services, 2011). Numbers of migratory shore-birds present in local roost sites, mangroves and near-coastal habitats are low when compared to other sites to the north of Darwin (e.g. Lee Point) and Darwin Harbour has not been found to support Nationally or Internationally significant numbers of migratory shorebirds or wetland birds (Chatto, 2003; Harrison et al., 2009). However the area does support locally significant numbers of some migratory shorebirds (Ecological Management Services, 2011).

The most significant aggregations of migratory birds within the study area are associated with the dredge spoil ponds, which provide high tide foraging and roosting sites for birds that move onto adjacent mud flats, rocky shores and saline wetlands at low tide. Other wetland bird species also occur on the water-bodies at the dredge spoil ponds, including ducks, stilt, Australian Pelican (*Pelecanus conspicillatus*) (refer Plate ES-2), ibis and spoonbill. Acer Vaughn (1993a) reported that significant numbers of migratory birds were known to roost on off-shore islands, including South Shell Island, however few birds were observed on these islands during the 2010 - 2011 surveys (Ecological Management Services, 2011).

DPC has an existing Flora and Fauna Management Plan for EAW. A key object of this plan is to ensure that the East Arm Wharf does not have an adverse impact on native flora and fauna and is kept free of declared noxious weeds and that feral plant species and animal species are controlled. This plan identifies potential impacts on the surrounding environment and lists management strategies to address these impacts.

Executive Summary

The DPC has a regular program of inspections to identify pest species present in the EAW management area. This program includes support of marine pest surveys undertaken by the Aquatic Biosecurity section of the Department of Resources (Fisheries). All environmental including pest incursions must be reported and there is a regular review of the efficiency of flora and fauna management measures to ensure implementation of continuous improvement.

Land Clearing Guidelines (NRETAS, 2010b) will be followed for proposed clearing of mangrove and MVF communities. Applications to Clear land will provide additional specific information regarding the 'potential or expected impacts of the land clearing on the habitats of the area and the steps to be taken to reduce and manage risks (Ecological Management Services, 2011).

Management of the local population of *Cycas armstrongii* will consider the management program for Cycads in the Northern Territory (Liddle, 2009). Under the TPWC Act a permit is required by individuals to take Protected Wildlife or their parts for non-commercial purposes. Any proposed clearing or *Cycas armstrongii* habitat within the EAW will be conducted with reference to provisions and requirements of the Act. If possible habitats supporting known populations of *Cycas armstrongii* will be retained (Ecological Management Services, 2011).

Source: Ecological Management Services, 2011

Plate ES-2 Australian Pelican (*Pelecanus conspicillatus*) Pond B East Arm Wharf

Measures will be taken to minimise potential impacts on migratory shorebirds and their habitats. These measures will include (Ecological Management Services, 2011):

- Minimise the area of mangrove, salt pan/saline flats and tidal mudflat areas disturbed for any works or reclamation.

Executive Summary

- Inclusion of buffer zones to significant mangrove and marine habitats, as well as any other habitats that support aggregations of listed migratory/marine species where possible.
- Strict controls on sedimentation or other impacts that may impact shorebird feeding sites.
- Protection of high tide roost sites and provision of additional high tide roost sites where possible.
- Controls on activities or facilities that might disturb feeding and roosting birds (e.g. noise, nocturnal lighting).
- Undertaking significant works in the vicinity of areas where migratory shorebirds in the dry season when most northern hemisphere migrants are absent (May – August).
- Implement measures to minimise the potential import and / or spread of weeds during construction.
- Put in place controls to ensure that no cane toad breeding habitats are created during or following construction (e.g. small, still ponded freshwater or brackish areas).
- Continued restricted access to the public and animals (dogs) to areas where migratory shorebirds roost and feed.
- Control and management of feral cats, as part of management programs for feral species.

Areas that are disturbed during construction activities or no longer required will be progressively rehabilitated with due consideration of the requirements of fauna species that will potentially recolonise these areas (Ecological Management Services, 2011). It is noted that dredge spoil ponds have become locally significant habitat for migratory and wetland birds, and represent the most significant high tide roost for migratory shorebirds in the East Arm area. However these areas will ultimately be filled and developed as hardstand areas and the roost sites will be lost. It is not known where birds will subsequently roost during high tides, however there may be alternative sites on offshore islands or adjacent areas (Ecological Management Services, 2011).

DPC currently monitors shorebirds and wetland birds within the EAW, mainly at the dredge spoil ponds (David McMaster, Darwin Port Corporation pers. comm. 2011). This monitoring program should be continued and expanded to include the saline flats/tidal mudflats within Area 1 and Area 3/4.

Terrestrial Ecology Commitments
DLP commits to minimising areas of disturbance, particularly areas of mangrove and MVF communities. *DLP commits to ensuring that clearing of vegetation for construction and operational activities associated with the proposed expansion of EAW will be undertaken in accordance with the NRETAS Land Clearing Guidelines (NRETAS, 2010b). Wherever possible, DLP will seek to identify opportunities to rehabilitate previously disturbed areas as part of the proposed development.* *DLP commits to ensuring that the management of the local populations of Cycas armstrongii will consider the requirements of the Northern Territory TPWC Act 2000 and the management program for Cycads in the Northern Territory (Liddle, 2009).* *DLP commits to ensure that measures will be taken to minimise potential impacts on migratory shorebirds and their habitats, such as:* • *Minimise the area of mangrove, salt pan/saline flats and tidal mudflat areas disturbed for any works or reclamation.* • *Inclusion of buffer zones to significant habitats.* • *Controls on sedimentation or other impacts that may impact shorebird feeding sites.* • *Controls on activities or facilities that might disturb feeding and roosting birds (e.g. noise, nocturnal lighting).*

1.12.12 Visual Amenity

A desktop visual impact assessment was undertaken to examine the changes to visual amenity associated with the proposed development. This assessment drew largely upon the findings of the visual assessment undertaken in 2009 as part of the EIS for the INPEX Gas Plant at Blaydin Point.

The desktop study included a review of the conceptual layout of the developments, including any tall or wide infrastructure such as cranes, jetties and breakwalls that will extend into Darwin Harbour. Other considerations that were included in assessments were lighting, emissions such as dust generated during site clearing / earthworks, sediment disturbance during dredging and loading / unloading of ore; and operating hours.

A part of the INPEX EIS (Inpex Browse, 2009) a list of 14 viewpoints of interest to the community from around Darwin Harbour was compiled in consultation with government authorities. These sites were selected to account for a range of viewing angles, potential receptor types and residential, cultural, heritage and tourism values. These same sites have been used for this visual impact assessment. The locations of identified viewpoints are shown in Figure ES-9.

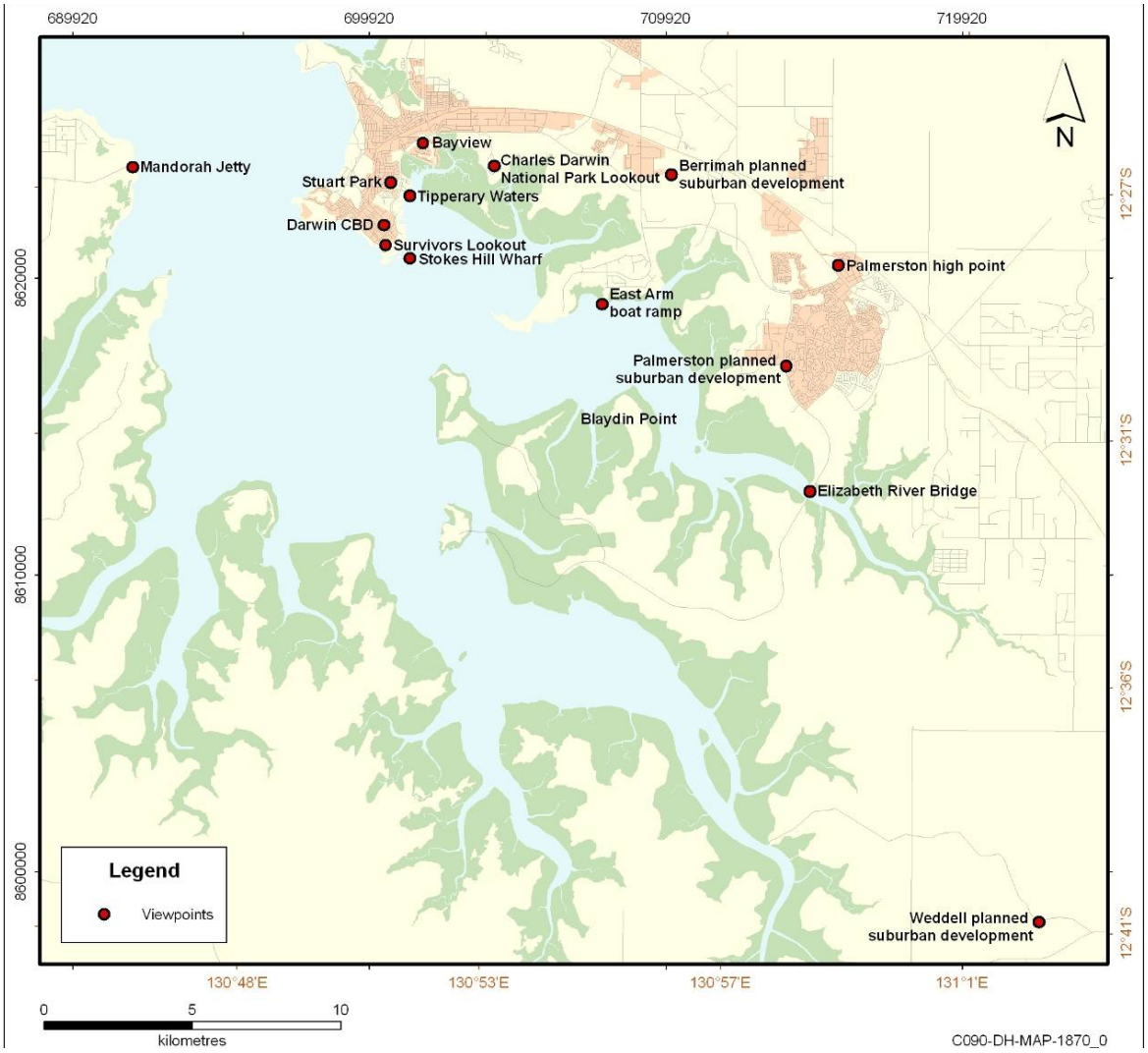


Figure ES-9 Viewpoints Considered in the Visual Impact Assessment

Executive Summary

A viewshed analysis was undertaken to plot the likely visual catchments of the development areas, from the various viewpoints. Computer simulated viewsheds were created using the Viewshed Analysis module in *ArcGIS Version 9.3 Spatial Analyst* based on a detailed digital terrain model. The digital terrain model was based on the 1:10,000 orthophoto map sheets supplied by DPI, and interpreted coastline data. The height of vegetation was modelled using the publicly available National Vegetation Inventory System vegetation mapping. The vegetation mapping was then intersected with land use mapping.

As no 3D models of the proposed EAW development were available at the time of the study, heights of the various features (hardstand areas, jetties, breakwalls, etc) were estimated from the surrounding topographic features.

Site inspections were not carried out as part of this visual impact modelling, however site inspections were carried out at each viewpoint for the proposed INPEX gas plant development looking towards Blaydin Point (adjacent to EAW) to ground-truth the viewshed analysis for the INPEX project. As the same viewpoint locations have been used for this assessment and there have been no major land clearing or land development projects in these areas, it is assumed that the same sites will be screened from the Proposed EAW project.

Viewpoints from which the proposed development area was visible were broadly considered to be *Medium* to *High* impact sites. Viewpoints where the views to EAW were significantly obscured by vegetation, buildings or topography were considered *Low* or *No* impact sites.

The only site rated “high” impact is the East Arm public boat ramp, as the proposed development would be clearly visible from this viewpoint, over a moderate distance. This view of the Project could potentially be experienced by a large number of people that utilise the boat ramp for recreational fishing, boating, or tourism.

The view from Stokes Hill Wharf in Darwin was rated “medium” impact, as were five other sites: Darwin CBD (view from high-rise building), Survivors Lookout, Hilly residential area at Stuart Park, Harbour foreshore at Tipperary Waters, and Harbour foreshore at Bayview Haven. The proposed development area would be visible from these viewpoints, but over relatively long distances and with some partial obstructions to this view. The proportion of the view taken up by the proposed development areas from these distances would be small.

The view from Mandorah, Berrimah and Palmerston (planned residential subdivision) were rated “low” impact, as the distance to EAW is very long and would be barely visible. EAW is not visible from Weddell, Elizabeth River Bridge, Charles Darwin National Park or from the highest point in Palmerston.

Retaining a strip of naturally occuring vegetation around as much of the proposed development area will “buffer” the visual impact of the site to receivers at some viewpoints, (e.g. around the proposed rail loop). It is likely that mangroves will recolonise this area naturally, further buffering the site from external view over time.

Some of the proposed infrastructure (such as cranes) will be taller than the existing tree line and will not be completely hidden, but the retention of vegetation in the foreground (when viewed from the east) will reduce the otherwise stark contrast between the proposed development area and surrounding undeveloped mangrove coastline. However, it is recognised that the nature of the proposed infrastructure (jetty’s and wharfs) precludes the retention of shoreline vegetation around

some parts of the proposed development area, and that these areas would need to be cleared of vegetation. Some visual impact is inevitable for an operational port facility.

Light from the proposed development areas will be attenuated to some extent over the 4-km distance to Palmerston, and 10 km distance to the Darwin CBD. To minimise lighting effects on surrounding areas, lights should be faced inwards as much as possible.

Some of the emissions from the wharf facilities could be visible on occasion from short to medium distances. Visual impact should be considered when developing air emissions management controls for the Project. The possible negative impact of smoke and dust on the viewshed around EAW (and further offsite) may be reduced through actions such as:

- Committing not to burn vegetation.
- Controlling dust by wetting down exposed surfaces during dry weather.
- Conducting clearing work in stages, where practicable, to minimise total exposed area.

1.12.13 Historical and Cultural Heritage Values

Earth Sea Heritage Surveys was commissioned by URS to undertake an archaeological assessment for the proposed EAW Expansion. The scope of the study included a:

- desktop study that describes World War II (WWII) maritime and Indigenous heritage of EAW and the corresponding legislative, historical and environmental setting; and
- field survey by cultural heritage specialists accompanied by a Larrakia representative.

The survey methodology used a participative resource management strategy to engage Traditional Owner representatives in the physical survey and the cultural heritage assessment of sites located during the survey. Lorraine Williams of the Larrakia Nation accompanied the consultant during the field work component of the East Arm Survey.

The field surveys and desktop research 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)
- Maritime wreck sites

Only one of these sites, Indigenous Site 1, is located within the proposed development.

Each of the cultural heritage places identified are listed in Table ES-2, along with a summary of their features and assessments of their heritage values.

Indigenous Cultural Heritage Recommendations

The Indigenous archaeological sites located in this survey are afforded interim protection under the Heritage Conservation Act until the Minister for Heritage determines otherwise. These archaeological sites contain a representative sample of the significant archaeological features of the general Darwin Harbour area.

Executive Summary

Currently, there is not enough data to properly assess the significance of each archaeological feature. As per the guidelines from the Australia ICOMOS Burra Charter, it is necessary to obtain further data to inform future management and conservation decisions. This would include an attempt to characterise the stone tool technological system that is occurring in the region and further radiometric dating of the shell scatters and middens to obtain a comprehensive account of marine exploitation and environmental change which would also contribute to further understanding of residential mobility in the Darwin coastal region.

Table ES-2 Cultural Heritage Places located in the Vicinity of EAW

Site Name – ID	Features	Heritage Assessment Value
Indigenous Site 1	Midden, Stone Artefacts	Very High cultural and archaeological significance
Indigenous Site 2	Stone Artefacts	High cultural and archaeological significance
WWII Dump F1	44gal drum dump	Low cultural and archaeological significance
WWII Dump F2	Artefact scatter	Low cultural and archaeological significance
WWII Dump 3	Scatter of artefacts	Moderate cultural and archaeological significance
WWII Site 1	Drum emplacement feature; artefacts	Moderate cultural and archaeological significance
Unidentified Shipwreck	Wrecked boat – possibly Vietnamese refugee boat	Limited archaeological significance Moderate social and cultural significance
ID3408 (Con Dao 3) ID3430 (Vietnamese Refugee Boat 2) ID3584 (Vietnamese Refugee Boat Pk76) ID3429 (Vietnamese Refugee Boat 1)	Vietnamese refugee shipwrecks 1976-78	Limited archaeological significance Moderate social and cultural significance
ID3427 (East Arm Barge 2) ID3428 (East Arm Two Part Barge)	WWII small water craft shipwreck sites	Limited archaeological significance Limited social significance Moderate historical significance
WWII Catalina 2 WWII Catalina 3	RAAF Catalina wreck sites	Very high archaeological, historical, and social significance
WWII Catalina 6	US Navy PatWing 10	Very high archaeological, historical, and social significance
Kelat	WWII shipwreck site	Very high archaeological and cultural significance

Should the proposed EAW Expansion impact on the Indigenous archaeological site identified, it is recommended that the following archaeological mitigation works are implemented with the general disturbance approval:

- Excavation and recording of shell deposits and scatters to establish MNI, NISP and changes in marine utilisation strategies.

Executive Summary

- Collection and submission of samples for radiocarbon determinations to assess timings of marine exploitation, occupation of the area, and residential mobility patterns.
- Collection and metrical analysis of a reasonable sample of the stone artefact assemblages to investigate stone artefact technology issues and residential mobility patterns.
- Establish a protective buffer zone around each site of 100 m until Ministerial approval has been sought for the disturbance of these sites and mitigation works have been conducted.

Historic WWII Archaeological Sites

The review identified four historic WWII archaeological features located in the vicinity of EAW. These sites are not recommended for protection owing to their low cultural heritage values.

It is unlikely that there will be an impact on these four WWII historic sites as they are outside of the likely corridor for the proposed rail loop (the nearest component of the proposed development). If disturbance is required, however, it is recommended that these sites are only disturbed or destroyed after further mapping and documentation of the artefact assemblages and features is undertaken.

Historic archaeological sites are not afforded blanket or automatic protection under the *Heritage Conservation Act 2008* and none of these historic archaeological sites have been nominated, assessed, or declared under this Act. However should these heritage recommendations be made part of the environmental impact assessment under the NT *Environmental Impact Assessment Act 1982*, then recommendations regarding historic archaeological sites made in the course of the Government assessment process are enforceable. As a result, the proponent may be obliged to undertake conservation and mitigation works on the historic archaeological sites that may be impacted from the expansion project.

An important reason for consideration of the WWII cultural heritage is that there is generally a high level of interest from sections of the community in the conservation and management of WWII sites. Developments from WWII infrastructure had a large impact on the Darwin Harbour region, especially East Arm.

Although some interest groups would prefer that sites remain *in-situ*, a reasonable compromise may be to conduct recording and salvage operations before major impacts. DLP should therefore consider notifying the public of any potential impacts to WWII sites.

Maritime Wreck sites outside the proposed development area

There are four significant maritime wreck sites within 2 km of the proposed EAW expansion area. These wreck sites are located to the south and east of East Arm and consist of the following sites:

- Catalina 2 (RAAF Catalina A24-69).
- Catalina 3 (RAAF Catalina A24-206).
- Kelat.
- Catalina 6.

These wreck sites are not protected under the Shipwrecks Act. These aircraft wreck sites have been nominated to the NT Heritage Register. Ownership of the RAAF Catalina aircraft is still believed to be by the Commonwealth. These WWII aircraft have been assessed by the NT Heritage Branch as having a high level of cultural heritage significance; however a final assessment has not been made by the Minister for Heritage. It is noted that none of the sites are war graves.

Executive Summary

As noted above, the wreck sites are outside of the proposed development area, and modelling results show that dredging activities associated with the Project will have little impact on current flows and sedimentation (Chapter 8).

Maritime Wrecks Site within the proposed development zone

There is one maritime wreck site identified near the proposed railway loop. This site is the unidentified maritime wreck site that may be a Vietnamese refugee boat wreck. The wreck site appears to be in poor physical condition and preservation. If the site is a Vietnamese shipwreck, it is likely to have some social and historical value.

This site is not proposed to be impaired by the EAW Expansion Project. However, should the proposed EAW Expansion impact on the site, a program would be undertaken by a maritime archaeologist to positively identify, document and map the wreck.

A Cultural Heritage Management Plan (CHMP) should be incorporated into the CEMP for the proposed expansion of EAW. It should contain the recommendations, details, and the conservation steps to be taken in regards to the Indigenous, historic, and maritime cultural heritage places and features identified in this DEIS.

The CHMP would include a communications plan for effectively communicating to affected parties that consider the cultural heritage values of the East Arm area to be significant. The communications plan should state clearly how the potential impacts will be communicated to the general public, with special attention to the Indigenous community. The communications should also include maritime archaeological work.

A general Indigenous community communications strategy should be developed given the high profile of indigenous cultural heritage in the Darwin region. Indigenous participants in the archaeological and cultural heritage survey expressed concern regarding the potential destruction of important ecological habitats for natural resources such as the mangroves. It is recommended that the proponents of the EAW expansion ensure limited damage to the mangrove environments. Further communications with the Indigenous community may be required to discuss concerns regarding the mangrove environments on the northern side of East Arm and their possible conservation. It is also recommended that DLP, in cooperation with local traditional owners and native title claimants, are involved in the future cultural heritage mitigation works proposed for the EAW Expansion.

Historic and Cultural Heritage Commitments
Indigenous Site 1 (shell midden and artefact scatter) adjacent to the rail loop would be avoided as much as is practicable. If disturbance cannot be avoided, the site will be studied, documented and recorded prior to disturbance.
The unknown shipwreck site to the south-west of the rail loop would be avoided as much as is practicable. If disturbance cannot be avoided, the site will be studied, documented and recorded prior to disturbance.
The CEMP and EMP for the proposed development will refer to the heritage sites identified by the historic and cultural heritage sites.

1.12.14 Social Environment

A social environment impacts assessment was undertaken as part of the preparation of this DEIS. Potential impacts are described for construction and operational phases of the project. Due to a lack of information on specific workforce requirements and construction timing, these assessments are based on experience of potential impacts that have occurred in similar developments.

Opportunities for training and employment would exist within the construction period, which will likely require skilled professionals, such as engineers; technical workers, electricians, skilled construction workers and equipment operators; labourers; and, managers and administrators. It is expected that less than 200 people will be required to work on construction of the expanded facilities. Longer term employment opportunities associated with the operations of the EAW are likely to be of a small number (less than 20 FTE staff), as there will be existing operational staff at the wharf.

If local employment is favoured there will be an improvement in local skills base and the local economy. However, existing low unemployment levels may create competition for employees, which may cause an increase in wages, and draw people away from jobs where the employers are unable to pay commensurate wages; thus causing a gap and potentially higher costs for some employers. Additionally, there are a number of significant projects in development that may compete for local labour and there is anecdotal evidence that the reconstruction following the recent natural disasters in Queensland has also drawn labour away from the Darwin region. There is also a potential for widening of the gap between those in employment and those with lesser opportunities. Therefore it may be difficult to source local labour as a preference. It is noted, however, that construction is an industry that will always have temporary / finite work and therefore there may be some fluidity in the availability of contractors and employees.

Depending on the degree to which workers are local residents, or non-locals, there may be demographic changes and inflationary pricing within the area. However the duration of time and peak for the non-local workforce cannot be established as yet and it may be that the significance of this impact is reduced if certain workers are only required for a limited amount of time. It should be considered that many of the direct impacts will be relatively short term (of a two year duration or less) and associated with the construction period. This is when peak employment will occur.

An increased need for housing and accommodation may provide additional income to local businesses and individuals who provide these services. Conversely, increased demand may further reduce what is already a limited housing and accommodation stock and cause increased competition and inflationary pricing, which may adversely affect some members of the population. Again the likelihood of this impact occurring depends on the size of the non-local workforce and the duration of required inputs. The likelihood is also influenced by other developments and demand for housing and accommodation within the region - a high level of economic growth has been predicted for Darwin and there are currently low vacancy rates for both rental properties and hotel-style accommodation. Therefore it is possible that there may be some low level impacts, mostly due to cumulative impacts.

There is a strong likelihood that there will be opportunities for the use of local content and many goods and services for construction can be sourced from local or regional suppliers. This could include the provision of construction materials and labour, provision of management and oversight, and indirect employment to support the operations or workers. However although there will be benefits to local businesses associated with the provision of local content, these are not considered to be significant to the overall economy.

Executive Summary

Depending on the levels of non-local employment, duration of inputs and whether or not employees were to bring family members with them, there may be an increase in the need for community goods and services. An increased population may place constraints on the level of access to services and strain on community infrastructure. It may also cause inflationary pricing due to increased demand and limited supply.

However, it is recognised that both Darwin and Palmerston are high growth areas and the increase in temporary population would not be significant in comparison to ongoing natural growth, tourism and the related government planning. There has been recent expansion to medical service provision, both at Darwin hospital and the Palmerston 'super clinic', and it is unlikely that the proposed workforce or ongoing activities will have more than a low level of impact on the availability of access to community services or infrastructure.

Other potential social impacts that have been considered within other parts of this DEIS include;

- The potential for increases in vector born diseases from biting insects.
- The potential for exposure to hazardous materials due to increased trade volumes during operations.
- The likelihood of issues related to the increase of road traffic, especially during the construction phase, when raw materials will be hauled to the site.
- Reduced safety of proximate recreational activities during the construction phase.
- Changes to visual amenity of the site.
- The potential for increased noise and air pollution.

The site is located in close proximity to the Charles Darwin National Park and is also located close to, or holds sacred or heritage sites. There is community concern relating to the potential for impacts on mangroves, cultural sites, marine creatures, coral and the general environment that is valued by recreational users. There are also concerns about the increased industrialisation of the harbour especially with consideration of the cumulative impacts of the development within Darwin Harbour.

Construction exclusion zones will be required on a temporary basis to ensure public safety, and the expansion of the site and volume of harbour traffic may have some effect on the location of recreation activities. Sacred sites are protected from direct disturbance though the Aboriginal Areas Protection Authority, but it is possible that there may be temporary indirect impacts.

During construction and operation of the proposed development, mechanisms should be put in place for communities to register concerns or issues associated with the project, and these concerns will be appraised and investigated as necessary. DLP will specify that contractors develop a strategy to minimise impacts on existing housing stock, including prioritising local employment. DLP will also monitor and evaluate social impact management strategies to be implemented by Contractors and establish a means by which to report on their effectiveness

The proponent will enhance safety, wellbeing, and security of the community by developing traffic management plans, air quality management plans, biting insect management plans, codes of conduct for personnel, and robust controls for hazardous goods transport and management. These will be communicated to the community as appropriate. Efforts will also be made to minimise the project footprint and rehabilitate areas no longer in use.

Executive Summary

Social Environment Commitments
Promote local content, revenue generation and skills development, as well as participation by indigenous people in the project, in the construction contracts for the project.
Work with other government agencies to ensure that their planning is informed by EAW activities.
Ensure that the main contractors develop a strategy to minimise impact on existing housing stock.
Ensure that contractors and then operations include management measures for community health and safety.
Inform communities about avoidance of environmental impacts, and environmental mitigation activities.
Monitor and respond to community concerns about the project and operations, and implement corrective action resulting from outcomes of investigation of community concerns.

1.12.15 Economics

Total trade volume across the DPC's facilities for 2009/10 increased by 802,894 t or 21% from 2008/09 to a record 4,577,532 t in 2009/10. Total trade since 2006/07 has increased by 3,116,368 t or on average 71% per year across the EAW. The major components of this increase are in dry bulk. A record for the number of trading vessels visiting the Port of Darwin was reached in 2009/10, totalling 1642 vessels. This was a 13% increase on the previous year. Since 2006/07 trading vessel visits to the Port of Darwin have grown on average 31% per annum (DPC, 2010c).

Table ES-3 shows the volumes of cargo that pass through the East Arm facility by type, and indicates the dominance of dry bulk products. In terms of export, dry bulk volumes increased by 817,024 t or 37% in 2009/10 over the previous year to reach a record 3,023,581 t. The key product increases were in iron ore, manganese and copper concentrates. Dry bulk exports have now increased for the 8th year in a row (DPC, 2010c).

Estimates of growth based on proposed mineral developments in the Darwin region and those likely to utilise Darwin as a service and export hub indicate that mineral tonnages being shipped by road and rail and through the Port of Darwin could reach 10 Mt/a (ACIL Tasman, 2009). This is some three times greater than the dry bulk tonnages handled in the 2009/10 year. If infrastructure capacity is not expanded then this will constrain these potential developments.

Three studies were available to provide some indication of economic impact or net benefit of the proposed EAW expansion. AECOM (2010b) provides a business case assessment for increasing port capability in land-based infrastructure and channel access to provide for potential increases in exports of dry bulk minerals and in exports of LNG from processing plants located in Darwin. ACIL Tasman (2010a) provides a benefit-cost analysis of the MSB component of the EAW expansion, and the ACIL Tasman (2010b) report provides an assessment of the economic impacts of the MSB.

Executive Summary

Table ES-3 Darwin Ports – Cargo by Type 2009/10

Cargo (tonnes)	Total traded
Livestock	177,159
Foodstuffs	4,710
Building Supplies	11,118
Livestock Feed	14,541
Beverages	25,837
Dry Bulk	3,163,787
Metal Waste	17,792
Petroleum	821,152
Chemicals	181,084
Paper	3,049
Timber	231
Metal Products	26,810
Machinery & Equipment	38,005
Motor Vehicles and Parts	10,927
Glass	752
Other	80,578
Total	4,577,532

Source: DPC, 2010c

The AECOM (2010b) report suggests mine development facilitated by the port expansion will create flow-on economic impacts in the Northern Territory in terms of "additional value added, employment, household income (through wages and salaries) and taxation (royalty payments and payroll tax)". The report suggests that these effects will contribute to the NT economy over 20 years up to an additional:

- $8.4 billion of value added (in present value terms). This represents an annual value of $765 million, which is equivalent to about 4.7% of NT Gross State Product for 2008-09 ($16.3 billion).
- $1.7 billion of household income (in present value terms) through the payment of wages and salaries over the 20 year analysis period, representing an annual value of $156 million. This represents about 1.8% of estimated household income for NT (based on gross household income per head of $38,433 and population of 227,000 persons).
- $1.4 billion in payments of royalties and payroll tax to the NT Government, representing an annual value of $129 million. This represents about 34% of payments of royalties and payroll tax budgeted for 2010-11.
- 370 jobs (full-time equivalent) in 2015, representing about 0.3% of estimated total current full-time equivalent jobs in NT (based on 96,045 full-time jobs and 23,218 part-time jobs).
- It is noted that this financial modelling was undertaken for a particular staged development which may or may not be directly comparable to current options.

Executive Summary

The benefit-cost analysis of the Marine Supply Base (ACIL Tasman, 2010a) assessed:

- net revenues from the MSB
- increases in port revenues
- increases in land sales, and
- improved manufacturing outcomes.

ACIL Tasman (2010a) recognises that a MSB provides for a transfer of services to increase the capacity of other infrastructure to better focus on the key growth business of minerals exports. The report suggests the MSB, and the business it is expected to enable, is likely to stimulate demand for industrial land in and around Darwin. The report suggests that in order to realise these benefits it is important that the MSB is well linked to surrounding industrial areas and that inappropriate impediments to the establishment of this business are removed (ACIL Tasman, 2010a).

The ACIL Tasman (2010b) report analyses the potential economic impacts associated with the construction and operation of the MSB. It assesses additional NT local content generated from the offshore petroleum sector as a result of the MSB and examines macroeconomic impacts of the MSB's construction and operation.

The construction phase of the MSB will generate a substantial number of short-term jobs and provide a larger boost to real income since the investment is increasing the demand for NT goods and services which results in an improvement in the NT's terms of trade. As well as creating additional long term employment in the NT economy (and most likely in the Darwin region), the construction of the MSB in Darwin will generate a substantial number of short-term jobs (ACIL Tasman, 2010b). In addition to the direct jobs generated on-site, the construction and operation phases will “require significant quantities of NT sourced goods and services. Production of these inputs will further increase the demand for labour across the NT economy” (ACIL Tasman, 2010b).

At this stage the design and investment cost of the overall project is uncertain and direct employment during construction and operation has not yet been estimated. As such the capacity to make a complete economic assessment is constrained. Notwithstanding this it is anticipated that the potential positive and negative economic impacts of the expansion include:

- Investment cost of the project.
- Disruption to port services, local community and businesses – short term disruptions to existing port services during construction, such as traffic impacts, and cross sectoral competition for labour.
- Short and long term environmental and social costs caused during construction, and operation of the facility.
- Port operational efficiency gains – reduced per unit operating costs, and reduced berthing times that might come with improved infrastructure and operating systems.
- Port capacity gains – increased port revenues that come with increased capacity and throughput.
- Macro effects on the NT economy – short and long term.

It is anticipated that expansion activities proposed for EAW will improve operational efficiency and capacity. This will provide an economic benefit to the Port and potentially to its customers in the long term. The rail loop will be expected to provide greatest improvement in capacity and operational efficiencies; this may be reflected in reduced costs and turnaround times.

There may be some additional costs associated with managing impact to existing port services during the construction phase, however, it is expected that these costs will be minimal. There may also be

some aggregate impacts on the local community and businesses during construction but these have not been determined as yet.

Key risks to delivering positive economic benefits will arise primarily from construction cost overruns and from changing commodity prices. Demand for increased services and the ports expansion will continue with demand for mineral, oil and gas exports. The AECOM (2010b) report suggests the financial modelling to show a positive net financial return to be sensitive to capital cost increases with a 20% increase reducing the net value to negative. This would then require increases in wharfage charges.

1.12.16 Biting Insects

One of the most significant impacts of construction in or adjacent to tidal areas is the potential for the creation of new biting insect breeding sites (Medical Entomology, 2009a). Mosquitoes are a serious potential public health issue in the NT, both as pest insects and as vectors of a number of human diseases (Warchot and Whelan, 2011). In appreciation of this issue a biting insect investigation was recommended as part of the Environmental Assessment process for the proposed expansion of EAW.

Medical Entomology of the Northern Territory Department of Health (DoH) was commissioned by URS to conduct this assessment. Medical Entomology was also separately commissioned by DPC to undertaken routine monitoring at East Arm boat ramp from February 2009 to February 2010 to provide recommendations to minimise the mosquito problem in the area and to provide baseline data to advise this assessment.

The report prepared by Medical Entomology indicates that the East Arm area has been an appreciable mosquito breeding area since the development of the port, 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 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).

The report prepared by Medical Entomology includes specific recommendations in regards to filling borrow areas, site clearing / reclaiming, stormwater, sediment ponds, mud ponds, water sensitive

urban design, ongoing site management and other activities that could lead to the creation of water ponding, along with information from relevant Medical Entomology Guidelines. These Guidelines include:

- *Construction practice near tidal areas in the Northern Territory - Guidelines to prevent mosquito breeding* (Medical Entomology, 2009a).
- *Guidelines for preventing biting insect problems for urban residential developments or subdivisions in the Top End of the Northern Territory* (Medical Entomology, 2009b).
- *Constructed Wetlands in the Northern Territory – Guidelines to prevent mosquito breeding* (Warchot and Whelan, 2008).
- *Biting midges or sandflies in the Northern Territory* (Whelan, 2003).
- *Personal protection from mosquitoes and biting midges in the Northern Territory* (Whelan, 2009).

This report also includes recommendations in relation to chemical control.

Routine mosquito trapping is undertaken by the AQIS at EAW (Medical Entomology, 2010). DLP and DPC will continue to consult with Medical Entomology and AQIS regarding requirements for managing and monitoring biting insects at EAW into the future.

Landholders will be responsible for identifying wet season ponding areas for rectification, and maintaining stormwater drains and sediment ponds to prevent mosquito breeding. Landholders will also be required to regularly inspect rainwater tanks and sites for unwanted artificial receptacles that could act as breeding sites for exotic dengue carrying mosquitoes. Any receptacle that has the potential to pond water will be appropriately disposed of, stored under cover away from rain, fitted with drainage holes or treated with an appropriate larvicide, to prevent endemic mosquito breeding.

Biting midge buffers, in the form of larger industrial lots (>4,000m^2) and promotion of land use such as storage or other activity that results in most of these lots being maintained free of vegetation, are recommended adjacent to the mangroves to minimise the number of people working in the worst areas for biting midges (Warchot and Whelan, 2011).

All lots should have a notification on titles mentioning the high biting midge pest problems that occur at the East Arm Port Area and adjacent areas between the wharf and Hudson Creek east of Berrimah Rd (Warchot and Whelan, 2011).

Biting Insects Commitments
DLP commits to advising all workers that pest and disease-carrying mosquito species may be periodically present at the wharf.
DLP will also provide advice on appropriate personal protection measures and ensure appropriate personal protection equipment is available in accordance with guidelines developed by the Medical Entomology Branch of the Department of Health. .
DLP commits to ensuring that the construction and operational activities associated with the proposed expansion of EAW will be undertaken in accordance with the guidelines developed by the Medical Entomology Branch of the Department of Health and the recommendations included in this Draft EIS. Wherever possible DLP will seek to identify opportunities to rectify existing mosquito breeding sites as part of the proposed development.
DLP commits to ensure that Landholders regularly inspect sites to identify areas requiring rectification

Executive Summary

Biting Insects Commitments
and maintain stormwater drains and sediment ponds to prevent mosquito breeding. Any insecticide control programs will be funded by the relevant landholders and subject to ongoing evaluation to determine if insecticide resistance is occurring.
DLP commits to ensure that Landholders regularly inspect rainwater tanks and sites for unwanted artificial receptacles that could act as breeding sites for exotic dengue carrying mosquitoes. Any receptacle that has the potential to pond water will be appropriately disposed of, stored under cover away from rain, fitted with drainage holes or treated with an appropriate larvicide, to prevent endemic mosquito breeding.
DLP commits to ensure that where possible larger lots that are free of vegetation will be recommended adjacent to the mangroves, to provide a buffer to minimise the number of people working in the worst areas for biting midges. Activities such as storage will be promoted in these areas.

1.12.17 Fire

The *Fire and Emergency Act 1996* legislates the operation of the Northern Territory Fire and Rescue Service (NTFRS) and provides for the creation of Emergency Response Areas (ERA), in which the NTFRS operates. The EAW lies within the Darwin ERA so emergency response (including fire fighting) at the EAW is the responsibility of NTFRS (NTFRS, 2010). Duties of owners and occupiers of land within an ERA in relation to fire management and prevention include fire breaks, storage of containers, tyres, oily waste and other combustible materials, and operation of flues and heating / cutting / welding equipment.

At present, the NTFRS consider that the EAW has an extremely low risk factor for bushfires (NTFRS pers. comm.). The site is primarily devoid of grasses and vegetation that would provide high fuel loads, however colonies of various weeds (including Mission and Gamba grasses) are present at the site. These weeds can potentially provide fuel for a fire.

The construction phase of the EAW expansion works will include further reclamation and the corresponding clearance of existing weeds and other vegetation. After the site has been cleared, there will be little vegetation remaining and a continued extremely low risk factor for Bush Fires, unless poor management allows for the growth of invasive weed species and shrubs. Likewise, the bushfire risk will remain extremely low when the EAW is fully operational.

Notwithstanding the low bushfire risk, potential ignition sources throughout construction and operation phases include:

- ‘Hot work’ activities such as grinding and welding.
- Faulty electrical equipment.
- Machinery and vehicles.
- Human behaviour including careless disposal of cigarette butts.
- Controlled burning practices.
- Uncontrolled events such as lighting strikes and arson.

Executive Summary

The EAW has bulk liquid and hazardous materials infrastructure including pipelines and storage vessels and storage sheds. Additional fuel storage (and minor storage of other flammable materials, such as lubricants) will be present at the MSB. There is potential for fire to be caused by a variety of ignition sources, which could lead to human and environmental harm.

Fire prevention mitigation measures have been identified for the project. These measures include:

- Control of grassy vegetation and exotic weeds to limit fuel loads.
- Vehicles and equipment used for clearing vegetation will be regularly cleaned to remove accumulated combustible material, and maintained to ensure against release of exhaust sparks.
- Stockpiling mulched vegetation from clearing operations, in designated areas away from potential ignition sources and reusing this vegetation or disposing of it off-site rather than burning it.
- Ensuring appropriate fire fighting equipment (e.g. fire hydrants, fire hoses, fire extinguishers) and water storage for fire prevention will be available on site at all times.
- Establishing designated smoking areas and receptacles for cigarette butts.
- Use of firebreaks and emergency fire access tracks.
- Establishing a suitable means of raising the alarm in the event of a fire or other emergency will be established.
- Compilation and implementation of ongoing updated construction and operational Fire Management Plans (FMPs), including updates to emergency procedures and muster points as individual facilities are developed.
- Encouraging operators to equip permanent site vehicles with a compatible and appropriately sized fire extinguisher and to store all flammable and combustible liquids in accordance with Australian Standards.
- Use of training and induction schedules, and periodic emergency evacuation and response exercises.
- Encouraging operators to ensure that all site inductees are aware of main fire management control measures, including general fire extinguisher use, hot work requirements, emergency evacuation procedures and muster points.

Many of the activities and much of the infrastructure involving hydrocarbons and hazardous materials is not under the direct control of the DPC. Management strategies that the DPC have in place require environmental management plans from port users to cover their activities, including the management of fire risk.

Appropriate monitoring will be undertaken as part of the operation of the expanded EAW, during both the construction and operational phases, recognising that some facilities will be operational while others are under construction or awaiting development. Monitoring will include:

- Encouraging operators to identify all fire incidents on an incident reporting database.
- Encouraging operators to work cooperatively with each other and undertake emergency response drills and exercises to ensure that individual site FMPs are compatible with each other and the overall EAW precinct FMP, and that there is no deficiency or conflict in approach.
- Encouraging operators to undertake workplace ‘housekeeping’ to ensure no accumulation of debris or combustible material.
- Regularly checking invasive grasses and weed spread to ensure limited growth and systematic control.
- Regularly checking fire breaks and emergency fire access tracks.

1.12.18 Waste and Hazardous Material Management

An assessment of impacts in relation to dust and light emissions, solid and liquid waste generation and storage of hazardous waste was undertaken.

Dust / Air Quality

Monitoring and management of dust / air quality will be integrated into air quality, stormwater, and sediment and erosion control plans. Management measures currently undertaken at EAW to reduce dust emissions and spillage include:

- Enclosure of dust generating activities where operationally practical and efficient.
- Implementation of appropriate dust suppression or capture technology where enclosure is not practical.
- Efficient operation of machinery, equipment and vehicles to minimise exhaust emissions.
- Clean up of residues and spills in a timely manner.
- Adherence to activity specific EMPs.
- Adherence to the Monitoring Plan for the NT as prepared in accordance with the AAQ NEPM.
- Regular review of the efficiency of air quality management measures to ensure implementation of continuous improvement.

In addition to the above air quality management measures, the bulk mineral facilities (ship loader rail dump) is not operated until:

- Clean up of the previous user has been completed.
- All emission and capture devices have been returned to their “in use position” (i.e. covers closed, tarpaulins strapped closed, gallery louvers closed, spill trays and collection bins are in place and bund outlets closed).
- All dust emission equipment such as dust suppression sprays, return belt wetting sprays, dust extractors, and scrapers, are operating and functioning correctly, as and if required. This equipment is not required where saturated product or other circumstances provide for satisfactory environmental performance.

Lighting will be designed in accordance with relevant Australian standards to ensure that worker safety and site security are not compromised, reduce the risk of environmental or safety incidents, and maintain light spill to reasonable levels. Lighting for construction and operation will be designed in consultation with the DPC in order to minimise maritime navigation hazards.

Waste associated with the proposed development will be managed in compliance with the EAW EMP (Coffey Environments, 2010). A Construction Waste Management Plan (CWMP) and project component specific EMPs will be developed in accordance with the EAW EMP. These plans will incorporate provision of recycling and waste disposal facilities at the construction sites, reduction of waste related environmental nuisance (e.g. covered receptacles, regular collection of waste and recyclables from site to reduce odour), promotion of recycled packaging and construction materials and composting of organics where practicable.

The CWMP and project component specific EMPs will also detail:

- Responsibilities for waste management, collection, disposal, and documentation.
- All chemicals, including fuels, to be stored and / or used on the project site.
- Proposed methods for transportation, storage and use of chemicals.

- All government approvals and agreements required and obtained for all waste disposal and management matters.

Hazardous materials

Each construction laydown will have a dedicated storage area for fuels, lubricants, and small quantities of other hazardous materials (e.g. pesticides, herbicides, cleaning products). These storage areas will be covered and bunded to reduce the risk of spills and leaks.

During operations, storage areas of the MSB and Defence hardstand facility will be covered and bunded to prevent spills or leakages of any hazardous materials stored within. The MSB fuel supply area will be paved, bunded, and graded away from the harbour to an oil separator. This will prevent any spillage, during refuelling or fuel loading activities, from contaminating soil or water at the EAW. Security fencing and lockable doors will also be installed at the MSB and Defence hardstand facility to prevent misuse of any goods and materials stored within.

Sewage

During construction, toilet / washroom facilities for construction workers will be provided in the form of portable facilities. These facilities will retain sewage and sullage in sealed tanks until they are removed by a licensed contractor for disposal to an approved waste disposal site. Licensed contractors will be engaged to maintain these facilities and dispose of sewage as required.

Ablution facilities, including male and female toilets, and hand washing facilities, will be installed at the MSB and tug berths. These facilities will also include basic kitchen facilities for meal and drink preparation. Both the MSB administrative building and tug berth support services building will be connected to the sewer via a rising mains connection. The MSB refuelling and rig tender sewage transfer infrastructure will be covered and bunded.

1.13 Stakeholder Consultation

The NT Government, under direction of DLP, developed a Community Consultation and Communications Strategy to ensure that community stakeholders are informed about the EAW expansion environmental assessment process from inception through to final public exhibition.

The objectives of the consultation strategy for the EAW EIS are to:

- Gain insight into the concerns each organisation may have in regards to the proposed EAW expansion.
- Understand the issues each organisation felt should be addressed by the DEIS.
- Inform the stakeholders of the planning process.

The consultation program for the DEIS consists of a number of activities, to provide a range of entry points for stakeholders to obtain information and provide feedback which in turn can inform the design and management of the program.

The consultation program consists of two phases:

Phase 1: Consultation during preparation of the DEIS. This phase of the project consists primarily of meetings with key stakeholders to provide input into the DEIS.

Executive Summary

Phase 2: Consultation following public exhibition of the DEIS. This phase of the project includes website feedback, community information sessions and submissions to the DEIS.

A project website was established to provide information and feedback opportunities and communication materials such as newsletters and media releases have also been utilised to distribute up-to-date project information.

Key stakeholders consulted with during phase 1 included:

- Darwin Port Corporation Port Users Group
- DHAC
- EPA
- Defence
- Amateur Fishermen's Association of Northern Territory
- Australian Institute of Marine Science
- Environment Centre NT
- Perkins Shipping
- Larrakia Development Corporation
- Northern Land Council
- Larrakia Nation Aboriginal Corporation
- Northern Territory Seafood Council
- Tourism NT
- INPEX Corporation.

Phase 1 consultation took place over the period from 23 February 2011 to 11 March 2011. Discussion with stakeholder groups provided an opportunity for groups to express their considerations and concerns about the DEIS process and the potential environmental, social and economic issues to be addressed.

Feedback collected during Phase 1 included the following concerns:

- Impacts of existing and future stormwater and waste discharges into the harbour as well as harbour dynamics, particularly tidal and creek flows.
- Cumulative impacts of developments and consideration of the scale and staging of the project and the desire to see planning undertaken at a more strategic level, as well as adherence to the Darwin Harbour Strategy.
- Increased demands on existing infrastructure such as utilities, roads and rail and the ability for Darwin Harbour to cope with additional shipping traffic.
- Marine traffic management including the potential for accidents and introduction of pests and access to adjacent creeks and port facilities.
- Management of dredging and the storage and disposal of dredge and fill material.
- Impacts on mangroves and concerns with potential clearing requirements.
- Protection of marine life and knowledge about marine fauna and flora existing in the harbour.
- Effects on marine life commonly gathered and eaten by Aboriginal people.
- Areas of significance to Larrakia People, such as heritage and sacred sites and access to areas for Larrakia people during construction and development.
- Employment issues including opportunities for indigenous employment and businesses and concern about the impact of construction jobs on the commercial fishing and tourism industry.
- Physical impacts, such as noise and visual impact, and impacts on natural values of adjacent land.
- Impacts on greenhouse emissions and climate change.

During Phase 2 the DEIS for the proposed EAW Expansion project will be open for public review, and available for download from the EAW Expansion EIS website: www.eastarmwharf-eis.com.au.

1.14 Risk assessment

A semi-quantitative risk assessment has been undertaken for the EAW expansion project. The approach for the EAW risk assessment is based on the Risk Identification and Strategy Using Quantitative Evaluation (RISQUE) method, which is an iterative process based on the ISO/Australia and New Zealand Standard for Risk Management (ISO 31000:2009) framework, shown in Figure ES-10. Risks associated with social, environmental, engineering and economic issues and events were assessed. The main elements of the RISQUE process are:

- Communicate and consult (with stakeholders).
- Establish the context (project description).
- Identify risks (workshop attended by technical specialists).
- Analyse risks.
- Evaluate risks.
- Treat risks (mitigation and management measures in EMP).
- Monitor and review.

A workshop attended by subject matter specialists was held to identify risks associated with the proposed development, and included representatives from DLP and DPC. A preliminary list of risk events was developed prior to the risk workshop and was built upon during the initial stage of the workshop. The preliminary list of risks was then developed into event trees by establishing cause and effect relationships. An event tree is a diagram that clearly shows the linkages between initiating events and their subsequent impacts and consequences for each risk event.

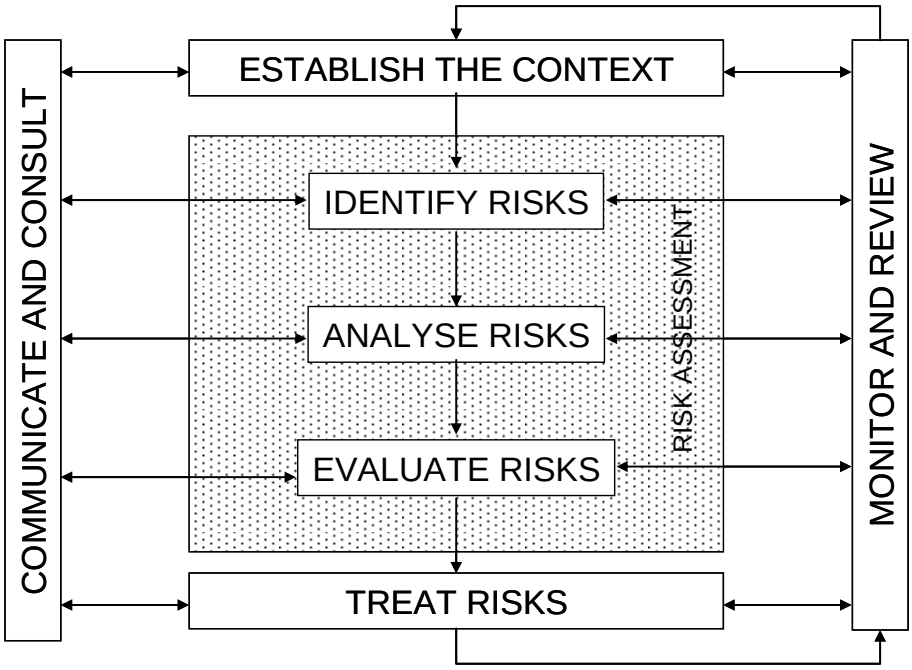


Figure ES-10 Overview of ISO 31000 Risk Management Process

Executive Summary

Risk is defined as a condition resulting from the prospect of an event occurring and the magnitude of its consequences. Therefore, risk is an intrinsic combination of:

- The likelihood of an event and its associated consequences occurring (this incorporates consideration of the frequency of the event and the probability of the consequences occurring each time the event occurs); and
- The magnitude of potential consequences of the event.

In quantitative terms, “risk” is defined by a risk “quotient”, which is:

Risk Quotient = Likelihood x Consequence

Event likelihood was estimated based on the specialist’s experience or knowledge of similar types of events, and documented information in the industry and literature (for more common events) or using a ‘likelihood guide’ (for unusual events).

A ‘consequence table’ was used to identify and quantify levels of impact resulting from the occurrence of a potential risk event. The following types of impacts included in the consequence table:

- Property and infrastructure.
- Environment.
- Social.
- Economic.
- Public health and safety.

In some situations, it was considered that the event, if it were to occur, would have multiple consequences (for example, excessive noise would have consequences for the local community as well as the environment). In these situations, the consequence values were recorded for each of the categories. These were then summed for each risk issue. For example, a value of 1 for Environment consequences and a value of 10 for Social consequences give a total value of 11 for the total consequence of the risk issue.

The workshop resulted in the output of two registers:

- Events risk register
- Inputs risk register

The events risk register is a list of events that could result in impacts and potential impacts from implementation of the EAW Project. The events risk register identified 92 risk events which were considered for inclusion in the risk assessment, of these 36 were categorised as Priority 1 events and assessed in more detail. The inputs risk register shows the event pathways, likelihoods and consequences that were provided by the subject matter specialists at the workshop.

After the workshop the participants were provided with copies of the combined risk register (event risk register and inputs risk register) for review and validation. The outcomes of all corrections additions were entered into the risk registers and input to the final risk model.

Risk analysis involved modelling the probabilities and consequences for each substantive risk event for the EAW Project. The risk profiles generated by the risk model show ranked (prioritised) risk events in order of decreasing risk.

Executive Summary

Establishment of a risk target helps stakeholders to understand what level of risk might be considered acceptable in the context of the scale of the Project. For the EAW Project the risk target was set at a risk level of 1. A risk target of 1 is equivalent to a 10% chance of a Moderate level impact occurring (i.e. consequence value of 10) or a 1% chance of a Major event occurring (i.e. a consequence value of 100).

The outcome of the EAW risk analysis (impacts and potential impacts assessment) is a series of graphs showing the highest risks for the project in order of risk quotient, the level of risk considered acceptable for each event, and the consequences and timing of the risks, (i.e. whether the risk was posed to the environment, public health and safety, etc, and whether the issue could occur during construction, operation, or both).

All projects will have positive and negative impacts on the wider environment (impacts on people and their activities, the natural environment, infrastructure, economics). Communities and regulators need to weigh the benefits of the project against the anticipated negative impacts. This risk assessment considers only the negative impacts of the project, positive impacts have been described earlier.

Impacts can be separated into two classes:

- Known impacts.
- Potential impacts.

Known impacts are derived from events for which it is practically certain that they will occur (be initiated) at some stage during the life of the project. The chance that these events and their consequential impacts will occur is effectively 100% (or 1). The only real uncertainty lies in the magnitude of impacts when the event occurs. Known impacts on the wider environment from a project need to be identified and reduced to levels that are as low as reasonably practical.

Potential impacts are derived from events that may or may not occur due to project activities. These events are known as risk events. For risk events there is uncertainty as to whether the event will occur in addition to the uncertainty of impact magnitude. The level of risk posed by a project can often be reduced by implementing actions that reduce the likelihood of the risk event occurring and, or actions that reduce the level of impact if the event were to occur.

The following main conclusions have been derived from the EAW DEIS risk assessment:

- Known impacts:
  - Rail loop construction and cutter suction dredging will cause known impacts on the wider environment.
  - Six events are expected to lead to known negative impacts from the Project, causing three Moderate level impacts and three Minor level impacts:
    - Rail loop placement - habitat loss
    - Rail loop placement - middens
    - Dredging - spoil smothering
    - Dredging – organism removal
    - Dredging – current and waves
    - Berths placement - smothering

- Two of the expected Moderate impacts will be on habitat and middens and will be caused by construction of the rail loop. The remaining Moderate impact (organism removal) will be caused by dredging activities.
- Most of the known impacts will occur due to construction activities.
- The expected impact on natural environment assets due to smothering, habitat loss and organism removal will be relatively small, but the perceived value of those assets by people is relatively high, which will lead to elevated social impact (mainly amenity) levels.

- Potential impacts (risks)
  - All the individual risk events for the Project are below the target risk level.
  - However, the risk levels posed by seven events lie within one half an order of magnitude of the target risk level for a single event.
    - MSB – stormwater
    - Barge Ramp – stormwater
    - MSB – Vehicle accident
    - Barge Ramp and Hardstand – Vehicle accident
    - MSB – Fuel pipeline
    - Dredging – spoil smothering
    - Dredging - reduced light
  - The risk posed by three of the highest eight risk events (stormwater and vehicle accidents) applies for the construction period only and the remaining five events pose risk only during operation.
  - Most of the risk would be posed to society (mainly potential impact on amenity) and the risk posed to the natural environment, the economy, infrastructure and public safety is comparatively low.

Construction and operation of the MSB and barge ramp and hardstand, and to a lesser extent dredging activities, will pose the highest risk to the wider environment.

Actions to be taken to reduce known risks and manage and monitor potential risks and their associated impacts are included in the DEIS EMP.

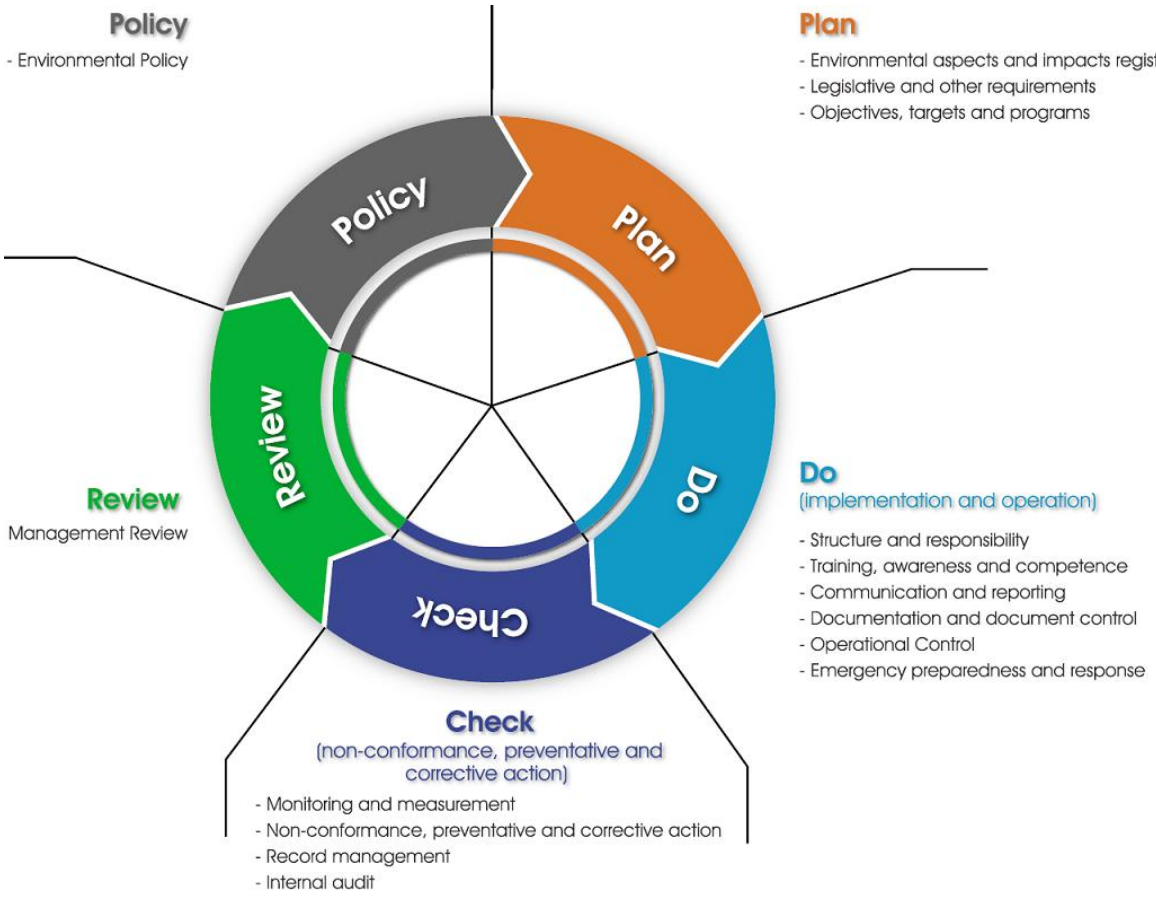
1.15 Environmental Management System and Environmental Management Plans

The DPC already operates an EMS, which is based on the requirements of ISO14001:2004 (International Standard for EMS).

An EMS is a mechanism by which an organisation's environmental issues are systematically managed. Relevant aspects of the environment are monitored, monitoring results and records are documented, and the environmental performance of an organisation can be audited. The EMS is supported by EMP's that address key environmental risks. The EMP proposed as part of this DEIS aligns and meets the requirements of the existing DPC EMP and is designed to be integrated with DPC's EMS.

An EMS consists of five main elements: policy; plan; do; check; and review (refer to Figure ES-11). The current status of DPC's EMS is detailed in reference to the five main elements below.

Executive Summary



Source: Coffey Environments, 2010

Figure ES-11 Environmental Management Process Flow

The objectives and targets of the EMP for the proposed expansion of EAW incorporate the significant potential impacts that were identified in the DEIS and the risk workshop and the existing EAW EMP (Coffey Environments, 2010). Consideration was also given to stakeholder input, legislation, business requirements, operating conditions and financial and technological options.

Executive Summary

The EMP has been developed to support this DEIS and achieve the environmental performance objectives for the proposed expansion of EAW focuses on 13 environmental aspects:

- Systems.
- Regulatory compliance.
- Planning.
- Communication.
- Energy and resources.
- Air quality.
- Land and soils.
- Water and marine sediments.
- Flora and fauna.
- Biting insects.
- Hydrocarbons and hazardous materials.
- Waste management.
- Cargo handling – bulk minerals.
- Cultural heritage.
- Social management.

A separate draft DMP (AECOM, 2011) was also developed and is included in this DEIS. The intent of the EMP for the proposed expansion is that:

- It will be integrated with the existing EAW EMP, and referred to on an ongoing basis to guide and inform environmental planning and management at EAW.
- It will define the roles and responsibilities of DPC, tenants, contractors, government agencies and other organisations.
- It will be reviewed over time and updated to reflect any significant changes in DPC's environmental risks, impacts, management strategies or legislative requirements

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Glossary

Airshed - This refers to a part of the atmosphere that behaves in a coherent way with respect to the dispersion of emissions.

Bund - An earth, rock or concrete wall constructed to retain a reclaimed area, or to prevent the inflow or outflow of liquids.

Cavitation - when the negative component of a pressure wave exceeds the surrounding hydrostatic pressure and becomes sufficiently large to cause bubble formation in water.'

Geotextile - Permeable fabrics which, when used in association with soil, have the ability to separate, filter, reinforce, protect, or drain.

Holocene - Geological epoch which began 11,700 ybp and continues to the present.

Map Grid Australia (MGA) – A UTM projection based on the GDA. The continent is divided up into zones which have a width of six degrees of longitude.

Mud waving - Refers to refers to the lateral squeezing of soft foundation soil that occurs due to the surcharging effect of dumped embankment fill.

Oxides of nitrogen (NO_X) - Air emissions produced during the high temperature combustion of fossil fuels. Oxides of nitrogen are the sum of NO and NO_2; referred to generically as NO_X, and are reported in terms of NO_2.

Particulate matter (PM) - Small discrete masses of solid or liquid matter that remain individually dispersed in emissions to atmosphere.

Passing loop - Also called a **passing siding**, **crossing loop**, or **crossing place –** a place on a single-line railway where trains or trams in opposing directions can pass each other.

Piezo Cone Testing - a cone penetration test with additional measurement of the pore water pressure at one or more locations on the penetrometer surface.

Particulate Matter (PM) - A small discrete mass of solid or liquid matter that remains individually dispersed in gas or liquid emissions (usually considered to be an atmospheric pollutant).

PM_{10} - Particulate matter with an average aerodynamic diameter of 10 micrometers [10μm] and less.

Portainer Crane - A ship-to-shore (quay) crane that loads and unloads cargo from container ships.

Rail crossing - Also called a **level crossing**, **train crossing** or **grade crossing** - is a crossing on one level (an 'at-grade intersection') of a railway line by a road or path.

Refusal – the depth past which a soil bore cannot extend (because of resistance from rock, for example)

Rip-rap - A layer of coarse rock used to line or protect earthen embankments from erosion.

Rock Armour – see Rip-rap

Storm surge - A raised mass of water, generally 2–5 m higher than normal tide levels, which results from strong onshore winds and reduced atmospheric pressure.

Sulphur Dioxide (SO_2) - Chemical compound produced by volcanoes and in various industrial processes. Combustion of coal and petroleum often generates SO_2. Emissions of SO_2can be a precursor to atmospheric particulates.

3 Glossary

Surcharging – Placing fill additional to that required to fill a volume (e.g. a bunded lagoon), such that the mass of the additional fill acts to consolidate the fill beneath it. The surcharge fill may be removed once the required volume has been filled and the fill consolidated.

Universal Transverse Mercator (UTM) - A grid-based method of specifying locations on the surface of the Earth that is a practical application of a 2-dimensional Cartesian coordinate system. It is a horizontal position representation which employs a series of sixty zones.

Vane Shear Testing - In-situ method for calculating the undrained shear strength of a soil.

Vibrocore - Vibrocore surveys involve acquiring cores of seabed sediments using a vibrating steel tube which penetrates the seabed to a particular depth.

Victualling – Provision of food or other stores

Viewshed - an area of land, water, or other environmental element that is visible to the human eye from a fixed vantage point.