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GOVERNMENT

AECOM

Darwin Ship Lift Draft EIS

Draft Environmental Impact Statement

Darwin Ship Lift Project

Client: Department of the Chief Minister and Cabinet

ABN: 18 108 001 191

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02-Nov-2021

Job No.: 60633505

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Quality Information

Document Draft Environmental Impact Statement

Ref 60633505

Date 08-Nov-2021

Prepared by AECOM

Reviewed by Rouven Lau

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	21-Oct-2021	Draft for Client Review	James Jentz	
1	02-Nov-2021	Final for Client Review	James Jentz	
2	08-Nov-2021	Final Draft EIS	James Jentz	

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Acronym	Spelling
ABF	Australian Border Force
ABS	Australian Bureau of Statistics
ADF	Australian Defence Force
AFANT	Amateur Fishermen's Association of the Northern Territory
AHD	Australian Height Datum
AIMS	Australian Institute of Marine Science
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australia New Zealand Guidelines
APAA	Aboriginal Areas Protection Authority
AQPSP	Air Quality Planning Scheme Policy
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASS	Acid Sulfate Soils
BCC	Brisbane City Council
BCF	Burrell Creek Formation
BHD	Backhoe Dredge
BoM	Bureau of Meteorology
CAQMP	Construction Air Quality Management Plan
CCTV	Closed Circuit Television
CEMP	Construction Environmental Management Plans
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNVMP	Construction Noise and Vibration Management Plan
CO	Carbon monoxide
CO ₂	Carbon Dioxide
CPESC	Certified Professional in Erosion and Sediment Control
CSD	Cutter Suction Dredge
CUF	Common User Facility
DAFF	Department of Agriculture Fisheries and Forestry (Commonwealth)
DAWE	Department of Agriculture Water and Energy (Commonwealth)
DAWR	Department of Agriculture and Water Resources (Commonwealth)
DCMC	Department of the Chief Minister and Cabinet (Northern Territory)
DDSPMP	Dredging and Dredge Spoil Placement Management Plan
DENR	Department of Environment and Natural Resources (Northern Territory)
DGVs	Default Guideline Values
DIPL	Department of Infrastructure, Planning and Logistics (Northern Territory)
DITT	Department of Industry, Tourism and Trade (Northern Territory)
DLRM	Department of Land Resource Management (Northern Territory)
DO	Dissolved Oxygen
DoEE	Department of the Environment and Energy (Commonwealth)
DPC	Darwin Port Corporation

Acronym	Spelling
DRLU	Darwin Regional Land Use Plan
DTorR	Draft Terms of Reference
EA Act	<i>Environment Assessment Act (NT) 1982</i>
EAW	East Arm Wharf
EIS	Environmental Impact Statement
EMF	Environmental Management Framework
EMS	Environmental Management System
ESCP	Erosion and Sediment Control Plan
FBB	Flying Boat Base
FEED	Front-End Engineering Design
FIFO	Fly-in fly-out
FTE	Full-time Equivalents
GHG	Greenhouse Gas Emissions
GPT	Gross Pollutant Trap
ha	Hectares
HAT	Highest Astronomical Tide
IAP2	International Association for Public Participation
ICN	Industry Capability Network
ICOMOS	International Council on Monuments and Sites
IMO	International Maritime Organization
IMP	Introduced Marine Pests
IUCN	International Union for Conservation of Nature
kg	Kilogram
kL	Kilolitre
L	Litre
LAT	Lowest Astronomical Tide
LMS	Lugger Maintenance Section
m	Metre
mg	Milligram
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
MIP	Marine Industry Park
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
mm	Millimetres
MOS	Metocean Solutions
MSL	Mean Sea Level
MUBRF	Multi-user Barge Ramp Facility
MW	Megawatts

Acronym	Spelling
N ₂ O	Nitrous oxide
NAGD	National Assessment Guidelines for Dredging
NAIF	Northern Australia Infrastructure Facility
NATA	National Association of Testing Authorities
NEPM	National Environment Protection Measures
NGERS	National Greenhouse and Energy Reporting
NO ₂	Nitrogen dioxide
NOI	Notice of Intent
N _{ox}	Oxides of nitrogen
NPI	National Pollutant Inventory
NQWMS	National Water Quality Management Strategy
NSS	Northern Ship Support Pty Ltd
NT	Northern Territory
NT EPA	Northern Territory Environment Protection Authority
NTG	Northern Territory Government
NTPS	Northern Territory planning Scheme
NTU	Turbidity
O ₃	Ozone
OCP	Oil Spill Contingency Plan
OEMP	Operational Environmental Management Plan
OPVs	Offshore Patrol Vessels
PAR	Photosynthetically Available Radiation
PASS	Potential Acid Sulfate Soils
PM ₁₀	Particulate under 10 micrograms
PM _{2.5}	Particulate under 2.5 micrograms
PMST	Protected Matters Search Tool
PSI	Preliminary Site Investigation
PTS	Permanent threshold shift
RAAF	Royal Australian Air Force
SEL	Sound Exposure Level
SIA	Social Impact Assessment
SIMP	Social Impact Management Plan
SL	Source Level
SLAMI	Ship Lift and Marine Industries
SO ₂	Sulfur Dioxide
SoR	Statement of Reasons
SPL	Sound Pressure Level
SPMT	Self-propelled modular transporter
SSC	Suspended Solid Concentration

Acronym	Spelling
t	Tonnes
TERC	Territory Economic Reconstruction Commission
TIA	Traffic Impact Assessment
TMP	Traffic Management Plan
ToR	Terms of Reference
TPWC Act	<i>Territory Parks and Wildlife Conservation Act 1976</i>
True North	True North Strategic Communication
TSP	Total Suspended Particulate
TSS	Total Suspended Solids
TTS	Temporary threshold shift
TWMS	Trade Waste Management System
UNFCCC	United Nations Framework Convention on Climate Change
UXO	Unexploded Ordinance
VOC	Volatile Organic Compounds
WDL	Waste Discharge License
WoNS	Weed of National Significance
WWII	World War 2

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Executive Summary

Executive Summary

The Northern Territory Government (NTG) is delivering the Darwin Ship Lift Project ('the Project') which comprises of the construction and operation of a ship lift facility and an adjacent maintenance facility at East Arm, Darwin (Figure 1). The early design and procurement of the Project has been managed by a dedicated NTG Ship Lift Project Team within the Department of the Chief Minister and Cabinet (DCMC). Final procurement and construction will be managed by the Department of Infrastructure, Planning and Logistics (DIPL).

The location of the Project at East Arm is consistent with long-term master planning for Darwin. The NTG has been developing land at East Arm for marine industries since 2004 and in 2014, proposed to include a ship lift as part of the development of its East Arm Marine Industry Park. The NTG's vision is for the Project to be enabling economic infrastructure that will grow the maritime sector and enhance Darwin's competitive advantage as a marine repair, maintenance and sustainment centre for Northern Australia. Government and business stakeholders suggest the facility will be foundational infrastructure for a marine services precinct, consolidating a range of marine services on the East Arm Peninsula.

The Project will enable maintenance and servicing of a broad range of industries including the Australian Defence Force (ADF) and Australian Border Force (ABF) vessels and for commercial and private vessels (oil, gas, pearling, fishing and other marine industries). The Project will support the continued economic growth of Darwin as a logistics and marine services hub of the Northern Territory (NT), and Northern Australia.

Assessment Process

A notice of intent (NOI) for the Project was submitted to the Northern Territory Environment Protection Authority (NT EPA) in April 2018 by Northern Ship Support Pty Ltd. In November 2018 the NT EPA determined that further assessment was required in the form of an Environmental Impact Statement. Concurrently further studies were undertaken that identified where enhanced functionality and changes to design for supporting marine facilities would provide benefit to the overall Project. This process led to a number of updates to the development concept. In 2019 the NTG advised the NT EPA of the updates to the Project concept which included the NTG becoming the proponent for the Project.

The NT EPA considered the material provided and issued the Draft Terms of Reference (DToR) in September 2019. The NT EPA determined that the Project has the potential to have significant environmental impacts on the following key environmental factors (NT EPA 2018a):

- marine environmental quality
- marine flora and fauna
- air quality and greenhouse gases
- social, economic and cultural surroundings.

The DToR were made available for the public consultation period. On completion of the public consultation period, the final ToR for the Project were issued by the NT EPA in December 2019.

AECOM was engaged to prepare this Draft EIS to address the ToR. The Draft EIS will be subject to public review period of 6 weeks. During this time, the Proposal will undergo further review by regulators and the community.

An *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) referral for the original project was submitted by Northern Ship Support Pty Ltd in 2018 to the Commonwealth Department of the Environment and Energy (DoEE). On 25 September 2018, DoEE determined the Project to be not a controlled action (Reference No. 2018/8195).

As the Project has undergone material changes since the original referral, the NTG is submitting a new referral for the Project. The referral was lodged concurrently to this EIS and will likely to be available for public comment in November 2021 on the EPBC referrals website.



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Project Description

The Project will be Northern Australia's largest common user ship lift. The infrastructure layout is shown in Figure 2 and will include:

- ship lift of approximately 26 metres (m) width and 103 m length, capable of lifting vessels weighing up to 5,500 tonnes (t) plus associated platform, trestles and vessel transfer system
- self-propelled modular transporter (SPMT) vessel transfer system
- approximately 13 hectares (ha) of hardstand area for ship repair and maintenance
- vessel wash area with separate contained drainage and treatment system
- stormwater system to capture and treat runoff water before discharge
- enclosed blast and paint facility with separate contained drainage system and a negative pressure and air filtration system
- site services and utilities
- security infrastructure
- ancillary facilities including:
 - administration building
 - ship lift control room
 - SPMT garage.
- access channel and dredged manoeuvring areas
- six wet berths
- heavy lift platforms suitable for a 100 t crane at each berth
- revetments and quay structures.

Once constructed, the Project will comprise:

- an NTG owned facility that will lease areas/berths on a common user basis under a principal operator (Darwin Ship Lift Facility), and
- a privately owned berthing and maintenance facility.

The infrastructure delivered by the Project will fill an existing industry gap and is anticipated to facilitate further development of the region's marine services and logistics, thereby supporting jobs and economic growth of the NT.

Project construction is expected to be completed in 24-36 months following completion of approvals and detailed design by the end of 2022, with the Project planned to be operational by 2025.

The Project is assumed to create 100 direct jobs per annum during the two to three-year construction phase, although the actual number will be determined by the design and delivery methods chosen by the contracted builder. It is expected that a large portion of the work will be completed within the NT.

The NT Government estimates that jobs generated and supported by infrastructure delivered by the Project will range from 78 to 146 full-time equivalents (FTE) a year in Year 3 (start-up) and between 187 and 359 additional FTE a year by Year 20. These estimates do not consider further job creation for contractors working on vessels within the facility. The employment benefits are expected to grow incrementally as the East Arm marine precinct grows however, it may take up to a decade to gain the full market share and for the estimated economic, employment and social benefits to be delivered.

The Project is currently at a concept design level and will continue to undergo design refinement. These changes are not anticipated to extend beyond the disturbance areas defined in Figure 2 or to change the significance of environmental impacts presented in this document.



PROJECT ID 60633505
CREATED BY PK
APPROVED BY JC
LAST MODIFIED 02 NOV 2021

AECOM
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1:5,000 when printed at A4
DATUM GDA 1994, PROJECTION MGA ZONE 52

0 50 100 150 200
Metres

Data sources:
Source: Esri, Mapbox, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority (Landscape 2010).

LEGEND

- Project footprint
- Darwin Ship Lift Facility
- Privately-owned Facility
- Potential disturbance area
- Revetments
- Berths and manoeuvring basin
- Multi-user Barge Ramp Facility (MUBRF) channel

Note:
The layout is indicative only

Proposed infrastructure layout

NORTHERN TERRITORY
GOVERNMENT OF AUSTRALIA
DARWIN SHIP LIFT PROJECT

Figure
2

Alternatives

Initially, the Marine Industry Park to the northeast of the current site was earmarked for the location of the Project. When expressions of interest were sought in 2015-16 several respondents proposed alternative locations, including the current site.

The current site was selected for several reasons and has the following environmental benefits:

- naturally deeper water access close to the site providing the opportunity to use of the existing Multi-user Barge Ramp Facility (MUBRF) channel and thereby minimising additional channel dredging requirements and facilitating all-tide access for ADF and ABF vessels. This also minimises alterations to existing Darwin Harbour navigational procedures
- brownfield disturbed site that limits mangrove loss to an isolated 1.0 ha patch
- existing knowledge of the landside and marine areas due to previous heritage and environmental studies undertaken for the nearby Marine Supply Base (MSB) and MUBRF developments
- direct access off Berrimah Road, which is designed for heavy vehicle traffic accessing East Arm Wharf (EAW)
- low expected volume and frequency of maintenance dredging.

Several site-specific design alternatives were also considered including alternative Project footprints, ship lift size, dredging volumes and alternate fill material sources and ship lift systems.

The Project is currently at a concept design level and will continue to undergo design refinement. The NTG is undertaking a staged procurement process for the Project and is currently at Request for Proposal stage to support the design development and construction planning. The final procurement stage will include potential construction contractors providing detailed design. Following this, a design and construction contractor will be engaged. Potential construction contractors are encouraged to consider alternatives that promote innovation, flexibility and efficiency.

Stakeholder Consultation

The NTG has consulted with key stakeholders while completing the Project feasibility studies over the past five years. This has included consultation with industry, government departments and regulators, as well as providing public updates of the Project through media releases and via NTG website updates.

Further to this a communication and engagement strategy was prepared in 2020 to support formal regulatory approvals, including consultation to support the EIS and Development Consent Process being advanced at that time. The overall objectives of this strategy are to:

- provide objective and appropriate communication on the project to key stakeholders, so they can give informed feedback
- identify and map stakeholders and issues to ensure the consultation strategy is tailored to the needs and interests of relevant stakeholder groups
- provide timely reports on issues raised during consultation to guide good decision-making.

Engagement has included the preparation and distribution of fact sheets, briefings and interviews of targeted stakeholders, including Territory and Commonwealth Government, Larrakia organisations, environment groups, industry groups and amateur fishermen.

Consultation with these stakeholders has informed the social impact assessment, a consultation report and the Social Impact Management Plan (SIMP) which outlines measures to enhance the benefits and reduce potential negative impacts of the Project.

The NTG will continue to consult during the public review period by:

- incorporating stakeholder comments from the public review period of this EIS
- maintaining the Project website (<https://cmc.nt.gov.au/advancing-industry/ship-lift>) to keep the community up-to-date on progress of the Project

- providing information to stakeholders when requested, including providing responses directly to the stakeholders who asked questions during earlier consultations.

Environmental Setting

The Project is located on the East Arm Peninsula within the Darwin Harbour. The existing land portion of the Project is fully fenced and is used for the provision of marine services activities by a private company. It currently accommodates a car park, site office, marine equipment, material hardstand/laydown area, a works depot, marine workshop and a boat ramp. The boat ramp was constructed in World War II and used in more recent times for recreational boating purposes, prior to the construction of the current East Arm Boat Ramp at Casey Street.

Major developments on the shoreline within Darwin Harbour include INPEX LNG and Santos Darwin LNG plants located on Middle Arm, PWC's Channel Island power station, adjacent to Middle Arm, EAW located on East Arm Peninsula, Darwin CBD, the Waterfront Precinct on the eastern side of the main body of the Harbour, and suburban developments on the Harbour shoreline from Darwin in the north to Palmerston in the east. A small residential area also exists at Wagait Beach, near Mandorah, on the western side of the mouth of the Harbour.

Darwin Harbour contains a wide diversity of habitats, and associated flora and fauna communities, some of which may be important to the continued viability of populations of protected marine fauna within the region. However, East Arm (including the Project area) is not known to contain any habitats that are of critical importance to the survival of protected marine species.

The East Arm Peninsula played a crucial role during World War II when it became a refuelling base and defence headquarters. Defence infrastructure included the strategically significant Catalina Flying Boat Base (FBB), occupied by the Royal Australian Air Force during the war. About 200 metres east of the Project site is the former Luger Maintenance Section (LMS), which supported Z Special Unit's operations in South-East Asia during the war.

Most of the FBB has been demolished to make way for industrial development. The surviving features as of 2015 were the Catalina ramp, crash boat slip way, a mooring pile and some fragments of a fuel pipeline. In 2015, the Minister for the Environment decided not to grant the FBB heritage status under the NT *Heritage Act 2011*. The Project construction phase will extend over the remaining FBB area. It is proposed that interpretative signage close to the Project be installed in a public place to indicate that the area was once the location of FBB and the LMS and its significance during World War II.

The Project is also close to two registered Sacred Sites protected under the NT Aboriginal Sacred Sites Act 1989. These sites, Catalina Island and Old Man Rock, are on the Aboriginal Areas Protection Authority (AAPA) register of sacred sites. A current AAPA certificate has been obtained for the Project which outlines management requirements in relation to these sites. No Aboriginal heritage sites are located within the Project footprint.

Assessment Methodology

Each of the four environmental factors that the NT EPA identified as having the potential to be significantly impacted by the Project have been assessed in terms of: relevant policy and guidelines, existing values, potential impacts, and proposed mitigation and monitoring measures. They include:

- marine environmental quality
- marine flora and fauna
- air quality and greenhouse gases
- social economic and cultural surroundings.

A risk-based assessment framework methodology was used which included an initial risk identification, a risk assessment workshop, and risk review and refinement following technical studies and stakeholder consultation. This assessment identified the need to consider further environmental factors additional to the ToR.

Risks have been assessed both pre and post-mitigation to identify residual impacts that may persist following the implementation of proposed mitigation and management measures.

Technical study methodologies to inform the EIS and risk assessment comprised a mix of desktop reviews, fieldwork (site visits/surveys, sample collection and subsequent laboratory analysis and assessment), remote sensing, modelling and consultation. A summary of the technical studies that support the EIS is included in Table 1.

Table 1 Technical studies that support the EIS

NT EPA Factor	Technical Studies
Marine environmental quality	• Marine water quality sampling events • Marine sediment sampling and modelling • Benthic habitat modelling and ground truthing • Turbidity assessment using remote sensing
Marine ecology	• Site visit to document extent of existing mangrove community • Underwater noise modelling
Air quality and greenhouse gases	• Air emissions modelling • Emission estimation and calculations
Social, cultural and economics	• Social impact assessment • Cultural heritage assessment • Noise impact assessment • Traffic impact assessment
Terrestrial environmental quality	• Preliminary site investigation (PSI) and soil sampling
Terrestrial flora and fauna	• Site visit to document existing native and introduced vegetation species

Marine Environmental Quality

The marine environmental quality assessment considers the risks and potential impacts of the Project development to marine water and sediment quality in Darwin Harbour. Marine water and sediment are not considered as end receptors, but vectors by which secondary impacts may occur to sensitive receptors such as marine flora and fauna.

The water quality in East Arm where the Project is located is generally very high and typically meets the water quality objectives set out in the Darwin Harbour Water Quality Protection Plan. Similarly, sediment quality is typically very good; the sediment geochemical assessment undertaken for the Project detected only low levels of some toxicants in unconsolidated sediments in the vicinity of the Project location. These were typically well below the Australian and New Zealand Fresh and Marine Water Quality Guidelines.

From a marine environmental quality perspective, the potential impacts to water quality are the primary concern during the Project construction phase, specifically elevated suspended sediment concentrations associated with dredging and placement of dredged material on shore as fill for land reclamation. Sediment transport modelling was undertaken to predict the potential extent and concentration of turbid plumes generated by dredging activities. This modelling suggested that the zones of impact and influence were restricted to the Project footprint for most of the time and unlikely to extend to the nearest sensitive hard coral and filter feeder communities at South Shell Island.

The potential for water quality impacts during operations will largely be reduced by in-built design mitigations such as containment and treatment of all stormwater and wastewater on site before disposal via licensed discharges onshore, or into Darwin Harbour under applicable licenses and limits.

Specific mitigation and management measures during construction and operations will be incorporated into construction environmental management plans (CEMPs), a Dredging and Dredge Spoil Placement Management Plan, and operational environmental management plans (OEMPs) to be approved prior to commencement of construction or operations. It is considered that the proposed mitigation and management measures are sufficient to reduce impacts to marine water and sediment quality during construction and operational phases of the Project so as to maintain the beneficial uses and water quality objectives for Darwin Harbour.

Marine Flora and Fauna

The marine flora and fauna assessment considers the risks and potential impacts of the Project development to marine flora and fauna habitats and species in Darwin Harbour. The marine communities that will be affected during Project construction are widely distributed within East Arm and the broader Darwin Harbour. These comprise:

- Benthic communities in intertidal and shallow subtidal 'soft sediment' habitats within, and adjacent to, the dredging and reclamation footprints. The value of these communities to the overall ecosystem function of Darwin Harbour is recognised. However, it is considered that the areas of these communities that will be disturbed are of insufficient magnitude for Project construction and operation to represent a risk of significant adverse effects upon the ecosystem function of Darwin Harbour.
- An isolated stand of remnant mangrove community of ~1.0 ha extent will be removed during reclamation works. The value of mangroves to ecosystem function is recognised, though the area of loss is considered to be sufficiently small that there is negligible risk of detectable impacts upon the East Arm or Darwin Harbour ecosystems.

While Project construction also has the potential to impact upon other marine flora and fauna communities, such as those comprised of filter feeders (e.g. sponges, soft corals), hard corals and macroalgae, it is predicted from modelling that these communities are not at risk of significant impacts.

The potential for non-native marine pest species to be introduced to Darwin Harbour is considered to pose a substantial risk of impacts to the marine flora and fauna of the harbour. These would have the potential to disturb the harbour ecosystem through their predating upon, or outcompeting of, native species, with associated food web effects. However, robust vessel risk assessment and inspection protocols have been demonstrated to be an effective means of mitigating the risk of such introductions. Such protocols were implemented for the substantial INPEX Ichthys construction program that engaged a considerably greater number of vessels than will be involved with construction and operation of the Project. In addition, there is a routine monitoring program for marine pest species within Darwin Harbour that will have the capacity to detect the introduction of these species, should it occur.

Underwater noise and vibration were identified as potential impacts during construction. Modelling indicated that the predicted area in which adverse noise and vibration levels may potentially occur does not extend across the full width of East Arm; hence, it is predicted that there is minimal potential for disruption of passage of any species between Elizabeth River and the main harbour.

Incremental increase in vessel traffic associated with the construction and operation of the Project will not be of a sufficient magnitude to represent a significantly greater risk of impacts upon benthic communities, or individuals and populations of marine fauna from vessel strike or grounding. However, mitigation measures will include surveillance protocols and controls on vessel speeds within the vicinity of the Project area. It is noted that surveillance protocols are already routinely implemented by vessels traversing the harbour, to mitigate the risk of collision with floating objects.

The potential for impacts upon marine flora and fauna via contaminant release and light spill during operations will be reduced through Project design mitigations including the containment and treatment of stormwater and wastewater on site before disposal via licensed discharges onshore, or into Darwin Harbour.

Overall, it is concluded that, with the implementation of appropriate Project design, monitoring, management and mitigation measures, the marine flora and fauna of Darwin Harbour will be protected to the extent that biological diversity and ecological integrity will be maintained. As such the impacts to marine flora and fauna are expected to be limited to areas within close proximity of the Project site.

Air Quality and Greenhouse Gases

The air quality and greenhouse gas assessment consider the risks and potential impacts of the Project development to sensitive receptors surrounding the Project area. The air quality assessment was undertaken by means of air dispersion modelling in accordance with the ToR and appropriate guidelines.

A baseline assessment was conducted to identify existing meteorology, air quality conditions as well as the location of surrounding sensitive receptors. Background concentrations for pollutant species of concern were adopted for the assessment considering available monitoring data from NT EPA air quality monitoring stations, or comparable stations where suitable local data was unavailable.

Pollutants of concern assessed in the air quality impact assessment were combustion emissions such as particulate matter. Based on the results of the dispersion modelling, there were no exceedances of the identified goals for construction or operation for any air pollutant across all averaging periods, and no significant impacts were predicted for any pollutant at sensitive receptors.

GHG emission sources were identified for both the construction and operation phases using NGER guidance and reference material. A comparison to the NT and Australian benchmark for reported emissions from 2019 data estimated a less than 1% contribution to total NGER reported emissions across all sectors within the NT.

Mitigation measures have been recommended for potential air quality impacts and greenhouse gas emissions attributed to both the construction and operational phases of the Project. Provided the mitigation strategies to further reduce pollutant emissions and GHG emissions are implemented, air quality and GHG impacts from construction and operation of the Project are consistent with surrounding industrial land use and are not expected to cause significant impact.

Social, Economic and Cultural Surroundings

A SIA was prepared in 2021 to predict and assess the social, economic, and cultural impacts of the Project. An initial scoping exercise indicated that a low-scale SIA was warranted. The SIA then assessed potentially positive and negative impacts after screening out those rated as likely to be negligible or imperceptible.

The SIA identified significant economic opportunities arising from the Project that will contribute to developing Darwin's capacity as a maritime service and supply hub, and transport and logistics precinct on East Arm. The Project is well positioned to contribute to the development of the NT economy, capacity of local businesses and industry, and a marine labour force. Key potential benefits of the Project include:

- strengthening and diversifying the economy from enabling economic infrastructure and capacity-building
- local businesses benefitting from winning work and enhanced capabilities
- enhanced employment and training opportunities for local people
- Aboriginal jobs and training opportunities resulting from the Project.

Potential negative impacts identified by the SIA included:

- Cumulative impacts of development on the values of Darwin Harbour: However, it is considered that given the scale of this Project, its contribution to these cumulative impacts has been assessed as minimal.
- Damage to Aboriginal and European heritage, including World War II heritage: There are no Aboriginal heritage sites within the Project footprint. Potential indirect impacts to nearby Aboriginal sacred sites and World War II Catalina sites resulting from minor ocean current changes will be monitored before and after construction. A suggested mitigation strategy is interpretive signage to explain the history of World War II activity at East Arm Peninsula.
- Reduced amenity and impacts on recreational values and activities: While permanent, the scale of change is relatively small and in line with existing industrial activities. The site is designated Zone DV (Development) under the Northern Territory Planning Scheme 2020. The purpose of this zoning is to facilitate the development of major strategic industries that are important to the future economic development of the NT, including gas, road, rail, or port-related industries.
- Crowding out of other economic activities on the harbour, such as tourism and recreational fishing: While the Project is predicted to have negligible to no impact on recreational and tourism

businesses, this will be monitored during construction. The NTG will also continue to communicate with harbour tourism and recreational fishing organisations.

- Frustration by businesses who fail to win tenders or have unrealistic expectations of opportunities and detrimental impacts on competing maritime businesses: In response the NTG is committed to working with the Industry Capability Network, Maritime Industry Development Plan and Chamber of Commerce Marine Industry Council to develop a blueprint or master plan for development of the maritime sector that identifies opportunities, capacity and workforce gaps. It is noted that the facility includes the construction of a Common-user Facility (CUF) to enable growth of the marine repair and maintenance industry.
- Noise and vibration: Noise and vibration modelling indicates that impacts may be potentially audible in residential suburbs located approximately 6 km from the Project, but only in the short-term. Modelling found that construction and operational noise levels will comply with assigned noise levels under the *Northern Territory Noise Guidelines* at all noise sensitive receptors located in residential and commercial areas. Similar construction, dredging and piling occurred for the EAW Expansion and MSB, with no record of complaints or community sensitivity to these impacts.
- Heavy vehicle traffic during the construction phase of the Project. The SIA identified potential community concern about traffic safety. A Traffic Impact Assessment undertaken to assess this risk found that the additional trip generation created by the proposed construction schedule is not predicted to have a significant impact on the road network or a material decrease in road safety. Marine traffic activities for construction of the Project will be localised and relatively short-term.

Other Environmental Factors

Other environmental factors considered in response to Project risk assessments, findings of technical studies and stakeholder consultation included:

- terrestrial environmental quality
- terrestrial flora and fauna
- inland waters and hydrological processes
- human health.

Terrestrial environmental quality

A Preliminary Site Investigation (PSI) was conducted to assess the potential for contamination from historic uses of the site. The PSI indicated that it is unlikely that significant contamination of soil or groundwater had occurred at the site, limiting the risk that proposed earthworks will disturb contaminated material.

The PSI also found that the site is located within a high-risk acid sulfate soils (ASS) area and is likely to require consideration of managing potential ASS risks. However, analysis of materials to be dredged indicated that the acid neutralising capacity was well within the adopted criterion.

Notwithstanding these findings, proposed management measures also include the development of an unexpected finds protocol for contaminated soils and ASS.

Terrestrial flora and fauna

The initial EIS risk assessment identified the potential for the proposed Project to impact on biological diversity and ecological integrity through the introduction and spread of pest and weed species via the movement of vehicles and vessels to and from the Project area. It also identified the potential for piling activities to increase terrestrial noise and result in the disturbance to migratory birds that are known to roost at the EAW Dredge Spoil Pond D which is a preferred migratory bird habitat area at East Arm Peninsula.

Noise and lighting impacts associated with the construction and operation of the facility are considered unlikely to impact the migratory bird species utilising the pond as this habitat is already within an operational industrial port area and is also separated from the Project area.

Management measures to mitigate noise and lighting impacts of the Project will include a Construction Noise and Vibration Management Plan. While weeds and pests will be managed via CEMPs and OEMPs with links to the site Biosecurity Management Plan as required.

Inland waters and hydrological processes

The Project has the potential to impact on surface water and groundwater quality through the mobilisation of sediments and contaminants during rainfall and storm events. The primary sources of potential stormwater pollutants during the construction phase will be disturbed soils, storage of hydrocarbons and hazardous substances, and vehicle usage on site. During the operational phase, potential contaminants in stormwater will vary depending on the type of business' occupying the site, associated activities undertaken, and products stored.

During construction a CEMP containing an Erosion and Sediment Control Plan will be used to capture suspended sediments before they reach the Harbour. During operation the overall management of stormwater and potential contaminants mobilised in runoff and wash down waters will be a requirement of the design process. Impacts during operations will largely be reduced by in-built design mitigations such as containment and treatment of all stormwater and wastewater on site before disposal via licensed discharges and appropriate sizing of stormwater drainage infrastructure. Mitigation and management measures contained in CEMP's and OEMP's will further reduce risk of Project related impacts on hydrological processes.

Human health

Potential creation of new biting insect breeding sites was identified as a potential Project related risk during the risk assessment and stakeholder consultations. It is also noted that mosquito breeding sites pose a risk to passengers at the nearby rail terminal, and potential quarantine issues, in regard to, international health regulations. The impacts to human health from biting insects will be managed through the development of a Biting Insects Management Plan during Project construction and operation.

Historic assessments of the potential for unexploded ordinance (UXO), which included removal of UXO from the Project site as part of construction of the nearby MUBRF facility, reduce the risk of finding additional UXO. However, as these findings do not completely preclude this risk UXO risk assessment will be undertaken by construction contractors prior to the commencement of construction works.

Cumulative Impacts

Cumulative impact assessments were undertaken for each of the key preliminary factors identified in the ToR in the context of existing environmental values and reasonably foreseeable future developments.

Marine environmental quality

Assessment of impacts on marine environmental quality indicated that, if dredging is to occur concurrently with other dredging operations there is the potential for cumulative environmental impacts on water quality. It is noted that all dredging programs undertaken in the Darwin Harbour require Developmental Consent and an approved Dredging and Dredge Spoil Placement Management Plan and hence the impacts and proposed measures to manage and mitigate these potential cumulative impacts can be further considered and coordinated by regulators. As part of the approval processes stakeholders will also be given an opportunity to comment on proposed dredging programs.

In response to the NT EPA's concern regarding cumulative impacts of dredging within Darwin Harbour, and the fact that there are several developments planned in the near future, the NTG have commenced the development of a Darwin Harbour Dredging Strategy that aims to provide a framework for sustainable, leading practice management of dredging in Darwin Harbour. The Dredging Strategy will be undertaken concurrently with the assessment of this EIS, and whilst it may not be finalised prior to the finalisation of the EIS assessment process, it is anticipated to be complete prior to any dredging for the Project. The Project intends to undertake any dredging in line with the Darwin Harbour Dredging Strategy.

Marine flora and fauna

Assessment of impacts on marine flora and fauna during construction indicated that impacts are predominantly associated with cumulative habitat loss such as the loss of mangrove and soft sediment habitat and their associated biological communities. There is also potential for cumulative impacts of underwater noise and vibration associated with dredging and piling. These potential cumulative impacts were considered minor, or not to be significantly greater than the risk of impact from each Project when considered in isolation.

Air quality and greenhouse gas

The air quality assessment considered background air quality in addition to Project related air emissions for assessment against air quality goals. The potential for air quality impacts are considered to be low when assessed alongside the emissions from other known developments as there is sufficient land separation between the majority of projects considered in the cumulative impact assessment and the Project area.

Social, economic and cultural heritage

The SIA found significant cumulative economic opportunities arising from the Project that are likely to contribute to developing Darwin's capacity as a maritime service and supply hub, and as a transport and logistics precinct on East Arm. The Project is well positioned to contribute to economic growth, enhanced capacity of the NT's maritime sector and workforce development.

The SIA also found that the potential cumulative additive and interactive impacts of development in Darwin Harbour was of concern to some stakeholders. Whilst the EIS found the contribution of the Project to cumulative impacts on values of the harbour to be minimal, consideration of potential overlap with known maintenance dredging for other projects has been proposed. To further support the sustainable management of cumulative impacts within Darwin Harbour, all relevant Project impact assessments will be made available to other projects such as the Middle Arm Strategic Environmental Assessment for cumulative impact consideration.

Environmental Management

The EIS includes an environmental management framework for the delivery of the Project. This framework defines the parameters for the preparation of subsequent CEMPs and OEMPs by the Construction Contractor and site operator to ensure that potential impacts and risks associated with the delivery of the Project are appropriately managed and monitored and fulfils environmental and social commitments and obligations. Environmental requirements will be explicitly specified in contract documents.

The environmental management framework is structured around the NT EPA objectives for the key environmental factors, and includes:

- proposed mitigation measures that are designed to reduce or mitigate residual risk
- requirements for monitoring, reporting and reviewing the effectiveness of these measures.

Management measures will be revised and refined over time to ensure objectives are met. The environmental management framework identifies and describes the relevant management plans that are required for the Projects construction and operation. These documents include:

- Heritage Management Plan (developed as part of this EIS)
- Noise and Vibration Management Plan
- Traffic Management Plan
- Dredging and Dredge Spoil Placement Management Plan
- Erosion and Sediment Control Plan
- Marine Spill Response Plan
- Biosecurity Management Plan.

Environmental management requirements for the privately-owned facility are outside the scope of this EIS and will be regulated under separate approval processes. However, as the operational activities are likely to be broadly similar to the Project, the environmental management framework could form the basis of developing site-specific management measures across the broader operations.

A SIMP was also developed as part of this EIS. The SIMP summarises the social and economic risks and opportunities of the Project and sets out strategies to enhance the positive and mitigate or manage potentially negative impacts.

Conclusion

This EIS has considered the potential environmental impacts of the Project consistent with the requirements of the Project ToR. Relevant technical studies have been completed to assess impacts on key environmental factors and applying a risk-based approach to developing and evaluating effective mitigation and management measures. Assessment of residual risks found a low risk of impacts upon most environmental factors following the implementation of appropriate mitigation and management measures.

The risk assessment identified one high residual risk to marine flora and fauna within Darwin Harbour associated with introduction of marine pests. The extreme consequence of the introduction of marine pest species, highlights the need to effectively implement stringent vessel risk assessment and inspection procedures. Fortunately, these are readily available, are routinely applied Australia-wide and have been demonstrated to be effective in Darwin Harbour during the INPEX Ichthys dredging campaign. In addition, there is a routine monitoring program for marine pest species within Darwin Harbour that will have the capacity to detect the introduction of these species, should it occur.

It is predicted that there is minimal potential for disruption of passage of any species between Elizabeth River and the main harbour. Incremental increase in vessel traffic associated with the construction and operation of the Project will not be of a sufficient magnitude to represent a significantly greater risk of impacts upon benthic communities, or individuals and populations of marine fauna.

Consultation found that the loss of World War II historical remnants was a concern to one stakeholder, despite their lack of formal heritage status. It is suggested that these areas be acknowledged with interpretative signage installed in nearby public areas.

The social impact assessment identified significant economic opportunities arising from the Project that will contribute to developing Darwin's capacity as a maritime service and supply hub, and transport and logistics precinct on East Arm. The Project is well positioned to contribute to the economic development of the NT, and likely to enhance capacity of local businesses and industry, and the growth of a skilled marine workforce. Several potential adverse impacts were also identified through the SIA, and these will require considered management and ongoing monitoring during the planning and construction phase of the Project.

Secondary approvals and permits under NT legislation will also be required for the construction and operation of the Project following completion of the EIS process. Approval conditions and legislative requirements associated with these secondary approvals and permits will be incorporated into subsequent environmental management plan revisions. Final dredging programs will be subject to Developmental Consent and approval of a Dredging and Dredge Spoil Placement Management Plan. As such the impacts and proposed measures to manage and mitigate resulting impacts can be considered further by regulators once the detailed design has been completed. Stakeholders will also be provided further opportunity to comment on these programs as part secondary approval processes.

NTG commits to an ongoing engagement and communication strategy during the development of the Project and broader marine industry precinct. Project information will continue to be posted on the Project website (<https://cmc.nt.gov.au/advancing-industry/ship-lift>).

Chapter 1

Introduction

1.0 Introduction

The Northern Territory Government (NTG) is delivering the Darwin Ship Lift Project ('the Project') which comprises construction and operation of a ship lift facility and an adjacent maintenance facility at East Arm.

The location of the Project at East Arm is consistent with long term master planning for Darwin. The NTG has been developing land at East Arm for marine industries since 2004 and in 2014, proposed to include a ship lift as part of the development of its East Arm Marine Industry Park.

The Project will enable maintenance and servicing of a broad range of industries, including the Australian Defence Force (ADF) and Australian Border Force (ABF) vessels, as well as commercial and private vessels, including those servicing the oil, gas, pearling, fishing and other marine industries.

The Project will support the continued economic growth of Darwin as a logistics and marine services hub of the Northern Territory (NT), and Northern Australia.

1.1 Overview of the Project

The NTG is developing the Project on the East Arm Peninsula within Darwin Harbour. The Project will be Northern Australia's largest common user ship lift. The Project is planned to be operational in 2025 and the concept design currently includes:

- ship lift of approximately 26 metres (m) width and 103 m length, capable of lifting vessels weighing up to 5,500 tonnes (t) plus associated platform, trestles and vessel transfer system
- self-propelled modular transporter (SPMT) vessel transfer system
- approximately 13 hectares (ha) of hardstand area for ship repair and maintenance
- vessel wash area with separate contained drainage and treatment system
- stormwater system to capture and treat runoff water before discharge
- enclosed blast and paint facility with separate contained drainage system as well as a negative pressure and air filtration system
- site services and utilities
- security infrastructure
- ancillary facilities including:
 - administration building
 - ship lift control room
 - SPMT garage.
- access channel and dredged manoeuvring areas
- six wet berths
- heavy lift platforms suitable for a 100 t crane at each berth
- revetments and quay structures.

Once constructed, the Project will comprise:

- an NTG owned facility that will lease areas/berths on a common user basis under a principal operator (Darwin Ship Lift Facility), and
- a privately owned berthing and maintenance facility (Privately-owned Facility).

The Project will provide marine infrastructure that will deliver key services to Northern Australia and act as an enabler for long-term growth of the region's marine services and logistics hub status.

A detailed Project description is presented in Chapter 2: Project Description.

1.2 Objectives and benefits of the Project

The infrastructure delivered by the Project will fill an existing industry gap and is anticipated to facilitate further development of the region's marine services and logistics, thereby supporting jobs and economic growth of the NT.

The Darwin Ship Lift Facility was recognised as a Priority Project for ADF and commercial marine industries in the NTG's *10 Year Infrastructure Plan 2017 – 2026* (DIPL, 2017), and again in the *10 Year Infrastructure Plan 2019-2028 annual review* (DIPL 2019).

The ship lift and transfer system has been designed to accommodate the servicing of Australian Navy offshore patrol vessels (OPVs). This will provide long-term maintenance opportunities and is mutually beneficial to Darwin and the ADF, with six of Northern Australia's OPVs anticipated to be based nearby at HMAS Coonawarra.

Other vessels that will be able to utilise the long-term maintenance opportunities provided by the Project include:

- the pearling industry
- the fishing industry
- the resources and energy sector.

Multiple commercial marine service providers will be able to operate concurrently at the site, providing vessel operators with a variety of maintenance services located within a secure facility.

The location of the Project maximises the use of existing and suitably zoned industry land and is in proximity to available and proposed industrial lots to support future growth. Environmental benefits include minimal clearing and disturbance of mangroves and reduced dredging due to use of the existing Multi-user Barge Ramp Facility (MUBRF) channel.

The Project is expected to contribute between \$130 to \$260 million annually to the NT economy upon reaching its full capacity over the next decade.

1.3 Proponent

The proponent of the Project is the Department of the Chief Minister and Cabinet (DCMC). The early design and procurement stages have been managed by a dedicated NTG Ship Lift Project Team within the DCMC. Final procurement and construction will be managed by the Department of Infrastructure, Planning and Logistics (DIPL).

Proponent's address:

Department of the Chief Minister and Cabinet

GPO Box 4396

Darwin NT 0801

Attention: Mr Craig Smith, Department of Infrastructure, Planning and Logistics.

1.4 Purpose of the draft Environmental Impact Statement

The purpose of the Environmental Impact Statement (EIS) is to

- inform the public of the nature of the Project
- evaluate the environmental risks and potential impacts of the construction and operations of the Project
- present the proposed measures to control these risks and appropriately manage impacts.

Environmental impact assessments (the subject of the EIS) have been undertaken in accordance with the Terms of Reference (ToR) issued by the Northern Territory Environment Protection Authority (NT EPA) in December 2019 for the Project.

Further to the EIS, secondary approvals will be required to construct and operate the Project. Secondary approvals may include Development Consent and waste treatment and disposal permits. These would be supported by other documents that will also be subject to approval such as Dredge Management Plans and Environmental Management Plans. Secondary approval requirements are discussed further in Chapter 3: Strategic and Statutory Framework.

In addition to secondary approvals the Project has been referred under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A referral for the original Project was submitted by Northern Ship Support Pty Ltd (NSS) in 2018 to the Commonwealth Department of the Environment and Energy (DoEE). On 25 September 2018, DoEE determined the Project to be not a controlled action (Reference No. 2018/8195). As the Project has undergone material changes since the original referral, the NTG will submit a new referral concurrently with this draft EIS. The new referral is likely to be available for public comment in November 2021 on the EPBC referrals website.

1.5 Overview of the draft Environmental Impact Statement

The EIS is comprised of a set of chapters and supporting technical appendices. The chapters describe the outcomes of the environmental impact assessment and are organised as follows:

- Chapter 1: Introduction provides a brief overview of the Project, the proponent and the Project's objectives and benefits. It also provides an outline of the environmental impact assessment process and discusses the approach to gain regulatory approval.
- Chapter 2: Project Description provides information regarding the location of the Project, an overview of its features, proposed construction methodologies and details on its operation. The chapter also summaries various design and construction alternatives considered to date, and details future refinement within detailed design.
- Chapter 3: Strategic and Statutory Framework details the legislation, codes of practice, guidelines, secondary approvals and permits that will govern the design, construction and operation of the Project.
- Chapter 4: Environmental Setting provides a description of the regional and site setting in relation to climatic and atmospheric characteristics, the marine environment, the terrestrial environment, and economic and social values.
- Chapter 5: Stakeholder Consultation outlines the public consultation process undertaken to inform the Project's social impact assessment (SIA) and the wider EIS.
- Chapter 6: Assessment Methodology provides a detailed description of the environmental impact assessment process and methodology, including the methodologies for identifying key environmental factors, undertaking the risk assessment, developing mitigation and management measures and assessing residual risk.
- Chapters 7 to 10 report the findings for assessments of potential impacts to each of the key preliminary environmental factors that were identified for consideration in the ToR: marine environmental quality, marine ecology, air quality and greenhouse gases, social, economic and cultural surroundings. These chapters detail environmental objectives, policy and guidance, environmental values, potentially significant impacts and benefits, potential cumulative impacts, proposed mitigation and management measures, and predicted outcomes (statement of residual risk) for each factor.
- Chapter 11: Other Environmental Factors considers potential impacts to other environmental factors that were not specifically described in the ToR but were raised as potential issues or concerns during the risk assessment and stakeholder consultation.
- Chapter 12: Cumulative Impacts considers the potential cumulative impacts of the Project in relation to the four key preliminary environmental factors. This assessment considers other projects that are proposed or currently being constructed, have the potential to overlap spatially or temporarily, or compete for resources such as labour.
- Chapter 13: Environmental Management Framework establishes the environmental management framework (EMF) for the delivery of the Project. It is designed to provide the parameters for the

preparation of subsequent Construction Environmental Management Plans (CEMPs) and Operational Environmental Management Plans (OEMPs) to ensure that potential impacts and risks associated with the delivery of the Project are appropriately managed and monitored in order to fulfil environmental and social commitments and obligations.

The chapters are set out as per Table 1-1.

Table 1-1 EIS chapter structure

Chapter	Chapter Title
1	Introduction
2	Project Description
3	Strategic and Statutory Framework
4	Environmental Setting
5	Stakeholder Consultation
6	Assessment Methodology
7	Marine Environmental Quality
8	Marine Flora and Fauna
9	Air Quality and Greenhouse Gases
10	Social, Economic and Cultural Surroundings
11	Other Environmental Factors
12	Cumulative Impacts
13	Environmental Management Framework
14	Conclusion
15	References

The EIS is supported by appendices containing technical information relating to the preparation of the EIS. Information includes technical reports, baseline data information and data analysis. These appendices are set out as per Table 1-2.

Table 1-2 Technical appendices structure

Appendix	Appendix Title
A	Terms of Reference
B	Persons Involved in Preparation of EIS
C	Social Impact Assessment
D	Risk Assessment
E	Water Quality Technical Reports
F	Benthic Habitats Modelling Technical Report
G	Underwater Noise Technical Report
H	Marine Sediment Geochemical Assessment Report(s)
I	Sediment Transport Modelling Technical Report(s)
J	Air Quality and Greenhouse Gas Technical Report
K	Terrestrial Noise Impact Assessment
L	Traffic Impact Assessment

Appendix	Appendix Title
M	Cultural Heritage Assessment
N	Preliminary Site Investigation

1.6 Terms of Reference

The Terms of Reference and corresponding cross-references to the EIS is provided in Table A-1 in Appendix A. A summary table containing specific Terms of Reference and corresponding cross-references relating to each key environmental factor is also provided at the beginning of Chapters 7 to 10.

Chapter 2

Project Description

2.0 Project Description

The location of the Project at East Arm is consistent with long term master planning for the East Arm Peninsula and Darwin Harbour which has been ongoing since the early 1980s. The key driver for the NTG is the continued growth of the region's marine and logistics industries.

The Project is currently at concept design phase. The concept design will be further progressed to a detailed design stage following a comprehensive contractor procurement process, in parallel with the development of this EIS.

This chapter is based on the detail available at the time of preparation. The impact assessments documented in this EIS will inform both the mitigation and management measures presented within the EIS and the progress of the Project design. Potential construction contractors are encouraged to consider alternatives that promote innovation, flexibility, efficiency and whole of life maintenance needs, while appropriately considering environmental impacts.

Financing for the Project consists of a \$300 million concessional loan from the Northern Australia Infrastructure Facility (NAIF) and a \$100 million NTG contribution.

The broader economic benefits arise from the opportunity to use this new infrastructure to catalyse a significant increase in marine repair, maintenance and sustainment work. Once operational the estimated economic, employment and social benefits are expected to arise over the next decade upon the Project reaching full capacity, with expenditure on marine repairs and maintenance is forecast to increase by around \$130 to \$260 million per annum over subsequent years.

2.1 Site description

2.1.1 Site locality

The Project is situated approximately 6.5 Kilometres (km) south-east of the Darwin Central Business District, on the East Arm Peninsula within Darwin Harbour. The site is approximately 700 m east north-east of the East Arm Wharf (EAW) and the Marine Supply Base (MSB), and west of the Darwin Business Park. Road access is provided by Berrimah Road, linking the site to the Darwin road network including the Stuart Highway and Tiger Brennan Drive.

The mix of land uses surrounding the Project include:

- West: The EAW and MSB support export and import of dry bulk materials and liquids associated with the mining and petroleum industries, containerised/ break bulk (not containerised) and specialised heavy lift cargoes, general cargoes and live cattle exports.
- North: industrial land including the Darwin Port stockpile area and dredge spoil ponds, the Northern Cement plant, the Darwin Vopak Terminal (petroleum import and distribution terminal), the Common-user Facility (CUF) and the passenger terminal of the Adelaide - Darwin rail line.
- East: the recently constructed MUBRF, and Catalina Island.
- South: the southern end of the Project site encompasses the intertidal zone and the East Arm water confluence with Elizabeth River which forms part of Darwin Harbour.

There are no residences in close proximity to the Project area. The location of the Project is shown in Figure 2-1.



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2.1.2 Land use

The existing land portion of the site is fully fenced and is used for the provision of marine services activities by a private company. It currently accommodates a car park, site office, marine equipment, material hardstand/laydown area, a works depot, marine workshop and a boat ramp. The boat ramp was constructed in World War II and was used in more recent times for recreational boating purposes, prior to the construction of the current East Arm Boat Ramp at Casey Street. The existing use of the site is shown in Figure 2-2 and Plate 2-1.



Plate 2-1 Marine services activities conducted at Project site

The western portion of the site supports an isolated remnant stand of intertidal mangrove habitat (1.0 ha) (refer Plate 2-2). The intertidal area and seabed within the site have previously been disturbed as a result of historic uses during World War II.

Heritage studies undertaken prior to the construction of the neighbouring MUBRF resulted in the removal of substantial volumes of modern debris and historic cultural heritage material from the seabed. Remnants of the East Arm Flying Boat Base (FBB) infrastructure remain on the site, with the Catalina 2 WWII aircraft wreckage site on an area of seabed outside of, but in proximity, to the Project.

Catalina Island, to the east of the Project, is an identified sacred site and the nearby Old Man Rock is a registered archaeological site.



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Plate 2-2 Mangrove Habitat along the western extent of the Project area

2.1.3 Tenure

The Project site covers one marine and three land parcels including freehold, leasehold and perpetual lease land. The remaining over-water land component of the Project is unalienated Crown land that is shown as part administrative section 7398, Hundred of Bagot (excluding the access channel). The land based Project area principally consists of Sections 5163, 6370 and 5420, which are privately owned.

A summary of the current tenure applicable to the Project area is provided in Table 2-1 and shown on Figure 2-3.

Table 2-1 Summary of Tenure within the Project area

Parcel	Location Name	Parcel area (ha)	Tenure Reference	Owner
5420	Hundred of Bagot	1.72	Freehold	Paspaley Pearls Properties Pty Ltd
5163	Hundred of Bagot	2.65	Crown Lease Term	Paspaley Pearls Properties Pty Ltd
6370	Hundred of Bagot	0.56	Crown Lease Term	Paspaley Pearls Properties Pty Ltd
5167	Hundred of Bagot	5.76	Crown Lease in Perpetuity	Paspaley Pearls Properties Pty Ltd

2.1.4 Zoning

The East Arm Peninsula has been designated for port and industrial related development since the late 1980s, with the intent formalised in the Darwin Regional Structure Plan 1984, subsequent Darwin Regional Land Use Structure Plan 1990 and the East Arm/Middle Arm Peninsulas Masterplan 2008 (NT Department of Lands and Housing 1990; NTG 2008).

In 2015, the Darwin Regional Land Use Plan designated land at East Arm as Strategic Industry (SI), confirming the further expansion of the East Arm Business Park and logistics precinct, to assist business to grow and capitalise on future projects, with particular focus on the region's expanding oil and gas, marine and logistics industries (Department of Lands, Planning and the Environment [DLPE] 2015).

The Project was recognised as a CUF for the general maritime sector and the Department of Defence as a priority project through the '10 Year Infrastructure Plan 2017 – 2026' published by the NT DIPL.

From a statutory land use planning/management perspective, the Project site is zoned DV (Development) under the NT Planning Scheme (NTPS) 2020 (NTG 2020). As per NTPS 2020, the purpose for Zone DV is to facilitate the development of major strategic industries that are of importance to the future economic development of the NT, including gas, road, rail or port related industries.

The Project therefore complies with the purpose of the Zone, as well as the nature of development anticipated under the existing strategic framework. No residential land use zoning is located on the East Arm Peninsula or immediate surrounding area, with the closest residential areas being the Darwin Waterfront and CBD (6 km) to the north-west, the Northcrest development (Berrimah Farm) (6 km) and Haileybury Rendall School (5.5 km) to the north and Marlow Lagoon to the east (6 km).

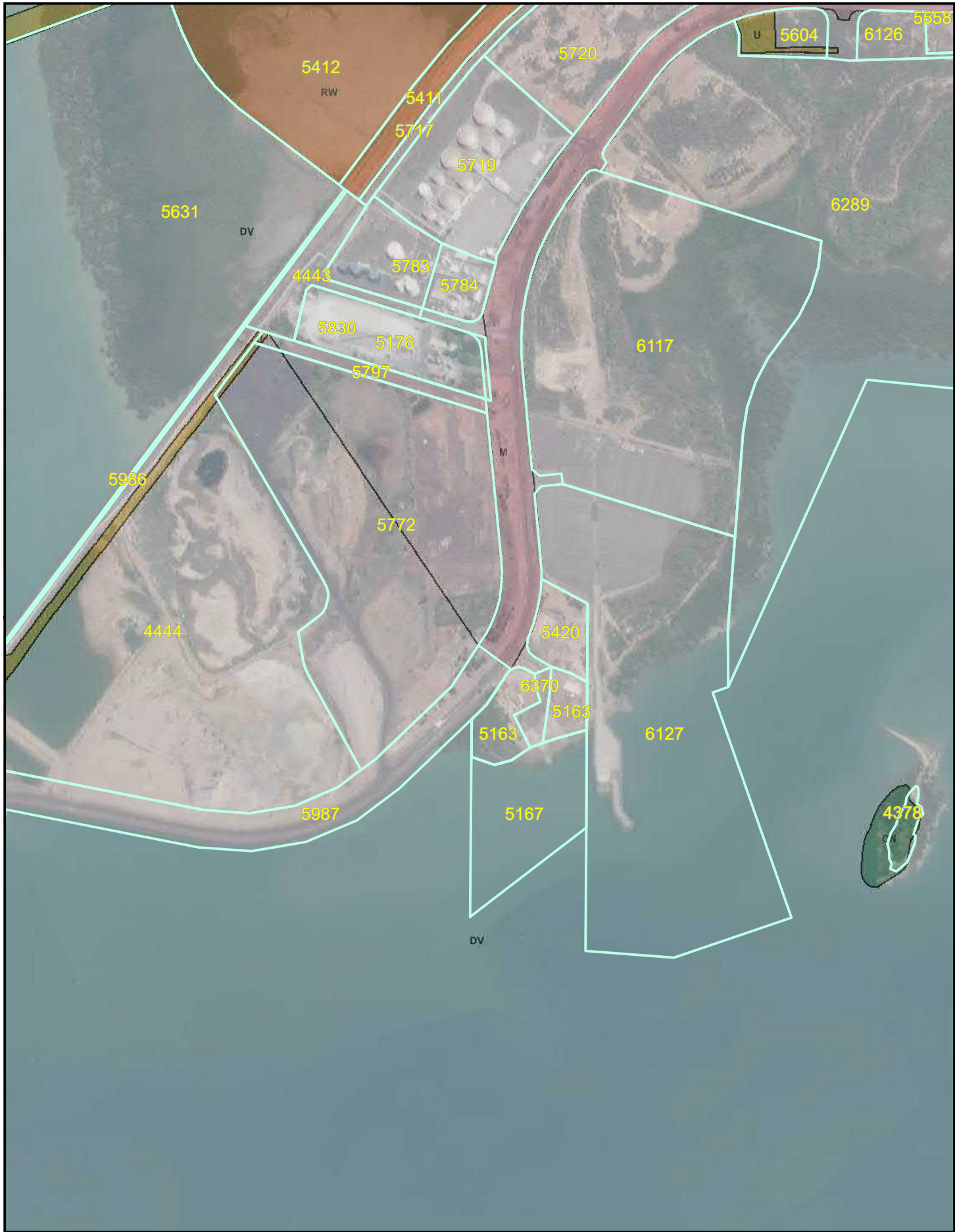
Current zoning for the Project site and surrounds is shown in Figure 2-3.

2.2 Facility Features

2.2.1 Overview

The Project is expected to include the following elements which are discussed in more detail below:

- Waterside infrastructure, including:
 - common user ship lift (26 m wide, 103 m long and capable of lifting vessels with up to 6 m draft and a maximum load of 5,500 t, plus associated platform, trestles and vessel transfer system)
 - six (6) wet berths
 - heavy/lift platforms suitable for a 100 t crane at each berth
 - dredged manoeuvring basin and berth pockets
 - access channel with navigation aids.
- Landside infrastructure, including:
 - vessel transfer area and equipment including a SPMT system and SPMT garage
 - trestles for vessel support, lifting and transfer
 - ship lift control centre
 - wash down area and water treatment plants
 - heavy and light duty hardstand, dry berths and laydown areas
 - blast and paint facility with negative pressure and air filtration system
 - services and utilities
 - stormwater management system
 - internal roads and car parks.
- ancillary buildings including workshops and administrative offices.



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LEGEND

Cadastral boundary

Development

Main road

Utilities

Conservation

Railway

Tenure and land zoning

NORTHERN TERRITORY

GOVERNMENT OF AUSTRALIA

DARWIN SHIP LIFT PROJECT

Figure

2-3

A4 size

Figure 2-4 shows the conceptual design of the Project including the extent of the existing MUBRF access channel which will be utilised by vessels to access the Project. No further dredging of this channel is intended to construct the facility.

The layout of the landside components of the Project will consider:

- safe operational movements of all vehicles, service vehicles, operating plant and vessels
- requirements for vehicles movement and transporting vessels within the site, and connectivity between facilities.

Provision has been made for future workshops and buildings on the western hardstand area. However, the details of future development on this land is not assessed in this EIS and will be subject to separate approvals as appropriate.

Designated vehicle access roads around the facility will be designed to provide safe access to the hardstand, wash areas, buildings, ship lift area and wharf assets.

The site will be fully secured with fencing along the land boundary, security lighting, a visual monitoring system, a gatehouse and electronic gated access.

Plans currently detail a dedicated intersection upgrade and access road from Berrimah Road.

2.2.2 Project footprint

The concept design footprint of the Project when constructed will cover 29.7 ha and incorporate both land and water components.

Based on the concept design, the area of land within the proposed Project footprint is 5.5 ha. Once constructed the land component will total approximately 17 ha and will include 8.8 ha of reclaimed land and 2.7 ha of revetments.

Based on concept design, the current area of water within the proposed Project footprint is 20.7 ha. A further 3.5 ha outside of the Project footprint has been considered as a potential disturbance area. Once constructed the area of water will measure 9.2 ha which will require dredging for the following areas:

- ship lift and wet berths at -6.8 m lowest astronomical tide (LAT) (6 ha)
- manoeuvring basin areas at -3.3 m LAT (3.2 ha).

A summary of the Project footprint when constructed is shown in Table 2-2.

Table 2-2 Concept design Project footprint when constructed

Component		Area (ha)
Land area		
Hardstand and land-based facilities	• Reclaimed land	8.8
	• Existing land	5.5
	Total hardstand	14.3
Revetment		2.7
Water area		
Dredging area	• Ship lift and wet berths – dredged at – 6.8 m	6
	• Manoeuvring basin – dredged at – 3.3 m	3.2
	Total dredging	9.2
Project footprint		26.2
Potential disturbance area		3.5
Total land and water area		29.7



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Metres

Data sources:
Source: Esri, Mapbox, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority (Landscape 2010).

LEGEND

- Project footprint
- Darwin Ship Lift Facility
- Privately-owned Facility
- Potential disturbance area
- Revetments
- Berths and manoeuvring basin
- Multi-user Barge Ramp Facility (MUBRF) channel

Note:
The layout is indicative only

Proposed infrastructure layout

NORTHERN TERRITORY
GOVERNMENT OF AUSTRALIA
DARWIN SHIP LIFT PROJECT

Figure
2-4

A4 size

2.2.3 Reclamation and ground improvement

Construction of the Project will involve reclamation of 8.8 ha of land. The reclaimed area is to be protected from erosion with an armoured revetment (protective covering) or wharf. The revetment areas will total 2.7 ha.

The revetment and bund crest will be constructed to withstand the following:

- potential for broad scale inundations of the site and surrounding areas
- potential effects of localised overtopping by waves around the seaward edges of the site.

The potential for overtopping from storm surges, particularly in cyclonic conditions, and the potential impacts of climate change and sea level rise, will be considered in the design.

Hardstand areas will be paved with a mixture of heavy, medium and light duty pavement. SPMT pavement will be located where the SPMT laden with maximum mass vessels are expected to travel. The SPMT pavement will be an interlocking concrete block paver surface or an alternate. This type of pavement is used at heavy load-bearing locations such as the adjacent MUBRF.

2.2.4 Navigation channel and manoeuvring basin

Vessels will access the site at controlled speeds via the existing navigation channels within Darwin Harbour, including the Bladin Point dredged channel, the MSB channel and the MUBRF channel.

The existing MUBRF channel will provide incoming vessels access to the manoeuvring basin, adjacent to the ship lift system and wet berths.

2.2.5 Wet berths

Vessels will be moored at wet berths to undergo in-water maintenance activities, such as maintenance and repair of electronics, internal ship repairs, or for crane support to lift plant and equipment to and from the berthed vessel. Alternatively, if utilising the ship lift system to transfer to land-based maintenance facilities, vessels may moor at the wet berths to queue whilst awaiting the appropriate tide before proceeding to the ship lift area.

The facility will include six (6) wet berths which will be accessed via gangways. Each berth will include wharfs for access to the vessel side by light service vehicles such as all-terrain vehicles and 100 t mobile cranes.

Shore power will be provided for vessels to minimise the requirement for vessels to run their engines or generators while berthed. One (1) low volume potable water connection and fire hydrants will be provided as required by relevant standards. Salt water firefighting systems will be considered.

No reticulated services connections for high flow bunkering of potable water, telecommunications, fuel bunkering, petroleum oils and lubricants, sewage or wastewater will be provided to/from vessels at wet berths.

2.2.6 Ship lift system

The ship lift design will employ a Mechanical Lift Dock ship lift. Designs will be confirmed in the detailed design and procurement stage but is likely to consist of several sections operated by pairs of hydraulic winches. The number of ship lift sections utilised to lift a vessel will depend on vessel size.

A single platform design operated by twelve pairs of hydraulic winches has been selected for impact assessment for the EIS. If alternative modes of operation are adopted, it is assumed that the potential environmental impacts associated with these alternatives will not be significantly different.

The ship lift platform design will allow for:

- vessel inspection, maintenance, and repairs
- light vehicle movement for maintenance and trestle placement
- efficient operation of the vessel transfer system.

On the last one-to-two hours of an incoming tide, vessels utilising the ship lift will be manoeuvred over the trestles on the lowered lifting system by line handling systems (warping). When the vessel is in the

correct position, the vessel will be lifted to the vessel transfer level, SPMTs will then be manoeuvred into position beneath the vessel-laden trestles.

A modern computerised ship lift control system will be provided. This system will be housed in an elevated Ship Lift Control Room.

2.2.7 Vessel transfer system

A range of modular SPMTs and trestle sets will be available to transport vessels from the ship lift platform, and the landside dry berths and maintenance bays, across the Project site. The SPMTs will be battery or diesel operated units with solid tyres and will be stored in a dedicated shed when not in use.

The vessel will initially be moved by SPMTs for full wash down at the designated wash down bay. The requirements for which will be detailed in a Biosecurity Management Plan. Biosecurity is discussed further in Section 2.2.17.

2.2.8 Wash down bay

The wash down process will involve high pressure water and mechanical scraping to remove biofouling from the submerged portion of the vessel's hull. The wash down bay will consist of a defined heavy-duty concrete pavement area with a specialised contained drainage system, isolating the solid waste, wastewater and rainfall runoff from the remainder of the site drainage system.

Solid waste from the wash down will be captured and contained for off-site disposal at an approved facility. Wastewater generated from the wash down bay and any stormwater runoff will be captured for treatment and either:

- reused on site
- disposed of to the sewer via a trade waste agreement with Power and Water Corporation (PWC)
- treated and discharged into the harbour within environmental compliance obligations and pursuant, if required, to an approved waste discharge license (WDL).

Wastewater, water treatment and stormwater management are discussed further below in Sections 2.2.13 and 2.2.14 respectively.

2.2.9 Dry berths

Once vessels are declared clean, they will be moved via SPMTs to the selected dry berth or blast and paint facility. General vessel maintenance including welding, repair and refurbishment works will occur in the general-purpose dry berths.

2.2.10 Blast and paint facility

One dry berth will be dedicated to a fully enclosed blast and paint shed where activities include abrasive blasting for paint and corrosion removal (including anti-fouling paint) and surface preparation, then painting of the vessel hull, including anti-fouling paints as well as other maintenance, fabrication and repair activities (including hot works, welding and cutting).

The purpose of the blast and paint facility is to provide protection from weather and a controlled environment to prevent contaminants (including, blast materials, dust and overspray, from blasting and painting works) from escaping into the environment. The blast and paint facility will include a negative pressure shed with filters to prevent dust from entering the shed during painting works and fumes from escaping into the atmosphere. Air emissions will be exhausted via roof mounted exhaust stacks. Air filtration will be installed as part of the mechanical ventilation system to minimise emissions to air.

The shed is expected to fit the majority of vessels, however for longer vessels, temporary structures may be placed around the end of the shed to minimise movement of dust and fumes. Blasting, painting and other maintenance activities may occur in the same area, divided areas or separate facilities, as determined by the operator.

As proposed for the wash down facility, the blast and paint shed will have a separate drainage system to facilitate full containment and treatment of water produced during these works.

2.2.11 Road access

Road access to the facility will be via the existing Berrimah Road, which currently links to the main arterial routes of the Stuart Highway, Tiger Brennan Drive and Wishart Road. Berrimah Road is the existing heavy vehicle access route to the East Arm Peninsula and EAW. Existing access routes are shown in Figure 2-5.

The site road layout and car parking will be designed to facilitate servicing requirements and emergency vehicle access.

2.2.12 Ancillary facilities

Buildings sufficient to meet the intended operational requirements of the Project will include:

- an administration building.
- an elevated Ship Lift Control Room
- a SPMT garage.

The administration building will provide:

- a suitable area for administration, security, staff facilities, first aid
- open plan office space
- meeting/training rooms
- IT connections
- kitchenette, toilets, shower and ablution facilities.

A smaller guard house or similar may also be constructed if the administration building does not provide security and access control for the site. Other access control considerations may also be considered during detailed design development.

A modern computerised ship lift control system will be provided. This system will be housed in an elevated Ship Lift Control Room. The function of the ship lift control room is to provide an elevated control room facility to oversee the lift operation.

The function of the SPMT garage is to provide a suitable space for the storage and maintenance of the vessel transfer system. The building will have adequate storage space for the full complement of vessel transfer vehicles while not in use and include workshop and maintenance facilities.



PROJECT ID 60633505 CREATED BY PK APPROVED BY JC LAST MODIFIED 25 AUG 2021  www.aecom.com N 01,2502,5003,7505,000 Meters 1:125,000 when printed at A4 DATUM GDA 1994, PROJECTION MGA ZONE 52 Data sources: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).		LEGEND ● Features ■ Project footprint — Arnhem Highway — Berrimah Road — Channel Island Road - Elrundie Avenue — Gunn Point Road - Howard Springs Road — Kirkland Road — Stuart Highway — Tiger Brennan Drive — Wishart Road		Existing access roads NORTHERN TERRITORY GOVERNMENT OF AUSTRALIA DARWIN SHIP LIFT PROJECT	Figure 2-5

2.2.13 Wastewater and water treatment

The wash down and blast and paint bays will have specific design features to ensure waste can be properly contained and treated. These areas will be designed so that 'at source' mechanical clean-up of solid waste material (e.g. removed biofouling in the wash-down bay, blasting grit and removed paint, including anti-fouling paint, in the blast/paint bay) can occur before it enters the wastewater system.

Specially designed drainage will capture wastewater generated by high pressure spraying or wash down processes. This wastewater will be treated and re-used on site in these bays (e.g. for wash down). Treated wastewater in excess of what can be re-used will be disposed to sewer under a trade waste agreement with PWC or treated and discharged into the harbour within environmental compliance obligations and pursuant, if required, to an approved WDL.

Runoff from the outside bays will be managed by a combination of operational measures such as 'at source' solids removal (e.g. biofouling solids and wastewater from the wash-down bay,) and capture and treatment. This will target the 'first flush' from the outside bays, which will be treated before discharge. Runoff in excess of this, for example from prolonged rainfall events, will also be captured and treated consistent with the approach for stormwater from the remainder of the general hardstand area.

Water treatment plant design will be further progressed during detailed design, however, is likely to contain two 30 kilolitre (kL) tanks, with underground precast concrete drains, pipe work and containment.

Wastewater removal from vessels will be via mobile waste removal vehicles and disposed off-site at a licenced waste disposal facility. No fixed asset is to be provided for the removal of wastewater from vessels.

2.2.14 Stormwater management

Stormwater runoff from other areas of the Project will be treated in accordance with the relevant requirements including environmental approval commitments and conditions.

Site run-off may impact on water quality in the adjacent harbour waters if not managed appropriately. A key priority is to ensure that the Project design includes features which will provide the appropriate management of any contaminants which may be mobilised in runoff and wash down from hardstand work areas during operations. The effective management of this issue will be addressed in the design, and proven techniques implemented to ensure no adverse impact on receiving waters occurs.

The stormwater drainage system will be consistent across the entire site and will be designed to incorporate separation of 'clean' and 'dirty' stormwater. 'Clean' runoff is surface runoff captured from a clean surface such as rainwater collected on the roofs of buildings or any garden areas and will be allowed to be discharged to the stormwater system and ultimately discharged to the sea.

'Dirty' stormwater runoff is derived from all other general use areas such as car parks and hardstand areas and will be captured and treated in accordance with water sensitive urban design (WSUD) principles and treatment including, trash exclusion, the removal of hydrocarbons which may be present, and gross pollutant traps (GPT's), before being discharged to the marine environment.

The overall management of stormwater and potential contaminants mobilised in runoff and wash down waters is a key requirement of the design process. No water will leave the site without appropriate treatment consistent with the principles of WSUD.

Stormwater management is discussed further in Chapter 11: Other Environmental Factors

2.2.15 Waste management

In accordance with the NT EPA *Waste Management Strategy for the Northern Territory 2015 – 2022* (2015) management of wastes will follow the principles of the waste management hierarchy. The waste management hierarchy ranks waste avoidance and reduction as the optimal approach, followed by reuse through recycling and recovery options, with disposal as the least preferred approach (NT EPA, 2015).

Activities producing waste containing materials that have potential to cause significant environmental impact will be managed by segregation and containment of waste. Waste will be stored in appropriate

bins and transported by licenced waste contractors to an offsite licenced waste facility for recycling or disposal.

Waste management is discussed further in Chapter 11: Other Environmental Factors.

2.2.16 Spill management

The drainage network and capture system will be designed to consider the potential for spills from the onshore land side vessels and activities to prevent uncontrolled discharge into the environment. Training, operational procedures and associated equipment (such as containment devices and spill kits) requirements will be provided to manage spills of contaminants on landside and seaside areas as appropriate and detailed in relevant management plans.

A Marine Spill Response Plan will be developed and implemented in line with the existing Darwin Port Oil Spill Contingency Plan (OSCP). The plan should also reference the NT OSCP (Department of Transport Marine Safety, 2014).

2.2.17 Biosecurity

Given the significance of the potential consequences of introduction of invasive marine pests it is recognised that it will be imperative to implement stringent mitigation and management measures during both construction and operations.

Marine pest species may be introduced into marine environments within ballast water, as biofouling on vessels or through deliberate introductions. Of these, ballast water and biofouling are the most important and relevant to the Project.

As noted above the wash down facility design will include a fully contained waste and wastewater system to capture and contain biofouling removed from vessels during washdown. Ballast water will be managed by vessel owners as per the requirements of the *Biosecurity Act 2015*. Management measures will be aligned with the existing framework for reducing the risk of introduction of invasive species to Darwin Harbour (e.g. Darwin Port's Port Environment Protection Plan, INPEX's Operational Environmental Monitoring Program, NTG Aquatic Biosecurity Unit monitoring program) and with Australian national guidelines (e.g. Department of Agriculture Fisheries and Forestry [DAFF] 2009a,b, 2010 Department of Agriculture and Water Resources [DAWR] 2017).

Measures will be documented in a Biosecurity Management Plan, which will include quarantine procedures, vessel risk assessments and inspection protocols. The management plan will be developed in consultation with the Aquatic Biosecurity Unit within the NT Department of Industry, Tourism and Trade (DITT) to ensure consistency with existing quarantine arrangements for Darwin Harbour facilities.

The Biosecurity Management Plan will also include measures for managing weeds, mosquitoes and feral animals that might be transported to site via vehicles and vessels.

2.2.18 Utilities

Site utilities will include power, water, sewage and telecommunications. Existing utilities for the East Arm Peninsula through to EAW are located along Berrimah Road. DIPL and PWC are currently engaged in strategic planning to coordinate upgrades to meet the area's current and future growth demands.

Required upgrades to utilities are outside the scope of this EIS and will be undertaken in consultation with the asset owner. These works will be required to comply with relevant environmental and regulatory frameworks applicable to the works or public utility.

All utilities will be located below ground and accessed through a network of service pits or access hatches.

2.2.18.1 Electricity supply

The design of the electrical distribution system will accommodate the electrical demand of the ship lift system with enough capacity to meet the operational needs of Project infrastructure. Electricity supply will be reticulated throughout the facility or, alternatively, the electrical system may provide some of the supply and a generator may provide the surge/balance of needs. Shore power will be provided to

wharfs for vessels to minimise the requirement for vessels to run their engines or generators while berthed.

The annual electricity consumption for Project operations is conservatively estimated at 1,440 megawatts of energy, including buildings, marine infrastructure and shore-power for berthed vessels.

2.2.18.2 Lighting

Perimeter lighting of the whole facility will be required for safety and security, and for vessels to utilise the ship lift system and berthing facilities at night and facilitate navigational and operational safety.

The roadways, gate access and car park will be provided with lighting to facilitate safe movement of personnel and vehicles and to facilitate security with a minimum illuminance of 20 Lux or as required by design standards. Careful consideration will be given to the positioning of any permanent light towers and poles to ensure that they have no significant adverse impact on vessel transfers.

The ship lift area will be provided with lighting to allow ship lifting operations to occur safely at night with a minimum illuminance of 50 Lux or as required by design standards.

Lighting will be designed inward-facing where feasible to minimise over-water light spill.

Mobile lighting rigs will provide extra lighting for night works when required.

Lighting is discussed further in Chapter 8: Marine Flora and Fauna and Chapter 10: Social, Economic and Cultural Surrounds.

2.2.18.3 Water supply

Non-potable water, raw water and potable water will be clearly labelled and available to meet the requirements of the Project. Water and sewage networks will be designed and installed in compliance with relevant PWC's requirements.

Efficiency principles will be applied to manage water use. Non-potable water can be utilised as a first resource for dust suppression during construction, and where possible, recycled water will be used for wash down following on site treatment. Fire water hydrants and reticulation will be provided in accordance with relevant codes and standards.

Wet Berths will be provided with one low volume potable water connection.

2.2.18.4 Sewage

Volumes of sewage and licenced trade waste to be discharged to the sewage system were unavailable at the time of preparing the EIS.

Sewer connections will be provided to:

- administration building
- Ship Lift Control Room
- SPMT garage.

Detailed design will size appropriate systems for expected peak usage, however annual volumes will depend on the level and type of operational activities undertaken each year. Future connection to a PWC sewer main will also be considered.

On site storage of sewage shall have an appropriate storage capacity in accordance with relevant standards. Sewage removal from vessels and on-site holding storage will be transported and disposed of at a regulated waste disposal facility.

No fixed infrastructure will be provided for discharge of ship wastewater. Sewage and wastewater removal is to be carried out by licenced waste removal contractors using road transport.

2.2.18.5 Telecommunications

Telecommunications will be to NBN standard and will connect to existing NBN Fibre to the Premises asset on Berrimah Road.

2.2.18.6 Security

Security will be installed around the perimeter of the facility, excluding revetments bunds facing onto water. Access control will be via a gate. A secondary boom gate will also be installed for use for areas with higher levels of security requirements.

The site perimeter is to be monitored by closed circuit television (CCTV).

2.3 Design

Currently the Project designs is at a concept level. The detailed design and construction of the Project will be undertaken by a suitably experienced construction company, selected through the NTG's staged design and construct procurement process.

The successful contractor will be required to demonstrate commitment to, and capability of meeting, basic and legislated health, safety, environment and security. Where possible sustainability initiatives will be considered in designs and construction methodologies to maximize resource efficiency, enhance local economic activity and mitigate environmental and social impacts.

Designs will be progressed in accordance with relevant standards such as:

- Commonwealth and NT legislation and regulations
- environmental and regulatory approvals, commitments and conditions
- ADF and ABF requirements
- Australian and international standards, including standards relating to shipping and maritime activities
- relevant codes of practice published by Commonwealth or NTG bodies and industry organisations.

Statutory and industry standards and codes of practice relevant to this EIS are presented in Chapter 3: Strategic and Statutory Framework, while further detailed discussion of these topics is contained in each of the key preliminary environmental factors chapters (Chapters 7 to 10).

In addition, as noted in Section 2.2.3, the potential for overtopping from storm surges, particularly in cyclonic conditions, and the potential impacts of climate change and sea level rise, will be considered in the design.

2.4 Construction

A detailed construction schedule is not available at this stage, however an indicative concept design schedule is presented in Section 2.4.2. The current concept design schedule will be further developed as part of the detailed design process.

The construction phase will comprise several key activities that are discussed further in this section. Some of these activities will occur concurrently (e.g. dredging, transport of fill from off site and land reclamation).

The following construction works are anticipated:

- site preparation
- dredging
- transport of fill and materials
- land reclamation and revetments
- service installation, pavement sealing and paving
- piling
- infrastructure/component fabrication and installation
- corrosion protection.

This section also discusses:

- machinery and equipment requirements
- road access
- construction timeframes and workforce.

2.4.1 Site preparation

The existing site will be cleared of all above ground infrastructure. The landside area of the site will be levelled to allow reclamation works to commence. Existing inground services may be capped and abandoned unless expected to conflict with new services.

Approximately 1.0 ha of isolated mangroves will be removed from the western portion of the Project area as well as the clearing of a small number of eucalypts and weed species which fringe the landward edge of the mangrove area. It is anticipated that mangroves will be flattened and left in situ to maintain ground stability and to reduce the risk of exposing any underlying ASS that may be present.

A Preliminary Site Investigation (PSI) (Appendix N: Preliminary Site Investigation) was undertaken to assess the potential risks associated with historical site activities. The PSI indicated that it is unlikely that significant contamination of soil or groundwater had occurred at the site, limiting the risk that proposed earthworks will disturb contaminated material. If the presence of contaminated land is confirmed during construction activities, a protocol will be developed and management of any potentially contaminated materials is expected to include removal to an approved waste facility or incorporation into the Project and in situ treatment.

Material requiring offsite disposal during the site preparation stage will be appropriately managed to minimise any environmental impacts. Clean material that can be recycled as reclamation fill will be stockpiled on site, with any excess volumes stored locally, likely on the cleared area north of the CUF, prior to site return.

2.4.2 Dredging options

It is anticipated that approximately 9.2 ha will require dredging for construction of the:

- ship lift and wet berths at -6.8 m LAT (6 ha)
- manoeuvring basin areas at -3.3 m LAT (3.2 ha).

There are two components to the program for dredging the footprint of the wet berth and manoeuvring basin areas:

- removal of approximately 185,000 cubic metres (m³) of unconsolidated marine material
- removal of approximately 315,000 m³ of consolidated materials.

The dredging campaign will be undertaken by either:

- Option 1: using a cutter suction dredge (CSD), similar to that used for the neighbouring MUBRF dredge campaign, to remove the unconsolidated material to settling ponds, then a backhoe dredge (BHD) to remove the consolidated stiff clays and rock for land reclamation.
- Option 2: using a BHD to mix all spoil and for land reclamation.

Under Option 1, the CSD, supported by work boats, will (pending agreement with Darwin Port) pump the unconsolidated material (via floating, submerged and/or overland pipelines) to the existing EAW settlement ponds (refer Figure 2-6). The dredged material will be deposited into dredge Pond K, in which the larger particles (sands and silts) will settle out. The supernatant tailwater will then flow into Pond E (north), in which finer particles will settle out. Silt curtains may be installed in Pond E (north) to assist in this process. Pond E (south) will provide a final settlement stage before discharge of the tailwater to Darwin Harbour via a permeable section of the bund wall. Testing of the water will take place prior to discharge to ensure all environmental targets are met.

The EAW settlement ponds have been utilised in this manner in the past for dredged material placement for the MSB and MUBRF dredging campaigns. All dredging works will be undertaken in

accordance with an approved Dredge and Dredge Spoil Placement Management Plans (DDSPMP) and a WDL. These will be submitted to the relevant regulators for approval prior to commencement of dredging.

Under Option 2, a BHD will deposit the dredged material into hopper barges, in which the material will be transferred into the reclamation area. Unconsolidated and consolidated dredged material will be mixed on site and the site progressively filled from the shoreline in a seaward direction until the extent of the proposed reclamation is reached. Water quality impacts generated by filling of barges and reclamation will be managed under an approved DDSPMP.

The dredges to be used will be determined by the dredging contractor based on dredge availability and marine geotechnical information. Silt curtains will also likely be used at the dredging and reclamation areas to control the movement of suspended silt and sediment.



PROJECT ID 60633505 CREATED BY PJY APPROVED BY PYoung LAST MODIFIED 16 SEP 2021 AECOM www.aecom.com 1:18,000 when printed at A4 DATUM GDA 1994, PROJECTION MGA ZONE 52 0 180 360 540 720 Meters Data sources: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).	LEGEND ■ Project footprint — Settlement pond	Location of East Arm Wharf settlement ponds NORTHERN TERRITORY GOVERNMENT OF AUSTRALIA DARWIN SHIP LIFT PROJECT	Figure 2-6

Note:
The layout is indicative only

2.4.3 Construction material transport

To build the landside components of the Project, approximately 715,000 m³ of fill, 16,500 m³ of revetment filter rock and 46,000 m³ of armour materials are required. This is expected to comprise approximately:

- 400,000 m³ of sand fill, or clean fill, transported by road from local borrow pit site(s) within 20 km of the Project site.
- 315,000 m³ consolidated material, comprising stiff clays and rock, dredged (likely by BHD and barge) from below the ship lift system, manoeuvring basin and wet berth footprint areas which will be transported ashore.
- 16,500 m³ of filter rock sourced from a commercial quarry.
- 46,000 m³ of armour rock either be sourced from a commercial quarry or comprise pre-cast concrete units.

Various options exist for sourcing reclamation fill and hard rock. The closest potential option is from the LDC's project area near Truck Central at Wishart Road/Tiger Brennan Drive intersection; the furthest (for revetment rock only) being commercial quarries at Mount Bundy, approximately 100 km east along the Arnhem Highway.

The hardstand area finished surface will comprise:

- 90,000 m³ of pavement and subgrade material
- 1.2 ha of interlocking concrete block pavers for the SMPT vessel transfer areas.

Existing road access to EAW is via Berrimah Road, with the haul route's main highways and arterial roads designed to carry high volumes of heavy vehicle traffic. Haulage and material management areas within the Project site will be unsealed. Existing road access routes to the site are described further in Section 2.2.11 and shown in Figure 2-5, along with potential material source areas.

Details of the traffic assessment undertaken for the project are presented in Appendix L: Traffic Impact Assessment and summarised in Chapter 10: Social, Economic and Cultural Surroundings.

2.4.4 Land reclamation and revetments

The land reclamation process will be further refined within detailed design. The following methodology options were considered for the EIS impact assessment.

- Shoreline outwards placement: Imported fill and consolidated dredged fill material (brought to the shoreline by barge), would be placed, pushed and compacted outwards from the shoreline by earthmoving machinery. This would continue until the outward edge of the reclamation was reached and revetments are installed using geofabric, primary filter rock and pre-cast concrete armouring.
- If dredged unconsolidated material is used in lieu of imported fill, it would be placed onshore and mixed with consolidated material where excess water would drain off, then pushed back over the fill face as the reclamation advances seaward.
- The quality of water leaving the site (from dewatering of dredged material or surface water runoff from rainfall) would be managed through measures developed within an Erosion and Sediment Control Plan (ESCP) and CEMP which would include mitigation, management and monitoring procedures to be implemented by the Construction Contractor, such as silt curtains.
- Hardstand areas and facility construction: Once material within the reclamation area has sufficiently settled and consolidated, hardstand areas and internal access roads will be formalised with the construction of pavement (the timing of this can be managed by construction approach and ground improvement techniques, dependent on the demand for the area). Upon completion of the hardstand areas, workshops and buildings will progressively be constructed on site, as needed.
- Removal of mangroves and vegetation: The western portion of the current site contains approximately 1.0 ha of isolated mangroves and a small number of fringing eucalypts and weed

species at the landward edges. The fringing terrestrial vegetation and weed species will be cleared and likely removed from the site during the site preparation or early reclamation stage. It is anticipated that mangroves will be flattened slowly using an excavator, covered with heavy duty geofabric and fill material, compacted and left in situ. Works and visual monitoring would be undertaken to minimise the chance of mud-waving occurring, a process that occurs on soft subsoils of reclamation areas where low shear strengths can result in inadequate compaction and fill mass properties.

- This proposed method maintains ground stability of mangrove muds and reduces the risk of exposing underlying ASS that may be present.
- Surface water and erosion and sediment control: Surface water runoff has the potential to transport sediment or other pollutants into the adjacent marine environment during construction. Management of erosion and sediment transport during construction is routine for the type of soils, topography and scale of works to be undertaken at the site.
- To manage activities during construction an ESCP and Stormwater Management Plan would be prepared for the site. This Plan would incorporate routine sediment and erosion control measures which would address items such as diversion of clean runoff, management of stockpiles, stabilisation and rehabilitation of exposed soils, and provision of silt fences and other proven controls during construction.

2.4.5 Service installation

On completion of the reclamation and revetment walls, underground services, permanent stormwater and waste management systems and building foundations will be installed, and the hardstand areas paved and completed. The load ratings and final surface finish will depend on the proposed use of the area. Pavement types are discussed in Section 2.2.3.

2.4.6 Ship lift and marine structures

The ship lift structure will consist of a number of elements including:

- piles and finger wharf piers to provide the foundation for the ship lift winches
- precast deck panels
- in-situ concrete deck slab
- ship lift platform
- fenders and bollards.

The ship lift components and marine structures will be constructed individually on land (either at the site or an offsite facility) and then floated by barge into position for installation at the Project location. It is estimated that the concrete finger wharfs and fenders will require up to 485 piles (the final number to be determined during detailed design) to be driven into the seabed using a crane barge, piling rig and hydraulic hammer.

Tubular piles will be both drilled using an auger or pneumatic drill and driven in using a hydraulic hammer. Where drilling is required one or two drilling rigs may be used and operational at any one time.

A range of steel piles will be utilised with diameters likely to be 900 mm and 1050 mm with the final size and types of piles and piling methods to be determined during the detailed design process.

The piling schedule is yet to be finalised; however, it is estimated that two piles will be driven per day and an estimated duration of 240 days has been tentatively allowed to complete this work.

One existing navigation aid associated with the existing MUBRF channel will require relocation prior to operation of the facility. This will require the extraction of the existing navigation beacon and relocation further inshore via the use of a crane barge and piling rig.

2.4.7 Corrosion protection

All steelwork surfaces will be covered in a high build epoxy protective coating system. The paint system shall be a high build, high solids epoxy with a design-specified dry film thickness. Where

steelwork is required to be painted yellow or white, a compatible polyurethane-based coating system shall be applied over the high build epoxy coating. Materials used, cathodic protection systems and work carried out and testing performed on protection systems shall be governed by design specifications, a Durability Plan and referenced standards and codes of practice.

2.4.8 Machinery and equipment

Construction machinery and equipment requirements are estimated in Table 2-3.

Table 2-3 Construction machinery and equipment

Construction aspect	Equipment	Number required	Size / Power output	Frequency of use
Dredging	CSD	1	675 HP	Daily
	BHD	1	3000 HP	Daily
	Work boats	2	Multicat	Daily
	Pumps	2	500 HP	Daily
	Bulldozer	1	D8N Cat	Daily
	Roller	2	10 t	Daily
	Excavator / bulldozer (pond management)	1	D6 Cat	Daily
Land Clearing	Excavator	1	Cat 245 (45 t)	Daily
	Bulldozer	1	D8N Cat	Daily
	Scraper	1	623 Cat	Daily
Revetments	Excavator	2	245 Cat	Daily
	Crane	2	70 t	Daily
Piling	Land-based rig	1-2	130 IHC hydro	Daily
	Barge-based rig	1	130 IHC hydro	Daily
	Work boats	2	Multicat	Daily
	Cranes	3-4	150 t	Daily
Waterside infrastructure	Barges	2-3	Towed	Daily
	Cranes	2	70 t	Daily
	Workboats	2	Multicat	Daily
Hardstand	Grader	2-3	140M	Daily
	Roller	4	140M	Daily
	Water truck	3	17,000l	Daily
	Tipper	4	500 HP	Daily
	Backhoe	2	Cat 428	Daily
	Skidsteer	2	Cat 247	Daily
	Loader	2	Cat 950	Daily
	Excavator	4	Cat 245	Daily
	Concrete truck	2	107	Daily
	Concrete pump	2	103	Daily

Construction aspect	Equipment	Number required	Size / Power output	Frequency of use
Material delivery - Local - Interstate - International	Precast armour	11,400m ³	1 m ³ each	Not applicable
	Pile tubes (up to)	450	1 m+ OD	
	SPMT	1	5,000 t	
	Ship lift	1	5,500 t	
	Rock anchors	100	As required	

2.4.9 Vehicular traffic

Construction vehicles will access the site via Berrimah Road which is the main access road to EAW. The construction phase of the Project is expected to generate a short-term increase of heavy vehicles on specific parts of the surrounding road network, however the projected quantity of vehicle movements and the anticipated period of construction is unlikely to have adverse effects on the road network.

Existing road access routes are shown in Figure 2-5 and discussed in Section 2.2.11. A traffic impact assessment is included in Appendix L: Traffic Impact Assessment.

2.4.10 Vessel movement

During construction the number of vessels required will be small. Construction vessels would include dredge vessels, crane barges, piling barge and a small number of small support vessels. The majority of vessels will be large and slow moving which represent a low risk of vessel marine fauna interactions. Smaller support vessels may represent a higher vessel marine fauna interaction risk however the operation of these vessels will be mostly limited to a confined area around the larger construction vessels, reducing the risk of interactions.

The operation of all marine vessels will be managed to reduce interaction with vessels operation nearby (including recreation vessels), biosecurity risks, and the risk of vessel interactions with marine fauna. Vessel speed and movement within the Project area will be governed by navigational restrictions and a Marine Works Management Plan. Construction areas, safe operating practices, and operator awareness training requirements will be defined.

Given the slow speeds of vessel traffic expected during construction and the limited likelihood of susceptible marine fauna occurring within the Project area it is unlikely that the works would result in any significant risk of boat strike, or disturbance to marine fauna species. This will also minimise nuisance to existing boat users within the area.

2.4.11 Construction timeframe and workforce

Project construction is expected to be completed in 24-36 months following completion of approvals and detailed design by the end of 2022, with the Project planned to be operational by 2025. An indicative concept design construction schedule is presented in Table 2-4.

Dredging is expected to be undertaken during both day and night time hours, seven days per week. The dredging would not be continuous, and there would be periodic down time of the dredge (e.g. due to relocation of the dredge, shift changes, maintenance and weather interruptions). Other activities associated with the dredging (e.g. pipeline relocations, anchor relocations, movement of attendant work boats and barges) will also need to occur intermittently during both day and night time hours.

For other construction activities working hours will be refined by the Construction Contractor. Works may occur on a 24-hour basis, or be restricted to standard daytime hours, depending on the various factors, which may include the tasks to be undertaken, available timeframes, seasonal conditions, subcontractor agreements and environmental approval conditions.

It is anticipated there will be approximately 100 direct equivalent jobs during construction, with a large portion of the work completed within the NT.

Table 2-4 Indicative concept design construction schedule

Works	2021			2022				2023				2024				2025			
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Approvals																			
Contractor procurement																			
Site preparation																			
Transport of fill materials																			
Dredging																			
Land reclamation																			
Service installation, pavement sealing and paving																			
Piling																			
Infrastructure component and installation																			
Facility practical completion																			

2.5 Operation

The facilities to be delivered by the Project are planned to be operational in 2025. Operation of the facility will be undertaken by suitably qualified and experienced operators. Companies providing vessel maintenance services at the facility will provide their own workforce and operating methods and are accountable for their project execution, using the facility as an extension of their workplace.

Prior to access being granted to the facility, users must demonstrate commitment to, and capability of meeting, basic and legislated health, safety, environment, security, and employee management standards, contained within a site OEMP.

The operational phase is discussed below in terms of:

- anticipated traffic volumes
 - ship lift vessel traffic
 - marine facility vessel traffic
 - vehicular traffic.
- facility maintenance
- maintenance dredging
- spill management
- operational timeframe and workforce.

2.5.1 Facility utilisation

The facility will provide berthing and marine services for a mix of vessel types from small support boats to the maximum ship lift design size. It is anticipated that one to two large vessels may use the ship lift system per week. In addition to these vessels, small work boats would occasionally operate around

the ship lift system. It is not anticipated that these vessel movements would result in any significant increase to the level of vessel activity in this part of Darwin Harbour, where vessels already use the adjacent MUBRF and nearby EAW and MSB facilities.

2.5.2 Vehicular traffic

Vehicles will access the site via Berrimah Road (current access point) which is the main access road to EAW. Vehicle traffic generated by the site is considered to be consistent with the type of traffic currently generated by EAW and other nearby industries and is likely to include light vehicles and 4WD utilities, rigid body trucks, gross mass vehicles without trailers, articulated vehicles, B-Doubles, fuel transport vehicles, heavy lift and franna cranes and elevated work platforms.

The operational impact of ongoing traffic generation by the Project activity is expected to be relatively minor in context of the existing road network. It is anticipated that the operational workforce will include 15 directly employed full time staff. Contractors accessing the Project are predominantly expected to be located on existing industrial lots within the East Arm, containing the majority of traffic generation to the local road network. As the local road network has been built to accommodate the anticipated demand of the proposed developments in the East Arm area, including the Project, road access issues associated with contractors were not considered to be an issue from a volume perspective. Alternatively, external workforces may be bused to site to avoid generation of multiple light vehicle movements and accommodation of parking on-site.

Existing road access routes are shown in Figure 2-5 and discussed in Section 2.2.11. A traffic impact assessment is included in Appendix L: Traffic Impact Assessment.

2.5.3 Vessel movement

In the operational phase of the Project vessels will also need to comply with existing Darwin Port navigational restrictions which will control vessel speed and access within the nearby Bladin Point, MSB and MUBRF channels and in the vicinity of the facility. Australian legislation and Port controls will regulate the requirements for vessel operators to be suitably qualified to operate vessels and to navigate the facility safely. The facility will be designed to provide navigational safety.

The Project will cater for a range of vessels up to the ship lift lifting design capacity of 5500 t. The vessels typically utilising the facility during operation would already be operating within Darwin Harbour.

2.5.4 Facility maintenance

Regular maintenance and inspections will be undertaken of facilities and equipment and documented in operation management plans, such as the OEMP, as appropriate and in accordance with relevant standards, as well as ADF and ABF requirements. Provision will be made for a spares inventory for critical and long lead items, such as elements that would otherwise see the facility shut down until replacement parts were procured.

2.5.5 Maintenance dredging

Maintenance dredging will likely be required in the future to maintain safe operation and manoeuvring depths within the area under the ship lift, manoeuvring basin and all wet berth pockets. A review of the coastal processes of the area has identified that sediment accretion rates within the Project area are low and as such maintenance dredging is not anticipated to be frequent, likely occurring in the order of once every 10 years. Maintenance dredge volumes will also be low and could be dealt with using a small dredge vessel. If timing and availability permits, dredged sediment could be handled and disposed of on land, within a designated reclamation area.

For maintenance dredging which is required after the land area of the site has been fully developed, there would be an opportunity to coordinate dredge campaigns and dredged sediment handling methods with other maintenance dredging carried out routinely in the harbour (e.g. with neighbouring facilities of the MUBRF, EAW and MSB).

2.5.6 Operational timeframe and workforce

Once facilities are constructed, operations are expected generally to follow standard Monday to Saturday daytime shifts, however work outside these hours may be dictated by tidal conditions and individual vessel maintenance turnaround requirements.

Standard daytime hours in the NT are currently Monday to Saturday 7am to 7pm, and Sundays and public holidays 9am to 6pm.

The NT Government estimates that jobs generated and supported by infrastructure delivered by the Project will range from 78 to 146 full-time equivalents (FTE) a year in Year 3 (start-up) and between 187 and 359 additional FTE a year by Year 20. However, it may take up to a decade to gain the full potential market share and for the estimated economic, employment and social benefits to arise.

Contract marine service providers will be utilised according to workloads. Contractors are predominantly expected to be located on industrial lots within East Arm.

2.6 Decommissioning and rehabilitation

Although a design life of 50 years has been adopted, it is anticipated that the Project will remain in active use into the long term, and evolve to meet changes in demand, technology and shipping requirements.

Given this timeframe, no rehabilitation or decommissioning of the site is envisaged to occur. However, in the event of the site being decommissioned, appropriate planning would be undertaken, and approvals sought, if necessary, ahead of closure activities.

2.7 Summary of key components of Project

The key components of the Project and associated environmental aspects considered as part of impact assessments are summarised in Table 2-5.

Table 2-5 Key Project components summary

Component	Location in document	Proposed extent/ volume
Existing land area (above highest astronomic tide (HAT))	Section 2.1.2 and 2.2.2	5.5 ha
Existing mangrove area	Section 2.4.1 and 2.4.4	1.0 ha
Existing water area	Section 2.2.2	24.2 ha
Dredging - unconsolidated material from dredging footprint to be used as reclamation or placed onshore at EAW ponds - consolidated material likely used as fill on site	Section 2.4.2 and Figure 2-4	185,000 m ³ unconsolidated material 315,000 m ³ consolidated material
Reclamation Fill fill from nearby clean fill source(s)	Section 2.4.3	400,000 m ³
Revetment material - filter rock - armour: precast blocks (concrete batch plant) or rock from licenced quarry	Section 2.4.3 and 2.4.4	16,500 m ³ filter rock 46,000 m ³ armour
Final hardstand, revetment area and infrastructure - roads and service infrastructure - wash bay - vessel transfer area - dry berths - blast and paint facility - SPMT garage - administration buildings - water treatment plant and waste storage facilities	Section 2.4.4 and Figure 2-4	14.3 ha

Component	Location in document	Proposed extent/ volume
Piling - finger wharves - heavy lift wharves - fenders and bollards	Section 2.4.6	Up to 485 piles
Utilities - data and telecommunications - water - electricity/energy - sewerage	Section 2.2.18	Volumes dependent on operational requirements
Fixed lighting - ship lift: 50 Lux - hardstand, roads, wet berths: 20 Lux Other lighting will be mobile units for specific work requirements	Section 2.2.18.2	20 – 50 Lux minimum
Operating hours (construction) - generally: daytime 7am to 7pm - dredging and piling scheduled on 24/7 basis	Section 2.4.11	Daytime 7am to 7pm Dredging & piling 24/7 basis.
Workforce (construction) - local workforce will be recruited where skills are available - specialist roles may require interstate personnel	Section 2.4.11	100 direct
Operating hours (operation) generally: standard day time hours however work outside these hours may be dictated by tidal conditions and individual vessel maintenance turnaround requirements	Section 2.5.6	Standard daytime hours Monday to Saturday 7am to 7pm, and Sundays and public holidays 9am to 6pm
Workforce (operation) - local workforce will be recruited where skills are available - marine service providers are predominantly expected to be located on industrial lots within East Arm	Section 2.5.6	78 to 146 FTE a year in Year 3 (start-up) and between 187 and 359 additional FTE a year by Year 20

2.8 Assessment of alternatives

The location of the Project at East Arm is consistent with long term master planning of the Darwin Harbour which has been ongoing since the early 1980s. The Project location presents several benefits that were considered during the selection of the site. The design development commenced in 2015 and has considered a number of alternatives in progressing the design to its current stage (concept design) in parallel with the development of this EIS. These alternatives are discussed below in Sections 2.8.1, 2.8.2 and 2.8.3.

Design and construction methodologies will be further refined prior to commencement of construction works to optimising construction and operation whilst appropriately managing potential environmental impacts. Design development considerations are discussed in Section 2.8.4.

2.8.1 East Arm master planning

Master planning for the development of marine and logistics industries at East Arm has been undertaken since 1984, with planning and development ongoing, including the development of, but not limited to, EAW, Hudson Creek, Darwin Business Park and Wishart Road precincts (Northern Territory Department of Lands 1984).

The NTG has been developing land at East Arm for marine industries since 2004 and in 2014, a ship lift was proposed as part of the development of the East Arm MIP.

A development concept was originally prepared by NSS. In 2016 and a Front-End Engineering Design (FEED) process was undertaken in 2018. The NTG further reviewed the design and identified areas

where enhanced functionality and supporting marine facilities would provide additional benefit to the overall Project. This led to a number of post-FEED studies and updates to the development concept from 2019 and 2021.

Based on the outcomes of the Post-FEED studies the NTG now proposes to develop a common user vessel lifting, repair and maintenance facility, including both wet berth and dry berth vessel maintenance facilities, and a Privately-owned Facility which includes additional quay line, berths and hardstand.

2.8.2 Site selection

When the NTG announced in 2015 it would contribute and support the development of a common use ship lift facility, the subsequent competitive tender process resulted in potential proponents identifying several proposed locations and facility designs.

Initially, the Marine Industry Park (MIP) lots to the northeast of the current site, were earmarked for the location of the Project. When expressions of interest were sort in 2015-16 several respondents proposed alternate locations, including the current site which was proposed by Paspaley Pearls Properties Pty Ltd.

The current site was chosen for several reasons and has the following key environmental benefits:

- naturally deeper water access close to the site and use of the existing MUBRF channel thereby minimising additional channel dredging requirements and facilitating all-tide access for ADF and ABF vessels, and minimising alterations to existing Darwin Harbour navigational procedures
- brownfield disturbed site that limits mangrove loss to an isolated 1 ha patch
- existing knowledge of the landside and marine areas due to previous heritage and environmental studies undertaken for the nearby MSB and MUBRF developments
- direct access off Berrimah Road, which is designed for heavy vehicle traffic accessing EAW
- low expected frequency and volume of maintenance dredging.

2.8.3 Assessment of design alternatives

The design was initially developed by NSS and presented in the NOI submitted to the NT EPA (KBR, 2018). The design presented in the EIS was further developed by the NTG's design engineer SMEC following a change in facility capability to cater for larger vessels operating in northern Australia and future vessels, including the new class of ADF OPVs.

Updates to the design and associated changes in the level of potential environmental impact/benefits are detailed in Table 2-6.

Table 2-6 Design alternatives and level of environmental impact

Design alternatives	Reason	Environmental impact
Increased size of ship lift facility and load capacity	Increased vessel size capacity	Additional reclamation, piling, dredging
Dredging volume reduced	Geotech and sediment quality investigations resulted in removal of dredging under the reclamation footprint	Reduced volume of unconsolidated dredge spoil to treat or manage. Reduced dredging campaign duration
Dredging Channel alignment change	Change to use the MUBRF channel instead of the MSB channel resulting in lower dredging volumes required	Lower volumes of unconsolidated material to manage Reduced turbidity and subsequent impact on water quality and marine habitat
Addition of Privately-owned Facility	To provide additional hardstand and berthing facilities	Additional reclamation and dredging, but may provide area for

Design alternatives	Reason	Environmental impact
		unconsolidated dredge spoil and spoil handling prior to reuse for reclamation
Refinements due to technical studies to date	Ensure design is future-proofed for potential sea level change, extreme weather events and hydrodynamic processes within Darwin Harbour	Long-term investment for job security and income
Avoidance of identified marine heritage and sacred sites	Location of nearby maritime wrecks, heritage items and sacred sites within Darwin Harbour	Minimise impact on heritage and cultural sites, noting that certain sites will be impacted by the development
Use of SPMTs instead of fixed rail transfer system	Fixed rail transfer system limits flexibility of site activities and options	Flexibility increases usability of the site and hence increases economic capacity

2.8.4 Design refinement

The Project is currently at a concept design level and will continue to undergo design refinement. The NTG is undertaking a staged procurement process for the Project and is at a Request for Proposal stage to support the design development and construction planning. The final procurement stage will include potential construction contractors providing detailed design. Following this, a design and Construction Contractor will be engaged. Potential construction contractors are encouraged to consider alternatives that promote innovation, flexibility and efficiency.

The ultimate procurement model for the Project is expected to be determined by Q1-Q2 2022.

The construction activities, timing, methodology and materials may vary due to factors such as, but not limited to:

- outcomes of progressive site investigations
- final Project design specifications
- approval conditions and licencing requirements
- selected contractors preferred systems, methodology and equipment
- machinery and material availability and sources
- procurement processes and value for money
- extreme weather events including cyclones
- other construction projects being undertaken within the region.

The design process will continue to consider refinements within the selected site with the objective of optimising construction and operation whilst appropriately managing potential environmental impacts. Table 2-7 references areas of design and construction that may be refined and the potential environmental impacts/benefits associated with these.

Table 2-7 Design and construction refinements

Design / construction refinements	Reason	Environmental impact/benefit
Layout of the facility including reclamation area	Different expertise, technology and experience may provide alternative solutions	Expected to occur within the disturbance footprint Some areas of the Project footprint are constrained by the geological setting. Outcomes from technical reports, including heritage assessments, would also be considered
Dredging methodology and volumes	Further geotechnical studies to refine understanding of material to be dredged Availability of suitable dredging equipment	Decreased dredge volume may require additional imported materials for reclamation
Reclamation material sources and volumes: ratio of hard rock, precast concrete blocks and sand for reclamation and revetments	Cost, availability, technology, further geotechnical information	Differences in transport routes and volumes. Precast could include utilisation of licenced mobile site batch plant. Import of raw materials and management of waste
Pile numbers and construction methodologies	Geotechnical study and design refinement outcomes as well as consideration of pile types	A lower number of piles would reduce noise and vibration impacts (reduced social and underwater impacts)
Ship lift design	Design to include two smaller sections which may operate separately or together instead of one larger section	Less power required to lift smaller vessels as only a portion of the platform and operating hydraulic winches are used. Reduced wear and tear
Strategic planning of construction works with other regional projects	DIPL and ADF are coordinating several large infrastructure projects in the Darwin harbour vicinity. By streamlining timing a number of cost and social benefits may eventuate	Use of specialist equipment in a coordinated manner: • reduced mobilisation time and costs • retain constant workforce over longer period • may reduce or increase cumulative impacts Excess clean or approved fill from other projects may be stockpiled and used for reclamation

Chapter 3

Strategic and Statutory Framework

3.0 Strategic and Statutory Framework

This chapter summarises the following.

- approval process for the Project (Section 3.1)
- relevant Commonwealth, Territory, and Local Government legislation (Section 3.2)
- relevant Northern Territory Planning Scheme 2020 (Section 3.2.3)
- relevant Policy and Guidelines (Sections 3.3)
- post EIS approval requirements (Section 3.4).

3.1 Approval Process

3.1.1 Referral to the Northern Territory Government

In accordance with the *Environmental Assessment Act 1982* (EA Act) and associated Environmental Assessment Administration Procedures, a notice of intent (NOI) (KBR 2018) for the original SLAMI Project (now the Project) was submitted on 24 April 2018 to the NT EPA by NSS.

Post lodgement, the NT EPA circulated the NOI to the relevant advisory bodies, compiled and issued their comments. A response to the comments was prepared, and supporting information was provided back to the NT EPA on 22 May 2018 and 22 August 2018.

A FEED process was undertaken in 2018. The NTG further reviewed the design and identified areas where enhanced functionality and supporting marine facilities would provide additional benefit to the overall Project. This led to a number of post-FEED studies and updates to the development concept from 2019 and 2021.

Based on the outcomes of the Post-FEED studies the NTG now proposes to develop a common user vessel lifting, repair and maintenance facility, including both wet berth and dry berth vessel maintenance facilities.

The NT EPA considered the material provided and issued the Draft Terms of Reference (DToR) on 14 September 2019. The NT EPA determined that the Project has the potential to have significant environmental impacts on the following NT EPA factors (NT EPA, 2018c).

- marine environmental quality
- marine flora and fauna
- air quality and greenhouse gases
- social, economic and cultural surroundings.

The DToR were made available for the public consultation period. On completion of the public consultation period, the final ToR (NT EPA 2018a) and the corresponding Statement of Reasons (SoR) (NT EPA 2018b) for the Project were issued by the NT EPA on 12 December 2019.

This draft EIS has been developed to address the ToR and the requirements documented in the NT EPA *General Guidance for Proponents Preparing an Environmental Impact Assessment* (NT EPA 2019a) and the subsequent NT EPA guideline for *Preparing an Environmental Impact Statement* (NT EPA 2020).

3.1.2 Referral to the Commonwealth Government

An *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) referral for the original project was submitted by NSS in 2018 to the DoEE. On 25 September 2018, DoEE determined the Project to be not a controlled action (Reference No. 2018/8195).

As the Project has undergone material changes since the original referral, the NTG is submitting a new referral for the Project concurrently to this draft EIS. The new referral is likely to be available for public comment in November 2021 on the EPBC referrals website.

3.2 Legislative Framework

3.2.1 Commonwealth Legislation

A summary of Commonwealth Legislation expected to be potentially relevant to the Project are outlined in Table 3-1. Further information on applicable legislation is presented in each of the key preliminary factor chapters (Chapters 7 to 10).

Table 3-1 Relevant Commonwealth Legislation

Applicable Legislation	Relevance
<i>Aboriginal Land Rights (Northern Territory) Act 1976</i> (ALR Act)	Provides for the granting of Traditional Aboriginal Land in the NT for the benefit of Aboriginals, and for other purposes. This Act changed Aboriginal reserves within the NT to freehold title held in trust. The Act mandated the formation of Land Councils to act in the interests of NT Aboriginal people in the areas of land, access to lands, employment and the development of businesses. The Act also defined Sacred Sites as 'sites that are sacred, or otherwise significant, in the Aboriginal Tradition'. The Act protected these sites from damage, whether accidental or intentional. The NT Aboriginal Sacred Sites Act 1989 uses the ALR Act definition of sacred for the purpose of protecting sacred sites outside of those within Land Trust areas. See Table 3-2 below for further details.
<i>Aboriginal and Torres Strait Islander Heritage Protection Act 1984</i>	Provides for the preservation and protection from injury or desecration of areas and objects in Australia and in Australian waters that are of significance to Aboriginals and Torres Strait Islanders. At the time of assessment, no active applications were found over the Project area arising from this Act (refer Appendix M: Cultural Heritage Assessment).
<i>Australian Heritage Council Act 2003</i>	Provides for the protection of heritage values through assessment, registration and conservation of areas of National and Commonwealth heritage significance.
<i>Australian Maritime Safety Authority Act 1990</i>	Promotes maritime safety and provides for the protection of the marine environment from pollution and other environmental damage caused by shipping, and creates a national search and rescue service.
<i>Biosecurity Act 2015</i>	Provides for managing diseases and pests that may cause harm to human, animal or plant health or the environment. This includes managing biosecurity risks in relation to imported goods, aircraft or vessels entering Australian territory, risks related to ballast water, the risk of contagion of a listed human disease, the risk of listed human diseases entering, establishing or spreading in Australia, biosecurity emergencies and human biosecurity emergencies.

Applicable Legislation	Relevance
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act)	Provides for protection and conservation of matters of National Environmental Significance (MNES) (including natural, historic and Indigenous places) and assessment of projects that have the potential to have impact on MNES. A referral under the Commonwealth EPBC Act was submitted to the Commonwealth DoEE, now DAWE, on 24 April 2018, for the original project design. A decision that the referred action was determined not to be a controlled action (Reference No. 2018/8195) was issued by DoEE on 25 September 2018. A revised referral was submitted to the Commonwealth on 11 October 2021 as detailed in Section 3.1.2 and is awaiting determination.
<i>Hazardous Waste (Regulation of Exports and Imports) Act 1989</i>	Provides for the regulation of the export, import and transit of hazardous waste to ensure that exported, imported or transited waste is managed in an environmentally sound manner so that human beings and the environment, both within and outside Australia, are protected from the harmful effects of the waste.
<i>National Greenhouse Energy Reporting Act 2007</i>	Provides a national framework for the reporting and dissemination of information related to greenhouse gas emissions, greenhouse gas projects, energy production and energy consumption.
National Greenhouse Measurement Determination 2008 (Commonwealth) (DAWE, 2021)	The National Greenhouse Measurement Determination (the Determination) (2008) provides a guideline for use by companies and individuals to estimate and measure GHG emissions.
<i>Native Title Act 1993</i>	Provides for the recognition and protection of native title and to establish ways in which future dealings affecting native title may proceed. A search of the Native Title Register indicated that there are no Native Title claims or determinations in the Project Area (refer Appendix M: Cultural Heritage Assessment).
<i>Navigation Act 2012</i>	Provides for the promotion of the safety of life at sea and safe navigation; and the prevention of pollution of the marine environment.
<i>Occupational Health and Safety (Maritime Industry) Act 1993</i>	Provides for securing the health, safety and welfare at work of maritime industry employees and to protect persons at or near workplaces from risks to health and safety arising out of the activities of maritime industry employees at work. This act would apply to people and companies undertaking servicing and maintenance on a ship.
<i>Protection of the Sea (Harmful Anti-fouling Systems) Act 2006</i>	Provides for the protection of the sea from harmful anti-fouling systems and certification of the application or use of anti-fouling systems.
<i>Protection of the Sea (Prevention of Pollution from Ships) Act 1983</i>	Provides for the protection of the sea from pollution in any form from ships.
<i>Protection of the Sea (Powers of Intervention) Act 1981</i>	Authorises the Commonwealth Government to take measures for the purpose of protection of the sea from pollution in any form from ships.

Applicable Legislation	Relevance
<i>Underwater Cultural Heritage Act 2018</i>	Provides for the protection of Australia's underwater cultural heritage, and for related purposes. Different kinds of articles of underwater cultural heritage are, or can be, protected, depending on the kinds of articles, their heritage significance and their location. For example, remains of vessels or aircraft that have been in Australian waters for at least 75 years, are automatically protected, as are certain articles associated with these objects. The NT has jurisdiction over Darwin Harbour waters. However, the Commonwealth, States and the NT signed the Australian Underwater Cultural Heritage Intergovernmental Agreement in 2010. This agreement outlines coordinating roles and responsibilities between the Parties, including allowing the Commonwealth cross jurisdictional coordination and secretarial roles in protecting underwater cultural heritage. All aircrafts sunk from the 1942/43 Japanese air raids on Darwin will automatically be protected following 2017/2018 as the 75th Anniversary of their destruction/sinking occurs.

3.2.2 Northern Territory Legislation

A summary of the NT legislation expected to be potentially relevant to the Project are outlined in Table 3-2.

Table 3-2 Relevant Northern Territory Legislation

Applicable Legislation	Relevance
<i>Aboriginal Land Act 1978</i>	Provides for access to: Aboriginal land, certain roads bordered by Aboriginal land and the seas adjacent to Aboriginal land.
<i>Building Act 1993</i>	Provides for the establishing of technical standards for buildings, the registration of building practitioners and certifiers, the regulation of building matters, the granting of building permits and occupancy certification and the establishing of a building appeal process.
<i>Control of Roads Act 1953</i>	Provides for the administration and control of roads, including the construction, maintenance, opening and closing of roads.
<i>Crown Lands Act 1992</i>	Provides for the management of Crown Lands including the grant of lands in fee-simple, the issue of leases and the grant of Occupation Licences.
<i>Dangerous Goods Act 1998</i>	Provides for the safe storage, handling and transport of certain dangerous goods.
<i>Environmental Assessment Act 1982 (now superseded by Environment Protection Act 2019)</i>	Provides for the assessment of the environmental effects of development proposals and for the protection of the environment. (Department of Environment and Natural Resources). Note: The NOI and ToR were drafted under the Environmental Assessment Act 1982. However, the most recent 2020 NT EPA EIS guidelines have also been utilised to inform this assessment (NT EPA 2020).
<i>Environment Protection Act 2019</i>	Superseded the NT Environmental Assessment Act in June 2020 in providing for the assessment of the environmental effects of development proposals and for the protection of the environment.
<i>Fire and Emergency Act 1996</i>	Provides for the establishment of the NT Fire and Rescue Service and its operational and emergency response activities. It also provides for the

Applicable Legislation	Relevance
	protection of life, property and the environment against fires and for responses to other emergencies.
<i>Fisheries Act 1988</i>	Provides for the regulation, conservation and management of fisheries and fishery resources so as to maintain their sustainable utilisation, to regulate the sale and processing of fish and aquatic life, and for related purposes.
<i>Heritage Act 2011</i>	Provides for the conservation of the NT's cultural and natural heritage, for the establishment of the Heritage Council and the NT Heritage Register; the criteria for listing heritage places and the process for obtaining approval to work on heritage places. The Heritage Act provides a 'blanket' or 'presumptive' protection for Aboriginal and Macassan archaeological places and objects until a decision by the Minister to either permanently protect these places or permit their disturbance or destruction. This decision-making process is triggered by an application to disturb these places. There are penalties for accidental or deliberate destruction of these sites. Sites registered in the NT Heritage Register in or adjacent to the Project area are listed in Appendix M: Cultural Heritage Assessment.
<i>Land Title Act 2000</i>	Provides for the registration and transfer of land and interests in land.
<i>Marine Act 1981</i>	Regulates shipping in the NT and provides for the application to the Territory of the uniform shipping laws code and for the regulation of various matters including approval of private navigational aids in the NT.
<i>Marine Pollution Act 1999</i>	Provides for the protection of the NT's marine and coastal environment by minimising intentional and negligent discharges of ship-sourced pollutants into coastal waters. It achieves this primarily by giving effect to relevant provisions of The International Convention for the Prevention of Pollution from Ships (MARPOL) Annexes I – V. Any pollution sources from vessels during construction or operations of the Project will be required to operate under the provisions of this Act.
<i>National Environment Protection Council (Northern Territory) Act 1994</i>	Provides protection for people to enjoy the benefit of equivalent protection from air, water or soil pollution and from noise, wherever they live in Australia, and provides the business community with standard adoption or implementation of major environment protection measures.
<i>Northern Territory Aboriginal Sacred Sites Act 1989</i>	Provides for the protection of sites that are 'sacred and otherwise of significance in the Aboriginal Tradition' whether the location of the site is known or not by any person or company seeking to do work on lands. The Act is administered by the Aboriginal Areas Protection Authority (AAPA). The Authority can issue a Certificate indemnifying any proponent for an area. The Certificate will contain conditions limiting or preventing works in and around registered and recorded Sacred Sites. The Authority Certificate will contain maps outlining any restricted work areas within the area of application. There are two registered Sacred Sites within the meaning of this Act adjacent to the Project Area. An AAPA Certificate for the Project Area has been obtained and is included in Appendix M: Cultural Heritage Assessment.
<i>Planning Act 1999</i>	Provides for the orderly planning and control of sustainable use and development of land with appropriate consultation and fair and open decision-making processes. It also provides for the grant of development consents that permit, prohibit, restrict or impose conditions on a use or development of land.

Applicable Legislation	Relevance
<i>Ports Management Act 2015</i>	Provide for the control, management and operation of ports, and for related purposes.
<i>Port of Darwin Act 2015</i>	Authorises and facilitates the transfer of assets, rights and liabilities relating to, or connected with, the Port of Darwin, and for related purposes.
<i>Public and Environmental Health Act 2011</i>	Provides for the management of issues likely to affect public and environmental health including management guidelines for the prevention of breeding and control of mosquitoes and other pests.
<i>Soil Conservation and Land Utilisation Act 1969</i>	Provides for the prevention of soil erosion and for the conservation and reclamation of soil.
<i>Territory Parks and Wildlife Conservation Act 1976</i>	Provides for the establishment of Territory Parks and other Parks and Reserves and the study, protection, conservation and sustainable utilisation of wildlife. It sets aside areas of the NT as parks and conservation areas that may not be developed.
<i>Traffic Act 1987</i>	Regulates traffic, which includes provisions in relation to the erection and operation of traffic control devices. Traffic control devices refer to signals, signs or markings displayed for the purpose of regulating, warning or guiding traffic. Under the Act, consent from the applicable competent authority is required prior to the erection and operation of traffic control devices.
<i>Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Act 2010</i>	Provides for the safe transport of dangerous goods by road and rail around Australia, as part of the system of nationally consistent transport laws. It provides guidelines on packaging, signage and transport of dangerous goods.
<i>Waste Management and Pollution Control Act 1998 (WMPC Act)</i>	Provides for the protection, restoration and enhancement of the quality of the NT environment through encouragement of effective waste management and pollution prevention and control practices; the encouragement of ecologically sustainable development; and facilitation of the implementation of National Environmental Protection Measures (NEPMs) established by the National Environment Protection Council. Section 12 of the Act places obligation on a person to ensure they take all practicable measures to prevent or minimise pollution when undertaking an activity that could cause pollution and environmental harm.
<i>Water Act 1992</i>	Provides for the investigation, allocation, use, control, protection, management and administration of water resources, and for related purposes. The legislation includes a process for identifying and declaring beneficial uses or environmental values including environment, cultural and human use values and for establishing corresponding water quality objectives or water quality standards to protect identified beneficial uses. This Act regulates the pollution of water resources, under the Act it is an offence to: - pollute water, unless authorised to do so under this or other NT legislation - interfere with a waterway in methods that are not authorised under the Act - conduct bore work without holding a drilling license or a permit. A WDL is required under this Act to authorise waste to be discharged or come into contact with water. Refer to Table 3-5 for further information.
<i>Water Supply and Sewerage Services Act 2000</i>	Regulates the water supply and sewerage services industries and for other purposes. Under this act approval is required to discharge trade waste to sewer. Refer to Table 3-5 for further information.

Applicable Legislation	Relevance
<i>Weeds Management Act 2001</i>	Provides for the protection of the NT economy, community and environment from the adverse impact of weeds by preventing the spread of weeds in, into and out of the Territory and to ensure that the management of weeds is an integral component of land management.

3.2.3 Local Government Plans and Policy

In addition to the Commonwealth and Territory legislative requirements discussed in Sections 3.2.1 and 3.2 the Project will trigger approval requirements under the Northern Territory Planning Scheme 2020 (the Planning Scheme). Developmental Consent is required for the Project due to the following activities:

- dredging in Darwin Harbour
- constructing in the intertidal zone
- reclaiming land.

The following provides a review of the Planning Scheme and Policies.

Northern Territory Planning Scheme 2020 - Strategic Land Use Plan

Pursuant to the Planning Scheme Part 2 Strategic Framework: Policies and Land Use Plans, the Project site is located within the Darwin Regional Land Use Plan 2015 (DRLU Plan). The DRLU Plan's key purpose is to 'identify the essential characteristics and needs that will shape future development in the region and establish an overarching framework for that development'. The DRLU Plan Structure Mapping has identified the Project site as Strategic Industry.

Strategic Industry in this context includes the use of East Arm for the purposes of a logistics precinct, designed to assist business to grow and capitalise on future projects in the region, with a particular focus on the region's expanding oil and gas, marine and logistics industries. The development of the Project and proposed marine supply base in this location is consistent with this Strategic Industry designation under the DRLU Plan.

Northern Territory Planning Scheme 2020 - Land Use Zoning

Pursuant to the Planning Scheme, the Project site is located within an Industrial Zone DV (Development). The purpose for DV (Development) Zone is to facilitate the 'development of major strategic industries that are of importance to the future economic development of the NT, including gas, road, rail or port related industries'. The Project is considered to comply with the purpose of the Zone through the provision of a port related industry. The Project site and surrounds is shown in Figure 2-2.

3.3 Policy and Guidelines

3.3.1 Northern Territory Environment Protection Authority Guidelines

Relevant NT EPA guidelines that informed the development of the impact assessment methodology are listed in Table 3-3.

Table 3-3 Relevant Northern Territory Environment Protection Authority Guidelines

NT EPA Policies and Guidelines	Relevance
A Stormwater Strategy for the Darwin Harbour Region, Version 1.0 (NT EPA 2014b)	This strategy provides a basis for improving the management of stormwater quality entering Darwin Harbour.
Environmental factors and objectives (NT EPA 2018c)	These factors and objectives provide a systematic approach to organising environmental information for the purpose of the EIA; and establishing clear benchmarks based on values. The factors and objectives provide an important structure for the organisation of information and apply to all proposals considered by the NT EPA. This approach will facilitate consistent assessment and reporting.
Environmental Guidelines for Reclamation in Coastal Areas (NT EPA 2006)	This guideline provides practical environmental advice to developers who are planning to undertake reclamation work in coastal regions of the NT. The guidelines apply to activities such as foreshore filling in coastal areas and along rivers, canal estate, marina and port developments, coastal aquaculture developments and development occurring on coastal floodplains.
Guidance on adaptive management (NT EPA 2018f)	Provides guidance to proponents of proposed actions, authorisation agencies as well as the community about the circumstances under which the NT EPA may be willing to consider adaptive management in the context of environmental impact assessment and approvals.
Guidelines for Assessment of Impacts on Terrestrial Biodiversity, Version 2.0 (NT EPA 2013a)	This guideline provides guidance for impact assessment and applications for overarching approvals with regard to terrestrial biodiversity.
Guidelines for the Environmental Assessment of Marine Dredging in the Northern Territory, Version 2.0 (NT EPA 2013b)	Provides information for those planning to dredge in the marine and estuarine waters of the NT. The guidelines outline the issues for proponents to consider in submitting proposals for assessment, acquiring the necessary statutory instruments, and developing appropriate Environmental Management Plans for their projects.
General Guidance for Proponents Preparing an Environmental Impact Assessment (NT EPA, 2019a)	This guideline informs the requirements in relation to the content and standard of the Draft EIS, to ensure that it is adequate to be published for public comment. Guidance is also given on completing the Final EIS by submitting the Supplement to address written comments on the Draft EIS, expectations and in relation to public participation, addressing any changes to the Project and providing any further information requested by the NT EPA.
Guidelines for Preparing an Environmental Impact Assessment - Environmental impact assessment guidance for proponents (NT EPA 2020)	This guideline supersedes the 2019 version. The purpose of this guidance document is to provide general guidance to proponents, statutory decision makers and the

NT EPA Policies and Guidelines	Relevance
	community about the EIS method of environmental impact assessment including: • when an EIS is required • the EIS assessment process • the NT EPA expectations regarding the information requirements of an EIS • the submission of the EIS to the NT EPA
Guidance on adaptive management (NT EPA 2018f)	Provides guidance to proponents of proposed actions, authorisation agencies as well as the community about the circumstances under which the NT EPA may be willing to consider adaptive management in the context of environmental impact assessment and approvals.
Guidelines for Assessment of Impacts on Terrestrial Biodiversity, Version 2.0 (NT EPA 2013a)	This guideline provides guidance for impact assessment and applications for overarching approvals with regard to terrestrial biodiversity.
Guidelines for the Environmental Assessment of Marine Dredging in the Northern Territory, Version 2.0 (NT EPA 2013b)	Provides information for those planning to dredge in the marine and estuarine waters of the NT. The guidelines outline the issues for proponents to consider in submitting proposals for assessment, acquiring the necessary statutory instruments, and developing appropriate Environmental Management Plans for their projects.
Guidelines on Mixing Zones, Version 1.2 (NT EPA 2013c)	This guideline provides an authoritative guide for setting water quality objectives to sustain environmental values. It provides specific water quality for each environmental value and the context in which it should be applied.
Guidelines on Waste Discharge Licensing under the Northern Territory Water Act (NT EPA 2014a)	This guideline provides industry and the community with information about WDLs, and to assist industry to apply for a WDL.
Guidance for proponents – Stakeholder engagement. (NT EPA, 2019b)	This document provides guidance to proponents on the NT EPA's expectations for how effective stakeholder engagement is conducted and demonstrated, for proposals subject to assessment under the <i>Environmental Assessment Act 1982</i> (EA Act).
Guidelines to Prevent Pollution from Building Sites, Version 1 (NT EPA 2015a)	This guideline provides simple, effective and realistic advice on how to adopt control methods and procedures on building sites to ensure impacts on the environment are minimised.
Opportunities and timeframes for community engagement in the environmental assessment process (NT EPA 2018d)	This document identifies where the public can contribute to environmental decision making through the environmental impact assessment process. It also identifies what matters the NT EPA takes into consideration in determining timeframes for the public exhibition and how the NT EPA advises the proponent about the public exhibition timeframe.
Northern Territory Noise Management Framework Guideline (NT EPA 2018e)	This framework provides guidance to the community and industry about the noise regulatory framework as it applies in the NT. It covers information and technical guidance on: • the NT noise regulatory framework including the WMPC Act and appropriate regulatory agencies • recommended assigned noise levels for various types of noise • reference resources guidance on noise management tools, the science of sound, and health and amenity effects of noise.

NT EPA Policies and Guidelines	Relevance
Recommended Land Use Separation Distances, Version 1.0 (NT EPA 2017)	This guideline provides recommended separation distances between industry and sensitive land uses to ensure off-site emissions of offensive odour, noise, smoke, dust or fumes do not adversely impact on people. Separation distances acknowledge that for some industry/land use types residual emissions (once best practice environmental management techniques have been applied) may have the potential to cause impact on adjacent, sensitive land uses if located too closely.
Stakeholder Engagement and Consultation: Environmental impact assessment guidance for proponents (NT EPA 2021).	The guideline adopts as best practice the International Association for Public Participation principles for stakeholder engagement. It outlines expected formal feedback processes for projects on public exhibition and encourages proactive approaches to early engagement during preparation of environmental impact statements, starting at the scoping phase. The guideline defines engagement as including 'communication, dialogue, listening and responding'.
Territory Economic Reconstruction Commission (NTG 2020)	The Territory Economic Reconstruction Commission (TERC) is co-chaired by former Chief Minister Paul Henderson and businessman Andrew Liveris. The TERC's final report in November 2020 outlines strategies to support the Government's ambitions of a \$40B economy by 2030. Priorities are creating jobs, attracting private investment, supporting current and emerging industries, building on the Territory's competitive advantage and unlocking the potential of the Territory's regions The TERC report identifies the Territory's strengths as including its strategic location for both trade and defence, a deep-water harbour and intermodal logistics, world-class mineral deposits and highly prospective onshore gas resources. Key sectors identified as contributing to economic growth were mining and energy, manufacturing and agribusiness. Other focus areas include tourism, renewable energy, national security and defence, the maritime industry and digital and space industries. This report is discussed in greater detail in the Chapter 10: Economic, Social and Cultural Surrounds.

NT EPA Policies and Guidelines	Relevance
Territory Benefit Policy (NTG 2019)	The Territory Benefit Policy aims to 'maximise the contribution to the NT economy by private sector investments in the NT'. The policy must address all phases of the project's life. It applies to: • private sector projects granted major project status • private projects where the NT Government provides support valued at or greater than \$500,000 • projects where a Territory Benefit Plan is specified as a condition of an NT Government agreement. It covers: • local workforce development and employment • regional and Aboriginal economic and community development • local business participation and small to medium enterprise capability development • economic, industry and social infrastructure investment. The Territory Benefit Plan is consistent with the objectives of the Australian Industry Participation National Framework.
Waste Management Strategy for the Northern Territory 2015 – 2022 (NT EPA 2015b)	The purpose of this document is to improve the management of waste, reduce the generation of waste, increase rates of resource recovery and minimise environmental impacts caused by waste. It provides an overarching summary of the waste management issues currently being faced in the NT.

3.3.2 Other Policies and Guidelines

Other policies and guidelines that are expected to apply or have been used to inform the Project are outlined in Table 3-4 under relevant environmental factor headings.

Table 3-4 Other Relevant Policies and Guidelines

Relevant Policies and Guidelines	Relevance
Planning	
City of Darwin Strategic Plan: 2030 City for People. City of Colour (City of Darwin 2019)	The City of Darwin strategic plan identifies the following strategic directions for the Darwin municipality: • a capital city with best practice and sustainable infrastructure • a safe, liveable and healthy city • a cool, clean and green city • a smart and prosperous city (including to implement an economic development plan to retain people and jobs) • a vibrant and creative city. The aim is that Darwin will be known as a vibrant, creative, innovative, connected, healthy and environmentally responsible city, with well-planned amenities and services. Values of the plan are: • diversity and acceptance (including multicultural heritage and a sense of belonging) • choice of lifestyles (unique, laid back, connected, active, safe) • environment (integrated, long-term planning, sustainable, ecologically sound decisions) • sense of community (active participation) equality (collaborative and transparent decisions, listening and responding).
Darwin Region Land Use Plan (NT Planning Commission 2015)	The Darwin Region Land Use Plan (DRLUP) provides a strategic framework to manage future growth, including planning for land use, transport and infrastructure needed to support growth. The plan, based on broad community consultation, identifies the essential characteristics and needs of the region. It is supported by a number of sub-regional area plans. The vision of the plan is: “A Darwin Region that is alive and prosperous, led by a thriving global city with high-quality amenity and connectivity” and “A region with a diverse economy and strong society that promotes innovation and tropical concepts, and holds an enduring connection to the natural environment.” The plan identifies the East Arm Logistics Precinct as ideally located to grow and capitalise on the region’s expanding oil and gas, marine and logistic industries. It identifies East Arm and Middle Arm Peninsulas as supporting future strategic industrial development in the region (p.25).
Darwin Port Expansion Plan: Australia’s Gateway to Asia – Draft 2012 (NTG 2012)	This document summarises the Greater Darwin Plan (2012) specifically relating to the Port of Darwin, and outlines opportunities and recommendations for Australian Federal Government involvement in the expansion of port capacity in Darwin, specifically the investment of \$50 million toward the East Arm Wharf expansion project and greater involvement of the private sector in infrastructure development.
Darwin Harbour Strategy 2020-2025 (Darwin Harbour Advisory Committee 2021)	The Darwin Harbour Advisory Committee (DHAC) was established in 2003. Its role is to provide advice to government through the

Relevant Policies and Guidelines	Relevance
	Minister for the Environment. This strategy was published in 2020 to guide sustainable management and planning in the region. The values and goals espoused by the strategy are: • foster partnerships: To protect and enhance Darwin Harbour through integrated management and in a partnership between government, industry and the community. • protect and preserve: To protect and enhance the natural environment of Darwin Harbour. • celebrate connection: To protect and enhance the cultural values and heritage of Darwin Harbour. • sustainable industry: To protect and enhance the economic value of Darwin Harbour in accordance with ecologically sustainable development principles. • maintain our unique lifestyle: To protect and enhance social, recreational, lifestyle use and enjoyment of Darwin Harbour in an ecologically sustainable manner. • DHAC is working on the framework for an integrated harbour report card. The multidisciplinary report card would compare ecological, social and economic information about Darwin Harbour against predefined goals or objectives chosen by local stakeholders.
Darwin Port Development Plan (Landbridge 2020)	A Port Development Plan outlines plans to further expand the port and increase trade flow through Darwin. The plan outlines Darwin Port's role as the only major multimodal port in Northern Australia. Outcomes since Darwin Port's 2016 plan include: • expansion of its refrigerated container park storage capacity at EAW from 50 to 190 reefer outlets • an additional 17,000 square metres of additional hardstand on reclaimed land next to the main quay line to improve efficiencies in vessel unloading. • Development opportunities include a harbour support vessel facility for tugs, work boats and pilot boats.
Greater Darwin Plan 2012 (NTG 2012)	• The Plan outlines the long-term vision and plan for the Greater Darwin area as well as referencing the Port Masterplan for specific expansion plans for East Arm to support growth of tonnage capacity and related activity.
Litchfield Council Strategic Plan: 2018-2022 (Litchfield Council 2016)	The vision of Litchfield's strategic plan is "for a place where social and community wellbeing stems from four unique attributes": • wellbeing (personal, social, community) • natural and scenic (large blocks with attractive scenic outlooks) • spacious (but close to everything) • opportunity and prosperity (fully employment, strong industries and business) • family-friendly and connected ("the best place to live in the Top End").

Relevant Policies and Guidelines	Relevance
Maritime Industry Development Plan (Department of Industry, Tourism and Trade 2021)	Development of a Maritime Industry Development Plan was a recommendation of the Territory Economic Reconstruction Commission. The plan is intended to provide a whole-of-government and industry framework to develop the maritime sector. A discussion paper was circulated in July 2021. Actions under the plan include: • a master plan for the MIP • maritime infrastructure gap analysis • business capability gap analysis and development strategy • comprehensive workforce strategy • economic baseline analysis.
Palmerston Council Community Plan (City of Palmerston 2018)	The plan was developed through a deliberative democracy process with community members. Its vision is for Palmerston to be “A place for people”. The Mayor’s foreword outlines an ambition to be the “family city of the Northern Territory”. Outcomes of the strategy are: • family and community (including wellbeing, family values will determine everything we do, young people’s voices are heard) • vibrant economy • cultural diversity • future focussed (can sustain itself through the challenges of the future) • environmental sustainability • governance (values and encourages participation). In 2021, the City of Palmerston released a Local Economic Plan, designed to grow industry and economic development in the municipality.
10 Year Infrastructure Plan 2019- 2028 (NTG 2019b)	The 10 Year Infrastructure Plan aims to provide transparency in planning and prioritises projects that have been identified as supporting future growth and prosperity of the NT. The Plan discusses the Darwin Ship Lift facility and anticipated infrastructure upgrades, many of which have since been completed.
Environmental Management	
Ecologically Sustainable Development of Darwin Harbour (NT EPA 2010)	The former NT EPA examined governance frameworks for promoting ecologically sustainable design in the Darwin Harbour Region and described the region as “a jewel in the Territory’s crown, developmentally, economically, recreationally, environmentally”. “Darwin is recognised as one of the last remaining places in the world where a large natural harbour environment still exists next to a major urban settlement. It contains one of the largest intact areas of mangroves in Australia, is recognised as a site of international conservation significance and has strong cultural meaning for the Larrakia people and the residents of the wider Darwin region.” (p.1).

Relevant Policies and Guidelines	Relevance
	Among other things, the NT EPA report pointed to a lack of integration between strategic planning activities by various government agencies and suggested better consideration of cumulative impacts.
Standard Specifications for Environmental Management (DIPE 2019)	This environmental management specification covers the requirements for the environmental management of infrastructure projects, including general environmental controls, environmental management plans and sub-plans, heritage and cultural approvals, materials extraction approvals as well as site specific requirements such as soil erosion and weed management. Chapter 13 Environmental Management Framework outlines relevant environmental management plans that will be included under the Contractors Environmental Management Plan.
Marine Environment	
Anti-fouling and in-water cleaning guidelines (Commonwealth of Australia 2015)	This guideline provides best practice approaches to applying, maintaining, removing and disposing of anti-fouling coatings and managing biofouling and invasive aquatic species on vessels.
Australian Ballast Water Management Requirements 2001	Requirements designed to reduce the risk of introducing harmful aquatic organisms into Australia's marine environment through ships' ballast water. Australian ballast water management requirements are consistent with International Maritime Organization (IMO) guidelines for minimising the translocation of harmful aquatic species in ships' ballast water.
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018)	The guideline includes the revision of existing default guideline values (DGVs) based on increased understanding, broader monitoring data collected since 2000. For toxicants, the method for deriving DGVs was revised and subsequently applied to update existing or derive new DGVs for many toxicants, which included the incorporation of more recent toxicity data. The guideline also includes sediment quality guidelines, revised by Simpson et al in 2013. DGVs for toxicants in sediments as per DGVs for toxicants in water, indicate the concentrations below which there is a low risk of unacceptable effects occurring, and should be used, with other lines of evidence, to protect aquatic ecosystems.
Environmental Assessment Guideline No.5 - environmental assessment guideline for protecting marine turtles from light impacts (Environmental Protection Authority, Western Australia 2010)	This guideline specifically addresses approaches to proposal design and implementation to protect marine turtles from the adverse impacts of light. This guideline sets out. guidance on an array of approaches available for avoiding, reducing, managing and mitigating light impacts on marine turtles to be considered when preparing documentation relevant to the EIA process and during the implementation of proposals or planning schemes. alternative methods for the avoidance and management of light impacts that can be applied using a risk-based approach and by applying best practice methods.
Technical guidance – protecting the quality of Western Australia's marine environment	The purpose of this technical guidance is to.

Relevant Policies and Guidelines	Relevance
(Environmental Protection Authority, Western Australia 2016a)	- assist proponents to design fit-for-purpose modelling and monitoring programs to spatially define, assess and manage potential impacts of their proposal on marine environmental quality. - ensure proposals that have the potential to significantly affect marine environmental quality are described and assessed in a sound and consistent manner that demonstrates how the Western Australian Environment Protection Authority objective for the Factor 'marine environmental quality' will be met.
Technical guidance – protection of benthic communities and habitats (Environmental Protection Authority, Western Australia 2016b)	The purpose of this guidance is to explain how impacts on benthic communities and habitats are considered during Environmental Impact Assessment and to set out the type and form of the information that should be presented to facilitate the assessment of impacts on benthic communities and habitats in Western Australia's marine environment.
The national system for the prevention and management of marine pest incursions. Australian Government (Commonwealth of Australia 2010)	The guideline outlines the following. - the decision process for selecting the priority locations and monitoring target species in Australia - the governance arrangements for the implementation of monitoring programs - provides the decision pathways and management actions stemming from monitoring results - the review process to ensure future improvements of the monitoring programs, the manual and guidelines and the National Monitoring Strategy.
Underwater Piling Noise Guidelines, South Australia	Provides practical management and mitigation measures to minimise the risk of injury to occur in marine mammals within the vicinity of piling activities. Provides a framework that minimises the risk of significant impacts to occur on marine mammals in biologically important habitats or during critical behaviours (e.g. breeding and calving).
Terrestrial Environment	
Land Clearing Guidelines, Department of Environment and Natural Resources, July 2020 (NTG 2020b)	The NT Land Clearing Guidelines play an important role in guiding good land development practices in the NT by establishing standards for the management (i.e. clearing and retention) of native vegetation, including the clearing of mangroves.
Mangrove Management in the Northern Territory, Department of Infrastructure, Planning and Environment, 2003 (DIPE 2003)	Direction for the research and management of mangrove ecosystems.
Northern Territory Fauna Atlas. Department of Environment and Natural Resources, NTG (NTG 2021a)	The NT Fauna Atlas currently includes all known terrestrial vertebrate records for the NT. It has more than one million records and is the most comprehensive database available of mammals, birds, reptiles and frogs. It is used to work out where species can be found and make sure these species are protected. Data is collected by scientists, from museums, environmental consultants, researchers and historical accounts.
Northern Territory Flora Atlas Datasets. Department of Environment and Natural Resources, NTG (NTG 2021b)	The NT Flora Atlas has over one million plant records. Data comes from the NT Herbarium specimen database and the vegetation site database of the NT. The NT Herbarium database

Relevant Policies and Guidelines	Relevance
	has records of plants that have been collected in the field where a sample of that plant has been preserved, identified and kept in the Herbarium. Data in the vegetation site database includes basic plant observations to detailed flora surveys.
Statutory weed management plans. Weed Management Branch, Department of Environment and Natural Resources, NTG (NTG 2021c)	Statutory weed management plans are legal documents that explain what you must do to manage certain high priority weeds.
Matters of National Environmental Significance	
EPBC Protected Matters Search Tool (DAWE 2021a)	This search tool provides indicative information on whether MNES or other matters protected by the EPBC Act are likely to occur in an area of interest.
Threat abatement plans, action plans and recovery plans for listed species, Department of Agriculture, Water and the Environment, Australian Government.	Threat abatement plans provide for the research, management, and any other actions necessary to reduce the impact of a listed key threatening process on native species and ecological communities. Implementing the plan should assist the long-term survival in the wild of affected native species or ecological communities. Action plans are strategic documents undertaken by scientists to review the status of a defined group of related organisms (e.g. birds, fish). They review the conservation status of major Australian taxonomic groups against International Union for Conservation of Nature (IUCN) categories, identify threats and recommend actions to minimise those threats. Action plans assist government and non-government organisations to establish national priorities for threatened species conservation. Recovery plans set out the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species or threatened ecological communities. The aim of a recovery plan is to maximise the long-term survival in the wild of a threatened species or ecological community. Recovery plans should state what must be done to protect and restore important populations of threatened species and habitat, as well as how to manage and reduce threatening processes.
Sediment, Erosion and Dredging	
Best Practice in Erosion and Sediment Control Manual (International Erosion Control Association (Australasia) 2008)	This document provides a comprehensive reference document for erosion and sediment control professionals. It contains the necessary strategies and techniques assist erosion and sediment control practitioners to reduce the degradation of land and water from uncontrolled erosion and sedimentation.
Handbook for Sediment Quality Assessment (Simpson et al 2005)	This handbook discusses the approaches and methods that are recommended for sediment quality assessments that build on the Australian and New Zealand Environment and Conservation Council (ANZECC)/Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) tiered assessment and the integrated assessment philosophy. These involve the use of multiple lines of evidence and considerations of how these can be integrated in weight of evidence frameworks to be used in decision making. The handbook summarises the latest science and provides information to guide future investigations.

Relevant Policies and Guidelines	Relevance
National Assessment Guidelines for Dredging (Commonwealth of Australia 2009)	The National Assessment Guidelines for Dredging (NAGD) set out the framework for the environmental impact assessment and permitting of the ocean disposal of dredged material. The framework includes: - evaluating alternatives to ocean disposal - assessing loading and disposal sites - assessing potential impacts on the marine environment and other users determining management and monitoring requirements.
Sediment Quality Assessment. A Practical Guide, Second Edition (Simpson and Batley 2016)	A practical guide to assessing sediment quality for consultants, regulators and academics in environmental chemistry and ecotoxicology. Written by experts in the field, it provides coverage of sediment sampling, sample preparation, chemical analysis, ecotoxicology, bioaccumulation, biomarkers, and ecological assessment. In addition, detailed appendices describe protocols for many of the tests to be used.
Water Quality	
Australia and New Zealand Guidelines for Fresh and Marine Water Quality (2018)	This guideline provides authoritative guidance on the management of water quality for natural and semi-natural water resources in Australia and New Zealand. guidance includes setting water quality and sediment quality objectives designed to sustain current, or likely future, community values for natural and semi-natural water resources.
Coastal and Marine Management Strategy (2019-2029) (NTG 2019a)	This strategy sets a 10-year direction for the management and protection of the coastal and marine environments of the NT and provides guidance for Territorians and decision makers. Initially a set of foundation actions have been identified that focus on establishing governance arrangements, gaining knowledge, improving engagement and consultation processes and developing appropriate management models. The foundation actions are the key building blocks that underpin achieving the objectives and attaining outcomes. These actions will require substantial collaboration and cooperation across land owners, government, industry, and nongovernment sectors, as well as a strong commitment by communities and individuals. Building on these achievements and the knowledge and experience gained, an evaluation will be undertaken in year 5 of the Strategy to review progress and refine and identify new actions as necessary complete delivery of the Strategy objectives. This staged and adaptable approach will ensure that future action plans are responsive to previous actions and outcomes, and emerging challenges and priorities
Darwin Harbour Water Quality Protection Plan (DLRM 2014)	Aims to maintain the current quality of water resources in Darwin Harbour. A key component of this management strategy has been the development of water quality guidelines and objectives (DLRM 2014). It identifies management actions being undertaken by government, industry and community stakeholders that are

Relevant Policies and Guidelines	Relevance
	focused on monitoring, assessing and/or managing nutrient and sediment inputs to Darwin Harbour waterways. The Plan is supported by the Water Act 1992, with beneficial uses and water quality objectives declared under Section 73 of the Act.
National Water Quality Management Strategy (Commonwealth of Australia 2018a)	This strategy is to develop and maintain a voluntary, nationally coordinated framework, supported by all Australian governments, to facilitate water quality management for the productive and sustainable use of Australia's water resources and to protect community values such as aquatic ecosystems. The NWQMS consists of nationally agreed policies, guidelines and tools to assist governments, and other organisations and institutions, to manage water quality, taking account of local conditions and community values. Community values are also known as 'environmental values' or 'beneficial uses'.
Water Quality Objectives for the Darwin Harbour Region (NTG 2010)	The Water Quality Objectives for Darwin Harbour describe the water quality needed to protect and sustain the environmental values and beneficial uses identified, as per the National Water Quality Management Strategy (NWQMS) guidelines. The Water Quality Objectives are. - aimed at protecting human health and the health of the aquatic ecosystems - for regions of relative homogeneity in water quality - not for heavily urbanised areas - applied to perennial rivers and streams - not developed for intermittent/episodic streams, lakes, wetlands (base-flow only) - not to be used as a value to 'pollute up to' but instead be used to limit the amount and type of discharge flushed into waterways or a particular body of water.
Acid Sulfate Soils	
Acid Sulfate Soils Management Guidelines. Queensland Government	In 2018 the Commonwealth Government and the National Committee for Acid Sulfate Soils developed a suite of resources and guidance material to provide clear advice about investigating and managing acid sulfate soils. In Queensland, the following guidelines are recommended for acid sulfate soil investigations, risk assessments and management. - National acid sulfate soil sampling and identification methods manual - Queensland acid sulfate soil technical manual, soil management guidelines (Dear et al, 2014) - guidelines for the dredging of acid sulfate soils sediments and associated dredge spoil management - National acid sulfate soils guidance: guidance for the dewatering of acid sulfate soils in shallow groundwater environments - National acid sulfate soils guidance: overview and management of monosulfidic black ooze (MBO) accumulations in waterways and wetlands.

Relevant Policies and Guidelines	Relevance
National Acid Sulfate Soils Guidance – A synthesis (Commonwealth of Australia 2018b)	The purpose of this synthesis is to provide a review of the range of ASS guidance materials both past and present and to examine the coverage provided by them for a range of main issues of current concern associated with ASS. This report aims to clearly identify the past, and the current primary sources of ASS guidance material and introduces new national guidance for ASS as well as a decision support tool to assist users to navigate the range of guidance available. The guidelines concern the risks posed both during dredging operations (that is to the water column and surrounding aquatic environment) and during disposal of dredged spoil materials within water bodies (open-water disposal), including confined disposal resulting in creation of new land or on existing land.
Air Quality and Greenhouse Gases	
Approved methods for the modelling and assessment of air pollutants in NSW (NSW EPA 2016)	Statutory methods for modelling and assessing air quality in NSW. This is referred to by the Environmental Protection Act 1994 – Guideline: Application requirements for activities with impacts to air as the guiding document for the modelling of air pollutants.
Brisbane City Council (BCC) Air Quality Planning Scheme Policy (BCC 2014)	The Air Quality Planning Scheme Policy (AQPSP) prescribes the methodology required for air quality impact assessments for projects within the BCC local authority area. Although not geographically relevant to the Project, the AQPSP is considered to be a robust technical assessment guideline appropriate for application to the Project. The assessment methodology prescribed in the AQPSP has been adopted for the assessment for the Project in the absence of similar planning legislation for City of Darwin.
Environment Reference Standard (Victorian Government, 2001) and the Draft Guideline for Assessing and Minimising Air Pollution in Victoria (Environment Protection Authority Victoria 2021).	Statutory guideline for assessing and minimising air pollution in Victoria. Although these guidelines are not geographically relevant to the Project, the document provides air quality impact assessment goals which are considered appropriate for the assessment for the Project and have been considered in the air quality assessment.
Kyoto Protocol (Int.)	Aims to reduce the impact of human-induced climate change by setting nation-specific GHG emissions targets, involving the reduction of emissions of six specific GHGs; carbon dioxide (CO ₂), methane (CH ₄), nitrous oxide (N ₂ O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF ₆).
National environment protection (National Pollutant Inventory) measure and National Environment Protection Council 1998 and Emission estimation technique manual for shipbuilding repair and maintenance 1999 (Environment Australia 1999)	This manual describes the procedures and recommended approaches for estimating emissions of listed substances on the National Pollutant Inventory (NPI) from facilities engaged in shipbuilding and repair. The facilities covered by this Manual include building, repair and maintenance of ships, barges and other large vessels as well as smaller non-ocean going vessels primarily used for recreation, fishing and transport.
National Environment Protection (Ambient Air Quality) Measure (Australian Government, 1998) (Australian Government 1998)	This is a Commonwealth measure that sets standards for six major air pollutants in Australia, specifically particulate matter less than 10 micrometres in diameter (PM ₁₀), particulate matter less than 2.5 micrometres in diameter (PM _{2.5}), nitrogen, dioxide (NO ₂), carbon monoxide (CO), ozone (O ₃) and sulphur dioxide (SO ₂). The standards for these pollutants have been considered in this air

Relevant Policies and Guidelines	Relevance
	quality impact assessment and where relevant adopted as Project air quality goals.
National Environment Protection (Air Toxics) Measure (Australian Government 2004)	This is a Commonwealth measure that provides a framework for monitoring, assessing, and reporting on ambient levels of air toxics, specifically benzene, toluene, xylene, formaldehyde. The purpose of this NEPM is to collect information to facilitate the development of standards for ambient air toxics. The frameworks for these pollutants have been considered in this air quality impact assessment and where relevant adopted as Project air quality goals.
National Inventory Report 2017. Volume 1. DoEE (DoEE 2019a)	Australia's National Greenhouse Accounts (NGA) are made up of a series of comprehensive reports and databases that estimate, and account for, Australia's greenhouse gas emissions. The National Inventory Report fulfils Australia's international inventory reporting requirements and is submitted under the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol in May 2019. Volume 1 included Australia's data for energy (stationary energy, transport and fugitive emissions), industrial processes and product use, and agriculture.
Northern Territory Climate Change Response Towards 2050 (NTG 2019c)	Provides a platform for Territorians to access information on how to engage, access new opportunities and minimise climate risk, to reduce climate risk and deliver co-benefits, including an increase in health and wellbeing and cost-savings.
Paris Agreement (Int.)	Australia has committed to the Paris Agreement, which has a goal to limit the increase in the global average temperature to below 2°C above pre-industrial levels and reduce GHG emissions by encouraging technological innovation and clean energy.
Queensland Government Environmental Protection (Air) Policy (QLD) (EPP Air) (Queensland Government 2019)	Policy instrument beneath the Environmental Protection Act 1994, to protect the environmental values of air.
State and Territory Greenhouse Gas Inventories (Department of Industry, Science, Energy and Resources 2017)	The State and Territory Greenhouse Gas Inventories provide an overview of annual greenhouse gas emission estimates for each Australian state and territory. It is a disaggregation of the emission estimates in the National Inventory Report submitted to the United Nations Framework Convention on Climate Change (UNFCCC) each year.
Biting Insects	
Guidelines for Preventing Mosquito Breeding Associated with Construction Practice near Tidal Areas in the NT (NTG 2017)	These guidelines are intended as a checklist for planners, engineers or any supervisory officers, responsible for the planning or implementation of any construction activity near tidal areas, in order to prevent the creation of mosquito breeding sites.
Social	
International Association for Public Participation (IAP2) Quality Assurance Standard (2015) for community engagement (IAP2, 2015)	This standard seeks to provide a quality process by which engagement projects can be assessed to provide confidence and certainty for both practitioners and clients of community and stakeholder engagement practice.
IAP2, 2016. Core Values. International Association for Public Participation Australasia (IAP2 2016)	IAP2 has developed Core Values for Public Participation for use in the development and implementation of public participation processes. The Core Values define the expectations and aspirations of the public participation process.

Relevant Policies and Guidelines	Relevance
Social Impact Assessment: Guidance for assessing and managing the social impacts of projects (IAIA 2015)	The purpose of this guidance note is to provide advice to various stakeholders about what is expected in good practice SIA and social impact management processes, especially in relation to project development.
Heritage	
Commonwealth Underwater Cultural Heritage Register (UCH Act) (DAWE 2021b)	This database contains historical and environmental information about shipwrecks, sunken aircraft and other types of underwater heritage sites located in the Oceania and Southeast Asian regions. This database also includes the records of artefacts that originate from these sites. The database serves as the register of protected underwater cultural heritage for the UCH Act and provides a portal for the public to submit notifications and permit applications required under the UCH Act.
Northern Territory Heritage Register (NTG 2021d)	A database of sites and objects protected by the Heritage Act that have been recorded in the NT. Data includes location and description details. Data also includes places and objects that have been nominated to the register.
The Burra Charter: The Australia International Council on Monuments and Sites (ICOMOS) charter for places of cultural significance (ICOMOS 2013)	This charter sets a standard of practice for those who provide advice, make decisions about, or undertake works to places of cultural significance, including owners, managers and custodians.
Transport	
Development Guidelines for Northern Territory Government Controlled Roads, Version 1.0 (Department of Transport 2015)	The guidelines were developed by the Department of Transport and apply to any development or infrastructure that impacts on the road network or that will ultimately be transferred to the NTG. These Guidelines also outline the Department's involvement in the assessment of land use development applications under the Planning Act and provide details of the Department's approval processes.
Towards Zero Action Plan 2018-2022 (DIPE 2018)	The Towards Zero Road Safety Action Plan presents a vision of zero deaths or accidents on roads within the NT. It outlines a strategy taking a holistic approach to reducing road deaths and accidents, using a 'Safe Systems' approach, which considers how the whole road system can be more forgiving to reduce the consequence of mistakes by road users.
Waste	
Waste classification guidelines, Part 1: Classifying waste (NSW EPA 2014)	This part of the Waste Classification Guidelines covers the classification of wastes into groups that pose similar risks to the environment and human health. • special waste • liquid waste • hazardous waste • restricted solid waste • general solid waste (putrescible) • general solid waste (non-putrescible).

3.4 Post Environmental Impact Statement Approvals

A summary of the key potential post EIS approvals is provided within Table 3-5. These are subject to review and change during the detailed design process.

The NTG has commenced and will continue to undertake consultation with infrastructure owners and utility providers regarding interface and approval requirements.

If the tailwater settling ponds are to be used at EAW, prior to commencement of dredging activities consent will also be required from Port of Darwin for the use of the ponds and a contract will need to be established between DIPL (or the Construction Contractor) and the Port of Darwin.

All relevant approvals, and associated conditions procured during the Developed Design and construction shall be transferred to the Operator at the time of handover.

Table 3-5 Post Environmental Impact Statement Project Approvals

Legislation	Administering Authority	Action/trigger	Type of Approval	Timing
<i>NT Planning Act 1999</i>	DIPL	Permit for development activities proposed to take place in areas that are the subject of the EIS such as excavation, land-filling, clearing of native vegetation, constructing buildings, constructing or upgrading roads and drains.	Development Permit	Prior to commencement of construction
<i>NT Planning Act 1999</i>	DIPL	All dredging in Darwin Harbour requires Development Consent as per Section 3.9 of the NT Planning Scheme. The purpose of the consent is to ensure that dredging and dredge spoil disposal does not degrade the environmental value of the harbour waters. The development application process includes a public comments period.	Development Permit	Prior to commencement of dredging
<i>NT Environment Protection Act 2019</i>	DEPWS	Dredging works will be approved via the EIS, typically with condition that a Dredge Management Plan is submitted for approval prior to the commencement of dredging.	Dredge Management Plan(s) prepared by the dredging Contractor and submitted for approval by the NT EPA	Prior to commencement of dredging

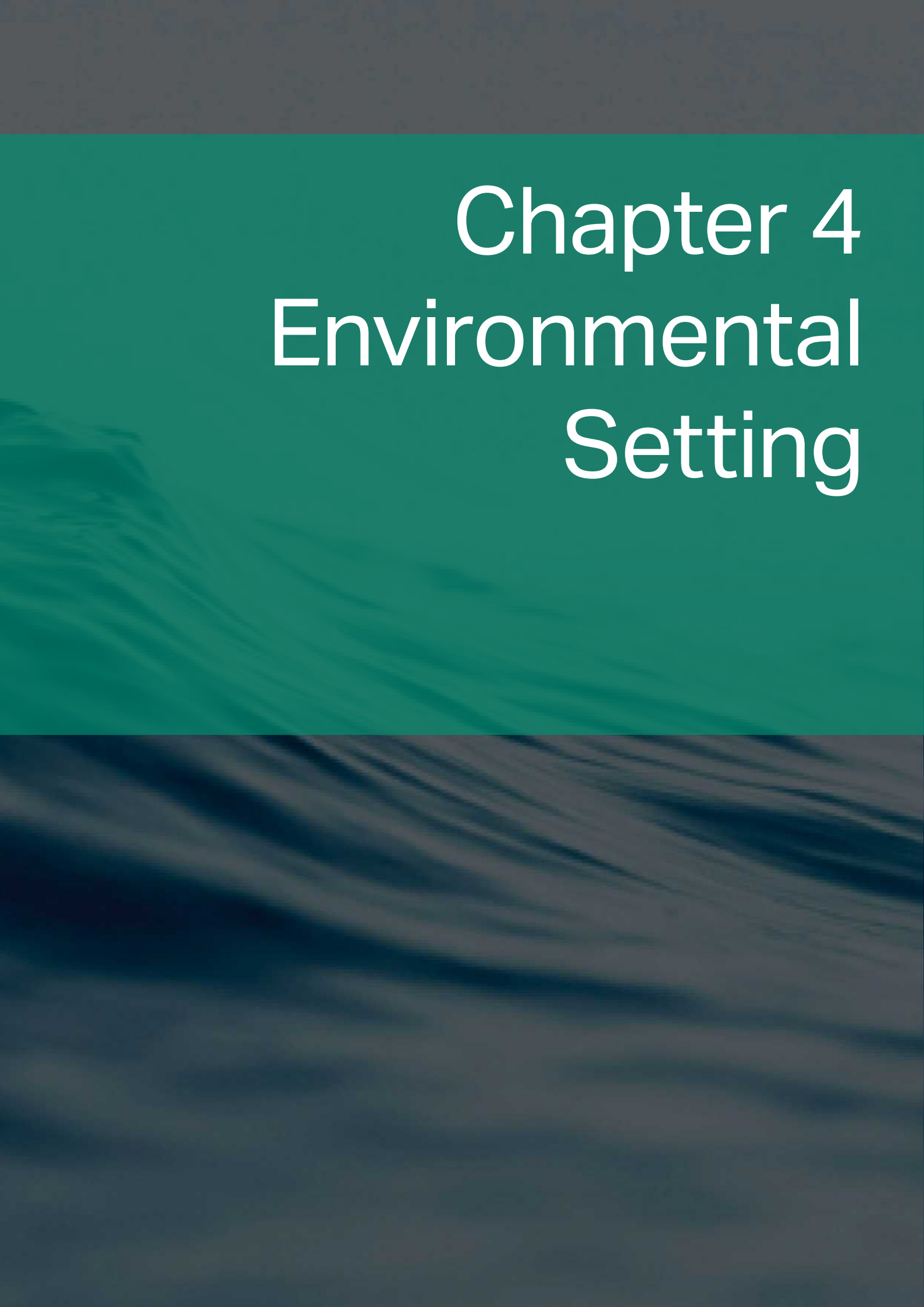
Legislation	Administering Authority	Action/trigger	Type of Approval	Timing
<i>NT Water Act 1992</i>	NT EPA	Activities where waste will come into contact with groundwater, tidal water, rivers, creeks, lakes and/or channels. Relevant activities to this proposal may include: - operating a sewage or wastewater treatment plants - dredged material disposal. Waste includes any matter whether wholly or partly in a solid liquid or gaseous state, which if added to water, may pollute the water (NT EPA, 2021b).	A WDL for treated wastewater or dredging tailwater discharge to Darwin Harbour	Prior to commencement of operations or dredging
<i>NT Water Supply and Sewerage Services Act 2000</i>	PowerWater	The NT Trade Waste Management System (TWMS) provides a framework for the administration, acceptance and regulation of the disposal of trade waste to the sewerage system. Under the TWMS, a business that discharges trade waste to sewer will need to apply for approval to discharge trade waste (PowerWater, 2021).	Trade Waste Discharge Permit	Prior to discharge to sewerage
<i>NT Planning Act 1999</i>	DIPL – Marine Safety Branch	Coastal development above low tide in NT Coastal Waters.	Marine Safety Branch Consent	Prior to construction
<i>NT Port Management Act 2015</i>	DIPL – Regional Harbour Master	Erection of structures below high tide in Darwin Harbour and dredging.	Written approval by Regional Harbourmaster	Prior to construction

Legislation	Administering Authority	Action/trigger	Type of Approval	Timing
<i>NT Heritage Act 2011</i>	Department of Tourism, Sport and Culture Territory Families, Housing and Communities	Approval to disturb heritage items and archaeological artefacts, if located.	Approval to disturb heritage items	Prior to disturbance
<i>Northern Territory Aboriginal Sacred Sites Act 1989</i>	Aboriginal Areas Protection Authority (AAPA)	It is noted that an Authority Certificate (C2019/004) was issued by the AAPA for the Project on the 18 January 2019. This certificate is included as an attachment to Appendix M: Cultural Heritage Assessment.	AAPA certificate	Completed

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Chapter 4

Environmental Setting

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4.0 Environmental Setting

The Project is located on the East Arm peninsula within Darwin Harbour. The existing land portion of the Project area is fully fenced and is used for the provision of marine service activities by a private company. It currently accommodates a car park, site office, marine equipment, material hardstand/laydown area, a works depot, marine workshop and a boat ramp. The boat ramp was constructed in World War II and was used in more recent times for recreational boating purposes, prior to the construction of the current East Arm Boat Ramp at Casey Street 1200 m to the east. The existing use of the site is shown in Figure 2-3 and Plate 2-1.

The area surrounding the Project is associated with marine and port infrastructure and industry. Major developments on the shoreline within Darwin Harbour include INPEX LNG and Santos Darwin LNG plants located on Middle Arm, PWC's Channel Island power station, adjacent to Middle Arm, EAW located on East Arm peninsula, Darwin CBD, the Waterfront Precinct on the eastern side of the main body of the Harbour, and suburban developments on the Harbour shoreline from Darwin in the north to Palmerston in the east. A small residential area also exists at Waigait Beach, near Mandorah, on the western side of the mouth of the Harbour.

Some residential, industrial and infrastructure development has been undertaken around the shorelines of East Arm and Middle Arm, while the shorelines around the western and northern margins of the Harbour are almost completely undeveloped.

The following chapter describes the environmental setting of the Project in terms of:

- climatic and atmospheric characteristics
- air quality
- marine environment
- terrestrial environment
- socio-economic values
- historical and cultural values
- people and communities.

4.1 Climate and atmospheric characteristics

Meteorological statistics have been reviewed and summarised to provide a description of the regional climate and atmospheric characteristics in terms of:

A more comprehensive discussion of the climate and atmospheric characteristics can be found in Chapter 9: Air Quality and Greenhouse Gas and Appendix J: Air Quality and Greenhouse Gas Technical Report.

The Bureau of Meteorology (BoM) Darwin Airport monitoring station is located approximately seven kilometres (km) north of the Project area. Due to the close proximity of the BoM Darwin Airport station to the Project, conditions are expected to be comparable and therefore representative. The BoM Darwin Airport monitoring station has been used to describe the local meteorological conditions including:

- temperature
- rainfall patterns
- relative humidity
- wind speed and direction
- cyclone and storm activity
- projected sea level rise.

4.1.1 Temperature

The warmest mean temperatures are recorded during spring months, with the highest mean maximum temperature recorded in November (33.4°C). The lowest mean maximum temperature is recorded in July (30.6°C). Table 4-1 and Figure 4-1 present statistics for temperature measurements recorded at the BoM Darwin Airport station from 1941 to 2021.

Mean minimum temperatures are highest in November and December (25.3°C) and lowest in July (19.3°C).

Mean monthly temperatures vary between months. Mean maximum and mean minimum temperatures in Darwin do not fluctuate as significantly as other areas in Australia.

Table 4-1 Temperature statistics for BoM station Darwin Airport (1941 to 2021)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug ^a	Sep ^a	Oct ^a	Nov ^a	Dec ^a
Mean maximum temperature (°C)	31.8	31.5	32.0	32.8	32.1	30.7	30.6	31.4	32.7	33.3	33.4	32.7
Mean minimum temperature (°C)	24.9	24.8	24.6	24.0	22.2	20.0	19.3	20.3	23.0	24.9	25.3	25.3

Table notes: Maximum and minimum temperatures are represented in red and blue respectively
^a2021 data is only available for months Jan-Jul at time of writing

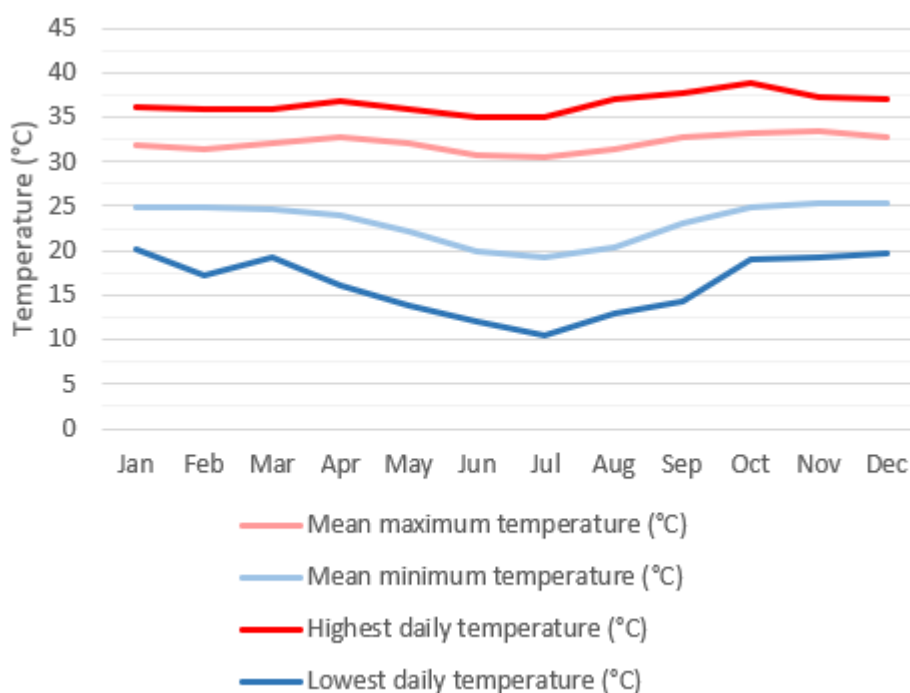


Figure 4-1 Monthly mean maximum, mean minimum, highest and lowest daily temperature statistics (°C) for BoM Darwin Airport monitoring station (1941-2021)

4.1.2 Rainfall

The Darwin area experiences a tropical climate with distinctly wet summers and dry winters (BoM 2020). Table 4-2 and Figure 4-2 present mean rainfall statistics for measurements recorded at the BoM Darwin Airport station from 1941 to 2021. The highest periods of rainfall are recorded in summer months, with the maximum mean monthly rainfall recorded in January (432 mm). Relatively low rainfall is recorded in the months of May to September, with the lowest mean rainfall month being July (1 mm). Figure 4-2 shows a clear pattern of wet and dry seasons, as expected for the Darwin area (BoM 2021).

Table 4-2 Rainfall statistics for BoM Darwin Airport station (1941 to 2021)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug ^a	Sep ^a	Oct ^a	Nov ^a	Dec ^a
Mean rainfall (mm)	432	36	312	102	21	2	1	5	17	71	142	250
Table notes: Maximum monthly mean rainfall measurement shown in bold ^a 2021 data is only available for months Jan-Jul at time of writing												

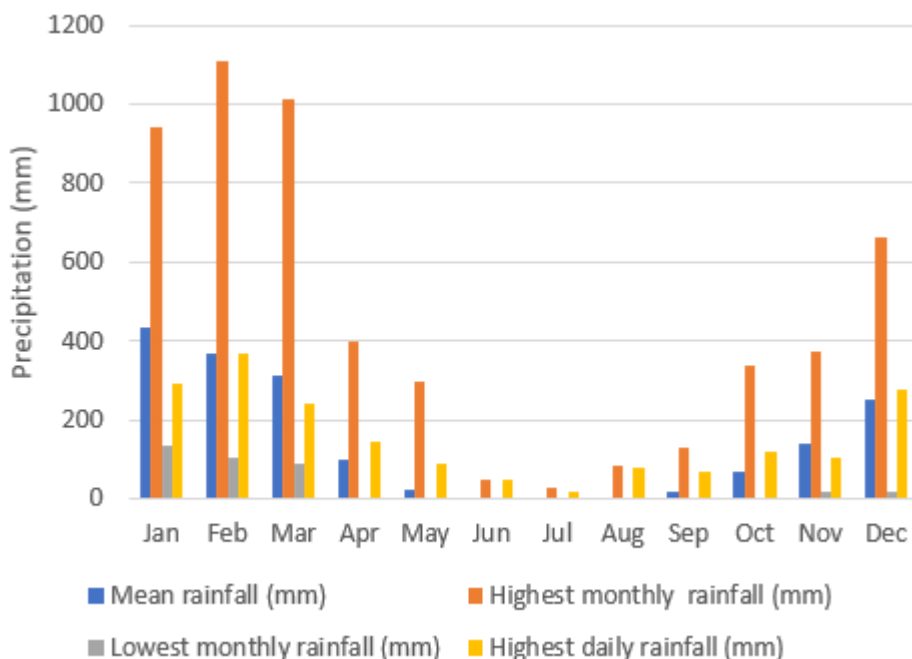


Figure 4-2 Monthly mean, highest, and lowest rainfall, and highest daily rainfall for BoM Darwin Airport monitoring station (1941-2021)

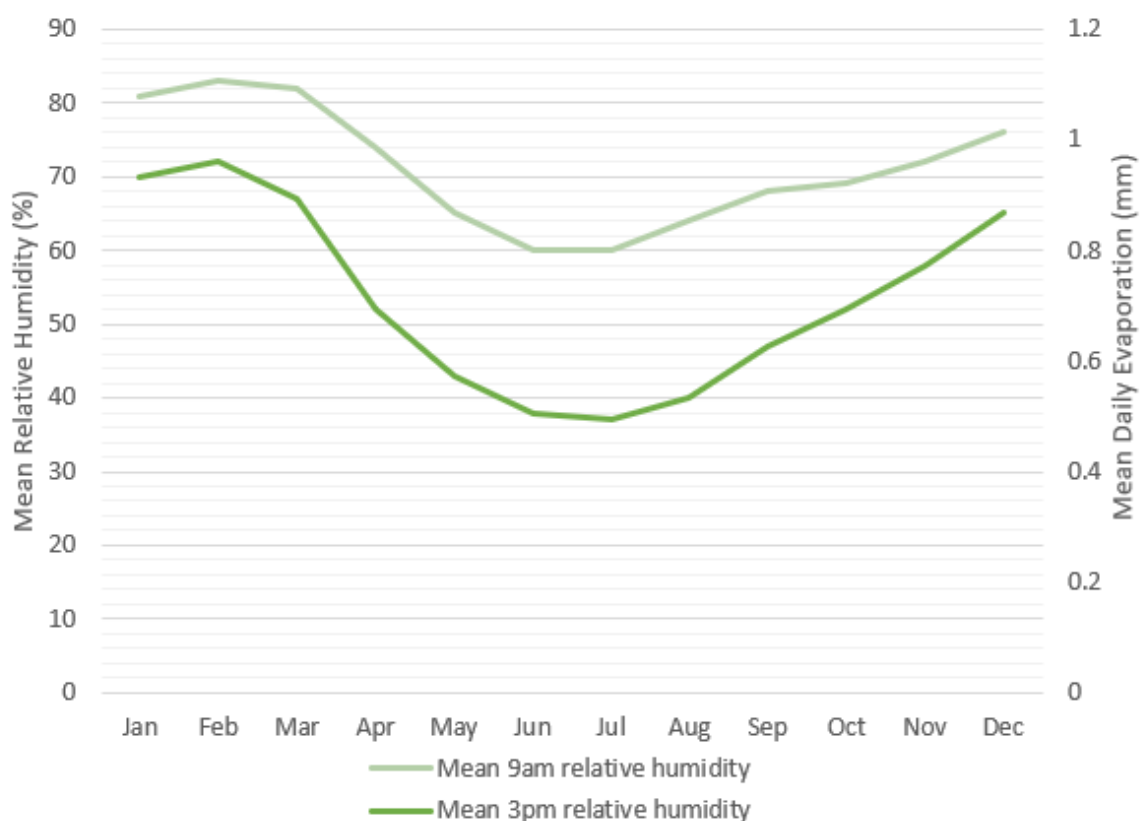
4.1.3 Relative humidity

Relative humidity percentages at 9 am range from 60% in July to 83% in January. Relative humidity percentages at 3 pm range from 37% in July to 72% in January. Table 4-3 and Figure 4-3 present relative humidity statistics recorded at the BoM Darwin Airport monitoring station at 9 am and 3 pm from 1954 to 2010 (BoM 2021). Relative humidity data is not available for the period of 2011 onwards at the BoM Darwin Airport.

Table 4-3 Relative humidity statistics for BoM station Darwin Airport (1954 to 2010)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean 9 am relative humidity (%)	81	83	82	74	65	60	60	64	68	69	72	76
Mean 3 pm relative humidity (%)	70	72	67	52	43	38	37	40	47	52	58	65

Table note: Maximum and minimum temperatures are represented in red and blue respectively

**Figure 4-3 Mean monthly relative humidity measures at 9 am and 3 pm for the BoM Darwin Airport monitoring station (1954-2010)**

4.1.4 Wind direction and speed

Seasonal variations in wind direction are evident, with noticeable variation between the wet season (spring and summer) and the dry season (autumn and winter) (refer Figure 4-5). The strongest winds are recorded from the west and north-west during the summer. Autumn has the weakest wind conditions, which is expected due to the effect of the tropical coastal outline (BoM 2021).

The wind roses show that west-north-westerly, easterly and westerly winds are the predominant wind directions.

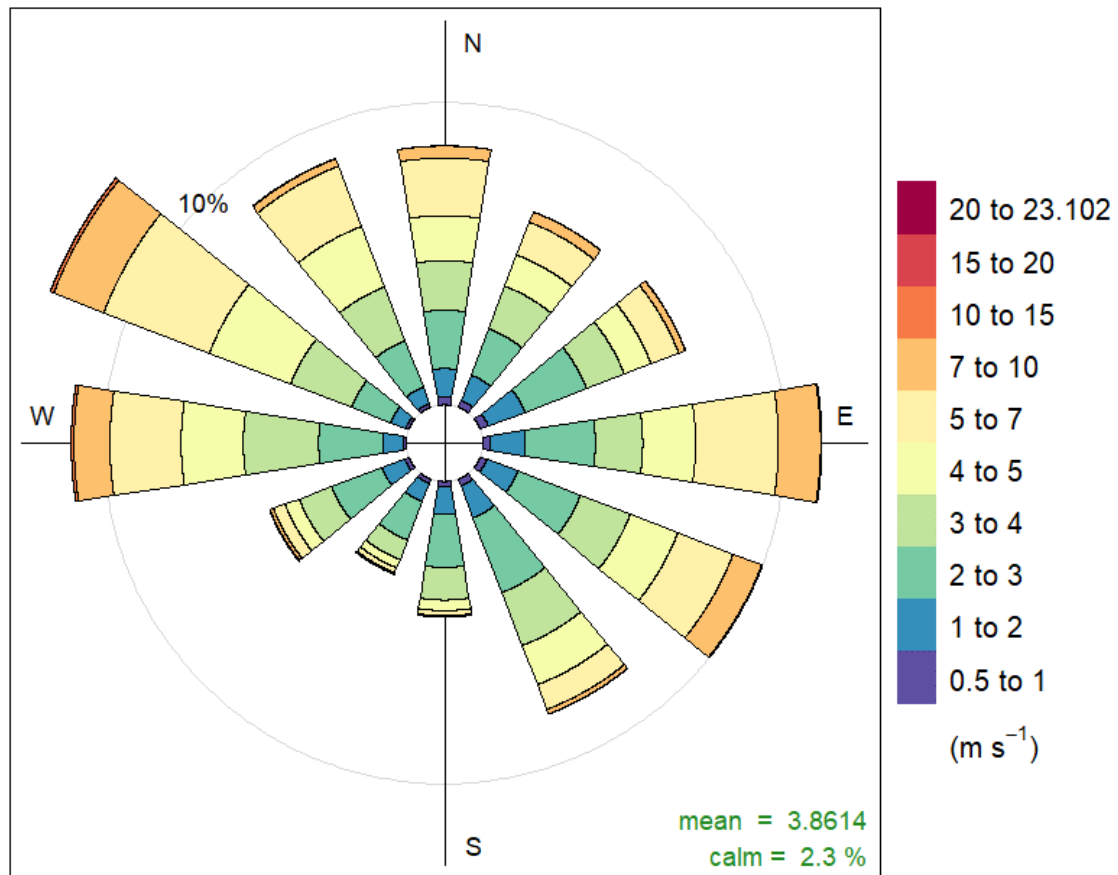


Figure 4-4 Wind rose for BoM Darwin Airport monitoring station (2001 to 2020)

4-

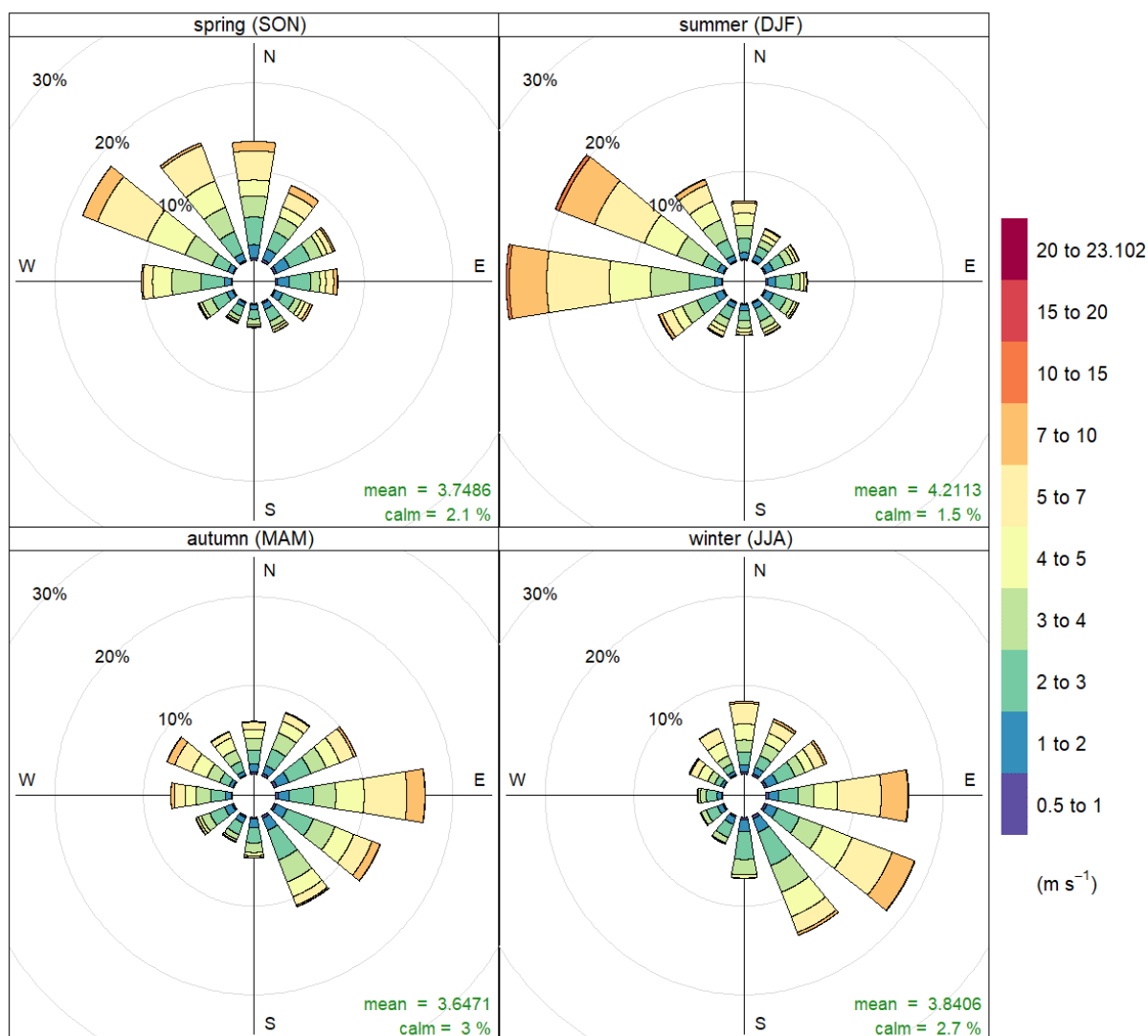


Figure 4-5 Seasonal wind roses for BoM Darwin Airport monitoring station (2001 to 2020)

4.1.5 Cyclonic activity

Tropical cyclones have a high occurrence of forming in Darwin's surrounding oceans during the wet season (November to April), and have the potential to result in strong to gale force winds, large wave heights and heavy rainfall along much of the coast of the NT. Tropical cyclones cause most damage within a distance of 50 km from the coast. Due to its location, Darwin has previously experienced significant cyclonic activity with 15 tropical cyclones tracking within 50 km of the Darwin area between 1969 and 2021 (BoM 2021)

4.1.6 Sea level rise

Sea level around Darwin and the NT has risen and is predicted to continue to rise at a higher rate than much of the rest of the country due to natural climate variability and climate change (White et al. 2014). Darwin's projected sea level rise at the current rate of 7.5 millimetres (mm) per year is 0.25 m by mid-century (2036 - 2065) and 0.62 m toward the end of the century (2075 - 2104), under a high emissions climate mitigation pathway, with only minor variation for a medium emissions pathway (CSIRO 2020). Sea level rise, while incremental, will impact on the natural and built environments along the Peninsula, and may impact low-lying coastal communities (NTG 2015).

4.2 Air quality

A desktop assessment of ambient air quality within the Project area has been conducted using monitoring data available from the NT EPA and Darwin Port Corporation (DPC). This data has been used to inform the assessment of the existing air quality environment for the Project for the following pollutants:

- Particulate less than 10 microns in diameter (PM₁₀)
- Particulate less than 2.5 microns in diameter (PM_{2.5})
- Nitrogen dioxide (NO₂)
- Carbon monoxide (CO)
- Sulfur dioxide (SO₂).

Background air quality within the Project area is influenced by industrial uses in the surrounding areas and strong variable winds that are characteristic of a dry, coastal environment. Air emissions generated include fugitive particulate emissions from the operation of the surrounding industrial area, wind erosion from uncovered areas, and vehicle movements on unsealed roads and hardstand areas. Combustion and industrial emissions from nearby industry and heavy vehicle traffic along Berrimah Road are also responsible. Bushfires are also a significant regional air emission source that impact on the Project area and surrounds.

The desktop analysis of ambient air quality data shows that background concentrations of PM₁₀ and PM_{2.5} are elevated and exceedances of the adopted air quality goals for these pollutant species are reported over several years of data (2015-2019) (refer Chapter 9: Air Quality and Greenhouse Gas). Bushfire smoke during the dry season is often a cause for high concentrations of PM₁₀ and PM_{2.5}. Analysis of NO₂, SO₂, and CO monitoring data shows that concentrations recorded at NT EPA stations within the (12 x 15 km) air quality study area are well below the adopted air quality goals, with the exception of CO in 2018. However, this year (2018) was considered an anomaly as every other year was below the adopted air quality goals for CO. The data from 2018 was therefore not used to estimate background concentrations.

4.3 Marine environment

Darwin Harbour is one of the least-disturbed working harbours in Australia and the Asia-Pacific region. The region's catchment extends from Charles Point in the west and Gunn Point in the east and covers approximately 3,230 km². The area includes the tributaries and estuarine areas of Cox Peninsula, West Arm, Middle Arm, East Arm, Blackmore River and Howard River.

Several major river systems drain to the estuary (Blackmore, Elizabeth and Howard) unlike other Australian cities which receive most of their catchment inflows from one large riverine system (DHAC 2020). Freshwater inflow into the Harbour occurs from January to April, when estuarine conditions prevail in all areas (Hanley 1988).

Darwin Harbour supports a range of ecosystems including mudflats, mangroves, coral reefs and seagrass. It is also home to varied animal life such as dolphins, dugong, sea turtles, shorebirds, sponges, and a large variety of fish (DLRM 2014).

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 natural channel continued into East Arm, towards Bladin Point, at water depths of more than 10 m below LAT. Over recent years, the bathymetry in this area has been modified by dredging and reclamation for the development and expansion of EAW and the construction of the INPEX LNG onshore processing plant on Bladin Point.

The Project is located on the northern shoreline of East Arm, adjacent to the MUBRF and EAW. The location features shallow bathymetry (approximately 0 to 10 m below LAT), bounded by dredged channels for the adjacent marine facilities and offshore by the main East Arm channel.

4.3.1 Marine coastal processes

Darwin Harbour is characterised by a macro-tidal regime (Harper 2010), with predominantly semidiurnal tides. Mean sea level is approximately 4.0 m LAT, and spring tides can produce tidal ranges up to 7.5 m. Due to the macro-tidal regime of the Harbour, prevailing currents are of tidal origin; Williams et al. (2006) indicates 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. Due to the harbour orientation, bathymetry and coastline configuration, energy of long period waves entering the Harbour quickly dissipates and thus wave heights decrease dramatically. Storm tide predictions – which take into account cyclone storm surges together with the effects of frequent waves (“wave set-up”) and the influence of astronomical tide - indicate that temporary increases in sea level would occur during cyclone conditions at sites around Middle Arm and East Arm (SEA 2006).

4.3.2 Water and sediment quality

Water quality in the Harbour is generally high, although naturally turbid most of the time. Water quality parameters vary greatly with the tide phase (spring versus neap; flood versus ebb), location of sampling (inner versus outer harbour), and with the season (wet season versus dry season). Duggan (2006) conducted research on the water quality of Darwin Harbour from 2002 to 2004. Seasonal aspects, rather than spatial or tidal aspects, were found to be the most important determinant of water quality within the harbour in general, with rainfall considered to have the greatest impact on water quality (increasing nutrients, suspended solids and chlorophyll-a).

Water quality is typically higher in outer harbour waters than within the inner harbour, though turbidity at the harbour mouth can be elevated in shallow areas due to re-suspension of sediments from intertidal flats, especially during spring tides.

There is no evidence of widespread water pollution in Darwin Harbour, although there is some localised pollution (Padovan 2003). Anthropogenic influences to Harbour water quality include the port operations at East Arm, historic industrial activities at Darwin Waterfront, Sadgroves Creek, wastewater outfalls (URS 2004), storm water runoff from rural, urban and industrial catchment diffuse sources during the wet season, and other licensed waste water discharges (Department of Land Resource Management (DLRM) 2014). There is no evidence of hydrocarbon or pesticide pollution in the Harbour (DHAC 2003).

Sediments of Darwin Harbour range from terrigenous gravels in the main harbour channel, calcareous sands among or close to the small coral communities, terrigenous sands on beaches and spits, and mud and fine sand on broad, gently inclined intertidal mudflats (Michie 1988). It is estimated that 60% of the Harbour’s sediments originate from offshore. The remainder is deposited by rivers and creeks, derived predominantly from erosion of channel walls. Direct contribution to the Harbour from sheet erosion is likely to be limited because of the very low hillslope gradients adjacent to the Harbour (DHAC 2006).

Sediments of Darwin harbour have generally been shown to have low levels of contamination (URS 2008; URS 2012; URS 2014, AECOM 2020). Some metals (arsenic, chromium and/or mercury), tributyltin compounds and petroleum hydrocarbons have been recorded in the East Arm area at concentrations exceeding national dredging guideline levels (URS 2008; URS 2011; URS 2014).

Further dissuasion of the Marine water and sediment quality within Darwin Harbour and the Project area is provided in Chapter 7: Marine Environmental Quality of the EIS.

4.3.3 Marine ecology

Darwin Harbour has a complex assemblage of marine ecological communities, including rocky shore biota, hard corals, filter feeders (primarily soft corals and sponges), macroalgae, seagrasses, soft sediment biota, mangroves and fish communities.

4.3.3.1 Marine communities

Smit et al (2012), in their summary of previous benthic habitat mapping of Darwin Harbour, suggest that the benthic habitats present in the inner and outer harbour differ significantly and are typically characterised as follows:

- Outer harbour:
 - extensive seagrass communities occur in shallow waters
 - corals and algae dominate on hard substrates in shallow waters
 - deeper waters are characterised by filter feeder communities (e.g. sponges).
- Inner harbour
 - hard substrates in shallow and deeper waters consist of mixed communities or are dominated by sponge communities
 - no seagrass communities are present.

The marine communities of Darwin Harbour and the Project area are described in further detail in Chapter 8: Marine Flora and Fauna.

4.3.3.2 Marine Fauna

A survey conducted in 1997 found 415 fish species in Darwin Harbour, including 31 new records for the NT (Larson & Williams 1997). The most diverse group of fishes were gobies (70 species), cardinal fish (20 species) and pipefish (19 species). Fish species commonly harvested recreationally and by aboriginal fishers are found in the mangroves, such as trevallies (*Caranx* spp.), mackerel (*Scomberomorus semifasciatus*), salmon (*Eleutheronema tetradactylum* and *Polydactylus macrochir*), grunter (*Pomadasys kaakan*) and barramundi (*Lates calcarifer*) (McKinnon et al 2006).

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

A search of Department of Environment and National Resources (DENR) Fauna Atlas NT, recorded sightings of both the Green turtle (*Chelonia mydas*) and the Flatback turtle (*Natator depressus*) in the Project area neither of which are listed under NT legislation.

A search of the PMST database search and desktop assessment revealed:

- 24 threatened marine species (2 mammals, six reptiles and three fish) listed under the EPBC Act, as potentially occurring within 5 km of the Project area.
- Seven marine migratory species listed under Commonwealth legislation which may occur or may have habitat which occurs within the Project area, of these 7 species, 1 species is also listed as migratory under the EPBC Act all of which are birds.

Chapter 8: Marine Flora and Fauna includes an assessment of the likelihood or occurrence and impacts on these species.

4.3.3.3 Marine Pests

Monitoring programs for introduced marine pests in Darwin Harbour have been in place since the late 1990's with a number of marine pest species having been detected over this time. The most serious incursion was that of the invasive Caribbean "mussel" *Mytilopsis sallei* in the Cullen Bay Marina in 1999. The elimination of *M. sallei* is one of a very small number of successful responses to the introduction of an IMP species (Willan et al. 2000, Bax et al. 2002). These monitoring programs and detections are also discussed further in Chapter 8: Marine Flora and Fauna.

4.4 Terrestrial environment

There is a large suite of studies and information available to describe the existing environment of the Project area and surrounds, including data gathered in support of previous development in Darwin Harbour, such as the MUBRF, MSB, various stages of the EAW expansion and other projects such as the Santos' Darwin LNG and INPEX Ichthys LNG Plants.

Characteristics of the terrestrial environment are discussed below in terms of:

- landform, geology and soils
- groundwater and surface water hydrology
- terrestrial flora and fauna.

4.4.1 Landforms, geology and soils

The general hinterland landforms around Darwin Harbour comprise of dissected upland terrain, low strike-ridges and hills (approximately 15-40 m high mostly along the southern coastline, formed on shales, siltstones and sandstones of the Proterozoic Burrell Creek Formation [BCF]) and intervening alluvial flats (Wood et al. 1985, Pietsch 1987, Burns 1997). Sediments of Cainozoic age cover most of the region and consist of Tertiary and Quaternary soils and laterite exposures. Quaternary sands, silty clay, laterites or ferruginous clayey sand are associated with drainage lines and low lying country (Pietsch 1987).

East Arm comprises areas of high ground with tropical woodland vegetation surrounded by intertidal mangroves which are partially or completely inundated by water at high tide. Some minor hills and ridges occur over the higher elevations of woodland areas (Douglas Partner 2015). Land elevation ranges from 0-30 m (URS, 2011).

Around the peninsula coastline, the mangroves merge into extensive tidal mudflats formed from marine alluvium and mud, clay and silt (Brocklehurst and Edmeades 1996). Sandy shelly chenier ridges and small areas of salt flats also occur (Pietsch 1987).

Land elevation throughout the Project area is generally between 0.0 m and 7.0 m Australian Height Datum (AHD) with elevation greatest in the northern and north-eastern sections of the Project area. The area is generally well drained with moderately sloping terrain up to approximately 5 degrees grading to the southern sections of the Project area (KBR 2018).

The wider East Arm area has been primarily cleared for industry and port activities. The Project area located above HAT is approximately 4.2 ha is consistent with this land use and consists of cleared bare and gravelled surfaces with occasional patches of grass and weed species. The Project area also includes approximately 14.6 ha of intertidal habitats, including an isolated stand of remnant mangrove habitat approximately 1.0 ha in area, with the remaining intertidal area being mudflats which become rocky to the east of the site. In the sub-tidal marine area, the Project area consists of bare sandy substrate with occasional encrusting sponges. The marine environment is discussed in Section 4.3.

The Project area has two primary land systems as defined by the Land System Mapping from NTG:

- Krans: This land system consists of plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products.
- Littoral 1: This land system consists of tidal mudflats and coastal floodplains with channels and estuaries, subject to tidal inundation. Soils are usually poorly drained clays and muds.

Based on the 1:100,000 scale geological map of Darwin (NTG 1983), the Project area is underlain by metasediments belonging to the BCF. Quaternary age cover, comprising alluvium, unconsolidated sands, colluvium, and marine and estuarine sediments cover the BCF rocks.

ASS commonly occur in Quaternary aged sediments of marginal marine or estuarine origin and are mainly confined to coastal lowlands. A review of the ASS Risk Mapping database (ASRIS 2017) classifies the area around the site as having a high probability of occurrence. Potential acid sulfate soils (PASS) is likely to occur within the intertidal flats associated with mangroves, the area between the mangrove line boundary and the proposed dredge area above the mean low tide, and subtidal zones that are permanently inundated estuarine or marine areas. The ASS risk mapping search results are presented in Appendix N: Preliminary Site Investigation. As the Project area is located within a high-risk ASS area it will require consideration of managing PASS risks.

4.4.2 Groundwater

Groundwater information is limited within the region. The available data indicates that groundwater can be encountered within the Quaternary and Proterozoic lithologies, which are shallow. Aquifers are low

yielding, with flows less than 0.5 L/s. Higher yields with low storage may be available from sand lenses with Quaternary sediments and fractures in sandstone (KBR 2018).

The groundwater hydraulic gradient would be expected to follow ground surface topography with flow toward the Harbour waters from areas of elevation. The topography and mangrove vegetation in the southern portion of the site suggests that the groundwater level remains relatively close to, or at, the surface year round, with a progressive lowering of the water table expected throughout the dry season (May to September). Near-shore groundwater levels are likely to be influenced by tides, which range up to 8 m (KBR 2018).

The quality of groundwater is typically saline to hyper saline and not suitable for drinking or irrigation. The high salinity is likely due to the proximity to the landward salt water intrusion and dissolution of salts derived from marine sediments (KBR 2018).

A search of the Department of Environment, Parks and Water Security website accessed in July 2021 did not identify current groundwater users at or within 500 m of the site. Given its adjacency to the marine environment, no beneficial use of groundwater at the site is considered likely (refer Appendix N: Preliminary Site Investigation).

4.4.3 Surface water

The Project site is located at East Arm, within Darwin Harbour. Darwin Harbour is a large estuary that experiences substantial tidal variation, with water quality varying with tide, weather, season and location. The southern harbour area consists of 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 Elizabeth River flows into East Arm, while the Darwin and Blackmore rivers flow into Middle Arm (Figure 4-6). During the dry season (May to September) the estuary is typically well mixed, but freshwater inflow from rivers during the wet season can result in salinity-based water column stratification in the arms of the Harbour (Drewry et al 2010).

Surface runoff at the Project area is entirely modified and occurs as sheet flow across gravelled or paved surfaces collected in minor constructed flow channels which drain southwards to the Harbour. There are minor drains in the east, west and south of the Project area. These drainage channels only carry water flow during and immediately after rainfall and do not contain persistent standing water (KBR 2018).

4.4.4 Preliminary Site Investigation

A PSI was undertaken by AECOM in 2020 to ascertain the likelihood for potential human health or environmental risks existing at the site due to legacy contamination from present or historical activities. The PSI undertaken at the site indicated that it is unlikely that significant contamination of soil or groundwater at the site had occurred over its history.

This investigation included a desktop review of available information, site visits and limited targeted soil sampling at surface around the site. Infrastructure and equipment on site with potential to cause contamination (such as fuel storage infrastructure) were identified. Targeted samples were collected and analysed for compounds of potential concern identified during the desktop searches, site visits and interviews.

Due to the nature of the development the PSI focused on the presence or absence of contamination at the surface and did not sample at depth where ground was unlikely to be disturbed during the construction of the Project. The PSI findings indicated that surface soils did not contain contaminants (TRH, BTEXN, TBT and heavy metals) above guideline levels. Based on the available data - including interviews with site knowledgeable staff (AECOM 2021), the potential for contamination at depth is not considered likely to pose an unacceptable risk to users at the site, or nearby ecological receptors.

Further information on the methodology and the findings of the PSI are included in Appendix N: Preliminary Site Investigation.

4.4.5 Unexploded Ordinance

Given the military history of the site, the potential for Unexploded Ordinance (UXO) was also assessed through desktop searches of UXO databases and assessment of previous studies in the area (G-TEK 2017).

Studies commissioned to inform the construction of the adjacent MUBRF channel also covered the Project area, these studies used a magnetometer and dive teams to identify potential UXO artefacts, finding ammunition from 1942 (Cosmos Archaeology 2015).

A 2015 study focused on locating, excavating and analysing ferrous materials in the MUBRF and Project areas to the east and south of the Catalina Ramp. The survey used a magnetometer to identify 52 magnetic anomalies across the area. No larger UXO, such as maritime bombs, torpedoes or mines were found or recovered.

A second Cosmos Archaeology excavation was conducted in September 2015 prior to the construction of the MURBF (Cosmos Archaeology 2017). The study focused on several features recorded during the 2015 magnetometer survey. No UXO was recovered during this survey, most having been removed in the first study.

While these findings do not preclude future finds, it does reduce the risk of finding additional UXO. Construction Contractors will be required to prepare a UXO risk assessment prior to the commencement of works. More information on UXO finds is discussed in Appendix M: Cultural Heritage Assessment and Appendix N: Preliminary Site Investigation. An unexpected finds procedure is included as Appendix B to Appendix M: Cultural Heritage Assessment.

4.4.6 Terrestrial Ecology

For the purpose of this EIS terrestrial ecology refers to the terrestrial habitat above the HAT, with the exception of shorebirds which additionally includes the inter-tidal mudflat zone.

The Project area located above HAT is approximately 4.2 ha and consists of cleared bare and gravelled surfaces with occasional patches of grass and weed species. The Project area also includes approximately 14.6 ha of intertidal habitats, including an isolated stand of remnant mangrove habitat approximately 1.0 ha in area, with the remaining intertidal area being mudflats which become rocky to the east of the site. In the sub-tidal marine area, the Project area consists of bare sandy substrate with occasional encrusting sponges.

Several studies and ecological assessments have been conducted along the East Arm Peninsula and within the surrounding area of Darwin Harbour including assessments for the MUBRF, MSB Santos' Darwin LNG and INPEX Ichthys LNG Plants. Notably, a terrestrial flora and fauna survey was

conducted in the East Arm area as part of the EAW Expansion Project (EMS, 2011). The survey targeted species listed in threatened categories under Commonwealth and NT legislation, as well as migratory/marine bird species listed under Commonwealth legislation that potentially occur in the vicinity of the survey area (EMS 2011).

4.4.6.1 Flora

East Arm peninsula is part of the Darwin Coastal bioregion featuring vegetation communities consistent with this bioregion; primarily lateritised Cretaceous sandstones and siltstones dominated by Darwin stringybark (*E. tetradonta*) and other common canopy species.

Terrestrial vegetation communities recorded in the East Arm area include:

- Monsoon Vine Forest
- Low to Mid High, Mixed Species Open Woodland to Woodland
- Disturbed Areas with Regrowth Monsoon Vine Forests.

(EMS, 2011)

East Arm peninsula is within a planned industrial and port precinct, and, whilst patches of native vegetation are still present, in general much of the area has been disturbed through previous land use and development (Chapter 11: Other Environmental Factors). Within the Project area, minimal native vegetation remains, restricted to fringing vegetation at the mangrove edges.

A search of the DENR's NT Flora atlas in July 2021, and shows that no native, threatened, significant, restricted or introduced terrestrial flora have been recorded within the Project area.

An on-line search of the EPBC Protected Matters Search Tool (PMST) database was carried out using a searchable area which included the Project area plus a 5 km buffer zone on 5 August 2021. Results from the PMST also did not identify any listed threatened flora species or communities within this search area.

A site walkover of the Project area was undertaken by AECOM in September 2020 and identified the remnant mangrove area (approximately 1.0 ha), located along the western edge of the Project area. A mix of wattles, including the Northern black wattle (*Acacia auriculiformis*), and introduced species including Coffee bush (*Leucaena leucocephala*) and Upland cotton (*Gossypium hirsutum*) were found to fringe the landward edge of the mangrove habitat.

The mangrove habitat in the upper intertidal is largely dominated by Grey mangrove (*Avicennia marina*) and Myrtle mangrove (*Osbornia octodonta*). A distinct zonation exists between the upper and lower tidal areas of the mangrove habitat. As the lower tidal area becomes rocky, with significant rock outcrops located to the east, the area becomes characterised by large individual Mangrove apple species (*Sonneratia alba*) with some Stilted mangroves (*Rhizophora stylosa*) scattered throughout the lower intertidal area.

Native vegetation recorded during the survey is outlined below in Table 4-4.

Table 4-4 Native species recorded at the Project area

Species	Common name	Comments
<i>Acacia auriculiformis</i>	Northern Black Wattle	Native species on laydown and edge of mangroves - common
<i>Acacia holosericea</i> – Common	Candelabra Wattle	Transition species
<i>Bauhinia cunninghamii</i>	Butterfly tree	Transition species
<i>Canavalia rosea</i> – Scattered	Coastal Jack Bean	Native species on laydown and edge of mangroves - scattered
<i>Sterculia quadrifida</i>	Peanut Tree	Transition species
<i>Waltheria indica</i>	Waltheria	Native species on laydown and edge of mangroves - scattered

Species	Common name	Comments
Mangrove species		
<i>Avicennia marina</i>	Grey mangrove	Upper intertidal
<i>Lumnitzera racemosa</i>	Red-flowered Black mangrove	Upper intertidal
<i>Osbornia octodonta</i>	Myrtle mangrove	Lower intertidal
<i>Rhizophora stylosa</i>	Stilted mangrove	Lower intertidal
<i>Sonneratia alba</i>	Mangrove apple	Lower intertidal

4.4.6.2 Weeds

Sparse patches of grass and weed species occur at the site (Plate 4.1). The NT weeds database identifies Coffee bush (*Leucaena leucocephala*) and Mission grass (*Cenchrus pedicellatus*) have previously been recorded at the site, with a single instance of Gamba grass (*Andropogon gayanus*) recorded within the Berrimah Road Corridor leading to the entrance of the Project area. Perennial Mission grass and Gamba grass are declared weeds in the NT, with Gamba grass also listed as a Weed of National Significance (WoNS) (KBR, 2018).



Plate 4.1 Cleared site with sporadic patches of grass and weed species

Weeds and introduced species recorded during the site visit in September 2020 are listed in Table 4-5 and Table 4-6 respectively. This table includes their current declaration under the Weeds Management Act 2021 (NTG 2021a).

Table 4-5 Weed species recorded in Project area

Species	Common name	NT declared weeds classification	Comments
<i>Andropogon gayanus</i>	Gamba grass	Class B	1 x tussock
<i>Hyptis suaveolens</i>	Hyptis	Class B	1 x plant
<i>Sida acuta</i>	Spiny head sida	Class B	1 x plant
<i>Sida cordifolia</i>	Flannel weed	Class B	Small patch

Table 4-6 Introduces species recorded in the Project area

Species	Common name	Classification
<i>Cenchrus pedicellatus</i>	Mission grass	Dominant
<i>Chloris barbata</i>	Purple top chloris	Dominant
<i>Tridax procumbens</i>	Tridax daisy	Dominant
<i>Leucaena leucocephala</i>	Coffee bush	Scattered
<i>Gossypium hirsutum</i>	Upland cotton	Small patch on edge of mangroves
<i>Melinis repens</i>	Natal grass	1 x plant
<i>Urochloa mosambicensis</i>	Urochloa grass	1 x plant

4.4.6.3 Fauna

A search of DENR's Fauna Atlas NT, recorded sightings of both the Green turtle (*Chelonia mydas*) and the Flatback turtle (*Natator depressus*) in the Project area neither of which are listed under NT legislation.

The PMST database search and desktop assessment revealed:

- 24 threatened terrestrial species (13 birds, 10 mammals and seven reptiles) listed under the EPBC Act, as potentially occurring within 5 km of the Project area.
- 40 terrestrial migratory species listed under Commonwealth legislation which may occur or may have habitat which occurs within the Project area:
 - Of these 40 species, 34 species are listed as migratory under the EPBC Act all of which are birds.

Threatened species

Thirteen potential threatened bird species were identified from the PMST report. Of these, seven are known to utilise the existing EAW dredge spoil settlement ponds the closest being located approximately 350 m to the north-west of the site and 500 m from construction activities. The location of the EAW settlement Ponds are shown in Figure 2-6.

A study undertaken as part of the EAW Expansion Project identified that some of the EAW settlement ponds provide high tide foraging and roosting sites for birds (EMS 2011). The most significant sightings of threatened and migratory shore birds occurred within dredge disposal settlement Pond D, this is considered the most usable and high value habitat within the East Arm area. It is therefore considered likely that threatened shorebirds may opportunistically visit the small area of intertidal mudflats within the Project area at low tide when moving between more preferred habitats. These comprise:

- Red knot (*Calidris canutus*)
- Curlew sandpiper (*Calidris ferruginea*)
- Great knot (*Calidris tenuirostris*)
- Eastern curlew (*Numenius madagascariensis*)
- Lesser sand plover (*Charadrius mongolus*)
- Greater sand plover (*Charadrius leschenaultia*)
- Nunivak Bar-tailed godwit (*baueri*) (*Limosa lapponica baueri*).

It should be noted that the bar-tailed godwit is also listed as Vulnerable under the TPWC Act.

The Project area does not contain suitable habitat for the remaining six bird species and none of these species has been recorded in the vicinity Project area:

- Red goshawk (*Erythrorhynchus radiatus*)
- Gouldian finch (*Erythrura gouldiae*)
- Grey falcon (*Falco hypoleucos*)
- Partridge pigeon (*Geophaps smithii smithii*)
- Australian Painted Snipe (*Rostratula australis*)
- Masked owl (*Tyto novaehollandiae kimberli*).

Previous studies undertaken as part of the EAW Expansion Project (EMS 2011) and records on the Atlas of Living Australia database (ALA 2020) identified 31 migratory bird species as occurring in the vicinity of the Project area. Seven of these species are also threatened and are listed above. The following 24 migratory (and not threatened) species have been recorded in the vicinity of the Project area.

- Common greenshank (*Tringa nebularia*)
- Terek sandpiper (*Xenus cinereus*)
- Common sandpiper (*Actitis hypoleucos*)
- Gull-billed tern (*Gelochelidon nilotica*)
- Bridled tern (*Onychoprion anaethetus*)
- Eastern osprey (*Pandion haliaetus*)
- White-winged tern (*Chlidonias leucopterus*)
- Little tern (*Sternula albifrons*)
- Red-necked stint (*Calidris ruficollis*)
- Oriental plover (*Charadrius veredus*)
- Pacific golden plover (*Pluvialis fulva*)
- Grey plover (*Pluvialis squatarola*)
- Grey-tailed tattler (*Tringa brevipes*)

- Asian dowitcher (*Limnodromus semipalmatus*)
- Black-tailed godwit (*Limosa limosa*)
- Little curlew (*Numenius minutus*)
- Whimbrel (*Numenius phaeopus*)
- Sharp-tailed sandpiper (*Calidris acuminata*)
- Wood sandpiper (*Tringa glareola*)
- Marsh sandpiper (*Tringa stagnatilis*)
- Ruddy turnstone (*Arenaria interpres*)
- Crested tern (*Thalasseus bergii*)
- Common tern (*Sterna hirundo*)
- Sanderling (*Calidris alba*).

The Wood sandpiper (*Tringa glareola*) and Asian dowitcher (*Limnodromus semipalmatus*) are also listed as Vulnerable under the TPWC Act.

The wider area of East Arm has been cleared for maritime and port industry. With the Project area consisting of gravel and cleared areas colonised by occasional weed species. There is one ha of mangroves present within the Project area. It is considered unlikely that species will frequently utilise the Project area due to its disturbed nature, however other areas within East Arm such as the dredge spoil ponds, in particular Settlement Pond D, are used for foraging and roosting. As such, some species may infrequently visit the intertidal portion of the Project area.

In addition to the dredge ponds there are extensive intertidal mudflats located in the broader East Arm area. It is estimated that within 3 km of the Project area, there is over 800 ha of intertidal mudflats sufficiently separated from areas of industrial activity and traffic to provide suitable habitat for shorebirds during the different tidal phases. Unlike the small, isolated area of intertidal habitat within the Project area these larger intertidal areas provide more suitable foraging and roosting habitat for shorebird species which are not frequently subject to noise, traffic and human disturbances.

As described in the Project description (Section 2.4.2) Settlement Pond D will not be utilised if the EAW spoil disposal ponds are used for placement of dredged material, rather Ponds K and E (North) may receive dredged material with tailwater flowing through these ponds before discharge into Darwin Harbour via Pond E (South) (refer). This same pond flow regime has been used for disposal of dredged material and tailwater treatment for the MSB and MUBRF dredging campaigns.

The shorebird studies and field assessments undertaken as part of the EAW Expansion Project observed very few marine birds or shorebirds foraging or roosting within the foreshore of the Project area (EMS, 2011). These studies noted that during high tides, small numbers of birds were observed to be roosting on saline flats and in mangrove areas along the East Arm peninsula shoreline, however, no large aggregations (> 30 birds) of roosting birds were detected anywhere other than the settlement ponds. It was concluded that the Project area is not a known or potential roost site for threatened or migratory shorebirds (Lilleyman, Lawes and Garnett 2013).

Mammals

A total of 10 potential threatened mammal species were identified from the PMST report. Suitable habitat for 10 of these species does not occur in the Project area. The water mouse (*Xeromys myoides*) is known to occur within intertidal mangroves, however, the closest record of this species was over 90 km from the Project area and the species is unlikely to occur in fragmented mangrove habitat surrounded by industrial activities. The Northern Brushtail Possum (*Trichosurus vulpecula arnhemensis*) occurs mainly in tall eucalypt open forests. However, the subspecies also occurs in some mangrove communities and potentially occurs in the small mangrove stand within Project area.

Reptiles

A total of seven threatened reptile species were identified as potentially occurring within the Project area in the PMST report. Most of these species are marine turtles, of which Green turtle (*Chelonia mydas*), Hawksbill turtle (*Eretmochelys imbricata*), Olive ridley turtle (*Lepidochelys olivacea*) and Flatback turtle (*Natator depressus*) have been recorded within 1 km of the Project area. These species are unlikely to nest in the Project area but may be sighted in Darwin Harbour moving through foraging areas.

The Project area does not contain suitable habitat for the Plains death adder (*Acanthophsis hawkei*), and it is therefore unlikely to occur. Additionally, the Yellow-spotted monitor (*Varanus panoptes*), which is listed as Vulnerable under the TPWC Act and has been recorded within 1 km of the project area, is unlikely to occur due to lack of suitable habitat.

4.4.6.4 Biting insects

The NOI (KBR, 2018) provided an assessment of the prevalence of biting insect in the Project area. The East Arm Peninsula is subject to large numbers of biting insects such as midges and mosquitoes due to the proximity of the mudflat and mangrove breeding sites along Hudson Creek, Bleasers Creek and the peninsula shoreline (Department of Health, 2011) (KBR 2018). Biting insects are discussed further in Chapter 11: Other Environmental Factors.

4.5 People and communities

The Greater Darwin Region is likely to be the key catchment for workers and procurement of services and supplies for the Project. Greater Darwin comprises the three municipalities of:

- Darwin
- Palmerston
- Litchfield.

In the September quarter of 2020, the NT's population of 246,500 accounted for 1 per cent of Australia's population, about 60 per cent of whom live in the Greater Darwin area. According to 2021 Budget papers, the NT's population is expected to increase from 2020-21 as economic activity strengthens, supporting jobs growth and reducing net interstate outflows. In the two years before the December quarter of 2019, the NT reported declining population as the economy normalised after construction of the Ichthys LNG project. The population was static in 2019-20 as growth from natural increase and overseas migration offset net interstate outflows.

Fluctuations in the NT's annual population growth are largely due to variations in interstate migration, which tends to reflect employment opportunities. The NT's population is predicted to grow by about 8,900 people over the five years to 2024-25, increasing by an average of 0.7 per cent a year (NT Treasury and Finance 2021).

True North Strategic Communication has undertaken an assessment impact and benefits of the Project for the people and communities of the Greater Darwin region and their values, to inform the SIA that supports this EIS. The social economic and cultural setting of the Project is discussed further in Chapter 10: Social, Economic and Cultural Surrounds, Appendix C: Social Impact Assessment and Appendix M: Cultural Heritage Assessment.

4.5.1 Darwin

The City of Darwin has the largest population of the three municipalities, with an estimated 82,030 residents in 2020 (ABS 2020). Reflecting its larger population, Darwin has substantially more registered businesses than the other two local government areas in Greater Darwin (7,284 compared with less than 2,000 for both Litchfield and Palmerston) (ABS 2020). Many registered businesses in Darwin are small, with almost two-thirds (63 per cent) non-employing, 33 per cent employing between 1 and 19 people and the remaining 4 per cent employing 20 or more people.

4.5.2 Palmerston

Palmerston is the second largest city in the NT and the fastest growing municipality. Palmerston is a relatively new city, with residential development dating back to 1982. During the 1980s and 1990s the municipality experienced significant growth, with the population more than doubling between 1991 and 2001. Much of this growth was due to Defence personnel moving into the area (.id community 2020). Palmerston has an estimated population of 39,032 (ABS, 2020).

Households in Palmerston tend to be larger, with an average of 2.9 people per household, compared with 2.7 in Greater Darwin. This may reflect the higher proportion of families living in Palmerston.

4.5.3 Litchfield

The Litchfield Local Government Area accounts for 91.8 per cent of Greater Darwin's land, but only a small portion of this land is residential, with a lower population density. Other land uses include conservation, horticultural and pastoral. An estimated 25,566 people lived in Litchfield in 2020 (ABS, 2020).

4.6 Socio-economic environment

The SIA that supports the EIS provides a comprehensive analysis of the socio-economic environment of relevance to the Project (refer Appendix C: Social Impact Assessment). This information is summarised below to describe the socio-economic environment in relation to the NT economy, the maritime industry and the labour force. Further information is also included in Chapter 10: Social, Economic and Cultural Surroundings.

4.6.1 Northern Territory Economy

The NTG is aiming for a \$40 billion economy by 2030 to drive growth and accelerate jobs and population growth (TERC 2020). A proposed \$1.62 billion investment in infrastructure in the 2021 Budget includes enabling economic infrastructure in Darwin, such as the \$400 million Darwin Ship Lift Project at East Arm, and development of a gas-based manufacturing precinct on Middle Arm Peninsula to support downstream processing and manufacturing.

Economic growth in 2021-22 and 2022-23 is forecast to moderate after two years of strong growth and as government stimulus measures are removed. Economic growth is expected to be driven by stronger private and public sector investment, such as the Barossa offshore gas project, new Charles Darwin University campus in the Darwin CBD, this ship lift Project, defence-related works and significant investments in transport infrastructure (NT Treasury and Finance, 2021).

In November 2020, the Territory Economic Reconstruction Commission (TERC) released a report, with recommendations to accelerate an economic rebound post COVID-19. The report identifies mining and manufacturing, tourism, agribusiness and national defence and security as underpinning the Territory's future growth. The TERC report highlights the opportunity to rapidly grow a broader-based regional maritime industry, with more than 7,500 vessels operating within 850 nautical miles in the 12 months to March 2020, and Darwin's potential as a busy naval port. It recommends investing in infrastructure that enables growth, pointing to the importance of strategic infrastructure and development planning.

The TERC report suggests achieving a \$40 billion economy by 2030 will require a sustained average annual gross state product growth of 3.9 per cent, based on the NTG facilitating investment as opposed to actively pursuing investment.

4.6.2 Maritime industry

Australia is heavily reliant on the maritime industry because it has a trade-driven economy which is greatly dependent upon seaborne exports to earn income, and imports for key inputs and consumable items. Australia's 10 million square kilometre marine estate is a significant and growing source of wealth for Australians (AIMS 2020).

The Australian Institute of Marine Science (AIMS) Index of the Marine Industry project, which began in 2008, estimates the output of Australia's 'blue economy' at \$81.2 billion in 2017-18. Marine-based activities employ 34,000 people in Australia and contributed \$62.9 billion of economic value to Australia's economy in 2017-18. Increased offshore natural gas production, naval activities, ship building and repair, and strong growth in international and domestic marine tourism (AIMS, 2020) has driven growth in marine centres in areas such as Cairns, Perth (Henderson) and Adelaide (Osborne).

In the NT, a diverse maritime sector has evolved over generations to service trade, naval activities, offshore oil and gas, fishing, pearling, cruise shipping, coastal barges and tugs. Existing maritime districts in the Darwin region are the Frances Bay Mooring Basin and Hudson Creek industrial estate. Government's long-term vision for Frances Bay is a mixed use waterfront that retains the area's historic character while consolidating most marine activities at the East Arm MIP (Department of Industry, Tourism and Trade, 2021).

The Darwin Port is Australia's northern gateway for trade with Asia and beyond, the terminus of the AustralAsia Railway and a support hub for the offshore oil and gas fields in the region. Darwin is the only natural deep water port in northern Australia and supports international and coastal trade throughout the region.

4.6.3 Labour force

Territory employment is highly cyclical and heavily influenced by investment and construction activity for large, resource-based projects such as the Ichthys LNG project. Significant project-related employment growth is usually followed by a period of declining employment as the economy adjusts. Monthly labour force statistics for the Territory are volatile, with unemployment falling from 7.5 per cent in July 2020 to 5.6 per cent in March 2021.

The labour market is characterised by a substantial public sector, with government and community services accounting for 42 per cent of employment in 2019-20, and a relatively large defence and fly-in fly-out (FIFO) workforce that is not captured in Northern Territory data reported by the Australian Bureau of Statistics (ABS). According to the 2016 Census, there were about 8,700 FIFO workers in the NT (NT Treasury and Finance 2021). Budget papers note that skills shortages in 2020-21 were being experienced in many industries, particularly construction, tourism and agriculture.

The TERC report (2020) identified priority areas to develop the economy, with a goal of creating 35,000 new jobs by 2030. Important industries to achieve this include mining and manufacturing, renewable energy, agribusiness, tourism, defence and maritime and digital and space industries.

4.7 Historic and cultural values

East Arm Peninsula has played a strong role in Darwin's unique history, first as home to Darwin's traditional owners, the Larrakia 'saltwater' people, who have lived, fished and foraged along its shores for centuries. East Arm also has a rich post-settlement history. Historical and cultural values of the area are discussed further in Chapter 10: Economic, Social and Cultural Surrounds

4.7.1 Larrakia connections

Larrakia people retain strong cultural and spiritual connections to Darwin Harbour. Based on observations during AECOM studies for the MIP in 2015, Aboriginal people still frequent the broader East Arm shoreline for traditional hunting and foraging activities and picnics. However, these activities do not occur within the current Project area as the site is currently fenced off from the general public.

A cultural heritage assessment for the EAW Expansion EIS noted that Larrakia people consulted during the archaeological and cultural heritage survey "expressed concern regarding the potential destruction of important ecological habitats for natural resources such as mangroves" (Earthsea 2011).

The Project area is close to two registered Sacred Sites protected under the NT Aboriginal *Sacred Sites Act* 1989. These sites, Catalina Island and Old Man Rock, are both on the AAPA register of sacred sites. An AAPA certificate is current for the Project with conditions including avoiding impacts on the sand bar on the northern end of Catalina Island (see Appendix A to Appendix M: Cultural Heritage Assessment).

4.7.2 Aboriginal heritage

A survey undertaken by to inform the EIS did not record any archaeological sites of Aboriginal origin within the small area of mangroves in the Project area (Appendix M: Cultural Heritage Assessment). A single Aboriginal midden site known as 'East Arm 1' lies approximately 90 m from the eastern boundary of the Project and will not be impacted upon by the construction or operation of the ship lift.

A copy of the archaeological and heritage assessment is included in Appendix M: Cultural Heritage Assessment.

4.7.3 European heritage

The Darwin area is rich in European heritage since the founding of Palmerston and the Port of Darwin 1869 (NTG 2021a). The Project area was originally an island hosting a quarantine station, Quarantine Island, which operated from 1931 until it was largely demolished in the 1990s to develop East Arm Port. A leprosarium was operated from 1955 to 1982 and then demolished to make way for the new railway.

The East Arm Peninsula played a crucial role during World War II when it became a refuelling base and defence headquarters (refer Appendix M: Cultural Heritage Assessment). Defence infrastructure included the strategically significant Catalina FBB, occupied by the Royal Australian Airforce (RAAF) during the war and the Luger Maintenance Section (LMS) 200 m to the East which supported operations in East Asia.

In 1946, most of the military buildings on Quarantine Island were sold by the Commonwealth and the remaining buildings were prepared for hand back to the Quarantine Station service (Dermoudy 1993:1). The LMS slipway and workshop were retained for the servicing of boats used for the Channel Island Leprosarium until 1956. This feature remains until today, along with some of the building foundations of the LMS.

A number of aircraft wreck sites in the general East Arm area include the Catalina 2 (RAAF Catalina A24-69), which is within the proposed boundary, however no works are proposed in this location. The Catalina 3 (RAAF Catalina A24-206) is to the south of Catalina Island, more than a kilometre from the Project area. Other maritime wreck sites to the south of the Project area, include Catalina 4 (United States (US) Navy Patrol Wing 10 28-5MNE) and Catalina 5 and 6 (US Navy Patrol Wing 10 PBY-4). Catalina 1 (RAAF Catalina A24-1) is located over 4 km, to the south-east of the Project.

Most of the FBB has been demolished to make way for industrial development. The surviving FBB features as of 2015 were the Catalina ramp, crash boat slip way, a mooring pile and some fragments of a fuel pipeline.

More detailed information on the European heritage sites in the Project area and surrounds is contained in Appendix M: Cultural Heritage Assessment.

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Chapter 5

Stakeholder Consultation

5.0 Stakeholder Consultation

5.1 Introduction

The NTG has consulted with key stakeholders while completing the Project feasibility studies over the past five years. Further to this, the ToR and initial risk assessments identified the need to undertake an SIA to advise the EIS. In mid-2020 True North was engaged by AECOM, to prepare a SIA and supporting communication and engagement strategy, outlining the proposed approach to consultation for the Project.

The environmental impact assessment process in the NT emphasises the importance of early and meaningful engagement and providing stakeholders with information on projects. Proponents are responsible for stakeholder engagement and consultation throughout the environmental impact assessment process (NT EPA, 2020). Stakeholder consultation by True North to support the EIS is summarised below. A copy of the Stakeholder Consultation Report is included as Appendix B to Appendix C: Social Impact Assessment.

5.2 Objective of engagement

The proponent's approach to stakeholder engagement and consultation must be consistent with the NT EPA stakeholder engagement guidance (NT EPA, 2020). These guidelines (NTEPA, 2021) recognise that stakeholder consultation is an important component of social, cultural and health impact assessments, over and above formal opportunities for feedback on documents placed on public exhibition. The guidance note recommends that proponents adopt the International Association for Public Participation (IAP2) core values as principles for best practice stakeholder engagement. These core values are shown in Figure 5-1.



Figure 5-1 International Association for Public Participation core values (source: True North Strategic Communication)

To support the environmental impact assessment stakeholder engagement was at the level of inform and consult, based on the IAP2 Spectrum of Participation:

- **Inform:** proactive communication about the Project to ensure interested and impacted stakeholders were aware of the Project, the regulatory processes and how they could seek briefings and provide feedback
- **Consult:** proactively contacting stakeholders most likely to have an interest in the Project to seek their insights and perspectives.

Communication objectives were to:

- build awareness of the Project
- provide objective and accurate information so stakeholders could provide informed feedback
- provide a tailored approach to communicating with different stakeholder groups
- build understanding, trust and relationships with individuals or groups likely to be positively or negatively impacted by the Project.

Consultation objectives were to:

- listen to and understand the perspectives of all stakeholder groups
- ensure concerned groups have a chance to provide early input
- manage stakeholder expectations
- provide early identification of potential issues or concerns that may contribute to better Project outcomes, avoid mistakes or mitigate negative impacts
- support delivery of a Project that is environmentally, economically, culturally and socially acceptable to the community and key stakeholders
- provide regulators with confidence that all positive and negative impacts are well understood and can be managed through all phases of the Project
- provide guidance for the Project proponent's long-term social performance.

5.3 Consultation methodology

Initial stakeholder mapping identified key stakeholders who may be impacted by the Project or who were likely to have an interest in, or influence on the future of the Project. The engagement strategy was then developed commensurate with stakeholders' predicted level of concern or sensitivity to impacts.

In general, a low-key, targeted approach to communication and engagement was considered appropriate. This is because:

- There has been significant communication and consultation on industrial development in the region already, including the EAW Expansion, MSB, the MUBRF and aspects of the adjacent MIP.
- The Project has a relatively small footprint and is in an industrial area that has seen significant development in recent years.
- There has been substantial communication about the Project in the form of media releases, media coverage and direct business communication by the NTG and Industry Capability Network (ICN).

Preliminary analysis suggested that the key issues of interest to stakeholders would be the economic benefits of the Project, reflecting the NTG's economic reconstruction agenda, as well as potential cumulative impacts on Darwin Harbour and cultural heritage. This aligned with the ToR for the EIS.

5.3.1 Consultation with Aboriginal custodians

In 2018, as part of the application process for an Authority Certificate from the AAPA, the NTG met with Aboriginal Custodians with the then Project Proponent, NSS. This engagement was arranged through AAPA and resulted in the issuing of an Authority Certificate in 2019 and conditions for construction of the project.

No major concerns were raised by Custodians during this consultation, with hydrodynamic modelling suggesting there would be no significant impacts on Catalina Island, a sacred site. The NTG agreed to provide updated modelling, resulting from the final design, to Custodians to allay any concerns of construction impacting on Catalina Island.

5.3.2 Early works dredging

On 3 November 2020, the NTG announced plans to submit an early works dredging application with the Development Consent Authority. Stakeholders were emailed a fact sheet, which included an outline of how they could provide feedback (Appendix C: Social Impact Assessment, Appendix A). The fact sheet was posted on the ship lift project's website. The NT Government briefed the Darwin Harbour Advisory Committee in December 2020.

There were no public submissions and three from NTG departments (the Transport and Civil Services Division of DIPL, PowerWater Corporation and Medical Entomology).

- Transport and Civil Services indicated that traffic and material transport proposal should be subject to review and approval by the Division. Traffic and material transport are discussed in Chapter 2: Project Description and Appendix L: Traffic Impact Assessment.
- PowerWater had no concerns but advised that the developer should consider the use for non-potable water for non-domestic water use. Efficiency principles will be applied to manage water use. These are discussed in Chapter 2: Project Description, Section 2.2.18.
- Medical Entomology raised concerns regarding the creation of potential mosquito breeding sites. These are discussed in Chapter 11: Other Environmental Factors, Section 11.4.

The Development Application was subsequently withdrawn when it was agreed with the NT EPA not to proceed with the early works dredging and that all impact associated with the Project be as part of the EIS.

5.3.3 Consultation as part of Environmental Impact Statement development

A second NTG fact sheet was emailed to stakeholders on 26 July 2021 outlining the Project, environmental studies and opportunities to provide feedback (refer Appendix A to Appendix C: Social Impact Assessment). Recipients were primarily government departments, Members of Parliament and the leaders of various industry, heritage and community groups.

The fact sheet was posted on the NTG's ship lift website, which has been maintained since the NTG became the proponent for the Project in 2019 (<https://cmc.nt.gov.au/advancing-industry/ship-lift>).

A total of 53 stakeholders were emailed fact sheets, 21 of which were advised that they would be contacted by True North and targeted for an interview. These stakeholders had been identified as those most likely to have an active interest in the Project. The interviews took place over a three-week period from 6 to 27 August 2021.

Of the remaining 32 stakeholders emailed the fact sheet, none responded, sought further information or requested a briefing. No feedback was received on the inquiries email address promoted in the fact sheet and on the NTG website.

For face-to-face interviews, True North was accompanied by members of the NTG ship lift team, who provided a Project briefing and answered stakeholder questions. True North then asked specific questions about awareness, specialist insights or perceptions of the Project.

Interviews of varying depth were conducted with:

- Amateur Fishermen's Association of the Northern Territory (AFANT)
- Chamber of Commerce, Marine Industry Council
- City of Darwin
- Darwin Port
- Department of Industry, Tourism and Trade (regarding the Marine Industry Development Plan)
- Industry Capability Network (ICN)
- Land Development Corporation
- Larrakia Development Corporation
- Litchfield Council

- Master Builders Association of the Northern Territory (MBANT)
- Paspaley Group
- Planning Action Network (PLan).

In addition to a scheduled meeting, the PLan provided a written submission. Comments from the submission are incorporated in the summary of issues raised at Section 3 of the Stakeholder Consultation Report in Appendix C: Social Impact Assessment.

5.3.4 Additional consultation by the ship lift team

Planning for the Project has been guided by a Project control group. Additional consultation undertaken by this team has included:

- a briefing of the NT EPA by members of the NTG ship lift team and AECOM on 21 June 2021, with follow-up meetings planned
- establishment of an inter-agency working group
- consultation with the Heritage Branch of the NTG
- consultation with the DHAC sub-group to discuss a Darwin Harbour Dredging Strategy
- meetings with the Transport section of DIPL and Darwin Harbour Infrastructure Projects Working Group
- meeting with Darwin Port, about the use of the port's spoil ponds and property boundaries along Berrimah Road.

5.4 Major themes of consultation process

The main issues raised were the long-term economic benefits of the Project as enabling infrastructure, the economic and labour force benefits and the strategic nature of the Project. Industry sought earlier and greater involvement in the design process to ensure that the ship lift facility would meet the needs of the entire industry. As designs are at concept level there is opportunity for industry to be involved in the refinement of designs. The marine industry also expressed a need for greater certainty on pricing and need for visible acceptance by foundation customers to give smaller players the confidence to relocate and invest in business growth. Pricing legislation is currently being developed by the NTG.

From a social and cultural perspective, the Project was seen as invoking limited change processes. No stakeholders raised topics such as social infrastructure or impacts on community cohesion and wellbeing. Environmental, social and cultural issues were confined to questions regarding the management of wastewater, potential sedimentation impacts on Catalina Island (a sacred site) and the progressive loss of Darwin's World War II heritage and history. Several stakeholders commented that their concerns related more broadly to the cumulative impacts of dredging and industrialisation of the harbour.

A summary of stakeholder feedback, NTG responses and where they are addressed in the EIS is included in Table 5-1. The Consultation Report provided as Appendix C: Social Impact Assessment, Appendix B provides a more detailed description of stakeholders consulted, issues raised, responses provided and where these are addressed in the EIS

Stakeholders will have a further chance to provide formal feedback to the NT EPA once the EIS is on public exhibition in Q4 2021.

Table 5-1 Summary of stakeholder feedback for the Project

Element	Issue raised	Response	Addressed in EIS
Building capacity	There was widespread agreement that the Project would contribute to the capacity of the NT's maritime industry. The larger, more modern ship lift will be a strategic asset that can accommodate more vessels. This should be attractive to time-sensitive fleets such as oil and gas, naval and Border Force vessels, saving up to 10 days' sailing time for emergency repairs. COVID19 and the current geopolitical environment make Darwin more attractive. Stakeholders were pleased to note that the ship lift facility would provide common user infrastructure. The ship lift will double the capacity of the current two largest ship lifts at Frances Bay and Coonawarra, both of which are aged and due for decommissioning.	Consistent with NTG economic growth objectives. The DITT (DITT, 2021) is coordinating a Maritime Industry Development Plan for the NT, as a recommendation of the Territory Economic Reconstruction Commission (TERC) to build capacity and workforce development. The Land Development Corporation is working on a master plan for the Marine Industry Park. Industry involvement in the refinement of facility designs.	Section 10.7.2 and 10.8 Appendix C: Social Impact Assessment, Section 5.6 Appendix C to Appendix C: Social Impact Assessment, Section 5
Economic benefits	The main issues raised were: - the long-term economic benefits of the ship lift as enabling infrastructure - stakeholders supported the government investment, given that enabling economic infrastructure is not always commercial in its own right - the incremental growth of economic and labour force benefits, including longer-term growth of the marine industry sector - the strategic nature of the Project - Darwin Port is likely to benefit from increased imports of Project materials.	As above	Section 10.7.2 and 10.8 Appendix C: Social Impact Assessment, Section 5.6 Appendix C to Appendix C: Social Impact Assessment, Section 5
Reservations	Some reservations expressed included: - poor engagement in the design process, concerns about whether the ship lift facility would meet the needs of the entire industry - a need for greater certainty on pricing - need for visible acceptance by foundation customers to give smaller players the confidence to relocate and invest in business growth.	Work by the NTG to grow the sector and work collaboratively with industry, e.g. the Maritime Industry Development Plan. Industry involvement in the refinement of facility designs.	Section 10.7.2 and 10.8 Appendix C: Social Impact Assessment, Section 5.6 Appendix C to Appendix C: Social Impact Assessment, Section 5
Social infrastructure	No stakeholders raised concerns about social infrastructure or impacts on community cohesion and wellbeing.	The TIA and SIMP includes commitments that traffic management plan (TMP)	Section 10.7.5 and 10.8

Element	Issue raised	Response	Addressed in EIS
	Darwin Port felt extra construction traffic shouldn't cause problems for the port. There is already significant industrial traffic along Berrimah Road and the capacity to accommodate more.	will be prepared and implemented for both the construction and operational phases of the Project. These plans include commitments to communicate with other road users about peak transport requirements, e.g. haulage of equipment and materials.	Appendix L: Traffic Impact Assessment, Section 11 Appendix C: Social Impact Assessment, Section 8.5
Indigenous and European culture	Cultural issues raised included: - the potential sedimentation impacts on Catalina Island (a sacred site) - the progressive loss of cultural sites and Darwin's World War II heritage and history. There are no shell middens in the Project footprint.	Modelling suggests sedimentation risks are low. An approved DDSPMP will be developed prior to works. It is proposed that interpretive signage highlighting World War II historical remnants be placed in a public place	Section 10.7.3 Section 10.8 Appendix M: Cultural Heritage Assessment, 10.1.5 Appendix C: Social Impact Assessment, Section 6.5
Labour force	While the Project will provide some immediate construction jobs, stakeholders felt the key benefits of the Project would be a longer-term growth in the marine industry sector, supporting employment and a broader range of trade training in the NT. Particular skills shortages in Darwin include marine engineers and vessel masters and skilled, experienced vessel crews. For repairs and maintenance, it is hard to attract people in all fields due to competition with other industries.	This will be addressed through the proponents Australian Industry Participation Plan, a Territory Benefit Plan to be prepared by the design and Construction Contractor and work by the Maritime Industry Development Plan (DITT, 2021), including workforce development and skills planning for the local labour market. Good communication will be provided on jobs available on the project.	Section 10.8 Appendix C to Appendix C: Social Impact Assessment, Section 5.6
Aboriginal participation	Concern was raised that commitments to Aboriginal participation may not translate to real benefits, without measures by the NTG to enforce accountability for these commitments.	There will be requirements for local and Indigenous employment in the construction contract and as part of the NAIF agreement. Short-listed proponents will need to prepare a Territory Benefit Plan to show how they will meet Government and stakeholder expectations of local participation. DIPL will do regular compliance audits.	Section 10.8 Appendix C to Appendix C: Social Impact Assessment, Section 5.6
Local business participation	Darwin's construction industry has strong experience of major projects. The industry is currently working at less than	ICN capability mapping will highlight local capacity and help address any gaps.	Section 10.8 Appendix C: Social Impact

Element	Issue raised	Response	Addressed in EIS
	full capacity. The land-based nature of the work should suit the local civil industry which has experience of large projects such as the: - Larrakeyah/Coonawarra, RAAF Darwin and Tindal, Robertson Barracks and other defence work - NT industries tend to work across sectors, rather than specialise in just one.	ICN will brief industry to enhance the preparedness of local businesses to win work and manage expectations. DIPL will do regular compliance audits.	Assessment, Section 5.5 Appendix C to Appendix C: Social Impact Assessment, Section 5,
Recreation and amenity	Concerns were raised regarding: maintaining the harbour's recreational and tourist values reduced access to the harbour and creeks from construction and dredging activities.	Commitments to ensure good communication with other harbour users, including recreational fishing/boating community before the start of marine works and during the design and construction phase to advise of operations and safety requirements, for example, Harbour Master's Notices and advice to AFANT.	Section 10.8 Appendix C to Appendix C: Social Impact Assessment, Section 4.2
Environmental disturbance	There was concern about: - the Project footprint and impacts on mangroves from reclamation - properly managing water quality, run-off sediment, and waste - biosecurity, though it was noted the facility will further promote biosecurity management - protecting marine animals such as dolphins, dugong and their feeding grounds.	Environmental management requirements will be incorporated into facility design. The EMF includes mitigation measures to address key environmental factors identified in the ToR. The design and construct contractor will be required to have a certified EMS and prepare a CEMP prior to commencing works on site. The operator will also be required to prepare an OEMP. The EMF will be supported by Stormwater Management Plans, Biosecurity Management Plans and the DDSPMP.	Section 2.2.17 (biosecurity) Section 11.2.3 mangroves Section 7.8.3, 7.9, 11.1.4, 11.3.4 (runoff, sediment and waste) Section 8.7 and 8.8 (marine mammals) Chapter 2: Project Description Chapter 13: Environmental Management Framework
Cumulative impact on the harbour	Some stakeholders are concerned at the cumulative impacts of dredging in Darwin Harbour, including for proposed developments on the Middle Arm Peninsula. Stakeholders also commented that the Project is in an industrial precinct, next to a working port. They saw dredging and construction of the ship lift as having short-term, localised impacts	DIPL has convened a Darwin Harbour dredging working party to look at the cumulative impacts of dredging. Dredge operators will be required to prepare and approved DDSPMP prior to the commencement of dredging programs.	Section 10.7.5, 12.3, 12.4 and 12.6. Appendix C: Social Impact Assessment, Section 10

5.5 Consultation during the public review process

The Draft EIS will be subject to public review period of 6 weeks. During this time, the Project will undergo further scrutiny by regulators and the community.

The NTG will continue to consult during the public review period. The program will include the following actions:

- maintenance of the Project website (<https://cmc.nt.gov.au/advancing-industry/ship-lift>) to keep the community up-to-date on progress of the Project
- provide information to stakeholders when requested, including providing responses directly to the stakeholders who asked questions during earlier consultations.

5.6 Future consultation with stakeholders

NTG commits to an ongoing engagement and communication strategy for construction and operation of the Project and broader marine industry precinct, including coordinated messaging. Project information will continue to be posted on the Project website (<https://cmc.nt.gov.au/advancing-industry/ship-lift>).

Other actions suggested in the SIMP (Appendix C: Social Impact Assessment, Appendix C) include:

- provide regular progress updates to the local communities and stakeholders on progress of the Project and timeframes
- announcements about key local/major contracts to be awarded
- work with NTG, ICN and Chamber of Commerce to communicate opportunities and package and promote tenders to suit local capacity
- communicate any work or contract opportunities to stakeholder groups.

DIPL will develop and implement a proactive communications and engagement plan for design and construction with input from the Construction Contractor where required. This plan will provide community updates on Project activities, particularly those likely to be disruptive (significant traffic movements, piling, dredging, reduced access or safety issues for recreational fishing). DIPL will maintain a public hotline and complaints register, and DIPL and the Contractor will work together to manage and resolve any complaints and their resolution.

DIPL will be responsible for overseeing the complaints management procedure to:

- ensure that all complaints or issues are investigated
- respond to the complainants
- amend procedures if necessary
- provide feedback on how any incident was resolved
- document complaints and how they were resolved in Annual Reports.

Further information on the stakeholder consultation can be found in Appendix C: Social Impact Assessment.

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Chapter 6

Assessment

Methodology

6.0 Assessment Methodology

This chapter describes the process by which potential risks and benefits of the Project were identified in accordance with the ToR and the guidelines for *Preparing an Environmental Impact Statement* (NT EPA 2020a). The methodology was designed to provide a structured and objective approach to identifying environmental, social and economic risks and benefits and identify appropriate mitigation measures, with these informing the proposed environmental management framework to ensure residual risks are mitigated or reduced to as low as practically possible.

Development of the Project design has been ongoing since 2015 and considered a number of alternatives to arrive at the current Project (concept design). Alternatives considered in parallel and as a result of the EIS process are discussed separately in Chapter 2 Project Description (Section 2.8).

This draft EIS contains information based on the understanding of the concept design and the proposed construction methodologies at the time of writing, noting that the design and construction methodologies will be subject to further refinement as detailed design is progressed.

It is noted that at the time of release of the ToR the 2019 *General Guidance for Proponents Preparing an Environmental Impact Statement* (NT EPA, 2019c) document was the current NT EPA guideline for preparing an EIS. This document has been subsequently superseded by the 2020 guideline for *Preparing an Environmental Impact Statement* (NT EPA, 2020a). Although the ToR refers to the 2019 guideline for preparing this EIS, wherever possible, the 2020 guidelines have been incorporated into this assessment methodology.

6.1 Summary of approach

The objective of this document is to inform the NT EPA, NT government authorities, stakeholders and the public about the potentially significant environmental, social and economic impacts of the proposed action, and the measures proposed by the proponent to avoid, mitigate and/or offset those impacts.

The ToR focuses on four key preliminary environmental factors identified by the NT EPA (marine environmental quality, marine flora and fauna, air quality and greenhouse gases, and social, economic and cultural surroundings) (refer Chapters 7 to 10). Other potential impacts have been identified through stakeholder consultation and environmental impact assessment process (refer Chapter 11: Other Environmental Factors).

Factors are assessed in terms of the NT EPA objectives and described in terms of connections and interactions between environmental factors where appropriate. Cumulative impacts from other projects located within proximity to the Project and/or have the potential to interact spatially and temporarily, have also been considered for each of the key environmental factors as per the requirements of the ToR (refer Section 6.5).

Risks have been assessed both pre and post-mitigation to identify residual impacts that may persist following the implementation of mitigation and management measures. Mitigation measures may include the scoping and implementation of:

- further technical investigations and field work, for example post-dredging bathymetry surveys, soil contamination investigations or UXO assessments
- engineering solutions within detailed designs
- construction methodologies
- management plans for example an overarching environmental management plan (OEMP) including Erosion and Sediment Control Plans (ESCP) and Biosecurity Management Plan.

Management plans include requirements to monitor and report on potential impacts against performance criteria. The results of monitoring and reporting measures will be reviewed to identify where improvements to management practices can be made.

6.2 Environmental factors and objectives

The NT EPA has identified key environmental factors and corresponding objectives to improve certainty and increase transparency within the environmental impact assessment process (NT EPA, 2018b).

Environmental factors are those parts of the environment that may be impacted by an aspect of a proposal. There are 13 key environmental factors categorised under five major themes of: Land, Water, Sea, Air and People and Communities.

Each key factor has a corresponding environmental objective. These factors and objectives are targeted to:

- ensure the intent of the EA Act is achieved
- provide a systematic approach to organising environmental information for the purpose of environmental impact assessment
- establish clear benchmarks based on values
- apply to all proposals considered
- facilitate consistent assessment and reporting.

The objectives are used by the NT EPA to judge whether the environmental impact of a proposal may be significant.

6.2.1 Preliminary key environmental factors

The NT EPA identified four preliminary key environmental factors that could be significantly impacted by the project:

- marine environmental quality
- marine flora and fauna
- air quality and greenhouse gases
- social economic and cultural surroundings.

Table 6-1 Preliminary key environmental factors

Theme	Key environmental factor	Objective
Sea	Marine environmental quality	Maintain the quality and productivity of water sediment and biota so that environmental values are protected
	Marine flora and fauna	Protect marine flora and fauna so that biological diversity and ecological integrity are maintained
Air	Air quality and greenhouse gas	Maintain air quality and minimise emissions and their impact so that environmental values are protected
People and communities	Social, economic and cultural surrounding	Protect the rich social, economic, cultural and heritage values of the NT

(NTEPA, 2019)

6.2.2 Assessment of preliminary key environmental factors

As per the guidelines for *Preparing an Environmental Impact Statement* (NT EPA, 2020a), each of the preliminary key environmental factors identified in the ToR are discussed in terms of:

1. Name of environmental factor – e.g. Marine environmental quality
2. Objective for environmental factor – e.g. Maintain the quality and productivity of water, sediment and biota so that environmental values are protected

3. Policy and guidance - Relevant policy and guidance for issues relating to this factor, as relevant to the Project
4. Environmental values:
 - Existing environment and environmental values relevant to this factor that would potentially be impacted by the implementation of the Project and references to the sources of information used
 - Reference to relevant surveys, studies, standards and guidelines where appropriate. Where appropriate maps have been included showing both the local and regional context as well as the disturbance footprint (direct impacts) and zone of influence (indirect and cumulative impacts).
 - Specific environmental value may be relevant to more than one factor and where relevant these linkages are discussed, and cross-references are made within the EIS.
5. Assessment of potentially significant environmental and social impacts:
 - Identification, description and evaluation of the significance of potential direct, indirect and cumulative impacts and risks on environmental and social values, under each of the relevant factors.
 - Potential impacts and risks are discussed for both construction and operational phases of the Project with consideration of the extent, magnitude and duration; the resilience of the environment to cope with impact or change; and any potential cumulative impacts. Where relevant, impacts of other proposals or activities to the environmental and social value are also evaluated.
 - Assessment methodologies used to assess each environmental factor are discussed further in the corresponding key environmental factor chapters (refer Chapters 7 – 10). These methodologies are summarised in Table 6-2 below.
 - Impacts are both pre and post-mitigation to arrive at an assessment of residual impacts (refer Section 6.3).
 - Wherever possible, benefits arising from the Project are identified and quantified.
 - The risk assessment methodology is discussed further in Section 6.3 and Appendix D: Risk Assessment.
6. Avoidance and mitigation:
 - Avoidance, mitigation and offset measures that can be implemented to manage the potentially significant environmental and social impacts of the Project and ensure the environmental objective is highly likely to be met are documented in Chapters 7 to 10 and Chapter 13: Environmental Management Framework.
 - Where possible measures are:
 - specific and enforceable, but also targeted to allow for the development of specific supporting procedures by contractors when the detailed designs and construction methodologies are defined
 - based on accepted best industry practice.
7. Monitoring and reporting:
 - Measures include monitoring and reporting on potential impacts and risks to the environment
 - Wherever possible performance criteria have been defined in order to continually improve environmental management techniques.

8. Predicted outcomes:

- Residual impacts and predicted outcomes are discussed in relation to the objectives defined by the EPA for each of the key environmental factors
- Where it is considered likely that there would be significant residual impacts, a description is included on how these residual impacts would be offset and how any proposed offset would compensate for the impact.

6.2.3 Other environmental factors

Other potential environmental impacts identified through the stakeholder consultation and environmental impact assessment process are discussed in Chapter 11: Other Environmental Factors. These factors include:

- terrestrial environmental quality
- terrestrial flora and fauna
- inland waters and hydrological processes
- human health.

These factors are also considered, to a lesser degree, in terms of existing values, potential impacts, connections and interactions (including cumulative impacts) between the environmental factors identified in Section 6.2.1, proposed mitigation and monitoring measures. An assessment of risks and a statement of residual risk is also included for these factors.

6.3 Significance assessment

The draft EIS must evaluate whether an impact is likely to have a significant impact, as defined under Section 11 of the EP Act. That is, an impact of major consequence having regard to the context and intensity of the impact, and the sensitivity, value and quality of the environment impacted on and the duration, magnitude and geographic extent of the impact. To assess significant impacts a semi-quantitative risk assessment methodology was selected for the Project using a risk and likelihood matrix. The assessment considered impacts both pre and post mitigations to understand the residual impacts following the implementation of management measures.

The risk assessment process included:

- preliminary risk identification process
- risk assessment workshop
- risk review and refinement process.

(NT EPA, 2020a)

The risk assessment process and summary tables are described further in Appendix D: Risk Assessment.

6.3.1 Preliminary risk identification process

A desktop review and gaps analysis was undertaken to identify the key potential impacts of the Project to the wider environment and key stakeholders at a high level. The purpose of the preliminary risk identification process was to identify at an early stage those aspects of the Project, which, if unmanaged, have the potential to adversely impact the environment.

This process was documented through a risk register for consideration by the Project team and subsequent calibration through a risk assessment workshop.

6.3.2 Risk assessment workshop

Based on the findings of the preliminary risk identification a risk assessment workshop was conducted to confirm risks documented in the draft risk register were appropriate and that proposed mitigation measures were achievable. As noted above, risks were assessed pre and post-mitigations to ensure

that proposed mitigation measures were sufficient to reduce or eliminate risk where practically possible.

The risk assessment methodology for the Project is based on the ISO/Australia and New Zealand Standard for Risk Management (ISO 31000:2009) framework. This methodology is widely used and has been successfully utilised in the preparation of other EISs within the NT. The methodology allows for:

- identification, documentation and comparison of impacts across the Project
- mitigation measures to be developed and risks to subsequently be re-evaluated
- for the nature of the risks to be understood in terms of their likely timing, extent, and potential impact to assets.

The risk assessment methodology is documented in Appendix D: Risk Assessment.

6.3.3 Risk review and refinement process

Subject matter specialists reviewed and updated the draft risk assessment register and scoring as technical studies and stakeholder consultations were completed, and the Project design and management measures were refined. As part of the specialist review, separate assessments were conducted by a social and economic specialist to further assess the potential risks posed by the Project. The methodology of these assessments can be found in Appendix C: Social Impact Assessment. An iterative approach was then taken to ensure that the mitigation and management measures were appropriate to achieve an acceptable level of residual risk. The finalised risk register is included in Appendix D.

Proposed avoidance and mitigation measures that were used to determine residual risk, as well as supporting monitoring programs for each of the environmental factors assessed as part of this EIS, are presented in Chapter 13: Environmental Management Framework.

6.4 Technical studies

A number of technical studies were undertaken to inform the EIS in accordance with the approved ToR. Study methodologies comprised a mix of desktop reviews, fieldwork (site visits/surveys, sample collection and subsequent laboratory analysis and assessment), remote sensing, modelling and consultation.

Study methodologies utilised to assess impacts are summarised in Table 6-2. The outputs of these technical studies informed the impact assessments for each of the environmental factors presented within Chapters 7 through 11. Detailed methodologies for each technical study are presented within the referenced EIS appendix or environmental factor chapter.

Table 6-2 Technical Study methodologies

NT EPA Factor	Methodology	Methodology Reference
Marine environmental quality	• Desktop review of available information • Marine water quality sampling events (Appendix E: Water Quality technical Reports) • Marine sediment sampling and modelling (Appendix I: Sediment Transport and Modelling Technical Report) • Benthic habitat modelling and ground truthing (Appendix F: Benthic Habitats Modelling Technical Report) • Turbidity assessment using remote sensing (Appendix H: Marine Sediment Geochemical Assessment Report).	• Chapter 7: Marine Environmental Quality, Section 7.5 • Appendix E: Water Quality Technical Reports, Section 2 • Appendix F: Benthic Habitats Technical Report, Section 3 • Appendix H Marine Sediment Geochemical Assessment Report, Section 3 to 7 • Appendix I: Sediment Transport Modelling Technical Report, Section 2.

NT EPA Factor	Methodology	Methodology Reference
Marine ecology	- Desktop review of available information (Chapter 8: Marine Flora & Fauna) - Site visit to document extent of existing mangrove community (Chapter 8: Marine Flora and Fauna) - Underwater noise modelling (Appendix G: Underwater Noise Technical Report)	- Chapter 8: Marine Flora & Fauna, Section 8.5 - Appendix G: Underwater Noise Technical Report, Section 5
Air quality and greenhouse gases	- Desktop review based on available information (Appendix J: Air Quality and Greenhouse Gas Assessment) - Air emissions modelling (Appendix K: Air Quality and Greenhouse Gas Assessment) - Emission estimation and calculations (Appendix J: Air Quality and Greenhouse Gas Assessment).	- Chapter 9: Air Quality and Greenhouse Gases, Section 9.5 - Appendix J: Air Quality and Greenhouse Gas Assessment, Section 4.
Social, cultural and economics	- Desktop review of available information (Appendix C: Social Impact Assessment) - Social impact assessment scoping exercise (Appendix C: Social Impact Assessment) - Social impact assessment (Appendix C: Social Impact Assessment) - Stakeholder consultation (Chapter 5: Stakeholder Consultation, Appendix C: Social Impact Assessment) - Site visit to document existing cultural heritage values (Appendix M: Cultural Heritage Assessment) - Terrestrial noise modelling and compliance assessment against relevant noise standards (Appendix K: Terrestrial Noise Impact Technical Report).	- Chapter 5: Stakeholder Consultation - Chapter 10: Social, Economic and Cultural Surrounding, Section 10.5 - Appendix C: Social Impact Assessment, Section 1.4 and 1.5 and Appendices 1 and 2 - Appendix K: Terrestrial Noise Impact Technical Report, Section 2 - Appendix L: Traffic Impact Assessment, Section 3 - Appendix M: Cultural Heritage Assessment, Section 5.
Terrestrial environmental quality	- Desktop review of available information (Appendix N: Preliminary Site Investigation) - PSI and soil sampling (Appendix N: Preliminary Site Investigation).	- Chapter 11: Other Environmental Factors, Section 11.1 - Appendix N: Preliminary Site Investigation, Section 4.
Terrestrial flora and fauna	- Desktop review of available information (Chapter 11: Other Environmental Factors) - Site visit to document existing native and introduced vegetation species (Chapter 11: Other Environmental Factors).	Chapter 11: Other Environmental Factors, Section 11.2.
Inland water and hydrological processes	Desktop review of available information (Chapter 11: Other Environmental Factors).	Chapter 11: Other Environmental Factors, Section 11.3.
Human health	Desktop review of available information (Chapter 11: Other Environmental Factors).	Chapter 11: Other Environmental Factors, Section 11.4.

6.5 Cumulative impacts

The NT EPA EIS Guidelines state that the proponent should consider the overall cumulative potential impact of the project in the context of existing developments and reasonably foreseeable future developments. Existing developments have been incorporated into Chapter 4: Environmental Setting and the environmental values section of the preliminary key environmental factors chapters (Chapters 7 to 10). The methodology for assessing potential impacts from future developments is discussed below.

The potential impacts of an individual project considered in isolation may not reflect the full extent of impacts to environmental, social and economic receptors. By considering Project impacts in the context of cumulative impacts from other projects a more comprehensive impact assessment can be undertaken. Impacts can be positive or negative and differ in severity and/or duration depending on the spatial and temporal overlap of projects. Cumulative impacts can accumulate over time and exacerbate the intensity, scale, frequency or duration of impacts in isolation or in combination with other known existing or planned projects.

For the purpose of this assessment, the area over which cumulative impacts are considered is defined as the zone of influence, which is determined by the specific nature of the environmental aspect being assessed.

The cumulative impact assessment includes consideration of:

- projects that have commenced construction
- projects that have been approved but construction has not commenced
- projects that are currently being assessed.

As stated above, existing projects are not included in the cumulative impact assessment as they are assessed as part of the existing environmental values.

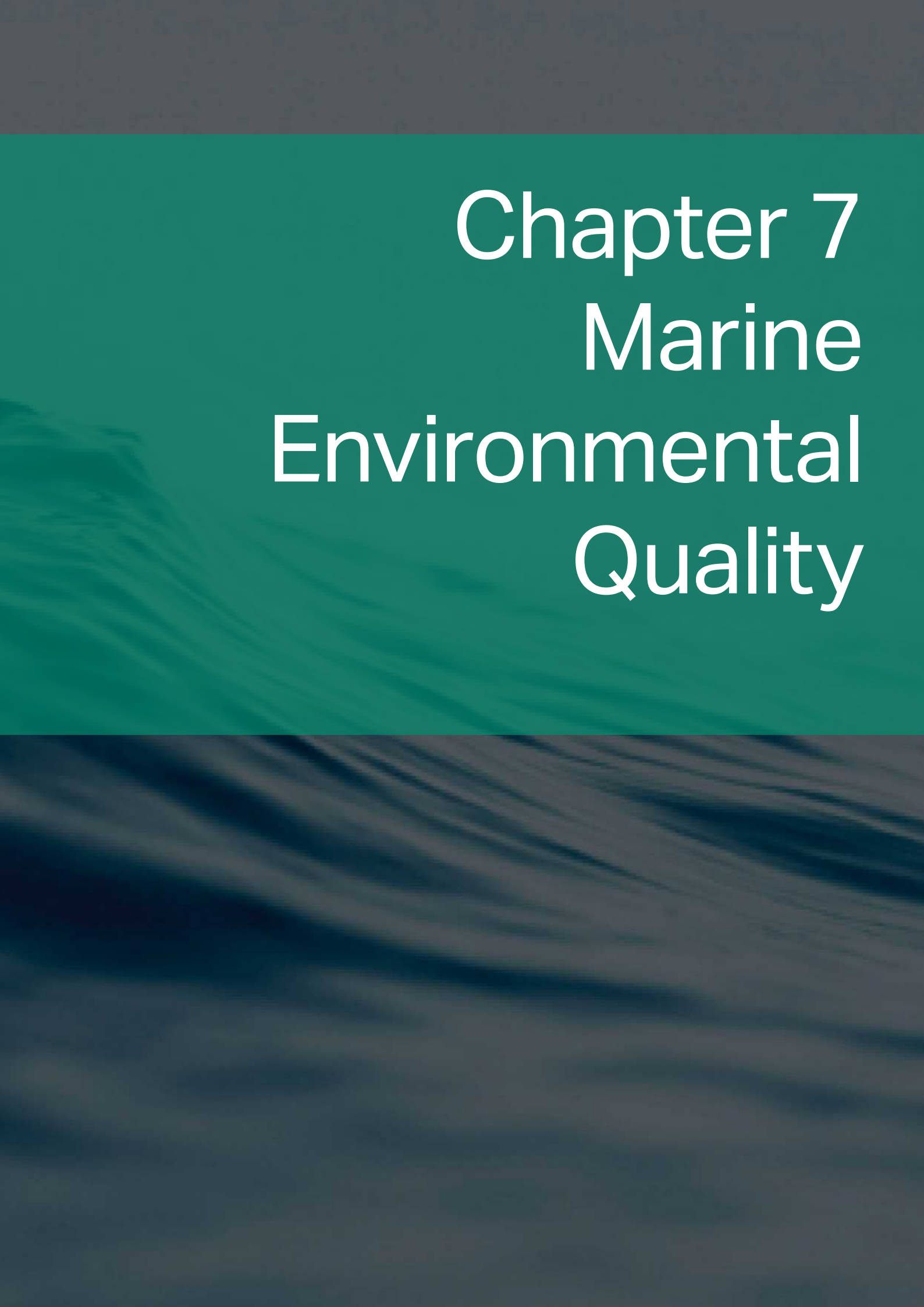
Given the Project's relatively short development timeframe the cumulative impact assessment excludes proposed projects that have not been developed to the point that their environmental assessment process has been made public.

A register of relevant projects is provided below and considers potential spatial and temporal interaction. Where a potential overlap in impacts (either spatially or temporally) was identified then cumulative impacts were considered within technical investigations to determine the nature of the cumulative impact.

Potential cumulative impacts are discussed in terms of each of the preliminary key environmental factors considered in this assessment:

- marine environmental quality
- marine flora and fauna
- air quality and greenhouse gases
- social economic and cultural surroundings.

Projects potentially contributing to cumulative impacts are described in Chapter 12: Cumulative Impacts.

The background of the slide features a close-up, high-contrast image of ocean waves. The top half of the image is a solid teal color, while the bottom half shows the dark, textured surface of the water with white foam from the waves. The text is positioned in the upper right quadrant, overlaid on the teal section.

Chapter 7

Marine Environmental Quality

7.0 Marine Environmental Quality

7.1 Introduction

The ToR identifies marine environmental quality as a key environmental factor that could be significantly impacted by the Project. The objective associated with this factor is to:

“Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.”

The relevant ToR requirements for marine environmental quality are summarised in Table 7-1. Compliance of the EIS against the full ToR is documented in Appendix A: Terms of Reference.

Table 7-1 ToR compliance table for marine environmental quality

ID	Terms of reference requirements	EIS section number
1.0 Environmental values		
1.1	Describe the environmental values with respect to marine environmental quality of the Proposal area and Darwin Harbour. Include discussion of: the influence of tides, current patterns and wave magnitudes, sediment dynamics, with consideration of extreme weather conditions	Section 7.2.1 and 7.4.3
	the outcomes of geotechnical investigations and bathymetry surveys (intertidal and subtidal; depth, backscatter and water column) of the zone of influence and an assessment of the site's suitability	Section 7.4.3
	water quality (chemical, physical and biological) of the Proposal footprint (surveyed baseline), zone of influence and Darwin Harbour including temporal and spatial variations and reference to the metric by which water quality is measured	Section 7.4.4 Appendix E: Water Quality Technical Reports
	water quality objectives and declared beneficial uses for Darwin Harbour	Section 7.2.1
	the physical and chemical characteristics of the sediment within the spoil/dredge footprint, the Proposal footprint and zone of influence (surveyed baseline) as required by the Guidelines for the Environmental Assessment of Marine Dredging in the Northern Territory (NT EPA 2013a), including acid sulfate soil potential, toxicities and nutrients	Section 7.4.6 Appendix H: Marine Sediment Geochemical Assessment Report
	the location and physical and biological characteristics of the spoil disposal site/reclamation site.	Section 7.4.8
2.0 Potential impacts and risks		
2.1	Utilise bathymetry surveys and field-verified hydrodynamic modelling to determine the areas that could feasibly experience impacts associated with the proposed activities. This is to take into account currents, waves, sediment transport, sediment plume, local-scale seabed features, dispersal and sedimentation characteristics including flocculation. Classify the areas as: Zones of impact – or direct disturbance footprint (Proposal footprint). These are the areas of propose infrastructure, vegetation clearing, dredging and direct use.	Section 7.5.1.1 Appendix I: Sediment Transport Modelling Technical Report
	Zones of influence – or indirect disturbance footprint. These are surrounding areas that may be indirectly affected by proposed activities, for example via	Section 7.5.1.1.1

ID	Terms of reference requirements	EIS section number
	the release of contaminants (air, water, land), changes in hydrodynamics and sedimentation.	Appendix I: Sediment Transport Modelling Technical Report
2.2	Provide a detailed and comprehensive assessment of potential impacts on and risks to marine environmental quality (sediment and water) utilising hydrodynamic modelling, geotechnical investigations, outcomes of sediment quality investigations and other relevant information. As a minimum, the assessment should take into consideration: dredging methods, equipment, timing and frequency	Section 7.5
	the likely scale, extent and fate of sediment plumes	Section 7.5.1.1 Appendix I: Sediment Transport Modelling Technical Report
	other industries and proposals in Darwin Harbour that may contribute to cumulative impacts of this Proposal e.g. from dredging, contamination and habitat loss	Section 7.4.77.8.6 and 12.4
	environmental management requirements associated with seasonal weather, extreme weather conditions such as storms and cyclones for the 2, 10 and 100 year average recurrence interval events	Section 7.3
	details of reclamation containment and dewatering method, including expected settlement timeframe	Section 7.4.8
	the physical and chemical characteristics of reclamation discharge	Section 7.4.8
	potential contaminants and sources (including accidental spills, antifoulant, metal loading from corrosion control for submerged steel structures and pipelines over water) from the Proposal, pathways and dispersal into the surrounding marine environment.	Section 7.5.1.2 and 7.5.1.3
2.3	The assessment must take into account all land and water based construction and operation activities of the Proposal including reclamation, site preparation, vessel traffic, spills, storm water discharge, biosecurity and hazardous substances used or mobilised during operations (e.g. antifouling paints, hydrocarbons, solvents, heavy metals etc.).	Chapter 6 Section 7.5
	The assessment must identify potential impacts and risks to marine water quality and quantify their significance: against relevant guideline thresholds	Section 7.5
	on the beneficial uses, water quality objectives and identified environmental values of Darwin Harbour	Section 7.2.1, 7.4 and 7.5
	on the food chain, particularly species that are consumed by people (bioaccumulation).	Chapter 8
	The assessment of each aspect should consider cumulative impacts and the reversibility of potential impacts.	Section 7.5.1, 7.8.6 and 12.4

ID	Terms of reference requirements	EIS section number
3.0 Mitigation and management		
3.1	Outline the measures for minimising, managing and mitigating potential impacts and risks to marine environmental quality (e.g. sediment and water). These may be incorporated into management plans and address at a minimum: facility design and layout	Section 7.6 Chapter 2
	water management, including stormwater and wastewater management	Section 7.5.1.2, 7.5.1.3 and 7.6
	waste management including a detailed description of management methods for all types of wastes (including bilge water, and anti-foul materials removed from and/or added to boats)	Section 7.5.1.3 Chapter 11
	dredging management	Section 7.6
	dredge spoil management	Section 7.6
	erosion and sediment control	Section 7.6
	acid sulfate soil management (if present)	Section 7.5.1.1.3
	emergency response management	Section 7.6
	compliance with any statutory or policy basis for the proposed measures.	Section 7.2
	Discuss adaptation to a changing climate including design and resultant viability of the Proposal.	Section 7.3
	All mitigation measures should be substantiated and in accordance with best practice advice from relevant Northern Territory Government advisory agencies.	Section 7.2
4.0 Monitoring and reporting		
4.1	Outline how the Proponent will monitor and report on potential impacts and risks to marine environmental quality as outlined above, including: water quality	Section 7.8
	sediment quality	
	dredge plume and operation	
	spoil and spoil leachate, including acid sulfate soils	
	bioaccumulation	
	erosion and sediment	Section 7.8
	waste management, including antifoul removal, disposal and application.	Section 7.8
	All monitoring activities should be substantiated and in accordance with best practice advice from relevant Northern Territory Government advisory agencies.	Section 7.2
5.0 Residual impact		
5.1	Assess the significance of any residual impact or risk of the Proposal to identified values.	Section 7.7

7.2 Policy and guidance

The legislation, policies, standards and guidelines of specific relevance to marine environmental quality in the context of the Project are described below:

Commonwealth

- *Environment Protection and Biodiversity Conservation Act 1999*
- Australian Ballast Water Management Requirements 2001
- National Assessment Guidelines for Dredging 2009 (NAGD)
- National Acid Sulfate Soils Guidance 2018
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).

Northern Territory

- *Environmental Assessment Act 1982 (superseded by Environment Protection Act 2019)*
- *Environment Protection Act 2019*
- *Water Act 1992*
- *Waste Management and Pollution Control Act 1998*
- *Marine Pollution Act 1999.*

Relevant policies and guidelines

- Darwin Harbour Strategy 2020 – 2025
- Darwin Harbour Water Quality Protection Plan
- Guidelines for the Environmental Assessment of Marine Dredging in the NT.

Further information on the legislative and strategic context can be found in Chapter 3: Strategic and Statutory Framework.

7.2.1 Beneficial uses and water quality objectives for Darwin Harbour

Under the *Water Act 1992*, beneficial uses were first declared for Darwin Harbour (including the waters in which the Project area is located) in 1996 (Fortune & Maly 2009). Department of Land Resource Management (DLRM) (2014) reported that in 2010, following extensive community consultation, the declared beneficial uses for saline waters in the Harbour were confirmed as:

- Aquaculture – to provide water for commercial production of aquatic animals
- Environment – to provide water to maintain the health of aquatic ecosystems
- Cultural – to provide water to meet aesthetic, recreational and cultural needs.

In order to protect these uses, water quality objectives have been determined for areas within the Harbour, appropriate to the physical setting (e.g. outer harbour, middle estuary and upper estuary, as determined by freshwater input and flushing times) in which they are located (NRETAS 2010). The waters in which the Project area is located, and where the modelling indicates that most effects of dredging will be seen, are defined as upper estuary, in which the key water quality objectives (NRETAS 2010) are to maintain:

- dissolved oxygen between 80 and 100% saturation
- pH between 6.0 and 8.5
- total nitrogen less than 300 µg/L
- nitrogen oxides (nitric oxide and nitrogen dioxide) less than 20 µg/L
- ammonia less than 20 µg/L

- total phosphorous less than 30 µg/L
- filterable reactive phosphorous less than 10 µg/L
- chlorophyll a less than 4 µg/L
- total suspended solids (TSS) less than 10 mg/L.

In the absence of site-specific guidelines for Darwin Harbour, toxicant concentrations are referred to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018).

7.3 Assessment methodology

The assessment methodology applied in this EIS is detailed in Chapter 6: Assessment Methodology. Development of this chapter (Chapter 7) comprised a number of components to assess the potential impacts of the Project on marine water and sediment:

- description of the existing state of water and sediment quality in Darwin Harbour and the Project area
- collection of water quality data from the Project area, and surrounding potential area of influence, including conducting a long-term temporal assessment of surface TSS conditions in the Project area by way of remote sensing using satellite imagery
- hydrodynamic and sediment transport modelling to predict plumes and sedimentation associated with Project related dredging
- identification of relevant trigger levels and definition of potential zones of impact and influence.

A number of data sources were identified and researched to inform the description of the marine water and sediment quality within Darwin Harbour and the Project area. These included previously completed impact assessments and associated studies, and monitoring reports and data from long-term environmental monitoring programs undertaken in Darwin Harbour. Specifically, these included:

- INPEX Ichthys Draft EIS (INPEX 2010) and EIS Supplement (INPEX 2011) including technical appendices:
 - nearshore marine water quality and sediment study (URS 2009)
 - baseline water quality investigation in East Arm (URS 2011a).
- the EAW Expansion Draft EIS (DLP 2011a) and EIS Supplement (DLP 2011b), including the technical appendix containing a marine water and sediment quality assessment (URS 2011b)
- sediment geochemical investigations for components of the EAW Expansion project (URS 2012; 2014a; 2014b)
- monitoring reports associated with the Ichthys dredging campaign in East Arm (Cardno 2014)
- long-term water quality monitoring in Darwin Harbour (Department of Environment and Natural Resources [DENR] 2019).

Combined with technical studies completed to inform this EIS, these resources provide the most complete and up-to-date publicly available body of knowledge on the marine water and sediment quality of Darwin Harbour and, specifically, the Project area and surrounds.

As part of the suite of technical studies undertaken to inform this EIS, water quality data were collected on four occasions to provide snapshots of local water quality conditions within and adjacent to the Project area. Turbidity measurements were also collected over two four-week periods, one in the wet season and one in the dry season, for comparison with the datasets previously mentioned.

Recognising the age of the most comprehensive turbidity dataset collected in East Arm (URS 2011a), a further study on the surface TSS concentrations between 2011 and 2020 was conducted through analysis of satellite imagery to derive surface TSS concentrations in Darwin Harbour (EnSTaR 2020). This study was designed specifically to contribute to the verification of the suitability of the long-term turbidity dataset collected by URS (2011a) and, therefore, the suitability of the proposed monitoring

trigger levels based upon this dataset. The outcomes of the water quality monitoring and remote sensing studies are discussed in Section 7.4.

A sediment geochemical investigation was also undertaken to characterise the sediments in the vicinity of the Project, including the proposed dredging footprint. A summary of the results of this geochemical assessment is provided in Section 7.4.

After describing the existing marine water and sediment quality of Darwin Harbour and the Project area, a number of key potential environmental impacts are considered. The impact assessment process is guided by the outputs of the risk assessment (Appendix D: Risk Assessment).

For the purpose of the risk and impact assessments, marine sediment and water quality were not considered to be end receptors. Activities associated with the construction and ongoing operation of the ship lift project have the potential to impact on water and sediment quality; however, these are vectors for potential impacts upon the ultimate end receptors, such as marine flora and fauna (Chapter 8: Marine Flora and Fauna).

To inform the impact assessment process, hydrodynamic and sediment transport modelling was undertaken to predict suspended sediment concentrations (SSC) resulting from dredging activities (Appendix I: Sediment Transport Modelling Technical Report).

This chapter of the EIS concludes with a summary of proposed mitigation measures and commitments pertinent to the maintenance of acceptably high levels of water and sediment quality.

Climatic conditions in Darwin, including extreme weather conditions (e.g. cyclonic activity) common to the region have been considered in the impact assessment carried out for marine environmental quality. Construction phase impacts such as stormwater management are considered, while impacts such as those associated with dredging consider background conditions in wet and dry seasons. Sediment transport modelling was not undertaken for extreme weather conditions since it is unlikely that a dredge will operate in such conditions, and also because the turbidity generated by such weather conditions within Darwin Harbour would be far greater than turbidity generated by dredging operations.

The Project design in its current format has considered extreme weather conditions of Darwin, with refinements during the detailed design stages to consider a changing climate. Any changes to the facility that are implemented during the detailed design and constructions of the Project will be within the parameters set out in this impact assessment for the Project footprint, and expected or predicted impacts to marine environmental quality.

7.4 Existing environmental values

This section provides an overview of the physical environmental values in the vicinity of the Project site. The biological values (marine flora and fauna) are discussed in detail in Chapter 8: Marine Flora and Fauna.

7.4.1 Climate

A description of the climatic conditions influencing environmental conditions at the Project site are provided in Chapter 4, Section 4.1.

7.4.2 Geology, landform and soils

A description of the regional geology, landform and soils is provided in Chapter 4, Section 4.4.

Approximately 80% of the seafloor of Darwin Harbour is estimated to be covered with soft surfaces consisting of mud and fine sand. Soft surfaces containing varying amounts of gravel and sand are found in the main channels around reefs, on beaches and on spits and shoals near the mouth of the Harbour (Fortune 2006).

The typical geological profile of the Darwin Harbour seafloor comprises Quaternary age intertidal marine alluvium comprising mud, silt, sand and coral remnants, underlain by the Proterozoic metasediments of the Burrell Creek Formation, consisting of meta-siltstone, meta-sandstone and phyllite. The rocks strike close to north-south and are steeply dipping either to the east or west. Quartz veins are widespread within the Burrell Creek Formation.

Sediments in the river catchments are predominantly fine-grained, mainly clay and silt. Creeks and rivers may transport coarser material (e.g. sand) into the estuary during the wet season, though much is trapped by coastal vegetation, both riparian and mangrove (McKinnon et al 2006). The fine sediment delivered to the upper arms of the Harbour settles out of suspension and is then eroded and re-deposited, mainly by tidal currents, especially at spring tides (Munksgaard 2013).

Hydrodynamic modelling of suspended sediment plumes has shown that substantial sediment fluxes are directed up-estuary, where fine sediments are trapped; the sediment fraction exported to the ocean is relatively small (Williams, Wolanski & Spagnol 2006).

Particle size distribution analysis carried out by AECOM (2020) analysed unconsolidated surface sediments from the seabed across the proposed dredging footprint and reclamation area. This study found sand and gravel/shell fragment sediments in surface layers (down to a maximum of 0.5 m below seabed), giving way to sediments with a greater portion of fine silt and clay with depth (greater than 0.5 m below seabed).

7.4.3 Coastal processes

The tidal range in Darwin Harbour is between 0 m LAT and approximately 8.2 m above LAT (Table 7-2). The mean spring tide range is approximately 5.6 m and the approximate mean neap tide range is 1.8 m. Tides within Darwin Harbour are predominantly semidiurnal, with a slight inequality between the successive tides during a single day.

Table 7-2 Darwin Harbour tidal planes

Tidal Plane	Description	LAT (m)
HAT	Highest Astronomical Tide	8.2
MHWS	Mean High Water Springs	7.0
MHWN	Mean High Water Neaps	5.1
MSL	Mean Sea Level	4.2
AHD	Australian Height Datum	4.1
MLWN	Mean Low Water Neaps	3.3
MLWS	Mean Low Water Springs	1.4
LAT	Lowest Astronomical Tide	0.0

Rigby et al (2014) indicate that the wave climate in the region is dominated by locally-generated waves, with little incident swell entering the Harbour from the west, except under monsoonal cyclone or tropical low events. Between November and March, north-westerly winds blow over the uninterrupted fetch of the Timor Sea, increasing incident wave energy in Beagle Gulf and at the entrance to Darwin Harbour. Due to the alignment and narrow nature of the Harbour entrance, and the presence of the Tiwi Islands to the north, the interior of the Harbour is sheltered from long-period swell, and any swell that does enter the Harbour is quickly dissipated by the generally shallow bathymetry and indented nature of the Harbour shoreline.

The daily Harbour inflow and outflow is approximately 216 million m³ on a spring tide and 71 million m³ on a neap tide. These flows represent 69% and 29% of water flows in Darwin Harbour, respectively (Williams et al. 2006). Tidal flows are strongest in the narrowest sections of the Harbour, including sections of the East Arm channel.

Modelling by Brinkman and Logan (2019) indicates that flood tidal current velocities within the Harbour are generally higher than ebb tide velocities. Elevated tidal energy, particularly during spring tides, results in the regular resuspension of fine sediments from the seabed, leading to naturally high turbidity levels within the Harbour.

It is noted that Baird (2019) found ebb tidal flows (measured between May and July 2019) at a site within the body of East Arm tended to be stronger than flood tidal flows, with peak current speeds of

0.6-0.7 m/s during spring tides and 0.2-0.25 m/s during neap tides. This suggests that the relative ebb/flood tidal flows within the main East Arm channel are contrary to those within the Harbour in general. As the Project is outside of the channel, the relative flows at the site are likely to be aligned with those within the Harbour in general.

Brinkman and Logan (2019) consider that, during the wet season, there is a significant contribution of fine sediments to the Harbour from terrestrial sources draining into the Harbour via the reaches of West, Middle and East Arms. McKinnon et al (2006) calculated that the annual total suspended sediment load transported to the Harbour had increased by a factor of 1.3 compared to the preurbanisation load. Nawaz (2010) estimated that in the order of 80% of terrestrial sediment transported into the Harbour was from channel erosion rather than from sheet erosion; the latter being a more likely source of contaminant inputs than the former.

Previous investigations within the Harbour have demonstrated that complex circulation occurs near headlands and embayments that includes jets, eddies, separation points and stagnation zones. This may result in trapping of fine sediments at headlands and in embayments; modelling by Brinkman and Logan (2019) predicts that the nearshore portion of the Project footprint lies within an area of net sediment deposition, while net erosion is predicted in the portion further from shore.

A study was undertaken by MetOcean Solutions (MOS) to better understand and define the ambient and extreme waves, currents and the joint probability between extreme waves and water levels post-construction of the Project. The study then estimated the potential change to currents and current-related sediment transport that may result from the construction of the Project.

The study (MOS 2020) looked at the difference in spring tide ebb and flood currents, both prior to and post-construction of the Project reclamation area and predicted that any substantial changes in tidal currents would generally be restricted to the region of the Project site. Additionally, the following is predicted during flood tides:

- Current speed is likely to be reduced near the proposed reclamation and dredged areas due to the deeper water depth.
- A decrease in current speed may occur west and east of the Project site, and east of South Shell Island.
- Noticeable changes may occur in the area extending from the south of the Project site, extending westwards towards the Marine Supply Base (MSB).
- A counter-clockwise eddy may be generated in the area between the MSB and Project reclamation area, resulting in increased current speeds to the west of the Project, adjacent to the MSB at EAW.
- Tidal currents in the vicinity of Catalina Island may reduce to a small degree.
- South of the Project, the flow is directed eastward and, at around the latitude of Catalina Island, the flow is directed north and west, forming a counter-clockwise eddy, which then flows westward adjacent to the coast.

During ebb tide, MOS (2020) predicted that the current flow pattern would mostly be to the west/northwest, with less apparent eddies. After construction of the Project reclamation area, it was predicted that:

- A reduction in current speed may occur in the region close to the Project as the reclaimed landmass obstructs the flows. As a result, there may be a slight increase in the current speed near the tip of the reclamation.
- These reductions and increases in the ebb currents may propagate downstream and may also be seen near South Shell Island and the EAW.
- A reduction in current speeds and directions may occur between the Project and MSB due to the protection created by the reclaimed area.
- Current changes adjacent (west) of South Shell Island may be small, with most of the change to current speeds predicted to occur in waters off the EAW area.

MOS (2020) surmised, based on comparison of modelled current timeseries, that:

- During flood tides, changes in current speeds may occur at locations towards Catalina Island.
- Changes in current speeds near South Shell Island are predicted to occur during ebb tides, with minimal change in current near the mangroves east of the Project site.

Changes in residual currents over a full spring / neap tide cycle were also predicted by MOS (2020) to provide a more suitable estimation of the potential for changes to sediment transport in the region as a result of construction of the Project. The absolute maximum changes were predicted to be in the order of approximately 0.10-0.30 m/s for spring tides, and 0.10 m/s for neap tides. The degree to which these changes in current alter the sediment transport in the region will be dependent on the sediment particle sizes present on the seabed.

7.4.4 Marine water quality

7.4.4.1 Overview

Water quality in Darwin Harbour is considered to be generally high, although naturally turbid most of the time. Water quality parameters vary greatly with the tide phase (spring versus neap; flood versus ebb), location of sampling (inner versus outer harbour), and with the season (wet season versus dry season). Duggan (2006) conducted research on the water quality of Darwin Harbour from 2002 to 2004. Seasonal aspects, rather than spatial or tidal aspects, were found to be the most important determinant of water quality within the Harbour in general, with rainfall considered to have the greatest impact on water quality (increasing nutrients, suspended solids and chlorophyll-a).

Water quality is typically higher in outer harbour waters than within the inner harbour, though turbidity at the Harbour mouth can be elevated in shallow areas due to re-suspension of sediments from intertidal flats, especially during spring tides.

A typical Darwin wet season extends from November to March and its effects on Darwin Harbours water quality (due to high surface runoff from the land) can last until April or May, depending on rainfall. Typically, dry season climate conditions prevail from May to September (URS 2011a). Table 7-3 provides a summary of the natural processes that impact water quality in Darwin Harbour.

Table 7-3 Summary of natural processes affecting water quality in Darwin Harbour

Parameter	Influencing factors	
	Open Harbour	Tidal Creeks
Temperature	Season	Season
Salinity	Season, location	Season, tide
Dissolved oxygen	Tide (minor)	Tide
pH	(none)	Season, tide
Turbidity and light attenuation	Season (minor), tide	Tide
Nutrients	(none)	Location

Water quality monitoring undertaken by DENR against Darwin Harbour water quality objectives indicates that water quality is generally good to excellent (Fortune 2015). There is no evidence of widespread water pollution in the Harbour (Fortune 2016, DENR 2020), although some localised pollution has been identified in the past (e.g. Padovan 2003) and the Harbour may be subject to occasional pollution events such as hydrocarbon spills.

Potential sources of hydrocarbon inputs to Darwin Harbour include:

- seasonal stormwater inflow from Darwin and Palmerston stormwater drainage networks
- creeks with industrial developments in their catchments (e.g. Hudson Creek, Sadgroves Creek)
- bulk hydrocarbon storage (e.g. at EAW, Darwin LNG plant, Ichthys LNG plant, Channel Island Power Station)
- inventories in recreational, commercial vessels and shipping

- refuelling locations (e.g. Cullen Bay, Fishermans Wharf).

Darwin Harbour water quality has been monitored against a series of water quality objectives and reported by DENR (now DEPWS) in annual report cards since 2009. The annual report cards provide a score based on the following parameters:

- dissolved oxygen
- TSS (by way of TSS – turbidity relationship)
- chlorophyll-a (as an indicator of algae)
- nutrients (nitrogen and phosphorus)
- temperature, pH and salinity are also measured but not included in the determination of the report card score.

The annual water quality report card process monitors water quality at 23 sites throughout East Arm. The East Arm region has consistently met water quality objectives over the period since the program began in 2009. In the first year of the monitoring program, East Arm received a B grade rating, meaning three out of four of the water quality indicators met desired levels. Between 2010 and 2012 an A grade was given, meaning all four indicators met desired levels. The long-term trend in water quality in East Arm since 2009, based on this program, is shown in Figure 7-1 (DENR 2020). The 2013 report card for East Arm delivered a B grade as dissolved oxygen concentrations were outside of the water quality objective limits on four occasions. These exceedances were not harmful and were considered to be within the limits of natural variation for this area, and not indicative of pollution (DLPE 2013). The B grade received in 2014 was attributed to nutrients (specifically total nitrogen), while those recorded in 2015 and 2017 were attributed to water clarity. The results of this program suggest that water quality in East Arm during dry season neap tides is generally very high.



Figure 7-1 Darwin Harbour water quality report card long-term trend for East Arm (DEPWS, 2021)

7.4.4.2 East Arm water quality studies

To inform this EIS, water quality was assessed within, and adjacent to, the Project site over a period of seven months, with sampling conducted to assess water chemistry on four occasions. These sampling events were conducted around two seasonal periods: late dry season and late wet season. Within each seasonal period two sampling events were carried out approximately four weeks apart, with water samples collected from near surface, mid-water column and adjacent to the seabed at six locations in East Arm. Details of this program and full analytical results are provided in Appendix E: Water Quality Technical Reports.

This program also included two instrument deployments to record turbidity (nephelometric turbidity units [NTU]) and photosynthetically available radiation (PAR) at the South Shell Island site at which loggers were deployed by URS (2011a) as described below. These instruments were deployed for a duration of six weeks and nine weeks during the late dry season (October – November 2020) and wet

season (March – May) respectively. These deployments collected data to contribute to a review and verification of the suitability of data collected by URS (2011a); this was primarily informed by a study using remote sensing methods to model long-term surface TSS between 2011 and 2020. The technical report for these sampling events is presented in Appendix E: Water Quality Technical Reports.

In order to characterise the existing conditions in the Ichthys nearshore development area in East Arm, a water quality survey was undertaken from April to August 2008 by URS (2008). The study was designed to capture the effects of both the wet and dry seasons. The study included measurement of physico-chemical water quality parameters in the water column at a number of sites. Subsequent to this study, additional water quality investigations were undertaken by URS (2011a) to develop trigger levels for application throughout the INPEX dredging campaign. This study included collection of water quality data every 15 minutes over a year-long program at a site near South Shell Island.

Data were grouped and averaged based on tidal cycle and seasonal variation, allowing seasonal means, medians, and percentiles to be calculated. This provided a robust body of data to compare background levels of turbidity with potential increases associated with various natural and artificial turbidity-generating events in the Harbour.

Water quality data from South Shell Island are relevant to the present Project as this location has the nearest receptor of concern (hard coral communities) to the Project location, although modelling does not predict that the communities are at risk of detectable impacts from the dredging works (refer to Section 7.5.1, Appendix I: Sediment Transport Modelling Technical Report and Chapter 8: Marine Flora and Fauna).

Table 7-4 presents summary statistics for dry and wet season water quality, as recorded at a site off the southern tip of South Shell Island (URS 2011a).

Table 7-4 Water quality parameters recorded at South Shell Island

Parameter	Dry Season			Wet Season		
	Mean	Min.	Max.	Mean	Min.	Max.
Temperature (°C)	28.1	25.3	32.1	30.4	28.1	32.0
Conductivity (mS/cm)	48.7	40.2	52.9	46.2	36.7	49.8
Depth (m)	6.3	2.4	11.0	6.7	2.5	11.3
pH	8.0	7.7	8.5	8.0	7.6	8.2
DO (%)	93.5	73.4	121.1	88.5	67.3	106.4
Turbidity (NTU)	4.4	0.1	46.4	8.3	0.2	68.0
SSC (mg/L)*	10.8	7.1**	46.4	14.1	7.2**	64.7

Source: URS (2011a)

* Calculated from NTU using relationship in URS (2011a): $SSC = 0.848 * NTU + 7.0477$

** These values are an artefact of applying a linear equation to the SSC/NTU relationship and the actual SSCs are likely to have been considerably lower.

The comprehensive water quality dataset provided by URS (2011a) for the location at South Shell Island (the closest site to the Project area) was utilised to develop trigger levels for dredge monitoring applications during the INPEX Ichthys and EAW expansion projects.

For this EIS, an assessment of TSS in Darwin Harbour, focussing on East Arm, was carried out using remote sensing methods (EnSTaR 2021). This assessment applied the semi-analytic sediment model from Dorji et al (2016) to estimate TSS concentrations in surface waters, based on reflectance from MODIS satellite imagery. Using this methodology, TSS concentrations in East Arm were derived for the period February 1, 2010 – January 31, 2011, the period that data were collected by URS (2011a), and then again for the period January 1, 2016 – October 30, 2020. While TSS derived through remote sensing methods and in situ turbidity measurements are not directly comparable, EnSTaR (2021) showed that, generally, based on the satellite-derived TSS results, TSS in Darwin Harbour during the period that the URS (2011a) turbidity dataset was collected (median TSS = 4.72 mg/L, 95th percentile

= 14.89 mg/L), was lower than that estimated for the period between 2016 – 2020 (median TSS = 5.4 mg/L, 95th percentile = 20.6 mg/L).

Considering the results of the remote sensing study (EnSTaR 2020), it is suggested that the URS (2011a) study remains a suitable dataset to describe pre-impact water quality (turbidity) conditions for the Project. Thus, the trigger levels developed for the Ichthys project (based on these data) remain a suitable and conservative benchmark to be applied to the Project.

7.4.4.3 Water temperature

Water temperatures in Darwin Harbour are typically high, and some seasonal variations do occur. Temperatures are typically lowest (23°C) in June-July and highest (33°C) in October-November (Padovan 1997).

Water temperature measured in the INPEX nearshore development area by URS (2011a) ranged from 25.3 to 32.1°C, with an average temperature of 30.4°C in the wet season and 28.1°C in the dry season. Comparison between sites over both the wet and dry seasons by URS (2008) found that the water temperature was elevated by about 5°C in the wet season. These ranges were reflected in the Ichthys monitoring program, where temperatures during the wet season ranged from 30 to 32°C and dry season temperatures of 24 to 26°C were recorded (Cardno 2014). These distinct seasonal variations in sea-surface temperature were apparent in previous studies of the Harbour (e.g. Michie et al 1991). URS (2008) observed no significant difference in temperature at any site as a result of either water column position (surface or bottom) or tidal flow (ebb or flood).

7.4.4.4 Salinity

Salinity in Darwin Harbour varies considerably during the year, particularly in East, Middle and West Arms where freshwater influence is greatest during the wet season. Seawater has a global average salinity of 35 parts per thousand (ppt) (DEWHA 2008); however, salinities throughout Darwin Harbour are about 37 ppt during the dry season, with surface and bottom depths having similar levels. Salinity tends to be higher in the dry season owing to increased evaporation and less freshwater inflow.

At the height of monsoonal inflow during February to March, areas in the middle of the Harbour such as Weed Reef can experience salinity levels of 27 ppt (Parry & Munksgaard 1995). Salinities in the arms, which are largely influenced by freshwater inflow, can drop to as low as 17 ppt. The water at this time is highly stratified, with freshwater input from land-based catchments flooding the Harbour and overlying the intrusion of more dense, higher-salinity water from outside the Harbour, forming a classic “salt wedge” that is typical of estuarine systems. Parry and Munksgaard (1995) reported salinities on the bottom of the Harbour to be as much as 12 ppt higher than on the surface. As the rains cease, runoff decreases and salinities return to their higher dry-season levels (Parry & Munksgaard 1995).

Salinity levels recorded in the East Arm area by URS (2008) ranged from 19.1 to 36.3 ppt. Average salinity was 32.7 ppt and was higher in the dry season than the wet season. This was supported by URS (2011a) in which a salinity range (measured as conductivity) of 36.7 to 52.9 mS/cm was recorded, with an average of 46.2 mS/cm in the wet season and 48.7 mS/cm in the dry season. Under dry season conditions, salinity was higher in upstream areas than downstream, but this trend was reversed in the wet season with freshwater input to the arms from rainfall. These variations in salinity according to location in the Harbour, and according to season, have also been previously reported by Michie et al (1991) and Padovan (1997).

No significant differences in salinity levels attributable to position in the water column were observed by URS (2008); this may have been a result of water sampling occurring in April and not earlier in the wet season, when a substantial salt wedge underlying a freshwater lens would likely have been present. Tidal flushing and a lack of major rainfall events during the wet season sampling period may have also assisted with mixing of the water column at the sampling sites.

7.4.4.5 Dissolved oxygen

Harbour waters remain well oxygenated throughout the year, with levels ranging from 74% to 96% saturation, typically around 84%. In a study by Padovan (1997) no seasonal effects were observed, and there were only minor changes in oxygen levels with location in the main body of the Harbour. Dissolved oxygen levels at sites closest to the Harbour mouth were slightly higher than sites further

into the estuary. Oxygen levels during a spring tidal cycle were 7% higher at high tide than at low tide (Padovan 1997).

Dissolved oxygen levels in tidal creeks fluctuate with the tidal cycle, with oxygen concentrations lowest during low tide. Oxygen levels in Blessers Creek (adjacent to EAW, on the west side) at low neap tide have been recorded at 60% saturation, compared with 90% at high tide (Parry & Munksgaard 1996). This indicates a certain oxygen demand in tidal creeks, probably from mangrove root systems and sediment infauna. To date there are no reports of anoxia in undisturbed tidal creeks, and it is not known whether the conditions under which anoxia is most likely to occur have ever been sampled. These conditions are during small tidal movements in October–November, when temperatures are highest and calm conditions prevail (Padovan 2003).

Dissolved oxygen concentrations of 74.4% to 119.3%, with an average saturation of 93%, were measured by URS (2008). Overall, dissolved oxygen was generally found to be higher in the dry season and in the main body of the Harbour, with decreasing levels further upstream. Higher dissolved oxygen levels were recorded towards the surface than at the bottom of the water column. No significant differences in dissolved oxygen levels were observed between flood and ebb tides (URS 2008). During their long-term water quality study, URS (2011a) measured dissolved oxygen levels in the INPEX nearshore development area that ranged from 67.3% to 121.1% saturation, with an average saturation of 93.5% in the dry season and 88.5% in the wet season.

7.4.4.6 pH

The pH of Darwin Harbour waters generally remains within a narrow range (8.3–8.6, with a mean of 8.5) throughout the main waterbody. Padovan (1997) found no seasonal or spatial effects on pH, and no tidal effects.

The pH of tidal creeks varies to a greater degree than the open Harbour waters, and is affected predominantly by tide and season. During the dry season or periods of no freshwater inflow, the pH of Blessers Creek and Middle Arm was 0.3 pH units lower at low tide than at high tide (Parry & Munksgaard 1996). This indicates that processes occur in the mangrove environment that result in the slight acidification of inflowing waters.

URS (2008) recorded a mean pH level of 8.4 in the INPEX nearshore development area, with a range from 7.8 to 9.2. In the upper reaches of the Harbour, mean pH levels were found to be lower (more acidic), with pH levels increasing (becoming more alkaline) in the main body of the Harbour in both wet and dry season sampling. No significant difference in pH attributable to water column position or tidal state was observed (URS 2008). Measurements at South Shell Island by URS (2011a) recorded a mean pH of 8 and a range from 7.6 to 8.5.

7.4.4.7 Turbidity and light attenuation

Light levels reaching the sea surface in the Harbour are typically very high, especially in the dry season when cloud cover is usually low. However, because of the high levels of suspended solids in the water column the light is rapidly dissipated, and even within a depth of a few metres light levels can be greatly reduced. Turbidity is a measure of this “light scattering” effect, and the turbidity of the main waterbody of the Harbour is typically in the range 1–35 NTU.

The most important factors affecting turbidity are the tidal cycle and location within the Harbour (Padovan 1997). Turbidity is highest during spring tides when current velocity, and therefore capacity of the water to move sediment, is greatest. During the spring tide cycle, turbidity is greatest at the midpoint between high and low water, and lowest at slack water (DHAC 2005).

Turbidity is higher in the wet season than the dry season because of the influx of terrigenous sediments to Harbour waters through the rivers and, to a lesser extent, from surface-water sheet flow. Even at a depth of only 3 m below the surface, light levels during the wet season can be as low as 7.7% of surface levels. Light levels at the bottom of the Harbour can be as low as 1% of surface levels during the wet season (DHAC 2005).

In analysing turbidity data from the EAW development, Munksgaard (2001) found statistically significant effects of season where turbidity was highest during the wet season. However, the mean change in turbidity was relatively minor, from 4 to 12 NTU over the range of conditions analysed. These differences are much lower than the range typically found in the Harbour, between 1 and 35

NTU (Padovan 1997). It can be concluded that season has only a minor effect on turbidity in the main body of the Harbour. Padovan (2003) suggests that seasonal effects on turbidity, if present, would most likely be found in the upper reaches of East Arm and Middle Arm. This is supported by monitoring undertaken for the INPEX Ichthys dredging program. Cardno (2014) reported a strong influence of episodic events such as tropical storms and cyclones in the wet season. Such events were observed to cause naturally elevated turbidity at much higher intensities over large areas than those observed from dredging alone.

Turbidity levels recorded in the nearshore development area by URS (2008) were up to 73.6 NTU, with a mean reading of 6.9 NTU. Predictably, higher NTU values were found at the bottom of the water column than at the surface, with higher levels also being recorded in the wet season when compared with the dry. During ebb tides, turbidity levels were higher upstream than in the main body of the Harbour; this was reversed during flood tides (URS 2008).

Turbidity at South Shell Island was again measured by URS (2011a) where minimum, average and maximum turbidity in the dry season was recorded as 0.1 NTU, 4.4 NTU and 46.6 NTU respectively. Expectedly, turbidity was higher in the wet season with minimum, average and maximum turbidity levels reported as 0.2 NTU, 8.3 NTU and 68 NTU respectively.

Turbidity was measured by AECOM (2021a,b) over two deployments at the same South Shell Island location from which data were collected by URS (2011a). The first deployment of six weeks between 12 October and 26 November 2020 was late in the dry season. Turbidity during this period ranged from 1.5 – 52 NTU, with an average of 6.8 NTU, slightly higher than that reported by URS (2011a) for the whole of the dry season in that study. The second deployment captured data over a nine week period between 1 March to 5 May 2021 and is considered a snapshot of late wet season conditions. Turbidity during the second deployment ranged from 0.2 – 26.4 NTU with an average of 5 NTU for the duration of the deployment. At these levels, the maximum turbidity was lower than that recorded by URS (2011a), while the minimum and average turbidity were closer to those recorded by URS (2011a). It is noted that the 2021 deployment was at the end of wet season and into May, which is typically classified as dry season. As such this may have resulted in lower maximum and average turbidity across the deployment period than may have been present at the peak of the wet season.

7.4.4.8 Total Suspended Solids

Measurements of TSS and turbidity both indicate the levels of solids suspended in the water column, whether mineral (e.g. soil particles) or organic (e.g. algae). However, TSS measures an actual weight of material per volume of water while turbidity, as described above, measures the amount of light scattered.

TSS levels around Bladin Point measured by URS (2008) ranged from 1.5 to 83 mg/L, with an average measurement of 14.6 mg/L. Elevated TSS levels were found to occur in the wet season at the bottom of the water column on a flood tide at all sites. Generally, TSS levels were not as high in Harbour waters as in the upper reaches of East and Middle Arms. No clear distinction was found between wet and dry season TSS levels at the surface (URS 2008).

AECOM (2021a,b) analysed water samples collected from East Arm, including at the Project site. Samples were collected on four occasions representing late dry season neap and spring tide conditions and late wet season spring and neap tide conditions. TSS concentrations in samples collected during neap tides were generally very low (<5 mg/L) in both late dry and wet seasons. During the late dry season, TSS ranged from <5 mg/L to 20 mg/L with the highest concentration recorded at the Project site, the shallowest site sampled. During late wet season sampling, TSS was typically <5 mg/L with the exception of one sample collected to the south of Catalina Island in which TSS was 8 mg/L. During spring tides, TSS was substantially higher, ranging from 5 mg/L to 83 mg/L, with the highest concentrations recorded approximately 250 m to the east of the Project site. TSS at a reference site, located mid-way across East Arm, was higher than that recorded at most sites.

7.4.4.9 Nutrients and phytoplankton

Studies on nutrients in the waters of Darwin Harbour are few and their scopes have been limited. Padovan (1997, 2002) and Sly et al (2002) found total nitrogen in the main body of the Harbour to be in the range 0.2–0.6 mg/L. The concentration of total nitrogen in most of the inflowing river waters was

similar to that found in the Harbour and therefore wet season inflows were not expected to affect nitrogen concentrations in the main waterbody (Padovan 1997, 2003).

This was somewhat supported in the results of sampling undertaken by AECOM (2021a,b) which found total nitrogen in East Arm ranging from 0.056 mg/L – 0.156 mg/L during the late dry season and between 0.094 – 0.209 mg/L during the late wet season.

Phytoplankton is an important water quality measure as its abundance and composition are directly influenced by environmental factors including nutrients and light. The abundance of phytoplankton is typically quantified through the enumeration of cell numbers and through the measurement of chlorophyll-a, the main light absorbing pigment used in photosynthesis.

Planktonic organisms, along with mangrove plant and animal communities, can form the basis of the food web in coastal marine ecosystems. About 250 different species of phytoplankton have been found in Darwin Harbour, which is typical of tropical, oceanic waters in northern Australia (Water Management Branch [WMB] 2005). Results from the monitoring study by WMB (2005) demonstrated that for most of the year the amount of phytoplankton in the Harbour was very low (less than 2 µg/L of chlorophyll-a), though some measurements in the Blackmore River were up to ten times higher than this.

No seasonal or inter-annual changes in concentrations of chlorophyll-a in the Harbour have been found, though concentrations vary with tide cycle (Padovan 1997, 2002). Concentrations were highest during the midpoint of a spring tide, suggesting the re-suspension of algal cells from the bottom. Overall, the concentrations measured in the Harbour were similar to those found in other northern Australian waters (Padovan 1997).

The formation of cyanobacteria blooms (also known as blue-green algal blooms) occurs naturally in Darwin Harbour during the dry season (Drewry et al 2010) and remnants of blooms may be found washed up on Harbour beaches at this time.

7.4.4.10 Metals

AECOM (2021a,b) analysed marine water samples collected from within and surrounding the Project site for a suite of metals. The study included analysis to detect dissolved metals (aluminium, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, vanadium and zinc) in water samples collected in the upper, mid and lower water column at six locations in East Arm. The analytical results were compared to ANZG (2018) DGVs for a 95% species protection level (recommended for application in slightly to moderately disturbed ecosystems) where they exist. The results of this investigation are provided in Appendix E: Water Quality Technical Reports. There were no instances of metal concentrations exceeding the ANZG (2018) DGVs for a 95% species protection level.

7.4.5 Hydrocarbons

AECOM (2021a,b) analysed marine water samples collected from within and surrounding the Project site for total petroleum hydrocarbons, benzene, toluene, ethylbenzene and xylenes (BTEX) as well as a suite of 16 polycyclic aromatic hydrocarbons (PAHs). None of these hydrocarbons were detected above the laboratory limits of reporting in any of the samples analysed and are therefore considered to be below the ANZG (2018) DGVs for these parameters, where a DGV exists. It is possible that hydrocarbons may occur from time to time in or around a port setting, such as that in East Arm where the Project is situated, as a result of shipping operations. However, their volatility, especially in warm tropical waters, leads to rapid reductions in concentrations and they are likely to typically be undetectable in the marine waters in the vicinity of the Project site.

7.4.6 Marine sediment quality

7.4.6.1 Sediment types

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

- Terrigenous gravels, which occur primarily in the main channel.
- Calcareous sands with greater than 50% biogenic carbonate, which are among or close to the small coral communities at East Point, Lee Point and Channel Island. Carbonate sediments,

largely derived from molluscan shell fragments, also occur in spits and shoals close to the Harbour mouth.

- Terrigenous sands on beaches and spits, with 10–50% carbonate, largely derived from molluscs. This type of sediment is predominantly quartz and clay.
- Mud and fine sand on broad, gently inclined intertidal mudflats that occur in areas characterised by low current and tidal velocities, such as in Kitchener Bay (prior to the construction of the Darwin City Waterfront) and Frances Bay (on the north side of East Arm Port).

It is estimated that 60% of the Harbour's sediments originate from offshore. The remainder is deposited by rivers and creeks, derived predominantly from erosion of channel walls. Direct contribution to the Harbour from sheet erosion is likely to be limited because of the very low hillslope gradients adjacent to the Harbour (DHAC 2005).

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

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

7.4.6.2 Recent sediment sampling in East Arm

In 2008, URS (2009) sampled surface sediments at 145 sites, and subsurface sediments at 18 sites in East Arm and along the proposed INPEX gas pipeline route within Darwin Harbour. The surface sediments were analysed for a range of parameters: a suite of metals occurring both naturally and as a result of potential anthropogenic contamination (aluminium, antimony, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver and zinc); tributyltin (TBT); nutrients (nitrogen and phosphorus); total organic carbon; particle size distribution; total petroleum hydrocarbons; PAHs; and BTEX. In addition, organochlorine pesticides, polychlorinated biphenyls and radionuclides were investigated at some sites. Subsurface sediments were analysed for metal concentrations and ASS potential.

In 2012 and 2014, URS (2012, 2014a, 2014b) undertook sediment geochemical assessments of the sediments at sites within the EAW expansion locations prior to dredging associated with construction of the MSB, MUBRF and tug pens and small vessel berths. The suite of analytes was similar to that in the URS (2009) study.

In 2015, Douglas Partners undertook sediment sampling by grab and vibrocore within areas in which dredging for the Marine Industries Precinct project was proposed. Again, the suite of analytes was largely consistent with that in the URS (2009) study.

In August 2020, AECOM completed a geochemical assessment of the sediments in the vicinity of the Project site, including the proposed dredging footprint. Sediment samples were collected with a vibrocore to sample sediments down to the point of refusal. Sediment samples were collected from 0.5 m intervals through the depth of the sediment and analysed for metals, hydrocarbons, TBT, nutrients, radionuclides and ASS potential.

The results of these studies are discussed in the following sections.

7.4.6.3 Metals

Previous studies of heavy metal concentrations in Darwin Harbour sediments (e.g. Peerzada & Ryan 1987; Peerzada 1988; Currey 1988; Hanley & Caswell 1995; Parry et al 1995; Padovan 2002) all recorded levels below ANZG (2018) guideline levels. In many cases, the readings from these studies were an order of magnitude, and sometimes two orders of magnitude, lower than the recommended 95% upper confidence limit (UCL) of the mean (95% UCL).

Since those studies, Fortune (2006) has undertaken a detailed study of heavy metal concentrations in sediments throughout the Harbour. A number of sites in the study had concentrations of metals above

guideline values or were considered elevated. Arsenic was the only metal notably higher in the East Arm area; however, this was considered likely to be an indication of local geology rather than anthropogenic sources.

Metals levels recorded in East Arm surface sediments sampled by URS (2009) were generally below guideline levels, with the exception of arsenic, chromium and mercury. Arsenic levels were elevated above the NAGD (2009) screening level at six of the sites; however, tests using mild acid digests showed that the arsenic was unlikely to be toxic in the marine environment as only a very small proportion was bio-available. That is, the arsenic was bound to the sediment in such a way that it would not readily enter the food chain. Arsenic levels also exceeded the screening level in various subsurface samples in East Arm, and slightly elevated nickel levels were recorded at one site. However, when averaged across all sites, all metals were below screening levels.

URS (2012, 2014a, 2014b) and Douglas Partners (2015) also recorded arsenic concentrations above the screening level in samples of surface and sub-surface sediments from East Arm. The only other metal for which a screening level was exceeded was chromium, in a very small proportion of the Douglas Partners (2015) samples.

Munksgaard et al (2013) did not record any screening level exceedances in the general vicinity of the Project area, though they recorded screening level exceedances for arsenic, chromium and nickel in sediments in the upper reaches of Hudson Creek.

Arsenic concentrations reported during the recent geochemical assessment of the sediments within the Project footprint (AECOM 2020) typically exceeded NAGD (2009) screening levels. The 95% UCLs for all other metal concentrations analysed by AECOM (2020) were found to be below the corresponding NAGD (2009) screening levels.

7.4.6.4 Hydrocarbons

A survey by URS (2004) detected petroleum hydrocarbons (at a concentration of 4.9 mg/kg) in a surface sediment sample collected from the Elizabeth River. URS (2008) detected petroleum hydrocarbons, particularly in the C15–C28 range, in surface sediments at a number of sites in East Arm. However, BTEX compounds were below laboratory Practical Quantitation Limits (PQLs) at all sites, as were PAHs at the majority of sites. Petroleum hydrocarbons were not detected above the PQL in subsurface sediments (URS 2008).

URS (2014a) detected petroleum hydrocarbons at very low levels at the majority of sites sampled within the dredging footprint for the MUBRF. The highest concentration measured was 80.0 mg/kg (in the C10 – C36 range), well below the NAGD (2009) screening level of 550 mg/kg. The 95% UCL concentration (14.9 mg/kg) was also well below the screening level. PAHs were reported at a concentration above the PQL at only one site (0.129 mg/kg).

Similar results were observed at sites sampled on the north side of EAW in April 2014 (URS 2014b), with a maximum recorded hydrocarbon concentration of 174 mg/kg and a 95% UCL of 34 mg/kg. PAHs were detected in a number of samples; the maximum concentration detected was 0.086 mg/kg with a 95% UCL at or below the PQL for all species.

No hydrocarbons were detected by Douglas Partners (2015) in their samples of surface and sub-surface sediments from the proposed MIP dredging footprint within East Arm.

The 95% UCL concentration of hydrocarbons for sediment samples collected by AECOM (2020) was well below the NAGD (2009) and ANZG (2018) criteria levels, as were results for all individual samples collected.

7.4.6.5 Tributyltin

TBTs are chemicals that contain the $(C_4H_9)_3Sn$ group, forming the main active ingredients in broad-spectrum biocides. In the late 1960s, TBTs, especially tributyltin oxide, came into widespread use as antifoulant additives to marine paints applied to the hulls of vessels. The leaching of TBT from the paint was effective in preventing the growth of fouling organisms on hulls, but also had detrimental environmental effects on biota in the surrounding waters. These compounds are persistent organic pollutants that biomagnify up the marine food chain and also tend to accumulate in sedimentary environments, particularly in fine sediments. In September 2008, the *International Maritime Organization's International Convention on the Control of Harmful Anti-Fouling Systems on Ships*,

2001 entered into force. Annex 1 to this convention specified that, from 1 January 2008, ships could not bear anti-fouling coatings containing organotins unless coated with a barrier coating to prevent organotin release (Lewis et al 2010)

A survey of marine sediment quality by URS (2004) found detectable levels of TBTs across Darwin Harbour. However, although they were detected at most sites, the guideline criteria level (at that time, 5 ngSn/g) was exceeded at only one location - Fort Hill Wharf, which had received large numbers of vessels since the late 1960s.

Sampling of marine sediments in the INPEX nearshore development area at Bladin Point (URS 2008) and in the MUBRF dredge footprint (URS 2014a) did not detect TBTs above the PQL in surface or subsurface sediments at any of the sites. URS (2012) detected TBT at only one of the 22 sampling locations within the dredging footprint for the MSB at EAW; the concentration (0.9 µgSn/kg) was an order of magnitude below the NAGD (2009) screening level (9 µgSn/kg).

TBT was detected in three samples collected in April 2014 on the north side of EAW (URS 2014b) with the concentration in one sample (72.5 µgSn/kg) slightly exceeding the NAGD (2009) maximum level (70 µgSn/kg). It was concluded that this sample, collected from a layer of silty sediment which was noted to contain a 1 cm sand lens at approximately 0.8 m below ground level, may have presented with an elevated TBT level due to the presence of antifoulant paint in the sand lens. Sediments collected from within the proposed MIP dredging footprint by Douglas Partners (2015) were not tested for TBT.

During the recent geochemical assessment (AECOM 2020) for the Project, TBT was not detected in any of the samples collected within the dredging footprint. One sample collected from within the proposed reclamation area returned a detection of TBT above the ANZG (2018) high guideline value (GV-high). This sample was an isolated sample collected in an area historically utilised to dispose of impounded vessels, suggesting that this sample possibly contained a remnant of anti-foulant paint from these activities. It is not expected that this sample is representative of a wider contamination issue given that no TBT was detected at other sediment sampling sites during this study, or during sampling undertaken onshore during the terrestrial site investigation (Appendix N: Preliminary Site Investigation). Any contaminants detected within the reclamation area will be filled over and remain largely undisturbed throughout the construction and operational use of the Project site.

7.4.6.6 Nutrients

Nitrogen and phosphorus are major plant nutrients and their availability in marine systems most often determines the limits on plant growth. An overabundance of bio-available nitrogen and phosphorus can lead to the eutrophication of waterways and the proliferation of macroalgae and phytoplankton, which can choke estuaries and other confined marine systems. Large quantities of these nutrients can be held in sediments, mostly in non-bio-available forms. However, no guideline criteria are available for sediment nutrient levels.

Sediment samples collected by URS (2008) returned average total nitrogen levels of 581 mg/kg in the main body of the Harbour, and 355.6 mg/kg in East Arm. Sampling undertaken by URS (2012, 2014a, 2014b) in the vicinity of EAW found nitrogen to be present predominantly as organic nitrogen (Total Kjeldahl Nitrogen [TKN]) with a minor inorganic component (nitrate + nitrite). Concentrations at the sites on the south side of EAW (95% UCL of 260-382 mg/kg) were lower than those observed to the north (797 mg/kg). Douglas Partners (2015) also found TKN to be the dominant form of nitrogen in sediments collected from within the proposed MIP dredging footprint, where total nitrogen concentrations ranged from 110-2330 mg/kg; the higher concentrations (>1,000 mg/kg) were present in sediments collected from within the mangroves.

Mean total phosphorus levels in samples collected by URS (2008) ranged from 314.5 mg/kg in the main body of the Harbour to 508.5 mg/kg in East Arm, which is within the range of that reported by Parry et al (2002) in a similar study. Phosphorous concentrations in sediments collected by URS (2012, 2014a, 2014b) were higher to the north of EAW (95% UCL of 678 mg/kg) than to the south (176-408 mg/kg). In sediments collected from within the proposed MIP dredging footprint (Douglas Partners 2015) phosphorous concentrations ranged from 78-913 mg/kg; unlike for nitrogen, the higher concentrations were not necessarily present within mangrove sediments.

AECOM (2020) found TKN and total nitrogen (as N) concentrations ranged from 90 mg/kg to 560 mg/kg with a 95% UCL of 311 mg/kg. The results indicated that nitrogen was present predominantly as organic nitrogen (TKN) with a minor inorganic component (nitrate + nitrite). Total phosphorus concentrations ranged from 134 mg/kg to 1290 mg/kg with a 95% UCL concentration of 753 mg/kg.

7.4.6.7 Radionuclides

AECOM (2020) reported that alpha- and beta-emitting radionuclides were detectable in all samples collected from within the Project dredging and reclamation footprint, though the 95% UCL for total gross levels (1314 Bq/kg dry weight) was well below the NAGD (2009) screening level of 35,000 Bq/kg dry weight.

7.4.6.8 Potential Acid Sulfate Soils

In the Darwin region, PASS has been identified in association with mangrove sediments (e.g. Hill & Edmeades 2008). The materials to be dredged as part of the Project were sampled by AECOM (2020) and an assessment of the potential risk associated with ASS was undertaken. All sediments sampled were identified as having the potential to be acid generating (to varying degrees) if left in an oxygenated environment post-dredging. The outcome of that assessment is summarised below:

- No existing acidity (indicated by titratable actual acidity) was reported in any of the samples.
- All samples reported potential acidity (chromium reducible sulfur [percentage sulfur (%S)]) ranging between 0.04%S and 0.23%S, indicating presence of PASS (i.e. un-oxidised sulfides) which could generate acidity upon oxidation.
- The sum of existing and potential acidity in all samples exceeded the action criterion (as per Simpson et al [2018]) of 0.03%S.
- All samples reported some acid neutralising capacity (ANC) ranging between 1.57%S and 18.5%S. ANC is noted potentially due to the abundance of naturally occurring calcium carbonate such as shell fragments and coral skeletons as observed in the field. The ANC ranged between 19 and 231 times greater than the sum of existing and potential acidity concentrations; well within the adopted criterion of ANC being greater than 15 times the total acidity of samples (as per Simpson et al [2018]).

7.4.7 Waste and pollution

DLRM (2014) estimated that 30% of the land within the Darwin Harbour catchment was developed. About 13% of the developed area was subject to urban and other intensive land uses in and around the cities of Darwin and Palmerston, including residential living, manufacturing, industry, roads, airport infrastructure and defence facilities. Skinner et al (2009) note that runoff from urban areas contain a disproportionately high pollutant load relative to that from non-urban areas. The remainder of the developed area comprised rural land-uses, including horticulture and agriculture. Non-polluting uses (e.g. remnant native vegetation, surface water supply, conservation areas) were considered by the Darwin Harbour Advisory Committee (DHAC 2003) to occupy the remaining 70% of the Darwin Harbour catchment.

The Elizabeth River, which enters Darwin Harbour at East Arm, has the second largest catchment of the rivers entering Darwin Harbour (the largest is the Blackmore River that enters Middle Arm [Padovan 2001]). Skinner et al (2009) estimated that 58% of the Elizabeth River catchment area comprised native vegetation with minimal disturbance, rural land use (such as irrigated crops and rural living) accounted for approximately 39% of the catchment area and only 2% was considered to support urban or industrial land uses. Undeveloped land (predominantly mangrove communities) fringes the river over a distance of some 25 km between the rural land use areas and East Arm; this has the potential to act as a buffer to reduce the amounts of pollutants reaching East Arm from sources in the upper catchment.

Some 3 km upstream of the Project location is Hudson Creek, which has a history of livestock export and light industrial uses and which receives inputs from the Darwin Correctional Centre's Sewage Treatment Plant (KBR 2020). It also includes rural and urban land; Skinner et al (2009) calculated that 50% of the catchment supported urban or industrial land uses.

Approximately 6 km upstream of the Project location, the Palmerston Wastewater Treatment Plant discharges treated effluent into Myrmidon Creek; this enters the Elizabeth River estuary at the head of East Arm. The mass loadings of the nutrients in the release from the Plant in 2005-06 were 40 tonnes of ammonia, 69 tonnes of Kjeldahl nitrogen and 18 tonnes of phosphorus (Power and Water Corporation 2006); it appears that no more recent data are publicly available. Skinner et al (2009) noted that treated sewage effluent was the dominant anthropogenic point source of nutrients to Darwin Harbour. However, based upon the data of Butler et al (2013), Munksgaard et al (2018) considered that the water body in Darwin Harbour is generally nitrogen limited. Burford et al (2008) determined that the main input of nitrogen to the Harbour was from the open ocean, while inputs from rivers and wastewater treatment plants entering the Harbour were relatively minor.

Industrial, urban and rural land uses all represent sources of potential pollutants that may accumulate in the Project dredging area. The mean annual pollutant loads contributed to the Harbour from the Elizabeth River, Hudson Creek and Myrmidon Creek catchments were estimated by Padovan (2001) based upon the 1995-96 and 1996-97 wet seasons, and by Skinner et al (2009) for the 2006-07 wet season; these estimates are presented in Table 7-5. A fourth catchment, Palmerston South, also discharges into the Elizabeth River, though the pollutant loads predicted by Padovan (2001) and Skinner et al (2009) were markedly lower than those from the Elizabeth River and Hudson Creek catchments. Waterways entering Darwin Harbour with potential waste and pollution loads are displayed in Chapter 4: Environmental Setting, Figure 4-6.

Environmental factors that may potentially affect the distribution of contaminants within Darwin Harbour, and hence could influence the concentrations of contaminants in the sediments of the Project dredging footprint, include:

- Strong tidal currents that readily mobilise seafloor sediments on flood and ebb tides, especially during spring tide periods.
- Eddies in water flows that enhance the settlement of sediments from the water column in certain areas (such as at the eastern end of EAW).
- Wind-driven water circulation that can redistribute large amounts of seafloor sediments, particularly during tropical storms and cyclones.

Each of these factors would primarily influence the distribution of fine sediment fractions, to which many metals are typically bound at higher densities (Batley 1995, Munksgaard & Parry 2002, Welch et al 2008).

Munksgaard et al (2018) noted that sediments provide time-integrated measures of net accumulation of contaminants at a location; these are independent of the seasonal and tidal variations in contaminant concentrations within the overlying water column.

Table 7-5 Estimated mean annual pollutant loads to East Arm from Elizabeth River and Hudson Creek

	Elizabeth River			Hudson Creek			Myrmidon Creek		
	1995-97	2006-07	Change	1995-97	2006-07	Change	1995-97	2006-07	Change
Nitrogen (t)	69	72	+3	15	14.4	-0.6	1.4	1.76	+0.36
Phosphorus (t)	3.5	3.56	+0.06	3	1.32	-1.78	0.1	0.15	+0.05
Arsenic (kg)	70	54	-16	40	14	-26	2.0	1.64	-0.36
Cadmium (kg)	14	18.6	+4.6	6	3.17	-2.83	0.2	0.4	+0.2
Chromium (kg)	156	202	+46	220	55.9	-164.1	3.0	6.51	+3.51
Copper (kg)	373	576	+203	189	308	+119	10.0	31.6	+21.6
Lead (kg)	132	428	+296	327	287	-40	2.0	33.2	+31.2
Nickel (kg)	138	98.8	-39.2	43	19.2	-23.8	2.0	2.35	+0.35

	Elizabeth River			Hudson Creek			Myrmidon Creek		
	1995-97	2006-07	Change	1995-97	2006-07	Change	1995-97	2006-07	Change
Zinc (kg)	1,638	2,300	+662	1,860	969	-891	12.0	108.0	+96.0

7.4.8 Dredged material settlement ponds

Should disposal of dredged material be required to occur onshore (other than where dredged material is utilised on site as fill for reclamation purposes) it may be directed, via floating and/or onshore pipelines into the existing settlement ponds at EAW. These ponds have historically been used for this purpose and have received dredged material removed during the construction of the MSB (to the west of the Project site) and the MUBRF (adjacent to the Project site to the east).

It is anticipated that these ponds would be used only if dredged material is found to not be of the required nature to be utilised as fill at the Project site. The settlement ponds are managed by Darwin Port and water quality is monitored for toxicants prior to discharge into Darwin Harbour.

7.4.9 Surveys and studies undertaken

Table 7-6 provides a summary of the marine water quality and sediment surveys undertaken to support the Project assessments.

Table 7-6 Marine water and sediment surveys and studies undertaken for the Project

Date	Title	Author	Content	Report
August 2018	SLAMI FEED Study Geotechnical Investigation Report	SMEC	Presents the results of the geotechnical site investigation by SMEC for the Project FEED study. It summarises the geotechnical investigations, including factual and interpretive information.	Not provided
August 2020	Marine sediment geochemical assessment	AECOM	Undertaken to: - characterise the sediments to be dredged during the proposed capital dredging - assess the chemical characteristics of the sediments against criteria levels in NAGD (2009) - inform an assessment of the need for implementation of management and monitoring measures (specific to contaminants in, or acidification of, decant water in the reclamation area) during the dredging works.	Appendix H: Marine Sediment geochemical Assessment Report
Oct. – Nov. 2020 and Mar. – May 2021	Water quality surveys	AECOM	Two snapshot surveys (late dry season and late wet season) to describe water quality (turbidity and chemistry) in the vicinity of the Project site.	Appendix E: Water Quality Technical Reports
August 2020	Remote sensing of TSS	EnSTaR	Remote sensing comparison between current and historical TSS levels in East Arm.	EnSTaR (2021) Not Provided
November 2020	Hydrodynamic modelling (current assessment)	MOS	Predicted (modelled) effects on tidal currents in East Arm as a result of construction of the Project.	MOS (2020) Not Provided

Date	Title	Author	Content	Report
November 2020	Hydrodynamic and sediment transport modelling (dredging)	AIMS	Sediment transport modelling to assess the potential dispersion of dredge generated turbid plumes and potential sedimentation in the vicinity of the Project site.	Appendix I: Sediment Transport Modelling Technical Report

7.5 Potential impacts and risks

This section contains an assessment of the potential impacts to marine water and sediment quality, the key aspects of marine environmental quality (e.g. from waste materials, existing site contamination, acid sulfate soils, pollutants in stormwater runoff from the Project site, discharges from marine traffic).

The risk register identified all apparent potential risks associated with the Project. This was used to focus the EIS upon where the greatest risks are predicted. Particular emphasis was placed on those unmitigated risks that exceeded the target quotient. Further information on the risk assessment process is presented in Chapter 6: Risk Assessment.

At the EIS risk assessment workshop, potential impacts and unmitigated risk ratings related to marine water and sediment quality associated with the Project were concluded to be Low. The rationale underpinning this conclusion for each source of potential impact is described in the following sub-sections.

Marine water and sediment quality are not considered end receptors; though it is through their alteration that ecological receptors may be impacted. Hence the following sections describe potential changes to water and sediment quality that may arise during Project construction and operation, while potential impacts upon ecological receptors as a result of these changes are assessed in Chapter 8: Marine Flora and Fauna of this EIS.

7.5.1 Marine water quality

7.5.1.1 Construction Phase Mobilisation of Sediment

Marine water quality of the Project area, and the surrounding areas of East Arm, will be temporarily impacted by the suspension of sediments during construction, predominantly as a result of dredging and associated activities, and to a lesser extent, land reclamation.

Specific construction activities with the potential to impact upon water quality are detailed in Chapter 2: Project Description and may include:

- dredging of approximately 500,000 m³ of material (estimated to comprise 185,000 m³ of unconsolidated material and 315,000 m³ of consolidated material) from the 9.2 ha dredging footprint
- disposal of dredged material either within onshore settlement ponds at EAW (if it is not suitable for use as fill material) or as fill to complete reclamation within the Project footprint
- return to the Harbour of tailwater from onshore settlement ponds, or as runoff from reclamation activities
- pile driving (minor localised turbidity only)
- propeller wash from vessels associated with construction activities.

7.5.1.1.1 Dredging impacts

Dredging is the construction activity that will have the greatest potential to impact on water quality within East Arm, through the creation of turbid plumes. Dredging also has the potential to spread sediment-associated toxicants within the water column and across the seabed, though sediment analyses to date (Section 7.4.6) have not detected any contaminants of concern within the dredging areas. Hence the impact assessment in this chapter is focussed upon impacts on water quality from elevated turbidity and SSC levels.

Modelling of the dispersion of dredge plumes (Appendix I: Sediment Transport Modelling Technical Report) was undertaken by Simao and Tonin (2020) to provide predicted areas of SSC above background concentrations without the implementation of specific mitigation measures to minimise dredging related SSC. Dredging was modelled to represent a scenario which comprised the removal of unconsolidated material from the Project marine construction footprint (as described in Appendix I: Sediment Transport Modelling Technical Report); this included:

- Scenario 1: Base case SSC in Darwin Harbour under typical climatic conditions.
- Dredging of 324,800 m³ of unconsolidated sediments for disposal within the EAW ponds.

It is noted that the scenario modelled for this study does not completely align with the Project description as described in Chapter 2: Project Description of this EIS due to the evolving Project design since the modelling was completed. A comparison between the modelled dredging scenario and the present Project design is provided in Table 7-7.

Table 7-7 Modelled dredging campaign versus current Project design

Aspect	Modelled	Proposed
Volume of unconsolidated material	324,800 m ³	185,000 m ³
Volume of consolidated material	0	315,000 m ³
Material disposal location	Within the settlement ponds located at EAW.	Used as fill to construct the reclaimed area of the Project, or within the onshore settlement ponds at EAW if material is not suitable for use as reclamation fill.
Tailwater treatment and discharge to Darwin Harbour	Via the permeable section in the bund wall to the north of EAW, after water quality is deemed suitable for discharge. This scenario was modelled by AIMS (2013).	Where dredged material is used as fill, water will run off into Darwin Harbour adjacent to the reclamation area, with silt curtains used to manage turbid plumes. Where material is disposed into the EAW settlement ponds, the return of tailwater will be as described for the modelled scenario.

The modelled dredging scenario is used in this assessment as it provides a conservative prediction of areas of potential impact associated with the proposed dredging because:

- The volume of unconsolidated material to be dredged, and the area over which dredging will occur, have been reduced substantially compared to those upon which the modelling was based.
- Dredging and removal of consolidated material produces less intense plumes than dredging of unconsolidated material as fewer fine particles are released. The larger particle sizes generated settle more rapidly to the seabed, hence the plumes are not dispersed as widely as those from dredging of unconsolidated material.
- Results of the modelling show that turbidity during dredging is still predominantly affected by tidal currents and does not continue to increase over time as dredging progresses.

Model outputs for the dredging scenario comprised:

- 90th percentile plot of SSC
- 95th percentile plot of modelled SSC
- time series plots of SSC at points in the vicinity of the dredging footprint
- sediment accumulation one month after the cessation of dredging.

Predicted dredge plumes for the scenarios modelled are shown in Figure 7-2 and Figure 7-3 as SSC above background levels. Each 90th percentile contour delineates the distance from the source within which, for 90% of the time, the SSC is predicted to not exceed the contour value; and similarly for the 95th percentile contours. Further details of the modelling methods and each plot are provided in Simao and Tonin (2020) (Appendix I: Sediment Transport Modelling Technical Report).

Through interpretation of the sediment transport modelling and background investigations into tolerance to increased suspended sediments in the water column of the benthic communities present in East Arm, it is possible to identify zones where these communities may potentially be impacted by dredge plumes. The results of the modelling were used to inform the delineation of zones of influence and zones of moderate impact for marine ecological receptors; these are discussed below.

Modelling undertaken to predict suspended sediments in Darwin Harbour as a result of tailwater release from the EAW settlement ponds (AIMS 2013) indicated that, if these ponds are utilised for the treatment of tailwater and the proposed tailwater discharge criterion of 100 mg/L SSC is not exceeded, then any potential impacts arising from the discharge of tailwater through the permeable section of the railway bund wall are predicted to be limited to within a radius of approximately 120 m from the bund wall (Figure 7-4).

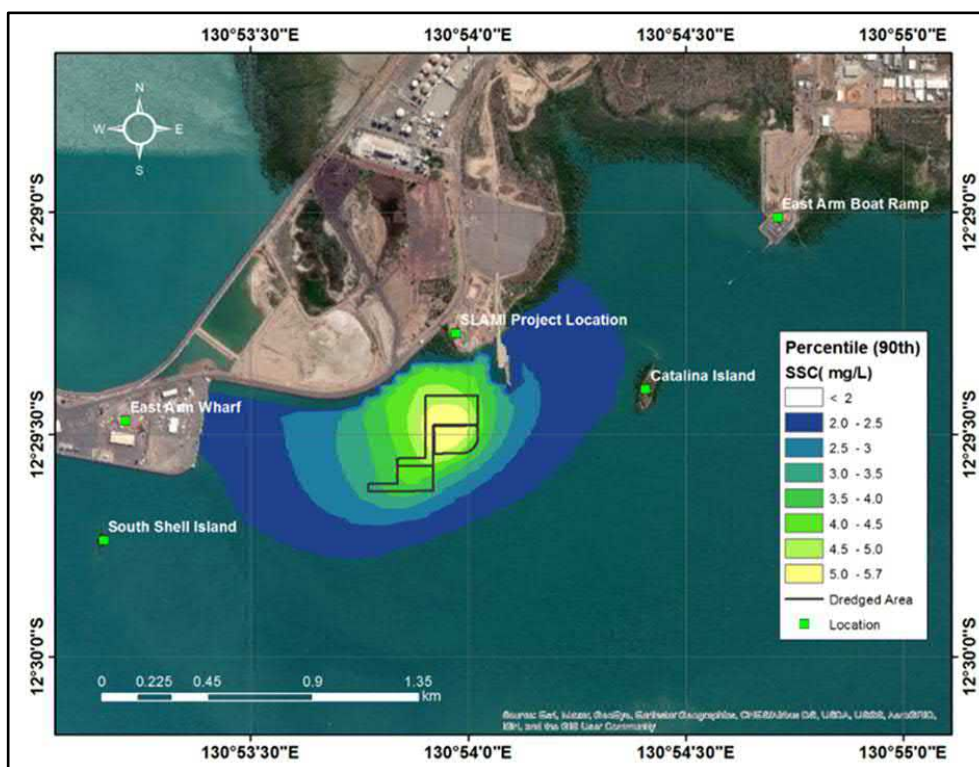


Figure 7-2 90th percentile modelled SSC (above background level) (mg/L)

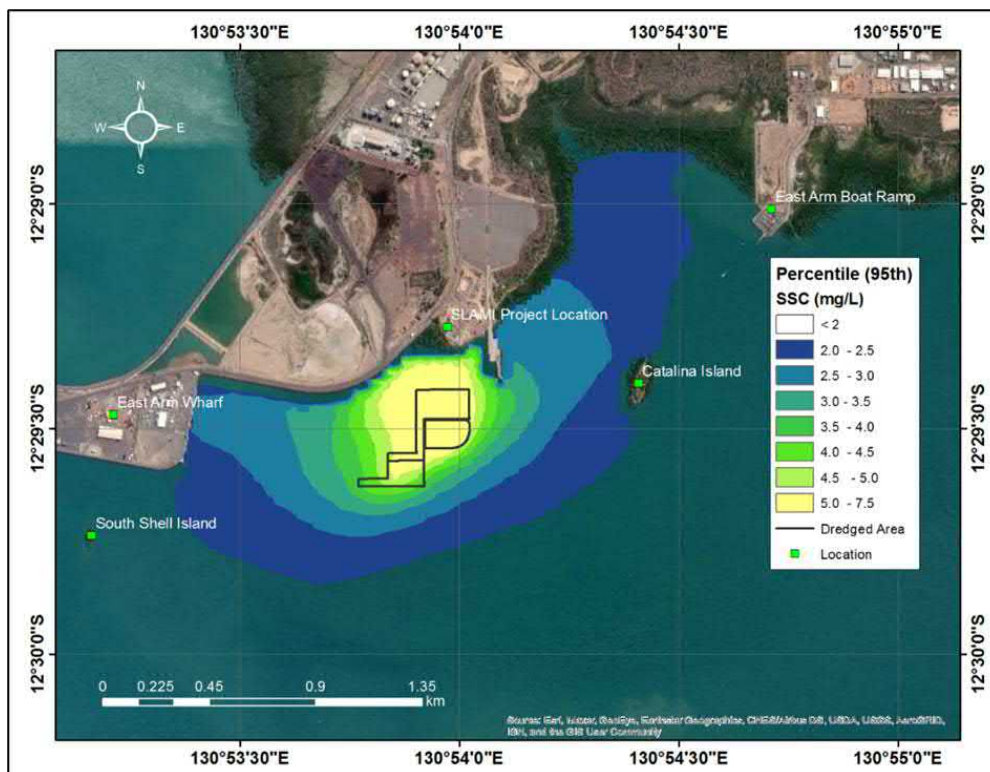


Figure 7-3 95th Percentile modelled SSC (above background level) (mg/L)



Figure 7-4 SSC (above background) outside the discharge location from the EAW settlement ponds showing the 90th and 95th percentile exceedance of 10 mg/L SSC

Tolerance Limits

Tolerance limits applied to dredging components of the EAW expansion project will be adopted for this Project. These tolerance limits are appropriate for use here as they were developed from baseline

data collected in East Arm in proximity to the nearest significant marine ecological receptors at South Shell Island. The data upon which these tolerance limits are based are discussed in Sections 7.4.4.2 and 7.4.4.7.

Tolerance limits were calculated from the appropriate (dry or wet season) subset of a one-year baseline dataset of water quality (URS 2011a), on the presumption that biological communities in East Arm are adapted to local conditions but will be stressed if exposed to conditions that regularly exceed the 95th percentile of normally prevailing background concentrations (calculated from URS 2011a).

As the sediment transport model calculates excess (above background) SSC predicted to be caused by the dredging, the median of the background concentrations was subtracted from the 95th percentile of the background concentrations to provide a comparable tolerance limit. This yielded a tolerance limit for dry season dredging of 10 mg/L and a wet season SSC tolerance limit of 25 mg/L.

Zones of impact and influence

Three zones of impact have been identified to represent varying degrees of direct and potential indirect impact to benthic communities as a result of the dredging activities to be undertaken during construction. The definitions of these zones are consistent with the WA EPA Technical Guidance for Environmental Impact Assessment of Marine Dredging Proposals (EPA 2016) and reflect the likely range of impacts of dredging on benthic habitats. The zones of impact and influence have been defined as:

- **Zone of High Impact:** this zone constitutes the direct footprint of the dredged area and a 20 m wide annulus around the footprint to account for smothering from coarse sediments liberated during dredging. Impacts in these areas are predicted to be severe and often irreversible.
- **Zone of Moderate Impact:** within this zone, damage to benthic habitats and mortality of benthic biota may occur, primarily as a result of the indirect impacts from increased turbidity and sedimentation that may occur at times over areas within the zone. Impacts within this zone are predicted to occur, but the disturbed areas may recover (after completion of the dredging and disposal operations). It is expected that there will be no long-term modification of the benthic habitats in this zone. The outer edge of the Zone of Moderate Impact is delineated by the 90th percentile contour plot for SSC, as defined by dredge plume modelling. This delineates the areas where, for 90% of the time, the predicted SSC is below the calculated tolerance for benthic communities (dredging-related SSC of 10 mg/L for East Arm communities during the dry season, 25 mg/L during the wet season). The 10% of time during which the SSC threshold is predicted to be met or exceeded is likely to represent periods of mid-flow tidal states (particularly during spring tides) and any one exceedance event is not likely to exceed two hours.
- **Zone of Influence:** this zone includes the areas in which, at some time during the dredging works, benthic communities may experience (detectable) changes in sediment-related environmental quality outside the natural ranges that are normally expected. However, the intensity, duration and frequency of these changes is such that any damage to benthic habitats is likely to be reversible, and no mortality of benthic biota is expected to occur. The outer boundary of this zone is delineated by the 95th percentile contour plot for SSC, as defined by dredge plume modelling. This reflects the area where, for 95% of the time, excess SSC from the dredging will be below the calculated tolerance for benthic communities (10 mg/L in the dry season, 25 mg/L in the wet season).

Based on the modelling results and the definitions of the zones of impact and influence above, it is apparent that sustained elevations in SSC from dredging activities are predicted to be generally limited to the vicinity of the dredging footprint.

From the modelling outputs presented in Figure 7-2 and Figure 7-3, it is apparent that the thresholds for the zones of moderate impact and influence (for both wet and dry seasons) are not predicted to be reached. This indicates that all impacts associated with dredging-related turbidity are predicted to fall within the area defined as the Zone of High Impact – the area of the dredging footprint plus a buffer of 20 m.

While the return flow of entrained water from the placement of dredged material for land reclamation purposes has not been modelled, it is anticipated that the suspended sediments within this water will be adequately managed through the use of silt curtains, such that turbid plumes will remain within the

spatial extent and intensity of the plumes modelled for the dredging activity. The nearshore areas into which the entrained water will flow are already typically highly turbid due to the resuspension of sediment on each ebb and flood tide cycle, and wind-driven waves generated within Darwin Harbour.

The potential implications for biological receptors of these predicted SSC elevations are described in Chapter 8: Marine Flora and Fauna.

7.5.1.1.2 Maintenance dredging

Maintenance dredging is expected to be required periodically (estimated at approximately every 10 years) to maintain safe navigable depths within the area under the ship lift, manoeuvring basin and all wet berth pockets. Since the dredge volumes are expected to be significantly lower than those assessed for construction, the impacts upon water quality in Darwin Harbour will be substantially lower and shorter lived than those described above.

Dredged material may be placed onshore (e.g. EAW ponds) or disposed of nearby within Darwin Harbour as is current practice for some locations within Darwin Harbour.

An assessment of the nature of material to be removed, predicted turbid plumes and potential environmental impacts of this small-scale dredging program would be required at the time of the planned dredging and would be subject to further environmental approvals.

7.5.1.1.3 Acid sulfate soils

AECOM (2020) assessed the risk associated with acid sulfate soils in the sediments to be dredged during the construction of the ship lift facility (Section 7.4.6.7). Based on this investigation, there is potential for acidification of sediments exposed to toxic environments; however, the neutralising potential of the sediments is expected to provide sufficient buffering to prevent acid production in these situations.

The use of PASS may become a risk during the construction of the Project should they be used as fill at the Project reclamation site. In this situation, it is possible that oxidation and acid generation may occur if the natural buffering in sediments is insufficient. If this situation were to occur, the pH of water running off the reclamation area may decrease, resulting in the leaching of metals from the sediments which could then be returned to Darwin Harbour.

There are a number of aspects of the reclamation process that are likely to mitigate against impacts of ASS. The natural buffering capacity of the material to be dredged was found to be high (AECOM 2020) and, should areas of ASS be disturbed during dredging, it is likely that these sediments will become well mixed with sediments of a higher buffering capacity, whether during the dredging process, during placement onshore or as it is moved around the site to progress the reclamation. Should ASS become oxidised to the point where acid is generated, and metals are leached from the sediments, the potential for detectable impacts to occur within the receiving environment is considered to be low as the volume of water running off the reclamation site is likely to be limited and it would rapidly mix, neutralise and disperse within the Harbour waters.

A DDSPMP will be developed for the Project; this will include a procedure for the identification, monitoring and management of ASS that will be implemented throughout, and subsequent to, the dredging campaign.

Where the EAW settlement ponds are utilised for the placement of dredged material, the monitoring and management of PASS will include placement into areas of the ponds where it can remain submerged (i.e. unable to oxidise) and monitoring of tailwater will be carried out prior to release from the ponds to detect any acidification or elevated metals concentrations that may impact upon the water quality in Darwin Harbour. Details of this process will be included in the DDSPMP developed for the Project.

7.5.1.1.4 Pile driving

Pile driving activities are likely to result in localised water quality impacts through increased turbidity and SSC. Most pile driving will take place close to shore (Chapter 2: Project Description) and these increases are predicted to be substantially less those associated with dredging. They will also most likely be indistinguishable from the natural turbid plumes that arise from suspension of seabed sediments by currents on each ebb and flood tide.

Hence it was considered that these will represent insignificant incremental increases in turbidity and SSC which did not warrant modelling. Further, it is evident from the modelling results presented in Figure 7-2 and Figure 7-3 that plumes emanating from sediment disturbance close to shore remain localised in the Project development area within East Arm. There is no indication that plumes arising from pile driving would encroach upon benthic communities that are sensitive to increased turbidity or SSC to the extent that adverse effects could occur.

7.5.1.1.5 Propeller wash from vessels associated with construction activities.

Propeller wash from Project-related vessels (tugs, workboats, survey vessels, anchor handling boats, etc.) in the comparatively shallow water of the construction area, particularly at low tide, could be expected to resuspend sediment due to the turbulence created by propellers coming into close proximity to the seabed. This typically results in localised redistribution of sediment, raises the SSC in the water column and causes increased levels of turbidity in the immediate vicinity of the vessel. Plumes caused by propeller wash are small (when compared to those created by dredging activities and tidal flows) and their effects on surrounding water quality are typically short lived. It is also noted that if transport (by vessel) of dredged material to shore occurs during land reclamation, then plumes generated by these vessels in shallow water will already be within a high turbidity environment and will most likely be within the dredging and reclamation footprint.

7.5.1.2 Chemical or Hydrocarbon Release

Based on the construction activities and potential future use of the Project facilities, impacts resulting from unplanned chemical, or hydrocarbon release may occur. Short-term impacts during the construction phase are possible with increased vessel activity in the marine environment and the introduction of vehicles and heavy machinery in the intertidal zone, increasing the potential for any chemical or hydrocarbon spills to be carried into the marine environment.

Potential causes of such spills include:

- spills during refuelling of machinery or vessels
- blowouts in hydraulic systems on vessels or heavy machinery
- contaminated runoff entering the water from dirty vessel decks and machinery
- vessel collision or other vessel operational incidents.

Potential impacts associated with chemical or hydrocarbon spills will persist into the operation phase of the facility and will largely be the result of operations over water. Possible causes of such spills include:

- blowout or failure of hydraulic winches operating the ship lift
- failure of hydraulic systems aboard vessels operating within the Project area
- spills occurring as a result of vessel collision
- release of small quantities of hydrocarbons from vessel exhaust and bilge water.

The Project will not provide bunkering facilities; however, refuelling of smaller vessels may be carried out from mobile tankers entering the facility.

7.5.1.3 Wastewater and Stormwater run-off and erosion control

Wastewater and stormwater management control are discussed in Sections 2.2.13 and 2.2.14 respectively. During operations of the facility stormwater runoff from hardstand areas will be captured and likely treated with traps to remove hydrocarbons (e.g. Ecosept or similar treatment system) prior to discharge to Darwin Harbour. Wastewater from the washdown bay and blast paint facility will be treated and re-used on site where possible or disposed of to the sewer system or Darwin Harbour depending on the final water quality achieved. Design principles applied to the Project will reduce the potential for impacts to marine water during construction and operation of the facility. These principles include the integration of capture, diversion and treatment facilities to manage the quality of any water leaving the Project site, particularly water entering the marine environment. Any discharge to Darwin Harbour during facility operations will be in accordance with relevant standards such that beneficial uses of water for Darwin Harbour are protected.

Surface water runoff has the potential to transport sediment or other pollutants into the adjacent marine environment during construction. Stormwater will be managed and monitored on site in accordance with an ESCP which will include measures to capture and, if necessary, treat stormwater on site during construction, prior to controlled discharge via existing stormwater drainage networks. Stormwater from outside the Project area will be prevented from entering the Project site via diversion from surrounding areas outside of the construction footprint into existing stormwater networks.

Stormwater and wastewater management and treatment systems will be incorporated into the ship lift facility design, with all stormwater to be either:

- reused on site
- disposed of to the sewer via a trade waste agreement with PWC
- treated and discharged into the Harbour within environmental compliance obligations and pursuant to an approved license should one be deemed to be required.

The measures for wastewater, water treatment and stormwater management are discussed in detail in Sections 2.2.13 and 2.2.14.

7.5.2 Marine sediment

Potential impacts to marine sediments in the vicinity of the Project may arise as a result of construction and/or operational phase activities. Impacts to marine sediments may result where a toxicant that is carried into the marine environment settles to the seabed and accumulates in the sediments. The potential pathways for such impacts include those associated with:

- spills of contaminants during the construction phase either onshore, where the pollutant is carried into the marine environment, or directly into the marine environment
- acute impacts associated with spills, or chronic releases of contaminants from land or water-based activities, during the operational phase.

As discussed in Section 7.5.1.3, onshore activities are considered unlikely to impact sediment quality as stormwater and wastewater will be collected and treated prior to controlled discharge.

Unplanned releases may or may not impact marine sediments, depending on the quantity and type of pollutant released. Where a pollutant is dense enough to sink to the seabed, it may accumulate in the sediment. Where a pollutant is buoyant, it may wash ashore where it could impact upon sediments in the intertidal zone.

Incidental discharge of contaminated water, and ongoing shipping and vessel maintenance activities, may have the potential to impact sediment quality as a result of chronic build-up of contaminants such as heavy metals or hydrocarbons.

7.6 Mitigation and management

To manage marine environmental quality risks during construction and operation, mitigation measures have been proposed. Table 7-8 identifies the relevant Project phase, aspect to be managed and proposed potential mitigation measures.

Table 7-8 Mitigation measures for marine environmental quality

Phase	Aspect	Proposed mitigation measures
Construction	Dredging & spoil disposal - liberation of sediments into water column	Preparation and implementation of a DDSMP, approved by regulatory bodies, which includes a tiered response plan that is based on monitoring water quality in the vicinity of the operating dredge. Specific management measures that may be implemented as a trigger response may include: • slowing the cutter head speed or slew speed of the dredge, reducing the rate of disturbance at the cutter head

Phase	Aspect	Proposed mitigation measures
		- reducing or suspending dredging activity during certain tidal periods when the migration of dredge plumes towards South Shell Island is greatest - relocating the dredge to an alternate dredge face. - Repairing pipeline joints to eliminate leakage of spoil - temporary cessation of dredging - deployment of silt curtains.
Construction	Potential to generate acidic and metal drainage/runoff	A Construction Environment Management Plan (CEMP) will be prepared which will include: - ASS Management Plan reflecting national standards and current best practice - ESCP - adoption of suitable construction methodologies to minimise mud waving. ASS management associated with placement of dredged material will be incorporated into the DDSPMP, with management based on National ASS Guidelines.
Construction	Discharge of sediment and associated contaminants from exposed soil during earthworks	- design considering WSUD - construction methodologies developed to contain reclamation material - soil contamination investigations prior to EIS preparation to determine level of contamination and remediation (if required) - unexpected finds protocol (ASS and contamination) - preparation and implementation of a CEMP containing an ESCP reflecting relevant Australian Standards - use of silt curtains during reclamation activities to remove silt from runoff prior to, and within, the marine environment.
Construction and Operation	Reportable spills (hydrocarbons, chemicals, paints, etc.) into marine environment	- engaging with Port of Darwin regarding the Port Environmental Protection Plan - preparation and implementation of a Marine Spill Response Plan in line with the existing Darwin Port Oil Spill Contingency Plan. The plan will also reference the NT (DIPL Marine) OSCP - compliance with AS1940-2004 (Storage and handling of flammable and combustible liquids) - preparation and implementation of a refuelling management plan - spill kits to be located at suitable locations on site during construction and operations and appropriate personnel trained in use.
Operation	Discharge of contaminants such as heavy metals and organic compounds in stormwater runoff from impervious surfaces	- stormwater treatment system to be installed during Project construction - OEMP to include mitigation to reduce build-up of contaminants on hardstand areas.

7.7 Statement of residual risk

Assessments of the risks of potential impacts on marine environmental quality are summarised in Table 7-9. Risks were assessed both prior to mitigations and following the implementation of mitigation to provide an assessment of residual risk.

The residual risk assessment indicated that there is a Low risk of impacts upon marine environmental quality (water and sediment quality) from any of the impacts identified during this assessment.

The mitigation, monitoring and management procedures proposed, in addition to the in-built design mitigations, are considered sufficient to reduce potential impacts to marine sediment and water quality to a level where they do not pose a risk of significant impact to the marine environment.

Table 7-9 Pre and post-mitigation risk assessment for marine environmental quality

Phase	Aspect	Pre-mitigation risk rating	EIS mitigations	Post-mitigation risk rating
Construction	Dredging and spoil disposal - liberation of sediments into water column	Medium	A DDSPMP will be developed that incorporates mitigation and management to minimise the impacts of suspended sediments on benthic communities Modelling and assessments to support this EIS	Low
Construction	Disturbance of ASS - Potential to generate acidic and metal drainage/runoff	Medium	A CEMP which includes: • ASS Management Plan • unexpected finds protocol • ESCP • suitable methodologies to minimise mud waving	Low
Construction - earthworks	Earthworks - Discharge of sediment and associated contaminants from exposed soil during earthworks/construction phase	High	Construction methodologies Soil contamination investigations prior to EIS (Appendix N) A CEMP which includes: • ASS Management Plan • unexpected finds protocol • ESCP DDSPMP Use of silt curtains during reclamation activities	Low
Construction and Operation	Reportable spills (hydrocarbons, chemicals, metals, paints etc) into marine environment	High	Engaging with Port of Darwin regarding the Port Environmental Protection Plan Marine Spill Response Plan in line with the Darwin Port OSCP and (DIPL Marine) OSCP Compliance with AS1940-2004 (Storage and handling of flammable and combustible liquids) Refuelling management plan Spill kits located on site and appropriate personnel trained in their use	Low
Operation	Discharge of contaminants (stormwater)	High	Stormwater and wastewater system maintenance OEMP to include mitigation to reduce build-up of contaminants on hardstand areas	Low

7.8 Monitoring and reporting

Monitoring of impacts to water quality during the construction phase of the Project will be specified in the DDSPMP to be developed for dredging works, and in the CEMP.

Monitoring will be undertaken:

- surrounding the dredge when the dredge is operating
- within the dredged material placement ponds (where ponds are being used) prior to the discharge of tailwater, at any time when tailwater is being discharged
- in the vicinity of reclamation works where dredged material is being placed onshore to construct the hardstand area and rock revetments, to assess the effectiveness of sediment and turbidity control measures implemented by the Construction Contractor to manage runoff
- at any stormwater discharge locations into Darwin Harbour where surface water is collected from the Project site during construction
- at appropriate reference sites sufficiently distant from the works to not be impacted by dredging and / or reclamation works
- at sensitive receptor sites such as South Shell Island, if water quality trigger levels (set out in the DDSPMP) are exceeded.

7.8.1 Routine monitoring the operating dredge and pipelines

Monitoring to be undertaken around the operating dredge will be detailed in the DDSPMP developed by the dredging Contractor but may comprise water quality profiles measuring turbidity through the water column at a location 150 m down-current of the operating dredge, and 150 m down-current of the pipeline conveying the dredged material to shore (if a plume is emanating from it). A rolling average of measured turbidity over a seven-day period would be used to assess compliance with trigger levels developed for the Project.

Results of monitoring will be reported by the dredging Contractor to DIPL in daily site reports, and to the NT EPA on the completion of the dredging campaign.

Where a trigger level for suspended sediment is exceeded:

- the exceedance will be reported by the dredging Contractor to the DIPL within 24 hours of the exceedance occurring
- a report on corrective actions implemented to address the cause of the exceedance will be submitted by the dredging Contractor to DIPL within two business days of the notification
- the dredging Contractor will notify DIPL of the outcome of their investigation into attributability of the exceedance to dredging within three business days of the notification.

7.8.2 Routine monitoring within onshore dredged material placement ponds

Should dredged material be placed into onshore dewatering ponds, tailwater within the ponds will be monitored, prior to release, for suspended sediments, toxicants and pH. Tailwater will be sampled near the discharge location and, where an exceedance is detected, tailwater release will be ceased until further monitoring indicates that the water quality is within the approved limits for discharge (i.e. within a WDL).

7.8.3 Routine monitoring adjacent to reclamation works

Where land reclamation works are being undertaken, monitoring of water quality in Darwin Harbour will be undertaken at a distance of 150 m down-current of the works to assess SSC associated with construction. The same trigger levels as those applied for dredging-generated SSC will be applied as these are based on the tolerance limits of benthic communities in Darwin Harbour.

This monitoring will be undertaken in addition to any monitoring undertake for dredging works (Section 7.8.1); however, where a plume generated by dredging and reclamation works is coincident at a distance of 150 m from construction, these may be sampled together.

7.8.4 Routine monitoring of stormwater discharges to Darwin Harbour

Monitoring of stormwater will include laboratory analysis of water for the presence of toxicants (metals and hydrocarbons) and suspended sediments. Monitoring will be undertaken at the time of a first flush, and then at regular intervals as specified in the CEMP to be developed by the Construction Contractor, when water is discharging to Darwin Harbour.

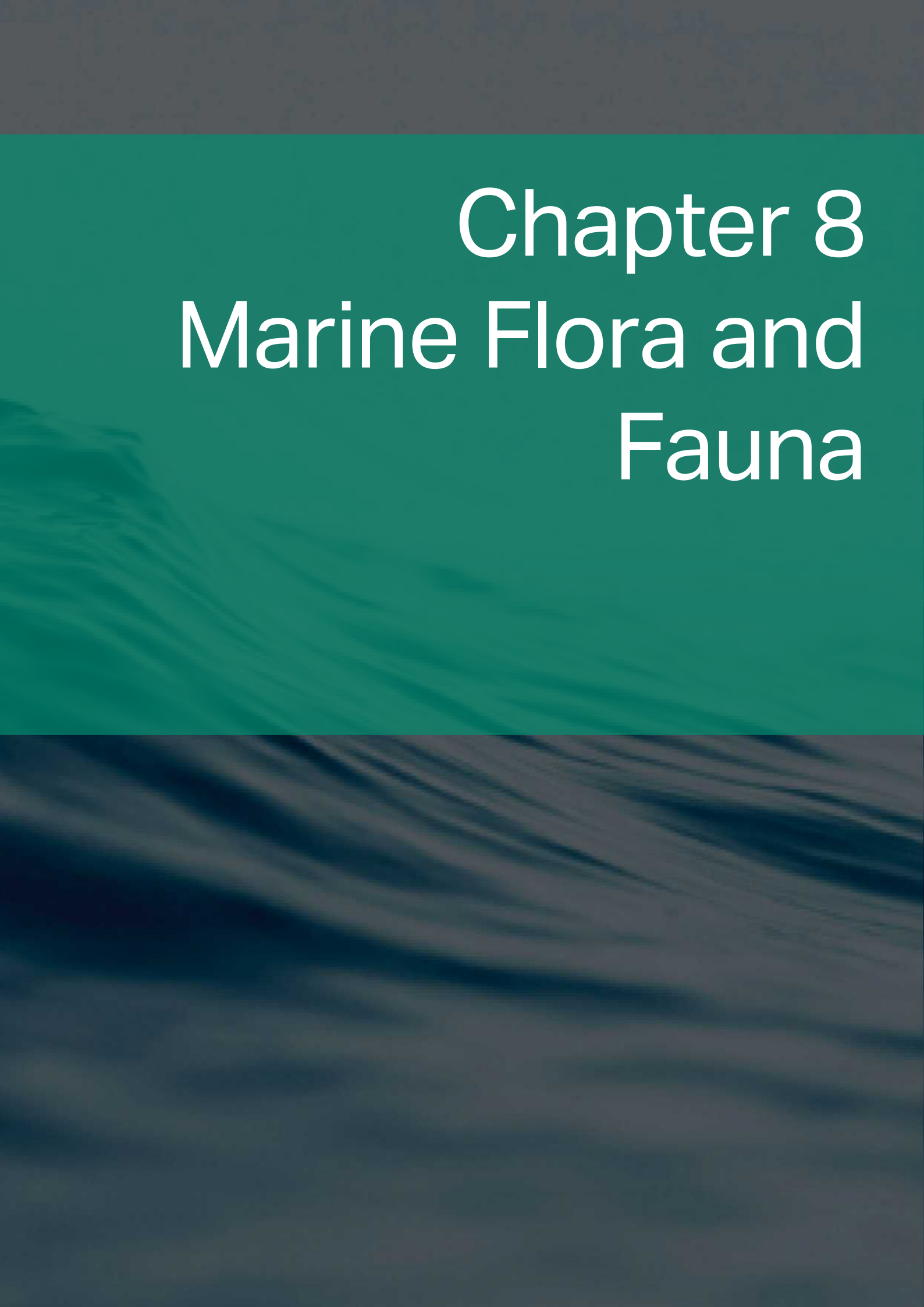
7.8.5 Spill event monitoring

Marine Spill Response Plans will be developed for the construction and operation phases. These will include reactive sediment and water quality sampling frameworks that will be implemented in the event of an unplanned release of a pollutant. The specific sampling locations and parameters monitored will be determined based on the location, extent and nature of the spill.

7.8.6 Reporting

All routine reporting during the construction phase will be reported in daily site environmental reports. Where an exceedance is detected, this will be communicated by the Construction Contractor to DIPL within 24 hours and an attributability assessment undertaken. A report on the attributability assessment and the management measures implemented will be provided to the DIPL within a suitable timeframe to be determined in the DDSPMP, CEMP or OEMP.

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Chapter 8

Marine Flora and Fauna

8.0 Marine Flora and Fauna

8.1 Introduction

The ToR identifies marine flora and fauna as a key environmental factor that could be significantly impacted by the Project. The objective associated with this factor is to:

“Protect marine flora and fauna so that biological diversity and ecological integrity are maintained.”

The relevant ToR requirements for marine flora and fauna are summarised in Table 8-1. Compliance of the EIS against the full ToR is documented in Appendix A: Terms of Reference.

Table 8-1 ToR compliance table for marine flora and fauna

ID	Terms of reference requirements	EIS section number
Table 4: Minimum information required for assessment of marine flora and fauna		
1.0 Environmental values		
1.0	As a minimum, describe and discuss within the context of the Proposal footprint, the zone of influence and Darwin Harbour:	Section 8.4
	the distribution, abundance, habitat utilisation and seasonality for species of conservation significance (including species listed as threatened under the <i>Territory Parks and Wildlife Conservation Act 1976</i> and marine megafauna)	
	the presence or likely presence of marine fauna and flora species with significant cultural, commercial and/or recreational value	Sections 8.4.1.7 and 8.4.3
	the quality and quantity of available habitat for significant species, and provide maps of the local extent of important habitat areas	Section 8.4.2
	the current status of marine pests and biosecurity measures	Section 8.4.3
	the importance of the local population of significant species in a regional, NT, national and international context	Section 8.4.3
	coastal habitat values, including mangroves and saltmarshes	Section 8.4.2, 10.6.4.1 and 11.2.2.1
	sensitive habitats with key ecological relationships and interdependencies (such as a food source for a threatened marine mammal), including benthic habitats and communities	Section 8.4.2
	detailed descriptions and fine scale maps (based on field verified modelling) of the benthic habitat and communities within the zone of influence, including reef communities, seagrass / macro algae, mangroves, intertidal and subtidal flats and keystone species. Keystone species information should be suitable to be used as baseline data to establish a pre-impact reference for seasonal presence and abundance.	Section 8.4.2
	broad scale maps of the regional context for benthic habitat and communities.	Section 8.4.2.1
	Use current data available from the Flora and Fauna Division, Department of Environment and Natural Resources and display findings in map format wherever possible.	Section 8.4.2.1
	Where important knowledge gaps exist, conduct surveys using appropriate methods and with sufficient sampling intensity to provide robust understanding of baseline conditions.	Section 8.4.2.1

ID	Terms of reference requirements	EIS section number
2.0 Potential impacts and risks		
2.1	Describe potential impacts and risks to marine flora and fauna during construction and operation, including but not limited to:	
	• collision with vessels	Section 8.5.1
	• grounding vessels	Section 8.5.1
	• disturbance through light, noise and vibration (e.g. temporary and permanent increase in underwater noise)	Section 8.5.7 and 8.5.3
	• changes in water and sediment quality, and exposure to contaminants (including increased particulate matter; hazardous chemicals from spills and runoff; contact with acid sulfate soils and antifoul products; metal loading [e.g. from corrosion control]; bioaccumulation in the food chain)	Section 8.5.7
	• loss of foraging habitat	Section 8.5.2
	• the introduction or spread of marine pests or weeds.	Section 8.5.8
	Include a detailed assessment of the nature and extent of the likely short-term and long-term impacts, including cumulative impacts, to marine species of conservation significance, and culturally, commercially and recreationally significant species in the local, regional and Territory context. The assessment should as a minimum:	Section 8.5
	• Include a discussion (with reference to maps showing important habitat areas) of areas to be disturbed or altered by the proposed action, making clear how they will be disturbed or altered and how much potential habitat will be lost or impacted permanently and temporarily.	
	• Identify potential impacts and threshold levels of underwater noise, including cumulative exposures, for species of conservation significance. This should include an evaluation of key construction and operational activities with elevated underwater noise e.g. pile-driving, dredging, shipping, rock placement, ship lifting and other operational activities with modelling taking into account geo-acoustic properties (sediment type and sediment thickness, depth, bathymetry, sound speed profiles (seasonal and spatial) and other relevant oceanic / environmental variables). Demonstrate how the model will be validated. Consider impacts experienced at similar facilities elsewhere.	Section 8.5.7, Appendix G
	• Provide a statement whether any relevant impacts to significant marine species and habitats are likely to be unknown, unpredictable or irreversible and the significance of any permanent loss of habitat on marine ecosystem integrity at an appropriate scale.	Section 8.7
	Include references to relevant research, statutory advice and statutory plans, such as conservation advices, action plans, recovery plans, threat abatement plans and health guidelines (where relevant to potential bioaccumulation), when assessing potential impacts and risks. Identify if and how the action is consistent with any relevant statutory recovery plans and threat abatement plans.	Section 8.2 and 8.5
3.0 Mitigation and management		
3.1	Outline the measures for avoiding, minimising, managing and mitigating potential impacts and risks to marine flora and fauna. These may be incorporated into management plans and address at a minimum:	
	• management for marine fauna of conservation significance	Section 8.6
	• underwater noise	Section 8.6
	• vessel traffic, including vessel strikes	Section 8.6
	• dredging operations	Section 8.6

ID	Terms of reference requirements	EIS section number
	biosecurity	Section 8.6
	contaminant load, including fugitive emissions (e.g. from sand/grit blasting and paint overspray) and other contamination sources	Section 8.6
	compliance with any statutory or policy basis for the proposed measures.	Section 8.6
4.0 Monitoring and reporting		
4.1	Outline how the Proponent will monitor and report potential impacts and risks to marine flora and fauna as outlined above, including: monitoring of benthic primary producer communities that contribute to marine fauna food chains	Section 8.8
	marine pest monitoring (such as marine pest settlement devices).	Section 8.8
	All monitoring activities should be substantiated and in accordance with advice from relevant Northern Territory Government advisory agencies.	Section 8.8
5.0 Residual impact		
5.1	Assess residual impact or risk of the Proposal to identified values.	Section 8.7

8.2 Legislation, policy and guidance

The legislation, policies, standards and guidelines of specific relevance to marine flora and fauna in the context of the Project are described below:

Commonwealth

- *Biosecurity Act 2015*
- *Environment Protection and Biodiversity Conservation Act 1999*
- National system for the prevention and management of marine pest incursions
- Anti-fouling and in-water cleaning guidelines.

Northern Territory

- *Environment Protection Act 2019*
- *Fisheries Act 1988*
- *Marine Act 1981*
- *Ports Management Act 2015*
- *Territory Parks and Wildlife Conservation Act 1976*
- Guidelines for the Environmental Assessment of Marine Dredging in the Northern Territory, Version 2.0.

Other relevant policies and guidelines

- Underwater Piling Noise Guidelines (South Australia)
- Technical guidance – protection of benthic communities and habitats (Western Australia)
- Environmental Assessment Guideline for protecting marine turtles from light impacts (Western Australia).

Those that are pertinent to marine environmental quality which, although if affected, may indirectly impact upon marine flora and fauna, are listed in Chapter 7: Marine Environmental Quality. Further information on the legislative and strategic context can be found in Chapter 3: Strategic and Statutory Framework.

8.3 Assessment methodology

Four studies of specific relevance to marine flora and fauna were undertaken:

- A desktop assessment was conducted and incorporated data from past studies that have occurred within the East Arm precinct and wider Darwin Harbour.
- A benthic habitat survey was undertaken by the AIMS in November 2020 (Case et al 2021) (refer Appendix F: Benthic Habitat Modelling Technical Report).
- The remnant mangrove community within the Project area was assessed during the PSI (refer Chapter 11: Other Environmental Factors (Section 11.2)).
- Modelling of underwater noise and vibration. This is detailed in Section 8.5.7 and a specialist subcontractor report is included as Appendix G: Underwater Noise Technical Report. The model outputs were used to predict the spatial extent of potential impacts, including behavioural disturbance, to protected marine species.

As some of these studies were conducted before the final Project footprint was decided, the footprint depicted in some of these reports differs from the final footprint. However, in all cases it is considered that the differences do not significantly alter the study outcomes, and they were taken into account when undertaking the risk assessment presented in Section 8.5.

8.4 Existing environmental values

8.4.1 Marine communities of Darwin Harbour

Darwin Harbour has a complex assemblage of marine ecological communities, including rocky shore biota, hard corals, filter feeders (primarily soft corals and sponges), macroalgae, seagrasses, soft sediment biota, mangroves and fish communities. Smit et al (2012), in their summary of previous benthic habitat mapping of Darwin Harbour, suggest that the benthic habitats present in the inner and outer harbour differ significantly and are typically characterised as follows:

- Outer harbour:
 - extensive seagrass communities occur in shallow waters
 - corals and algae dominate on hard substrates in shallow waters
 - deeper waters are characterised by filter feeder communities (e.g. sponges).
- Inner harbour
 - hard substrates in shallow and deeper waters consist of mixed communities or are dominated by sponge communities
 - no seagrass communities are present (though it is noted that, subsequent to the Smit et al [2012] report, there have been unpublished records of seagrasses around Wickham Point, and opposite the Channel Island boat ramp in Middle Arm).

8.4.1.1 Rocky shore communities

The general zonation of hard substrates in Darwin Harbour has been described by Ferns (1996) Russell and Hewitt (2000) and Smit (2003) and in environmental impact assessments for proposed developments. Zonation patterns can be seen with few species in the upper intertidal area and a greater number of species in the lower intertidal area where conditions are not as extreme (URS 2002).

In the intertidal area, exposed rocks are mainly colonised by oysters and barnacles while crevices, holes and underside of rocks are colonised by small molluscs (*Nerita* spp. and *Thais* spp.) and isopod crustaceans. At mean sea level (low intertidal) blue-green algae and diatoms form a dark band across the rock bed. The lower intertidal is further divided into two zones: an upper zone that has molluscs and crustaceans, soft corals, sponges, turf and brown algae (*Padina* spp.) and the lower zone represented by subtidal species covering the rocks (hard and soft corals, sponges, crustaceans, anemones and macroalgae) (Smit 2003).

8.4.1.2 Hard coral communities

Hard coral communities in Darwin Harbour are typically found from the lower subtidal to 5-10 m below LAT in areas where there are strong currents. The coral species present are tolerant to the variable salinity, high turbidity and sedimentation that exclude most coral species. A total of 123 species of corals were recorded in Darwin Harbour by Wolstenholme et al (1997).

Coral spawning is not known to have been observed in Darwin Harbour, although many of the species found reproduce by spawning elsewhere in the Indo-Pacific Region. Spawning in the NT aquarium has been observed around the full moon of October-November (Territory Wildlife Park, 2006).

8.4.1.3 Filter feeder communities

Previous studies have shown that Darwin Harbour has a relatively low diversity of sea whips (30-40 species in 40 genera) and other soft corals (20-25 species in 11 genera). Their poor representation was attributed to the turbidity of the water in the harbour and the combination of factors such as sedimentation, light availability, wave and flow exposure and steepness of reefs that control the abundance of soft corals (Fabricius & Alderslade 2001). Gorgonians (sea whips and sea fans) are generally restricted to areas that can be exposed to strong currents but are sheltered from wave action.

Sponge-dominated communities are widespread within the harbour, occurring in areas where hard substrate is available and coral-dominated communities are not established. These habitats can occur at any depth in the lower intertidal and subtidal areas. They are patchy by nature and often form a transition zone between hard substrates and the subtidal mud-dominated substrates. Substrates dominated by gravel and/or shell grit or sand-silt are the most favourable to sponge larval settlement. (Smit 2003).

8.4.1.4 Macroalgae

Macroalgae are present in Darwin Harbour and are often located on platform crests, generally a few metres on either side of the low water mark. Their abundance is seasonal, with turf algae dominating in October-December when the tidal range is at its greatest and low tides occur in the middle of the day causing the macroalgae to die back. During the dry season the larger macroalgae are more abundant. Substantial macroalgae-dominated communities have been recorded in East Point Aquatic Life Reserve and at Weed Reef (Smit 2003).

8.4.1.5 Seagrass

Seagrass communities are typically highly variable, with seasonal changes often significant. Within Darwin Harbour, the most extensive seagrass meadows are off Casuarina Beach and substantial seagrass meadows are not known to occur further south than in Fannie Bay (INPEX 2010). Seagrass communities in Darwin Harbour are largely dominated by *Halodule* spp. (e.g. *Halodule uninervis*) and *Halophila* spp. (e.g. *Halophila decipiens*) with *Cymodocea* sp. and *Syringodium* sp. also recorded (Geo Oceans 2011).

8.4.1.6 Soft sediment communities

It has been estimated that soft substrates cover about 80% of the seafloor of Darwin Harbour (McKinnon et al 2006). These substrates consist of mud and muddy-sand in the intertidal areas, various fractions of mud and sand in the subtidal areas, grading to coarser sediments in the channels.

The intertidal communities are dominated by polychaete worms while the more diverse subtidal communities have polychaete worms, crustaceans, echinoderms and sponges (Smit 2003). It has been estimated that Darwin Harbour has over 600 polychaete species (many of which may still be scientifically undescribed), over 1000 crustacean species and about 900 species of molluscs (McKinnon et al 2006).

Cardno (2014a) undertook four surveys of intertidal infauna to monitor the effect of dredging associated with the INPEX Ichthys project. The program included two baseline surveys, one survey during dredging and one survey at the end of dredging and monitored a number of control and impact sites around inner Darwin Harbour. Results supported earlier research in that the most abundant taxonomic group was polychaete worms followed by crustaceans, other worm phyla (e.g. nemerteans,

nematodes, phoronids and sipunculids), molluscs, echinoderms and other phyla (e.g. anemones, sponges and sea spiders).

In terms of taxon richness, crustaceans were represented by the greatest number of families/taxa, followed by polychaetes, molluscs, other worm phyla, other phyla and, lastly, echinoderms which comprised only two taxa (Cardno 2014a). The research detected a gradual, but statistically significant, decline in mean abundance and taxon richness across sites during the dredging campaign. However, as these declines were consistent at sites within both impact and control treatments, the broad-scale, harbour-wide changes measured could not be attributed to dredging (Cardno 2014a).

8.4.1.7 Fish communities

A survey conducted in 1997 found 415 fish species in Darwin Harbour, including 31 new records for the NT (Larson & Williams 1997). The most diverse group of fishes were gobies (70 species), cardinal fish (20 species) and pipefish (19 species). Fish species commonly harvested recreationally and by aboriginal fishers are found in the mangroves, such as Trevallies (*Caranx* spp.), Mackerel (*Scomberomorus semifasciatus*), Salmon (*Eleutheronema tetradactylum* and *Polydactylus macrochir*), Grunter (*Pomadasys kaakan*) and Barramundi (*Lates calcarifer*) (McKinnon et al 2006).

Barramundi is a particularly important commercial and recreational fish species that spawns in river mouths where tides carry the eggs into supralittoral swamps. There are no such swamp systems in Darwin Harbour; the nearest one is located at Shoal Bay north of the harbour (Harrison et al 2009). There is very little suitable nursery habitat for barramundi in Darwin Harbour (URS 2001).

Cardno (2014a) presents a summary of the Recreational Fishing and Fish Health Monitoring Program undertaken for the INPEX Ichthys Project. The program monitored finfish communities in both inner and outer Darwin Harbour and Bynoe Harbour, using a research angling methodology, prior to and throughout the INPEX Ichthys dredging activities. There were eight surveys - two baseline surveys, four surveys during dredging and two post-dredging surveys. The research found the most common finfish species caught were Golden snapper, Blue tuskfish, Stripey snapper and Javelin fish. Various spatial and temporal changes in catch characteristics, as well as finfish health parameters, were recorded as part of this monitoring program. There was no evidence to suggest there were any changes attributable to dredging activities (Cardno 2014a).

8.4.2 Marine communities of the Project area

8.4.2.1 Habitat Modelling

Predictive modelling of the benthic habitats within, and in the vicinity of, the Project area was encompassed within the modelling of major habitat classes within Darwin and Bynoe Harbours that was undertaken by the AIMS in 2019 (Galaiduk et al 2019). This extensive program considered bathymetric, physical seabed and biological data collected during Project specific and historical field sampling campaigns to produce spatial predictive habitat models (Galaiduk et al 2019).

It is noted that the model did not take account of water column characteristics such as turbidity, or factors such as sediment accumulation rates, any of which may preclude the establishment of certain biological communities (such as hard corals and seagrass) in areas that may otherwise be modelled as potentially suitable habitat for them. While the model provided a baseline for predicted benthic biodiversity, it was noted that improvements could be made in the future to better predict less common benthic classes (e.g. hard coral and seagrass) in the shallow subtidal and intertidal areas (Galaiduk et al 2019).

For this EIS, it was necessary for a benthic habitat survey to be undertaken to assess the accuracy of the model predictions in areas of direct and potential indirect disturbance from the construction and operation of the Project. This survey was undertaken by AIMS in November 2020 (Case et al 2021), with the objective of refining the model in these areas. Unfortunately, even with the addition of the further survey data, the model was found to have poor predictive ability due to uncertainty driven by the very subtle ecological and geomorphic gradients over the mosaic of patchy benthic communities. This was reflected in a high rate of misclassification errors due to overall low structural complexity and relief, and the low prevalence of key benthic classes (Case et al 2021).

Given the limited applicability of the model, the benthic habitat map presented in Figure 8-1 is a composite of model outputs coupled with actual observations of habitats from the various diver and

remote camera surveys undertaken within, and in the vicinity of, the Project area over the years. The latter included the viewing of all of the video records from the AIMS November 2020 survey transects within the area of direct disturbance from the Project. This supplemented the five-points-per-frame analysis of selected frames from the video records undertaken by AIMS and confirmed AIMS' conclusion that the seabed in this area was predominantly bare substrate, with only scattered filter feeders and no visible hard corals or seagrasses.

8.4.2.2 Rocky shore communities

There are few natural intertidal rocky shores in the vicinity of the Project area. However, the benthic communities on the artificial hard substrates (rock walls, wharf structures, piles, etc.) provided by the existing East Arm Port and nearby structures (such as those associated with the old East Arm boat ramp) would be expected to be similar (in composition, abundance and diversity) to those inhabiting natural rocky shores elsewhere within Darwin Harbour (described in Section 8.4.1.1).

8.4.2.3 Hard coral communities

Small isolated communities of hard corals can be found in the shallow subtidal and intertidal reefs in East Arm adjacent to the Project area. These hard coral communities are dominated by colonies with massive (i.e. family Faviidae), foliose (i.e. *Turbinaria* spp.) and encrusting (e.g. family Faviidae) growth forms (Geo Oceans, 2012). In the vicinity of the Project area, hard coral communities have been recorded around South Shell Island (south of East Arm Wharf) and at Old Man Rock (URS 2009, BMT WBM 2010, Case et al 2021). Around South Shell Island, hard coral cover has typically been highest (15-20%) at 0-1.5 m below LAT, declining with increasing depth. The community is comprised of at least 21 species; predominantly faviids with numerous *Turbinaria* colonies also present (URS 2009). Coral cover at Old Man Rock has been found to be typically lower (<10% cover) and more limited in distribution than at South Shell Island; with the community predominantly comprised of faviids (primarily *Goniastrea*) and *Goniopora* species (URS 2009).

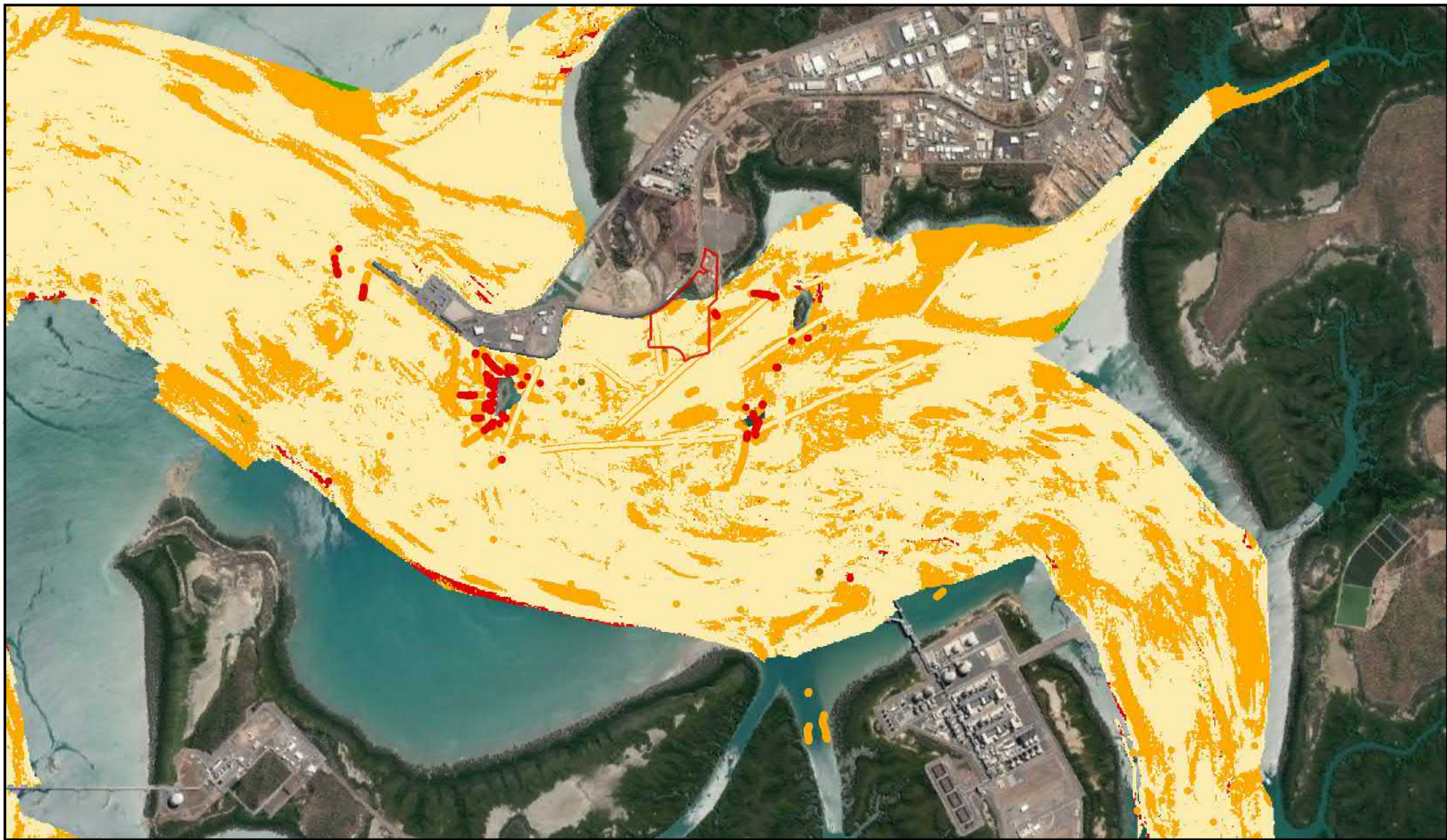
Cardno (2012) conducted baseline surveys for the INPEX Ichthys Project to describe the natural temporal and spatial distribution of hard corals at Channel Island, Northeast Wickham Point, South Shell Island, Weed Reef, Mandorah and Charles Point. The surveys recorded thirteen families of hard coral, no more than ten of which occurred at any one site. Hard coral percentage cover ranged from approximately 15% to 20% at most sites, apart from Northeast Wickham Point, which had approximately 2% cover in the three surveys.

Hard corals at the two East Arm monitoring sites (Northeast Wickham Point and South Shell Island) were predicted to be impacted by the INPEX Ichthys dredging campaigns (INPEX 2013), though probable dredging-related coral health impacts were only evident at the South Shell Island site, where coral cover declined from approximately 18% (mean baseline cover) to approximately 12% (Cardno 2014a). The reduced coral cover at South Shell Island was attributed by Cardno (2014a) to increased sedimentation, loss of colonies due to substrate instability (due to tidal currents and wave action) and, potentially, to effects from elevated turbidity.

8.4.2.4 Filter feeder communities

URS (2009) found that the dominant fauna on the lower slope (deeper than 1.5 m LAT) surrounding South Shell Island were numerous sponges, soft corals (including gorgonians [sea fans and sea whips]), crinoids (feather stars) and hydroids. Other sites surveyed by divers and remote operated vehicles (ROV) in East Arm revealed a moderate to low diversity of benthos, with the exception of the south side of Old Man Rock and at Walker Shoal which had numerous soft corals and a high diversity of sponge species.

A survey conducted in 2010 revealed moderate to high density sponge and soft coral beds in the areas surrounding South Shell Island and Old Man Rock and, to a lesser extent, low density sponge beds (BMT WBM 2010).



PROJECT ID
60633505

CREATED BY
PK

APPROVED BY
PY

LAST MODIFIED
07 OCT 2021

AECOM

www.aecom.com

N

1:40,000 when printed at A4

DATUM GDA 1994, PROJECTION MGA ZONE 52

0 410 820 1,230 1,640

Meters

Data sources:
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

Project location

Confirmed Habitats¹

Modelled Habitats²

Bare sediment

Filter feeders

Hard coral

Macroalgae

Bare sediment

Filter feeders

Hard coral

Seagrass

Note:

The layout is indicative only

Datasource:

1. Geo Oceans (2012) & AIMS (2020)

2. Galaiduk et al 2019

East Arm Benthic Habitats

NORTHERN TERRITORY
GOVERNMENT OF AUSTRALIA

DARWIN SHIP LIFT PROJECT

Figure

8-1

A4 size

Habitat maps presented in Geo Oceans (2011) suggest that large areas of filter feeder communities are present within East Arm, though not within the Project area. Only scattered individuals' colonies of filter feeders, and no substantial communities, were observed in the AIMS video transect records made by Case et al (2021) within the Project area.

It is recognised that filter feeder communities around South Shell Island may contain species that could be of importance to bio-prospecting for commercially valuable products. However, it is also recognised that large areas of filter feeder communities are present both within East Arm and across the broader harbour (Geo Oceans 2011, 2012; Siwabessy et al 2015, Galaiduk et al 2019).

Benthic habitat monitoring during the MSB capital dredging campaign (undertaken in 2012 and 2013) found no statistically significant changes in filter feeder communities across the three surveys (Macmahon 2013, DoI 2014). This is somewhat unsurprising as these communities are generally less sensitive than corals to the physiological pressures of reduced benthic light availability and sedimentation associated with dredging activities or natural environmental conditions. Filter feeder communities were not monitored as part of the INPEX dredging campaign that was conducted within the same period as the MSB dredging (INPEX 2013).

8.4.2.5 Macroalgae and seagrasses

While scattered occurrences of macroalgae and seagrasses have been recorded within East Arm, substantial macroalgal beds and seagrass meadows are not known to be present, and none were detected during surveys in East Arm by BMT WBM (2010), Geo Oceans (2012) and AIMS (Case et al 2021).

8.4.2.6 Soft sediment communities

The soft sediment communities within the Project area are highly likely to be similar to those described across the wider inner Darwin Harbour (Section 8.4.1.6), with polychaete worms and crustaceans the most abundant taxonomic groups. They are also expected to have strong affinities with the communities on the southern side of East Arm, which URS (2009) found were dominated by amphipods (small shrimp-like crustaceans) and polychaete worms.

8.4.2.7 Fish communities

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

As referenced in Section, Cardno (2014a) conducted a number of finfish surveys in association with the INPEX Ichthys dredging activities which were undertaken nearby within East Arm. However, there were no research angling sites within, or in close proximity to, the Project area.

8.4.3 Protected marine species

Certain species within Darwin Harbour are protected under the following legislation and conventions:

- The Commonwealth EPBC Act, which provides a legal framework to protect and manage nationally and internationally threatened plants and animals. The EPBC Act also considers potential impacts upon species listed under international treaties and conventions.
- The *Territory Parks and Wildlife Conservation Act* (TPWC Act). Under section 29 of the TPWC Act, the responsible Minister administers the NT Threatened Species List and assesses and classifies the conservation status of all wildlife species occurring in the NT. In this endeavour the Minister is supported by the relevant NT Government department, which is currently the Department of Environment, Parks and Water Security. Sightings of threatened species, as well as those considered to be 'significant', are recorded in the Natural Resource Maps NT database ([Biodiversity \(nt.gov.au\)](https://www.nt.gov.au/biodiversity)). In turn, these sightings are recorded in the Atlas of Living Australia (ALA 2021).
- The IUCN Red List of Threatened Species, which includes marine animals that are considered to be under threat of extinction.

- The Bonn Convention on migratory species.
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

The threatened species that the EPBC PMST database indicates may be found in the vicinity of East Arm, including the Project location, are listed in Table 8-2. However, it is noted that the database applies very broad distributions of species and their habitats and some of the listed species are not known to occur within Darwin Harbour. Hence, in relation to the species listed in Table 8-2:

- Humpback whales migrate to northern Australia from June to August but are not known to venture as far north-east as Darwin Harbour.
- The turtle and sawfish species are discussed in detail in sub-sections below.
- Whale sharks are not known to occur within Darwin Harbour.

Table 8-2 Threatened species listed in the EPBC protected matters database as potentially occurring in the vicinity of the Project area

Scientific Name	Common Name	EPBC Act	TPWC Act*	IUCN	Bonn	CITES
Cetaceans: Whales						
<i>Megaptera novaeangliae</i>	Humpback whale	V	LC	LC	I	I
Turtles						
<i>Caretta caretta</i>	Loggerhead turtle	E	V	E	I	I
<i>Chelonia mydas</i>	Green turtle	V	NT	E	I	I
<i>Dermochelys coriacea</i>	Leatherback turtle	E	CE	CE	I	I
<i>Eretmochelys imbricata</i>	Hawksbill turtle	V	V	CE	I	I
<i>Lepidochelys olivacea</i>	Olive ridley turtle	E	V	V	I	I
<i>Natator depressus</i>	Flatback turtle	V	DD	DD	-	I
Cartilaginous Fish						
<i>Pristis clavata</i>	Dwarf sawfish	V	V	E	-	-
<i>Pristis microdon</i>	Freshwater sawfish	V	V	CE	-	II
<i>Pristis zijsron</i>	Green sawfish	V	V	CE	-	-
<i>Rhincodon typus</i>	Whale shark	V	-	V	II	II

CE: Critically Endangered, DD: data deficient, E: Endangered, NT: Near Threatened, LC: Least Concern, V: Vulnerable, -: not listed, I: Listed under appendix I, II: Listed under appendix II.

*NRETAS (2011)

In addition to the species in Table 8-2, several other species known to be, or are potentially present in Darwin Harbour are listed as migratory species under the EPBC Act (Table 8-3). Dugongs and the dolphin species are discussed in sub-sections below. Bryde's and Humpback whales are not known to occur within Darwin Harbour, while Killer whales are regarded by Palmer et al (2017) to be occasional visitors to NT waters, though not specifically to Darwin Harbour.

Table 8-3 EPBC listed migratory species known to occur, or potentially occurring, in Darwin Harbour

Scientific name	Common name	Conservation status			
		EPBC Act	TPWC Act*	IUCN	Bonn
<i>Dugong dugon</i>	Dugong	Migratory	NT	V	-
<i>Balaenoptera edeni</i>	Bryde's whale	Migratory	NE	LC	II
<i>Megaptera novaeangliae</i>	Humpback whale	Migratory		LC	I
<i>Orcinus orca</i>	Killer whale	Migratory	NE	DD	II
<i>Orcaella heinsohni</i>	Australian snubfin dolphin	Migratory	DD	V	I
<i>Sousa sahulensis</i>	Australian humpback dolphin	Migratory	DD	V	II
<i>Tursiops aduncus</i>	Spotted bottlenose dolphin	Migratory	LC	NT	II

DD: data deficient, LC: Least Concern, NE: Not Evaluated, NT: Near Threatened, V: Vulnerable, -: not listed, I: Listed under appendix I, II: Listed under appendix II.

*NRETAS (2011)

8.4.3.1 Cetaceans

Three species of coastal dolphin are the most commonly recorded cetaceans in Darwin Harbour: the Australian humpback (*Sousa sahulensis*; formerly known as the Indo-Pacific humpback), Indo-Pacific bottlenose (*Tursiops aduncus*) and Australian snubfin (*Orcaella heinsohni*) dolphins (Palmer 2008). INPEX (2011) details knowledge of the taxonomy, distribution, microhabitats, residency and site fidelity of the three species of coastal dolphins, while Brooks and Pollock (2014), Brooks et al (2017) and Griffiths et al (2020) present data from the extensive surveys undertaken for the INPEX Ichthys LNG project. In addition, the conservation status of coastal dolphins in the NT has been assessed by Palmer et al (2017).

Other species of dolphin that may be present in Darwin Harbour include Common dolphin (*Delphinus delphis*), Risso's dolphin (*Grampus griseus*), Spotted dolphin (*Stenella attenuata*) and Bottlenose dolphin (*Tursiops truncatus*). Pods of False killer whales (*Pseudorca crassidens*) are considered by Palmer et al (2009) to be regular visitors to the harbour. It is notable that all cetaceans are protected under the EPBC Act.

Griffiths et al (2020) summarise the outcomes of studies of the abundance, movements and habitat use of coastal dolphins (Australian humpback, Indo-Pacific bottlenose and Australian snubfin) in the Darwin region (Darwin Harbour, Bynoe Harbour and Shoal Bay). On the basis of data from surveys undertaken between 2011 and 2019, and model outputs based upon capture-recapture data from these surveys, Griffiths et al (2020) concluded the following:

- All three species typically occurred at low densities, exhibited substantial emigration and had fluctuating population size.
- Humpback dolphins were the most commonly observed of the three species and there was demonstrable movement of this species between the three monitoring areas. Over the course of the monitoring program, there was a significant decrease in estimated abundance in Darwin Harbour a non-significant increase in Bynoe Harbour and a non-significant decrease at Shoal Bay.
- The Snubfin dolphin population was small, and was considered to have the greatest variability in population size and the greatest degree of temporary emigration (i.e. temporarily leaving the study area). Modelling indicated a significant negative trend in estimated abundance over the course of the monitoring program.
- The Bottlenose dolphin population was the smallest, with an apparently high degree of temporary emigration and a significant overall decrease in estimated abundance.
- The reasons for the significant declines were considered to be unclear, but were thought to potentially be related to population dynamics, environmental or anthropogenic factors.

- The estimated population density of each species appeared to be similar to average densities in NT coastal waters.
- The estimated population densities of Humpback and Snubfin dolphins appeared to be within the ranges of densities recorded in Western Australia and Queensland, while the estimated densities of Bottlenose dolphins in the Darwin Harbour region and the NT appeared to be lower than in similar northern Australian locations.
- The estimated temporary emigration rates were considered to be similar to those in coastal dolphin populations elsewhere in Australia and overseas.
- Apparent survival rates were considered to be similar to, or lower than, those reported elsewhere for the same species, though the difficulty in accurately assessing survival rates was recognised. It was considered that emigration probably had a greater influence on population growth than deaths.

It is noted that there are no known areas of critical feeding or breeding habitat for dolphins within the zone of potential effects from the development and operation of the Project. The Indo-Pacific humpback and the Australian snubfin dolphin appear to be opportunistic generalist feeders, eating a wide variety of fish both on the seabed and within the water column (Parra 2006). No calving areas have been identified in Australian waters for either species and little is known of their reproductive biology or population structure (Ross 2006, Parra et al 2006).

8.4.3.2 Dugongs

Dugongs are known to occur in Darwin Harbour waters, although in relatively low numbers. Dugongs have been recorded in higher densities at Gunn Point and the Vernon Islands, some 30–50 km to the north-east of the mouth of the harbour. Dugongs have also been observed in relatively high numbers at Bare Sand Island and Dundee Beach in Fog Bay, 60 km south-west of Darwin Harbour, and are known to travel long distances (Whiting 2008).

Cardno (2014b) compared the results of baseline surveys with four surveys undertaken throughout the dredging phases of the Turtle and Dugong Monitoring Program associated with the INPEX Ichthys project. This study revealed that dugongs were observed in varying numbers between surveys; however, no trends (including seasonal variations) were evident. There was a higher number of dugong observed in shallower waters (6 – 10 m), generally in foraging areas where seagrass was present. Variation in dugong observed between surveys within sites was concluded to most likely be a result of short term movement of dugongs to visit optimum foraging areas of seagrass.

During baseline surveys (June to October 2012) most sightings in Darwin Harbour were around Weed Reef, West Arm and near Bladin Point, as well as in the shallow regions of Shoal Bay. During later baseline surveys, most dugong sightings were around outer Darwin Harbour, with aggregations around mapped seagrass near Casuarina Beach (Cardno, 2014b).

During the first of the Dredging Phase surveys (May 2013), dugongs were predominantly sighted in outer Darwin Harbour, with only one dugong sighted near Weed Reef and another in the shallow areas in West Arm. During the Dredging Phase surveys in July/August and October 2013, no dugongs were sighted in the inner Darwin Harbour, while during the end of dredging survey (May 2014) three dugongs were sighted near Weed Reef (Cardno, 2014b).

During the two surveys undertaken in October 2013, sightings were concentrated around Casuarina Beach and were associated with areas of seagrass (*Halodule* sp.). Lower numbers were observed in this area in wet season surveys and it was considered that the reduced seagrass coverage in this season was likely to have been a contributing factor (Cardno 2014b).

In general, it is considered that dugongs could occur anywhere in the harbour that could support seagrasses or macroalgae. Within Darwin Harbour, dugongs have been observed at Channel Island in Middle Arm, where they were thought to be feeding on macroalgae (Whiting 2002). However, there are anecdotal records of seagrass occurrence in the vicinity of the Channel Island boat ramp and this may have been a contributory factor to their presence. While some macroalgal communities may be present in the vicinity of the Project area, substantially greater areas of potential foraging habitat for dugong exist elsewhere in the harbour (INPEX 2011).

8.4.3.3 Turtles

Six species of marine turtles are known to occur in NT waters. Of these, four (the Green, Hawksbill, Olive ridley and Flatback turtles) are considered to occur in the Darwin Harbour region (Whiting 2003). Loggerhead turtles are suspected to be infrequent users of the harbour and the Leatherback turtle is considered to be an oceanic species which is unlikely to occur in Darwin Harbour (Whiting 2003).

The shoreline throughout Darwin Harbour, and particularly in East Arm, consists largely of mangrove forests and mudflats and does not provide suitable nesting habitat for any species of turtle (INPEX 2010). The nearest nesting beach (used by the Flatback turtle) is located in the Casuarina Coastal Reserve near Lee Point on the north-eastern shore of the harbour. Turtles visiting the harbour are more likely to be foraging for food. Flatback and Hawksbill turtles forage on the filter feeder communities which are extensive in the harbour. The Hawksbill turtle also forages on seagrass and macroalgal communities in addition to filter feeders. Green forage amongst seagrass and macroalgal communities (INPEX 2011).

Cardno (2014b) implemented the Turtle and Dugong Monitoring Program for the INPEX Ichthys project; this included aerial and land survey techniques to monitor the abundance and distribution of turtles around Darwin Harbour. They concluded that:

- Statistical analysis of population and density estimates formed in this study did not indicate that the distribution or abundance of these animals had changed since the baseline phase.
- During survey D4 (during dredging) 813 turtles were sighted, which was higher than the average number of turtles sighted per survey during the baseline phase (634 turtles), but approximately 17% lower than the number of turtles recorded during baseline survey B3 (984 turtles), undertaken at the same time of year (October 2012).
- Statistical analyses of turtle population densities did not detect any significant difference between the impact and control treatments in either phase, or between baseline and dredging phases, for either treatment. In contrast, estimates of turtle density based on raw observations were significantly higher at the control blocks compared with the impact block during the baseline phase, but not during the dredging phase. The observed temporal and spatial variation in turtle distribution and abundance was considered possibly to be a result of short-term movements in and out of specific areas, possibly due to avoidance behaviour and/or the pursuit of more optimal foraging areas.
- Turtle sightings were most frequently recorded within relatively shallow water habitat, most commonly in waters less than 5 m in depth; however, a small number were sighted in the deep water channels near the Vernon Island (outside of Darwin Harbour) in waters greater than 30 m depth.
- Where benthic habitat type had been identified and mapped, turtles were primarily sighted in association with gravel, sand and reef. Only 3% of turtle sightings were associated with mud habitat, the predominant habitat within, and around, the Project area.

8.4.3.4 Sawfish

The EPBC PMST database indicates that Dwarf sawfish (*Pristis clavata*), Green sawfish (*Pristis zijsron*) and Freshwater sawfish (*Pristis microdon*) may potentially inhabit Darwin Harbour, or that their habitats may be present in the harbour. While these species are widely distributed throughout Australian tropical waters, within the Atlas of Living Australia (ALA 2021), in Darwin Harbour the following was recorded:

- One record of a Dwarf sawfish caught in a gill net in the creek leading to the Gardens Golf Course. This species inhabits shallow (2-3 m) coastal waters and estuarine habitats (Department of the Environment, Water, Heritage and the Arts [DEWHA] 2009) and is not known to move into freshwater areas (Thorburn et al 2007). Estuarine habitats in north-western Australia are used as nursery areas, with immature juveniles remaining in those areas up until three years of age (Thorburn et al 2007). Adults have been found to seasonally migrate back into inshore waters (Peverell 2007).

- One record of a Green sawfish caught on a line and released off Lee Point, in the outer harbour. This record was made by a 'citizen scientist' and the identification verification status on the ALA database is deemed to be 'uncertain'. However, elsewhere in northern Australia most records of the species have been from marine and estuarine areas (Thorburn et al 2003, Peverell et al 2004) and they have been noted to move into estuarine or more fresh waters to breed during the wet season and subsequently move into marine waters after the wet season (Peverell 2005).
- There are no records of Freshwater sawfish within harbour waters. Elsewhere in northern Australia, it has been reported that their first three to four years of life are spent in freshwater (Larson et al 2006, Thorburn et al 2007) before moving into marine waters. They are thought to breed either in freshwater (Peverell 2005) or in marine waters (Thorburn et al 2007).

Although there is a limited number of records of the three sawfish species within harbour waters, studies elsewhere in northern Australia indicate that there is the potential for them to occur in the vicinity of the Project area during parts of their lifecycles; this may only be transitory as they move between freshwater and marine habitats before and after the wet season.

8.4.4 Introduced marine pests

Introduced marine pests (IMP, also known as invasive marine species) are one of the major human induced threats to global marine environments (Bax et al 2003, Millennium Ecosystem Assessment 2005, Wells et al 2009). Australia has not been immune to the effects of IMP, with perhaps the most serious IMP outbreak actually occurring in Darwin Harbour; this heightened concern in the NT Government about the potential impacts of IMP.

During the late 1990s CSIRO conducted a number of IMP surveys in Australian ports; the one in Darwin Harbour was undertaken in conjunction with the Museum and Art Galleries of the NT. A dry season survey in August 1998 collected a wide range of species, but no potential IMP species. A post wet season survey in March 1999 found huge numbers (up to 23,650 m²) of the invasive Caribbean "mussel" *Mytilopsis sallei* in the Cullen Bay Marina. Every hard surface was covered by the mussels (Russell and Hewitt 2000; Willan et al 2000; Bax et al 2002). Additional surveys recorded *M. sallei* in much lower densities in the Tipperary Waters Marina and Frances Bay Marina, and on three vessels moored in the harbour. The high densities in Cullen Bay and the fact that the three vessels in Darwin Harbour had previously been in Cullen Bay led to the conclusion that the species was first introduced there.

The mussel was viewed as a serious threat to industries such as pearl farming, aquaculture and tourism. The NT Government declared an environmental emergency. Fortunately, because of the 8 m tidal range in Darwin Harbour all three of the marinas have a lock at their entrance that allows vessels to enter and depart at any tidal level. The marinas were closed and quarantined. Substantial quantities of chlorine and copper sulphate were used to totally eliminate the mussels. One Indonesian bamboo raft in Darwin Harbour was burned on shore. Vessels that had been in the marinas but had departed Darwin Harbour were tracked down and examined where they were located, but no additional infected vessels were found. The elimination of *M. sallei* is one of a very small number of successful responses to the introduction of an IMP species (Willan et al 2000, Bax et al 2002).

Following this incident, a routine monitoring program for IMP was established in Darwin Harbour; in 2010 the program was aligned with the National System (NTG & Golder 2011). Up until 2014, no IMP species had been detected by the program (Marshall et al. 2003; Cribb et al 2008; NTG & Golder 2010; Maher et al 2010; Maher et al 2011; Lawson & Beatty 2013; Lawson et al 2014).

In addition to the National System monitoring, INPEX implemented a monitoring program for the dredging campaign for the Ichthys LNG project (Golder and Cardno 2015); this extended from August 2012 (baseline) to September 2014 (post-dredging). During the survey period:

- Asian green mussels (*Perna viridis*) were observed on a cargo vessel berthed at EAW in August 2013.
- Five target species were identified during the baseline survey - *Amphibalanus amphitrite* (a barnacle), *Bugula neritina* (a bryozoan) and the ascidians *Botryllus schlosseri*, *Botrylloides leachi* and *Didemnum perlucidum*. These species were considered to have a relatively low-level of biosecurity risk, based on either their already cosmopolitan distribution around Australia or (with the exception of *D. perlucidum*) the lack of extensive populations at the sampling sites.

- *Botrylloides leachi* and *D. perlucidum* were also found following commencement of dredging, with the latter species still present during the post-dredging survey.

In 2015, the routine monitoring program undertaken by the NTG's Aquatic Biosecurity Unit at EAW was extended to incorporate Stokes Hill and Fort Hill wharves (Department of Primary Industry and Fisheries [DPIF] 2016). Between 2015 and 2020, *Didemnum perlucidum* was the only species identified through the program that is listed in the NT as an aquatic pest (Department of Primary Industry and Resources [DPIR] 2016, 2017, 2018, 2020; Department of Industry, Tourism and Trade [DITT] 2020). It is considered an invasive species due to its high reproductive output, rapid growth and ability to colonise disturbed environments (Muñoz & McDonald 2014) and is included on the National Introduced Marine Pest Information System (Department of Agriculture, Water and the Environment [DAWE] 2021). While *D. perlucidum* was recommended to the Australian Bureau of Agricultural and Resource Economics and Sciences for inclusion on a Northern Australia Priority Pest List, the species is not included on the Australian Priority Marine Pest List (Marine Pest Sectoral Committee [MPSC] 2019) as it was considered to have a low potential for significant environmental impact.

8.5 Potential impacts and risks

This sub-section provides an overview of pathways for potential impacts upon marine flora and fauna attendant to construction and operation of the Project. It broadly outlines the reasoning that leads to a conclusion that the Project does not represent a source of impacts with the potential to significantly impact upon the marine biological diversity or ecological integrity of East Arm, or of the broader Darwin Harbour. This is contingent upon the effective implementation of the management and mitigation measures described in Section 8.6.

Potential impacts upon marine flora and fauna may be:

- direct - via pathways such as vessel strike or grounding, and habitat modification from dredging
- indirect – via pathways such as underwater noise and vibration, and changes in water and sediment quality and ecological processes (e.g. due to habitat modification or the introduction of invasive marine species).

More detailed reasoning on potential impacts are presented in sub-sections 8.5.2 to 8.5.8.

8.5.1 Impacts from Project activities

For this Project, the activities that have the greatest potential to impact upon marine flora and fauna are considered to be:

- Dredging and reclamation – these will have direct, and potential indirect, pathways for impacts upon marine flora and fauna:
 - The remnant stand of mangroves within the Project area will be incorporated into the reclamation area. However, the stand is small (1.0 ha) and, whilst it does represent an incremental loss of mangrove habitat within East Arm, it is considered that there is negligible risk that the direct removal of this habitat could have any detectable impacts upon the ecosystem function of East Arm, or of Darwin Harbour.
 - The existing seabed habitat within the dredging and reclamation footprint will be directly impacted (refer Section 8.5.2). However, as described in Sections 8.4.1.6 and 8.4.2, the 'soft sediment' habitat is widespread over the areas of East Arm and the broader Darwin Harbour that are beyond the dredging and reclamation footprint.
 - Water quality in the vicinity of the dredging and reclamation operations will be directly impacted by increased turbidity arising from the liberation of fine materials into the water column (refer Section 7.8.2.1). As described in Section 8.5.3, though, it is considered that (with the implementation of appropriate monitoring, mitigation and management measures (Sections 8.6 and 9)) the turbidity levels can be managed to remain below those which may pose a risk of significant indirect impacts to marine flora and fauna.
 - Suspended sediments within the turbid plumes arising from the dredging and reclamation operations will eventually settle to the seabed. A portion of these sediments will be periodically resuspended and transported by tidal and wind-driven currents until they reach

'sink' locations where bed shear stress is insufficiently great to remobilise them.

Sedimentation depths are predicted by modelling to be of magnitudes that do not pose a risk of significant impacts upon the benthic communities in the habitats at the 'sink' locations (refer Section 8.5.4).

- Coastal processes (including hydrodynamic and wave conditions) within, and around, the Project footprint will be modified by both dredging and reclamation (refer Section 8.5.5). This has the potential to change erosion and accretion patterns in adjacent marine habitats. However, these habitats are well represented elsewhere in East Arm and throughout Darwin Harbour and there is no credible risk of significant impacts on the ecological functioning of the harbour from any changes that may occur.
- Underwater noise and vibration will be generated by the dredging operations (refer Section 8.5.7). However, the noise and vibration levels are of a more continuous nature than those arising from intermittent, percussive piling. Therefore, there is greater potential for marine species to avoid the areas where noise and vibration levels may be intolerable, and dredging activities are considered to pose a lesser risk of impacts to these species than does piling. Overall, it is considered that there is negligible risk of significant impacts upon individuals or populations of marine species as:
 - There are no known habitats of critical importance for these species within the area from which they may be temporarily excluded.
 - The area over which the potentially adverse noise and vibration levels are predicted to occur does not extend across the full width of East Arm; hence, it is predicted that there is minimal potential for disruption of any species migrations (between Elizabeth River and the main harbour) that may occur during the dredging operations.
- Piling – the underwater noise and vibration generated may temporarily prevent protected marine species from occupying, or transiting through, the immediate vicinity of the Project area (refer Section 8.5.7). As for dredging, it is considered that there is negligible risk of significant impacts upon individuals or populations of marine species, as critical habitats for these species are not known to occur in or around the dredging footprint, and the extent of elevated noise and vibration levels due to dredging is highly unlikely to prevent migration of marine species between Elizabeth River and the main harbour.
- In addition to the potential impact pathways specific to dredging, reclamation and piling activities, there are a number of more general pathways through which impacts upon marine flora and fauna could potentially occur, including:
- Contaminant inputs from terrestrial and/or marine sources during construction, and from unplanned releases of contaminants during construction and operations (refer Section 8.5.7). It is considered that the risk of significant impacts to marine flora and fauna from contaminant inputs is low, given:
 - The physico-chemical properties of the terrestrial soil and marine sediments that will be disturbed during construction.
 - The management and mitigation measures that will be implemented in relation to pathways for potential contaminant release during construction and operation (refer Section 8.6).
- Physical interaction, during both construction and operations, between Project vessels and:
 - Marine fauna. The potential for occurrence of 'vessel strike' will be reduced through the implementation of the management measures within documents described in Section 8.6. It is considered that the amount of vessel activity associated with the Project will represent a sufficiently small incremental increase in the existing level of activity within East Arm to not represent a significant source of additional risk to marine fauna in the region.
 - Seabed. The potential for occurrence of 'vessel grounding' will be reduced through the operation of Project vessels in accordance with standard navigational procedures, and through the inclusion in the Project of standard navigational aids. Given the water depth in the shipping channel through the main harbour and into East Arm, it is considered there is negligible risk of vessel grounding in these areas. If a vessel was to be grounded in the

immediate vicinity of the facility, then it would impact upon either soft sediment biota, or upon biota on the intertidal rock revetments of East Arm Port or the MUBRF. Following removal of the vessel from any of these areas, it is reasonable to predict that biotic communities of similar composition to those that were impacted would become re-established over time. Hence it is considered that there is negligible risk of any long-term impacts to the ecological function of the Project area, or to marine fauna that may utilise the habitats in and around the Project area.

- Increased light levels at night. Lighting of vessels and marine infrastructure will be necessary during both construction and operation in order to maintain a safe working environment for Project personnel, and to maintain public safety (i.e. by making obstacles visible to passing boat traffic). Light spill into the marine environment will be reduced to as low as reasonably possible by the implementation lighting management measures described in Chapter 2: Project Description. While some light spill will inevitably occur, it is recognised that:
 - The lighting will contribute only a marginal incremental increase in the existing light sources associated with the adjacent East Arm Port and MUBRF.
 - Some species of marine fauna may be attracted to the light, which may lead to increased predation by them, and of them. However, it is considered that this does not have the potential to be of sufficient magnitude to significantly impact upon populations of marine species in the Project area, or upon the ecosystem function of East Arm or the broader Darwin Harbour.
- Introduction of non-native marine pest species (refer Section 8.5.8). The potential for marine pest species to be introduced to the harbour via Project vessels will be reduced to as low as reasonably possible through the implementation of mitigation and management measures in documents described in Section 8.6.

8.5.2 Habitat alteration

Dredging will increase the water depth over some subtidal habitats. In addition, some areas of soft sediment habitat will be replaced with hard substrate in those areas where dredging into rock is required. The latter habitat will, over time, accumulate a veneer of unconsolidated material (sand, silt and clay); this veneer may be periodically disturbed during operations through the propeller wash of vessels transiting, or operating within, the dredged area and will be removed by maintenance dredging if the material accumulates to the extent that the operability of the Project is affected. As a consequence, the benthic communities that presently occupy the dredging footprint are unlikely to become re-established over the duration of Project operations. However, the habitats to be dredged are well represented elsewhere in East Arm and the broader harbour and it is considered that there is no credible risk of significant local or food chain effects from their modification.

The existing seabed habitat within the reclamation area will be replaced with terrestrial and intertidal habitats. The latter habitat (e.g. rock revetments skirting the reclamation area), as well as the immersed Project infrastructure, will provide artificial hard substrate habitats that will likely be colonised by biota similar to those inhabiting similar substrates nearby (e.g. the adjacent MUBRF)

As the seabed habitat within the dredging and reclamation footprint is well represented elsewhere in East Arm and the broader harbour (refer Sections 8.4.1.6 and 8.4.2.1), it is considered there is no credible risk of their replacement leading to significant localised or food chain effects. None of the habitats are considered to be of critical importance to protected species.

8.5.3 Turbidity generated by material placement for reclamation

The placement of fill and the progressive pushing of fill further into the marine environment to the extent of the reclamation across the intertidal and shallow subtidal zone will generate turbid plumes within the adjacent waters of Darwin Harbour. During this process fine sediments will also be washed from the seaward edge of the reclaimed area.

On completion of the reclamation, fines may continue to be washed by wave action from the reclaimed area through the rock walls for a period of time. Any turbidity generated in this manner would be substantially less than that generated during construction and would likely not be detectable above background turbidity conditions.

On the basis of the model outputs presented in Section 7.8.2.1.1 it is predicted that the sediments will enter the marine environment at sufficient distances from benthic communities which are sensitive to light attenuation or smothering (e.g. the hard coral and filter feeder communities at South Shell Island and Old Man Rock) that there is negligible risk of detectable impacts occurring to these communities. In addition, the magnitudes of any incremental increases in turbidity from these sources are considered to be sufficiently low, and the areal extents sufficiently small, to present a negligible risk of detectable impacts upon motile marine biota, including plankton, fish and protected species. Consequently, it is considered that turbidity associated with the reclamation process also poses a negligible risk of detectable impacts to the ecosystem function of East Arm or Darwin Harbour.

8.5.4 Sedimentation

Suspended sediments within the turbid plumes arising from the dredging and reclamation operations will eventually settle to the seabed. A portion of these sediments will be periodically resuspended and transported by tidal and wind-driven currents until they reach 'sink' locations where bed shear stress (the force exerted upon the seabed by currents) is insufficiently great to remobilise them.

Sedimentation after 30 days of completion of dredging was modelled by Simão and Tonin (2020) (refer Appendix I: Sediment Modelling Technical Report) to identify any potential areas for concern in relation to the potential exceedance of sedimentation tolerance limits for benthic communities in the vicinity of the Project area (Figure 8-2).

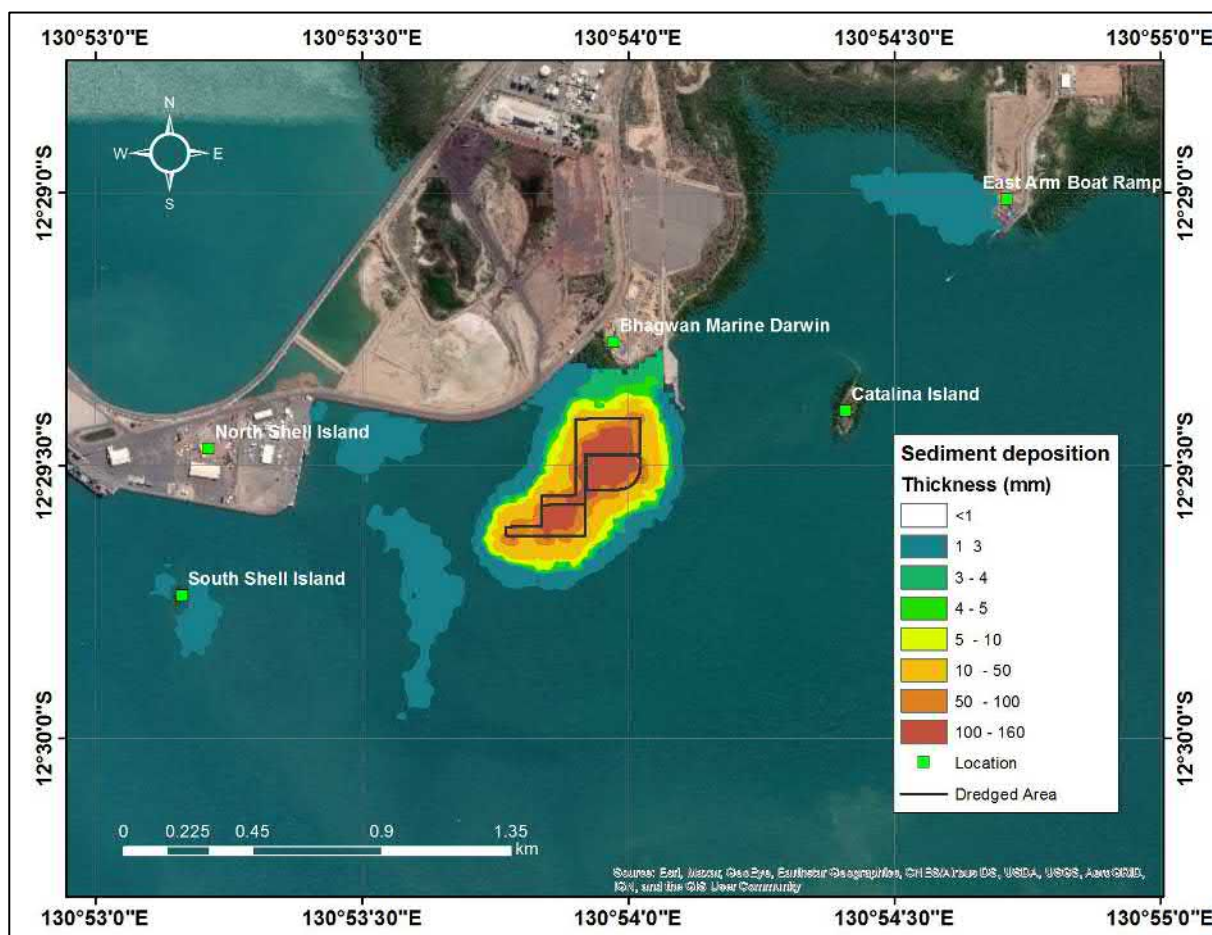


Figure 8-2 Predicted sediment deposition thickness

The following is noted in relation to benthic communities outside of the dredging and reclamation footprint:

- A pocket of sediment deposition of between 1-2 mm is predicted to occur near South Shell Island.

- For hard coral and filter feeder communities, INPEX (2011) contended that meaningful sedimentation thresholds could not be derived from the literature due to factors such as wide variations on tolerances between species, and between morphologies within species. Notwithstanding this, a sedimentation threshold of 15 mm was included in the approved Dredging and Spoil Disposal Management Plans for both the Ichthys capital dredging campaign (INPEX 2013) and for the Ichthys maintenance dredging campaigns (INPEX 2018). It is noted by INPEX (2018) that *“the tolerance limit values were extensively discussed with and endorsed by the Ichthys Project Dredging Expert Panel”*.
- In light of this, it is considered that the levels of sedimentation predicted to occur around South Shell Island do not pose a risk of significantly impacting upon the hard coral and filter communities that may occur in the deposition areas.

8.5.5 Modified coastal processes

Reclamation and dredging have the potential to affect coastal processes in the vicinity of the Project area. However, any increased erosional forces that may occur over sections of the hard intertidal substrate habitats (rock revetments, etc.) of the East Arm port infrastructure (to the west) and the MUBRF (to the east) are unlikely to have a detrimental effect upon the biotic communities thereon. On the contrary, the communities are likely to be predominantly comprised of filter feeders that may benefit from the greater water flow providing increased food supply.

Increased resuspension of sediments would also occur, reducing the potential for smothering of benthic biota. If increased sediment accretion occurs on other sections of hard intertidal substrate, then there is the potential for the biotic communities in these sections to be impacted. However, neither the increased biological productivity that may occur in areas of increased erosion, nor the reduced productivity that may occur in areas of increased accretion, can be considered to be potentially of a great enough magnitude to significantly affect the ecological function of the harbour ecosystem.

8.5.6 Underwater noise and vibration

Both dredging and piling are required as part of the Project, with pile-driving presenting the greater risk to marine fauna with respect to the effects of underwater noise. An extensive assessment and modelling of the risks and impacts of construction noise with respect to marine megafauna can be found in Appendix G: Underwater Noise Technical Report (Talis 2021); this is summarised in the following subsections.

Approximately 240 days of piling activity are predicted during the construction phase, employing both drilling and hydraulic hammering as pile-driving methods. Pile dressing is not required and therefore associated noise impacts are not considered.

The majority of the 485 piles are located above mean low water, meaning that some noise-impact risk is mitigated due to characteristics of local tidal regimes. Shallow water sound attenuation is significant due to the reflective properties of the narrow seabed-sea surface interface; as a result, acoustic energy decays faster with distance from the noise source than in deeper water. This effect is particularly exacerbated for low frequencies in shallow water; this further reduces the distance from source that deleterious effects of piling and dredging noise may be encountered.

8.5.6.1 Potential impacts

The impacts of construction noise on marine fauna are separated into two categories:

- The onset of (sub-lethal) injury, defined as permanent threshold shift (PTS), indicative of tissue injury within hearing organs. PTS is considered a reliable, conservative indicator of the onset of permanent, albeit slight, irreversible physical injury.
- Temporary threshold shift (TTS), indicative of reduced hearing sensitivity. This results primarily from fatigue, rather than injury, of hearing organs and is reversible. TTS therefore serves as a cautious indicator of the possible onset of reversible physiological effects.

As well as noise thresholds being classified as PTS and TTS, they are further split into:

- Impulsive sounds, which are typically less than a second in duration with a high peak pressure and rapid onset and decay. Pile-driving and blasting are examples of impulsive sound sources underwater (Gordon et al 2004, cited in Hastie et al 2019).
- Non-impulsive noise sources, which include a range of frequency band widths and can be brief, intermittent or continuous in duration and do not demonstrate high peak sound pressure waves. Dredging, drilling and vessel noise are typically non-impulsive noise sources.

Both impulsive and non-impulsive noise can cause behavioural changes in marine megafauna, particularly over long exposure times. Behavioural changes may include changes in feeding and breeding behaviour, as well as differences in more complex ecological interactions. It is noted that there are no known areas of critical breeding or feeding habitat for protected marine species within the zone of potential effects from the development and operation of the Project. Estimates for distances from source for predicted effects of underwater noise are estimated for TTS, PTS and behavioural changes in Appendix G: Underwater Noise Technical Report and summarised in the following sub-sections.

8.5.6.2 Species at risk

Conservation significant species at risk from the impacts of noise during Project construction include:

- Dugongs and dolphins, for which TTS and PTS are defined by Southall et al (2019) and National Marine Fisheries Service (2018).
- Turtles and sawfish, for which thresholds determined by Cavanagh (2000) and McCauley et al (2000) were used to predict the onset of TTS and PTS.

For species of interest in Darwin Harbor, Table 8-4 details sound exposure levels (SELs) (TTS and PTS) and possible behavioural disturbance onset criteria with respect to impulsive and non-impulsive noise types (refer Appendix G: Underwater Noise Technical Report for further details).

Table 8-4 Underwater Noise Assessment Criteria

Marine Fauna Type	Hearing Group	Hearing Bandwidth	Noise Type	SEL Onset (Weighted) dB re 1 μ Pa ² .s		Possible Behavioural Disturbance dB re 1 μ Pa ² .s
				TTS	PTS	
Dugongs	Sirenian	100 Hz to 50 kHz	Non-Impulsive	186	206	140 Dunlop et al (2017)
			Impulsive	175	190	
Dolphins	Mid-frequency cetaceans	150 Hz to 160 kHz	Non-Impulsive	178	198	
			Impulsive	170	185	
Turtles and sawfish		100 Hz to 1 kHz	Non-Impulsive	175	183	175 McCauley et al (2000)
			Impulsive	175	183	

8.5.6.3 Noise impact simulations

Desktop simulations were employed to predict transmission loss from multiple simultaneous broad and narrow band noise emission sources. Bathymetric, geo-acoustic and acoustic parameters facilitated three dimensional estimates of acoustic field strength as a function of depth and distance. Conservative modelling was used by employing environmental conditions likely to result in the greatest acoustic propagation.

Modelling of dredging noise adopted the typical sound pressure level (SPL) source level (SL) for a small cutter suction dredger of 166 dB re 1 μ Pa @ 1 m. However, Talis (2021) notes that dredging noise:

- below 50 Hz is most likely to attenuate rapidly in the water depths in which dredging will occur.

- above about 50 Hz is likely to be masked by background noise levels from the 1472-3178 large vessel transits that typically occur through the harbour annually.

Pile-driving noise levels are dependent on piling material, type and size, substrate, and hammer force. Bendy waves (waves that comprise a compression wave and a transverse wave) are produced by pile-driving and propagate through both the seabed and water column. Details of noise production predictions from hammer pile-driving are detailed in Appendix G: Underwater Noise Technical Report. Modelling of pile-driving adopted a sound exposure level (SEL) SL at maximum hammer energy for pile driving of 193 dB re 1 $\mu\text{Pa}^2\cdot\text{s}$ @ 1 m.

The propagation of noise from proposed dredging and piling locations, both at high and low tides, were used to predict the severity of noise impacts in Darwin Harbour. Details regarding model limitations, sediment and substrate assumptions, as well as bathymetric data used for the simulation, are detailed in Appendix G: Underwater Noise Technical Report.

8.5.6.4 Dredging simulation results

Dredging is typically a continuous non-impulsive noise, so SPL levels were expressed as a 1-hour SEL, assuming that this would be a typical time-period during which animals may transit through dredge noise. Key predictions from Talis (2021) are:

- Dugongs are predicted to potentially reach TTS onset at 90 m from the dredge cutter, and only at high tide, with behavioural disturbances occurring at 50 m distances from source.
- Dolphins are predicted to potentially reach TTS onset earlier, at a distance of 170 m at high tide, with behavioural disturbances at 50 m.
- No TTS thresholds are predicted to be exceeded at low tide, and at no point are PTS levels predicted to be exceeded for either dugongs or dolphins.
- TTS onset for turtles and sawfish is predicted to potentially be reached earliest, at distances of 240 m at high tide and 100 m at low tide. They are the only species predicted to potentially reach dredge-induced PTS onset, at 110 m and 30 m for high and low tides, respectively.

8.5.6.5 Piling simulation results

Pile driving predictions were based on 200 hammer strikes over a 7-minute duration, at water levels corresponding to LAT ('low tide') and HAT('high tide'). In this simulation:

- Dugongs are predicted to potentially reach TTS onset at 120 m during low tide and 100 m at high tide. Behavioural disturbances are predicted at 2200 m and 1050 m at low and high tides, respectively.
- Dolphins are predicted to potentially reach TTS onset earlier than dugongs, at 360 m and 300 m for low and high tide, respectively. Unlike dugongs they are predicted to reach PTS onset at 40 m and 30 m for low and high tide, respectively. Predicted behavioural disturbance distances are the same as for dugongs.
- Turtles and sawfish are predicted to potentially reach TTS onset at 175 m and 450 m for low and high tides, respectively, whereas PTS onset is predicted to potentially occur at 100 m and 150 m for low and high tides, respectively. Behavioural disturbance onset is predicted to potentially occur only at high tide, at approximately 70 m distant from the piling source.

8.5.6.6 Conclusions

From the simulation results, it is:

- Evident that the standard mitigation measure of assessing for the presence of dugongs, dolphins and turtles within Observation and Shut-down Zones prior to the commencement of (and during) dredging and piling activities is predicted to be implementable for the Project works. That is, a trained marine fauna observer (MFO) will be able monitor out to the maximum distance at which TTS is predicted to occur (450 m at low tide for turtles).
- Predicted that noise levels that could lead to behavioural disturbance will not extend across the width of East Arm. Hence, it is predicted that dredging and piling will not have the potential to

disrupt the passage of dugongs, dolphins, turtles or sawfish between Elizabeth River and Darwin Harbour.

It is considered that the mitigation and management measures to be incorporated into the environmental management plans described in Section 8.6 and 13.4, will be appropriate to reduce the risk of significant impacts upon marine fauna to as low as reasonably possible.

8.5.7 Contaminant inputs during construction and operation

8.5.7.1 Terrestrial soils

As indicated in Section 4.3:

- A PSI for contaminants in terrestrial soils has been undertaken as part of this EIS (refer Appendix N: Preliminary Site Investigation).
- The desktop study and sampling of surface soils on site found that the likelihood of substantial contamination with the potential to be mobilised by surface water runoff from the site is low.

With the application of standard management and mitigation measures (to be included within the management plans listed in Section 8.6 and 13.4), the potential for impacts upon marine flora and fauna, and their habitats, from contaminants (if present) in any soil that may enter the marine environment during terrestrial construction works is sufficiently low.

8.5.7.2 Acid sulfate soils

Exposure to air of ASS can result in increased soil acidity and, consequently, increased solubility and mobility of iron, aluminium, and other heavy metals and metalloids. One mechanism by which ASS may be exposed to air is due to mud waving caused by land reclamation works. If this was to occur then the acidity of, and toxicant concentrations within, surface water flowing across the oxidised soils may be increased.

However, as the reclamation of the Project area will progress seaward from the existing shoreline any mud waving that may occur would only expose ASS (if present) to air over those parts of the tidal cycle that they are not inundated by tidal waters.

It is not considered a credible risk that the exposure times would be of sufficient duration for soil acidity levels to be raised to the extent that toxicants could be mobilised to a degree that they could pose a risk to marine flora and fauna in the vicinity of the Project area.

8.5.7.3 Marine sediments

As indicated in Section 7.8.2, when compared against established guideline criteria the concentrations of potential toxicants within the material to be dredged are below those which are considered to potentially pose a risk of significant impact to marine environmental quality. It follows, then, that they are also considered to be sufficiently low as to not pose a risk of significant impact to marine flora and fauna.

8.5.7.4 Unplanned releases

As indicated in Section 7.9, management and mitigation measures will be in place to reduce (to) the potential for the following sources of contaminant inputs:

- spills (e.g. of hydrocarbons or chemicals) during construction and operation to enter the marine environment via surface water runoff.
- materials from vessel and infrastructure maintenance activities (e.g. removal and re-application of antifoulant coatings) to enter the marine environment via surface water runoff or dust.

It is considered that, with the effective implementation of these management and mitigation measures, the risk of impacts to marine flora and fauna from these toxicant sources will be as low as reasonably possible.

8.5.7.5 Operational inputs

Certain operational inputs of contaminants to the marine environment are inevitable; these include the release of:

- corrosion products (including those from cathodic protection systems) associated with immersed infrastructure.
- leaching of biocides from immersed infrastructure and from ships and ancillary vessels associated with operation of the Project.

Given the large tidal exchanges of water through East Arm, and the turbulent mixing associated with the strong tidal currents, it is considered that inputs from these sources will present negligible risk of significant impacts to the marine flora and fauna in the vicinity of the Project. This conclusion takes account of the equivalent pathways of contaminant inputs from the adjacent developments (East Arm port and the MUBRF), to which any inputs from the Project will be additive.

8.5.8 Introduction of marine pests

There is a risk that, during both construction and operation of the Project, vessels entering East Arm may introduce non-native marine species to the area. However, it should be recognised that not all introduced marine species become marine pests; in fact, only a small minority do so. Of the over 250 marine species known to have been introduced to Australian waters, only nine are listed as Australian Priority Marine Pest species, three of which are known to be established in some parts of Australia.

Unfortunately, the few species that do become IMP can have devastating consequences (e.g. Padilla et al 1996; Bax et al 2002, 2003). Potential impacts of IMP on local ecosystems may include the following:

- An IMP species may come to dominate local ecosystems by excluding local species or adversely affecting their health (Wyatt et al 2005). If the IMP fulfils a different ecological niche than the local species, then this may impact the functioning of the surrounding ecosystem.
- Fish and aquaculture stocks can be depleted. This may have both ecological and economic impacts.
- Dinoflagellates can produce toxins (Hallegraeff & Bolch 1991) that are concentrated as they move through the food webs. Subsequent consumption of shellfish by humans can cause paralytic shellfish poisoning, resulting in serious illness or even death (Walters 1996).
- IMP may also cause major economic impacts, such as by clogging intake valves and piping on marine infrastructure or slowing vessels as they move from one area to another.

Given the significance of the potential consequences of IMP introduction, it is recognised that it will be imperative to implement (during both construction and operation) stringent mitigation and management measures to reduce the risk of introduction to as low as reasonably possible. These measures will be aligned with the existing framework for reducing the risk of IMP introduction to Darwin Harbour (e.g. Darwin Port's Port Environment Protection Plan, INPEX's Operational Environmental Monitoring Program, NTG Aquatic Biosecurity Unit monitoring program) and with Australian national guidelines (e.g. Department of Agriculture Fisheries and Forestry [DAFF] 2009a,b, 2010 Department of Agriculture and Water Resources [DAWR] 2017).

8.6 Mitigation and management

To manage the potential for impacts to marine flora and fauna during Project construction and operation, mitigation measures have been proposed. Table 8-5 presents the relevant project phase, aspects to be managed, and proposed mitigation measures.

Table 8-5 Mitigation measures for marine flora and fauna

Phase	Aspect	Proposed mitigation measures
Construction	Dredging and reclamation – liberation of sediments	Preparation and implementation of Dredging and Dredge Spoil Placement Management Plan, including monitoring and reactive management protocols to reduce risk of impacts to: • benthic communities from turbidity and sedimentation • protected marine fauna species from underwater noise and vibration.
	Piling	Preparation and implementation of a Marine Noise and Vibration Management Plan, incorporating marine fauna observations and reactive management protocols.
	Discharges of contaminants from terrestrial activities	Preparation and implementation of a CEMP containing an Erosion and Sediment Control Plan, a Stormwater Management Plan and spill response measures. Compliance with AS1940-2004 (Storage and handling of flammable and combustible liquids).
	Potential to generate acidic and metal drainage	Preparation and implementation of a CEMP containing an ASS Management Plan. Adoption of construction methodologies that reduce potential for mud waving to as low as reasonably possible.
Construction and operation	Vessel discharges	Preparation and implementation of a Marine Spill Response Plan aligned with the NT (Department of Infrastructure, Planning and Logistics, Marine Safety Branch) and Darwin Port Oil Spill Contingency Plans.
	Marine traffic impacts	Implementation of vessel speed limitations aligned with Darwin Port Harbourmaster requirements. Implementation of standard navigational procedures and navigation aids.
	Lighting impacts on marine fauna	Reduction of light spill into marine environment from vessels and infrastructure to as low as practically possible.
	Biosecurity	Preparation and implementation of a Biosecurity Management Plan, including vessel risk assessment and inspection protocols. Consultation with the Aquatic Biosecurity Unit within the NT Department of Industry, Tourism and Trade to ensure consistency with existing quarantine arrangements for Darwin Harbour facilities.
Operation	Discharges of contaminants from terrestrial activities	Stormwater retention and treatment systems incorporated into Ship Lift facility design. Preparation and implementation of an Operations Environment Management Plan that includes spill response measures. Waste management procedures to capture biofouling removed from vessels on the hardstand areas.
	Lighting impacts on marine fauna	Reduction of light spill into marine environment from vessels and infrastructure to as low as practically possible.

8.7 Statement of residual risk

Assessments of the risks of potential impacts on marine flora and fauna are summarised in Table 8-6. Risks were assessed both prior to mitigation and following the implementation of the mitigation measures within the plans listed in Table 8-5, to provide an assessment of residual risk.

The residual risk assessment indicates that there is a:

- High risk of impacts to marine flora and fauna from the introduction of marine pest species. Given the Extreme consequence of such an introduction, it is not possible (utilising the risk assessment methodology applied within this EIS) to reduce the residual risk rank to lower than High.

This highlights the need to effectively implement stringent vessel risk assessment and inspection procedures. Fortunately, these are readily available, are routinely applied Australia-wide and have been demonstrated to be effective in Darwin Harbour during the INPEX Ichthys dredging campaign.

- A Medium risk of impacts to marine fauna from vessel strike. Given the Major consequence that would arise if vessel strike upon a protected marine species was to occur, it is not possible (utilising the risk assessment methodology applied within this EIS) to reduce the residual risk rank to lower than Medium.

This highlights the need to effectively implement surveillance protocols and controls on vessel speeds within the vicinity of the Project area. It is noted that surveillance protocols are routinely implemented by vessels traversing the harbour, to mitigate the risk of collision with floating objects that may result in damage to the vessels; these will also be effective in reducing the risk of vessel strike of protected species to as low as reasonably possible.

The residual risk to marine flora and fauna attendant to all other impact sources is considered, with the implementation of the mitigation measures in the plans listed in Table 8-5, to be Low.

With regards to significant marine species and habitats:

- Due to limitations in survey techniques (i.e. observations have only been made on discrete occasions, and only during daylight hours), there is inherent uncertainty around whether significant marine species will be present within the vicinity of Project construction and operation activities and, therefore, if they will be potentially vulnerable to disturbance or direct impact. However, the management and mitigation measures that will be included within the plans listed in Table 8-5 will be developed on the assumption that these species may be present in the vicinity of the Project at some time of the day or night, and during some seasons.
- It is not possible to predict the effects upon significant marine species, or upon their habitats, of the introduction of marine pest species. If this was to occur, then the effects would be dependent upon the species introduced and the extent to which they would alter the ecosystem functions upon which the significant marine species are reliant.
- The only habitats that will be permanently lost as a result of the Project are the remnant mangrove stand on the Project site, and the areas of intertidal and shallow subtidal 'soft sediment' habitat that will be replaced during dredging and reclamation. It is considered that, given the magnitudes of equivalent habitats elsewhere within East Arm, this loss does not present a risk of significant impacts upon marine ecosystem integrity in East Arm, or within the broader Darwin Harbour.

Table 8-6 Pre and post-mitigation risk assessment for marine flora and fauna

Phase	Aspect	Pre-mitigation risk rating	EIS mitigations	Post-mitigation risk rating
Construction	Dredging and Reclamation - Habitat modification	Low	DDSPMP, including monitoring and reactive management protocols Modelling and assessments undertaken and included in EIS	Low
Construction	Dredging and Reclamation - Liberation of sediments into water column (turbid plumes)	Medium	DDSPMP, including monitoring and reactive management protocols Modelling and assessments undertaken and included in EIS	Low
Construction	Dredging and Reclamation - Deposition of liberated sediments (sedimentation)	Medium	DDSPMP, including monitoring and reactive management protocols Modelling and assessments undertaken and included in EIS Modelling and assessments undertaken and included in EIS	Low
Construction	Dredging and Reclamation - Changes in hydrodynamic and wave conditions (erosion and accretion)	Low	DDSPMP, including monitoring and reactive management protocols Modelling and assessments undertaken and included in EIS DSMP, including monitoring and reactive management protocols	Low
Construction	Dredging and Reclamation - Underwater noise and vibration	Medium	DDSPMP, including monitoring and reactive management protocols Modelling and assessments undertaken and included in EIS	Low
Construction	Piling - Underwater noise and vibration	Medium	Marine Noise and Vibration Management Plan, incorporating marine fauna observations and reactive management protocols	Low
Construction	Earthworks - Discharge of contaminants (sediments, stormwater)	Medium	ESCP Stormwater Management Plan	Low

Phase	Aspect	Pre-mitigation risk rating	EIS mitigations	Post-mitigation risk rating
			Compliance with AS1940-2004 (Storage and handling of flammable and combustible liquids) Stormwater retention and treatment systems incorporated into Project design.	
Construction	Earthworks- Potential to generate acidic and metal drainage, mud waving and stockpiling of ASS	Medium	ASS Management Plan Adoption of construction methodologies that reduce potential for mud waving to as low as reasonably possible	Low
Construction and Operation	Vessel discharges - Hydrocarbon or chemical spills	Medium	Marine Spill Response Plan Refuelling plan	Low
Construction and Operation	Marine traffic - Vessel strike	High	Vessel speed limitations aligned with Darwin Port Harbourmaster requirements. Standard navigational procedures and navigation aids.	Medium
Construction and Operation	Marine traffic - Vessel grounding	Low	Vessel speed limitations aligned with Darwin Port Harbourmaster requirements. Standard navigational procedures and navigation aids.	Low
Construction and Operation	Lighting	Low	CEMP and OEMP will dictate that light spill be reduced to as low as reasonably possible.	Low
Construction and Operation	Introduction of marine pests	Very High	Preparation and implementation of a Biosecurity Management Plan and inspection protocols. Consultation with the Aquatic Biosecurity Unit to ensure consistency with existing quarantine arrangements for Darwin Harbour facilities. Waste management procedures to capture biofouling removed from vessels on the hardstand areas.	High
Operation	Discharge of contaminants (stormwater)	Medium	Stormwater and wastewater system maintenance OEMP that includes spill response measures.	Low

8.8 Monitoring and reporting

Monitoring and reporting protocols pertinent to marine flora and fauna will be incorporated into the management plans listed in Table 8-5. Protocols that are pertinent to marine environmental quality are provided in Section 7.8, it is noted that effective management of environmental quality (i.e. water and sediment quality) will, in turn, provide protection to marine flora and fauna.

Protocols that are specific to marine flora and fauna will include:

- monitoring of Observation and Shut-down zones around dredging and piling operations, to mitigate the potential for impacts upon protected marine species
- reporting of protected marine species observed during dredging and piling operations.

These will be incorporated into the Dredging and Dredge Spoil Placement Management Plan that will be developed for the Project.

It is noted that:

- Monitoring of benthic communities in the vicinity of South Shell Island will be undertaken if this is triggered via the monitoring of turbid plumes emanating from the dredging and reclamation activities. This will be detailed in the Dredging and Dredge Spoil Placement Management Plan.
- The current monitoring for introduced marine pest species that is undertaken by the Aquatic Biosecurity Unit provides adequate coverage for the detection of an introduction into harbour waters, if it was to occur during Project construction and operation. Hence, the need for Project-specific monitoring is not envisaged. There will, however, be a strong focus upon mitigating the risk of introductions through the vessel risk assessment and inspection protocols within the Project's Biosecurity Management Plan.
- During operation, waste management and corresponding inspection procedures will be in place to capture biofouling removed from vessels on the hardstand areas; this will mitigate the risk of introduction to harbour waters of any species that may have eluded detection prior to arrival of the vessel at the facility.

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Chapter 9

Air Quality and Greenhouse Gas

9.0 Air Quality and Greenhouse Gases

9.1 Introduction

The ToR identifies air quality and greenhouse gases as a key environmental factor that could be significantly impacted by the Project. The objective associated with this factor is to:

'Maintain air quality and minimise emissions and their impact so that environmental values are protected.'

The relevant ToR requirements for air quality and greenhouse gas are presented in Table 9-1. Compliance of the EIS against the full ToR are document in Appendix A: Terms of Reference.

Table 9-1 ToR compliance table for air quality and greenhouse gases

ID	Terms of reference requirements	Report section number
Table 1: Minimum Information required in the Proposal description		
Energy		
	Provide relevant information with respect to energy during construction and operation, including but not limited to:	Section 9.3.2 Appendix J: Section 8.0
	energy requirements and sources	
	consideration of renewable sources of energy and justification of selected	Section 9.7.2 Appendix J: Section 9.2
	estimate of greenhouse gas emissions	Section 9.7.2 Appendix J: Section 8.0
	measures to maximise energy efficiency and avoid and/or reduce greenhouse gas emissions, particularly relating to source and consumption of energy.	Section 9.7.2.2 and 9.8 Appendix J: Section 9.2
Table 5: Minimum information required for assessment of air quality and greenhouse gases		
1.0 Environmental values		
1.1	As a minimum, describe ambient air quality of the area potentially impacted by emissions released by the Proposal.	Section 9.4 Appendix J: Section 5.2
2.0 POTENTIAL IMPACTS AND RISKS		
2.1	Describe potential impacts and risks to air quality including potential impacts and risks to the environment from fugitive emissions. As a minimum:	Section 9.3.1 Appendix J: Section 4.2.2.2
	provide an inventory of significant emissions to air likely to result from the Proposal	
	identify and provide the location of sensitive receptors on land and sea	Section 9.6 Appendix J: Section 6.0
	include reporting requirements and compliance with relevant environmental standards	Section 9.2 Section 9.3.1.1.4 Appendix J: Section 6.3

ID	Terms of reference requirements	Report section number
	assess air emission impacts during construction and operation based on air dispersion modelling for odour and volatile organic compounds (VOCs).	Section 9.3.1.1.4 and 9.7.1.2 Appendix J: Section 6.3
3.0 Mitigation and management		
3.1	Outline the measures for avoiding, minimising, managing and mitigating potential impacts and risks to air quality including: design of painting facilities, e.g., enclosed facility with negative air capacity.	Section 9.7.2 Appendix J: Section 9.0
4.0 Monitoring and reporting		
4.1	Describe how the Proponent will monitor and report potential impacts and risks to air quality including air quality standards and trigger values.	Section 9.8 Appendix J: Section 9.3
5.0 Residual impact		
5.1	Assess residual impact or risk of the Proposal to identified values.	Section 9.10 Appendix J: Section 11

9.2 Policy and guidance

The legislation, policies, standards and guidelines relevant to air quality and greenhouse gas in the context of the Project are described below:

International

- Kyoto Protocol (Int.)
- Paris Agreement (Int.).

Commonwealth

- *National Environment Protection Council Act 1994*
- *National Greenhouse Energy Reporting Act 2007*
- National Environment Protection (Ambient Air Quality) Measure 1998 (Australian Government 1998)
- National Environment Protection (Air Toxics) Measure 2004 (Australian Government 2004)
- National Greenhouse Measurement Determination 2008 (DAWE 2021).

Northern Territory

- NT EPA Guideline-Recommended Land Use Separation Distances 2017 (NT EPA 2017)
- Northern Territory Climate Change Response Towards 2050 (NTG 2019c).

Other relevant policies and guidelines

- Queensland Government Environmental Protection (Air) Policy (QLD) (EPP Air) (2019)
- Environment Reference Standard (Victorian Government, 2001) and the Draft Guideline for Assessing and Minimising Air Pollution in Victoria (Environment Protection Authority Victoria 2021).
- Approved methods for the modelling and assessment of air pollutants in NSW (NSW EPA 2016)
- Brisbane City Council (BCC) Air Quality Planning Scheme Policy (BCC 2014).

Further information on the legislative and strategic context can be found in Chapter 3: Strategic and Statutory Framework.

9.2.1 Project air emissions

Review of applicable National Pollution Inventory (NPI) emission estimation manuals was undertaken to determine the primary air pollutants which have been considered in this impact assessment. Table 9-2 below presents an overview of each pollutant of concern

Table 9-2 Description of pollutants of concern relevant to the Project

Pollutant	Description
Total Suspended Particulate (TSP)	TSP refers to airborne particles ranging from 0.1 micrometres (µm) to 50 µm in diameter. TSP, which includes the coarser size particulate matter fraction, is generated primarily from fugitive emissions sources such as vehicle travel on unsealed roads, wind erosion from exposed areas or earthen material stockpiles and handling of earthen material.
Particulate under 10 micrograms (PM ₁₀)	PM ₁₀ particles tend to remain suspended in the air for longer periods than larger particles (e.g., TSP) and can penetrate into human lungs. PM ₁₀ can be created in high quantities through crushing and grinding of rocks and soil. PM ₁₀ is also emitted from vehicle exhausts (combustion engine emissions), but in significantly lower quantities as compared with construction activities and fugitive emission sources.
Particulate under 2.5 micrograms (PM _{2.5})	PM _{2.5} can travel further into human lungs than the larger particulates and are often made up of heavy metals and carcinogens. Therefore, it is considered to pose a greater risk to human health than larger particle sizes. However, PM _{2.5} is emitted in minor quantities from mechanical sources such as construction activity and is more commonly emitted from combustion sources (i.e., road vehicles and diesel generators).
Oxides of nitrogen (NO _x)	NO _x describes a mixture of nitric oxide and NO ₂ . NO _x is colourless at low concentrations but has an odour.
Nitrogen dioxide (NO ₂)	NO ₂ can cause damage to the human respiratory tract, increasing a person's susceptibility to respiratory infections and asthma. Sensitive populations, such as the elderly, children, and people with pre-existing health conditions are most susceptible to the adverse effects of NO ₂ exposure.
Nitrous oxide (N ₂ O)	N ₂ O is a GHG and is produced by human activities such as agriculture, fuel combustion, wastewater management, and industrial processes. N ₂ O has a global warming potential (GWP) or a potential to hold heat in the atmosphere 265 times greater than CO ₂
Carbon monoxide (CO)	CO is a colourless, odourless gas formed when substances containing carbon (such as petrol, gas, coal and wood) are burned with an insufficient supply of air.
Carbon Dioxide (CO ₂)	CO ₂ is a GHG and is produced from human sources such as cement production, deforestation and burning of fossil fuels like coal, oil and natural gas. GHGs are reported against their capacity to hold in the atmosphere compared to CO ₂ when determining their GWP.
Volatile organic compounds (VOCs)	VOCs are carbon-based chemicals that readily evaporate at room temperature, including xylene, toluene and benzene.
Odour	Odour emissions can be either a single compound or a mixture of compounds that have the potential to affect environmental amenity and cause nuisance.
Methane (CH ₄)	Methane is a GHG and is produced by the anaerobic decay of biological organisms and changes in land use. Methane has a GWP of 28.

Pollutant	Description
Sulfur dioxide (SO ₂)	Sulfur dioxide is a colourless gas with a sharp, irritating odour. The regulation of low sulphur content fuel in Australia has significantly decreased the generation and concentrations of SO ₂ near transport sources, however, is still contained in diesel fuel in marine diesel fuel.
Ozone (O ₃)	Ozone is not emitted directly from fuel combustion, but rather is a secondary pollutant formed via chemical reaction of other pollutant species in the local atmosphere. Assessment of the formation of ozone and other secondary pollutants has not been considered in this assessment.

A detailed description of each pollutant is provided in Appendix J: Air Quality and Greenhouse Gas Technical Report.

9.2.2 Adopted air quality goals

9.2.2.1 NEPM review

National Environment Protection Measures (NEPM) are broad framework-setting statutory instruments that outline agreed national objectives for protecting or managing particular aspects of the environment. The air quality of an environment is protected by the Ambient Air Quality NEPM.

The 2016 version of the Ambient Air Quality NEPM is referenced in the ToR for the Project. The Ambient Air Quality NEPM was amended in May 2021 (National Environmental Protection Council 2021), superseding the 2016 version. Amendments made in May 2021 included significant reductions to the standards for NO₂ and SO₂.

The Ambient Air Quality NEPM and Air Toxics NEPM standards are intended to be applied to air quality experienced by the general population in a region. The Ambient Air Quality NEPM and Air Toxics NEPM standards are not intended to be applied to assessing air quality in areas in the region affected by localised air emissions, such as individual industrial sources or projects. The Explanatory Statement issued with amendment of the Ambient Air Quality NEPM clarifies its intent as a standard for reporting representative ambient air quality within an airshed, and not as a regulatory standard. The Ambient Air Quality NEPM does not constrain a jurisdiction's ability to manage local or regional air quality issues.

Until recently (May 2021), the Ambient Air Quality NEPM standards have been comparable to the impact assessment air quality standards prescribed by other States and Territories, and this remains true for most pollutants. However, the recently amended standards for NO₂ and SO₂ are no longer consistent with the standards prescribed by other States and Territories and therefore review of appropriate assessment criteria for these pollutants is required for this project.

To determine appropriate air quality goals for the project, a review of air quality goals prescribed by the State Governments of Queensland, NSW and Victoria has been undertaken in comparison to the Ambient Air Quality NEPM (2021), and the Air Toxics NEPM (2011).

9.2.2.2 Annual average incremental PM_{2.5} goal

The annual average PM_{2.5} goal of 8 µg/m³ as prescribed by the Queensland, NSW and Victorian Governments is being approached or exceeded at ambient air quality monitoring stations in most major Australian capital cities. It is therefore becoming increasingly difficult to show compliance with the annual average PM_{2.5} goals for new projects which need to assess cumulative concentrations. An incremental PM_{2.5} (ΔPM_{2.5}) goal of 1.3 µg/m³ has been derived for the Project and has been considered in the air quality assessment. Further discussion of the derivation of the incremental PM_{2.5} goal is provided in Appendix J: Air Quality and Greenhouse Gas Technical Report.

The air quality goals adopted for the Project are presented in Table 9-3. Further discussion of the adopted air quality goals is also provided in Appendix J.

Table 9-3 Adopted Air Quality Goals for the Project

Pollutant	Averaging Period	Air Quality Goal ($\mu\text{g}/\text{m}^3$)	Source
PM ₁₀	24 hour maximum	50	NEPM, QLD, NSW, VIC
	Annual average	25	NEPM, QLD, NSW
PM _{2.5}	24 hour maximum	25	NEPM, QLD, NSW, VIC
	Annual average	8	NEPM, QLD, NSW, VIC
	Incremental Annual average	1.3	Derived method from South Australia Department of Planning, Transport and Infrastructure
NO ₂	1 hour maximum	226	QLD, NSW, VIC
	Annual average	56	QLD, NSW, VIC
SO ₂	1 hour maximum	523	QLD, NSW, VIC
	24 hour maximum	209	QLD, NSW, VIC
	Annual average	52	QLD, NSW, VIC
CO	8 hour maximum	10,000	NEPM, QLD, NSW, VIC
Benzene	1 hour 99.9 th percentile	580 ^a	VIC
	24 hour maximum	29 ^a	VIC
	Annual average	6.4	QLD
Toluene	30 minutes maximum	1,100	QLD
	24 hour maximum	3,700	QLD
	Annual average	376	NEPM, QLD
Xylenes	1 hour 99.9 th percentile	22,000 ^a	VIC
	24 hour maximum	1,100	NEPM, QLD
	Annual average	100	VIC
Table note: ^a Criteria is applied at and beyond the boundary of the Project and not only at sensitive receptors.			

9.3 Assessment methodology

This assessment identifies potential impacts to the surrounding air environment due to air emissions from construction and operational activities, as well as estimates of GHG emissions during both construction and operation. The assessment study area is defined as the area within a 15 km by 12 km area surrounding the Project. The study area is presented in Figure 9-1.



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Data sources:
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID,
IGN, and the GIS User Community
Base Data: (c) Based on information provided by and with the permission of the Western Australian
Land Information Authority trading as Landgate (2010).

LEGEND
 Project location
 Study area

Note:
The layout is indicative only

Project location and Study area

NORTHERN TERRITORY
GOVERNMENT OF AUSTRALIA
DARWIN SHIP LIFT PROJECT

Figure
9-1

A4 size

Construction of the Project involves site preparation, dredging, transport of material and fill, land reclamation and revetments, service installation, sealing and paving, piling, infrastructure installation and corrosion protection. Construction emissions are expected to be comprised of both combustion emissions and dust from material handling emissions.

Operation of the Project involves a blast and paint facility, which would undertake activities including abrasive blasting for paint and corrosion removal (including anti-fouling paint) and surface preparation, then painting of the vessel hull, including anti-fouling paints. Air emissions from this activity are expected to be predominantly VOC emissions.

Further details on the proposed construction and operation activities are included in Chapter 2: Project Description.

9.3.1 Air quality

Potential impacts on air quality due to construction and operation of the Project were assessed using air dispersion modelling. The CALPUFF modelling suite was selected as the model of choice for this assessment.

A summary of the methodology used for the modelling is presented in this section and detailed in Appendix J: Air Quality and Greenhouse Gas Technical Report.

9.3.1.1 Construction phase assessment

9.3.1.1.1 Modelling scenario

A single 'worst-case' construction phase modelling scenario was developed to assess potential impacts due to air emissions from construction of the Project. The number and type of sources were designed to represent a small number of many different machines operating over a period of several weeks. It should be noted that equipment with the same or similar emissions or tasks were classified as a single type of machine for simplicity and therefore the modelling scenario may not accurately detail each of the different types of machinery operating at any time. The activities included in the scenario are described below in Table 9-4.

Table 9-4 Construction phase modelling scenario inputs

Activity	Inputs
Dredging (based on Option 1)	1 x backhoe dredge (BHD) and barge within wet berth and manoeuvring areas 1 x cutter-suction dredge (CSD) within wet berth and manoeuvring areas 4 x work boats (Multicat) assisting the BHD - Activity hours: 24 hours/day, 7 days/week, for the entire modelled year.
Piling	2 x land-based and barge-based rigs^b within land reclamation area - activity hours: 7am to 7pm.
Importing fill	400,000 m³ (520,000 t) imported fill for land reclamation, occurring 24 hours/day using triple road trains 90,000 m³ (117,000 t) imported pavement and subgrade material, occurring between 7am to 7pm importing using triple road trains.
Land handling of materials	- imported material to be unloaded from road trains, and then reloaded to tipper trucks for distribution across the site 3 x dozers/bobcats^a for material shaping and forming 3 x graders for site levelling - activity hours: 7am to 7pm.
Table note: ^aEmissions for dozers and bobcats are calculated on the basis of amount of material moved, and for the purpose of the assessment have been included in the model under the assumption that the same amount of material is moved by each machine. As a conservative estimate, the higher emissions factor for the dozer has been applied to both machines in the model for simplicity. ^bLand based and barge-based drill rigs are assumed to have the same emissions and therefore not defined as separate machinery items in the model.	

9.3.1.1.2 Combustion Emissions

Combustion emissions are not typically assessed in detail for construction activity as emissions of exhaust gases are typically significantly lower in magnitude than construction dust emissions. However, as some construction activity required for the Project is required to be undertaken 24 hours per day, and requires large equipment, the potential for air quality impacts from combustion engines has been investigated. It is noted that due to the significant separation distance between construction activity areas and sensitive receptors (refer Section 9.6), the risk of significant air quality impacts resulting from combustion engines is considered to be low.

To investigate the potential for air quality impacts from combustion engines, emissions from the largest items of construction equipment and those which will operate for the longest durations have been assessed. Combustion engine emissions which have been assessed in detail include dredging operations and piling operations due to the engine size of this equipment and that dredging activity will occur 24 hours per day.

Combustion emissions from smaller items of equipment and items which will operate for shorter durations (e.g. trucks, dozers, graders, and construction-related vehicles) have not been considered in the assessment as emissions from these equipment items are not expected to be significant in comparison to emissions from larger engines such as those used in dredges and drill rigs. Similarly, emissions from road trains used to deliver material to site will also not generate significant emissions comparatively due to the short residence time on-site. Overall, investigation of emissions from dredging and piling operations is considered to provide a representative assessment of the potential for air quality impacts.

Emissions were estimated for two dredges operating simultaneously; CSD and a BHD both within the ship lift area, as well as land-based and barge-based rigs. Emission rates were estimated based on rated engine power. Emission and load factors for the CSD, BHD and workboats were referenced from the United States Environmental Protection Agency (USEPA) *Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories*, April 2009 (USEPA 2009). Emission and load factors for the BHD backhoe and the drilling rig are taken from the National Pollutant Inventory (NPI) *Emissions estimation technique manual for combustion engines-v3.0* (NPI 2008).

A summary of emission factors used for dredging vessels are presented in Appendix J: Air Quality and Greenhouse Gas Technical Report. Modelled emission rates are presented in Table 9-5.

Table 9-5 Emission rates

Plant	Engine Power (kW)	Emission Rate (g/s)					
		NO _x	CO	Total VOC	PM ₁₀	PM _{2.5}	SO ₂
CSD	503	1.398	0.210	0.038	0.042	0.041	0.088
BHD	2200	3.416	0.657	0.071	0.079	0.076	0.166
Work boats	390	2.460	0.205	0.205	0.088	0.080	0.001
BHD Backhoe	1900	4.961	1.071	0.362	0.354	0.346	0.330
Drill Rig	392	2.048	0.442	0.149	0.146	0.143	0.136

9.3.1.1.3 Material Handling Emissions

Land based material handling emission rates for PM₁₀ and PM_{2.5} were estimated based on published emission factors listed in the NPI *Emissions estimation technique manual for mining v3.1* (NPI 2012), the USEPA AP-42 11.9 *Western Surface Coal Mining* (USEPA, 1995), USEPA AP-42 13.2.5 *Industrial Wind Erosion* (USEPA 2006).

A summary of adopted emissions factors and mitigation controls for each activity is presented in Appendix J: Air Quality and Greenhouse Gas Technical Report. PM₁₀ to PM_{2.5} correction factors were applied to PM_{2.5} emission rates due to the absence of published emission factors for PM_{2.5} for some emission sources.

Emissions were estimated for each emission source based on the following:

- estimated equipment utilisation rates (percentage of shift time operating, e.g., 80% of 12 hour shift, etc) were provided by NTG
- assumed exposed area for estimating wind erosion emissions of 147,000 m², conservatively estimated to cover the entire construction footprint
- assumed average travel speed for the grader was 5 km/h
- assumed silt content for the haul routes was 8.5%
- estimated construction schedule of between 24 and 36 months.

Haul truck parameters used to estimate wheel generated dust emissions are presented in Appendix J: Air Quality and Greenhouse Gas Technical Report. A summary of modelled emission rates for each source is presented in Table 9-6. The emission rates were applied to the model according to the times listed in the table.

Table 9-6 Summary of modelled material handling emission rates

Source	Emission Rate (g/s)	
	PM ₁₀	PM _{2.5}
Imported fill/material haul (7am -7pm)	0.16984	0.00594
Imported fill/material haul (7pm-7am)	0.11713	0.0041
Dumping to stockpiles (7am to 7pm)	0.0185	0.00098
Dumping to stockpiles (7pm -7am)	0.01276	0.00068
Transfer to tipper trucks (7am-7pm)	0.08725	0.00345
Tipper truck haul (7am-7pm)	0.51978	0.00820
Dumping from tipper trucks (7am-7pm)	0.01563	0.00083
Grader (7am-7pm)	0.02509	0.00251
Dozers (7am-7pm)	0.24202	0.01907
Wind erosion	6.39E ⁻⁰⁶ a	8.33E ⁻⁰⁷ a
Table note: a. Emission rate in grams per square metre per second (g/m ² /s)		

9.3.1.1.4 Odour

Dredging

Dredging activities have the potential to generate odour emissions and nuisance impacts, dependent on the type of material being dredged and the dredge material placement methodology.

The potential for significant odour emissions and resulting nuisance impacts as a result of the main works dredging required to be undertaken for the construction of the Project is considered to be low, due to the nature of the material which would be dredged (which is predominantly unconsolidated muds and consolidated rocky material) and the significant separation distance between the Project and the nearest sensitive receptors (refer Section 9.6).

It is understood that previous dredging projects undertaken near the Project have not resulted in complaints or nuisance impacts with respect to odour emissions. It is expected that there may be some acid sulfate soils which are required to be dredged, but it is anticipated that disposal methodologies will ensure that no significant odour impacts occur.

On this basis, odour emissions from dredging during the construction phase have not been considered in this assessment.

Burning of material

Burning of material (vegetation, waste, etc) would not be undertaken during the construction phase of the Project and therefore no odour emissions would occur from burning.

9.3.1.2 Operational Phase Assessment

The only emissions source of concern for the operation phase of the Project is the blast and paint facility. Air emissions from the blast and paint facility have been assessed in detail.

Combustion emissions would most likely be generated during operation as a result of vehicle traffic and other diesel engine powered equipment such as cranes and generators. However, these are not considered to be significant air emission sources and do not have the potential to generate significant air quality impacts at sensitive receptors and therefore have not been assessed.

9.3.1.2.1 Blast and Paint Facility - VOCs

Operational phase emissions were estimated for the blast and paint facility. At the time of writing, specific details on the exact usage of the facility, including key information such as duration of blasting, paint and materials consumption and other relevant inputs were unavailable. Due to the data limitations, emissions from the blast and paint facility have been estimated based on total VOC emissions from similar existing facilities.

The NPI is regulated by the Australian Government and is tasked with tracking pollution across Australia, ensuring that the community has access to information about the emission and transfer of toxic substances which may affect them locally. All major polluters are required by the Australian Government to submit annual reports of their emissions to air.

Emissions data for the BAE Systems Henderson Shipyard in Western Australia, and the BAE Systems Williamstown Facility in Victoria, were sourced from the NPI for the reporting years 2013/14 to 2018/19.

The highest annual reported VOC emission rate of 36,165 kg/year reported in 2013/14 for the Henderson Shipyard was used to estimate VOC emissions for the blast and paint facility for the Project. A summary of total VOC and xylene emissions for each facility is presented below in Table 9-7 and detailed further in Appendix J: Air Quality and Greenhouse Gas Technical Report

Table 9-7 Exhaust vent parameters including VOC emission rate

Parameter	Value	Units
Operating hours per day	24	hours
Operating days per week	6	days
Number of exhaust vents	12	-
Stack height above ground	33	m
Stack diameter	1.13	m
Exhaust velocity	20	m/s
Exhaust Flow rate (total)	240	m ³ /s
Building Dimensions	80 long x 30 wide x 30 high	m
Building Volume	72,000	m
Air changes per hour	12	Changes per hour
Cross sectional velocity	0.27	m/s
VOC Emission rate (total)	1.40	g/s
VOC emission rate (per vent)	0.1163	g/s

For this assessment it has been assumed that fumes (VOCs) that are generated within the blast and paint facility would be ventilated to atmosphere via 12 exhaust vents located on the roof of the building. Parameters used in the modelling for the exhaust vents are presented in Appendix J: Air Quality and Greenhouse Gas Technical Report.

Ventilation rates were assumed based on achieving 12 air changes per hour and meeting a minimum in-building cross flow rate of 0.25 meters per second for full down draught spray booths (as required in *Australian Standard 4114:2020 Spray painting booths, designated spray painting areas and paint mixing rooms*). The blast and paint facility building was included in CALPUFF with calculations for building wake effects switched on.

Due to the limited information available with respect to emissions from the blast and paint facility, assessment of VOC emissions has been undertaken as a conservative screening assessment. The screening assessment has been undertaken by assessing predicted total VOC concentrations at sensitive receptors against the strictest air quality goals for either benzene, toluene or xylene, considering both the air quality goal and the existing background concentration for each VOC species. Further discussion on the selection of the strictest air quality goal for the VOC screening assessment is provided in Section 9.4.3

Air filtration would be installed as part of the mechanical ventilation system to minimise emissions to air. It is expected that this filtration would significantly reduce particulate matter emissions from the exhaust stacks to a level which is not significant and does not pose a risk to surrounding sensitive receptors. It is noted that the NPI emission reports for the BAE Systems Henderson Shipyard and the BAE Systems Williamstown Facility do not include particulate matter emissions. On this basis, particulate matter emissions from the blast and paint facility have not been assessed.

9.3.1.2.2 Blast and Paint Facility – Odour

Odour emissions from the blast and paint facility would be associated with VOCs emissions.

The NT EPA *Guideline: Recommended Land Use Separation Distances* (NT EPA, 2017) provides guidance with respect to air quality and odour impacts and the separation distance required between emission sources and sensitive land uses.

The recommended separation distance for boat building and maintenance, metal coating and metal finishing, where organotin compounds (used in anti-fouling paints) are used or removed from vessels, is 1,000 m (NT EPA, 2017). As discussed in Section 9.6, the nearest sensitive receptors are more than 5 km from the blast and paint facility, which is well beyond the NT EPA recommended separation distance.

VOC emissions from the blast and paint facility have been investigated in detail. As odour is primarily linked to VOC emissions, odour impacts at the receptors are expected to be negligible if predicted VOC concentrations are well below the adopted air quality goals.

Complex odour emissions and potential impacts have therefore not been included in the modelling assessment; though have been considered based on the results of the assessment for VOCs.

9.3.1.3 Conversion of NO_x to NO₂

Oxides of nitrogen are produced in most combustion processes and are formed during the oxidation of nitrogen in fuel and nitrogen in the air. During high-temperature processes, a variety of oxides are formed including nitric oxide (NO) and NO₂. NO would generally comprise 95 % of the NO_x by volume at the point of emission. The remaining NO_x would consist of NO₂. Over time, NO_x emitted into the atmosphere is oxidised to NO₂ and the fraction of NO₂ would generally increase the further from the point of emissions due to the increased time for oxidation.

When modelling NO_x emissions, some conversion between NO_x at the source and NO₂ at the receptor must be made. There are several methods that can be adopted to estimate NO₂ concentration, with varying degrees of conservatism. For the purpose of this assessment the Ozone Limiting Method (OLM) was adopted.

Further discussion of the OLM is provided in the technical report in Appendix J: Air Quality and Greenhouse Gas.

9.3.1.4 Assessment limitations

The atmosphere is a complex, physical system, and the movement of air in a given location is dependent on several different variables, including temperature, topography and land use, as well as larger-scale synoptic processes. Dispersion modelling is a method of simulating the movement of air pollutants in the atmosphere using mathematical equations. The model equations necessarily involve some level of simplification of these very complex processes based on our understanding of the processes involved and their interactions, available input data, and processing time and data storage limitations.

These simplifications come at the expense of accuracy, which particularly affects model predictions during certain meteorological conditions and source emission types. For example, the prediction of pollutant dispersion under low wind speed conditions (typically defined as those wind speeds less than 1 m/s) or for low-level, non-buoyant sources, is problematic for most dispersion models. To accommodate these known deficiencies, the model outputs tend to provide conservative estimates of pollutant concentrations at particular locations.

While the models contain a large number of variables that can be modified to increase the accuracy of the predictions under any given circumstances, the constraints of model use in a commercial setting, as well as the lack of data against which to compare the results in most instances, typically precludes extensive testing of the impacts of modification of these variables. Model developers typically specify a range of default values for model variables that are applicable under most modelling circumstances. These default values are recommended for use unless there is sufficient evidence to support their modification.

As a result, the results of dispersion modelling provide an indication of the likely level of pollutants within the modelling domain. While the models, when used appropriately and with high quality input data, can provide very good indications of the scale of pollutant concentrations and the likely locations of the maximum concentrations occurring, their outputs should not be considered to be representative of exact pollutant concentrations at any given location or point in time. As stated above, however, the model predictions are typically conservative, and tend to over predict maximum pollutant concentrations at receiver locations.

9.3.2 Greenhouse gas

9.3.2.1 Emissions inventory scenarios

Emissions inventories have been developed for the construction and operation phases of the Project. The emissions inventory scenarios are described as follows:

- Construction scenario: GHG emissions estimated for the entirety of the construction program. Emissions estimates for fuel consumption for the equipment are provided in Appendix J: Air Quality and Greenhouse Gas. Grid electricity usage for the construction phase is unknown at time of writing but is expected to be minimal.
- Operation scenario: GHG emissions based on a typical 12 months of operation. Emissions estimated for fuel consumption required ship lift cranes and diesel generators, in addition to the consumption of grid electricity.

9.3.2.2 Emission sources

Consistent with National Greenhouse and Energy Reporting (NGER) this inventory presents GHG emissions anticipated from the construction and operation of the Project for Scope 1 and Scope 2 emission sources. Scope 3 emissions have not been assessed in this report.

The emission sources for the Project which have been considered in this inventory are summarised as follows:

- Scope 1:
 - diesel fuel combustion for stationary energy (dredges, construction plant, ship lift cranes and diesel generators)
 - diesel fuel combustion for transport energy (construction vehicles)

- Scope 2:
 - electricity consumption for stationary energy (shore power for vessels at berth).

Scope 1 emissions from the clearing of vegetation have not been considered in the development of the emissions inventory. The area of vegetation clearing required for the Project is minimal (approximately 1.0 ha), and GHG emissions from land clearing are not expected to be significant.

Scope 3 emissions, such as embodied energy, combustion emissions from transport of construction materials and breakdown of waste, have been excluded from this assessment.

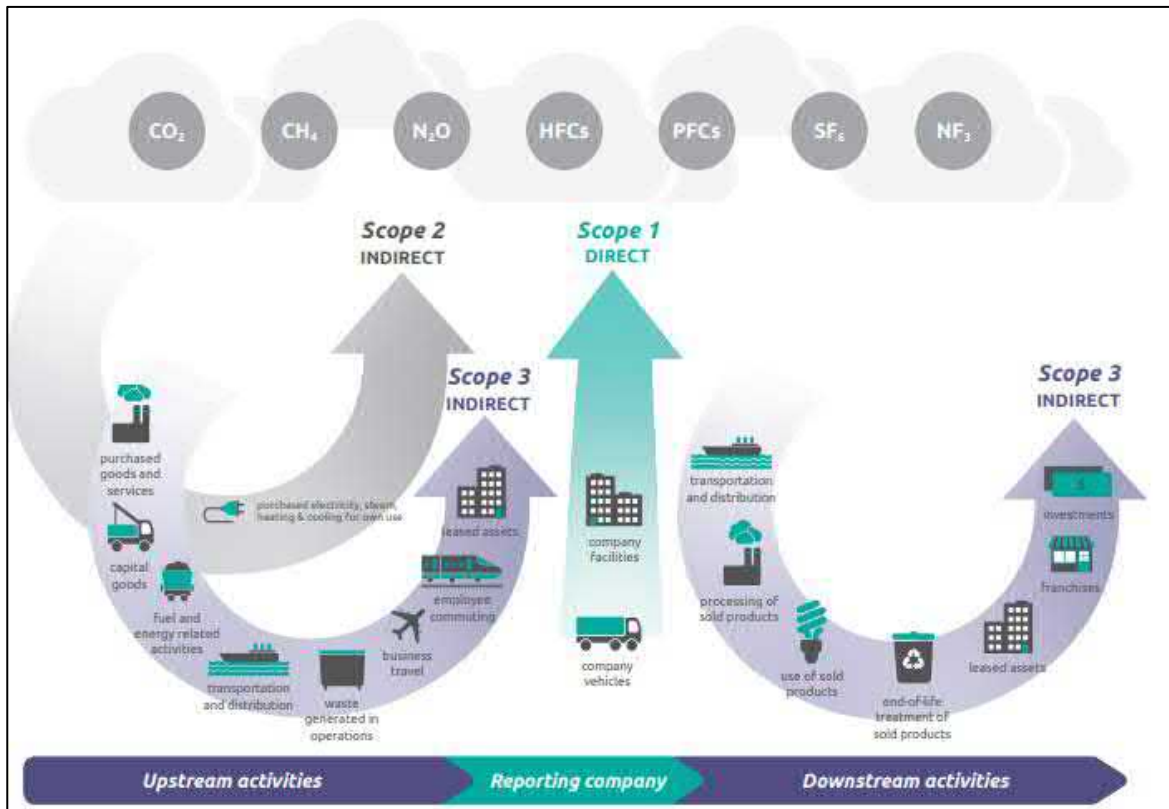


Figure 9-2 Overview of scope and emissions flow across reporting entity (GHG Protocol, 2013)

9.3.2.3 Emission calculations

The NGER (Measurement) Determination GHG emission factors for the sources considered for the Project, are summarised in Appendix J: Air Quality and Greenhouse Gas Technical Report.

It is noted that for the calculation of Scope 2 GHG emissions for grid electricity consumption, the current National Greenhouse Accounts (NGA) Factors (2021) GHG emission factor for electricity consumption in the Darwin Katherine Interconnected System (DKIS) has been used (0.54 kg CO₂-e/kWh). With the transition to a target of 50% renewably sourced energy across the NT energy supply sector, this emission factor may decrease in future years, which would in turn, decrease Scope 2 GHG emissions from this source. Therefore, estimation of Scope 2 emissions from operation of the project are considered conservative.

9.3.2.4 Emission inventory inputs and assumptions

GHG emissions were estimated based on total potential working hours for each plant or equipment item, and estimated diesel fuel consumption rate or engine power.

A summary of parameters used to calculate GHG emissions for each type of plant for both construction and operation is presented in Appendix J: Air Quality and Greenhouse Gas Technical Report.

Hourly diesel fuel consumption rates were sourced from the similar studies where available (and are referenced in the table) and emission were based on these. Dredging emission rates were calculated based on the engine power requirements of the dredges (including all onboard engines) and the calorific value for diesel.

Indirect Scope 2 GHG emissions from electricity consumption during operation were estimated based on an assumed annual usage rate of 1,440,000 kWh as provided by NTG.

9.4 Existing environmental values

Existing environmental values such as meteorology and ambient air quality form the basis of an air quality assessment as they inform the background to the Project. Further analysis of existing environmental values is provided in Appendix J: Air Quality and Greenhouse Gas Technical Report.

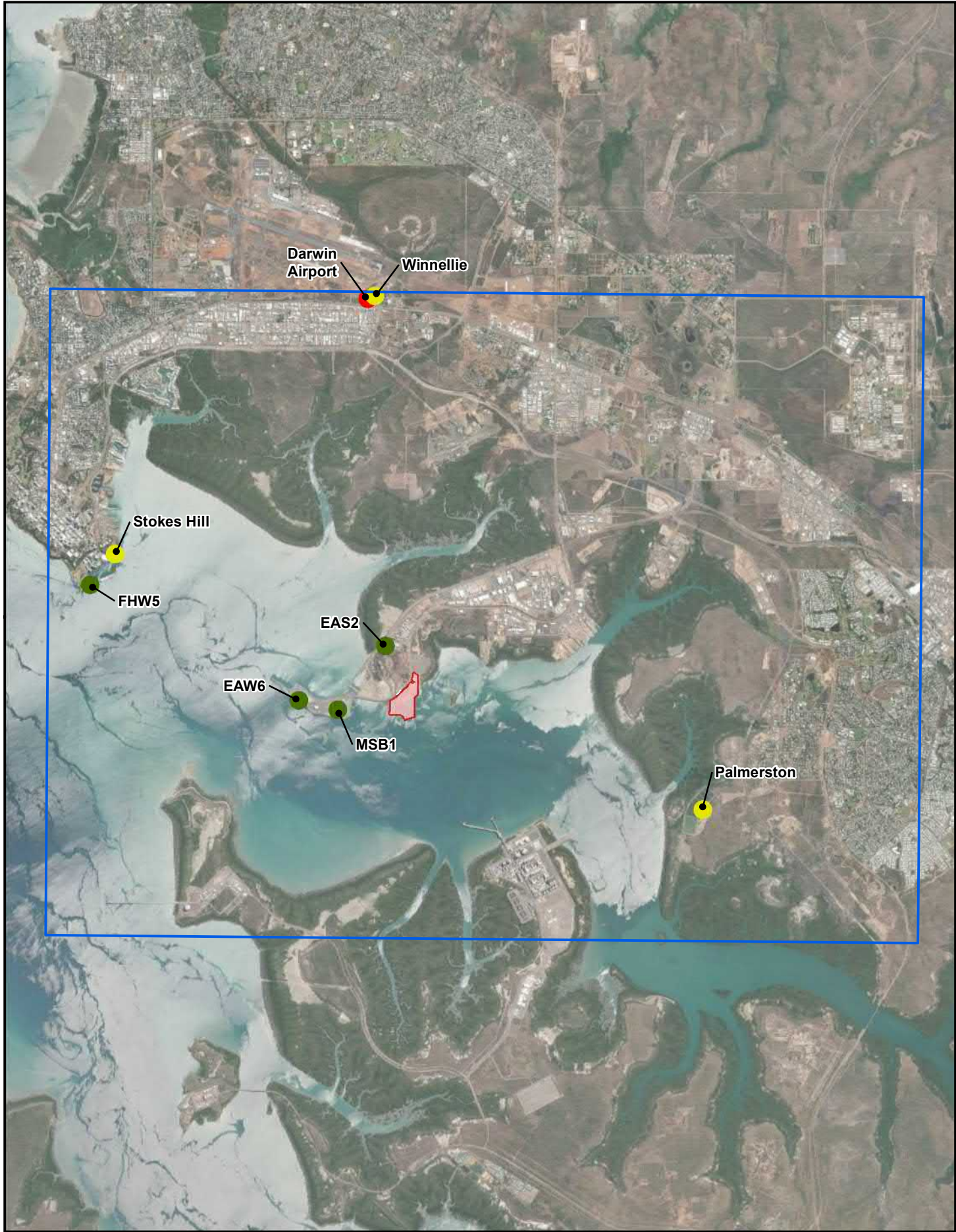
9.4.1 Meteorology

The BoM operates a network of meteorological monitoring stations within Australia. Long term meteorological data is available from the BoM monitoring station at Darwin Airport. Information on this meteorological station is provided in Table 9-8. The location of the monitoring station is shown in Figure 9-3.

Table 9-8 BoM Darwin Airport meteorological monitoring station details

BoM Station ID	BoM Station Name	Coordinates (UTM) (GDA Zone 52)	Distance and orientation from Project
014015	Darwin Airport	X: 705,722 Y: 8,625,840	7 km north

Figure 9-3 shows that the Darwin Airport monitoring station is located approximately 7 km inland from the inner shore of the Darwin Harbour and from the Study area. Due to the close proximity of the BoM station, wind speeds are considered comparable and therefore representative, however likely to experience slightly more sheltered conditions at the Study area than those measured at the BoM station. As a result, monitoring data from the Darwin Airport station has been considered in this assessment.



PROJECT ID

60633505

CREATED BY

PK

APPROVED BY

HS

LAST MODIFIED

23 SEP 2021

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DATUM

GDA 1994, PROJECTION

MGA ZONE 52

0

925

1,850

2,775

3,700

Meters

Data sources:

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

●

BoM Meteorological Monitoring Station

●

NTEPA Air Quality Monitoring Station

●

DPC Air Quality Monitoring Station

▭

Project location

▭

Study area

Note:

The layout is indicative only

Location of meteorological and air quality monitoring stations considered in the assessment

NORTHERN TERRITORY

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Figure

9-3

A4 size

9.4.1.1 Wind speed and direction

Suspended particles and gases are transported by wind and therefore wind speed and direction are important considerations when assessing the potential for air quality impacts to sensitive receptors.

Annual and seasonal wind roses for the BoM Darwin Airport station have been analysed and are presented in Appendix J: Air Quality and Greenhouse Gas Technical Report.

Analysis found that westerly, easterly, and west-north-westerly winds are the predominant wind directions.

Seasonal variations in wind direction are evident with noticeable variation between the wet season (spring and summer) and the dry season (autumn and winter). Strongest winds are recorded from the west and north-west and are present during Summer. Autumn has the weakest wind conditions, which is expected due to the effect of the tropical coastal outline (BoM, 2020).

9.4.1.2 Temperature

Table 9-9 presents temperature statistics for measurements recorded at the BoM Darwin Airport station from 1941 to 2020. Warmest temperatures are recorded during spring months, with the highest average maximum temperatures recorded in November (33.4°C), and lowest average maximum in July (30.6°C).

Average minimum temperatures are highest in November and December (25.3°C) and lowest in July (19.3°C). Monthly average maximum and minimum temperature do not vary greatly on an annual basis with a variance of 2.8°C in the mean maximum and a 6°C variance in the mean minimum.

Table 9-9 Temperature statistics for BoM station Darwin Airport (1941 to 2021)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug ^a	Sep ^a	Oct ^a	Nov ^a	Dec ^a
Mean maximum temperature (°C)	31.8	31.5	32.0	32.8	32.1	30.7	30.6	31.4	32.7	33.3	33.4	32.7
Mean minimum temperature (°C)	24.9	24.8	24.6	24.0	22.2	20.0	19.3	20.3	23.0	24.9	25.3	25.3
Table note: Maximum and minimum temperatures are represented in red and blue respectively ^a 2021 data is only available for months Jan-Jul at time of writing												

9.4.1.3 Rainfall

The Darwin area experiences a tropical climate with distinctly wet summers and dry winters (BoM, 2020). Table 9-10 presents mean rainfall statistics for measurements recorded at the BoM Darwin Airport station from 1941 to 2020. The highest periods of rainfall are recorded in summer months, with the maximum monthly rainfall recorded in January (432 mm). Relatively low rainfall is recorded in the months of May to September, with the lowest mean rainfall month being July (1 mm). Table 9-10 shows a clear pattern of wet and dry seasons, as expected for the Darwin area (BoM, 2020).

Table 9-10 Rainfall statistics for BoM Darwin Airport station (1941 to 2021)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug ^a	Sep ^a	Oct ^a	Nov ^a	Dec ^a
Mean rainfall (mm)	432	369	312	102	21	2	1	5	17	71	142	250
Table note: Maximum monthly mean rainfall measurement shown in bold ^a 2021 data is only available for months Jan-Jul at time of writing												

9.4.1.4 Relative humidity

Table 9-11 presents relative humidity statistics recorded at Darwin Airport BoM monitoring stations from 1954 to 2010. Relative humidity percentages at 9.00 am vary from 60% in July to 83% in January, with respective monthly values of 37% to 72% at 3.00 pm.

Table 9-11 Relative Humidity statistics for BoM station Darwin Airport (1954 to 2010)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean 9am relative humidity (%)	81	83	82	74	65	60	60	64	68	69	72	76
Mean 3pm relative humidity (%)	70	72	67	52	43	38	37	40	47	52	58	65
Table note: Maximum and minimum humidity is represented in red and blue respectively												

9.4.2 Air quality

NT EPA air quality monitoring data was used to inform the ambient air quality concentrations for the Project for PM₁₀, PM_{2.5}, NO₂, CO and SO₂. VOC data was not available from NT EPA stations, therefore ambient air quality concentrations for VOCs were inferred from Queensland Department of Environment and Science (QLD DES) air quality monitoring station at Gladstone.

9.4.2.1 QLD DES air quality monitoring

Monitoring data was used from DES Memorial Park monitoring station in Gladstone, QLD, to determine a background concentration that is representative of conditions surrounding the Project. Gladstone is a heavily industrialised town on Queensland's east coast, and could be considered similar to the Darwin Port area. Overall, ambient air quality monitoring data from the Memorial Park site could be considered a conservative representation of ambient air quality conditions. However, in the absence of more appropriate data for the Study area, VOC concentrations from Memorial Park are considered appropriate for the assessment to consider cumulative impacts.

9.4.2.2 NT EPA air quality monitoring

The NT EPA monitors ambient air quality data at numerous monitoring stations in the State for various pollutants of concern for the Project. There are three monitoring stations located nearby to the Study area located at Stokes Hill, Winnellie and Palmerston. The location of these stations is shown in Figure 9-3 and coordinates and proximity to the site are provided in Table 9.11.

VOC species are not monitored at any of the NT EPA stations. However, in order to assess the cumulative impact from operational emissions of VOCs of the Project, a background concentration was inferred from monitoring data at a similar location.

Details for the air quality monitoring stations considered in the assessment are provided in Table 9-12. Detailed information on background air quality monitoring is provided in Appendix J: Air Quality and Greenhouse Gas Technical Report.

Table 9-12 Air quality monitoring stations included in the assessment

Monitoring site	Owner / operator	Operation dates	Coordinates (UTM) (GDA Zone 52)	Distance and orientation from Site	Pollutants monitored
Stokes Hill	NT EPA	2017 to current	X: 701,126 Y: 8,621,140	6 km north-west	CO, NO ₂ , PM ₁₀ , PM _{2.5} , SO ₂
Winnellie	NT EPA	2012 to current	X: 705,813 Y: 8,625,830	7 km north	CO, NO ₂ , PM ₁₀ , PM _{2.5} , SO ₂
Palmerston	NT EPA	2011 to current	X: 711,740 Y: 8,616,520	6 km south-east	CO, NO ₂ , PM ₁₀ , PM _{2.5} , SO ₂
Memorial Hill (Gladstone, QLD)	QLD DES	2009 to current	X: 321, 955 Y: 7,361,912	2,488 km south-east	NO ₂ , O ₃ , SO ₂ , benzene, toluene, formaldehyde, xylene

9.4.2.3 Darwin Port Corporation monitoring

The DPC undertakes monitoring of PM₁₀ at four locations in the area near the Site. The locations of the monitoring sites are shown in Figure 9-3. Details for each of the monitoring sites are presented in Table 9-13. The monitoring was conducted for discrete 24 hour periods at about monthly intervals, unlike the NT EPA monitoring which is continuous.

Table 9-13 DPC monitoring stations

Monitoring site	Coordinates (UTM) (GDA Zone 52)	Distance and orientation from Site	Site Description
EAS2	706,007; 8,619,490	5.8 km north-west	Between cement factory and manganese stockpile
EAW6	704,443; 8,618,513	1.6km west	Along main wharf quay line
MSB1	705,146; 8,618,339	1 km west	Within main port facilities
FHW5	700,670; 8,620,595	0.7 km north	Adjacent to tugboat dock

The highest 24-hour PM₁₀ measured at these sites was 81.8 µg/m³ at EAW6 on 7 June 2019. Concentrations were all above the 24-hour air quality goal of 50 µg/m³ at the four stations in early June 2019. The cause of this is attributed to exceptional regional events (e.g., bushfires)

Data from the NT EPA monitoring stations is compared with the DPC measurements for 2019. All but one of the DPC samples (in March 2019), show a good correlation with regional PM₁₀ concentrations. Therefore, it was determined that PM₁₀ concentrations on East Arm mostly follows the regional trend, and that the use of the NT EPA data as a background is considered both suitable and representative for this assessment.

Further information regarding air quality monitoring data availability and validity is detailed in Appendix J: Air Quality and Greenhouse Gas Technical Report.

9.4.3 Adopted background concentrations

A summary of the adopted background concentrations is presented in Table 9.13. These background concentrations were added to predicted modelling results for the Project to provide a cumulative assessment of air quality impacts. Cumulative NO₂ predictions were assessed contemporaneously using the OLM, therefore the background concentration varies by the hour and has not been included in this table.

In accordance with the BCC Air Quality Planning Scheme Policy (AQPSP) (BCC 2014), the 70th percentile concentration was selected as the adopted background concentration for assessment of 1 hour, 8 hour and 24 hour average air quality goals.

In addition to the adopted background concentration, Table 9.13 also presents the assimilative capacity for each pollutant of concern. Assimilative capacity of the receiving air environment can be quantified through the difference between the adopted background concentration and the air quality goal. In Table 9.13 the assimilative capacity is reported as both a concentration (µg/m³) and as a percentage.

Table 9.13 below shows adopted background pollutant concentrations alongside assimilative capacity of each pollutant. Further detail about adopted background concentrations is available in Appendix J: Air Quality and Greenhouse Gas Technical Report.

Table 9-14 Adopted background pollutant concentrations

Pollutant	Averaging Period	Air quality goal (µg/m3)	Adopted background concentration (µg/m3)	Assimilative capacity		Data Source
				(µg/m³)	(%)	
PM ₁₀	24 hour	50	29.5	20.5	41.0%	Highest 70th percentile – 2018 Stokes Hill
	Annual	25	23.0	2.0	8.0%	Highest annual average - Winnellie 2019
PM _{2.5}	24 hour	25	11.9	13.1	52.4%	Highest 70th percentile - Palmerston 2019
	Annual	8	9.8	-1.8	-22.5%	Highest annual average – Palmerston 2019
	Annual	1.3	-	not applicable		Incremental annual pm2.5 criteria
NO ₂	1 hour	226	not applicable due to contemporaneous assessment using OLM method			
	Annual	56				
SO ₂	1 hour	523	1.9	521.1	99.6%	Highest 1 hour 70th percentile - Stokes Hill 2019
	24 hour	209	2.0	207	99.0%	Highest 24 hour 70th percentile - Stokes Hill 2019
	Annual	52	1.7	50.3	96.7%	Highest annual average - Palmerston 2019
CO	8 hour	10,000	573	9427	94.3%	Highest 8 hour 70th percentile - Stokes Hill 2019
Total VOCs	1 hour (benzene)	580	6.26	573.7	98.9%	Highest 1 hour 70th percentile - Memorial Park 2015
	24 hour (benzene)	29	8.2	20.8	71.7%	Highest 24 hour 70th percentile - Memorial Park 2019
	Annual (benzene)	5.1	4.6	0.5	9.8%	Highest annual average - Memorial Park 2018

9.4.4 VOC screening assessment

Assessment of VOC emissions has been undertaken as a conservative screening assessment considering predicted total VOC concentrations at sensitive receptors against the strictest air quality goals for either benzene, toluene or xylene.

Table 9.13 presents the assimilative capacity for each VOC species of concern. Based on Table 9.13, the VOC air quality goals with the smallest assimilative capacity, and therefore the strictest goal, are as follows:

- 1 hour: benzene (adopted background of 6.26 µg/m³, assimilative capacity of 573.7 µg/m³)
- 24 hour: benzene (adopted background of 8.2 µg/m³, assimilative capacity of 20.8 µg/m³)
- annual average: benzene (adopted background of 4.6 µg/m³, assimilative capacity of 20.8 µg/m³),

Based on the adopted background concentrations, the strictest VOC air quality goals are those for benzene, and therefore assessment of total VOC predictions has been undertaken considering the adopted air quality goals for benzene.

9.5 Existing emission sources

There are a number of existing emission sources within the Darwin Harbour region. There are many significant industry sites utilising the local port and transport infrastructure and relative proximity to energy supplies and mineral export facilities. These industrial sources are significant emitters of air pollutants within the Darwin region and should be considered when assessing cumulative air quality impacts. The NPI was used as the primary tool to identify the main emission sources in the Study area.

The NPI as discussed in Section 9.2.1 is regulated by the Australian Government and is tasked with tracking pollution across Australia, ensuring that the community has access to information about the emission and transfer of toxic substances which may affect them locally.

An NPI search conducted within the Study area identified 10 facilities within a 6 km radius, that report annual air pollutant emissions. A brief description of each source, the pollutants emitted, and its approximate distance from the Site is provided in Table 9-15. The location of these emission sources are presented in Figure 9-4.

Table 9-15 Existing NPI-listed sources of air pollution in the Study area

Source	Distance from Project	Pollutants
OM Manganese	< 1km	Manganese, copper, lead, zinc
VOPAK Darwin Industry Fuel Terminal	< 1km	VOCs
Berrimah Freight Terminal	3 km NE	VOCs
Darwin Chemicals	5 km NE	Chlorine
Downer Group EDI Berrimah	5 km NE	Fluoride
Darwin Galvanising	5 km NE	Hydrochloric acid, zinc
Palmerston Wastewater Stabilisation Ponds	5.5 km SE	Odour
INPEX Operations Wickham	4 km SE	PM ₁₀ , PM _{2.5} , NOx, SO ₂ , CO, VOCs
Wickham Point Regulating Station	5 km SW	VOCs
Conoco Phillips Darwin LNG Plant Wickham	5 km SW	PM ₁₀ , PM _{2.5} , NOx, SO ₂ , CO, VOCs

Many of the identified industrial sites listed in Table 9-15 do not emit any of the Project pollutants of interest and do not need to be considered further. Of the industries with similar air emissions to the Project, the Berrimah Freight Terminal (rail transport) has only minor emissions and would be unlikely to cumulatively impact sensitive receptors.

VOC emissions from VOPAK Darwin Industry Fuel Terminal, INPEX Wickham, and Conoco Phillips Wickham are significant in comparison with the Project. In the 2018/19 NPI reporting year 430,000 kg, 1,900,000 kg and 530,000 kg of VOC were emitted respectively from these three sites. VOC

emissions from the three sites are almost exclusively via elevated point (stack) sources, meaning greater dispersion of pollutants into the atmosphere compared with ground-based sources. Considering this, along with the buffer distance between these sources and sensitive receptors (> 4 km), it is likely that VOC emissions would disperse to well below relevant air quality goals before reaching the receptors. In comparison with these three sites, the Project is estimated to emit only about 36,000 kg (see Section 9.3.1.2), or about 1.2 % of the total emissions for the three nearby sites. On this basis, it is considered acceptable to assess Project VOC emissions in isolation and not consider cumulative effects from nearby sources.

Similar to VOCs, emissions of NO₂, PM₁₀, PM_{2.5}, CO and SO₂ from INPEX Wickham and Conoco Philips Wickham are also significant but are primarily emitted from point sources. Emissions from these sources are included in the background monitoring data presented in Section 9.4.3 and were therefore not included as separate sources in the model.

9.6 Sensitive receptors

9.6.1 Sensitive land uses

The NT EPA *Guideline: Recommended Land Use Separation Distances* states that “sensitive land uses are land uses where people live or regularly spend time and which require a particular focus on protecting the health and well-being of humans and amenity values from the emissions of an activity”. The Guideline does not provide a definition for sensitive uses, but states that “sensitive land uses may include but are not limited to residential premises, accommodation facilities such as hotels and nursing homes, hospitals, childcare centres, schools and some outdoor recreation facilities”.

The Project area is located within the East Arm Wharf, which is an industrial area. It is acknowledged that the use of this area is expected to exceed the averaging period of 1 hour, 8 hours and potentially up to 24 hours, however these uses are not strictly defined as sensitive land uses under the definition provided by the NT EPA. Therefore, for the purpose of the assessment, land uses within the wharf area have not been considered as sensitive receptors and have not been considered further in the assessment.

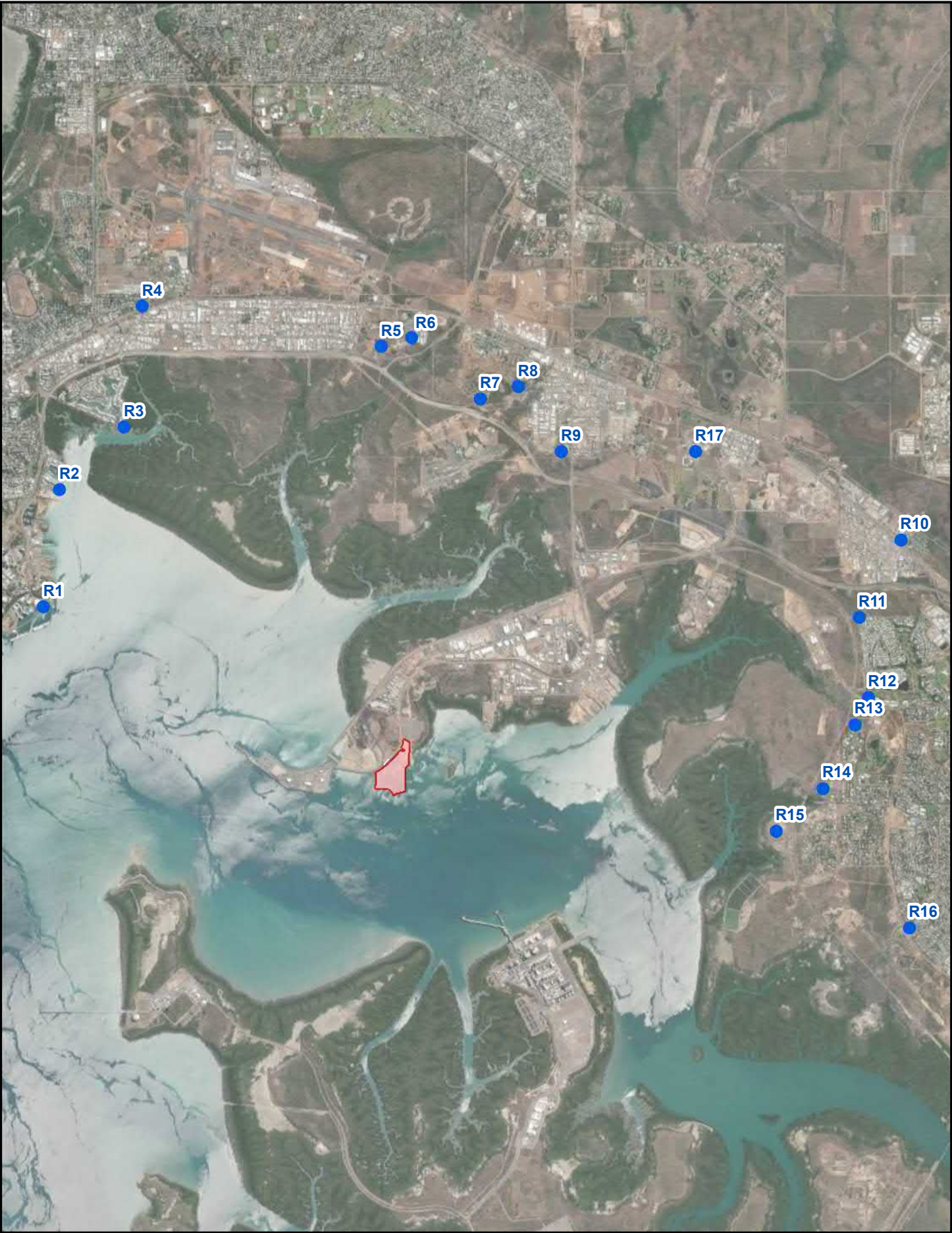
9.6.2 Modelled receptors

Sensitive land uses which are located nearest to the Project area have been included in the dispersion model developed for the assessment. The locations of sensitive receptors included in the model are shown in Figure 9-4. It is noted that sensitive receptor locations do not represent individual dwellings but instead represent areas where several dwellings are located (for example, streets, small suburbs, etc.). Details for the sensitive receptors which have been modelled are presented in Table 9-16.

It is noted that there is a future planned residential development for Weddell, which would be located approximately 14 km south-east of the Project. This separation distance is significantly further than the separation distance for the sensitive receptors which have been included in the model which are between 5.1 km to 8.2 km from the Project. Due to the separation distance, it is expected that if predicted pollutant concentration levels are compliant at the modelled sensitive receptors, they would also be compliant at the future Weddell residential development.

Table 9-16 Sensitive receptors included in the assessment

Receptor ID	Description	UTM Coordinates	Distance and orientation from the Site
R1	Stokes Hill area (residential)	701,008m E; 8,621,030m S	5.8 km WNW
R2	Stuart Park area (residential)	701,249m E; 8,622,820m S	6.6 km NW
R3	Bayview area (residential)	702,237m E; 8,623,770m S	6.5 km NW
R4	The Narrows area (residential)	702,513m E; 8,625,610m S	7.8 km NNW
R5	Winnellie area (residential)	706,165m E; 8,625,000m S	6.1 km N
R6	Winnellie area (residential)	706,624m E; 8,625,130m S	6.3 km N
R7	Coonawarra area (residential)	707,675m E; 8,624,200m S	5.5 km NNE
R8	Hidden Valley Holiday Park (accommodation)	708,257m E; 8,624,390m S	5.8 km NNE
R9	Berrimah area (residential)	708,909m E; 8,623,400m S	5.1 km NE
R10	Darwin Free Spirit Resort (accommodation)	714,094m E; 8,622,050m S	8.2 km ENE
R11	Durack area (residential)	713,457m E; 8,620,870m S	7.2 km ENE
R12	Durack area (residential)	713,595m E; 8,619,650m S	7.1 km E
R13	Marlow Lagoon area (residential)	713,388m E; 8,619,230m S	6.9 km E
R14	Marlow Lagoon area (residential)	712,898m E; 8,618,260m S	6.4 km E
R15	Marlow Lagoon area (residential)	712,188m E; 8,617,610m S	5.8 km ESE
R16	Moulden area (residential)	714,220m E; 8,616,130m S	8.0 km ESE
R17	Berrimah area (residential)	710,956m E; 8,623,400m S	6.4 km NE



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0 780 1,560 2,340 3,120

Meters

Data sources:
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

Study area

Sensitive Receptors

R1: Stokes Hill area

R2: Stuart Park area

R3: Bayview area

R4: The Narrows area

R5: Winnellie area

R6: Winnellie area

R7: Connawarra area

R8: Hidden Valley Holiday Park

R9: Berrimah area

R10: Darwin Free Spirit Resort

R11: Durack area

R12: Durack area

R13: Marlow Lagoon area

R14: Marlow Lagoon area

R15: Marlow Lagoon area

R16: Moulden area

R17: Berrimah area

Note:

The layout is indicative only

Sensitive receptors included in the assessment

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Figure

9-4

9.6.3 Water-based receptors

Water-based receptors such as docks and watercraft have not been modelled specifically due to uncertainty of their location, and the likely short-term occupation. However, results for locations at water-based receptors can be inferred from the assessment by reviewing modelling results presented as concentration contour maps. Contour maps are presented and explained further in Section 9.7.1.

9.7 Assessment of impacts

This section outlines the air quality modelling results and greenhouse gas emission estimates for both construction and operational phases of the Project.

9.7.1 Air quality modelling results

9.7.1.1 Construction phase

A summary of predicted pollutant concentrations at sensitive receptors for the construction phase assessment are presented in Appendix J: Air Quality and Greenhouse Gas Technical Report.

For all pollutants with the exception of NO₂, predictions at each modelled receptor are shown for the project only contribution (concentration at the receptor resulting from project emissions only), and the cumulative concentration (Project plus background). Potential NO₂ impacts have been assessed contemporaneously using the OLM method as such only cumulative impacts for NO₂ have been reported.

The predicted cumulative concentrations shown in Table 9-17 are assessable against the air quality goals adopted for the assessment as discussed in Table 9-3. The adopted air quality goals are also presented in Table 9-17.

Predicted model results show:

- Cumulative PM₁₀ and NO₂ concentrations are below the relevant air quality goals for all averaging periods.
- Cumulative 24 hour PM_{2.5} maximum concentrations are below the air quality goal of 25 µg/m³.
- Cumulative annual average PM_{2.5} concentrations exceed the air quality goal of 8 µg/m³.
 - This is due to the elevated background concentration (9.8 µg/m³) which already exceeds the air quality goal of 8 µg/m³.
 - The incremental contribution from the project is very small compared to the background with a maximum project contribution of 0.18 µg/m³ predicted to occur at receptor R1.
 - The maximum incremental annual average PM_{2.5} concentration at the worst affected receptor is well below the derived incremental PM_{2.5} air quality goal of a maximum increase of 1.3 µg/m³.
- Predicted cumulative SO₂ and CO concentrations are below the relevant air quality goals for all averaging periods respectively.
- Predicted cumulative total VOC concentrations, using the adopted background concentrations for benzene, are below the relevant adopted Victorian and Queensland air quality goals for all averaging periods for benzene, at sensitive receptors.
 - Different to the NT and Queensland, in NSW and Victoria the air quality goals prescribed by these states are assessed at the boundary of the project site and not just at sensitive receptors.
 - Concentrations beyond the boundary exceed the adopted total VOC criteria for 24 hour maximum of 29 µg/m³ and 1 hour 99.9th percentile goal of 29 µg/m³, however these concentrations are limited to mostly over the water.
 - Predicted model results also show that for total VOC concentrations, compliance against the adopted 1-hour 99.9th percentile goal (580 µg/m³) was achieved beyond the boundary of the site and at sensitive receptors.

- Predicted total VOC concentrations at sensitive receptors are significantly below the adopted goals for benzene, which has the strictest criteria. As predicted concentrations are well below the goals at sensitive receptors, concentration contours are not shown for VOCs for the construction phase.

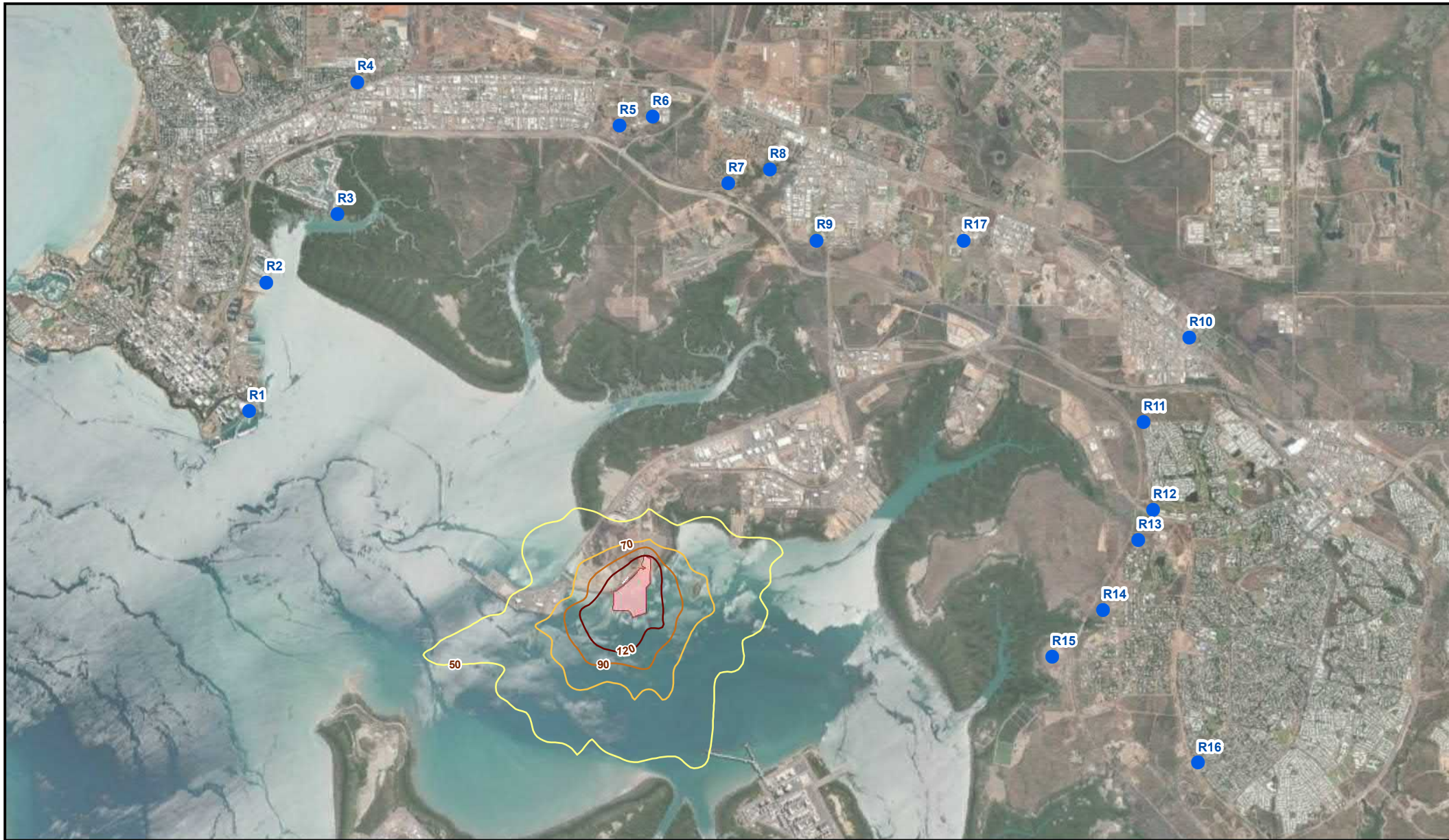
A summary of predicted pollutant concentrations at the worst affected receptor for each pollutant for the construction phase assessment are presented in Table 9-17.

Table 9-17 Summary of predicted modelled concentrations for the construction phase

Pollutant	Averaging period	Air Quality Goal (µg/m³)	Concentration at worst affected receptor (µg/m³)		Worst affected Receptor
			Cumulative	Project only	
PM ₁₀	24 hour maximum	50	3.04	32.5	R1
	Annual average	25	0.18	23.2	R1
PM _{2.5}	24 hour maximum	25	1.30	13.2	R1
	Annual average	8	0.18	10.0	R1
NO ₂	1 hour maximum	226	86.4	-	R2
	Annual average	56	4.49	-	R1
SO ₂	1 hour maximum	523	15.8	13.9	R1
	24 hour maximum	209	3.15	1.15	R1, R15
	Annual average	52	1.86	0.16	R1
CO	8 hour maximum	10,000	588	14.9	R15
Total VOC (benzene)	1 hour 99.9 th percentile	580 ^a	16.3	10.07	R1
	24 hour maximum	29	9.71	1.51	R15
	Annual average	6.4	0.19	4.79	R1
Table note- ^a NSW VOC goals (99.9 th percentile at 29 µg/m³) are lower than the adopted goals of 580 µg/m³					

In addition to the results tables, cumulative concentration contour maps for the construction phase for PM₁₀, PM_{2.5} and NO₂ are presented in Figure 9-5 to Figure 9-10 below. Cumulative concentration contour maps are presented below for the following pollutants and averaging periods:

- Figure 9.5 - PM₁₀ 24 hour average
- Figure 9.6- PM₁₀ annual average
- Figure 9.7- PM_{2.5} 24 hour average
- Figure 9.8- PM_{2.5} annual average
- Figure 9.9- NO₂ 1 hour average
- Figure 9.10- NO₂ annual average.



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0 740 1,480 2,220 2,960
 Meters

Data sources:
 Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
 Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

■ Project location
● Sensitive receptors

24 hour maximum PM10 concentration (µg/m³)

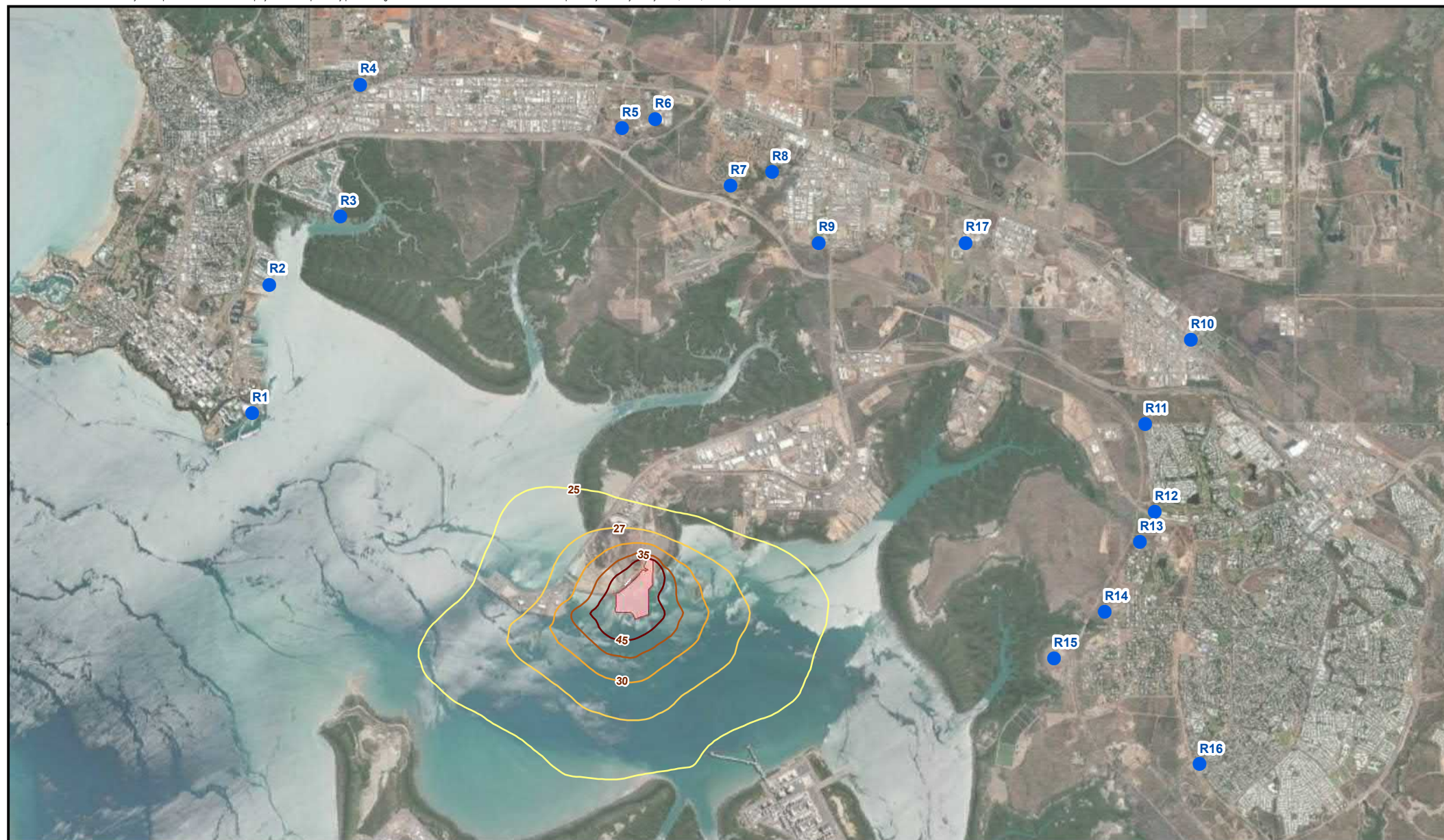
— 50 (Air quality goal)
— 70
— 90
— 120

Note:
 The layout is indicative only

Predicted cumulative 24 hour maximum PM₁₀ concentration- construction phase

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**Figure
 9-5**



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Data sources:
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 Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

- Project location
- Sensitive receptors

Annual average PM₁₀ concentration (µg/m³)

- 25 (Air quality goal)
- 27
- 30
- 35
- 45

Note:
 The layout is indicative only

Predicted cumulative annual average
 PM₁₀ concentration- construction phase

**NORTHERN TERRITORY
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Figure

9-6



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 DATUM GDA 1994, PROJECTION MGA ZONE 52

0 670 1,340 2,010 2,680
 Meters

Data sources:
 Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
 Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

Project location
 Sensitive receptors

24 hour maximum PM2.5 concentration (µg/m³)

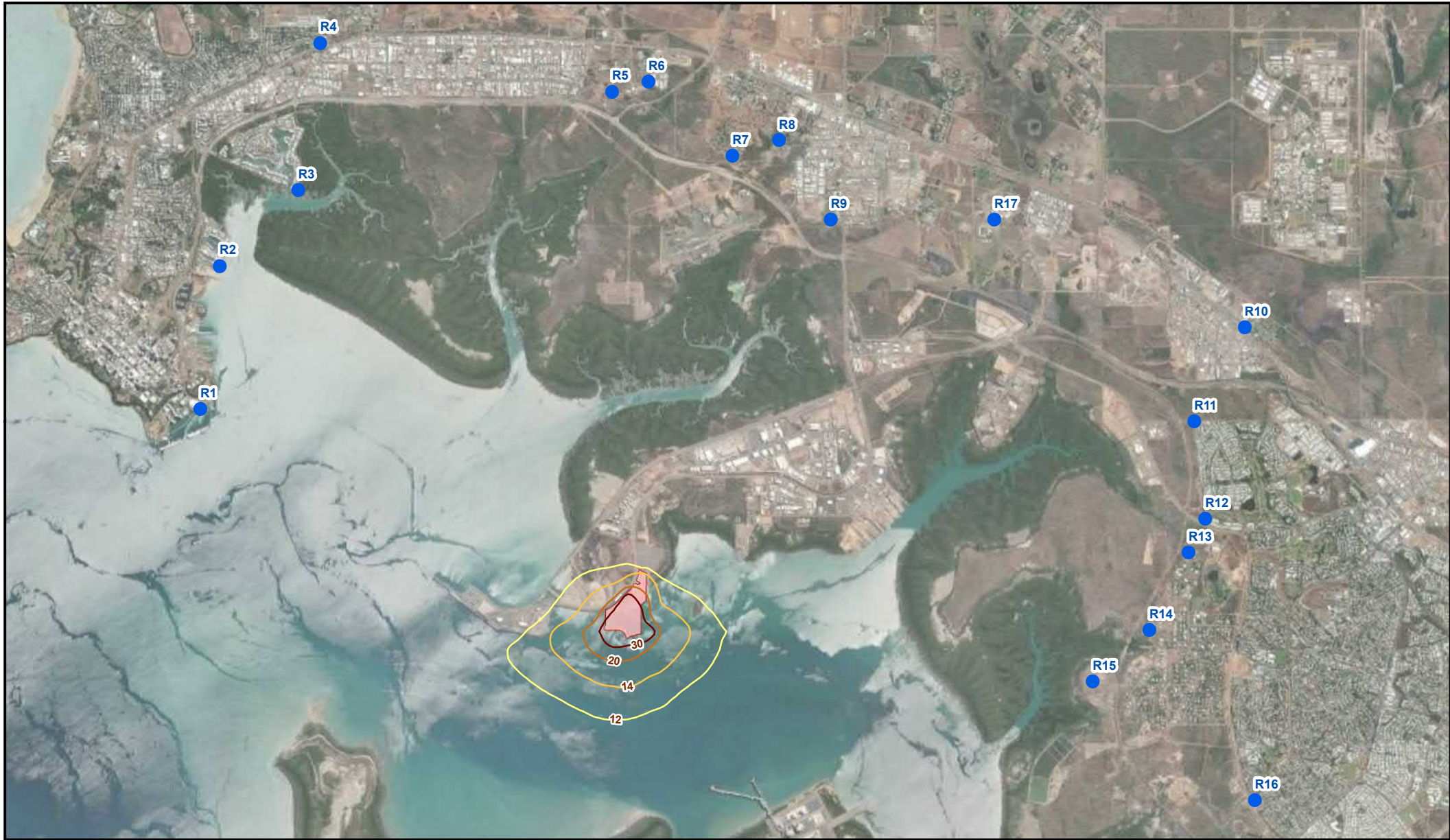
15
 25 (Air quality goal)
 35
 45
 55

Note:
 The layout is indicative only

Predicted cumulative 24 hour maximum
 PM_{2.5} concentration- construction phase

**NORTHERN TERRITORY
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Figure
9-7



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0 670 1,340 2,010 2,680
Meters

Data sources:
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

 Project location

 Sensitive receptors

Annual average PM2.5 concentration (µg/m³)

 12

 14

 20

 30

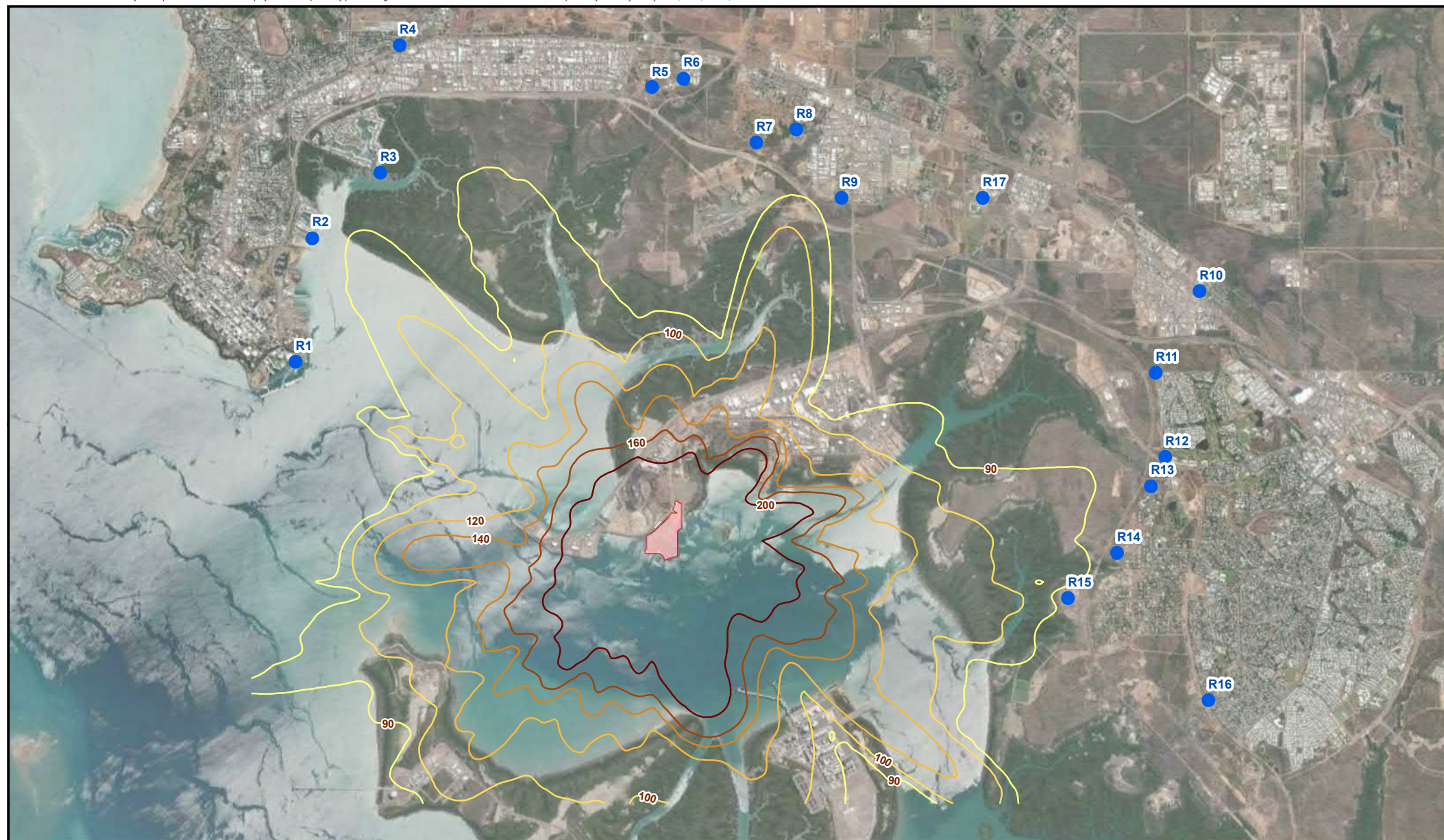
Note:
The layout is indicative only

Predicted cumulative annual average
PM_{2.5} concentration- construction phase

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Figure
9-8

A4 size



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 DATUM GDA 1994, PROJECTION MGA ZONE 52

0 770 1,540 2,310 3,080
 Meters

Data sources:
 Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
 Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

Project location
 Sensitive receptors

1 hour maximum NO2 concentration ($\mu\text{g}/\text{m}^3$)

90
 100
 120
 140
 160
 200

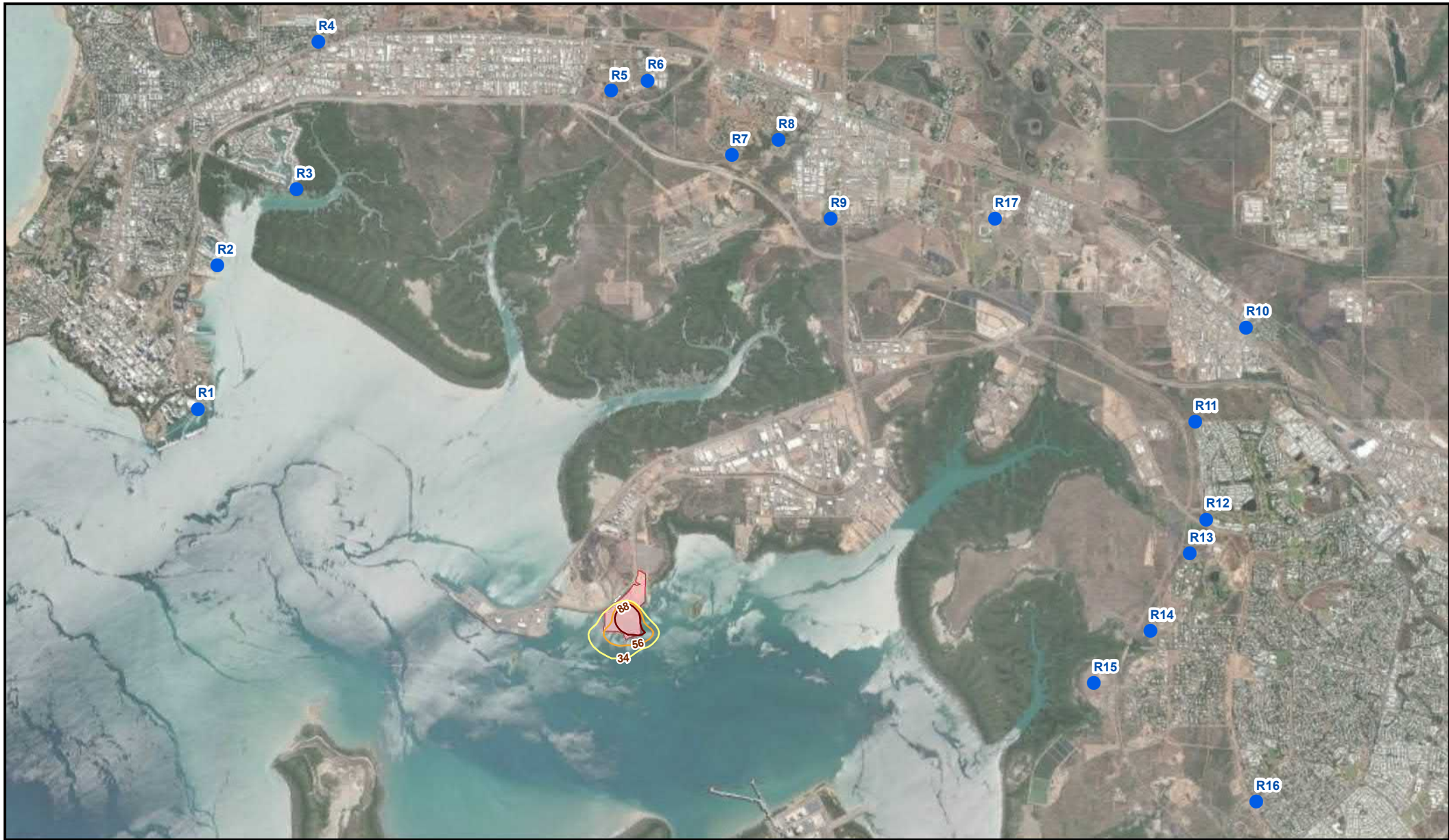
Note:
 The layout is indicative only

Predicted cumulative 1 hour maximum
 NO₂ concentration- construction phase

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Figure

9-9



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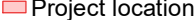

N

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DATUM GDA 1994, PROJECTION MGA ZONE 52


0 660 1,320 2,640
Meters

Data sources:
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

 Project location

 Sensitive receptors

Annual average NO2 concentration (µg/m³)

 34

 56 (Air Quality Goal)

 88

Note:
The layout is indicative only

Predicted cumulative annual average
NO₂ concentration- construction phase

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Figure
9-10

A4 size

9.7.1.2 Operation phase

Predicted VOC concentrations at sensitive receptors have been compared against background concentrations for benzene for each averaging period and are presented fully in Appendix J: Air Quality and Greenhouse Gas Technical Report. Predicted concentrations for the operation phase were well below the adopted air quality goals at all receptors.

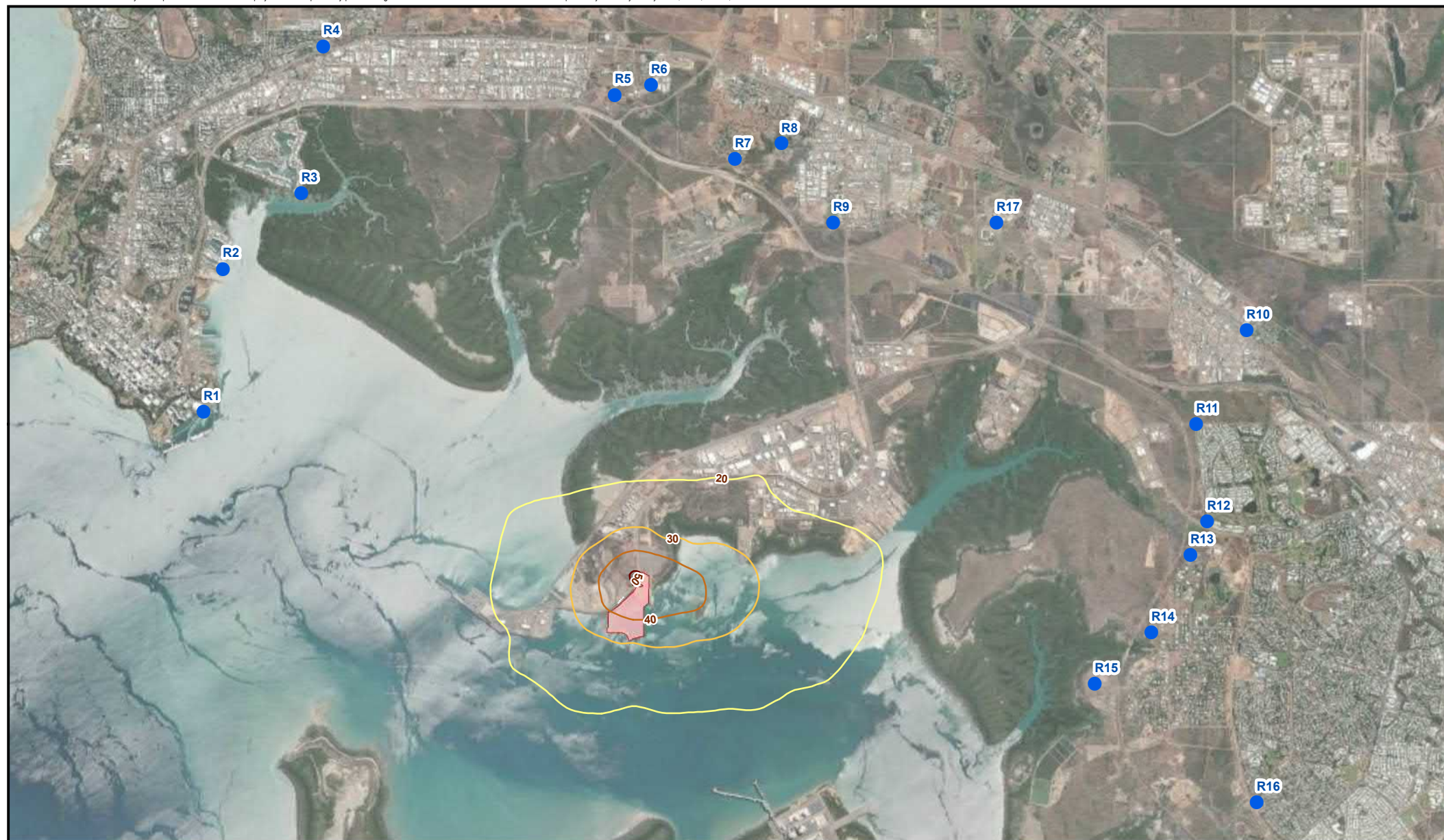
Predicted VOC Project only and cumulative concentrations at the worst affected receptor for the operational phase of the project are presented in Table 9-18.

Table 9-18 Summary of predicted concentrations for the operation phase

Pollutant	Averaging period	Air Quality Goal ($\mu\text{g}/\text{m}^3$)	Concentration at worst affected receptor ($\mu\text{g}/\text{m}^3$)		Worst affected Receptor
			Cumulative	Project only	
Total VOCs (benzene)	1 hour 99.9 th percentile	580	12.56	6.30	R1
	24 hour maximum	29	9.25	1.05	R1
	Annual average	6.4	4.74	0.14	R2
Table note: 1. Cumulative concentrations have been estimated by adding predicted total VOC concentrations from the model to the adopted background concentration for benzene for 1 hour, 24 hour and annual averages respectively. ^a NSW VOC goals (99.9 th percentile at 29 $\mu\text{g}/\text{m}^3$) are lower than the adopted goals of 580 $\mu\text{g}/\text{m}^3$					

Cumulative concentration contour maps for the operation phase (compared against benzene background concentrations) are provided below for the following pollutants and averaging periods:

- Figure 9-11 VOC 1 hour average
- Figure 9-12 VOC 24 hour average
- Figure 9-13 VOC annual average.



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Data sources:
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 Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

Project location

Sensitive receptors

1 hour 99.9th percentile total VOC concentration ($\mu\text{g}/\text{m}^3$)

20

30

40

50

Note:
 The layout is indicative only

Predicted cumulative 1 hour 99.9th
 percentile total VOC concentration -
 operation phase

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Figure

9-11



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0 750 1,440 2,160 2,880
 Meters

Data sources:
 Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
 Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate 2020

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LEGEND

Project location (Red rectangle)
 Sensitive receptors (Blue dots)

24 hour maximum total VOC concentration (µg/m³)

10 (Yellow)
 12 (Light Orange)
 14 (Orange)
 16 (Dark Orange)
 18 (Red-Orange)
 20 (Red)

Note:
 The layout is indicative only

Predicted cumulative 24 hour maximum VOC concentration- operation phase

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**Figure
 9-12**



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Data sources:
 Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
 Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

- Project location
- Sensitive receptors

Annual average total VOC concentration ($\mu\text{g}/\text{m}^3$)

- 4.8
- 5.2
- 5.6
- 6.0
- 6.4 (Air quality goal)
- 6.8
- 7.2

Note:
 The layout is indicative only

Predicted cumulative annual average
 VOC concentration- operation phase

**NORTHERN TERRITORY
 GOVERNMENT OF AUSTRALIA**
 DARWIN SHIP LIFT PROJECT

Figure
9-13

9.7.1.3 Discussion

9.7.1.3.1 Construction phase

The results of the construction phase assessment are summarised on an individual pollutant basis in Table 9-19.

Table 9-19 Pollutant summary- construction phase

Pollutant	Summary
PM ₁₀	The highest predicted cumulative concentration for PM₁₀ 24 hour average is 33.1 µg/m³ at R15 (representing the Marlow Lagoon area), and highest annual average concentration for PM₁₀ is 23.2 µg/m³ which occurred at R1 (location representing the Stokes Hill area). Predicted PM₁₀ concentrations are below adopted 24 hour (50 µg/m³) and annual average (25 µg/m³) air quality goals for all receptors and therefore no significant impact is predicted.
PM _{2.5}	The highest predicted cumulative concentrations for PM_{2.5} 24 hour average is 13.2 µg/m³ at R1, and highest annual average concentration for PM_{2.5} is 10 µg/m³ at the same receptor. The highest Project only contribution for PM_{2.5} 24 hour average and PM_{2.5} annual average is 1.30 µg/m³ and 0.18 µg/m³ respectively at R1. Although the cumulative annual average concentration exceeds the air quality goal (8 µg/m³) the Project only contribution to the predicted concentration is minor (1.8% of the cumulative concentration) and is well below the incremental PM_{2.5} air quality goal (1.3 µg/m³) derived for the assessment. It is noted that the construction phase of the project is temporary, and the predicted Project contribution as a result of attributed to construction phase emissions would be short-term. Based on the above, the construction of the Project is not considered to significantly impact air quality with respect to PM_{2.5} concentrations.
NO ₂	The highest predicted cumulative 1 hour concentration for NO₂ is predicted at receptor R2 (location representing the Stuart Park area), with predicted concentration of 86.4 µg/m³. The highest predicted cumulative annual average concentration was predicted at R1 at 4.49 µg/m³. Predicted NO₂ concentrations are below the adopted 1 hour (226 µg/m³) and annual average (56 µg/m³) air quality goals for all receptors and therefore no significant impact is predicted.
SO ₂	The highest predicted cumulative 1 hour concentration for SO₂ is predicted at receptor R1, with a predicted concentration of 15.8 µg/m³. The highest predicted 24 hour average was 3.15 µg/m³ predicted at R1 and R15 (location representing the Marlow Lagoon area). The highest predicted cumulative annual average SO₂ concentration was predicted at R1 at 1.86 µg/m³. Predicted SO₂ concentrations are below the adopted 1 hour (523 µg/m³), 24 hour (209 µg/m³) and annual average (52 µg/m³) air quality goals for all receptors and therefore no significant impact is predicted.
CO	The highest predicted cumulative concentration for CO 8 hour average was 588 µg/m³ at R1. CO concentrations are well below the adopted air quality goal (10 mg/m³) and therefore no significant impact is predicted.
VOC	Predicted cumulative total VOC concentrations, using the adopted background concentrations for benzene, are below the relevant air quality goals for all averaging periods (1 hour, 24 hour, annual average) for benzene, which is the pollutant with the lowest assimilative capacity.

9.7.1.3.2 Operation phase

The only modelled pollutant of concern during the operation phase is VOCs, shown in Table 9-20.

Table 9-20 Pollutant summary- operation phase

Pollutant	Summary
VOCs	Predicted total VOC concentrations at each receptor, adopting the background concentration for benzene, are below the air quality goals for benzene for each averaging period. The averaging period which is closest to the air quality goal is the annual average, with a maximum predicted cumulative concentration for total VOCs of 4.73 µg/m³, compared to the air quality goal of 6.4 µg/m³. However, it is noted that the Project contribution to this cumulative concentration is 0.13 µg/m³, which represents less than 3% of the total predicted concentration. Predicted model VOC concentrations for the operation phase were also evaluated against the more stringent NSW criteria. Results of the modelling show that the 1-hour 99.9th percentile criteria of 29 µg/m³ and 24 hour maximum goal of 29 µg/m³ extends beyond the boundary of the construction site. However, high concentrations are largely limited to the area over the water and all identified sensitive receptors are well below the respective air quality criteria. Results of the model show that the more stringent criteria is also exceeded past the boundary of the Project site, however these higher concentrations are limited to over the water, and concentrations at sensitive receptors are well below that of the more stringent criteria. Based on the predicted minor contribution from the operation of the Project to air quality at sensitive receptor locations, no significant air quality impact is predicted as a result of the operation of the paint and blast facility and resulting emissions from VOCs. As such the predicted VOC concentrations, the risk of odour impacts at sensitive receptors resulting from the operation of the paint and blast facility is considered to be low.

9.7.2 Greenhouse gas emissions

9.7.2.1 Construction phase

Construction phase GHG emissions for the Project are presented in Table 9-21. All GHG emissions associated with the construction phase are Scope 1 emissions from the combustion of fuels from both stationary and mobile equipment. Total GHG emissions are estimated to be 22,575 t CO₂-e across the entire construction phase of the Project.

Table 9-21 Estimated construction phase GHG emissions

Construction Stage	Plant	GHG emissions
		kg CO ₂ -e
Land Preparation	Excavator	13,565
	Bulldozer	13,565
Dredging	BHD	7,715,971
	CSD	947,272
	Work boats	4,035,724
Land Reclamation	Swamp dozer	1,329,415
	Excavator	332,354
	Tipper Trucks	664,708
	Dozer	332,354
	Roller	47,479
Revetments	Excavator	759,666
	Tipper Trucks	759,666
	Crane	379,833
Piling and Waterside Infrastructure	Land-based rig	305,223
	Barge-based rig	152,611
	Work boats	763,057
	Cranes	169,568
Filter Rock and Hardstand	Grader	700,486
	Roller	518,879
	Water truck	194,580
	Tipper Trucks	518,879
	Backhoe	259,439
	Skid steer	103,776
	Loader	518,879
	Excavator	1,037,758
Total (kg CO₂-e)		22,574,707
Total (tonnes CO₂-e)		22,575

Operation phase

Operation phase GHG emissions for the Project are presented in Table 9-22 based on a single year of operation for the Project. Emissions for the operation phase of the Project include both Scope 1 and Scope 2 emissions. On an annual basis, Scope 1 emissions are estimated to total 117.3 t CO₂-e per year, while Scope 2 emissions are estimated to be 777.6 t CO₂-e per year.

Table 9-22 Predicted operation phase greenhouse gas emissions

Activity	Emissions Scope	Annual GHG emissions (kg CO ₂ -e)	Annual GHG emissions (t CO ₂ -e)
Cranes	1	78,262	78.3
Diesel Generators	1	39,020	39.0
Electricity Consumption	2	777,600	777.6
Total (Scope 1)		117,282	117.3
Total (Scope 2)		777,600	777.6
Total annual GHG contribution-operation		894,882	894.9

9.7.2.2 Comparison to NT and Federal GHG contribution

A review of the most recently reported year of NGER data was undertaken to determine the Project contribution compared to reported state/territory and federal emissions. GHG emissions from 2019 for NT and Australia-wide were gathered from the National Greenhouse Accounts National Inventory Report 2019.

Construction emissions were compared against territory/national totals, whereas operation emissions were compared against those reporting to the Industrial Processes and Product sector also, however it is noted that this is a broad category defining a range of industries.

Emissions comparisons are presented in Table 9-22 below.

Table 9-22 Comparison of Project emissions against NT and Australia reported emissions for 2019

Comparison against territory and federal reported emissions		Project contribution against benchmark- construction phase (%)	Annual Project against benchmark- operation phase (%)
Sector emissions (t CO ₂ -e)		22,575 t CO ₂ -e	894.9 t CO ₂ -e
NT GHG emissions- Industrial Processes and Product Sector	130,000	-	0.688%
Australia GHG emissions Industrial Processes and Product Sector	31,750,000	-	0.003%
NT GHG emissions- all sectors	20,650,000	0.109%	0.004%
Australia GHG emissions - all sectors	529,300,000	0.004%	0.0002%

The total GHG contribution from the construction phase of the Project is estimated to be approximately 0.1 % compared to all reported NTGHG emissions in 2019, and 0.004 % of Australia's total reported emissions.

The total GHG emissions contribution from the first year of the operation phase of the Project is expected to be approximately 0.004 % of NT reported GHG emissions, and 0.0002 % of Australia's reported GHG emissions, compared to 2019 NGER data. Project GHG emissions are expected to be 0.7 % of NT's reported GHG emissions from the Industrial Processes and Product sector, as well as 0.003 % of Australia's emissions from the same sector.

The construction and operation phases of the Project are not expected to contribute majorly to either territory or nation-wide GHG emissions totals.

9.8 Mitigation and management

Air quality and GHG emissions from construction and operation of the Project are not expected to cause a significant impact, however the application of appropriate mitigation measures will further reduce the likelihood and consequence of any impact. A number of mitigation strategies are recommended for the Project. Table 9-23 and Table 9-24 identify the relevant project phase, aspect to be managed, and proposed mitigation measures.

Table 9-23 Mitigation measures for air quality

Phase	Proposed mitigation measures
Construction phase	- Develop and implement a Construction Air Quality Management Plan (CAQMP) specific to the Project, to be incorporated into the CEMP, prior to the start of construction activity. - Inform adjoining neighbours of intended construction activities. - Limit the intensity of the movement of dusty materials and construction work such as earth moving during periods of high levels of bushfire smoke. - Use a water truck to regularly apply water to unsealed roads or vehicle paths. At minimum, application of water at a rate of up to 2 litres per square metre per hour (L/m²/h) is required. - Regularly and lightly water dust-prone areas, ensuring not to over-water areas as it can cause damage and erosion. This is recommended for stockpiles and unsealed areas. - Minimise drop heights of materials (e.g., from loaders into tipper trucks). - Removal of topsoil and the importing or storing of soil and other materials must be done with due care to minimise dust. - Seal permanent roads and areas planned to be sealed as soon as practicable. - Cover materials during transport to and from the site. - Limit travel speed on site noting that slower speeds produce less dust. Travel speeds in excess of 10 km/h are not recommended on unsealed areas or paths. Speed limits should be sign-posted. - Operate machinery, equipment, vehicles, dredges and support vessels efficiently to minimise exhaust emissions. - Clean up residues and spills in a timely manner.
Operation phase	- All ships berthed at the Project shall make use of the available shore power. Auxiliary engines should not be in use over prolonged time periods when ships are at berth. - Operate machinery, equipment, vehicles, dredges and support vessels efficiently to minimise exhaust emissions. <i>Blast and paint facility</i> - The blast and paint facility shall be maintained under negative pressure to ensure air emissions are only released via the roof vents. - Air released to atmosphere via the roof exhaust stacks shall be passed through particulate, VOC and odour capturing filters (e.g., activated carbon) prior to exhaust to the atmosphere. <i>Abrasive painting</i> - Test for presence of lead paint before blasting. - When removing tough hull stains, minimise the use of stain removers and consider more abrasive rubbing or polishing compounds. - Place material collected from blasting, sanding and scraping operations in disposal containers to prevent emissions to the atmosphere as soon as practical. <i>Painting</i> - Maximise efficiency of antifouling paint by selecting the most appropriate product for a particular vessel. - When spray painting is required to occur partly outdoors (e.g., to accommodate a vessel larger than the building), fully enclose the vessel (sides, top and floor) or item being painted with temporary screening materials. Weight the edges of the screens to keep them in place. - Use efficient spray equipment (transfer efficiency >65%) such as high volume spray guns. - Where possible use electrostatic spraying methods. These require less pressure, produce little overspray, and use relatively little paint.

Phase	Proposed mitigation measures
	- Where appropriate, consider using low-VOC, high solids content and water-based paints or surface preparations instead of traditional paint and primer. - Keep spray guns and lines clean and well maintained to reduce emissions. - Prevent evaporation of solvents by using tight-fitting lids or stoppers.

Table 9-24 Mitigation measures for greenhouse gas emissions

Phase	Proposed mitigation measures
Construction and Operation	- Maintain equipment and vehicles to ensure engine efficiency and use fuel efficient equipment where able. - Reduce travel distances off-site by sourcing imported materials from local areas. - Reduce travel distances on-site by planning internal haul roads and staging of related activities efficiently. - Minimise idling time of plant and equipment and switch engines off when not in use. - Look for opportunities to add vegetation; where possible and plant species selected should be both drought tolerant and fast growing. - Where possible prioritise the selection and use of electric equipment (over fuel combustion engines). - Recycle any waste produced where feasible.
Operation	- Shore power during the operation phase should be procured from renewable energy suppliers where possible. In addition, look for opportunities to generate power on-site (e.g., solar arrays, etc). - Prioritise the selection and use of electric vehicles and equipment (over fuel combustion engines) as much as possible. This would include mobile plant such as forklifts and light vehicles for onsite use. - Maintain equipment and vehicles to ensure engine efficiency and use fuel efficient equipment where able.

9.9 Air quality monitoring

Air quality impacts at sensitive receptors due to construction and operation of the Project are not predicted to be significant due to the separation distance between the Project and sensitive receptors. Sensitive receptors are well outside the recommended separation distances listed in NT EPA *Guideline: Recommended Land Use Separation Distances*.

Based on the result of the assessment, no air quality monitoring is deemed to be required for the construction of operation phases of the Project.

9.10 Assessment of residual risk

Assessments of the risks of potential impacts on air quality and greenhouse gas emissions are summarised in Table 9-25. Risks were assessed both prior to mitigations and following the implementation of mitigation to provide and assessment of residual risk.

Table 9-25 Pre and post-mitigation risk assessment for air quality and greenhouse gas emissions

Phase	Aspect	Pre-mitigation risk rating	EIS mitigations	Post-mitigation risk rating
Construction	Dust emissions from activities, including reclamation, dredge spoil placement and stockpiles	Medium	Incorporation of a CAQMP into the CEMP. Inform adjoining neighbours of construction activities. Dust management controls including limiting movement of dusty materials when bushfire smoke levels are high, eliminating dust production at the source, use of water trucks and covering materials during transport.	Low
Construction	Emissions from plant and vessels	Medium	Incorporation of a CAQMP into the CEMP. Limit vehicle speed on site. Seal permanent roads and areas planned to be sealed as soon as practicable. Efficient operation of machinery, equipment, vehicles, ships and dredges to minimise emissions. Clean up residues and spills in a timely manner.	Low
Construction	Increase in greenhouse gas emission resulting in global warming	Medium	Maintain equipment and vehicles to ensure engine and fuel efficiency. Reduce travel distances both on-site and off-site. Minimise idling time of plant and equipment and switch engines off when not in use. Minimise the extent of vegetation cleared during construction. Recycle any waste produced where feasible.	Low
Operation	Emissions from sandblasting and paint spraying	Medium	Incorporation of a CAQMP into the OEMP. Blast and paint facility to operate under negative pressure to ensure air emissions are released via roof vents. Air released to atmosphere via the roof exhaust stacks shall be passed through particulate, VOC and odour capturing filters prior to exhaust to the atmosphere. Test for lead paint before blasting. Develop procedures for spray painting and managing anti fouling paint.	Low

Phase	Aspect	Pre-mitigation risk rating	EIS mitigations	Post-mitigation risk rating
			Minimise the use of hull stain removers. Storage of solvents and waste material in containers to prevent emissions. Keep spray guns and lines clean and well maintained.	
Operation	Emissions from operational traffic, vessels and plant	Medium	Incorporation of a CAQMP into the CEMP. Use of shore power while ships are at berth. Operate machinery and equipment to minimise exhaust emissions.	Low
Operation	Increase in greenhouse gas emission resulting in global warming	Medium	Consider NTG's towards 2050 policy. Procure power from renewable energy suppliers wherever possible. Prioritise the selection and use of electric vehicles and equipment if possible. Maintain equipment and vehicles to ensure engine and fuel efficiency.	Low

Chapter 10

Economic, Social and Cultural Surroundings

10.0 Social, Economic and Cultural Surroundings

10.1 Introduction

The ToR identifies social, economic and cultural surroundings as a key environmental factor that could be significantly impacted by the Project. The objective associated with this factor is to:

Protect the rich social, economic, cultural and heritage values of the Northern Territory.'

The relevant ToR requirements for social, economic and cultural surroundings are presented in Appendix A: Terms of Reference, along with references to where these are addressed in the SIA and other technical reports.

Table 10-1 ToR compliance table for social, economic and cultural surroundings

ID	Terms of reference requirements	EIS section number
1.0 Environmental values		
1.1	Describe, using maps where appropriate, the existing social and economic aspects and values (including key stakeholders) of Darwin Harbour that may be impacted by the Proposal including commercial and recreational values such as marine tourism, recreational fishing and the amateur fishing industry. Identify and map all places and items with historic and/or indigenous cultural heritage values and/or protected under legislation within the Proposal footprint, the zone of influence and in areas that could be otherwise impacted by the Proposal activities.	Sections 4.5, 4.6, 4.7 and 10.4 Appendix C: Social Impact Assessment Section 7 and 8 Appendix M: Cultural Heritage Assessment, Section 5 and 8
	Baseline information should be provided regarding historic or cultural heritage values and significance of the sites/areas, including: • areas listed on Commonwealth and Northern Territory registers of historic and/or cultural heritage	Section 4.7 and 10.4.4 Appendix M: Cultural Heritage Assessment, Section 5 and 8
	• a description and location of Aboriginal and non-Aboriginal sites, places or objects of natural, historic or cultural heritage significance, current utilisation and spiritual significance. Information sources should include published archaeological and anthropological information, respective registers, consultations and other research	Section 4.7 and 10.4.4 Appendix M: Cultural Heritage Assessment, Section 5 and 8
	• provision of an Authority Certificate under the Northern Territory Aboriginal Sacred Sites Act 1989 or an application under the Act	Section 4.7.1 and 10.4.4.1 Appendix M: Cultural Heritage Assessment, Appendix A
	• provision of information on the current status of any approvals, permits or clearances in relation to the protection of heritage items or places.	N/A
2.0 Potential impacts and risks		
2.1	Describe and quantify: • the potential social and economic opportunities and impacts with an analysis of the social and economic values, benefits and potential impacts of the Proposal on a local/regional, NT and national scale, including but not limited to: - projected economic costs and benefits of the Proposal, including a cost/benefit analysis or similar studies, the estimated capital and annual operational expenditure and estimated total revenue - details of relevant costs and benefits of alternative options to the proposed action	Section 10.5 Appendix C: Social Impact Assessment, Section 5, 7 and 8

ID	Terms of reference requirements	EIS section number
	- training and employment opportunities expected to be generated by the Proposal - opportunities for local and regional businesses - impacts on the local community such as on the amenity of the area, marine tourism, recreational fishing and the amateur fishing industry - risks of the Proposal not realising its proposed economic and social benefits - social impacts associated with not achieving the proposed economic benefits	
	• the potential impacts of Proposal infrastructure and activities, such as land transport and traffic impacts, water vessel traffic, dredging and reclamation, on cultural and historic heritage values on land, within the intertidal zone and submerged in Darwin Harbour. This should include: - the potential impacts and risks of destruction and / or damage to the Catalina A24-69 wreck site (Catalina 2) and the East Arm Flying Boat Base - the potential cumulative impacts and risks, taking into consideration other users and activities	Section 10.4 Appendix C: Social Impact Assessment, Section 3, 8 and Appendix B Appendix L: Traffic Impact Assessment, Section 8 and 9 Appendix M: Cultural Heritage Assessment, Section 9.2
	details of unexploded ordinance clearance.	Section 4.4.5 Appendix M: Cultural Heritage Assessment, Section 5.4.3 Appendix N: Preliminary Site Investigation, Section 2.9
3.0 Mitigation and management		
3.1	Address all potential impacts and risks identified through the economic and social impact assessment, identify measures to avoid, reduce or mitigate these impacts including: • measures to protect, and avoid impacts and entry, to sacred sites, including transit of vessels in the vicinity of sacred sites	Section 10.5 Appendix M: Cultural Heritage Assessment, Section 10
	• procedures to avoid significant heritage values and sites, and protect key sites during construction and operation	Section 10.5 Appendix M: Cultural Heritage Assessment, Section 10
	• any requirement to apply to, or applications already made to, the NT Minister for Tourism, Sport and Culture to disturb or destroy a prescribed archaeological place and/or object under the Heritage Act 2011	N/A
	• procedures that would be implemented in the event that any surface, sub- surface or submerged items/sites of heritage/cultural significance (additional to those identified in the EIS) are identified during implementation of the Proposal	Section 10.5 Appendix M: Cultural Heritage Assessment Appendix B
	• traffic management.	Section 10.5 Appendix L: Traffic Impact Assessment, Section 11
	Describe how emerging social impacts would be identified, assessed and mitigated in the future.	Section 5.7 Appendix C: Social Impact Assessment, Appendix C

ID	Terms of reference requirements	EIS section number
4.0 Monitoring and reporting		
4.1	Describe monitoring and reporting of identified potential economic, social and cultural impacts and risks.	Section 10.7 Appendix C: : Social Impact Assessment 10.4
5.0 Residual impacts		
5.1	Assess any residual impact or risk of the Proposal to identified values.	Section 10.6 Appendix C: Social Impact Assessment 10.4 Appendix C: Social Impact Assessment, Appendix C Appendix M: Cultural Heritage Assessment, Table 9 and Section 10

10.2 Policy and guidance

The legislation, policies and plans relevant to social, economic and cultural surroundings in the context of the Project are describe below. A comprehensive list of legislation, policy and guidelines and strategic context can be found in Chapter 3: Strategic and Statutory Framework.

Commonwealth

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (ATSIP Act)
- *Aboriginal Land Rights (Northern Territory) Act 1976* (ALR Act)
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Native Title Act 1993* (NT Act)
- *Underwater Cultural Heritage Act 2018* (UCH Act)
- Maritime Industry Development Plan (Department of Industry, Tourism and Trade 2021).

Northern Territory

- *Aboriginal Sacred Sites Act 2011*
- *Environmental Assessment Act 1982* (superseded by Environmental Protection Act 2019)
- *Environment Protection Act 2019*
- *Heritage Act 2011*.

Other policy, guidelines and plans

- Territory Economic Reconstruction Commission (NTG, 2020)
- Territory Benefit Policy (NTG, 2019)
- Darwin Region Land Use Plan (NT Planning Commission, 2015)
- City of Darwin Strategic Plan: 2030 City for People. City of Colour (City of Darwin, 2019)
- Palmerston Community Plan (Palmerston Council, 2018)
- Litchfield Strategic Plan 2018-22 (Litchfield Council, 2018)
- Darwin Harbour Strategy 2020-2025 (Darwin Harbour Advisory Committee, 2021)
- Ecologically Sustainable Development of Darwin Harbour (NT EPA, 2010)
- Darwin Port Development Plan (Landbridge, 2020).

Numerous guidelines, codes of practice and standards have also been referenced in the social, cultural heritage, noise and traffic assessments that support this chapter. These references are documented in each of the corresponding technical reports:

- Appendix C: Social Impact Assessment
- Appendix K: Terrestrial Noise Impact Technical Report
- Appendix L Traffic Impact Assessment
- Appendix M: Cultural Heritage Assessment.

10.3 Assessment methodology

10.3.1 Social

The methodology for the social impact study accorded with the *New South Wales Guidelines for the Social Impact Assessment of Significant Projects* (2017 and updated in 2021), the *NT EPA's Guidance for Economic and Social Impact Assessment* (2013), a *Guide to Social Impact Assessment* (Munday 2020) and internal research by True North into best practice social and cultural impact assessment.

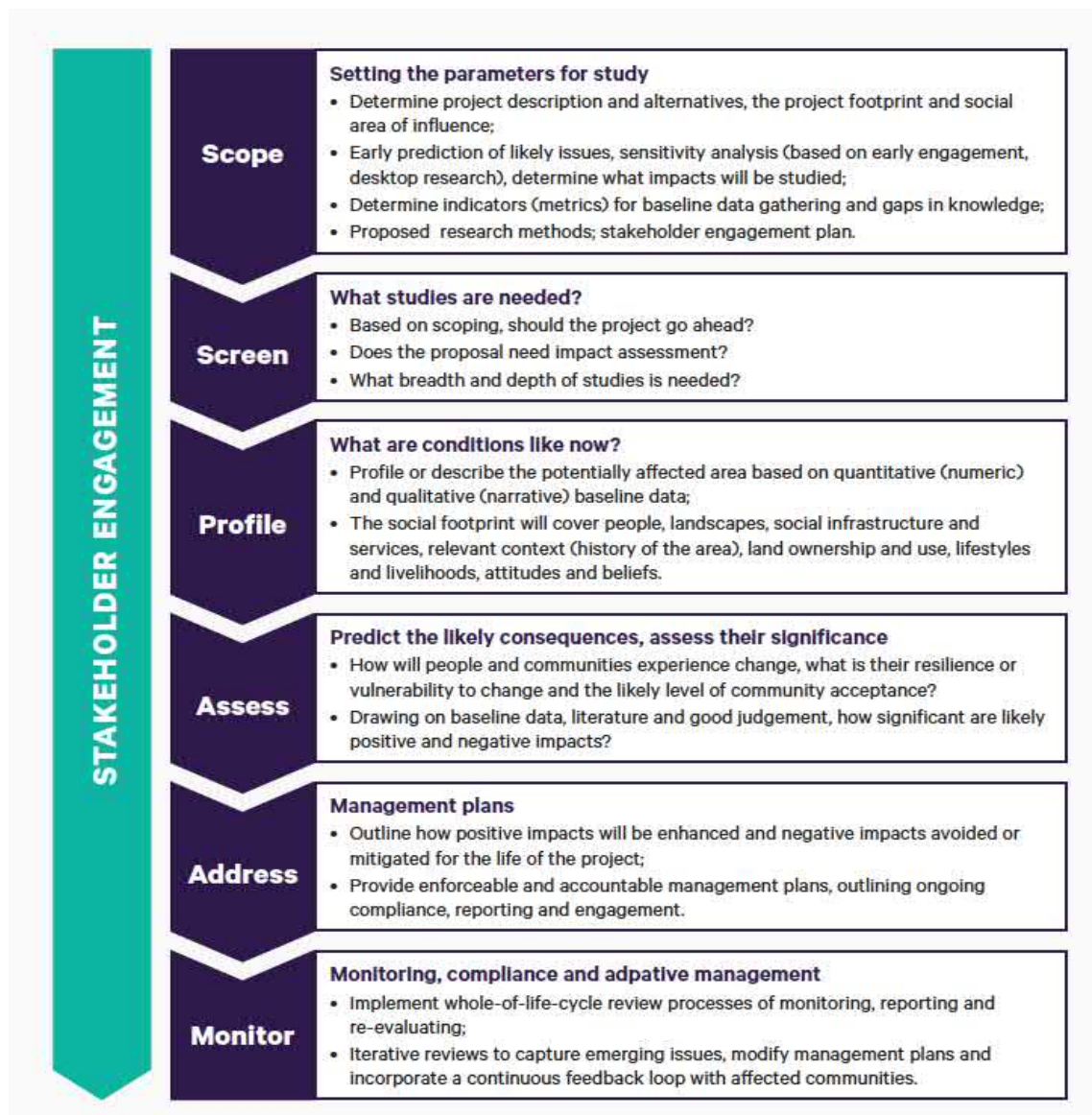


Figure 10-1 Methodology overview

A scoping exercise in December 2020 drew on desk research to profile:

- the existing social zone of influence
- current land and sea use
- change processes likely to be invoked by the Project
- people and communities affected by these changes
- issues that may be of concern or interest.

This scoping exercise suggesting a low-scale SIA was appropriate, given the proposed ship lift facility is in accord with its industrial zoning and existing maritime and logistics activities on East Arm Peninsula. A copy of the scoping exercise is included as Appendix C: Social Impact Assessment, Appendix A.

Assessments of economic impacts and benefits are based on material and briefings provided by the NTG (DCMC), the Marine Industries Development Plan coordinator and the Marine Industry Council of the NT Chamber of Commerce as well as interviews with key stakeholders. The SIA also cross-references the findings of other relevant technical studies, in particular traffic, noise and cultural

heritage technical reports contained in Appendix L: Traffic Impact Assessment, Appendix K: Terrestrial Noise Impact Technical Report and Appendix M: Cultural Heritage Assessment.

A preliminary significance assessment considered the likelihood and consequences of potential impacts, paying particular attention to the sensitivity of affected people and communities.

The following criteria (Munday, 2020) was used to determine consequence from the community's perspective:

1. **Extent:** how many people will experience the impacts
2. **Duration:** how long the impacts will last
3. **Severity:** the scale of change from the current conditions
4. **Sensitivity:** based on the level of controversy, disturbance to values, people's resilience and capacity to absorb change.

Impacts assessed as likely to be inconsequential or imperceptible were screened out of further study unless raised by stakeholders. For example, a relatively small construction workforce is likely to be drawn mainly from the existing population therefore no material impacts are likely on social infrastructure, such as schools, health, transport and emergency services and utilities. Safety and wellbeing issues were not raised during consultation and were not deemed to warrant further analysis, apart from road and marine safety.

A detailed description of the preliminary significance assessment methodology is included in Appendix C: Social Impact Assessment. Benefits and impacts that were identified as requiring further assessment are summarised below.

- key potential benefits
 - strengthening and diversifying the economy from enabling economic infrastructure and capacity-building
 - local businesses benefitting from winning work and enhanced capabilities
 - enhanced employment and training opportunities for local people
 - Aboriginal jobs and training opportunities resulting from the Project.
- key potential negative impacts:
 - cumulative impacts of development on the values of Darwin Harbour
 - damage to Aboriginal and European heritage, including World War II heritage
 - reduced amenity impacts due to construction activities such as increased heavy vehicle traffic and noise and vibrations from piling
 - impacts on marine vessel safety and recreational values and activities
 - crowding out of other economic activities on the harbour, such as tourism and recreational fishing
 - frustration by businesses who fail to win tenders or have unrealistic expectations of opportunities
 - detrimental impacts on competing maritime businesses.



Figure 10-2 Dimensions of social impacts adapted for a North Australia context (Munday 2020)

The contribution of this Project to potential cumulative impacts has been assessed as minimal. However, the SIA concluded that the cumulative additive and interactive impacts of other development projects on the values of Darwin Harbour have the potential to be substantial. The potential cumulative impacts will be determined by other projects outside the scope of this EIS, and are best addressed elsewhere, such as a harbour-wide strategic assessment, or possibly the proposed Middle Arm Strategic Assessment. Issues raised during the desktop review and stakeholder consultation in relation to potential cumulative impacts are included in the Stakeholder Consultation Report that informed the SIA (Appendix B to Appendix C: Social Impact Assessment).

10.3.2 Cultural

A cultural heritage assessment was conducted for the Project area including a desktop review of the existing heritage features (Appendix M: Cultural Heritage Assessment).

The aim of the desktop study was to identify areas likely to host Aboriginal and historical sites of heritage significance. Baseline information that advised the heritage study included:

1. Register searches on the Commonwealth Heritage Database, the Commonwealth Heritage Register and the National Heritage Register
2. Register searches on the NT Heritage Register and the NT Archaeological Database held by Heritage Branch, NT Department of Tourism Sport and Culture
3. A description and location of Aboriginal and non-Aboriginal sites places or objects of natural, historic and cultural heritage significance, current utilisation and spiritual significance. This included using published archaeological and anthropological sources, registers, consultations, field and historical research.
4. Provision of a current Authority Certificate for the Project area issued by the AAPA of the NT.

A field inspection was conducted in December 2020 with two primary objectives:

1. Create a visual record of the East Arm FBB and part of the LMS site to add to the existing images and mapping from 2003, 2010, 2015 and 2016 projects (Earthsea, 2021). These sites are discussed further below.
2. Conduct a site condition audit for the remaining features of the site.
3. Conduct a survey for Aboriginal sites or artefacts on an area of remnant mangroves on the western edge of the Project Area.

Details on the cultural heritage assessment methodology are included in Appendix M: Cultural Heritage Assessment. The findings of the cultural heritage assessment and recommendations in relation to management and monitoring are discussed in Appendix M and cross-referenced in Appendix C: Social Impact Assessment.

10.4 Existing social, cultural and economic environment

The SIA included an initial stakeholder mapping and scoping exercise based on local knowledge and desk research of issues raised in environmental studies for other projects in the region. This exercise determined that a low-scale SIA was warranted because:

- the Project has a relatively small footprint and proposed activities are similar to those in the surrounding areas. The site is part of a maritime and logistics precinct an area set aside for strategic marine industries and progressively developed over the past 20 years.
- minimal feedback was received when the Draft ToR for the Project were advertised in 2019 and no public submissions were received in response to a development application for proposed early works (subsequently withdrawn)
- the scale of change is minimal and should be readily absorbed:
 - Berrimah Road and the Tiger Brennan Drive Extension were funded to improve access to EAW (and an overpass over Tiger Brennan Drive is planned), so additional industrial traffic is likely to be readily absorbed
 - the site is several kilometres from residential areas, although sensitivity to disturbance from noise, pile-driving vibrations and traffic will need to be monitored, as outlined in management framework
 - disturbance to mangroves may be of concern, but reclamation will affect only a small isolated one-hectare stand of mangroves
 - the site has been degraded by decades of industrial activity and the disposal of rubble and weeds
 - most of the 100 construction workers are likely to be drawn from the Greater Darwin Region's existing labour force, so there should be negligible impact on social infrastructure and short-term accommodation
- most concerns documented for other projects and in media reports, such as impacts on fish health and reduced access to the harbour, relate to cumulative impacts from dredging and industrialisation of the harbour, not Project-level impacts.

The initial scoping exercise (refer Appendix C: Social Impact Assessment, Appendix A) led to many significance ratings of negligible, hence most impacts typically associated with a marine infrastructure project were screened out from further study. The key issues that remained for research and analysis aligned with the requirements of the regulatory ToR (NT EPA, December 2019) under the 'People and Communities' key environmental factor, these being:

- a description and assessment of economic benefits and potential negative impacts
- potential impacts on Larrakia and World War II cultural heritage values
- potential impact on the diverse values of Darwin Harbour

- discussion of other industrial activity in Darwin Harbour that may contribute to the cumulative impacts of the Project.

In line with the social impact methodology outlined in Section 10.5.1 social, economic and cultural impacts and benefits are discussed under the following key themes:

- people and communities
- social infrastructure and services
- economies and jobs
- cultural identity
- healthy land and seas
- living environment
- governance and being able to have a say.

10.4.1 People and communities

An overview of the communities of the Greater Darwin area is presented in Chapter 4: Environmental Setting. The primary footprint for the social area of influence covers East Arm and its closest residential suburbs (6 km to the east), as well as transport routes likely to be used by workers and to quarries for transport of construction materials.

The nearest residential areas to the Project include the Northcrest housing development in Berrimah and Palmerston's outer suburbs of Marlow Lagoon and Durack, 6 km to the east or a 9-km commute.

The area is accessed by Berrimah Road, which links to two arterial roads: Tiger Brennan Drive and the Stuart Highway. The \$6.5 million Tiger Brennan Drive Extension, completed in 2009, saw the duplication of Berrimah Road between Tiger Brennan Drive and EAW to provide better access and ease traffic congestion. An overpass is planned for the busy intersection of Berrimah Road and Tiger Brennan Drive, which has been the scene of several high-profile multiple fatalities in recent years. The \$61.5 million project will be jointly delivered by the Australian and NT Governments under a national road safety program. The overpass is intended to improve road safety, traffic flow and connectivity for freight transport to EAW.

Darwin Harbour, which surrounds East Arm Peninsula, is an important ecological, social, cultural and economic asset. The harbour spans 3230 square kilometres from Charles Point in the West to Gunn Point in the East and Darwin River Dam to the south. The harbour embraces Shoal Bay, Middle Arm, West Arm and their respective tributaries. Sometimes referred to as a 'working harbour', the natural deep-water port supports northern Australia's largest concentration of marine and logistics activities. East Arm Port, backed by the AustralAsia Railway, is promoted as Australia's gateway to Asia and northern gateway for trade. This makes it a nationally significant economic hub which provides services to international and domestic trading vessels, cruise ships, gas exports, livestock exports, defence and dry and liquid bulk trades

Further information on the people and communities within the social area of influence refer to Appendix C: Social Impact Assessment.

10.4.2 Social infrastructure and services

The estimated construction workforce for the Project is relatively small, at about 100 direct jobs. Stakeholder interviews suggest contractors are likely to draw mainly on workers already living in the Greater Darwin Region. While specialist positions may be filled from elsewhere, the size of any external workforce relocating to Darwin is unlikely to exceed the absorptive capacity of existing social infrastructure and impacts on social infrastructure and services has therefore not been included in this assessment.

Cumulative industrial development, however, could put pressure on the availability, quality and affordability of social infrastructure in the catchment area for workers, particularly given current pressures on the housing, rental and accommodation markets (REINT 2021). This is best assessed at a more strategic level, such as the current Middle Arm Strategic Assessment, and has not been considered further in this assessment.

10.4.3 Economics and jobs

The NT Government's vision is for the as enabling economic infrastructure that will grow the maritime sector and enhance Darwin's competitive advantage as a marine repair and maintenance and sustainment centre for Northern Australia and leading to direct and indirect economic benefits to the region. The NT economy, marine sector and labour force are discussed in Chapter 4: Environmental Setting. The NTG has prepared projections for capital expenditure and jobs against various stages of the Project. These are described at a high level as the Project design is at a concept level and will be further refined in consultation with the successful design and construct Contractor and therefore there is uncertainty about future Project phases and their associated effects. Further information can be found in Appendix C: Social Impact Assessment.

Capital expenditure of \$400 million on design and construction of the ship lift and adjacent hard stand is likely to be concentrated in the years 2022 to 2024/25. Although the design of the facility and related costs have not been finalised, Government suggests that 35-40 per cent of the capital cost of construction may be expended on marine and civil engineering work that could be delivered by firms operating in the NT. The balance represents the cost of purchasing, delivery and commissioning of imported items, project management, consulting and contingency costs. These broad estimates will be refined once the design and construct Contractor is selected and the construction contract awarded.

Government will make complementary investments in the adjacent MIP to enable the operations of existing and prospective marine service providers. The MIP is operated by the Land Development Corporation, which operates on commercial principles, so it is assumed the delivery of these blocks will be self-funded (Appendix C: Social Impact Assessment).

Revenue has been estimated as direct revenue from the ship lift as a CUF and economic benefits as the broader uplift to the NT economy based on increased expenditure on marine repairs and maintenance and the indirect benefits to the regional economy. The additional customer spend is estimated at between \$2.283 billion and \$4.504 billion over 20 years, including the construction phase. The NT Government suggests that, over the next decade, the Project should act as enabling infrastructure, increasing expenditure in the local economy by \$130 million to \$260 million a year and an industry workforce by 187 to 359 additional jobs a year. However, it may take up to a decade to gain the full potential market share and for the estimated economic, employment and social benefits to arise. Contract marine service providers will be utilised according to workloads. Contractors are predominantly expected to be located on industrial lots within East Arm.

Table 10-2 summarises Project capital expenditure, revenue, direct and indirect employment estimates provided by the NTG, based on a preliminary 2019 ACIL Allen study: Assessment of SLAMI Complex: Preliminary Market, Financial and Economic analysis. The NTG has also based these projections on the following assumptions:

- The Project involves delivering new marine infrastructure so that the Darwin-based marine repairs and maintenance industry can utilise and leverage these facilities to gain market share in a growing market, generate additional income, and employ more people. The benefits are assumed to arise from five sequential phases from planning through to consolidation and expansion, after local industry has established a reputation and comparative advantage in the market. Gradually phasing in the estimated economic effects recognises that the Darwin-based industry will be a new entrant to a mature market, competitors may act to limit competition, and it may take time for the Darwin-based industry to establish successful and sustainable growth strategies. The government is currently developing a Territory wide Maritime Industry Development Plan to inform and underpin this growth opportunity for local industry.

The sequential phases are simply a mechanism to gradually introduce the benefits of the opportunity. The duration of these phases is an estimate and could be shorter or longer than assumed.

- The estimated economic effects arising after the facilities are delivered and operational have been estimated over 20 years, even though the facilities will be built to a design life of 40 years and regular maintenance and upgrades could see the facilities operational for longer. Twenty years is consistent with the forecasting horizon adopted by ACIL Allen's preliminary 2019 study and was deemed to be acceptable, as forecasting accuracy beyond 20 years is questionable.

- The Project budget is \$400 million, covering all phases and aspects of the Project. The estimates assume the Project-related infrastructure will cost \$385 million to deliver, although this is not certain as the design has not been finalised and a contract has not yet been signed.
- The estimates of ongoing capital expenditure, additional industry spend on marine repairs and maintenance, and additional NT employment are based on a 2019 preliminary study by ACIL Allen. Changes in the scale and delivery of the facilities have occurred since ACIL Allen completed its study in early 2019 and a number of minor adjustments were made to align some ACIL Allen's estimates to the approach assumed for the EIS submission in late 2021. The ACIL Allen study adopted three different scenarios to estimate varying levels of use of the new facilities, and the associated expenditure and employment effects – a low case, a base case and a high case. The table shows two of ACIL Allen scenarios the base case and the high case.
- The level of ongoing capital expenditure will be directly affected by the design, and the level and intensity of use of the facilities. The estimates in the table align to the level of activity assumed by the preliminary ACIL Allen study (2019) in their base case, and adjusted to recognise that the capital expenditure will be lower in the early years of operation than in later years because newly installed facilities will be covered in the early years by such things as manufacturer's warranties, and the liability of the builder for any defects arising from construction.
- ACIL Allen (2019) effectively assumed that all benefits would arise as soon as the facilities were operational, but subsequent discussions with industry and the operator of the facilities confirmed that a more conservative, phased approach is warranted. Hence, the benefits estimated by ACIL Allen for the early years of operation have been adjusted to align to the phasing assumptions, and it is not until around Year 8 after the facilities are commissioned that the full increase in expenditure on marine services and supply, and increased employment, assumed by ACIL Allen, are reflected in the projections.
- The total additional industry spend on marine repairs and maintenance is over 20 years, and the numbers in the table reflect the base and high level of activity assumed by ACIL Allen's preliminary study (2019), but with activity and expenditure gradually increasing over the first 10 years of operation.
- The Project is assumed to create 100 direct jobs per annum (FTE) during the two to three years construction phase, although the actual number will be determined by the design and delivery methods chosen by the contracted builder. Analysis of the nature of the work required suggests that much (but not all) of this work could be undertaken by local firms with the existing labour in the Darwin market. If this is the case, there will be limited spill over effect in supporting additional indirect jobs because the 100 FTE are assumed to be already in the Darwin labour force. A conservative approach has been adopted, and the table does not include an estimate of the number of indirect jobs supported during the construction phase.
- The estimate of additional annual employment once the facilities are fully operational includes both direct and indirect employment opportunities invoked by the use of the facilities the Project will deliver. The level of activity and expenditure is assumed to gradually increase over the early years of operation, and it is assumed that it takes until Year 8 for the full employment effects to arise. The table includes the estimated additional employment per annum made in the preliminary study by ACIL Allen (2019) for the base and the high case.
- The increased spending by the Darwin-based marine repairs and maintenance industry, and the increased workforce will generate broader benefits for the NT and Australian economies because they will consume inputs that create opportunities for other businesses and employees, generally known as the multiplier effect. It is difficult to predict how much of the multiplier effect will be captured within the NT economy because of the confounding effects of the NT's relatively small, existing manufacturing and white collar/ technical services base, the difficulty forecasting how demand for various inputs may change as sub-sectors grow, and many of the inputs consumed within the NT are, and may continue to be, produced elsewhere. The challenges of forecasting these effects into the future with a high level of confidence has encouraged the adoption of a conservative approach, and the table does not include estimates of the potential multiplier effects for the broader NT economy, although they are expected to arise.

Table 10-2 NTG summary of projected Project capital expenditure, revenue, direct and indirect employment estimates

		Drivers of project economic and social opportunities and effects					
Phase	Approx. duration	Upfront capital expenditure	Ongoing capital expenditure Assuming a level of activity in the base case	Estimated additional customer spend on marine repairs and maintenance		Additional NT employment opportunities arising from the Project Average additional FTE/ per annum	
				Base case	High case	Base case	High case
Planning, design, procurement, and contracting	2 years	\$15 million	N/A	N/A	N/A	N/A	N/A
Construction and Commissioning	2-3 years	\$385 million	N/A	N/A	N/A	100 FTE	100 FTEs
Start-up	3 years	N/A	\$1.8 million	~\$159 million	~\$314 million	78 FTE	147 FTE
Consolidation	10 years	N/A	\$11.7 million	~\$1.195 billion	~\$2.358 billion	170 FTE	324 FTE
Expansion	Ongoing	N/A	\$10.2 million	~\$930 million	\$1.834 billion	187 FTE	359 FTE
All phases	~20+ years	~\$400 million	~\$23.85 million	~\$2.283 billion	~\$4.505 billion		

Note: Table to be read in conjunction with assumptions included in Appendix C Social Impact Assessment.
(NTG, 2020)

As stated above these numbers should be used with caution as designs are at concept level and construction contracts have not been awarded. The report also preceded several changes to the Project engineering and footprint, changes in Australia's defence posture in the north and a renewed focus on economic reconstruction from COVID-19. In addition, the Project will operate in a competitive market and future revenue streams and benefits cannot be guaranteed.

The Project is expected by the NTG to deliver important enabling infrastructure that will underpin growth in the Darwin-based marine service and supply industry. This would generate substantial economic benefits, particularly in terms of long-term economic uplift, jobs and increased skills levels. It is difficult to quantify the distribution of these impacts, which will be reliant on the NT's ability to gain market share, attract private sector investment and boost local business and workforce development capacity. However, to maximise the local distribution of benefits, it will be important to ensure that benefits flow across Darwin's long-established maritime sector, grow a skilled workforce, and are driven by a collaboratively developed master plan for the maritime industry.

In 2021, the NT Chamber of Commerce established a Maritime Industry Group, now Marine Industry Council, to better position industry to take advantage of opportunities such as the ship lift and marine industries precinct, better harbour access for deep-water vessels, increased defence needs, and growth in oil and gas and coastal shipping. The council's priorities include a master plan for Darwin Harbour, improved and affordable infrastructure and workforce skills and capacity development.

Darwin Port, operated by Landbridge, is Australia's northern gateway for trade with Asia and beyond, the terminus of the AustralAsia Railway and a support hub for the offshore oil and gas fields in the region. Darwin is the only natural deep-water port in northern Australia and supports international and coastal trade throughout the region. In 2019-20, the following vessels entered Darwin Port (Darwin Port 2021).

- 1472 trading vessels
- 85 container and general cargo vessels
- 67 liquid bulk vessels
- 32 car carrier vessels
- 313 rig tender vessels
- 61 cruise ship vessel visits.

An assessment by Deloitte in 2020 for the NTG and Industry Skills Advisory Council of the NT (ISACNT) suggested the ship lift and naval investments in Darwin represent "a unique opportunity" to invest in a skilled maritime workforce.

10.4.4 Cultural identity

Cultural identity covers both material (archaeological) and living (anthropological) culture. This section draws on the cultural heritage assessment undertaken by Earthsea (2021) (refer Appendix M: Cultural Heritage Assessment). It also considers broader potential cultural values such as Larrakia values and spiritual connections to Darwin's land and seas and historical sites both listed and not listed that are important to Territorians' cultural identity.

Larrakia connections, Aboriginal and European heritage are also discussed in Chapter 4: Environmental Setting, Appendix M: Cultural Heritage Assessment and Appendix C: Social Impact Assessment. Aboriginal and European heritage values associated with the Project area are summarised below.

10.4.4.1 Aboriginal heritage

The Project area is close to two registered Sacred Sites protected under the *Northern Territory Sacred Sites Act 1989*. These sites, Catalina Island and Old Man Rock, are both on the AAPA register of sacred sites. An AAPA certificate is current for the Project with conditions including avoiding impacts on the sand bar on the northern end of Catalina Island (see Appendix M: Cultural Heritage Assessment (Appendix A)).

The cultural heritage survey to support this EIS did not record any archaeological sites of Aboriginal origin within the small area of mangroves in the Project area (Earthsea, 2021). A single Aboriginal midden site known as 'East Arm 1' lies 90 metres from the eastern boundary of the Project and will not be impacted by the construction or operation of the ship lift (refer Appendix M: Cultural Heritage Assessment).

10.4.4.2 European heritage

The East Arm Peninsula played a crucial role during World War II when it became a refuelling base and defence headquarters. Defence infrastructure included the strategically significant Catalina FBB, occupied by the RAAF during the war. About 200 metres east of the Project site is the former LMS, which supported Z Special Unit's operations in South-East Asia during the war.

Most of the FBB has been demolished to make way for industrial development. The surviving features as of 2015 were the Catalina ramp, crash boat slip way, a mooring pile and some fragments of a fuel pipeline (Earthsea, 2021). The Project construction phase will cover the remaining FBB with fill and concrete. There is no reasonable mitigation strategy for the FBB sites. The recommendations propose interpretative signage close to the Project to indicate that the area was once the location of FBB and the LMS and its significance as a base for Allied operations in the South-West Pacific Area during World War II.

Six Catalina aircraft wreck sites occur in the general East Arm area, those of significance to this Project include the Catalina 2 (RAAF Catalina A24-69) and the Catalina 3 (RAAF Catalina A24-206). Catalina 2 is 200 metres south of the Project boundary adjacent to the access channel, however no works are proposed in this location. The Catalina 3 is to the south of Catalina Island, a kilometre from the Project site. An exclusion zone is proposed around Catalina 2 for larger vessels that could potentially impact on the site during construction.

More detail on the cultural heritage assessment and proposed mitigation methods are contained in Appendix M: Cultural Heritage Assessment.

10.4.5 Healthy land and seas

Darwin Harbour is integral to the lifestyle, commercial activities and sense of place for Top End residents. It has been described "as an internationally significant conservation area that supports native flora and fauna, provides recreation spaces and generates cooling breezes" (Darwin Area Land Use Plan 2019); as the "jewel in the Territory's crown" providing a "wealth of ecosystem services that directly support the environmental, economic, social and cultural wellbeing of the communities that make the region their home" (NTEPA, 2010, p.2); "a biologically rich and diverse marine and terrestrial environment" (Darwin Harbour Strategy, 2010) and a "unique coastal lifestyle... providing a beautiful backdrop to the daily lives of Darwinites" (ECNT, 2020).

So integral is the sense of connection with the harbour, that several studies have explored its diverse values. The 2003 Darwin Harbour Plan of Management (DHAC, 2003) found the harbour's environmental, cultural, commercial and recreational values generate employment and revenue, in addition to providing a source of pleasure and enjoyment for those who live in and visit the region. Consultation by DHAC for its 2003 plan of management suggested high conservation values, cultural values for Larrakia people and the importance of recreational fishing (with 40 per cent of Darwin residents pursuing this activity each year). The harbour's scenic values encourage recreational activities such as boating, swimming, bird-watching, diving and cycling. Economic values support a working harbour and growing industry base.

A report by Dr Tom Brewer (2015) of CDU, on the values of the harbour found that participants felt it was important to maintain a healthy harbour but agreed that "the harbour has fragile environments that are being permanently degraded and disagreed that it was necessary to sacrifice natural environments to improve the quality of life for residents". The most highly rated landscape values of the harbour in this study were, in order of priority: aesthetic, recreation, biodiversity, economic, heritage, life-sustaining, wilderness, therapeutic, future, knowledge, intrinsic and spiritual. Preferences for development of the harbour were for it to be where most coastal industry already exists, rather than spreading to other parts of the harbour.

10.4.6 Living environment

The living environment covers changes to people's sense of place, enjoyment of their natural surroundings and impacts on their amenity from nuisance impacts, such as noise, dust, pollution, vibration and light pollution.

Impacts on individual and community living environments are likely to flow from how people experience the impacts of construction and operation. In many respects, these impacts are likely to vary with context and sensitivity to disruption, which is a subjective judgement influenced by sense of place, lifestyles, perceived contribution to quality of life and strength of values associated with the environmental qualities of our land and seas.

Earlier studies for projects in the East Arm area have identified stakeholder concerns about amenity impacts such as construction noise from earthmoving equipment, cranes, concrete mixers and pumps, generators, compressors, pile drivers and pneumatic and hydraulic breakers (TNG SIA 2019). The EAW Expansion SIA (URS 2011) identified concerns with potential noise, dust, pollution, visual impacts on the harbour, traffic congestion, changed sense of place and reduced safety on the harbour. Consultation for the EAW (2010) and INPEX LNG plant at Bladin Point on Middle Arm Peninsula (2011) saw concerns expressed at potentially reduced access to nearby creeks and port facilities for commercial and recreational vessels.

Collectively, these impacts were rated as low in the scoping exercise for the SIA and were not raised during stakeholder consultation, therefore retain a residual rating of low. However, exceedances of noise, dust and traffic impacts during construction in particular are still possible and adherence to management plans and a grievance procedure to capture and respond to complaints will be important.

In response to impacts identified in the initial risk assessment as potentially impacting on the living environment, two studies were commissioned by the NTG to support the SIA:

- Terrestrial Noise and Vibration Impact Assessment (refer Appendix K).
- Traffic Impact Assessment (refer Appendix L).

The findings of these studies and their relevance to the SIA are summarised below in Section 10.5.

10.4.6.1 Noise and vibrations

The Terrestrial Noise and Vibration Impact Assessment describes and quantifies the potential impacts of the Project with reference to the policies, guidelines and standards that apply to the treatment and management of operational and construction noise and vibration. This assessment reported the following outcomes:

- The noise level assessment indicates that the predicted construction noise levels will comply with the Project specific assigned construction noise levels at all noise sensitive receptors located in residential and commercial areas.
- Nominated vibration criteria were derived from several Australian and international standards which were selected based on the type and nature of the vibration sources and the land use and sensitivity of the receptors. If these criteria are complied with, no adverse impacts from vibration intensive works are likely in terms of human response or cosmetic damage.

Further information on the impacts of noise and vibration are discussed in Appendix K: Terrestrial Noise and Vibration Impact Assessment, while assessment findings as they relate to the SIA are summarised further in Section 10.5.

10.4.6.2 Traffic

The Traffic Impact Assessment describes and quantifies the potential impacts of the Project with reference to the policies, guidelines and standards that apply to traffic within the vicinity of the Project. This assessment reported the following outcomes:

- The construction phase of the Project is expected to generate a temporary increase of heavy vehicle traffic on specific parts of the surrounding road network. However, the projected quantity of vehicle movements and the anticipated period of construction is unlikely to have adverse effects on the road network operations.

- The traffic forecast during the operational phase of the Project is expected to have a negligible operational impact on the road network during peak periods. Therefore, no material reduction in Level of Service or intersection performance is anticipated.
- Vehicle noise generated by the potential 24/7 haulage construction schedule may temporarily impact surrounding local residences. The risk of this impact to the Project can be managed through local consultation and communications.

Further information on the impacts of traffic is discussed in Appendix L: Traffic Impact Assessment, while assessment findings as they relate to the SIA are summarised further Table 10-4. Amenity impacts potentially associated with the Project are summarised in Table 10-3 below with reference to supporting technical studies.

Table 10-3 Impacts on the living environment

Impacts	Assessment findings
Noise and vibration	Noise and vibration impacts on residential suburbs are possible, but short-term. Pile-driving is expected to include up to 485 steel piles for the ship lift, tenders and concrete finger wharves, with two a day for 240 days (see Chapter 2: Project Description). Construction and operational noise levels will comply with assigned noise levels at all noise sensitive receptors located in residential and commercial areas. Similar construction, dredging and piling occurred for the EAW Expansion and MSB, with no record of complaints or community sensitivity to these impacts. The noise assessment concludes that likely noise and vibration levels are likely to be minimal and within EPA guidelines. Refer Appendix K: Terrestrial Noise Impact Assessment and Appendix C: Social Impact Assessment.
Disruption from road traffic	The traffic impact assessment found that the additional trip generation created by the proposed construction schedule is not predicted to have a significant impact on the road network or a disproportional increase in road safety. Increased congestion and inconvenience from Project traffic is unlikely, given the existing volumes of traffic, upgrades to arterial roads such as Tiger Brennan and Berrimah Roads and haul routes mainly passing through industrial areas. Some increased traffic may be experienced between quarries in the rural area and EAW, but this is predicted to be barely noticeable in residential areas or to existing road users. Refer Appendix L: Traffic Impact Assessment and Appendix C: Social Impact Assessment.
Disruption from marine traffic	Marine activities for construction of the Project will be localised and relatively short-term. Impacts on marine traffic during operations is considered to be minimal with 1 to 2 vessels using the facility a week. Refer Chapter 2: Project Description.
Reduced air quality	Reduced air quality on residential areas from dust or pollutants is unlikely to be consequential. Pollutants of concern were found to be combustion emissions such as particulate matter (PM ₁₀ and PM _{2.5}) nitrogen dioxide, carbon monoxide, sulfur dioxide (SO ₂) and volatile organic compounds (VOCs). Emission sources for each scenario were identified and emission rates estimated based on published emission factors and Project specific data. Based on the results of modelling, no significant impacts were predicted for any pollutant at sensitive receptors for construction or operations. Details of the air quality impact assessment are included in Chapter 9: Air Quality and Greenhouse Gas, Appendix J: Air Quality and Greenhouse Gas Technical Report and Appendix C: Social Impact Assessment.

Impacts	Assessment findings
Visual impacts	While permanent, the scale of change is relatively small and in line with existing industrial activities. The site is designated Zone DV (Development) under the Northern Territory Planning Scheme 2020. The purpose of this zoning is to facilitate the development of major strategic industries that are important to the future economic development of the NT, including gas, road, rail or port-related industries.
Turbidity	Turbidity from dredging may detract from the aesthetics of the harbour, however modelling indicates that all impacts associated with dredging-related turbidity are predicted to fall within the area defined as the Zone of High Impact (the area of the dredging footprint plus a buffer of 20 m). As such no significant turbidity impacts are anticipated outside of the vicinity of this zone. Impact from dredging are discussed further in Chapter 7: Marine Environmental Quality.

10.5 Mitigation and management

A SIMP has been developed for the Project and is included as to Appendix C: Social Impact Assessment, Appendix A. The SIMP is intended as a stand-alone document that summarises social impacts and opportunities of the Project and outlines the proponent and Contractor's required management plans for construction and operation.

As for the proposed environmental management framework presented in Chapter 13: Environmental Management Framework, the SIMP will be complimented by a number of other management plans such as the:

- Construction Noise and Vibration Management Plans (CNVMP)
- Construction and Operational Traffic Management Plans (TMP)
- Dredging and Dredge Spoil Placement Management Plan (DDSPMP)
- Air Quality Management Plan (AQMP)
- Erosion and Sediment Control Plans (ESCP)
- Biosecurity Management Plan
- Heritage Management Plan (HMP)
- Marine Spill Response Plan.

Table 10-4 identifies specific construction and operation mitigation measures identified in the SIMP in relation to:

- people and communities
- cultural identity
- economies and jobs
- living environment.

Mitigation measures in relation to land and sea are discussed in the context of cumulative impacts in Chapter 12: Cumulative impacts. The risks to land and sea for the Project in relation to social, economic and cultural surroundings are considered negligible due to the Projects small footprint and location in an area designated for strategic development.

Further information on proposed mitigation measures can be found in Chapter 13: Environmental Management Framework.

Table 10-4 Mitigation measures for social, economic and cultural surroundings

Phase	Proposed mitigation measures
People and communities	
Construction	• Development of a Construction TMP covering construction traffic and haul roads. • Communication with other road users during any peak transport tasks, such as haulage of equipment and materials. • Good communication with other harbour users, including recreational fishing/boating community before the start of marine works and during the design and construction phase to advise of operations and safety requirements. • Vessel speed and movement within the Project area will be governed by navigational restrictions and a Marine Works Management Plan, which should minimise nuisance to recreational traffic. • Organised bus transport for workers to reduce the number of vehicles travelling to site and potential traffic congestion. • Collaboration with Darwin Ports TMP. • Implement marine safety plan including high safety standards and communication of standards and expectations to all Project staff. • Harbour Master's Notices to Mariners.
Operation	• Development of an Operational TMP. • Collaboration with Darwin Ports TMP. • Project vessels will need to comply with navigational restrictions.
Cultural identity	
Construction	• Develop working relationship with custodians to monitor and avoid damage. • Adherence to the AAPA Certificate requirements. • Implementation of a HMP including restricted work, cultural protocols and unexpected finds procedures as well as contractors inductions. • Workforce codes of behaviour and cultural awareness training. • Installation of interpretive signage telling the story of World War II historical and non-declared sites that will be lost such as the FBB and the LMS. • Further sediment monitoring for the Catalina 2 and Catalina 3 sites. This should be undertaken prior to construction and at the commencement of operations. • An exclusion zone around the Catalina 2 site should be established to limit the impact of larger vessels around the wreck site. • Current owners to remove Rushcutter to a more appropriate location. • A qualified maritime archaeologist to be on call during dredging operations if significant artefacts are located in any spoil. It is recommended using the NTG Heritage Branch maritime archaeologist where possible. • Should further Aboriginal sites or artefacts be located during construction, work should be stopped immediately in that area and the Director of NT Heritage Branch contacted for further instruction.
Operation	• Cultural heritage values will be recorded within the OEMP in adherence with the AAPA certificate requirements.
Economics	
Construction	• NTG economic and investment attraction strategies to maximise benefits unlocked by the infrastructure: - collaborative strategic planning between the Marine Industry Development Plan, gas industry task force and Middle Arm master planning - a Territory Benefit Plan for the project, to maximise local industry participation and jobs. • Design and construct Contractor's local industry and Indigenous participation plan, to meet NTG's Territory Benefit Plan. • ICN capability mapping to highlight local capacity and address any gaps.

Phase	Proposed mitigation measures
	- Industry briefings in conjunction with the Northern Territory ICN to enhance the preparedness of local businesses to win work and manage expectations. - Good communication about jobs available on the Project. - Ongoing communication to manage local content expectations and provide early advice of opportunities.
Operation	- Ongoing development of workforce and skills for the marine sector, with input from local industry to enhance capacity development, through the Marine Industry Development Plan. - Development of a CUF and expanded marine repairs and maintenance industry that grows the sector. - Good communication about jobs available on the Project.
Living environment	
Construction	- Development and implementation of the following construction management plans: - SIMP - CEMP - Construction TMP - AQMP (included in CEMP) - CNVMP - Marine Works Safety Plan - Ongoing stakeholder engagement and consultation plans.
Operation	- Development and implementation of the following management plans - SIMP - OEMP - Operational TMP. - Ongoing stakeholder engagement and consultation plans.

10.6 Statement of residual risk

A risk and opportunity matrix which summarises proposed management and monitoring measures is included in Table 10-5. Risks were assessed both prior to mitigations and following the implementation of mitigation to provide an assessment of residual risk. A description of the SIA risk assessment methodology is contained in Appendix C: Social Impact Assessment. The risk assessment forms the basis of the SIMP and is documented in the SIMP (Appendix C to Appendix C: Social Impact Assessment.)

Recorded opportunities/positive impacts included:

- strengthening and diversifying the economy from enabling economic infrastructure and capacity-building
- local businesses benefitting from winning work and enhanced capabilities
- enhanced employment and training opportunities for local people
- Aboriginal jobs and training opportunities resulting from the Project.

Potential negative impacts included:

- Indirect impacts to nearby Aboriginal sacred sites and World War II Catalina sites nearby the Project, as a result of minor ocean current changes. These sites will be monitored before and after the construction of the Project. Furthermore, a current AAPA certificate has been obtained for the Project which outlines management requirements in relation to these sites.
- There was also concern from one stakeholder over the continued loss of historical and heritage sites and the reduction of their interrelatedness with other World War II sites around Darwin and visible remnants of the war effort. As suggested above these consequences may be able to be mitigated through interpretive signage.

Table 10-5 Pre and post-mitigation risk assessment for social, economic and cultural surroundings

SIA theme	Phase	Social impact or opportunity	Pre-mitigation risk rating	SIA mitigation s	Post-mitigation risk rating
People and communities - impacts on social fabric, health and wellbeing, vulnerable community segments	Construction	Reduced sense of safety as a result of road trauma	High	TMP covering construction traffic and haul roads. Organised bus transport for workers to reduce the number of vehicles travelling to site and potential traffic congestion. Collaboration with Landbridge's TMP for Darwin Port. Communication with other road users during any peak transport tasks, such as haulage of equipment and materials. Government's proposed overpass at the intersection of Berrimah Road and Tiger Brennan Drive.	Low
Economics (jobs, industry participation, livelihoods, economic development)	Construction	Frustration by businesses who fail to win tenders or have unrealistic expectations of opportunities	Low	Territory Benefit Plan to outline requirements for design and construction Contractor, including packaging and promoting tenders to suit local capacity, procurement processes that prioritise the local market and good communication of opportunities for local businesses. Industry briefings in conjunction with the NT ICN to enhance the preparedness of local businesses to win work and manage expectations. Accountability and reporting requirements for prime contractors and their sub-contractors against local participation provisions. Ongoing communication to manage local content expectations and provide early advice of opportunities.	Low

SIA theme	Phase	Social impact or opportunity	Pre-mitigation risk rating	SIA mitigation s	Post-mitigation risk rating
Cultural identity	Construction	Loss or damage to declared or valued European heritage sites, including World War II sites	Medium	While no declared heritage sites are in the project's footprint, work with the Heritage Branch or Heritage Advisory Council on interpretive signage telling the story of World War II historical and non-declared sites that will be lost. Monitoring of sediment impacts on Catalina 2 and 3 pre and post-construction. Larger vessel exclusion zone around Catalina 2 during construction. Arrange for the <i>Rushcutter</i> to be moved to a place where it can be protected and restored. Unexpected finds protocols.	Medium
People and communities - impacts on social fabric, health and wellbeing, vulnerable community segments	Construction and Operation	Reduced sense of marine safety as a result of dredging and increased marine activity on the harbour	Medium	Navigational requirements and marine safety plan including high safety standards and communication of standards and expectations to all Project staff. Harbour Master's Notices to Mariners Good communication with other harbour users, including recreational fishing/boating community before the start of marine works and during the design and construction phase to advise of operations and safety requirements.	Low
Cultural identity	Construction and Operation	Loss of cultural heritage due to damage, or reduced access, including fears and anxieties of damage to sites or custodians' responsibilities	High	Aboriginal Areas Protection Authority (AAPA) Certificate. Cultural Heritage Management Plan including implementing restricted work areas and cultural protocols. Unexpected finds protocols. Monitor changes in tidal flow and sediment mobility at Catalina Island and Old Man Rock areas pre and post-construction. Close working relationship with custodians to monitor and avoid damage.	Medium

SIA theme	Phase	Social impact or opportunity	Pre-mitigation risk rating	SIA mitigation s	Post-mitigation risk rating
Economics - including jobs, industry participation, livelihoods, economic development)	Construction and Operation	Strong and more diverse economy from enabling economic infrastructure and capacity building	Noticeable (positive)	NTG's economic and investment attraction strategies to maximise benefits unlocked by the infrastructure: • collaborative strategic planning between the Marine Industry Development Plan, gas industry task force and Middle Arm master planning • a Territory Benefit Plan for the project, to maximise local industry participation and jobs • NTG to prepare an Australian Industry Participation Plan.	Beneficial (positive)
Economics (jobs, industry participation, livelihoods, economic development)	Construction and Operation	Local businesses benefit from winning work and enhanced capabilities	Imperceptible (positive)	Design and construct Contractor's local industry and Aboriginal participation plan, to meet NTG's Territory Benefit Plan. To include outline of how tenders will be packaged and promoted to suit local capacity, procurement processes that prioritise the local market and good communication of opportunities for local businesses. ICN capability mapping to highlight local capacity and address any gaps. Maritime Industry Development Plan. Industry briefings in conjunction with the NT ICN to enhance the preparedness of local businesses to win work and manage expectations. Accountability and reporting requirements for prime contractors and their sub-contractors against local participation provisions.	Noticeable (positive)
Economics (jobs, industry participation, livelihoods, economic development)	Construction and Operation	Enhanced employment and training of local people	Imperceptible (positive)	Territory Benefit Plan and contractor participation plans, including recruitment processes prioritising the local market. Maritime Industry Development Plan on workforce development. Good communication about jobs available on the Project.	Noticeable (positive)

SIA theme	Phase	Social impact or opportunity	Pre-mitigation risk rating	SIA mitigation s	Post-mitigation risk rating
Economics (jobs, industry participation, livelihoods, economic development)	Construction and Operation	Aboriginal jobs and training as a result of the Project	Imperceptible (positive)	Aboriginal Engagement Plan (required by NAIF) to maximise Aboriginal employment and Aboriginal enterprises winning work on the Project. Territory Benefit Plan to outline approach to employment and training of local Aboriginal people. Ongoing development of workforce development and skills development for the marine sector, through the Marine Industry Development Plan. Good communication about jobs available on the Project. Compliance framework to ensure accountability by contractors against commitments to employ and train local Aboriginal people.	Noticeable (positive)

10.7 Monitoring and reporting

The SIMP includes proposed monitoring and reporting requirements to ensure that the objectives of the SIMP are met. These are summarised below in relation to:

- people and communities
- cultural identity
- economies and jobs
- living environment.

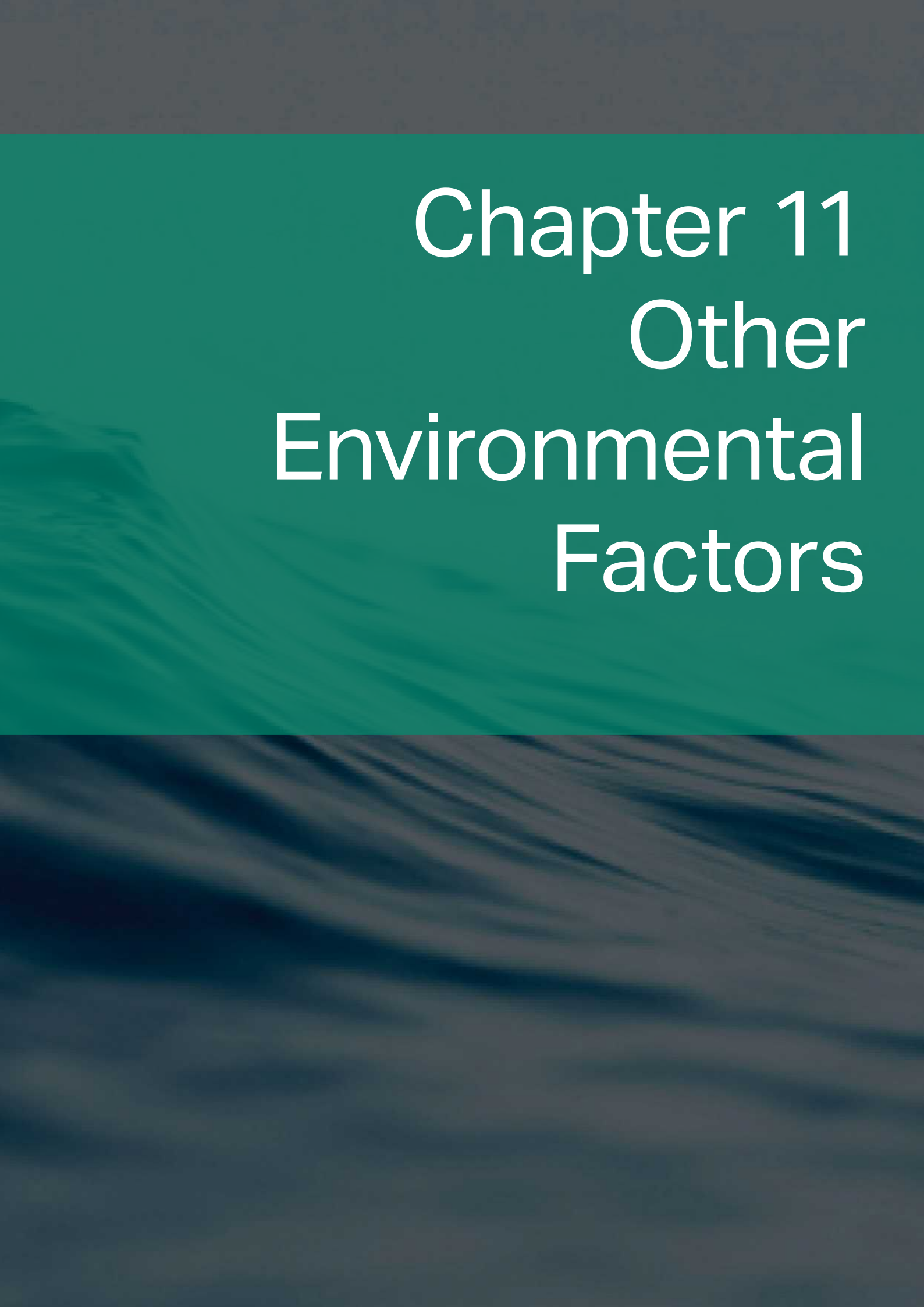
Further details can be found in Appendix C to Appendix C: Social Impact Assessment.

Table 10-6 Social impact management plan monitoring and reporting

People and Communities	• Ongoing monitoring measures in relation to vehicle and vessel traffic will be outlined in Traffic Management Plans and Marine Works Management Plans. • Records will be kept of traffic incidents involving project vehicles or vessels or identified road safety or marine navigation risk. • Construction Contractor will maintain a public inquiry line and grievance register to record and action all complaints, follow up to determine satisfaction with resolution of complaints and report to Government. • Report on implementation of NTG communication and engagement plan for construction.
Cultural identity	• Monitoring requirements specified in the Heritage Management Plan will include sediment monitoring pre and post-construction at sacred sites and Catalina 2 and 3. Monitoring requirements will also be incorporated into the DDSPMP. • Ongoing communication and monitoring of feedback from custodians and feedback from historical and heritage bodies on interpretive signage regarding World War II sites at East Arm. • The HMP also includes an unexpected finds protocol, that details reporting requirements in the unlikely event that Aboriginal or European heritage sites, human remains or UXO are encountered during construction.
Economy and jobs	• Reporting against key economic indicators: • Monitoring of the local participation commitments. • Reporting on construction jobs, proportion of new jobs, retention and skills development of workers. • Feedback from Aboriginal stakeholders, government departments and the community on participation rates and level of satisfaction with construction and operational jobs on the ship lift and in the broader marine industry. • Feedback from harbour tourism and recreational fishing organisations. • Market sounding exercises and surveys of satisfaction levels, e.g. through Chamber's Marine Industry Council. • Reporting of outcomes in line with the Marine Industry Development Plan, and other strategic plans. • Construction Contractor will maintain a public inquiry line and grievance register to record and action all complaints, follow up to determine satisfaction with resolution of complaints and report to Government.

Living environment

- Traffic impacts will be monitored as outlined in the Traffic Management Plan.
- Air quality will be monitored as outlined in the Air Quality Management Plan.
- Noise and vibration impacts will be monitored as outlined in the CNVMP.
- Construction Contractor will maintain a public inquiry line and grievance register to record and action all complaints, follow up to determine satisfaction with resolution of complaints and report to Government.
- Any incidents that have caused environmental harm, or that have the potential to cause environmental harm, will also be reported to the designated NTG representative and to NT EPA Pollution Hotline (1800-064-567) or, within 24 hours.



Chapter 11

Other Environmental Factors

11.0 Other Environmental Factors

The purpose of this chapter is to assess potential impacts to environmental matters or factors that were not specifically identified in the ToR but that have emerged during the risk assessment or during the stakeholder engagement process. These impacts are discussed in terms of the connections and interactions with other factors to ensure a holistic assessment of the potential impacts of the Project is presented.

The following additional environmental factors were identified as potentially being impacted by this Project:

- terrestrial environmental quality
- terrestrial flora and fauna
- inland waters and hydrological processes
- human health.

Whilst these additional factors were not considered to have the potential for significant impacts on the Project, they require consideration due to their potential relationship or alteration of key environmental factors. The impacts associated with these factors are summarised in Table 10-1.

Table 11-1 Other environmental factors and potential impacts

Other Environmental Factors	Potential Impacts
Terrestrial environmental quality*	Contamination of land and acid sulfate soil
Terrestrial flora and fauna*	Clearing of vegetation and habitats Noise impacts on migratory birds Introduction of weeds and feral animals
Inland waters and hydrological processes*	Surface water (stormwater) contamination Erosion and sedimentation Groundwater contamination
Human health*	Increases in biting insect populations UXO Safety of vessels and road traffic Contamination of land and soil Surface water (stormwater) contamination Groundwater contamination

* NT EPA Environmental Factors and Objectives (NT EPA, 2018).

As per the structure of the preliminary key environmental factor chapters (Chapters 7 to 10) each of the environmental factors identified above are assessed in terms of:

- NT EPA environmental factors and corresponding objectives
- existing environmental values
- potential impact and risks
- proposed mitigation measures
- residual risk.

11.1 Terrestrial Environmental Quality

The risk assessment identified the following potential impacts on land and soils in the Project site:

- spills associated with the storage, transportation and handling of chemicals, hydrocarbons and hazardous materials as well as poor waste management during both construction and operation

- potential disturbance of historical contamination in the Project area during construction
- possible presence of ASS and PASS.

It is noted that due to the hydrological characteristics of the site, impacts to land and soils also have the potential to impacts on marine environmental quality as all surface water (stormwater) and groundwater currently flows to the sea (refer Chapter 4: Environmental Setting). Impacts on the marine environment are discussed in detail in Chapter 7: Marine Environmental Quality and Chapter 8: Marine Flora and Fauna. Impacts to surface run-off and hydrology are discussed in Section 11.3 below.

11.1.1 NT EPA objectives relating to terrestrial environmental quality

The key objective associated with terrestrial environmental quality is:

Maintain the quality of land and soils so that the environmental values are maintained.

In addition to this objectives Section 27 of the *EP Act* sets out the following requirement in relation to waste management:

In designing, implementing and managing an action, all reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.

11.1.2 Existing environmental values

The Project site is currently used for a marine services business. It has a car park, site office and hardstand areas which are used to conduct marine services activities (including marine equipment and material hardstand/laydown), a works depot and marine workshop. Activities carried out on the Project site, including the storage and maintenance of marine equipment, would likely involve the use of a range of hydrocarbons, oils and degreasers, and products associated with the maintenance, cleaning and wash down of marine equipment including buoys and vessels (KBR 2020).

Portions of the site have been partially reclaimed and raised with imported clean fill from across the wider Darwin area. Fill thickness at the site is up to 8 m thick, with approximately 4 m below the high tide mark at the site, and up to 4 m above it (Appendix N: Preliminary Site Investigation).

A PSI was undertaken to assess the likelihood for potential human health or environmental risks existing at the site due to potential legacy contamination from present or historical activities. Due to the nature of the development the PSI focused on the presence or absence of contamination at the surface and did not sample at depth where ground was unlikely to be disturbed during the construction of the Project. The PSI findings indicated that surface soils did not contain contaminants (TRH, BTEXN, TBT and heavy metals) above guideline levels. Based on the available data - including interviews with site knowledgeable staff, the potential for contamination at depth is considered unlikely to pose an unacceptable risk to users at the site, or nearby ecological receptors. The PSI is included in Appendix N: Preliminary Site Investigation.

ASS are mapped as having a high probability of occurrence in the Project site. PASS are mapped as likely to occur within the intertidal flats associated with mangroves, the area between the mangrove line boundary, the proposed dredge area above mean low tide, and subtidal zones that are permanently inundated estuarine or marine areas. ASS are discussed further in Chapter 7: Marine Environmental Quality where analysis of materials to be dredged indicated that the acid neutralising capacity ranged between 19 and 231 times greater than the sum of existing and potential acidity concentrations; well within the adopted criterion of acid neutralising capacity being greater than 15 times the total acidity of samples (as per Simpson et al [2018]).

It is also noted that, during the placement of dredged material into the ponds for the Marine Supply Base and MUBRF projects:

- No evidence of ASS material was recorded during routine visual inspections of the ponds.
- There were no changes to tailwater pH to suggest the presence of ASS material within the pond system (Department of Infrastructure 2014) (AECOM 2018).

11.1.3 Potential impacts and risks

The PSI indicated that based on the available data. the potential for contamination at depth is considered unlikely to pose an unacceptable risk to users at the site, or nearby ecological receptors

during construction. The PSI also found that the site is located within a high-risk ASS area and although there is also a high acid neutralising capacity, management of potential ASS risks will still need to be considered.

Impacts on the environment and human health from poor waste management has been identified as a risk during construction and operation. Risks include the adverse effects of soil and land contamination, odour, noise and dust associated with waste management facilities (NT EPA 2015). Poor waste management practices can attract feral animals and vermin to site and result in an increase in mosquitoes at site and therefore mosquito borne diseases (refer Section 11.4). More serious health concerns can escalate through contamination of land, groundwater and adjoining surface waters (NT EPA 2015).

The wash down and blast and paint bays will have specific design features to ensure waste can be properly contained and treated. These areas will be designed so that 'at source' mechanical clean-up of solid waste material (e.g. removed biofouling in the wash-down bay, blasting grit and removed paint, including anti-fouling paint, organisms cleaned from vessels) can occur before it enters the wastewater system.

The use, storage and transportation of hydrocarbons and chemicals at site also poses a risk of contamination of land and soils, as well as groundwater and surface water. The Project will likely include the use of the following materials during its construction and operation.

- Construction - will involve the use of a range of hydrocarbons, oils and degreasers, and products associated with the maintenance, cleaning and wash down of equipment
- Operation – will involve the use of a range of hydrocarbons, oils and degreasers, and products associated with the maintenance, cleaning and wash down of marine vessels and equipment.

11.1.4 Mitigation and management

Proposed measures to mitigate impacts from hydrocarbons and hazardous goods management and waste management on site are presented in Table 11-2.

Table 11-2 Mitigation measures for terrestrial environmental quality

Phase	Aspect	Proposed mitigation measures
Construction	Loss of containment or wastes, including wastewater	• Engineering design to capture all hazardous waste and wastewater runoff. • A water treatment system (including first flush stormwater treatment) installed during Project construction. • Waste management programs which includes a routine waste management program for all waste management systems.
Construction	Disturbance of contamination, ASS, or leaching of acid water, during construction.	• An unexpected finds procedure to identify and manage contaminated materials and ASS that may be encountered during construction. • ASS Management Plan reflecting national standards and current best practice. • The mangrove area will be filled without the removal of trees to minimise risk of PASS exposure.
Construction and operation	Waste management	• Materials will be recycled wherever possible. • Waste will be segregated by type on site and collected on a regular basis by a suitably licenced contractor and disposed of at a licenced landfill. • Waste oil will be stored in an appropriate fuel storage bund prior to transportation for appropriate disposal. • Littering on site is prohibited and work and office sites are to be kept clean and tidy. • Rubbish containers are to be carried in all vehicles and provided at all work sites. • Waste management requirements will be addressed in site inductions. • Routine maintenance program will be developed for all waste management systems including wastewater management systems.

Phase	Aspect	Proposed mitigation measures
Construction and operation	Hazardous goods management	• All hazardous and dangerous goods will be handled and stored according to the Australian Standards. • Minimise use of hazardous materials where possible and use alternatives where feasible. • Delivery of hazardous materials will be in line with site use to avoid the need to store significant quantities. • Spill response procedures and availability of spill kits and training. • Contaminated runoff and contaminated soil will be collected and remediated or transported to a suitable facility for disposal.
Operation	Loss of containment or wastes (including potentially hazardous grit blast waste material, antifoulant, organisms cleaned from vessels)	• Routine maintenance for all waste management systems. • Routine maintenance of wastewater and water treatment systems with links to Biosecurity Management Plan. • Routine maintenance of stormwater management systems.

11.1.5 Statement of residual risks

Assessments of the risks of impacts on terrestrial environmental quality are summarised in Table 11-3. Risks were assessed both prior to mitigations and following the implementation of mitigation to provide and assessment of residual risk.

The residual risk assessment indicated that there is a low to medium risk of impacts on terrestrial environmental impact from chemical, hydrocarbon and hazardous goods use on site and the generation of waste.

Table 11-3 Pre and post-mitigation risk assessment in relation to terrestrial environmental quality

Phase	Aspect	Pre-mitigation risk rating	EIS mitigations	Post-mitigation risk rating
Construction	Disturbance of contamination, ASS, or leaching of acid water, during construction.	Medium	Preparation of an ASS Management Plan. Mangrove area will be filled without the removal of trees. An unexpected finds procedure to identify and manage contaminated materials if present.	Low
Construction	Loss of containment of construction wastes	High	Engineering design to capture all hazardous waste and wastewater. A water treatment system installed during Project construction. Waste management programs.	Low
Construction and Operation	Loss of containment or spills of chemicals, hydrocarbon, and hazardous substances	High	Chemical storage and handling procedures which includes minimising storage onsite. Stormwater management system. Spill response procedures including marine spill response plan and availability of spill kits and training.	Low
Operation	Loss of containment or wastes (including potentially hazardous grit blast waste material, antifoulant, organisms cleaned from vessels, removal of anodes, paint, sewage, run-off)	Moderate	Waste management programs which includes a routine maintenance for all waste management systems. Routine maintenance of wastewater and water treatment systems with links to Biosecurity Management Plan. Routine maintenance of stormwater management systems.	Low

11.1.6 Monitoring and reporting

The following monitoring waste management reporting activities are proposed during construction and operation:

- weekly inspections of the site will be conducted
- inspections of waste and wastewater management systems will be undertaken as per manufacturer requirements
- confirmation of the segregation of wastes will be included in site inspections
- volumes of waste material and recycled material will be reported via the Annual Report to the NTG
- inappropriate waste disposal will be reportable as an incident and reported as per the Construction Contractor or Operation Contractors incident reporting processes.

The following chemical, hydrocarbons and hazardous goods management reporting activities are proposed:

- inspections of storage tanks and bulk containers and the integrity of bunded areas, pavement and associated containment systems will be conducted on a monthly basis
- regular review of handling, storage and use will be undertaken and alternatives will be identified where feasible
- the results of the hydrocarbon and hazardous management program will be documented by the Operation Contractor in the sites Annual Report to the NTG.

Where an incident causes or threatens to cause pollution resulting in material or serious environmental harm the EPA must be informed within 24 hours of becoming aware of the incident as per the requirements of the *Waste Management and Pollution Control Act 1998*.

11.2 Terrestrial flora and fauna

Minimal native vegetation remains within the Project site, where it does occur it is restricted to fringing vegetation at the mangrove edges. Notwithstanding this, the risk assessment identified the potential for the Project to impact on NT's biological diversity and ecological integrity through the introduction and spread of pest and weed species via the movement of vehicles, machinery, materials and equipment onsite.

The impact assessment also identified the potential for piling activities to increase terrestrial noise and result in the disturbance to migratory birds that are known to roost at the EAW dredge spoil Pond D which is currently a protected migratory bird habitat.

11.2.1 NT EPA objectives relating to terrestrial flora and fauna

The key objective associated with terrestrial flora and fauna is:

Protect the NTs flora and fauna so that biological diversity and ecological integrity are maintained.

11.2.2 Existing environmental values

Although a number of ecological assessments have been conducted along the East Arm Peninsula and within the surrounding area of Darwin Harbour, the Project site is an industrialised and highly disturbed area as described in Section 11.1.2. The existing terrestrial ecology values of the Project area and surrounds are discussed in Chapter 4: Environmental Setting and values relevant to the Project site are summarised below.

11.2.2.1 Flora

A search of the DENR's NT Flora atlas in September 2021, shows that no native, threatened, significant, restricted flora have been recorded within the Project area.

Three introduced and weed species records were present within or adjacent to the Project site including Sandburs (*Cenchrus*), Gamba grass (*Andropogon gayanus*) and Coffee bush (*Leucaena*

leucocephala). An online search of the EPBC PMST database undertaken in on the 5 August 2021, did not identify any listed threatened flora species or communities within the search area.

A site walkover of the Project was undertaken by AECOM in September 2020 of the mangrove area (approximately 1.0 ha), located along the western edge of the Project Area. A mix of wattles, including the Northern Black Wattle (*Acacia auriculiformis*), and introduced species including Coffee Bush (*Leucaena leucocephala*) and Upland cotton (*Gossypium hirsutum*) were found to fringe the landward edge of the mangrove habitat.

The NT Weeds Record database (NRETAS Weeds Database) also notes that instances of Coffee Bush and Mission Grass have previously been recorded at the site, with a single instance of Gamba Grass recorded within the Berrimah Road Corridor leading to the entrance of the Project area. Mission Grass and Gamba Grass are declared weeds in the NT, with Gamba Grass also classed as a WoNS (KBR 2018).

Weeds and introduced species recorded during a site visit in September 2020 are listed in Table 11-4 and Table 11-5 respectively. This table includes their current declaration under the *Weeds Management Act 2021* (NTG 2021).

Table 11-4 Weed species recorded at the Project site

Species	Common name	NT declared weeds classification	Comments
<i>Andropogon gayanus</i>	Gamba grass	Class B	1 x tussock
<i>Hyptis suaveolens</i>	Hyptis	Class B	1 x plant
<i>Sida acuta</i>	Spiny head sida	Class B	1 x plant
<i>Sida cordifolia</i>	Flannel weed	Class B	Small patch

Table 11-5 Introduced species recorded at the Project site

Species	Common name	Comments
<i>Cenchrus pedicellatus</i>	Mission grass	Dominant
<i>Chloris barbata</i>	Purple top chloris	Dominant
<i>Tridax procumbens</i>	Tridax daisy	Dominant
<i>Leucaena leucocephala</i>	Coffee bush	Scattered
<i>Gossypium hirsutum</i>	Upland cotton	Small patch on edge of mangroves
<i>Melinis repens</i>	Natal grass	1 x plant
<i>Urochloa mosambicensis</i>	Urochloa grass	1 x plant

11.2.2.2 Fauna

The DENR NT Fauna atlas recorded sightings of both the Green turtle (*Chelonia mydas*) and the Flatback turtle (*Natator depressus*) at the Project site. Although these species are listed as vulnerable under the EPBC Act neither of are listed under NT legislation (for further information on marine flora refer to Chapter 8: Marine Flora and Fauna).

A total of 38 terrestrial and marine threatened species (under the EPBC Act) were identified as potentially occurring or having habitat potential occurring in the Project Area from the PMST report undertaken in August 2021. The majority of these species were considered unlikely to occur as no suitable habitat occurs in the Project area (refer Chapter 4: Environmental Setting).

Past studies adjacent to the Project site identified that some of the EAW settlement ponds provide high tide foraging and roosting sites for birds (EMS 2011). The most significant sightings of threatened and migratory shore birds occurred within settlement Pond D, this is considered the most usable and high value habitat within the East Arm area. The location of these ponds in relation to the site are

shown in Figure 2-6. It is considered likely that threatened shorebirds may opportunistically visit the small area of intertidal mudflats within the Project area at low tide when moving between more preferred habitats. These comprise:

- Red knot (*Calidris canutus*)
- Curlew sandpiper (*Calidris ferruginea*)
- Great knot (*Calidris tenuirostris*)
- Eastern curlew (*Numenius madagascariensis*)
- Lesser sand plover (*Charadrius mongolus*)
- Greater sand plover (*Charadrius leschenaultia*)
- Nunivak Bar-tailed godwit (*baueri*) (*Limosa lapponica baueri*).

11.2.3 Potential impacts and risks

The risk of potential impacts on native flora and fauna within the Project site is considered low due to the high level of disturbance at the site. There is however a risk of introducing weeds and pest species that may escape beyond the Project area through the movement of vehicles, vessels, equipment and materials both during construction and operation, including the risk of weeds and pests being transported to the site via marine vessels. Management practices to prevent the introduction and spread of weeds and pests during construction will be managed through mitigation measures administered under the CEMP. Biosecurity management during the operation of the site is addressed in Chapter 8: Marine Flora and Fauna.

Piling activities will cause a temporary increase in terrestrial noise during construction and result in the disturbance to migratory birds that are known to roost at the EAW dredge spoil (Pond D) which is the preferred habitat location for migratory bird species at EAW.

Noise and lighting impacts associated with the construction and operation of the facility are considered unlikely to impact the species while they utilise Pond D and the surrounding suitable intertidal habitats, as the most substantial noise and lighting generating activities (e.g. pile driving and pond wall placement) will occur over 500 m from the Pond D. The works are also separated from Pond D by Berrimah Road, earthen bunds and stockpiles in the port land which provide a noise and lighting barrier and are located in an area surrounded by industrial infrastructure which operates 24 hours a day and generates both noise and lighting impacts.

There are also extensive intertidal mudflats located in the broader East Arm area. It is estimated that, there are over 800 ha of intertidal mudflat within 3 km of the Project area. These areas are sufficiently separated from areas of industrial activity and traffic to provide suitable habitat for shorebirds during the different tidal phases. The larger intertidal areas provide more suitable foraging and roosting habitat for shorebird species which are not frequently subject to noise, traffic and human disturbances.

It is noted that there is a potential for impacts on flora and fauna at or surrounding the Project area from contamination of land, soil and stormwater. Given that there is minimal vegetation on site these potential impacts are discussed in Sections 11.1: Terrestrial Environmental Quality and 11.3: Inland Waters and Hydrological Processes.

11.2.4 Mitigation and management

Table 11-6 Mitigation measures for terrestrial flora and fauna

Phase	Proposed mitigation measures
Construction	• Management practices to prevent the introduction and spread of weeds and feral animal species will be included in the CEMP. This will be linked to the Biosecurity Management Plan as appropriate to prevent the introduction of weed or feral/pest species via vessels as appropriate. • Adoption of suitable construction methodologies to minimise impacts from pile driving noise, including monitoring and reactive management protocols to reduce risk of impacts to protect fauna from noise impacts during construction. • Develop and implement a CNVMP to support the EMP.
Operation	• Management practices to prevent the introduction and spread of weeds and pests during construction will be managed through mitigation measures administered under the CEMP. This will be linked to the Biosecurity Management Plan during operation and administered under the OEMP to prevent the introduction of weed or feral/pest species via vessels as appropriate.

11.2.5 Statement of residual risks

Assessments of the risks of impacts on terrestrial flora and fauna are summarised in Table 11-7. Risks were assessed both prior to mitigations and following the implementation of mitigation to provide an assessment of residual risk.

The residual risk assessment indicated that after the application of the proposed mitigation measures the risk of impacts on terrestrial flora and fauna from construction are considered to be low. The movement of vessels during operation poses a medium risk due to the potential of introducing weeds and pests from outside of the region. Proposed pest and weed control measures will be incorporated into the OEMP and linked to the Biosecurity Management Plan (Chapter 13: Environmental Management Framework) as appropriate. These measures will cover both the movement of vehicles and vessels. Marine biosecurity measures are discussed in further detail in Chapter 8: Marine Flora and Fauna.

Table 11-7 Pre and post-mitigation risk assessment for terrestrial flora and fauna

Phase	Aspect	Pre-mitigation risk rating	EIS mitigations	Post-mitigation risk rating
Construction	Impacts on migratory birds known to roost on Pond D at EAW from pile driving activities	Low	Adoption of suitable construction methodologies to minimise impacts from pile driving noise. Preparation and implementation of a CNVMP to support the CEMP.	Low
Construction	Spread of introduced weed species and pest species from movement of vehicles, vessels, machinery, materials and equipment	Medium	Management practices to prevent the introduction and spread of weeds to be included in the CEMP and linked to the Biosecurity Management Plan as appropriate.	Low
Operation	Spread of introduced weed and pest species movement of vessels, machinery, materials and equipment	Medium	Management practices to prevent the introduction and spread of weeds to be included in the OEMP and linked to the Biosecurity Management Plan as appropriate.	Low

*While mitigation measures will be implemented to reduce the likelihood of this risk, the consequence of this aspect occurring is still moderate. As such the rating has not changed.

11.2.6 Monitoring and reporting

The following monitoring and reporting activities are proposed:

- weekly site inspections
- reporting on environmental incidents including incursions of weed, pest and feral species
- weed and pest monitoring as required in the Biosecurity Management and Monitoring Plan.

11.3 Inland Water Quality and Hydrological processes

Stormwater runoff is a major contributor of sediment, nutrients and toxicants to Darwin Harbour (NT EPA 2014). The Project has the potential to impact on surface water and groundwater quality through the mobilisation of sediments and contaminants during rainfall and storm events.

The primary sources of potential stormwater pollutants during the construction phase will be disturbed soils, storage of hydrocarbons and hazardous substances, and vehicle usage on site. During the operational phase, potential contaminants in stormwater will vary depending on the type of business' occupying the site, associated activities undertaken, and products stored.

Refer to Appendix N: Preliminary Site Investigation. for further information on chemicals likely to be used and stored on site.

11.3.1 NT EPA objectives relating to surface water and hydrology

The key objectives associated with inland water quality and hydrological processes are:

Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and the welfare and amenity of people are protected.

Maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.

11.3.2 Existing environmental values

The groundwater hydraulic gradient is expected to follow surface topography with flow toward the Harbour waters from areas of elevation. The topography and mangrove vegetation in the southern portion of the site suggests that the groundwater level remains relatively close to, or at, the surface year-round, with a progressive lowering of the water table expected throughout the dry season (May to October). Near-shore groundwater levels are likely to be influenced by tides, which range up to 8 m (KBR 2018).

The quality of groundwater is typically saline to hyper saline and not suitable for drinking or irrigation. The high salinity is likely due to the proximity to the landward salt-water intrusion and dissolution of salts derived from marine sediments (KBR 2018).

Surface runoff at the Project site is entirely modified and occurs as sheet flow across gravelled or paved surfaces collected in minor constructed flow channels which drain southwards to the Harbour. These drainage channels only carry water flow during and immediately after rainfall and do not contain persistent standing water (KBR 2018).

11.3.3 Potential impacts and risks

Potential impacts upon inland water and hydrological processes associated with the Project include:

- discharge of sediment and contaminants from exposed soil and vehicle movement during earthworks/construction
- contamination of groundwater systems from chemicals and hydrocarbons spills on soil surfaces or discharges of contaminants such as heavy metals and organic compounds
- chemical or hydrocarbon spills on impervious surfaces resulting in discharge of contaminated stormwater
- discharge of contaminants such as heavy metals and organic compounds in stormwater runoff from impervious surfaces

- increased peak flow rate of stormwater discharges due to increase in impervious areas resulting in erosion around stormwater outfalls (damaged infrastructure) and reduction of surface water infiltration to groundwater.

The overall management of stormwater and potential contaminants mobilised in runoff and wash down waters is a key requirement of the design process. The facility design will ensure containment and/or treatment of wastewater and stormwater prior to discharge from the site.

Stormwater runoff which collects on the general use hardstand areas will be separated into 'clean' and affected runoff. The 'clean' runoff (e.g. roof water not captured for use) will be allowed to drain to the marine environment. The affected runoff will be captured and treated using routine inline WSUD principles and inline treatment such as the removal of solids and hydrocarbons (e.g. via GPT's) before being discharged to sea.

Process and wash water from higher risk areas (wash-down bay and blast and paint bay) will be captured, treated and re-used. Excess re-cycled wastewater beyond re-use requirements will be disposed of to an approved offsite facility, for example to sewer under a trade waste agreement.

No water will leave the site without appropriate treatment consistent with the principles of WSUD. ESCPs will be developed and implemented for areas that will be disturbed during construction and operation and to ensure that drainage designs prevents do not erosion at stormwater discharge locations.

A DDSPMP will be developed to manage potential risk of surface water contamination in relation to the management of dredge spoil. This is discussed further in Chapter 8: Marine Environmental Quality.

11.3.4 Mitigation and management

Table 11-8 Mitigation measures for inland waters and hydrological processes

Phase	Proposed mitigation measures
Construction	• Project design to incorporate stormwater outfall structures with appropriate low velocity minimisation and energy dissipation measures. • Adopt suitable construction methodologies to contain reclamation material. • Ensure that on-site activities are carried out by such practicable means necessary to minimise the contact of incidental rainfall and stormwater runoff with wastes or other contaminants. • Develop and implement an ESCP for areas to be disturbed during construction and operation. • Develop and implement a DDSPMP. • Install operate and maintain stormwater drainage system and stormwater treatment devices. • Implement spill and leak prevention and control techniques for land-based activities. • Ensure appropriate spill kits are available and provide training on kit use. • Ensure spillage of wastes, contaminants or other materials are cleaned up as quickly as practicable using procedures that prevent contaminants or material being transferred to the stormwater drainage system. • Implement bunded areas and drainage lines separate from the stormwater drainage in chemical storage and handling areas to reduce the likelihood of chemical contamination of stormwater.
Operation	• Ensure rainfall runoff from the bays is captured and treated, consistent with the principles of WSUD. • Contain, and where possible treat and reuse wastewater from wash down and blast and paint bays. • Undertake 'at source' mechanical clean-up of solid waste material to minimise entry to the wastewater system. • Operate and maintain wastewater treatment system and stormwater drainage system and stormwater treatment devices. • Inspect wastewater and stormwater system for the Project weekly to identify any failures and, if necessary, repairs shall be undertaken.

Phase	Proposed mitigation measures
	• Ensure treated wastewater in excess of what can be re-used will be disposed to sewer under a trade waste agreement. • Implement spill and leak prevention and control techniques for land-based activities. • Ensure appropriate spill kits are available and provide training on kit use. • Any spillage of wastes, contaminants or other materials shall be cleaned up as quickly as practicable using procedures that prevent contaminants or material being transferred to the stormwater drainage system. • Install bunded areas and drainage lines separate from the stormwater drainage in chemical storage and handling areas to reduce the likelihood of chemical contamination of stormwater. • Delivery of hazardous materials will be in line with site use to avoid the need to store significant quantities.

11.3.5 Statement of residual risks

Assessments of the risks of impacts on inland water and hydrological processes are summarised in Table 11-9. Risks were assessed both prior to mitigations and following the implementation of mitigation to provide an assessment of residual risk.

The residual risk assessment indicated that there is a medium risk of discharge of sediments and contaminants associated with earthworks and a low risk of contamination of land, stormwater and groundwater due to loss of containment or spills of chemicals, hydrocarbons and hazardous substances.

Table 11-9 Initial and residual risk assessment for inland water and hydrological processes

Phase	Aspect	Risk rating	EIS mitigations	Risk rating
Construction	Discharge of sediments and contaminants from exposed soils	High	Preparation of a CEMP containing an ESCP reflecting relevant Australian Standards including the use of silt curtains. Unexpected finds protocols for contamination and ASS Stormwater management system.	Medium
Construction	Loss of containment or spills of chemicals, hydrocarbons and hazardous substances	High	Chemical storage and handling procedures including minimising hazardous materials stored on site. Stormwater management system. Spill response procedures including marine spill response plan and availability of spill kits and training.	Low
Construction	Increased peak flow rate of stormwater discharges due to increase in impervious areas	Medium	Project design and drainage strategy to incorporate stormwater outfall structures with appropriate energy dissipation measures. Ongoing monitoring and maintenance of stormwater systems.	Low
Operation	Loss of containment or spills of chemicals, hydrocarbons and hazardous substances	High	Contain, treat and reuse wastewater from wash down and blast and paint bays and manage solid waste material to system. Ongoing monitoring and maintenance of wastewater treatment system and stormwater management system. Chemical storage and handling procedures including minimising hazardous materials stored on site. Spill response procedures including marine spill response plan and availability of spill kits and training.	Low

11.3.6 Monitoring and reporting

The following monitoring and reporting activities are proposed:

- weekly inspection of stormwater system and drains
- monitor and manage surface water from within the reclamation and material handling areas to meet appropriate water quality criteria before it is discharged to the marine environment
- where an incident causes or threatens to cause pollution resulting in material or serious environmental harm the NT EPA must be informed within 24 hours of becoming aware of the incident as per the requirements of the *Waste Management and Pollution Control Act 1998*.

11.4 Human Health

The environmental impact assessment identified the potential for the Project to impact on human health via potential increases in biting insects populations and mosquito borne diseases and potential disturbance of UXO. It is noted that the following may also have the potential to impact upon human health:

- contamination of land, soil, stormwater and ground water
- air emissions
- collisions with vehicles or vessels.

The impacts of contamination are discussed above in terms of terrestrial environmental quality, and hydrological processes (refer Sections 11.1 and 11.3) and also in detail in Chapter 7: Marine Environmental Quality. Air emissions also have the potential to have adverse impacts on human health. Air quality and emissions are discussed in detail in Chapter 9: Air Quality and Greenhouse Gas Emissions. The management and mitigation of these impacts are also discussed in Chapter 13: Environmental Management Framework.

Road safety is discussed in Appendix L: Traffic Impact Assessment, with findings suggesting the Project will likely have a low impact to existing traffic conditions. Vessels using the Project site will need to adhere to Darwin Port Harbourmaster requirements which define speed limits and navigational procedures.

11.4.1 NT EPA objectives relating to biting insects

The key objectives associated with biting insects are:

Ensure that risks to human health are identified, understood and adequately avoided and/or mitigated.

11.4.2 Existing environmental values

As discussed in Chapter 4: Environmental Setting, biting insect sites are common on constructed surfaces, such as stockpile hardstands and ponds along the peninsula. The East Arm Port Area contains numerous mosquito breeding sites created by the original development, with notable sites including the large mud ponds, shallow depressions on reclaimed land and on an extensive site used for borrow material, small sediment traps and numerous drainage lines (KBR 2018).

Routine weekly mosquito trapping conducted by Medical Entomology – Department of Health Northern Territory, was previously conducted within the Project area from February 2009 to February 2010. A number of mosquito species were recorded near the boat ramp in seasonally very high numbers during the wet season months (KBR 2018).

Feedback from the Medical Entomology Branch during early consultations on the Project highlighted that proposed option of dredge disposal into dredge Ponds K or E (north) has the potential to create an additional very large mosquito breeding site in the area. Currently other ponds in the area that were historically used for dredge disposal, are large sources of pest and potential disease carrying mosquitoes (Pers comm. Medical Entomology, 2021). This is particularly relevant to Pond D which is a preferred habitat at East Arm for migratory birds. Protection of this pond has resulted in the preservation of a very large mosquito breeding site, posing a local mosquito borne disease risk to

workers, and a risk of transporting local disease carrying mosquitoes overseas (Pers comm. Medical Entomology, 2021).

In order to prevent the creation of an additional large mosquito breeding site, as has occurred at Pond D, Pond K or E would need to be rendered clear of all residual surface ponding upon completion of works (Pers comm. Medical Entomology, 2021). This management measure is expected to be a priority for the Port of Darwin to manage impacts to human health.

The NT Department of Health has developed a number of guidelines to assist in managing biting insect populations. These include:

- *Construction Practice Near Tidal areas in the Northern Territory - Guidelines to Prevent Mosquito Breeding* (Department of Health, 2017)
- *Guidelines for Preventing Biting Insect Problems for Urban Residential Developments or Subdivisions in the Top End of the Northern Territory* (Department of Health, 2014).
- *Constructed Wetlands in the Northern Territory – Guidelines to prevent mosquito breeding* (Department of Health and Families 2008).

As there are no effective broad scale biting midge control methods, workers will be required to protect themselves via personal protection measures, including protective clothing and insect repellents.

The potential for UXO was assessed through desktop searches of UXO databases (G-TEK 2017) and assessment of previous studies in the area which also included the removal of potential UXO artefacts (Cosmos Archaeology 2015). Studies commissioned to inform the construction of the adjacent MUBRF channel also covered the Project area, these studies used a magnetometer and dive teams to identify and remove potential UXO artefacts, finding ammunition from 1942 (Cosmos Archaeology, 2015). No larger UXO, such as maritime bombs, torpedoes or mines were found or recovered (Cosmos Archaeology, 2015).

A second survey was also undertaken which did not recover any UXO in the Project area (Cosmos Archaeology, 2017). These studies are discussed further in Chapter 4: Environmental Setting and Appendix M: Cultural Heritage Assessment.

11.4.3 Potential impacts and risks

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 (Northern Territory Coastal Management Committee [CMC], 1988). Stormwater management is integral to prevent the ponding of water and creation of mosquito breeding sites. This is discussed in Section 11.3 above. It is also noted that mosquito breeding sites pose a risk to passengers at the nearby rail terminal, and potential quarantine issues, in regard to international health regulations (Warchot and Whelan, 2011). A Biting Insect Management Plan will be developed in accordance with NT Department of Health Guidelines to prevent the creation of biting insect breeding sites and manage and monitor populations as required.

The Medical Entomology Branch of NT Health has advised that there is currently no routine mosquito control program at East Arm. With a projected increase in workers close to the mud ponds, future biting insect complaints can be expected, and landowners will be required to conduct mosquito control, until such time that the ponds are fully reclaimed for development. Without management it is most likely that the mosquito risk will increase in the medium to longer term, when the mud ponds no longer receive dredge material and have settled and are beginning to grow vegetation.

If required the Darwin Port dredge ponds are used for disposal of dredge materials, the Biting Insect Management Plan will outline measures to minimise shallow, residual ponding in the ponds receiving dredge spoil. If residual ponding for > 4 days is required for sediment settlement, there will be a mosquito surveillance program implemented to ensure mosquito breeding is detected and controlled until such time that residual ponding is no longer present. The management plan will also include future remediation measures to be implemented, in case of residual surface water ponding occurring, caused by further subsidence, vegetation growth blocking drains or other factors (Pers comm. Medical Entomology, 2021).

Although there is a risk of injury to workers or fauna and damage to equipment in relation to disturbance of UXO, past UXO surveys reduce the risk of finding additional UXO to unlikely. However, these findings do not completely preclude the risk of future finds during construction. To address this risk a UXO risk assessment will be undertaken by the Construction Contractor prior to the commencement of construction works.

11.4.4 Mitigation and management

Table 11-10 Mitigation measures for biting insects

Phase	Aspect	Proposed mitigation measures
Construction	Biting Insects	• Designs and stormwater management plans to include a drainage strategy that prevents water from ponding and becoming a breeding site.
Construction	Disturbance of UXO	• Cultural Heritage Assessment (Appendix M) including liaison with NT Heritage Branch regarding UXO surveys undertaken to date. • UXO risk assessment to be undertaken prior to construction works. • UXO to be incorporated into the unexpected finds procedure.
Operation	Biting insects	• Develop and implement a biting insect management plan in accordance with NT Department of Health Guidelines. • Site inspections to identify to potential breeding sites. • Monitor impacts associated with disposal of dredge spoil to land (if required). • Ensure Biosecurity Management Plan includes requirements in relation to mosquitoes and international health regulations.

11.4.5 Statement of residual risks

Assessments of the risks of impacts on human health from biting insects are summarised in Table 11-11. Risks were assessed both prior to mitigations and following the implementation of mitigation to provide and assessment of residual risk.

The residual risk assessment found that with the above controls risk of increased biting insect populations and breeding sites as a result of construction and operation of the Project will be reduced from medium to low. Development and implementation of an effective Biting Insects Management Plan in consultation with the Medical Entomology Branch of the NT Department of Health (as required) will be essential in managing this potential risk during both the construction and operation phases of the Project.

The residual risk of disturbance or detonation of UXO is considered unlikely based on findings of previous studies, however the consequences could potentially be major. In response, Construction Contractors will be required to undertake a UXO risk assessment prior to the commencement of construction works and incorporate UXO into unexpected finds procedures to reduce this risk from high to low.

Table 11-11 Initial and residual risk assessment for biting insects

Phase	Aspect	Risk rating	EIS mitigations	Risk rating
Construction	Increase in biting insect populations and associated health risks to workers and community	Medium	Designs and stormwater management plans to include a drainage strategy. Biting Insect Management Plan compliant with NT Medical Entomology guidelines. Monitor impacts associated with disposal of dredge spoil to land (if required). Ensure Biosecurity Management Plan includes requirements in relation to mosquitoes and international health regulations	Low
Construction	UXO detonation disturbance or detonation	High	Heritage assessment including liaison with Heritage Branch regarding historical activities and surveys for UXO (Appendix M: Cultural Heritage Assessment). UXO to be incorporated into unexpected finds procedures. UXO risk assessment to be undertaken prior to construction works.	Low
Operation	Increase in biting insect populations and associated health risks to workers and community	Medium	Biting Insect Management Plan compliant with NT Medical Entomology guidelines. Ensure Biosecurity Management Plan includes requirements in relation to mosquitoes and international health regulations.	Low

11.4.6 Monitoring and reporting

The following monitoring and reporting activities are proposed:

- site inspections to identify potential mosquito breeding sites
- any significant mosquito activity will also be reported to DIPL and/or the Medical Entomology Branch and monitored if risks to human health are identified
- if Darwin Port dredge ponds are to be utilised for dredge materials, a biting insect surveillance program will be developed and implemented as part of the dredge management program. If residual ponding for greater than four days is required for sediment settlement, this program will be designed to ensure mosquito breeding are detected and controlled until such time that residual ponding is no longer present. Results of the biting insects management and surveillance program will be documented in the Annual Report to DIPL.
- if UXO are found in the Project the NT Police should be contacted as per the unexpected finds protocol.

Chapter 12

Cumulative Impacts

12.0 Cumulative Impacts

12.1 Introduction

When numerous projects occur in close proximity to each other they have the potential to create cumulative impacts, both positive and negative. Cumulative impacts and opportunities differ from those of individual projects when considered in isolation. The severity and/or duration of the impact or benefit will depend on the spatial and temporal overlap of projects in an area. Cumulative impacts and benefits may accumulate over time and exacerbate or enhance the scale, frequency, intensity or duration of impacts and benefits, both in isolation, or in combination with other existing or planned projects.

The purpose of this cumulative impact assessment is to present information on the potential cumulative impacts and opportunities of the Project. This section provides a summary of the cumulative impact assessment undertaken for each of the key factors identified in the ToR in the context of existing environmental values and reasonably foreseeable future developments.

12.2 Assessment methodology

The cumulative impact assessment is based on a desktop review of other projects in the Darwin area and have the potential to cumulatively impact on the any of the four key preliminary environmental factors identified in the ToR, being:

- marine environmental quality (Section 12.3)
- marine flora and fauna (Section 12.4)
- air quality and greenhouse gases (Section 12.5)
- social economic and cultural surroundings (Section 12.6).

For example, projects that have the potential to impact on water quality or amenity of the Darwin Harbour, or projects that might compete for resources such as workforce.

The area over which cumulative impacts and opportunities were considered was determined by the specific nature of the environmental aspect being assessed (refer Chapters 7 to 10).

The assessment criteria included:

- projects that have commenced construction
- projects that have been approved but construction has not commenced
- projects that are currently being assessed.

Existing projects were not included in the cumulative impact assessment as they are assessed as part of the existing environmental values. Existing environmental values are described in Chapter 4 Environmental Setting and the environmental values section of each of the preliminary key environmental factors chapters (Chapters 7 to 10).

Given the Project's relatively short development timeframe the cumulative impact assessment excludes proposed projects that have not been developed to the point that their environmental assessment process has been made public.

A register of relevant projects is provided in Table 12-1 which considers potential spatial and temporal interaction. Where a potential overlap in impacts (either spatially or temporally) was identified then cumulative impacts were considered within technical investigations to determine the nature of the cumulative impact. Potential temporal and spatial overlaps are listed against each of the Projects included in the cumulative impact assessment.

Other environmental factors that have the potential to cause environmental impacts are also considered to a lesser degree and noted in Table 12-1. It is noted that each of these potential impacts are discussed further in Section 12.6 and the SIA that supports the EIS (Appendix C: Social Impact Assessment). Figure 12-1 shows the location of projects considered in the cumulative impact assessment in relation to the Project.

Table 12-1 Relevant Projects considered for potential cumulative impacts

Project Name and Proponent	Location	Description	Approval status	Development Timeframe	Spatial / temporal	Considerations	Relevance
HMAS Coonawarra and Larrakeyah Defence Precinct Redevelopment (Dept of Defence)	Larrakeyah	Construction of new wharf, fuel tanks, buildings, entry and upgrades of services	Under construction	2020 - 2024	Temporal	- Marine water quality - Marine ecology - Socio-economic – labour, amenity	This project was included due to potential cumulative impact upon the Darwin Harbour both from an ecological and potential competition for labour
Northcrest Residential Development (Northcrest NT)	Berrimah Farm	Staged new residential development and neighbourhood facilities with connection to Stuart Highway. Stage 1 complete	- Approved - Staged development by DA according to market conditions	Ongoing. Market driven. Stage 2 planning underway. 11 stages over 15 years	Temporal	- Air quality - Socio-economic - traffic, noise	This project was included as it is potentially a sensitive receptor for dust and noise, and for potential cumulative traffic impacts
Middle Arm Industrial Precinct – civil enabling works	Middle Arm Peninsula (Kittyhawk Estate)	Civil enabling works for three industrial lots (Stage 1) completed late 2020. Later stages either by DA or EIA process	Approved by DA	2020-2030	Temporal	- Marine environmental quality - Marine flora and fauna - Air quality - Socio-economic - traffic, labour, amenity	This project was included due to potential cumulative impacts upon the Darwin Harbour from construction (sediment), dust and potential competition for labour. There is also a potential for cumulative traffic impacts

Project Name and Proponent	Location	Description	Approval status	Development Timeframe	Spatial / temporal	Considerations	Relevance
Rustlers Roost and Quest 29 Redevelopment (Primary Gold)	Mount Bunday	Mining and processing gold at existing care and maintenance sites	Preparing Draft EIS	2022 - 2029	Temporal	Socio-economic – traffic (Mt Bunday quarry), labour	This project was included due to potential cumulative impacts associated with traffic in relation to transportation of materials from construction as well as potential competition for labour
Finniss Lithium Project (Core Lithium)	Bynoe, Cox Peninsula	Mining of lithium-rich ore from several defined deposits with ore/concentrate transported to EAW by road trains	- Mine Management Plan approved April 2020 - Federal Government awarded Major Project Status (March 2021)	2021 – 2024 (Grants and BP33 deposits) Longer-term development potential	- Temporal - Spatial	Socio-economic – traffic, labour	This project was included due to potential competition for labour and traffic. Ore will be transported to EAW by road trains
Wishart Estate (Land Development Corporation)	Wishart Road / Tiger Brennan Drive	Truckstop development and service station complete. Construction of light industrial estate and new roads in staged process. Focus to develop the area as a data services centre	- Notice of Intent approved 2014 - Staged development by DA process	Ongoing. Market driven	- Temporal - Spatial	- Air quality - Socio-economic – traffic, amenity	This project was included due to potential cumulative impacts on air quality from dust generation during construction and impacts on traffic. There is also a potential for competition for labour

Project Name and Proponent	Location	Description	Approval status	Development Timeframe	Spatial / temporal	Considerations	Relevance
Middle Arm Industrial Precinct – long term expansion / development	Middle Arm Peninsula (Spitfire Estate and adjacent blocks)	600-hectare precinct for large strategic industries for downstream gas processing and gas related industries, with potential further development adjacent blocks along Channel Island Road and Jenkins Road	Formal EIA process to be undertaken	By 2030	Spatial	- Marine water quality - Marine ecology - Air quality - Socio-economic, - traffic, labour, amenity	This project was included due to potential impacts upon the Darwin Harbour from construction (sediment), cumulative impacts on water quality (dredging), air quality (dust and pollutants) and competition for labour. There is also a potential for cumulative traffic impacts
Mandorah Jetty Redevelopment (Department of Infrastructure, Planning and Logistics)	Mandorah, Cox Peninsula	Construction of new ferry terminal and recreational boat ramp requiring construction of new breakwaters and dredging program	Referral to be lodged	2021-2024	Temporal	- Marine water quality - Marine ecology - Socio-economic – noise and amenity	This project was included due to potential cumulative impacts on marine water quality and ecology from construction and dredging, and impacts from noise (piling) and visual amenity in the Darwin Harbour

Project Name and Proponent	Location	Description	Approval status	Development Timeframe	Spatial / temporal	Considerations	Relevance
Australia-ASEAN Power Link Project (Sun Cable)	Elliott / Middle Arm Peninsula / Darwin Harbour	Capture of solar energy through solar array plant near Elliott. Power transferred to battery at Murrumujuk then submarine high voltage direct current (HVDC) cable to Singapore, where possible following existing cable and pipeline corridors	Draft EIS in development	Construction 2023 - 2027, subject to approvals and funding	- Temporal - Spatial	- Marine water quality - Marine habitat - Socio-economic - labour	This project was included for potential impacts upon the marine environment and marine flora and fauna from construction of the underwater cable links and competition for labour

Sources: DIPL (2021), LDC (2020, 2021), NT EPA (2020b, 2021)



PROJECT ID 60633505 CREATED BY PK APPROVED BY HS LAST MODIFIED 19 OCT 2021 AECOM www.aecom.com 1:208,706 when printed at A4 DATUM GDA 1994, PROJECTION MGA ZONE 52 0 2,100 4,200 6,300 8,400 Metres Data sources: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).	LEGEND ■ Project footprint ■ Projects considered in the cumulative impact assessment	Projects considered for cumulative impacts NORTHERN TERRITORY GOVERNMENT OF AUSTRALIA DARWIN SHIP LIFT PROJECT Figure 12-1

12.3 Marine environmental quality

Due to the location (spatial context) of the Project within Darwin Harbour, risk assessments identified increased turbidity associated with dredging as most likely to have cumulative impacts on marine environmental quality during construction, though only if dredging occurs concurrently with, or within a short period of time from, dredging carried out for another project.

Cumulative impacts with currently operating facilities in the immediate vicinity of the Project site (EAW, MSB, MUBRF and other marine services facilities in East Arm) are unlikely to occur as there is currently no maintenance dredging planned at these facilities. Similarly, concurrent dredging is unlikely to occur with any of the Projects listed in Table 12-1, nor will these projects occur in close proximity. In addition, it is more likely that one dredge will undertake multiple projects sequentially, rather than multiple dredges operating concurrently, due to the costs of mobilisation.

Maintenance dredging associated with the INPEX operations in Darwin Harbour may occur over the next two years. Should this dredging be undertaken concurrently with the proposed Project dredging campaign, there is a chance that the zones of impact and influence may overlap.

Modelling presented in the Maintenance Dredging and Spoil Disposal Management Plan (INPEX 2018) suggests that, for the worst case scenario (expected to last for a period of 15 – 29 days), maintenance dredging carried out by INPEX may generate turbid plumes that intersect with the outer limit of those predicted by the Projects dredge modelling. The 95th percentile dry season model outputs for INPEX maintenance dredging predict a potential for SSC of up to 5-10 mg/L which overlaps with a small area adjacent to the MSB, and south of the Project site where excess SSC generated by the Project dredging may reach 2 – 3 mg/L.

Given that the modelled SSC for INPEX maintenance dredging is predicted to overlap in an area close to the 0-5 mg/L contour for that dredging program, it is reasonable to assume that the 95th percentile SSC associated with the INPEX dredging would be closer to 5 mg/L in this area of overlap. Based on this, it is likely that the cumulative 95th percentile SSC for the Project and INPEX dredging may exceed 10 mg/L by a small amount, for short periods of time, if the most intensive dredging is carried out by INPEX at the same time as dredging is occurring at the Project site.

As this area of potential cumulative impact does not overlap with coral or seagrass habitats, the impacts are expected to be short lived and localised in nature, with recovery expected in line with the description of Zone of Moderate Impact provided in Chapter 7: Marine Environmental Quality.

All dredging programs undertaken in Darwin Harbour require Developmental Consent and an approved DDSPMP. As such the impacts and proposed measures to manage and mitigate these impacts will be considered by regulators. Stakeholders will be given an opportunity to comment on these proposed programs as part of the approval process. Furthermore, in response to the NT EPA's concern regarding cumulative impacts of dredging within Darwin Harbour, and the fact that there are several developments planned in the near future, the NTG have commenced the development of a Darwin Harbour Dredging Strategy that aims to provide a framework for sustainable, leading practice management of dredging in Darwin Harbour. The Dredging Strategy will be undertaken concurrently with the assessment of this EIS, and whilst it may not be finalised prior to the finalisation of the EIS assessment process, it is anticipated to be complete prior to any dredging for the Project. The Project intends to undertake any dredging in line with the Darwin Harbour Dredging Strategy.

Cumulative impacts to marine environmental quality associated with the ongoing operation of the facility are not expected to generate additional impacts when combined with those associated with existing industries in the region, due to:

- the inbuilt environmental management and mitigation measures
- the relatively minor incremental increase in vessel activity through the operational phase of the Project when compared to existing vessel traffic in this part of Darwin Harbour
- development of a Darwin Harbour Dredging Strategy.

12.4 Marine flora and fauna

It is recognised that, when considered in conjunction with other approved or planned projects within Darwin Harbour, the Project presents sources of potential impacts upon marine flora and fauna that may be additive to those from the other projects. However, it is also considered that the risks of impacts from these sources (e.g. habitat loss, underwater noise and vibration, contaminant inputs, vessel interactions, light emissions, introduction of non-native marine pest species), when assessed cumulatively, do not present risks that are of a significantly greater magnitude than those posed by the Project in isolation. Hence, it is concluded that potential cumulative impacts do not warrant increased levels of management, monitoring or mitigation above those that are presented in this EIS for the Project.

12.4.1 Mangroves

The loss of the isolated (~1.0 ha) remnant mangrove stand (due to its incorporation into the reclamation area) will represent a minor incremental loss of mangrove habitat. Insufficient data are available on the areas of mangroves that may be cleared for other proposed or approved developments to be able to quantify the relative loss that 1.0 ha represents. However, given the approximately 20,400 ha of mangrove communities within Darwin Harbour (Brocklehurst & Edmeades 1996), for the ecosystem function of Darwin Harbour to be significantly impacted the extent of mangrove loss associated with these other projects would have to be of such a large magnitude that the 1.0 ha within the Project footprint would be an insignificant contributor.

While the value of mangroves to the Darwin Harbour ecosystem is recognised, it is considered that retention of the remnant mangrove stand is not warranted as its loss does not represent a potential pathway for detectable adverse impacts upon the ecosystem function of East Arm or the broader Darwin Harbour.

12.4.2 Soft sediments

The loss of 'soft sediment' habitat and associated biological communities due to reclamation, and their modification due to dredging, will also be minor in comparison to the loss and modification attendant to the other proposed developments (notably the Middle Arm Sustainable Development Precinct which would require substantial dredging of sediment volumes that are orders of magnitude greater than those proposed for the Project). The value of 'soft sediment' communities to ecosystem function is recognised, though it is considered that the necessary Project-related changes do not represent a potential pathway for detectable adverse impacts upon this function.

12.4.3 Underwater noise and vibration

12.4.3.1 Construction

Potential cumulative impacts from underwater noise and vibration during the Project construction phase will occur if concurrent substantial noise and vibration generating activities (e.g. piling and dredging) are being undertaken either within the Project, or between the Project and adjacent developments.

While Project-related piling and dredging operations may conceivably occur concurrently, noise levels from separate activities are not necessarily additive due to the waveform nature of their propagation (i.e. they may interact antagonistically, thereby reducing their magnitudes). However, it is not possible to reliably estimate the potential increase or decrease in noise and vibration levels that may arise from concurrent Project activities as they are dependent upon the precise timing that they are generated by the activities (e.g. whether a pile is struck at precisely the same time, or at a time slightly offset from, the dredge cutter head contacting hard material on the seabed).

Similarly, it is not possible to reliably estimate the potential increase or decrease in noise and vibration levels that may arise if Project activities are undertaken concurrently with activities attendant to other developments that also generate noise and vibration. It is noted that piling for different projects is likely to occur sequentially, rather than concurrently, to share mobilisation costs of the piling rig. Hence, potential cumulative impacts would be temporal in nature (i.e. extended duration of fauna disturbance), rather than related to increases in noise intensity.

It is recognised that the cumulative effect of both intra and inter-Project generation of noise and vibration upon marine fauna has the potential to temporarily limit their access to any habitats in which noise and vibration levels are intolerably high. However, given the absence of known critical habitat within East Arm for marine fauna species, it is considered that the risk of cumulative impact will not be significantly greater than the risk of impact from each construction activity considered in isolation.

It is also recognised that if substantial noise and vibration generating activities were concurrently undertaken on both sides of East Arm, then there would be the potential for movement of marine fauna between Elizabeth River and the main body of Darwin Harbour (and beyond) to be temporarily affected. This will be addressed within the relevant management plans (refer Chapter 8: Marine Flora and Fauna and Chapter 13: Environmental Management Framework), though it is noted that the potential for this to occur can only be assessed once the timings of individual inter-Project activities are known. If the risk of significant impacts is deemed to be sufficiently great, then temporal offsetting of some activities may be required to reduce this risk to as low as reasonably possible.

12.4.3.2 Operation

As for the Project operation phase, it is not possible to reliably estimate the potential cumulative increase in noise and vibration levels attendant to Project operations in comparison to the levels associated with other developments within East Arm. However, given the Project location (between EAW and the MUBRF) it is considered highly unlikely that noise and vibration levels from sources beyond these existing developments will have the potential to interact significantly with operational levels from the Project.

12.5 Air quality and greenhouse gases

The cumulative impact assessment found that although there are several identified projects that relate to the Project both spatially and temporally, all are considered to have a low potential for cumulative air quality impact when assessed alongside the emissions from the Project.

Air quality impact assessments as a function of how they are performed are inherently cumulative assessments as they are required to consider background air quality in addition to Project related air emissions when assessing against air quality goals. The air quality assessment for the Project identified background concentrations for each pollutant species of interest for the construction and operation phases of the Project, predominantly using NT EPA air quality monitoring station data. The assessment of air quality impacts for both the construction and operation phases has considered this background air quality when assessing against the adopted air quality goals.

There is sufficient land separation between the majority of projects considered in the cumulative impact assessment and the Project area. Those that are related spatially (in close proximity) are not considered to have a significant cumulative impact, as they are either not expected to emit the same pollutants as the Project, or will emit the same pollutants but the quantities are not considered significant in the context of the findings of the air quality impact assessment for the Project.

Greenhouse gas emissions were not considered as part of the cumulative impact assessment as there is no recognised method to assess the cumulative impact of GHG emissions from two or more spatially or temporally related projects. The only possible exception being comparison against GHG emission reduction targets on a Territory or State level, which is outside the ToR requirements for the Project.

The results of the cumulative impact air quality assessment are detailed in Appendix J: Air Quality and Greenhouse Gas Technical Report. In summary, the cumulative impact assessment found that although there are several cumulative projects relating to the Project both spatially and temporally, all are considered to have a low cumulative air quality impact when assessed alongside the emissions from the Project.

12.6 Social economic and cultural surroundings

As enabling infrastructure, the Project has the potential to unlock significant direct and indirect economic benefits for the NT. However, given the size and nature of the Project development the contribution of the Project to adverse social cumulative impacts is considered minimal.

The SIA found that the potential cumulative additive and interactive impacts of ongoing development on the values of the Darwin Harbour are likely to be substantial. Desktop assessments of the projects included in the cumulative impact assessment (Table 12-1), which may not all proceed, identified potential impacts relating to all projects. Due to the complicated nature of assessing social and economic cumulative impacts, and the limited information available on the specifics of the projects considered, it is suggested that a harbour-wide strategic assessment will produce a better informed position.

As part of the SIA consultation process many of the issues raised by stakeholders related to broader cumulative, rather than Project level impacts, including:

- dredging and land reclamation for multiple projects
- growing industrialisation of the harbour, including the growth of gas-based manufacturing and processing industries on Middle Arm
- increased marine traffic
- growing risks from spills, pollution, stormwater discharge and loss of species from urban population growth around the harbour.

Until about 2000, there was little development on East Arm Peninsula. Over the past 20 years there has been incremental, but rapid, development of the entire peninsula as an industrial precinct. While it is widely accepted that Darwin Harbour is a 'working harbour', a key issue for many stakeholders, including the DHAC, is finding a balance between development and environmental protection. The TERC's final report (2021) highlights the economic value of developing Darwin's capacity as a maritime service and supply hub and transport and logistics precinct on East Arm, combined with gas-based manufacturing on Middle Arm, while protecting Territorians' quality of life as a key element of attracting and retaining a skilled workforce.

The NTG's vision is for the Project to be enabling economic infrastructure that will grow the maritime sector and enhance Darwin's competitive advantage as a marine repair and maintenance and sustainment centre for Northern Australia, unlocking direct and indirect benefits. Government and business stakeholders suggest the facility will be foundational infrastructure for a marine services precinct, consolidating a range of marine services on the East Arm Peninsula.

Potential adverse cumulative impacts as a result of the Project were assessed as minimal, these impacts will be mitigated to the greatest possible extent. Further mitigation of cumulative impacts will need to be considered across other developments in the area, such as the Middle Arm project. The results of the SIA will be used to further inform the strategic assessment currently being undertaken for the Middle Arm project to ensure mitigation measures for the two projects are aligned.

12.7 Conclusions

Assessment of impact on marine environmental quality indicated that, if dredging is to occur concurrently with other dredging operations there is the potential for cumulative environmental impacts on water quality. It is noted that all dredging programs undertaken in the Darwin Harbour, including the dredging program associated with the Project, will require Developmental Consent and an approved DDSPMP. Therefore, the impacts and proposed measures to manage and mitigate these impacts from dredging will be considered in detail by regulators. Stakeholders will also be given an opportunity to comment on these programs as part of approval processes.

Potential cumulative impacts on marine flora and fauna identified included.

- loss of mangrove and habitat
- loss of soft sediment habitat and associated biological communities
- underwater noise and vibration.

These were considered minor, or not to be significantly greater than the risk of impact from each construction activity considered in isolation.

The cumulative impact assessment also found that although there are several projects relating to the Project both spatially and temporally, all are considered to have a low cumulative air quality impact when assessed alongside the emissions from the Project.

The SIA found significant cumulative economic opportunities arising from the Project that are likely to contribute to developing Darwin's capacity as a maritime service and supply hub, and as a transport and logistics precinct on East Arm. The Project is well positioned to contribute to economic growth, enhanced capacity of the NT's maritime sector and workforce development.

The SIA also found that the potential cumulative additive and interactive impacts of development in Darwin Harbour was of concern to some stakeholders. Whilst the EIS found the contribution of the Project to cumulative impacts on values of the harbour to be minimal, consideration of potential overlap with known maintenance dredging for other projects has been proposed. To further support the sustainable management of cumulative impacts within Darwin Harbour, all relevant Project impact assessments will be made available to other projects such as the Middle Arm Strategic Environmental Assessment for cumulative impact consideration.

It is anticipated that all of the projects listed in Table 12-1 and considered as part of this Project's cumulative impact assessment will be required to undertake their own cumulative impact assessment and to mitigate and manage potential cumulative interactions to an acceptable level, where an overlap has the potential to cause unacceptable input levels. Mitigation and management measures to reduce potential cumulative impacts and enhance potential cumulative benefits related to the Project are presented in the mitigation and management section of each of the factor chapters (Chapter 7 to 10), Chapter 12: Environmental Management Framework and Appendix B to Appendix C: Social Impact Assessment.

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Chapter 13

Environmental Management Framework

13.0 Environmental Management Framework

This chapter establishes the environmental management framework (EMF) for the delivery of the Project. It is designed to provide the parameters for the preparation of subsequent CEMPs and OEMPs to ensure that potential impacts and risks associated with the delivery of the Project are managed and monitored and the NTG fulfils its environmental and social commitments and obligations.

Design and construction of the Project will be undertaken by a lead Construction Contractor and once constructed, the Darwin Ship Lift Facility will be leased to an operator. DIPL will be the construction agency for the NTG. The Construction Contractor will be required to submit a CEMP for the Project to DIPL for approval prior to commencing construction works. The operator of the Darwin Ship Lift Facility will be required to submit an OEMP to the NTG prior to commencing operation.

Similarly, the operator of the Privately-owned Facility will also be required to develop and implement environmental management plans which incorporate any operational conditions imposed as part of the Project approval process. The development of the environmental management requirements for the Privately-owned Facility are outside the scope of this EIS and will be regulated under separate approval processes.

This EMF provides a basis for incrementally improving management practices over time. It includes:

- environmental management objectives
- proposed mitigation measures that are designed to reduce or mitigate residual risk
- requirements for monitoring, reporting and reviewing the effectiveness of these measures.

Management measures will be revised and refined over time to ensure objectives are met.

Environmental and social impacts and risks will vary significantly in their nature and severity during the construction and operational phases of this Project. In response, this EMF discusses the construction and operational phases of the Project separately in Sections 13.4 and 0. Proposed objectives and mitigation measures are also presented separately for construction and operation in Sections 13.4.8 and 13.5.8 respectively. These measures focus on significant environmental factors identified in the ToR or as a result of risk assessments, technical studies and stakeholder engagement.

This EMF exists within a suite of documents that will guide the delivery of the Project. These key documents include, but will not be limited to:

- Social Impact Management Plan (SIMP)
- Heritage Management Plan (HMP).
- Noise and Vibration Management Plans
- Traffic Management Plans (TMPs)
- Dredging and Dredge Spoil Placement Management Plan (DDSPMP)
- Erosion and Sediment Control Plan (ESCP)
- Marine Spill Response Plans
- Biosecurity Management Plan

Each of these plans and the proposed approach to environmental management for site activities are discussed further below in Section 13.3.

13.1 Purpose of the Environmental Management Framework

This EMF identifies the proposed approach to managing environmental impacts associated with the design, construction and operation of the Project. The design and construction of the Project will be undertaken by a suitably experienced construction company, selected through the NTG's staged procurement process. Currently designs are at concept level. The specific scope and requirements of the construction contract are therefore still to be refined.

The construction company will be required to have a certified environmental management system (EMS) and prepare a CEMP that is consistent with this EMF to ensure that all regulatory and environmental requirements, including imposed conditions and secondary approval conditions, are met. Environmental requirements will be explicitly specified in contract documents.

NTG will lease the Darwin Ship Lift Facility and its operation to a suitably experienced operator. The operator will be required to submit an OEMP to NTG for approval prior to commencement of operation that is consistent with this EMF to ensure that environmental obligations are met and impacts are adequately managed. Environmental requirements will be explicitly specified in lease documents.

Following completion of the EIS process, secondary approvals and permits under NT legislation will be required for the construction of the and operation of the Project. Imposed conditions and legislative requirements associated with these secondary approvals and permits will be incorporated into subsequent EMPs. Legislative context and secondary approvals are discussed further in Chapter 3: Strategic and Statutory Framework.

13.2 Outline of the Environmental Management Framework

This EMF has been designed to be consistent with the AS/NZS ISO 14000 standards for environmental management. The EMF includes:

- roles and responsibilities
- inductions and training requirements
- incident, notification and emergency management requirements
- environmental objectives and performance criteria
- inspections monitoring, auditing and reporting requirements
- processes for dealing with a non-compliance and corrective actions
- complaints management requirements.

This framework includes proposed objectives, performance criteria, management and mitigation measures and monitoring and reporting requirements for impacts associated with the preliminary key environmental factors and other environmental factors identified in the ToR for the EIS, or as part of the Project environmental risk assessment, technical studies and stakeholder consultations (refer Table 13-1). These include:

- Marine Environmental Quality
- Marine Flora and Fauna
- Air Quality and Greenhouse Gases
- Terrestrial Environmental Quality
- Terrestrial Flora and Fauna
- Surface Water and Hydrological Processes
- Human Health.

A separate SIMP is presented in Appendix C of Appendix C: Social Impact Assessment. The SIMP includes management and mitigation relating to social, economic and cultural surroundings.

Table 13-1 Factors, objectives, mitigation measures, monitoring and reporting

Component	Description
Environmental aspect	Environmental aspect to be managed through the EMP Sub-plan
Environmental objectives	Targeted environmental outcomes to ensure that the requirements of the EA Act are achieved. These reference the environmental factor objectives defined by the NT EPA (2018a).
Performance criteria	Measurable goals or indicators of the environmental outcome. Environmental objectives are deemed to be achieved if the performance criteria are met. If the performance criteria are not met, mitigation measures must be implemented to achieve the environmental outcomes.
Proposed mitigation measures	Measures directed at achieving the environmental outcomes. The proposed mitigation measures have been identified through the EIS process, based on the requirements of the ToR recognising that additional or different mitigation measures may be applied in order to achieve the environmental and social outcomes as the Project progresses. These mitigation measures have been applied to determine residual risk of proposed activities.
Monitoring and reporting requirements	Monitoring and reporting requirements to demonstrate that the environmental objectives have been achieved, or corrective actions implemented, where applicable.

DIPL's Standard Specification for Environmental Management (DIPL 2019) details the requirements for environmental management of projects. This includes guidelines for Construction Contractors on preparation of Contractor's Environmental Management Plans and other supporting plans (DIPL 2019). Contractors will be expected to implement the requirements of these specifications where relevant and environmental requirements will be included in contractual documentation.

CEMPs and OEMP's will be developed in advance of relevant Project works. As the project progresses, objectives, performance criteria and mitigation measures presented in this EMF will be refined in consultation with successful contractors, to ensure that an adaptive approach is taken to management of the Project.

13.3 Supporting documents

As stated above, the CEMP's and OEMP's will interact and cross-reference a suite of other documents that will guide the delivery of the Project. These key documents are described below, but will not be limited to:

- SIMPs
- HMP
- Marine and Terrestrial Noise and Vibration Management Plans
- TMPs
- DDSPMP
- ESCP
- Marine Spill Response Plan
- Biosecurity Management Plan.

13.3.1 Social Impact Management Plan

The SIMP summarises social, economic and cultural impacts and opportunities identified for the Project and outlines the proponent and Construction Contractor's required management plans for construction and operation. It covers both:

- impacts and opportunities from the perspective of the expected economic and social uplift of the Project
- social and cultural consequences for people positively or negatively affected by the Project.

The SIMP contains commitments to:

- communication and engagement during construction and operation
- manage and mitigate social impacts
- strategies to capitalise on the social and economic benefits
- ongoing measurement against key indicators so progress can be monitored
- regular reporting of outcomes against key indicators
- implementing improvements to the SIMP as necessary.

The SIMP is intended to provide for a flexible, adaptive approach to identifying and responding to emerging issues.

Further information on the SIMP and details of specific impact management and mitigation measures are included in Chapter 10: Social, Economic and Cultural Surroundings and Appendix C: Social Impact Assessment.

13.3.2 Noise and Vibration Management Plans

Prior to commencement of construction the Construction Contractor will be required to prepare a terrestrial Construction Noise and Vibration Management Plan (CNVMP) to support the CEMP.

The terrestrial CNVMP plan will identify:

- nearest residences, other sensitive land uses and ecological receptors such as, migratory birds
- approved hours of work and requirements for site specific noise risk assessments for proposed activities outside standard work hours
- all construction activities, including work areas, equipment and duration
- what work practices (generic and specific) would be applied to minimise noise and vibrations.

The terrestrial CNVMP will include, a complaint handling process, noise and vibration monitoring procedures, and an overview of community consultation required for identified high impact works.

Noise and vibration mitigation measures which will be considered in the CNVMP are detailed in Appendix K: Terrestrial Noise Impact Technical Report.

Management and monitoring measures to mitigate the potential for dredging-related underwater noise and vibration impacts upon protected marine species will be incorporated into a DDSPMP.

For piling, a Marine Noise and Vibration Management Plan will be developed by the piling contractor also for approval prior undertaking piling works.

It is anticipated that the requirements pertinent to underwater noise and vibration will be consistent between these plans and will include:

- equipment to be maintained and operated so as to reduce the generation of underwater noise and vibration level to as low as practicable
- surveillance by trained marine fauna observers of Observation and Exclusion Zones for protected marine species prior to commencement of dredging and piling operation, and periodically during operation
- mitigation measures to be implemented if adverse impacts upon protected marine species are detected
- reporting of observations of protected marine species.

13.3.3 Traffic Management Plans

Detailed TMPs will be prepared and approved for both the construction and operational phases. These detailed TMPs will be prepared and approved prior to construction works taking place or to the operation of the facility.

The Construction TMP should take into consideration the following components for the construction phase:

- haulage routes and circulation within the Project site
- requirement for over dimensional permits
- requirement for traffic controllers
- community consultation
- dates and duration of construction
- access and egress on construction site for triple road train manoeuvring
- compliance with driver facility legislation.

The Operational TMP should take into consideration the following components for the operation phase:

- onsite parking requirements
- safe access and egress from the Project site
- safe passage from access road to parking area
- convenient and obvious ways to approach the entrance to the car park
- convenient and safe ways of circulating within the car park and advice about the location of pedestrian access to entrance doors
- safe routes to walk amongst or past parked cars to reach entrance doors.

Further information on traffic management measures are detailed in Appendix L: Traffic Impact Assessment.

13.3.4 Dredging and Dredge Spoil Placement Management Plan

The dredge operator will be required to prepare a DDSPMP, and have it approved by the NT EPA prior to the commencement of dredging operations. Development consent for dredging will also be required prior to the commencement of dredging operations.

The DDSPMP will outline the approach to the management and monitoring of dredging operations and onshore placement of the dredged material and include a tiered response that is based on monitoring water quality in the vicinity of the operating dredge. Management and monitoring measures to mitigate the potential for dredging-related underwater noise and vibration impacts upon protected marine species will be incorporated the DDSPMP.

This DDSPMP will be required to demonstrate that reasonable and practicable steps will be taken to manage the risks associated with, and the potential environmental impacts arising from, the dredging and dredged material placement activities to be undertaken during the Project dredging campaigns.

13.3.5 Erosion and Sediment Control Plans

An ESCP will be prepared by a Certified Professional in Erosion and Sediment Control (CPESC) in accordance with the International Erosion Control Association Best Practice Erosion and Sediment Control (2008).

The plan will detail the following procedures and protocols:

- soil/land conservation objectives for the Project
- temporary/permanent erosion and sediment control measures

- workplace health and safety requirements relating to management of contamination and unexploded ordnance risk
- management of problem soils (e.g. acid sulfate soils, erosive, dispersive, reactive, acidic, sodic, alkaline soils)
- stockpiling and management/segregation of topsoil where it contains native plants seedbank or weed material
- vehicle, machinery and imported fill hygiene protocols and documentation
- requirements for training, inspections, corrective actions, notification and classification of environmental incidents, record keeping, monitoring and performance objectives for handover on completion of construction.

This plan will be developed with reference to DIPL's Standard Specification for Environmental Management (DIPL 2019).

13.3.6 Marine Spill Response Plan

The Construction Contractor and Operation Contractor will be required to prepare and implement a Marine Spill Response Plan aligned with the NT (DIPL, Marine Safety Branch) and Darwin Port Oil Spill Contingency Plans (DoT 2014, Landbridge Darwin Port 2020).

Both of these documents describe procedures and resource requirements to enable responders to take the actions required to minimise the environmental and economic effects of any marine pollution incident in NT waters through rapid, effective and appropriate response procedures (DoT, 2014).

13.3.7 Biosecurity Management Plan

Given the significance of the potential consequences of introduction of invasive marine pests it is recognised that it will be imperative to implement stringent biosecurity mitigation and management measures during both construction and operations.

These measures will be aligned with the existing framework for reducing the risk of introduction of invasive species to Darwin Harbour (e.g. Darwin Port's Port Environment Protection Plan, INPEX's Operational Environmental Monitoring Program, NTG Aquatic Biosecurity Unit monitoring program) and with Australian national guidelines (e.g. DAFF 2009a,b, 2010, DAWR 2017).

Measures will be documented in a Biosecurity Management Plan, which will include quarantine procedures, vessel risk assessments and inspection protocols. The plan will be developed in consultation with the Aquatic Biosecurity Unit within the NT Department of Industry, Tourism and Trade to ensure consistency with existing quarantine arrangements for Darwin Harbour facilities.

The Biosecurity Management Plan will also include measures for managing weeds, mosquitoes and feral animals that might be transported to site via vehicles and vessels.

13.3.8 Heritage Management Plan

A HMP will be developed during the detailed design phase and implemented in the construction phase to manage impacts on heritage values within the Project area. This plan will incorporate site specific recommendations documented in the archaeological and heritage assessments that inform this EIS which are documented in Appendix N: Cultural Heritage Assessment. This plan will be developed with reference to DIPL's Standard Specification for Environmental Management (DIPL 2019).

Appendix N also includes a guide for the management of heritage values during the construction phase of the Project. This guideline describes the actions required by managers, contractors and employees in relation to unforeseen circumstances such as the discovery of:

- human remains
- artefacts of Indigenous origin
- submerged WWII artefacts
- UXO.

While it is considered, based on assessments of the Project area, that these circumstances are unlikely to occur, contingency planning for such occurrences will lower the risk to the Project and site personnel.

13.4 Construction Environmental Management

The successful Construction Contractor will be required to have a certified EMS and prepare a CEMP that is consistent with this framework to ensure that all regulatory and environmental requirements, including imposed conditions and secondary approval conditions, are met. The CEMP will be developed with reference to DIPL's Standard Specification for Environmental Management (DIPL 2019), environmental requirements specified in design and construction contracts industry accepted practice and relevant guidelines and standards. The CEMP will be submitted to DIPL for approval prior to commencement of construction works.

13.4.1 Key roles and responsibilities

Key roles and responsibilities will be confirmed by contractors on appointment and a Project-specific organisational chart will be developed and maintained by the contractors to ensure that adequate resources are available to meet the requirements of their EMS and the CEMP.

Site management responsibilities will be defined and documented by the Construction Contractor before works commence; these will include reporting and communication pathways between the Construction Contractor and DIPL personnel.

Key roles to be identified include (but are not limited to):

- Project Manager
- Health Safety Environment and Quality (HSEQ) Advisor
- Environmental representative
- supervisors/engineers
- employees and subcontractors.

An environmental representative must be on-site at all times when works are being undertaken. The environmental representative must have relevant experience and/or a certificate level qualification in Environmental Management for construction sites.

13.4.2 Inductions and training requirements

Inductions and training requirements will be determined by the DIPL and the contractors on appointment, and will be in accordance with DIPL's and the contractor's policies and procedures. All relevant inductions will be completed by all personnel before they begin work on the Project. A training and inductions register will be maintained by the Construction Contractor.

13.4.2.1 Environmental inductions

All Project personnel will be required to attend an induction session to inform them of their responsibilities under the CEMP. Short-term site visitors and contractors will also be required to undertake a Visitors Induction and will be required to be accompanied by inducted personnel at all times.

The induction will likely include:

- CEMP requirements
- environmental approval conditions
- statutory duties about notification of environmental harm
- environmental incident notification procedures which will include how an event is reported and to whom the event is reported (all incidents are to be reported, including near misses)
- emergency procedures which will cover the procedure for an emergency and for evacuation of the site in the event of a catastrophic situation arising
- contingency plans (e.g. for hydrocarbon or chemical spills)

- environmental data collection and documentation requirements
- complaints management procedures
- key environmental risks and issues
- location of sensitive receptors and culturally and environmentally sensitive areas
- cultural awareness training
- hours of operations
- key environmental and emergency contacts.

13.4.2.2 Environmental awareness

A variety of tools will be used to further increase awareness of significant environmental and safety issues, and to communicate the relevant requirements documented in environmental and safety management plans. These may include:

- daily prestart meetings
- toolbox meetings
- safety/risk assessments
- management meetings
- noticeboards
- environmental incident investigations/reports.

Typical items discussed in daily, toolbox and management meetings will include environmental items such as new procedures or reinforcement of existing procedures, handling of hazardous chemicals, management of waste/recycling, and the need to report all incidents and hazards/near misses.

It is also envisaged that these mechanisms will provide a vehicle for promoting adaptive management and encouraging the workforce to identify opportunities for continuous improvement.

13.4.2.3 Training

Only suitably qualified and experienced personnel will be engaged on the Project. All personnel will have appropriate qualifications and experience for their role on the Project.

Additional training for personnel may be required depending on the Project stage, the tasks to be undertaken and their level of responsibility. A training register will be developed and maintained that identifies requirements in relation to qualifications, competencies and Project-specific training courses.

The Construction Contractor's Environmental Policy or EMS shall commit them to providing sufficient and suitable resources and training to achieve the targets defined in its EMS and the CEMP, as appropriate.

13.4.3 Incidents, notifications and emergencies

In the NT, the EP Act and the *Waste Management and Pollution Control Act 1998* legislate obligations and duties to prevent environmental harm, environmental nuisance and contamination.

The two primary duties that apply to everyone in the NT are:

- General environmental duty – which means a person must not carry out any activity that causes or is likely to cause environmental harm, unless measures to prevent or minimise the harm have been taken.
- Duty to notify of environmental harm – to inform the administering authority and landowner or occupier when an incident has occurred that may have caused or threatens serious or material environmental harm.

All staff and contractors are required to report all environmental incidents or breaches of the approval conditions in accordance with statutory requirements and the timeframes that will be specified in the CEMP.

Project specific incident management procedures will be developed to detail the processes and resources required to respond and manage incidents through to resolution during construction.

Incidents shall be tracked through to closeout using an incident tracking system or register. Complaints will be investigated by the Project management team and action will be taken to enable satisfactory closeout.

Any incidents that have caused environmental harm, or that have the potential to cause environmental harm, will also be reported to the designated DIPL representative and to NT EPA Pollution Hotline (1800-064-567) or, for marine fauna incidents, Marine Wildwatch line (1800-453-941) within 24 hours.

When in any doubt as to the seriousness of the event, the Construction Contractor will notify the authorities, in liaison with DIPL. DIPL will also be notified of any notices received from authorities.

13.4.4 Environmental documents and records management

The Construction Contractors will develop or implement a document management system that fulfils requirements to operate under their EMS before the commencement of site works.

Project records, including subcontractor Project records, will be maintained to provide evidence of conformity to DIPLs requirements and commitments in the CEMP.

Such records include, but are not limited to:

- correspondence to/from DIPL and interested parties including minute of meetings (where relevant)
- permits, licenses and approvals
- induction and other training records
- environmental procedures and plans
- inspection, monitoring and test documentation (including calibration)
- non-conformance and corrective action/complaints
- environmental incidents
- audits and inspections
- daily monitoring site records
- delivery/waste dockets.

13.4.5 Performance management

Performance management includes activities to ensure that goals and objectives are consistently being achieved in an effective and efficient manner. A key component of the environmental management process is the development and implementation of specific measures to ensure that the environmental risks arising from Project activities are minimised.

13.4.5.1 Environmental objectives

The environmental objectives for preliminary key environmental factors have been defined by the NT EPA. Wherever possible, these objectives should be incorporated into the contractor's CEMP. Draft objectives have been included in Section 13.4.8. These will be confirmed by the contractor in consultation with DIPL as part of development of the CEMP.

13.4.5.2 Performance criteria

Similarly, performance criteria will be incorporated into the Construction Contractors CEMPs to assess the effectiveness of mitigation measures and allow for continuous improvement of environmental management. Draft performance criteria have also been included in Section 13.4.8. Key performance indicators (KPIs) will be defined by the successful Construction Contractors in consultation with DIPL. Where performance criteria are not met, this will form a trigger for review of the CEMP and initiate corrective actions specific to the scenario.

General KPI's are likely to include:

- all personnel working on site have undergone an environmental induction
- internal audit score of 100% compliance with the CEMP
- DIPL conducted audit score of 100% for compliance with the CEMP
- regulator conducted audit (if applicable) score of 100% for compliance with the CEMP
- no activity in breach of the provisions of any environmental legislation and Project environmental approval conditions
- 100% investigation and reporting of any environmental incident at the Project site
- 100% compliance required for management measures relating to dredging and dredge spoil management.

13.4.6 Inspections, monitoring and auditing and reporting

Inspections, monitoring, auditing and reporting will be developed and undertaken to document compliance with approval conditions, EIS commitments and the requirements of the CEMP.

13.4.6.1 Inspections/monitoring

Daily site and facilities inspections will be conducted by site supervisors. These inspections will focus on ensuring compliance with approval conditions, EIS commitments and the CEMPs. Monitoring will be undertaken in accordance with the CEMP and other supporting management plans (refer Sections 13.3 and 13.4.8).

Monitoring equipment should be maintained and calibrated in accordance with manufacturers guidelines to ensure reliability of equipment and data. Sampling should be undertaken by a National Association of Testing Authorities (NATA) accredited laboratory unless otherwise stated. Monitoring data and results will be maintained in a database, with results reviewed, interpreted and reported in accordance with the developed monitoring and reporting requirements and timeframes.

If monitoring or inspections indicate that activities are not in compliance with approval requirements or the CEMP, necessary corrective actions will be implemented, and authorities informed in accordance with approval conditions or legislative requirements.

Any corrective actions resulting from inspections will be entered onto a 'Non-conformance and Corrective Action Register' and the progress tracked for completion.

13.4.6.2 Internal audits

An internal audit of the CEMP will be undertaken prior to commencement of works to assess the likely effectiveness of the plan in the field and to identify any opportunities for improvement.

A second internal audit of the CEMP will be undertaken three months after the commencement of site activities to assess the effectiveness of the implementation of the CEMP, and of the monitoring and reporting procedures being applied. The intent of this audit will be to identify any opportunities for improvement to ensure monitoring, reporting and record keeping are sufficient to support required reporting.

13.4.6.3 External audits

External audits can be conducted by DIPL or third parties, such as other government departments. The NTG may conduct an audit at any time when they believe there is an issue in relation to environmental compliance. The Construction Contractors will assist with any external audit.

Results from any external audits will be reviewed by the Construction Contractor, with any necessary corrective actions assigned to Project personnel to ensure appropriate and timely closeout. Any corrective actions will be entered into a corrective action register and the progress tracked to completion.

13.4.6.4 Project corrective action register

Any environmental non-conformance (e.g. incidents, audit-related non-conformance, complaints, government notices) will be recorded in a Project corrective actions register or similar to be developed by the Construction Contractor. The corrective actions register will detail the non-conformance, the corrective action required, the responsible person(s), the timeframes by which the action is to be completed, and the actual completion date. Each non-conformance will be reviewed, and it will be established if there are any actions available to reduce the severity or likelihood of re-occurrence.

13.4.6.5 Reporting

During construction, a monthly compliance report will be prepared for the DIPL by the Construction Contractor. The report would be expected to include:

- summary of environmental inspections
- summary of monitoring data and interpretation of results
- details of environmental non-compliance events or incidents
- reporting of complaints including a description of the issues, responses and corrective actions.

An Annual Environmental Report will be prepared for each year of construction that will include, but not be limited to, the following:

- a statement of compliance with the approval conditions
- evaluation of compliance with the CEMP
- summary of non-compliance events
- relevant trends and interpretation against performance criteria for each environmental aspect.

13.4.7 Complaints management

The Construction Contractor will develop a Complaints Management Procedure to ensure that complaints are dealt with efficiently and effectively, and stakeholders have confidence in the complaints management system.

Complaints can be lodged by stakeholders or any member of the community. Should a complaint be made it will be recorded in a complaints register with details of the date, location, and contain details of the complainant and follow up actions required.

All complaints will be investigated thoroughly to ensure appropriate corrective actions are taken to resolve any issues as appropriate. They will also be recorded and tracked via monthly and annual compliance reports to be prepared by the Construction Contractor (refer Section 13.4.6.5).

DIPL will regularly monitor the quality and effectiveness of the complaints management system and revise relevant components where appropriate based on feedback from internal and external sources.

13.4.8 Environmental factor management measures

Mitigation and monitoring measures have been developed for each of the preliminary key environmental factors identified in the ToR as well as other factors identified during the risk assessment, technical studies and stakeholder engagements. For each factor or aspect identified, environmental objective and performance criteria have also been defined as outlined in Table 13-1.

Proposed management measure that will need to be considered during detailed design and construction are presented below under the following factor headings to maintain consistency with the structure of the technical chapters in this EIS (Chapters 7 through 11):

- Marine Environmental Quality
- Marine Flora and Fauna
- Air Quality and Greenhouse Gases
- Terrestrial Environmental Quality

- Terrestrial Flora and Fauna
- Surface Water and Hydrological Processes
- Human Health.

13.4.9 Marine environmental quality

Table 13-2 Marine environmental quality construction management measures

Environmental objectives	<i>Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.</i>
Performance criteria	• No activity in breach of the provisions of any environmental legislation and Project environmental approval conditions. • 100% investigation and reporting of any environmental incident at the site. • No exceedances of dredging trigger levels • Audit score of 100% compliance on any audits of hazardous goods storage and handling requirements.
Proposed mitigation measures	
• Preparation and implementation of DDSPMP, approved by regulatory bodies, which includes a tiered response plan that is based on monitoring water quality in the vicinity of the operating dredge. Specific management measures that may be implemented as a trigger response may include: - slowing the cutter head speed or slew speed of the dredge, reducing the rate of disturbance at the cutter head - reducing or suspending dredging activity during certain tidal periods when the migration of dredge plumes towards South Shell Island is greatest - relocating the dredge to an alternate dredge face - repairing pipeline joints to eliminate leakage of spoil - temporary cessation of dredging - deployment of silt curtains. • Preparation and implementation of a CEMP including: - ASS management plan reflecting national standards and current best practice - ESCP. • Adoption of suitable construction methodologies to minimise mud waving. ASS management associated with placement of dredged material will be incorporated into the DDSPMP, with management based on National ASS Guidelines. • Design considering water sensitive urban design. • Construction methodologies developed to contain reclamation material. • Soil contamination investigations during EIS preparation to determine level of contamination and remediation (completed refer Appendix N: Preliminary Site Investigation) • Unexpected finds protocol (ASS and contamination). • Use of silt curtains during reclamation activities to remove silt from runoff prior to, and within, the marine environment. • Engaging with Port of Darwin regarding the Port Environmental Protection Plan. • Preparation and implementation of a Marine Spill Response Plan in line with the existing Darwin Port Oil Spill Contingency Plan. The plan will also reference the NT (DIPL Marine) OSCP. • Compliance with AS1940-2004 (Storage and handling of flammable and combustible liquids). • Preparation and implementation of a refuelling management plan. • Spill kits to be located at suitable locations on site during construction and operation and appropriate personnel trained in use.	

Monitoring and reporting requirements

- Monitoring will be undertaken:
 - surrounding the dredge when the dredge is operating
 - within the dredged material placement ponds (where ponds are being used) prior to the discharge of tailwater
 - in the vicinity of reclamation works where dredged material is being placed onshore to assess the effectiveness of sediment and turbidity control measures to manage runoff
 - at any stormwater discharge locations into Darwin Harbour where surface water is collected from the Project site during construction
 - at appropriate reference sites sufficiently distant from the works to not be impacted by dredging and/or reclamation works
 - at sensitive receptor sites such as South Shell Island, if water quality trigger levels (set out in the DDSPMP) are exceeded.
- Reactive sediment and water quality sampling frameworks will be implemented in the event of an unplanned release of a pollutant.
- All routine reporting will be reported in daily site environmental reports. Where an exceedance is detected, this will be communicated by the Construction Contractor to the proponent within 24 hours and an attributability assessment undertaken. A report on the attributability will be provided to the Proponent within a suitable timeframe to be determined in the DDSPMP and CEMP.
- Any incidents that have caused environmental harm, or that have the potential to cause environmental harm, will also be reported to the designated DIPL representative and to NT EPA Pollution Hotline (1800-064-567) or, within 24 hours.

13.4.10 Marine flora and fauna

Table 13-3 Marine flora and fauna construction management measures

Environmental objectives	<i>Protect marine flora and fauna so that biological diversity and ecological integrity are maintained.</i>
Performance criteria	- No activity in breach of the provisions of any environmental legislation and Project environmental approval conditions. 100% investigation and reporting of any environmental incident at the site.
Proposed mitigation measures	
- Preparation and implementation of DDSPMP, including monitoring and reactive management protocols to reduce risk of impacts to: - benthic communities from turbidity and sedimentation - protected marine fauna species from underwater noise and vibration. - Preparation and implementation of a Marine Noise and Vibration Management Plan, incorporating marine fauna observations and reactive management protocols. - Preparation and implementation of a CEMP containing an Erosion and Sediment Control Plan, and a stormwater management plan and spill response measures. - Compliance with AS1940-2004 (Storage and handling of flammable and combustible liquids). - Preparation and implementation of a CEMP containing an ASS Management Plan. - Adoption of construction methodologies that reduce potential for mud waving to as low as practically possible. - Preparation and implementation of a Marine Spill Response Plan aligned with the NT (DIPL, Marine Safety Branch) and Darwin Port Oil Spill Contingency Plan. - Implementation of vessel speed limitations aligned with Darwin Port Harbourmaster requirements. - Implementation of standard navigational procedures and navigation aids. - Stormwater retention and treatment systems incorporated into Ship Lift facility design. - Reduction of light spill into marine environment from vessels and infrastructure to as low as practically possible. - Preparation and implementation of a Biosecurity Management Plan, including vessel risk assessment and inspection protocols. - Consultation with the Aquatic Biosecurity Unit within the NT Department of Industry, Tourism and Trade to ensure consistency with existing quarantine arrangements for Darwin Harbour facilities.	
Monitoring and reporting requirements	- Monitoring of Observation and Shut-down zones around dredging and piling operations, to mitigate the potential for impacts upon protected marine species. - Reporting of protected marine species observed during dredging and piling operations. - Vessel risk assessment and inspection protocols as per requirements of Biosecurity Management Plan. - Any incidents that have caused environmental harm, or that have the potential to cause environmental harm, will also be reported to the designated DIPL representative and to NT EPA Pollution Hotline (1800-064-567) or, for marine fauna incidents, Marine Wildwatch line (1800-453-941) within 24 hours.

13.4.11 Air quality and greenhouse gases

Table 13-4 Air quality and greenhouse gases construction management measures

Environmental objectives	<i>Maintain air quality and minimise emissions and their impact so that environmental values are protected.</i>
Performance criteria	- No activity in breach of the provisions of any environmental legislation and Project environmental approval conditions. 100% investigation and reporting of any environmental incident at the site. - No complaints from onsite staff or the community regarding dust or air quality.
Proposed mitigation measures	
<i>Air Quality</i> - Develop and implement a Construction Air Quality Management Plan specific to the Project, to be incorporated into the CEMP, prior to the start of construction activity. - Inform adjoining neighbours of intended construction activities. - Limit the intensity of the movement of dusty materials and construction work such as earth moving during periods of high levels of bushfire smoke. - Use a water truck to regularly apply water to unsealed roads or vehicle paths that are in use. At minimum, application of water at a rate of up to 2 litres per square metre per hour (L/m²/h) is required. - Regularly and lightly water dust-prone areas, ensuring not to over-water areas as it can cause damage and erosion. This is recommended for stockpiles and unsealed areas. - Minimise drop heights of materials (e.g., from loaders into tipper trucks). - Removal of topsoil and the importing or storing of soil and other materials must be done with due care to minimise dust. - Seal permanent roads and areas planned to be sealed as soon as practicable. - Cover materials during transport to and from the Project site. - Limit travel speed on site noting that slower speeds produce less dust. Travel speeds in excess of 10 km/h are not recommended on unsealed areas or paths. Speed limits should be sign-posted. - Operate machinery, equipment, vehicles, dredges and support vessels efficiently to minimise exhaust emission. - Clean up residues and spills in a timely manner. <i>Greenhouse gas</i> - Maintain equipment and vehicles to ensure engine efficiency and use fuel efficient equipment where able. - Reduce travel distances off-site by sourcing imported materials from local areas. - Reduce travel distances on-site by planning internal haul roads and staging of related activities efficiently. - Minimise idling time of plant and equipment and switch engines off when not in use. - Look for opportunities to add vegetation; where possible and plant species selected should be both drought tolerant and fast growing. - Where possible prioritise the selection and use of electric equipment (over fuel combustion engines). - Recycle any waste produced where feasible.	
Monitoring and reporting requirements	Air quality impacts at sensitive receptors due to construction and operation of the Project are not predicted to be significant due to the separation distance between the Project and sensitive receptors. Sensitive receptors are well outside the recommended separation distances listed in NT EPA <i>Guideline: Recommended Land Use Separation Distances</i> (2017). Based on the result of the assessment, no air quality monitoring is deemed to be required for the construction of operation phases of the Project.

13.4.12 Terrestrial environmental quality

Table 13-5 Terrestrial environmental quality construction management measures

Environmental objectives	<i>Maintain the quality of land and soils so that the environmental values are maintained.</i>
Performance criteria	• No activity in breach of the provisions of any environmental legislation and Project environmental approval conditions. • 100% investigation and reporting of any environmental incident at the site. • Audit score of 100% compliance on any audits of hazardous goods storage and handling requirements.
Proposed mitigation measures	
• Engineering design to capture all hazardous waste and wastewater runoff. • A water treatment system(including first flush stormwater treatment) installed during Project construction. • Waste management programs which includes a routine waste management program for all waste management systems. • An unexpected finds procedure to identify and manage contaminated materials and ASS that may be encountered during construction. • ASS Management Plan reflecting national standards and current best practice. • The mangrove area will be filled without the removal of trees to ensure there is no exposure of PASS • Materials will be recycled wherever possible. • Waste will be segregated by type on site and collected on a regular basis by a suitably licenced contractor and disposed of at a licenced landfill. • Waste oil will be stored in an appropriate fuel storage bund prior to transportation for appropriate disposal. • Littering on site is prohibited and work and office sites are to be kept clean and tidy. • Rubbish containers are to be carried in all vehicles and provided at all work sites. • Waste management requirements will be addressed in site inductions. • Routine maintenance program will be developed for all waste management systems including wastewater management systems. • All hazardous and dangerous goods will be handled and stored according to the Australian Standards. • Minimise use of hazardous materials where possible and use alternatives where feasible. • Delivery of hazardous materials will be in line with site use to avoid the need to store significant quantities. • Contaminated runoff and contaminated soil will be collected and remediated or transported to a suitable facility for disposal.	

Monitoring and reporting requirements

- Weekly inspections of the site will be conducted.
- Inspections of waste and wastewater management systems will be undertaken as per manufacturer requirements.
- Volumes of waste material and recycled material will be reported via the Annual Report to DIPL.
- Inappropriate waste disposal will be reportable as an incident as per the Construction and Operational Contractors incident reporting processes.
- Inspections of storage tanks and bulk containers and the integrity of bunded areas, pavement and associated containment systems will be conducted on a monthly basis.
- Regular review of handling, storage and use will be undertaken and alternatives will be identified where feasible.
- The results of the hydrocarbon and hazardous management program will be documented by the Operational Contractor in the sites Annual Report to DIPL.
- Any incidents that have caused environmental harm, or that have the potential to cause environmental harm, will also be reported to the designated DIPL representative and to NT EPA Pollution Hotline (1800-064-567) or, within 24 hours.

13.4.13 Terrestrial flora and fauna

Table 13-6 Terrestrial flora and fauna construction management measures

Environmental objectives	<i>Protect the NTs flora and fauna so that biological diversity and ecological integrity are maintained.</i>
Performance criteria	- No activity in breach of the provisions of any environmental legislation and Project environmental approval conditions. 100% investigation and reporting of any environmental incident at the site.
Proposed mitigation measures	
- Management practices to prevent the introduction and spread of weeds and pests during construction will be managed through mitigation measures administered under the CEMP. This will be linked to the Biosecurity Management Plan as appropriate to prevent the introduction of weed or feral/pest species via vessels as appropriate. - Adoption of suitable construction methodologies to minimise impacts from pile driving noise, including monitoring and reactive management protocols to reduce risk of impacts to protect fauna from noise impacts during construction. - Develop and implement a CNVMP to support the CEMP.	
Monitoring and reporting requirements	- Weekly site inspections. - Reporting on environmental incidents including incursions of weed, pest and feral species. - Weed and pest monitoring as required in CEMP and Biosecurity Management Plan.

13.4.14 Surface water and hydrological processes

Table 13-7 Surface water and hydrological processes construction management measures

Environmental objectives	<i>Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and the welfare and amenity of people are protected.</i> <i>Maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.</i>
Performance criteria	- No activity in breach of the provisions of any environmental legislation and Project environmental approval conditions. 100% investigation and reporting of any environmental incident at the site.
Proposed mitigation measures	
- Project design to incorporate stormwater outfall structures with appropriate low velocity minimisation and energy dissipation measures. - Adopt suitable construction methodologies to contain reclamation material. - Ensure that on-site activities are carried out by such practicable means necessary to minimise the contact of incidental rainfall and stormwater runoff with wastes or other contaminants. - Develop and implement an ESCP for areas to be disturbed during construction and operation. - Develop and implement a DDSPMP. - Install operate and maintain stormwater drainage system and stormwater treatment devices - Implement spill and leak prevention and control techniques for land-based activities. - Ensure appropriate spill kits are available and provide training on kit use. - Ensure spillage of wastes, contaminants or other materials are cleaned up as quickly as practicable using procedures that prevent contaminants or material being transferred to the stormwater drainage system. - Implement bunded areas and drainage lines separate from the stormwater drainage in chemical storage and handling areas to reduce the likelihood of chemical contamination of stormwater.	
Monitoring and reporting requirements	- Weekly inspection of stormwater system and drains - Monitor and manage surface water from within the reclamation and material handling areas to meet appropriate water quality criteria before it is allowed to discharge to the marine environment. - Any incidents that have caused environmental harm, or that have the potential to cause environmental harm, will also be reported to the designated DIPL representative and to NT EPA Pollution Hotline (1800-064-567) or, within 24 hours.

13.4.15 Human health

Table 13-8 Human health construction management measures

Environmental objectives	<i>Ensure that risks to human health are identified, understood and adequately avoided and/or mitigated.</i>
Performance criteria	100% investigation and reporting of any environmental incident at the site. - No increase in biting insect populations. - No complaints from onsite staff or the community regarding biting insects.
Proposed mitigation measures	
- Designs and stormwater management plans to include a drainage strategy that prevents water from ponding and becoming a breeding site. - Develop and implement a Biting Insect Management Plan in accordance with NT Department of Health Guidelines. - Monitor impacts associated with disposal of dredge spoil to land (if required). - Ensure Biosecurity Management Plan includes requirements in relation to mosquitoes and international health regulations. - Cultural Heritage Assessment (Appendix M: Cultural Heritage Assessment) including liaison with NT Heritage Branch regarding UXO surveys undertaken to date. - UXO risk assessment to be undertaken prior to construction works. - UXO to be incorporated into the unexpected finds procedure.	
Monitoring and reporting requirements	- If Darwin Port settlement ponds are utilised during construction, a biting insect surveillance program will be developed and implemented as part of the dredge management program if residual ponding for greater than four days is required for sediment settlement to ensure mosquito breeding is detected and controlled until such time that residual ponding is no longer present. Results of the biting insects management and surveillance program will be documented in the Annual Report to DIPL. - Site inspections to identify potential breeding sites. - Any significant mosquito activity will also be reported to DIPL and/or the Medical Entomology Branch and monitored if risks to human health are identified. - If UXO are found in the Project area DIPL and the NT Police should be contacted as per the unexpected finds procedure.

13.5 Operational Environmental Management

The Darwin Ship Lift Facility operator will also be required to prepare an OEMP that is consistent with this framework to ensure that all regulatory and environmental requirements, including imposed conditions and secondary approval conditions, are met. The OEMP will be developed with reference to environmental requirements specified in contractual documents, industry accepted practice and relevant guidelines and standards. The OEMP will be finalised following the detailed design stage of the Project, which may require changes to these management plans. As such, what is presented in this section broadly represents what will be in the final OEMP. The OEMP will be submitted to the NTG for approval prior to commencement of operation.

13.5.1 Key roles and responsibilities

Key roles and responsibilities will be confirmed by the operator on appointment and a Project-specific organisational chart will be developed and maintained by the operator to ensure that adequate resources are available to meet the requirements of the OEMP.

Site management responsibilities will be defined and documented by the operator before operations commence; these will include reporting and communication pathways between the operator and DIPL personnel.

Key roles to be identified include (but are not limited to):

- Operations Manager
- Health Safety, Environment and Quality Advisor
- supervisors
- employees and subcontractors.

13.5.2 Inductions and training requirements

Inductions and training requirements will be determined by the NTG and the operators, and will be in accordance with NTG's and the operator's policies and procedures. All relevant inductions will be completed by all personnel before they begin work on the site.

13.5.2.1 Environmental inductions

All operational personnel will be required to attend an induction session to inform them of their responsibilities under the OEMP. The induction will likely include:

- OEMP requirements
- statutory duties about notification of environmental harm
- environmental incident notification procedures which will include how an event is reported and to whom the event is reported (all incidents are to be reported, including near misses)
- emergency procedures - which will cover the procedure for an emergency and for evacuation of the site in the event of a catastrophic situation arising
- contingency plans - e.g. for hydrocarbon or chemical spills
- environmental data collection and documentation requirements
- complaints management procedures
- key environmental risks and issues
- cultural heritage and cultural awareness training
- hours of operations.

13.5.2.2 Environmental awareness

A variety of tools will be used to further increase awareness of significant environmental and safety issues, and to communicate the relevant requirements documented in environmental and safety management plans. These may include:

- safety/risk assessments
- management meetings
- noticeboards/newsletters/electronic communications
- environmental incident investigations/reports.

It is also envisaged that these mechanisms will provide a vehicle for promoting adaptive management and encouraging the workforce to identify opportunities for continuous improvement.

13.5.2.3 Training

The operator's shall commit to providing sufficient and suitable resources and training to achieve the targets defined in the OEMP, as appropriate. All personnel will have appropriate qualifications and experience for their role. A training register will be developed and maintained that identifies requirements in relation to qualifications, competencies and training requirements.

13.5.3 Incidents, notifications and emergencies

In the NT, the EP Act and the *Waste Management and Pollution Control Act 1998* legislate obligations and duties to prevent environmental harm, environmental nuisance and contamination.

The two primary duties that apply to everyone in the NT are:

- General environmental duty – which means a person must not carry out any activity that causes or is likely to cause environmental harm, unless measures to prevent or minimise the harm have been taken.
- Duty to notify of environmental harm – to inform the administering authority and landowner or occupier when an incident has occurred that may have caused or threatens serious or material environmental harm.

All staff and contractors are required to report all environmental incidents or breaches of the approval conditions in accordance with statutory requirements and the timeframes that will be specified in the OEMP.

Operation-specific incident management procedures will be developed to detail the processes and resources required to respond and manage incidents through to resolution. Incidents shall be tracked through to close out using an incident tracking system or register. Complaints will be investigated by the operations management team and action will be taken to enable satisfactory closeout.

Any incidents that have caused environmental harm, or that have the potential to cause environmental harm, will also be reported to the designated NTG representative and to NT EPA Pollution Hotline (1800-064-567) or, for marine fauna incidents, Marine Wildwatch line (1800-453-941) within 24 hours.

When in any doubt as to the seriousness of the event, the operator will notify the authorities, in liaison with NTG. NTG will also be notified of any notices received from authorities.

13.5.4 Environmental documents and records management

The operators will develop or implement a document management system that fulfils requirements to operate under their OEMP before the commencement of site works.

Operational records, including subcontractor records, will be maintained to provide evidence of conformity to NTG's requirements and commitments in the OEMP.

Such records include, but are not limited to:

- correspondence to/from NTG and interested parties including minute of meetings (where relevant)
- induction and other training records

- environmental procedures and plans
- inspection and monitoring documentation (including calibration)
- non-conformance and corrective action/complaints
- environmental incidents
- audits and inspections
- delivery/waste dockets.

13.5.5 Performance management

Performance management includes activities to ensure that goals and objectives are consistently being achieved in an effective and efficient manner. A key component of the environmental management process is the development and implementation of specific measures to ensure that the environmental risks arising from operations are minimised.

13.5.5.1 Environmental objectives

The environmental objectives for key environmental factors have been defined by the NT EPA. Wherever possible, these objectives should be incorporated in to the OEMP. Draft objectives have been included in Section 13.5.8. These will be confirmed by the operator in consultation with NTG as part of development of the OEMP.

13.5.5.2 Performance criteria

Similarly, performance criteria will be incorporated into the OEMP to assess the effectiveness or mitigation measures and allow for continuous improvement of environmental management. Draft performance criteria have also been included in Section 13.5.8.

Key performance indicators (KPIs) will be defined by the successful Operational Contractors in consultation with NTG. Where performance criteria are not met, this will form a trigger for review of the OEMP and initiate corrective actions specific to the scenario.

General KPI's are likely to include:

- all personnel working on site have undergone an environmental induction
- internal audit score of 100% compliance with the OEMP
- NTG conducted audit score of 100% for compliance with the OEMP
- regulator conducted audit (if applicable) score of 100% for compliance with the OEMP
- no activity in breach of the provisions of any environmental legislation and Project environmental approval conditions
- 100% investigation and reporting of any environmental incident at the site.

13.5.6 Inspections, monitoring and auditing and reporting

Inspections, monitoring, auditing and reporting will be developed and undertaken to document compliance with approval conditions, EIS commitments and the requirements of the OEMP.

13.5.6.1 Inspections/monitoring

Site and facilities inspections will be conducted by site supervisors to ensure compliance with the OEMP. Monitoring will also be undertaken in accordance with the OEMP and other supporting management plans (refer Sections 13.3 and 13.5.8).

Monitoring equipment should be maintained and calibrated in accordance with manufacturers guidelines to ensure reliability of equipment and data. Analysis should be undertaken by a NATA accredited laboratory unless otherwise stated. Monitoring data and results will be maintained in a database, with results reviewed, interpreted and reported in accordance with the developed monitoring and reporting requirements and timeframes.

If monitoring or inspections indicate that activities are not in compliance with the OEMP, necessary corrective actions will be implemented, and authorities informed in accordance with legislative requirements.

Any corrective actions resulting from inspections will be entered onto a 'Non-conformance and Corrective Action Register' and the progress tracked for completion.

13.5.6.2 Internal audits

Internal audit of the OEMP will be undertaken in the following order:

- Prior to commencement of operations to assess the likely effectiveness of the plan in the field and to identify any opportunities for improvement.
- Following a period of operation (three to six months) after the commencement of operations to assess the effectiveness of the implementation of the OEMP, and of the monitoring and reporting procedures being applied. The intent of this audit will be to identify any opportunities for improvement to ensure monitoring, reporting and record keeping are sufficient to support required reporting.
- Further internal audits may be conducted as required during the operation of this facility. These audits will be used to incorporate changes, or to reaffirm the effectiveness of the OEMP.

13.5.6.3 External audits

External audits can be conducted by NTG or third parties, such as other government departments. The NTG may conduct an audit at any time when they believe there is an issue in relation to environmental compliance. The operator will assist with any external audit.

Results from any external audits will be reviewed by the operator, with any necessary corrective actions assigned to operational personnel to ensure appropriate and timely closeout. Any corrective actions will be entered into a corrective action register and the progress tracked to completion.

13.5.6.4 Project corrective action register

Any environmental non-conformance (e.g. incidents, audit-related non-conformance, complaints, government notices) will be recorded in a corrective action register or similar to be developed by the operator. The corrective actions register will detail the non-conformance, the corrective action required, the responsible person(s), the timeframes by which the action is to be completed, and the actual completion date. Each non-conformance will be reviewed, and it will be established if there are any actions available to reduce the severity or likelihood of re-occurrence.

13.5.6.5 Reporting

An incident report will be prepared for the NTG by the operator following a non-compliance event or incident. This report will include (but is not limited to):

- details of the incident
- how the incident was managed
- impacts of the incident
- mitigations to reduce the likelihood of future occurrence.

An Annual Environmental Report will be prepared for each year of operation that will include, but not be limited to, the following:

- a statement of compliance with the approval conditions
- evaluation of compliance with the OEMP
- summary of monitoring data and interpretation of results
- summary of non-compliance events
- relevant trends and interpretation against performance criteria for each environmental aspect.

13.5.7 Complaints management

The operator will develop a Complaints Management Procedure to ensure that complaints are dealt with efficiently and effectively, and stakeholders have confidence in the complaints management system. Complaints can be lodged by stakeholders or any member of the community.

All complaints will be investigated thoroughly to ensure appropriate corrective actions are taken to resolve any issues as appropriate. They will also be recorded and tracked through an Annual Environmental Report to be prepared by the operator (refer Section 13.5.6.5).

NTG will regularly monitor the quality and effectiveness of the complaints management system and revise relevant components where appropriate based on feedback from internal and external sources.

13.5.8 Proposed factor management measures

Mitigation and monitoring measures have been developed for each of the preliminary key environmental factors identified in the ToR as well as other factors identified during the risk assessment, technical studies and stakeholder engagements. For each factor or aspect identified, environmental objective and performance criteria have also been defined as outlined in Table 13-1.

Proposed management measure that needs to be considered during operations are presented below under the following factor headings to maintain consistency with the structure of the technical chapters in this EIS (Chapters 7 through 11):

- Marine Environmental Quality
- Marine Flora and Fauna
- Air Quality and Greenhouse Gases
- Terrestrial Environmental Quality
- Terrestrial Flora and Fauna
- Surface Water and Hydrological Processes
- Human Health.

13.5.9 Marine environmental quality

Table 13-9 Marine environmental quality operational management measures

Environmental objectives	<i>Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.</i>
Performance criteria	• No activity in breach of the provisions of any environmental legislation and Project environmental approval conditions. • 100% investigation and reporting of any environmental incident at the site. • Audit score of 100% compliance on any audits of hazardous goods storage and handling requirements.
Proposed mitigation measures	
• Stormwater treatment system to be maintained. • OEMP to include mitigation to reduce build-up of contaminants on hardstand areas. • Engaging with Port of Darwin regarding the Port Environmental Protection Plan. • Preparation and implementation of a Marine Spill Response Plan in line with the existing Darwin Port Oil Spill Contingency Plan. The plan will also reference the NT (DIPL Marine) OSCP. • Compliance with AS1940-2004 (Storage and handling of flammable and combustible liquids). • Preparation and implementation of a refuelling management plan. • Spill kits to be located at suitable locations on site during construction and operation and appropriate personnel trained in use.	
Monitoring and reporting requirements	• Reactive sediment and water quality sampling frameworks will be implemented in the event of an unplanned release of a pollutant. • Any incidents that have caused environmental harm, or that have the potential to cause environmental harm, will also be reported to the designated NTG representative and to NT EPA Pollution Hotline (1800-064-567) or, within 24 hours.

13.5.10 Marine flora and fauna**Table 13-10 Marine flora and fauna operational management measures**

Environmental objectives	<i>Protect marine flora and fauna so that biological diversity and ecological integrity are maintained.</i>
Performance criteria	- No activity in breach of the provisions of any environmental legislation and Project environmental approval conditions. 100% investigation and reporting of any environmental incident at the Project site.
Proposed mitigation measures	
- Stormwater retention and treatment systems constructed on site to be maintained. - Incorporate spill response measures into OEMP. - Reduction of light spill into marine environment from vessels and infrastructure to as low as practically possible. - Preparation and implementation of a Biosecurity Management Plan, including vessel risk assessment and inspection protocols. - Implementation of vessel speed limitations aligned with Darwin Port Harbourmaster requirements. - Implementation of standard navigational procedures and navigation aids. - Waste management procedures to capture biofouling removed from vessels on the hardstand areas. - Consultation with the Aquatic Biosecurity Unit within the NT Department of Industry, Tourism and Trade to ensure consistency with existing quarantine arrangements for Darwin Harbour facilities.	
Monitoring and reporting requirements	- Vessel risk assessment and inspection protocols as per requirements of Biosecurity Management Plan. - Any incidents that have caused environmental harm, or that have the potential to cause environmental harm, be reported to the designated NTG representative and to NT EPA Pollution Hotline (1800-064-567) or, for marine fauna incidents, Marine Wildwatch line (1800-453-941) within 24 hours.

13.5.11 Air quality and greenhouse gases

Table 13-11 Air quality and greenhouse gases operational management measures

Environmental objectives	<i>Maintain air quality and minimise emissions and their impact so that environmental values are protected.</i>
Performance criteria	- No activity in breach of the provisions of any environmental legislation and Project environmental approval conditions. 100% investigation and reporting of any environmental incident at the site. - No complaints from onsite staff or the community regarding air quality from operation of facility.
Proposed mitigation measures	
- All ships berthed at the Project shall make use of the available shore power. Auxiliary engines should not be in use over prolonged time periods when ships are at berth. - Operate machinery, equipment, vehicles, dredges and support vessels efficiently to minimise exhaust emissions. <i>Blast and paint facility</i> - The blast and paint facility shall be maintained under negative pressure to ensure air emissions are only released via the roof vents. - Air released to atmosphere via the roof exhaust stacks shall be passed through particulate, VOC and odour capturing filters (e.g., activated carbon) prior to exhaust to the atmosphere. <i>Abrasive painting</i> - Test for presence of lead paint before blasting. - When removing tough hull stains, minimise the use of stain removers and consider more abrasive rubbing or polishing compounds. - Place material collected from blasting, sanding and scraping operations in disposal containers to prevent emissions to the atmosphere as soon as practical. <i>Painting</i> - Maximise efficiency of antifouling paint by selecting the most appropriate product for a particular vessel. - When spray painting is required to occur partly outdoors (e.g., to accommodate a vessel larger than the building), fully enclose the vessel (sides, top and floor) or item being painted with temporary screening materials. Weight the edges of the screens to keep them in place. - Use efficient spray equipment (transfer efficiency >65%) such as high-volume spray guns. - Where possible use electrostatic spraying methods. These require less pressure, produce little overspray, and use relatively little paint. - Where appropriate, consider using low-VOC, high solids content and water-based paints or surface preparations instead of traditional paint and primer. - Keep spray guns and lines clean and well maintained to reduce emissions. - Prevent evaporation of solvents by using tight-fitting lids or stoppers. <i>Greenhouse gases</i> - Maintain equipment and vehicles to ensure engine efficiency and use fuel efficient equipment where able - Reduce travel distances off-site by sourcing imported materials from local areas. - Reduce travel distances on-site by planning internal haul roads and staging of related activities efficiently. - Minimise idling time of plant and equipment and switch engines off when not in use. - Look for opportunities to add vegetation; where possible and plant species selected should be both drought tolerant and fast growing. - Where possible prioritise the selection and use of electric equipment (over fuel combustion engines) - Recycle any waste produced where feasible. - Shore power during the operation phase should be procured from renewable energy suppliers where possible. In addition, look for opportunities to generate power on-site (e.g., solar arrays, etc). - Prioritise the selection and use of electric vehicles and equipment (over fuel combustion engines) as much as possible. This would include mobile plant such as forklifts and light vehicles for onsite use. - Maintain equipment and vehicles to ensure engine efficiency and use fuel efficient equipment where able	

Monitoring and reporting requirements

Air quality impacts at sensitive receptors due to construction and operation of the Project are not predicted to be significant due to the separation distance between the Project and sensitive receptors. Sensitive receptors are well outside the recommended separation distances listed in NT EPA *Guideline: Recommended Land Use Separation Distances* (2017).

Based on the result of the assessment, no air quality monitoring is deemed to be required for the construction of operation phases of the Project.

13.5.12 Terrestrial environmental quality**Table 13-12 Terrestrial environmental quality operational management measures**

Environmental objectives	<i>Maintain the quality of land and soils so that the environmental values are maintained.</i>
Performance criteria	• No activity in breach of the provisions of any environmental legislation and Project environmental approval conditions. • 100% investigation and reporting of any environmental incident at the site. • Audit score of 100% compliance on any audits of hazardous goods storage and handling requirements.
Proposed mitigation measures	
• Routine maintenance for all waste management systems. • Routine maintenance of wastewater and water treatment systems with links to Biosecurity Management Plan. • Routine maintenance of stormwater management systems. • Materials will be recycled wherever possible. • Segregation of waste by type on site and collected on a regular basis by a suitably licenced contractor and disposed of at a licenced landfill. • Waste oil will be stored in an appropriate fuel storage bund prior to transportation for appropriate disposal. • Littering on site is prohibited and work and office sites are to be kept clean and tidy. • Rubbish containers are to be carried in all vehicles and provided at all work sites. • Waste management requirements will be addressed in site inductions. • Routine maintenance program will be developed for all waste management systems including wastewater management systems. • All hazardous and dangerous goods will be handled and stored according to the Australian Standards. • Minimise use of hazardous materials where possible and use alternatives where feasible. • Delivery of hazardous materials will be in line with site use to avoid the need to store significant quantities. • Contaminated runoff and contaminated soil will be collected and remediated or transported to a suitable facility for disposal.	

Monitoring and reporting requirements

- Weekly inspections of the site will be conducted.
- Inspections of waste and wastewater management systems will be undertaken as per manufacturer requirements.
- Volumes of waste material and recycled material will be reported via the Annual Report to NTG.
- Inappropriate waste disposal will be reportable as an incident as per the Operational Contractors incident reporting processes.
- Inspections of storage tanks and bulk containers and the integrity of bunded areas, pavement and associated containment systems will be conducted on a monthly basis.
- Regular review of handling, storage and use will be undertaken and alternatives will be identified where feasible.
- The results of the hydrocarbon and hazardous management program will be documented by the operator in the sites Annual Report to NTG.
- Any incidents that have caused environmental harm, or that have the potential to cause environmental harm, will also be reported to the designated NTG representative and to NT EPA Pollution Hotline (1800-064-567) or, within 24 hours.

13.5.13 Terrestrial flora and fauna

Table 13-13 Terrestrial flora and fauna operational management measures

Environmental objectives	<i>Protect the NTs flora and fauna so that biological diversity and ecological integrity are maintained.</i>
Performance criteria	- No activity in breach of the provisions of any environmental legislation and Project environmental approval conditions. 100% investigation and reporting of any environmental incident at the site.
Proposed mitigation measures	
Management practices to prevent the introduction and spread of weeds and feral animal species will be included in the OEMP. This will be linked to the Biosecurity Management Plan as appropriate to prevent the introduction of weed or feral/pest species via vessels as appropriate.	
Monitoring and reporting requirements	- Weekly site inspections. - Reporting on environmental incidents including incursions of weed, pest and feral species. - Weed and pest monitoring as required in CEMP and Biosecurity Management Plan.

13.5.14 Surface water and hydrological processes

Table 13-14 Surface water and hydrological processes operational management measures

Environmental objectives	<i>Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and the welfare and amenity of people are protected.</i> <i>Maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.</i>
Performance criteria	- No activity in breach of the provisions of any environmental legislation and Project environmental approval conditions. 100% investigation and reporting of any environmental incident at the site.
Proposed mitigation measures	
- Ensure rainfall runoff from the washdown, blast and paint bays is captured and treated, consistent with the principles of WSUD. - Contain, and where possible treat and reuse wastewater from wash down and blast and paint bays. - Undertake 'at source' mechanical clean-up of solid waste material to minimise entry to the wastewater system. - Operate and maintain wastewater treatment system and stormwater drainage system and stormwater treatment devices as intended. - Inspect wastewater and stormwater system for the Project weekly to identify any failures and, if necessary, undertake repairs. - Ensure treated wastewater in excess of what can be re-used will be disposed to sewer under a trade waste agreement. - Implement spill and leak prevention and control techniques for land-based activities. - Ensure appropriate spill kits are available and provide training on kit use. - Any spillage of wastes, contaminants or other materials shall be cleaned up as quickly as practicable using procedures that prevent contaminants or material being transferred to the stormwater drainage system. - Install bunded areas and drainage lines separate from the stormwater drainage in chemical storage and handling areas to reduce the likelihood of chemical contamination of stormwater. - Delivery of hazardous materials will be in line with site use to avoid the need to store significant quantities.	
Monitoring and reporting requirements	- Weekly inspection of stormwater system and drains - Monitor and manage surface water from within the reclamation and material handling areas to meet appropriate water quality criteria before it is allowed to discharge to the marine environment. - Any incidents that have caused environmental harm, or that have the potential to cause environmental harm, will also be reported to the designated NTG representative and to NT EPA Pollution Hotline (1800-064-567) or, within 24 hours.

13.5.15 Human health**Table 13-15 Human health operational management measures**

Environmental objectives	<i>Ensure that risks to human health are identified, understood and adequately avoided and/or mitigated.</i>
Performance criteria	• No activity in breach of the provisions of any environmental legislation and Project environmental approval conditions. • 100% investigation and reporting of any environmental incident at the site. • No increase in biting insect populations. • No complaints from onsite staff or the community regarding biting insects.
Proposed mitigation measures	
• Implement a Biting Insect Management Plan in accordance with NT Department of Health Guidelines. • Ensure Biosecurity Management Plan includes requirements in relation to mosquitoes and international health regulations.	
Monitoring and reporting requirements	• Site inspections to identify potential breeding sites. • Any significant mosquito activity will also be reported to NTG and/or the Medical Entomology Branch and monitored if risks to human health are identified.

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Chapter 14

Conclusions

14.0 Conclusions

The NTG's vision is for the Project to be enabling economic infrastructure that will grow the maritime sector and enhance Darwin's competitive advantage as a marine repair and maintenance and sustainment centre for Northern Australia. Government and business stakeholders suggest the facility will be foundational infrastructure for a marine services precinct, consolidating a range of marine services on the East Arm Peninsula.

The Project will enable maintenance and servicing of a broad range of industries including the ADF and ABF vessels and for commercial and private vessels (oil, gas, pearling, fishing and other marine industries). The Project will support the continued economic growth of Darwin as a logistics and marine services hub of the NT and Northern Australia.

The NT EPA determined that the Project has the potential to have significant environmental impacts on the following NT EPA factors (NT EPA, 2018):

- marine environmental quality
- marine flora and fauna
- air quality and greenhouse gases
- social, economic and cultural surroundings.

The findings from assessments conducted as part of this EIS on the potential impacts to each of these factors are described below.

14.1 Marine Environmental Quality

Potential impacts to marine environmental quality due to construction and operational activities associated with the Project have been assessed. The primary impact to marine environmental quality during the construction of the Project will be associated with elevated suspended sediment concentrations resulting from dredging and reclamation activities. Sediment sampling and sediment transport modelling has been undertaken to predict the areas of potential impact associated with dredging and reclamation activities; these were found to be restricted to the Project footprint for most of the time and unlikely to extend to the nearest sensitive hard coral and filter feeder communities at South Shell Island.

The potential for water quality impacts during operations will largely be reduced by in-built design mitigations such as containment and treatment of all stormwater and wastewater on site before disposal via licensed discharges onshore, or into Darwin Harbour under applicable licenses and limits.

14.2 Marine Flora and Fauna

The greatest potential risk of impacts to marine flora and fauna is considered to be via the introduction of non-native marine pest species. However, robust vessel risk assessment and inspection protocols have been demonstrated to be an effective means of mitigating the risk of such introductions. Such protocols were implemented for the substantial INPEX Ichthys construction program that engaged a considerably greater number of vessels than will be involved with construction and operation of the Project.

The marine communities that will be disturbed during Project construction are widely distributed within East Arm and the broader Darwin Harbour. Although the values of these ecosystems are recognised, the area of loss is considered to be sufficiently small that there is negligible risk of detectable impacts upon the ecological function of the East Arm or Darwin Harbour ecosystems.

The predicted area in which adverse underwater noise and vibration levels may potentially occur does not extend across the full width of East Arm; hence, it is predicted that there is minimal potential for disruption of passage of any species between Elizabeth River and the main Harbour. Incremental increase in vessel traffic associated with the construction and operation of the Project will not be of a sufficient magnitude to represent a significantly greater risk of impacts upon benthic communities, or

individuals and populations of marine fauna. The potential for impacts upon marine flora and fauna via contaminant release and light spill during operations will be reduced through Project design mitigations including the containment and treatment of stormwater and wastewater on site before disposal via licensed discharges onshore, or into Darwin Harbour.

14.3 Air Quality and Greenhouse Gases

An air quality assessment was undertaken for the Project. Both construction and operational impacts were modelled for the Project to assess the potential impacts on the receiving existing environment at nearby sensitive receptors. There were no exceedances of the identified goals for construction or operation for any pollutant or averaging period, and no significant impact was predicted for any pollutant at sensitive receptors. Relevant mitigation commitments were identified and applied to the emission rates where applicable. Overall, the air quality assessment determined that no significant air quality or odour impacts are likely to occur as a result of the construction or operation phases of the Project and air quality monitoring is not deemed to be required for the Project.

GHG emission sources were identified for both the construction and operation phases, with Scope 1 and Scope 2 emissions estimated using NGER guidance and reference material. A comparison to the NT and Australian benchmark for reported emissions from 2019 data estimated a less than 1% contribution to total NGER reported emissions across the Industrial Processes and Product sector and all sectors for the NT.

14.4 Social, Economic and Cultural Surroundings

The SIA identified significant cumulative economic opportunities arising from the Project that will contribute to developing Darwin's capacity as a maritime service and supply hub, and transport and logistics precinct on East Arm. The Project is well positioned to contribute to the economic growth, enhanced capacity of the maritime sector and workforce development. Cumulative additive and interactive impacts of development in Darwin Harbour were identified as a concern to stakeholders. However, the contribution of the Project to cumulative impacts on values of the harbour is considered minimal. Further mitigation of cumulative impacts will need to be considered across other developments in the area, such as the Middle Arm project. The results of the SIA will be used to further inform the strategic assessment currently being undertaken for the Middle Arm project to ensure mitigation measures for the two projects are aligned.

While no Indigenous sites are within the Project footprint, the Project is close to two registered Sacred Sites protected under the *NT Aboriginal Sacred Sites Act 1989*. These sites, Catalina Island and Old Man Rock, are on the AAPA register of sacred sites. A current AAPA certificate has been obtained for the Project which outlines management requirements in relation to these sites.

The stakeholder consultation found that the loss of World War II historical remnants is a probable impact of concern, despite their lack of formal heritage status. The recommendations propose interpretative signage close to the Project to indicate that the area was once the location of FBB and the LMS and its significance as a base for Allied operations in the South-West Pacific Area during World War II.

14.5 Environmental management

Risks have been assessed both pre and post-mitigation to identify residual impacts that may persist following the implementation of mitigation and management measures. These mitigation and management measures have been incorporated into an environmental management framework for the delivery of the Project. This framework defines the parameters for the preparation of subsequent CEMPs and OEMPs to ensure that potential impacts and risks associated with the delivery of the Project are managed and monitored. The environmental management framework identifies and describes the relevant management plans that are required for the Project's construction and operation and enable the NTG to fulfil its environmental and social commitments and obligations.

14.6 Concluding remarks

The NTG has consulted with key stakeholders while completing the Project feasibility studies over the past five years. The SIMP for this study incorporates the results of both technical studies and stakeholder feedback for the SIA in outlining measures and commitments likely to enhance the positive benefits and reduce the likelihood of potential adverse impacts from the Project.

Secondary approvals and permits under NT legislation will also be required for the construction and operation of the Project following the completion of the EIS process. Approval conditions and legislative requirements associated with these approvals and permits will be incorporated into subsequent environmental management plan revisions. Final dredging programs will be subject to Developmental Consent and approval of a Dredging and Dredge Spoil Placement Management Plan. As such the impacts and proposed measures to manage and mitigate resulting impacts can be considered further by regulators once the detailed design has been completed. Stakeholders will also be provided further opportunity to comment on these programs as part secondary approval processes.

In addition to secondary approvals the Project has been referred under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). As the Project has undergone material changes since the original referral, the NTG will submit a new referral concurrently with this draft EIS. The new referral is likely to be available for public comment in November 2021 on the EPBC referrals website.

NTG commits to an ongoing engagement and communication strategy during the development of the Project and broader marine industry precinct. Project information will continue to be posted on the Project website (<https://cmc.nt.gov.au/advancing-industry/ship-lift>).

References

15.0 References

Executive Summary

[Department of Infrastructure, Planning and Logistics \(DIPL\)](https://dipl.nt.gov.au/data/assets/pdf_file/0004/428854/ntg-10-year-infrastructure-plan-web.pdf), 2017, *10 Year Infrastructure Plan 2017 – 2026*, Northern Territory Government plan, available at https://dipl.nt.gov.au/data/assets/pdf_file/0004/428854/ntg-10-year-infrastructure-plan-web.pdf

Department of Infrastructure, Planning and Logistics (DIPL) 2019, *10 Year Infrastructure Plan 2019-2028*, Northern Territory Government, available at https://dipl.nt.gov.au/data/assets/pdf_file/0007/769408/10-year-infrastructure-plan-2019-web.pdf

Kellogg, Brown & Root Pty Ltd (KBR), 2018, *Darwin Ship Lift Facility and Marine Industries Project – Notice of Intent*, prepared for Northern Ship Support Pty Ltd.

Northern Territory Environment Protection Authority (NT EPA) 2018, *Statement of Reasons – Northern Ship Support Pty Ltd – Darwin Ship Lift and Marine Industries (SLAMI) Project*. Northern Territory Environment Protection Authority.

Project Description

Department of Agriculture Fisheries and Forestry (DAFF) 2009a, *National Biofouling Management Guidance for Commercial Vessels*, Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Department of Agriculture Fisheries and Forestry (DAFF) 2009b, *National Biofouling Management Guidance for Non-Trading Vessels*, Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Department of Agriculture Fisheries and Forestry (DAFF) 2010, *Australian Marine Pest Monitoring Manual*. Version 2.0. Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Department of Agriculture and Water Resources (DAWR) 2017, *Australian Ballast Water Management Requirements*, Version 7, Department of Agriculture and Water Resources, Commonwealth of Australia.

Department of Infrastructure, Planning and Logistics (DIPL) 2019, *10 Year Infrastructure Plan 2019-2028*. Northern Territory Government, available at https://dipl.nt.gov.au/data/assets/pdf_file/0007/769408/10-year-infrastructure-plan-2019-web.pdf

Department of Lands, Planning and the Environment (DLPE) 2015, *Darwin Regional Land Use Plan 2015*, available at <https://planningcommission.nt.gov.au/projects/drlup>, accessed 17 December 2020

Northern Territory Department of Lands 1984, *Darwin Regional Structure Plan 1984*.

Northern Territory Department of Lands and Housing 1990, *Darwin Regional Land Use Structure Plan 1990*.

Northern Territory Environment Protection Authority (NT EPA) 2018, *Term of Reference for the Preparation of and Environmental Impact Statement - Darwin Ship Lift and Marine Industries Project*.

Northern Territory Environment Protection Authority (NT EPA) 2015, *NT EPA Waste Management Strategy for the Northern Territory 2015 – 2022*.

Northern Territory Department of Lands and Housing 1990, *Darwin Regional Land Use Structure Plan 1990*.

Northern Territory Government (NTG) 2008, *Strategic Development Area, East Arm/Middle Arm Peninsulas Masterplan 2008*, Northern Territory Government.

Northern Territory Government 2020, *Northern Territory Planning Scheme (NTPS) 2020*.

Strategic and Statutory Framework

Australia and New Zealand Guidelines for Fresh and Marine Water Quality 2018, Accessed at <https://www.waterquality.gov.au/guidelines/anz-fresh-marine>, Accessed March 2021.

Australian Government 1994, National Environment Protection (National Pollutant Inventory) Measure 1994, accessed at <https://www.legislation.gov.au/Details/F2008C00620>, Accessed March 2021.

Australian Government 1998, National Environment Protection (Ambient Air Quality) Measure, Available at <https://www.legislation.gov.au/Details/F2016C00215>, Accessed March 2021.

Australian Government 2004, National Environment Protection (Air Toxics) Measure, Available at <https://www.legislation.gov.au/Details/F2011C00855>, Accessed March 2021.

Australia International Council on Monuments and Sites (ICOMOS) 2013, *The Burra Charter: The Australia ICOMOS charter for places of cultural significance*, Accessed at <https://australia.icomos.org/publications/burra-charter-practice-notes/>, Accessed March 2021

Commonwealth of Australia 2009, *National assessment guidelines for dredging*, Accessed at <https://www.environment.gov.au/marine/publications/national-assessment-guidelines-dredging-2009>, Accessed March 2021.

Commonwealth of Australia 2010, *The national system for the prevention and management of marine pest incursions*, Accessed at <https://www.marinepests.gov.au/sites/default/files/Documents/australian-marine-pest-monitoring-guidelines.pdf>, Accessed March 2021.

Commonwealth of Australia 2015, *Anti-fouling and in-water cleaning guidelines*. Accessed at <https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/animal-plant/pests-diseases/marine-pests/antifouling-consultation/antifouling-guidelines.pdf>, Accessed March 2021.

Commonwealth of Australia 2018a, *National Water Quality Management Strategy*, Accessed at https://www.waterquality.gov.au/sites/default/files/documents/nwqms-charter_0.pdf, Accessed August 2021.

Commonwealth of Australia 2018b, *National Acid Sulfate Soils Guidance – A synthesis*, Accessed at <https://www.waterquality.gov.au/sites/default/files/documents/national-acid-sulfate-soils-guidance-synthesis.pdf>, Accessed August 2021.

Darwin Harbour Advisory Committee 2020, *Darwin Harbour Strategy 2020-2025*, Accessed at https://nt.gov.au/_data/assets/pdf_file/0008/915038/darwin-harbour-strategy-2020-2025.pdf, Accessed March 2021.

Department of Agriculture, Water and the Environment (DAWE) 2021a, *EPBC Protected Matters Search Tool*, Accessed at <https://www.environment.gov.au/epbc/protected-matters-search-tool>, Accessed March 2021.

Department of Agriculture, Water and the Environment (DAWE) 2021b, *Underwater Cultural Heritage Register*, Accessed at <https://www.environment.gov.au/heritage/underwater-heritage/auchd>, Accessed March 2021.

Department of Infrastructure, Planning and Environment (DIPE) 2003, *Mangroves in the Northern Territory*, Accessed at https://nt.gov.au/_data/assets/pdf_file/0007/204694/mangrove-education-pack.pdf, Accessed March 2021.

Department of Infrastructure, Planning and Environment (DIPE) 2004, *Northern Territory Road Safety Strategy 2004 – 2010: Reduced Road Trauma*, Accessed at https://roadsafety.nt.gov.au/_data/assets/pdf_file/0004/484708/Towards-Zero-FINAL-FOR-PRINT-Discussion-document-17-May.pdf

Department of Infrastructure, Planning and Environment (DIPE) 2018, *Road Safety Action Plan 2018 – 22*, Accessed at https://roadsafety.nt.gov.au/_data/assets/pdf_file/0007/466675/Towards-Zero-Action-Plan-v18.1.pdf.

Department of Infrastructure, Planning and Environment (DIPE) 2019, *Standard specifications for environmental management – Version 2*, Accessed at <https://dipl.nt.gov.au/industry/technical-standards-guidelines-and-specifications/technical-specifications/environmental-management>, Accessed March 2021.

Department of Land Resource Management (DLRM) 2014, *Darwin Harbour Water Quality Protection Plan*, Accessed at https://depws.nt.gov.au/_data/assets/pdf_file/0011/254855/Water-Quality-Protection-Plan-Feb2014-web.pdf, Accessed March 2021.

Department of Transport 2015, *Development Guidelines for Northern Territory Government Controlled Roads*, Version 1.0, Accessed at https://nt.gov.au/_data/assets/pdf_file/0003/165351/development-guidelines-for-ntg-controlled-roads.pdf, Accessed March 2021.

Development of Northern Australia 2012, *Darwin Port Expansion Plan: Australia's Gateway to Asia – Draft 2012*, Accessed at <https://www.aph.gov.au/DocumentStore.ashx?id=8f61d209-e589-4ba0-8f88-64256767ae47&subId=206634>, Accessed March 2021.

Environment Australia, 1999, *Emission estimation technique manual for shipbuilding repair and maintenance 1999*, Available at <http://npi.gov.au/resource/emission-estimation-technique-manual-shipbuilding-repair-and-maintenance>.

Environment Protection Authority, South Australia, 2017, *Code of practice for vessel and facility management (marine and inland waters)*, Accessed at <https://ablis.business.gov.au/service/sa/code-of-practice-for-vessel-and-facility-management-marine-and-inland-waters-/583>, Accessed March 2021.

Environmental Protection Authority, Western Australia 2010, *Environmental Assessment Guideline No.5 - environmental assessment guideline for protecting marine turtles from light impacts*, Accessed at <https://www.epa.wa.gov.au/policies-guidance/environmental-assessment-guideline-protecting-marine-turtles-light-impacts-eag-5>, Accessed March 2021.

Environmental Protection Authority, Western Australia 2016a, *Technical guidance – protecting the quality of Western Australia's marine environment*, Accessed at <https://www.epa.wa.gov.au/policies-guidance/technical-guidance-protecting-quality-western-australia%E2%80%99s-marine-environment>, Accessed March 2021.

Environmental Protection Authority, Western Australia 2016b, *Technical guidance – protection of benthic communities and habitats*, Accessed at <https://www.epa.wa.gov.au/policies-guidance/technical-guidance-protection-benthic-communities-and-habitats>, Accessed March 2021.

International Association for Impact Assessment (IAIA) 2015, *Social Impact Assessment: Guidance for assessing and managing the social impacts of projects*, Accessed at https://www.iaia.org/uploads/pdf/SIA_Guidance_Document_IAIA.pdf, Accessed March 2021.

International Association for Public Participation (IAP2) 2015, *Quality Assurance Standard for community engagement*, Accessed at https://iap2.org.au/wp-content/uploads/2019/07/IAP2_Quality_Assurance_Standard_2015.pdf, Accessed March 2021.

International Association for Public Participation (IAP2) 2016, *Core Values*, International Association for Public Participation Australasia, Accessed at <https://iap2.org.au/about-us/about-iap2-australasia/core-values/>, Accessed March 2021.

International Erosion Control Association (Australasia) 2008, *Best practice in erosion and sediment control manual*, Accessed at <https://www.austieca.com.au/publications/best-practice-erosion-and-sediment-control-bpesc-document>, Accessed March 2021.

Kellogg Brown & Root Pty Ltd (KBR) 2018, *Darwin Ship Lift Facility and Marine Industries Project - Notice of Intent*, Prepared for Northern Ship Support Pty Ltd.

Northern Territory Department of Lands and Housing 1990, *Darwin Regional Land Use Structure Plan 1990*, Accessed at https://nt.gov.au/_data/assets/pdf_file/0007/240289/darwin-regional-land-use-structure-plan.pdf, Access March 2021.

New South Wales Environment Protection Authority (NSW EPA) 2014, *Waste classification guidelines, Part 1: Classifying waste*, Accessed at <https://www.epa.nsw.gov.au/your-environment/waste/classifying-waste/waste-classification-guidelines>, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2006, *Environmental Guidelines for Reclamation in Coastal Areas*, Accessed at https://nt.gov.au/_data/assets/pdf_file/0011/228989/environmental-guidelines.pdf, Access March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2013a, *Guidelines for Assessment of Impacts on Terrestrial Biodiversity, Version 2.0*, Accessed at https://ntepa.nt.gov.au/_data/assets/pdf_file/0004/287428/guideline_assessment_terrestrial_biodiversity.pdf, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2013b, *Guidelines for the environmental assessment of marine dredging in the Northern Territory, Version 2.0*, Accessed at https://ntepa.nt.gov.au/_data/assets/pdf_file/0007/287422/guideline_assessments_marine_dredging.pdf, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2013c, *Guidelines on Mixing Zones, Version 1.2*, Accessed at

https://ntepa.nt.gov.au/_data/assets/pdf_file/0011/284681/guidelines_mixing_zones.pdf, Accessed March 2021

Northern Territory Environment Protection Authority (NT EPA) 2014a, *Guidelines on Waste Discharge Licensing under the Water Act, Version 1.0*, Accessed at https://ntepa.nt.gov.au/_data/assets/pdf_file/0005/950603/guidelines_waste_discharge_licences.pdf, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2014b, *A Stormwater Strategy for the Darwin Harbour Region, Version 1.0*, Accessed at https://ntepa.nt.gov.au/_data/assets/pdf_file/0004/284872/stormwater_strategy_darwin_harbour.pdf, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2015a, *Waste Management Strategy for the Northern Territory 2015 – 2022*, Accessed at https://ntepa.nt.gov.au/_data/assets/pdf_file/0008/284948/ntepa_waste_strategy_2015_2022.pdf, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2015b, *Guidelines to Prevent Pollution from Building Sites, Version 1*, Accessed at https://ntepa.nt.gov.au/_data/assets/pdf_file/0010/284680/guideline_prevent_pollution_building_sites.pdf, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2017, *Guideline: Recommended Land Use Separation Distances*, Accessed at https://ntepa.nt.gov.au/_data/assets/pdf_file/0006/453192/guideline_recommended_land_separation_distances_oct.pdf, Accessed August 2021.

Northern Territory Environment Protection Authority (NT EPA) 2018a, *Statement of Reasons – Northern Ship Support Pty Ltd – Darwin Ship Lift and Marine Industries (SLAMI) Project*.

Northern Territory Environment Protection Authority (NT EPA) 2018b, *Term of Reference for the Preparation of and Environmental Impact Statement - Darwin Ship Lift and Marine Industries Project*.

Northern Territory Environment Protection Authority (NT EPA) 2018c, *NT EPA Environmental Factors and Objectives, February 2018 Version 1.0*, Accessed at https://ntepa.nt.gov.au/_data/assets/pdf_file/0005/546791/guideline_environmental_factors_objectives.pdf, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2018d, *Opportunities and timeframes for community engagement in the environmental assessment process, February 2018 Version 1.0*, Accessed at https://ntepa.nt.gov.au/_data/assets/pdf_file/0006/546792/guideline_opportunities_timeframes_community_engagement_eia_process.pdf, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2018e, *Northern Territory Noise Management Framework Guideline*, Accessed at <https://ntepa.nt.gov.au/news/2018/nt-noise-management-framework-guideline>, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2018f, *Northern Territory Guidance on Adaptive Management*, Accessed at <https://ntepa.nt.gov.au/consultation/guidance-adaptive-management>, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2019, *General Guidance for Proponents Preparing an Environmental Impact Statement – October 2019*.

Northern Territory Environment Protection Authority (NT EPA) 2019b, *Guidance for proponents – stakeholder engagement*, Accessed at <https://ntepa.nt.gov.au/news/2019/guidance-for-proponents-stakeholder-engagement>, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2020, *Preparing an EIS – Environmental impact assessment guidance for proponents*, Accessed at https://ntepa.nt.gov.au/_data/assets/pdf_file/0009/818217/guidance-preparing-eis-g8-public-comment.pdf, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2021b, *Waste Discharge Licence – Northern Territory*, Accessed at <https://ablis.business.gov.au/service/nt/waste-discharge-licence/3318>, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2021a, Stakeholder Engagement and Consultation: Environmental impact assessment guidance for proponents Accessed at https://ntepa.nt.gov.au/_data/assets/pdf_file/0005/884696/guidance-proponents-stakeholder-engagement-and-consultation.pdf, Accessed September 2021.

Northern Territory Government (NTG) 2010, *Water Quality Objectives for the Darwin Harbour Region*. Accessed at https://depws.nt.gov.au/_data/assets/pdf_file/0003/254856/WQGO_for_DH_Feb_2010_final.pdf, Accessed March 2021.

Northern Territory Government (NTG) 2012, *Greater Darwin Plan 2012*, Accessed at https://planinc.org.au/images/stories/pdfs/Greater_Darwin_Plan_Full_1.3.2012.pdf, Accessed March 2021.

Northern Territory Government (NTG) 2015, *Darwin Regional Land Use Plan*, Accessed at https://nt.gov.au/_data/assets/pdf_file/0019/240247/darwin-regional-land-use-plan-2015.pdf, Accessed March 2021.

Northern Territory Government (NTG) 2017, *Guidelines for Preventing Mosquito Breeding Associated with Construction Practice near Tidal Areas in the NT*, Accessed at <https://digitallibrary.health.nt.gov.au/prodjsui/bitstream/10137/2687/2/Construction%20practice%20near%20tidal%20areas%20Dec%202017.pdf>, Accessed March 2021.

Northern Territory Government (NTG) 2019a, *Coastal and Marine Management Strategy (2019-2029)*, Accessed at <https://depws.nt.gov.au/programs-and-strategies/coastal-and-marine-management>, Accessed March 2021.

Northern Territory Government (NTG) 2019b, *10 Year Infrastructure Plan 2019- 2028*, Accessed at <https://dipl.nt.gov.au/industry/10-year-infrastructure-plan-2019-annual-review>, Accessed March 2021.

Northern Territory Government (NTG) 2019c, *Northern Territory Climate Change Response. Towards 2050*, Accessed at <https://apo.org.au/sites/default/files/resource-files/2019-09/apo-nid259766.pdf>, Accessed March 2021.

Northern Territory Government (NTG) 2020a, *Northern Territory Planning Scheme (NTPS) 2020*.

Northern Territory Government (NTG) 2020b, *Land Clearing Guidelines, Version 1.2*, Accessed at https://nt.gov.au/_data/assets/pdf_file/0007/236815/land-clearing-guidelines.pdf, Accessed March 2021.

Northern Territory Government (NTG) 2021a, *NT Fauna Atlas*, Darwin, Northern Territory, Australia. Accessed at <https://nt.gov.au/environment/environment-data-maps/fauna-atlas>, Accessed March 2021.

Northern Territory Government (NTG) 2021b, *NT Flora Atlas Datasets*, Darwin, Northern Territory, Australia, Accessed at <https://data.nt.gov.au/dataset?tags=Biota&organization=department-of-environment-and-natural-resources>, Accessed March 2021.

Northern Territory Government (NTG) 2021c, *Statutory Weed Management Plans*, Accessed at <https://nt.gov.au/environment/weeds/how-to-comply-with-the-law/statutory-weed-management-plans>, Accessed March 2021.

Northern Territory Government (NTG) 2021d, *Northern Territory Heritage Register*, Accessed at <https://dtsc.nt.gov.au/nt-heritage-council>, Accessed March 2021.

PowerWater, 2021, *Trade Waste*, Accessed at <https://www.powerwater.com.au/developers/water-development/trade-waste>, Accessed March 2021.

Simpson, S.L, Batley, G.E, Charlton, A.A, Stauber, J.L, King, C.K, Chapman, J.C., Hyne, R.V, Gale, S.A, Roach, A.C, Maher, W.A. 2005, *Handbook for Sediment Quality Assessment*, Accessed at http://www.clw.csiro.au/publications/cecr/handbook_sediment_quality_assessment.pdf, Accessed March 2021.

Simpson, S.L, Batley, G.E 2016, *Sediment Quality Assessment. A Practical Guide, Second Edition*. Accessed at https://www.researchgate.net/publication/287218086_Sediment_Quality_Assessment_A_Practical_guide, Accessed March 2021.

Environmental Setting

AECOM 2020, *Marine Sediment Geochemical Assessment – Darwin Ship Lift Project*, Report prepared by AECOM for the Department of Chief minister and Cabinet, Doc. R1890/M&C4170, November 2020.

AECOM 2021, *Preliminary Site Investigation – Darwin Ship Lift Project*, Report prepared for the Department of Chief minister and Cabinet.

Australian Bureau of Statistics (ABS) 2020, *Region summary: Greater Darwin*, Accessed at <https://dbr.abs.gov.au/region.html?lyr=gccsa&rqn=7GDAR>, Accessed July 2021.

Australian Institute of Science (AIMS) 2020, *Index of Marine Industry 2020*, Townsville: Australian Institute of Marine Science. Retrieved from <https://www.aims.gov.au/aims-index-of-marine-industry>.

Bureau of Meteorology (BoM) 2021, Climate statistics for Australian locations, Monthly climate statistics, Summary statistics Darwin Airport, Accessed at http://www.bom.gov.au/climate/averages/tables/cw_014015.shtml, Accessed August 2021.

Bureau of Meteorology (BoM) 2021, Tropical cyclone reports, accessed at <http://www.bom.gov.au/cyclone/tropical-cyclone-knowledge-centre/history/past-tropical-cyclones/>, Accessed August 2021.

Burns, T 1997, *A Report on Aboriginal Shell Midden Sites at Winnellie, Darwin Harbour*, Unpublished report prepared for the Heritage Conservation Branch, Department of Lands Planning and Environment, Darwin, NT.

Brocklehurst, P. and Edmeades, B 1996, *The mangrove communities of Darwin Harbour. Technical Memorandum No. R96/9*, Resource Capability Assessment Branch, Department of Lands, Planning and Environment, Darwin, NT.

City of Palmerston 2018, Community Plan, Palmerston: City of Palmerston, Retrieved from https://www.palmerston.nt.gov.au/sites/default/files/uploads/files/2019/CoP_Community%20Plan.pdf.

Cosmos Archaeology 2015, *East Arm Multi-user Barge Ramp Facility (MUBRF), Darwin Harbour, Northern Territory: Recovered Cultural Objects Maritime Archaeological Analysis Report*, Unpublished Report to NT Heritage Branch, NT Department of Tourism, Sport and Culture.

Cosmos Archaeology 2017. *WWII East Arm Flying Boat Base Jetty, Darwin Harbour, Northern Territory, Archaeological Survey and Artefact Analysis*. Unpublished Report to NT Heritage Branch, NT Department of Tourism, Sport and Culture.

Commonwealth of Australia 2020. State of the Climate 2020, Accessed at <http://www.bom.gov.au/state-of-the-climate/documents/State-of-the-Climate-2020.pdf>, Accessed August 2021.

Commonwealth Scientific and Industrial Research Organisation (CSIRO) 2020, Climate change in the Northern Territory- state of the science and climate change impacts, September 2020, accessed https://depws.nt.gov.au/_data/assets/pdf_file/0011/944831/state-of-the-science-and-climate-change-impacts-final-report.pdf. Accessed August 2021.

Currey, N 1988, *Darwin Harbour Ambient Water Quality*, In Larson, HK, Michie, MG and Hanley, JR (eds), Darwin Harbour: proceedings of a workshop on research and management held in Darwin 2–3 September 1987. Mangrove Monograph No. 4, Australian National University North Australian Research Unit, Darwin.

Darwin Harbour Advisory Committee (DHAC) 2006, *Sediment, nutrients, organic matter and metals input to Darwin Harbour from its catchment, and the ecological impacts on the Harbour*, DHAC, Darwin, NT.

Darwin Harbour Advisory Committee (DHAC) 2003, *Darwin Harbour Regional Plan of Management*, Darwin Harbour Advisory Committee, Department of Infrastructure, Planning and Environment, Darwin, Accessed at https://nt.gov.au/_data/assets/pdf_file/0007/661804/darwin-harbour-strategy-managment-plan-2003.pdf. Accessed September 2021.

DHAC (2020), Darwin Harbour Strategy 2020-2025, Darwin Harbour Advisory Committee, NT Government, July 2020.

Department of Health 2011, *East Arm Port Expansion Project - Biting Insect Investigation October to December 2010*, prepared for URS Australia Pty Ltd, Medical Entomology Centre for Disease Control, February 2011.

Department of Trade Industry and Tourism 2021, *Maritime Industry Development Plan Discussion Paper*. Darwin: Northern Territory Government, Accessed at <https://industry.nt.gov.au/industries/maritime-industry>. Accessed August 2021.

Department of Land Resource Management (DLRM) 2014, *Darwin Harbour Water Quality Protection Plan*, Northern Territory Department of Land Resource Management, Darwin, NT, Australia.

Department of Trade Industry and Tourism (DLRM) 2021, *Maritime Industry Development Plan Discussion Paper*. Darwin: Northern Territory Government, Accessed at <https://industry.nt.gov.au/industries/maritime-industry>, Accessed August 2021.

Department of Treasury and Finance 2021, *Budget and Regional Overview*, Darwin: Northern Territory Department of Treasury and Finance, Retrieved from https://budget.nt.gov.au/data/assets/pdf_file/0007/1000411/2021-22-Budget-Regional-book.pdf.

Department of Industry, Science, Energy and Resources 2021, *National Greenhouse Accounts*, Accessed at <https://www.industry.gov.au/data-and-publications/national-greenhouse-accounts-2019/state-and-territory-greenhouse-gas-inventories-annual-emissions>, Accessed August 2021.

Dermoudy, P 1993, *East Arm Port Development EIS*, An unpublished report for ACER Vaughan Consulting Engineers, Darwin.

Drewry, J, Fortune, J, Majid, M 2010, *Flood plume water quality and spatial distribution of water quality indicators in Elizabeth River Estuary, Darwin Harbour*, Report No. 20/2010D, Department of Natural Resources, Environment, the Arts and Sport, Palmerston, NT, Australia.

Douglas Partner 2015, *Assessment of Marine Sediment, Proposed Marine Industry Park East Arm, Northern Territory*, Document number R.004, 21 September 2015.

Earthsea Pty Ltd (Earthsea) 2011, *Archaeological Survey of the East Arm Wharf Expansion, Darwin NT*, Unpublished Report prepared for URS Corporation and Land Development Corporation, Darwin.

Earthsea Pty Ltd (Earthsea) 2021, *Archaeological and Heritage Assessment: Proposed Darwin Ship Lift, NT*, Report prepared for AECOM Australia.

Ecological Management Services (EMS) 2011, *East Arm Wharf Expansion Project – Terrestrial Flora and Fauna Assessment*, Report prepared for URA Australia/ Northern Territory department of Lands and Planning.

G-TEK 2017, *Unexploded Ordnance Desktop Investigation SLAMI Site East Arm, Darwin, Northern Territory*, V2.01 19 December 2017.

Hanley, J. R 1988, *Invertebrate fauna of marine habitats in Darwin Harbour*, In H.K. Larson, M.G. Michie and J.R. Hanley (eds) *Proceedings of the Workshop on Research and Management in Darwin Harbour*. Australian National University North Australia Research Unit, Australian National University Press, Canberra, ACT. Hanley, JR and Caswell, GM (1995), *East Arm Port - Stage 1. Water Quality Monitoring Program. Report on Setup Phase and Baseline Data Collection*. Marine Ecology Technical Report 95/1.

i.d community, 2020. *City of Palmerston LGA, About the profile areas*. Accessed at <https://profile.id.com.au/rda-northern-territory/about?WebID=200>. Accessed July 2021.

Kellogg Brown and Root (KBR) 2018, *Notice of Intent – Darwin Ship Lift Facility and Marine Industries Project*, Prepared for Northern Ship Support Pty Ltd.

Lilleyman, A., Lawes, M.J. and Garnett, S 2013, *Migratory Shorebirds in Darwin Harbour, Northern Territory*, Report for the Northern Territory Government, Research Institute for the Environment and Livelihoods, Charles Darwin University, Darwin, Northern Territory.

Northern Territory Environment Protection Agency (NT EPA) 2021, *NT EPA air quality monitoring data*, Accessed at: <http://ntepa.webhop.net/NTEPA/Default.ltr.aspx>, Accessed August 2021.

Northern Territory Government (NTG) 1983, *1:100,000 scale geological maps (Darwin Sheet 5073)*.

Northern Territory Government (NTG) 2021a, *Declared Weeds in the Northern Territory*, Accessed at https://nt.gov.au/data/assets/pdf_file/0016/252133/declared-weeds-in-the-nt.pdf, Accessed September 2021.

Northern Territory Government (NTG) 2021b, *Darwin History*, Accessed at <https://www.darwin.nt.gov.au/community/about-darwin/history>, Accessed September 2021.

Padovan, AV 2002, *Darwin Harbour Water Quality Monitoring 2001/02*, Report 23/2002. NT Department of Infrastructure, Planning and Environment, Darwin.

Parry, DL and Munksgaard, NC 1995, *Physiochemical Baseline Data for Darwin Harbour-East Arm Port Development*, Northern Territory University, Darwin.

Pietsch, B.A. and Stuart-Smith, P.G 1987, *Darwin SC52-4, 1:250,000 Geological Map Series Explanatory Notes*, Northern Territory Geological Survey, Darwin, NT.

Peerzada, N 1988, *Distribution of Heavy Metals in Darwin Harbour, in Proceedings of a Workshop on Research and Management*, H.K. Larson, M.G. Michie and J.R. Hanley (eds), held in Darwin, 2- 3 September 1987, Mangrove Monograph 4, Australian National University, North Australia Research Unit, Darwin, Northern Territory.

Peerzada, N and Ryan, P 1987, *Determination of lead, zinc, copper and cadmium in Darwin Harbour*, Marine Pollution Bulletin 18: 458-461.

Queensland Government Department of Environment and Science (DES) 2021, *QLD DES air quality monitoring data*, Accessed at <https://apps.des.qld.gov.au/air-quality/>, Accessed March 2021.

topographic-map.com, 2021. East Arm. Accessed at <https://en-au.topographic-map.com/maps/penz/East-Arm/>. Accessed September 2021.

Territory Economic Reconstruction Commission 2020, *Final Report*, Darwin: Northern Territory Government, Retrieved from https://ntrebound.nt.gov.au/data/assets/pdf_file/0020/952301/terc-final-report.pdf

True North Strategic Communication (True North) 2021, *Darwin Ship Lift Project – Social Impact Assessment*, Report prepared for AECOM.

URS Australia Pty Ltd (URS) 2008, *Marine Water and Sediment Quality Study*, Prepared for INPEX Browse Ltd, Ref: 42906729-1892: R1359.

URS Australia Pty Ltd (URS) 2011, *Marine Water and Sediment Quality Assessment*, Prepared for the NT Department of Lands and Planning, Darwin, NT.

URS Australia Pty Ltd (URS) 2012, *East Arm Wharf Expansion Project: Sediment Geochemical Investigation*, Report prepared for Department of Lands and Planning, Ref:R1638, July 2012.

URS Australia Pty Ltd (URS) 2014, *Multiuser Barge Facility Sediment Geochemical Investigation*, Report prepared for Department of Lands, Planning and Environment, Ref:42214008/MUBF SGI/0, April 2014.

SEA, 2006, *Northern Territory Emergency Services, Darwin Storm Tide Mapping Study 2006*, Darwin, NT.

Smit N, Penny SS and Griffiths AD 2012, *Assessment of marine biodiversity and habitat mapping in the Weddell region, Darwin Harbour*, Report to the Department of Lands, Planning and Environment. Department of Land Resource Management, Palmerston.

Williams, D., Wolanski, E. and Spagnol, S 2006, *Hydrodynamics of Darwin Harbour*, The environment in Asia Pacific harbours, Springer, Dordrecht, pp.461-476.

White, et.al 2014, *Australian sea levels—Trends, regional variability and influencing factors*, Earth-Science Reviews, Volume 136, 2014, Pages 155-174, ISSN 0012-8252, <https://doi.org/10.1016/j.earscirev.2014.05.011>. Accessed <https://www.sciencedirect.com/science/article/pii/S0012825214000956>.

Wood, B.G, Fogerty P.J, and Day, K 1985, *The Land Systems of the Darwin Region. Technical Report Number 24*, Conservation Commission of the Northern Territory, Darwin, NT.

Stakeholder Engagement

Department of Industry, Trade and Tourism 2021, *Maritime Industry Development Plan Discussion Paper*, Darwin: Northern Territory Government, Accessed at <https://industry.nt.gov.au/industries/maritime-industry>, Accessed August 2021.

Northern Territory Environment Protection Authority (NT EPA) 2020, *Preparing an EIS – Environmental impact assessment guidance for proponents*, Accessed at https://ntepa.nt.gov.au/data/assets/pdf_file/0009/818217/guidance-preparing-eis-g8-public-comment.pdf, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2021, *Stakeholder Engagement and Consultation: Environmental impact assessment guidance for proponents*, Accessed at https://ntepa.nt.gov.au/data/assets/pdf_file/0005/884696/guidance-proponents-stakeholder-engagement-and-consultation.pdf, Accessed September 2021.

True North Strategic Communication (True North) 2021, *Darwin Ship Lift Project – Social Impact Assessment*, Report prepared for AECOM.

Assessment methodology

Bowden, AR, Lane, MR and Martin, JH 2001, *Triple Bottom Line Risk Management: Enhancing Profit, Environmental Performance, and Community Benefits*. Wiley, New York, NY.

Department of Infrastructure Land and Planning (DIPL) 2021, NT projects, Available at <https://dipl.nt.gov.au/projects> Accessed November 2020, March 2021.

Land Development Corporation (LDC) 2021, Projects and places. Available at <https://landdevcorp.com.au/projects-places/>, Accessed September 2020, November 2020, March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2018a, *Environmental Factors and Objectives* Version 0.4, Accessed at https://ntepa.nt.gov.au/_data/assets/pdf_file/0014/571010/draft_guidance_on_adaptive_management.pdf, Accessed February 2021

Northern Territory Environmental Protection Authority (NT EPA) 2018b, *Guidance on Adaptive Management* Version 1.0, Accessed at https://ntepa.nt.gov.au/_data/assets/pdf_file/0005/546791/guideline_environmental_factors_objectives.pdf, Accessed February 2021.

Northern Territory Environment Protection Authority (NT EPA) 2019a, *Terms of Reference for the Preparation of an Environmental Impact Statement*, Available at https://ntepa.nt.gov.au/_data/assets/pdf_file/0011/775109/terms_reference_darwin_ship_lift_marine_industries_slami.pdf, Accessed March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2019b, *Statement of Reasons. Northern Ship Support Pty Ltd – Darwin Ship Lift and Marine Industries (SLAMI) Project*, Available at https://ntepa.nt.gov.au/_data/assets/pdf_file/0003/631740/statement_reasons_darwin_ship_lift_marine_industries_slami.pdf, Accessed March 2021.

Northern Territory Environment Protection Authority NT (EPA) 2019c, General Guidance for Proponents Preparing an Environmental Impact Statement.

Northern Territory Environment Protection Authority NT (EPA) 2020a, Preparing an Environmental Impact Statement. Environmental impact assessment guidance for proponents.

Northern Territory Environment Protection Authority NT (EPA) 2020b, Environmental impact assessments register, Available at <https://ntepa.nt.gov.au/your-business/public-registers/environmental-impact-assessments-register>, Accessed September 2020.

Northern Territory Environment Protection Authority NT (EPA) 2021, Environmental impact assessments register, Available at <https://ntepa.nt.gov.au/your-business/public-registers/environmental-impact-assessments-register>, Accessed September 2020, March 2021.

Marine Environmental Quality

Acer Vaughan Consulting Engineers and Consulting Environmental Engineers 1993, *Draft Environmental Impact Statement, Darwin Port Expansion – East Arm*, Prepared for the Northern Territory Department of Transport & Works, Darwin, Northern Territory.

AECOM 2020 *Marine Sediment Geochemical Assessment – Darwin Ship lift Project*, Report prepared by AECOM for the Department of Chief minister and Cabinet, Doc. R1890/M&C4170, November 2020.

AECOM 2021a, *Darwin Ship Lift Project – Water Sampling Data Report*, Letter report prepared by AECOM for the Department of Chief Minister and Cabinet. Doc. M&C4175, 25 January 2021.

AECOM 2021b, *Darwin Ship Lift Project – Water Sampling Data Report*, Second Deployment, Letter report prepared by AECOM for the Department of Chief Minister and Cabinet, Doc. M&C4175, 6 September 2021.

AIMS 2013, *Modelling of suspended sediments and sedimentation arising from discharge of MSB dredging tailwater into Frances Bay*, Unpublished letter report to NT Chief Minister's Department by Australian Institute of Marine Science, February 2013.

ANZG 2018, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia, Available at www.waterquality.gov.au/anz-guidelines.

Baird 2019, *Technical Report for Hydrodynamic Modelling of Discharge*, Appendix O of TNG Limited Draft Environmental Impact Statement, Darwin Processing Facility, Baird Australia Pty Ltd, October 2019.

Batley GE, 1995, *Heavy metals and tributyltin in Australian coastal and estuarine waters*, in Zann, L (ed.), *State of the Marine Environment Report for Australia*, Technical Annex 2, Department of the Environment, Sport and Territories, Canberra.

Brinkman, R & Logan, M 2019, *Sediment Quality Sampling Design for Darwin Harbour*. Report prepared for Northern Territory Government, Department of Environment and Natural Resources. Australian Institute of Marine Science, Townsville.

Burford, MA, Alongi, DM, McKinnon, AD & Trott, LA 2008, *Primary production and nutrients in a tropical macrotidal estuary*, Darwin Harbour, Australia, *Estuarine and Coastal Shelf Science*, 79, 440–448.

Butler, ECV, Streten-Joyce, C, Tsang, JJ, Williams, DK, Alongi, DM, Furnas, MJ & McKinnon, AD 2013, *A procedure for evaluating the nutrient assimilative capacity of Darwin Harbour*, Report for Aquatic Health Unit, NT Department of Land Resource Management. Australian Institute of Marine Science, Darwin, Australia.

Cardno 2014, *Darwin Harbour – A Summary of the Ichthys LNG Project Nearshore Environmental Monitoring Program*.

Currey, N 1988, *Darwin Harbour Ambient Water Quality*, In Larson, HK, Michie, MG and Hanley, JR (eds), *Darwin Harbour: proceedings of a workshop on research and management held in Darwin 2–3 September 1987*. Mangrove Monograph No. 4, Australian National University North Australian Research Unit, Darwin.

Darwin Harbour Advisory Committee (DHAC) 2003, *Darwin Harbour Regional Plan of Management*, Darwin Harbour Advisory Committee, Department of Infrastructure, Planning and Environment, Darwin.

Darwin Harbour Advisory Committee (DHAC) 2005, *A review of Environmental Monitoring of the Darwin Harbour Region and Recommendations for Integrated Monitoring*, Darwin Harbour Advisory Committee, Darwin.

Darwin Harbour Advisory Committee (DHAC) 2020, *Darwin Harbour Strategy 2020-2025*, Darwin Harbour Advisory Committee, NT Government, July 2020.

Department of Environment Water Heritage and the Arts (DEWHA) 2009, *National Assessment Guidelines for Dredging*, Department of Environment, Water, Heritage and the Arts, Canberra.

Department of Lands and Planning (DLP) 2011a, *Draft Environmental Impact Statement: East Arm Wharf Expansion Project*, NT Department of Lands and Planning, Darwin.

Department of Lands and Planning (DLP) 2011b, *Environmental Impact Statement Supplement: East Arm Wharf Expansion Project*, NT Department of Lands and Planning, Darwin.

Department of Land Resource Management (DLRM) 2014, *Darwin Harbour Water Quality Protection Plan*, Northern Territory Department of Land Resource Management, Darwin, NT, Australia.

Dorji, P, Fearn, P. & Broomhall, M 2016, *A Semi-Analytic Model for Estimating Total Suspended Sediment Concentration in Turbid Coastal Waters of Northern Western Australia Using MODIS-Aqua 250 m Data*, *Remote Sensing*, 8(7), 556.

Drewry, J, Dostine, P, Fortune, J, Majid, M, Schult, J and Lamche, G 2010, *Darwin Harbour Region Report Cards 2010*, Department of Natural Resources, Environment, The Arts and Sport. Report No. 25/2010D. Palmerston, NT, Australia.

EnSTaR 2021, *Historical Water Quality Assessment*, Historical Total Suspended Sediment Concentration Assessment using Satellite Remote Sensing in Coastal Waters of Darwin Harbour, Assessment Report No. E015 for AECOM Australia Pty Ltd, Perth, WA.

Fortune, J and Maly, G 2009, *Toward the Development of a Water Quality Protection Plan for the Darwin Harbour Region*, Aquatic Health Unit, Department of Natural Resources, Environment, the Arts and Sport, Darwin.

- Fortune, J 2006, *The grainsize and heavy metal content of sediment in Darwin Harbour*, Environment Protection Agency, Department of Natural Resources, Environmental and the Arts. Report No. 14/2006D.
- Fortune, J 2015, *Supplement to the 2014 Darwin Harbour Region Report Card*, Report No. 01/2015D. Aquatic Health Unit, Department of Land Resource Management, Palmerston, NT.
- Hanley, JR and Caswell, GM 1995, *East Arm Port - Stage 1*, Water Quality Monitoring Program. Report on Setup Phase and Baseline Data Collection, Marine Ecology Technical Report 95/1.
- INPEX 2010, *Ichthys Gas Field Development Project: Draft Environmental Impact Statement*, INPEX Browse, Ltd.
- INPEX 2011, *Ichthys Gas Field Development Project: Supplement to the Draft Environmental Impact Statement*, INPEX Browse, Ltd.
- INPEX 2018, *Maintenance Dredging and Spoil Disposal Management Plan*, INPEX Ichthys Project, Accessed 1 Sept. 2021 at:
https://ntepa.nt.gov.au/data/assets/pdf_file/0005/590171/plan_wdl240_inpex_maintenance_dredging_spoil_disposal_management.pdf.
- Kellogg Brown and Root (KBR) 2020, Darwin Ship Lift and Marine Industries Facility Sediment Sampling and Analysis Plan, Report prepared for the NT Department of Trade, Business and Innovation, BEN961-TD-EV-REP-0001 Rev. 0. 5 February 2020.
- Lewis, J.A., Baran, I.J., Carey, J.M. and Fletcher, L.E 2010, A contaminant in decline: Long-term TBT monitoring at a naval base in Western Australia. Available from:
https://www.researchgate.net/publication/267630753_A_contaminant_in_decline_Long-term_TBT_monitoring_at_a_naval_base_in_Western_Australia, Accessed Oct 06 2021.
- McKinnon, AD, Smit, N, Townsend, S & Duggan, S 2006, *Darwin Harbour: Water quality and ecosystem structure in a tropical harbour in the early stages of urban development*. In: Wolanski, E (ed.), *The environment in Asia Pacific harbours*, pp. 433-459. Springer, Dordrecht, The Netherlands.
- Michie, MG 1988, *Sediments, Sedimentary Environments and Palaeoenvironments in Port Darwin*, In Larson, HK, Michie, MG and Hanley, JR (eds), *Darwin Harbour: proceedings of a workshop on research and management held in Darwin 2–3 September 1987*, Mangrove Monograph No. 4, Australian National University North Australian Research Unit, Darwin.
- Michie, MG, Grey, DL and Griffin, RK 1991, *Sea water salinity and temperature measurements in the Darwin Harbour area 1972-1978*, Department of Primary Industries and Fisheries, Darwin, Northern Territory.
- MOS 2020, *Current Assessment – Impact of SLAMI Proposed Reclamation and Dredged Area on Currents and Sediment Transport*, Report prepared for SMEC by MetOcean Solutions, November 2020.
- Munksgaard, NC & Parry, DL 2002, *Metals, arsenic and lead isotopes in near pristine estuarine and marine coastal sediments from Northern Australia*, Marine and Freshwater Research, 53(3), 719–729.
- Munksgaard, NC, Kaestli, M, Gibb, K, Dostine, P & Townsend, S 2013, *Darwin Harbour Baseline Sediment Survey 2012*, Department of Land Resource Management Darwin, NT.
- Munksgaard, NC, Hutley, LB, Metcalfe, KN, Padovan, AC, Palmer, C & Gibb, KS 2018, *Environmental challenges in a near-pristine mangrove estuary facing rapid urban and industrial development*, Darwin Harbour, Northern Australia, Regional Studies in Marine Science, 25.
- Nawaz, S 2010, *Sediment Sources near the Extreme Ends of the Catchment Continuum and the Topographic Dependence of Denudation in a global context*, Ph.D, thesis Charles Darwin University.
- NRETAS 2012, *Darwin Harbour Water Quality Protection Plan: Phase 2 Factsheet. Greening the Territory*, Department of Natural Resources, Environment, the Arts and Sport, Darwin.
- Northern Territory Environment Protection Agency (NT EPA) 2013, *Draft Guidelines for the Environmental Assessment of Marine Dredging in the Northern Territory*, Version 1.3, April 2013. NT Environment Protection Authority, Darwin.
- Padovan, AV 1997, *The water quality of Darwin Harbour: October 1990–November 1991*, Water Quality Branch, Water Resources Division, Department of Lands, Planning and Environment, NT Government, Report No. 34/1997D December 1997.

Padovan, A 2001, *The Quality of Run-Off and Contaminant Loads to Darwin Harbour*, Report No. 29/2000D, Resource Management Branch, Natural Resources Division, November 2001.

Padovan, AV 2002, *Darwin Harbour Water Quality Monitoring 2001/02*, Report 23/2002, NT Department of Infrastructure, Planning and Environment, Darwin.

Padovan, AV 2003, *Darwin Harbour water and sediment quality*, pp. 5–18 in Darwin Harbour Region: current knowledge and future needs, Proceedings of public presentations hosted by the Darwin Harbour Advisory Committee at the Northern Territory University, Darwin, on 11, 19 and 26 February 2003, NT Department of Infrastructure, Planning and Environment, Darwin.

Parry, DL and Munksgaard, NC 1995, *Physiochemical Baseline Data for Darwin Harbour-East Arm Port Development*, Northern Territory University, Darwin.

Parry, DL and Munksgaard, NC 1996, *Environmental investigation of effluent disposal systems, impact of Leanyer-Sanderson sewage outfall on the water quality of Buffalo Creek*, Prepared for Power and Water Authority, Northern Territory.

Parry, DL, Munksgaard, NC, Foti, F, Langeveld, M and Gilmore, R 2002, *Monitoring of a tropical estuary for impacts of urbanisation*, National Heritage Trust Coast and Clean Seas Project No. 9703. Charles Darwin University, Darwin.

Peerzada, N 1988, *Distribution of Heavy Metals in Darwin Harbour*, in *Proceedings of a Workshop on Research and Management*, H.K. Larson, M.G. Michie and J.R. Hanley (eds), held in Darwin, 2- 3 September 1987, Mangrove Monograph 4, Australian National University, North Australia Research Unit, Darwin, Northern Territory.

Peerzada, N and Ryan, P 1987, *Determination of lead, zinc, copper and cadmium in Darwin Harbour*, Marine Pollution Bulletin 18: 458-461.

Power and Water Corporation 2006, *Wastewater Treatment, Reuse and Discharge Report 2006*.

Rigby, P, Steinberg, C, Williams, DK, Brinkman, G, Brinkman, R, Tonin, H & Hughes, D 2014, *Real-time marine observing systems: Challenges, benefits and opportunities in Australian coastal waters*, Australian Journal of Civil Engineering, 12, 83-99.

Simão, C. and Tonin, H 2020, *Modelling the Sediment Plume Associated with Dredging for the Darwin Ship Lift*, Prepared for AECOM, Australian Institute of Marine Science, Darwin. pp 45, including appendices.

Simpson, SL, Batley, GB and Chariton, AA 2013, *Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines*, CSIRO Land and Water Science Report 08/07, CSIRO Land and Water.

Simpson, SL, Mosley, L, Batley, GE and Shand, P 2018, *National Acid sulfate soils guidance: Guidelines for the dredging of acid sulfate soil sediments and associated dredge spoil management*, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.

Skinner, L, Townsend, S & Fortune, J 2009, *The impact of urban land-use on total pollutant loads entering Darwin Harbour*, Report 06/2008D Aquatic Health Unit, Northern Territory Department of Natural Resources, Environment, the Arts and Sport, Palmerston, NT, Australia.

Sly, SG, Marshall, AJ and Williams, TN 2002, *Integrated monitoring of water quality and biological diversity in Darwin Harbour and its marinas*, Technical Report No. 4 (Fisheries), Department of Business, Industry and resource Development, Darwin, Northern Territory.

URS 2008, *Marine Water and Sediment Quality Study*, Report R1359 to INPEX Browse Ltd by URS Australia Pty Ltd.

URS 2009, *Nearshore Marine Water Quality and Sediment Study*, Appendix 9 to INPEX (2010). Report R1382 to INPEX Browse Ltd by URS Australia Pty Ltd.

URS 2011a, *Summary of the Long-Term Water Quality Program for Darwin Harbour*, Appendix S9 to INPEX 2011, Report R1589 to INPEX Browse Ltd by URS Australia Pty Ltd.

URS 2011b, *Marine Water and Sediment Quality Assessment*, Appendix G to DLP (2011a), Report R1593 to NT Department of Lands and Planning by URS Australia Pty Ltd.

URS 2012, *East Arm Wharf Expansion Project: Sediment Geochemical Investigation*, Report R1638 to NT Department of Lands and Planning by URS Australia Pty Ltd.

URS 2014a, *Multi User Barge Ramp Facility Sediment Geochemical Investigation*, Report MUBRF SGI to NT Department of Lands, Planning and Environment by URS Australia Pty Ltd.

URS 2014b, *Tug Pen and Small Vessel Berths Sediment Geochemical Investigation*, Report TPSVB SGI to Darwin Port Corporation by URS Australia Pty Ltd.

Welch, M, Schult, J & Padovan, A 2008, *Effects of Urban Stormwater on Heavy Metal and Nutrient Concentrations in Mangrove Sediments of Darwin Harbour*, Report 08/2008D Aquatic Health Unit, Department of Natural Resources, Environment, the Arts and Sport.

Williams, D, Wolanski, E & Spagnol, S 2006, *Hydrodynamics of Darwin Harbour*, In: Wolanski, E (ed.), *The environment in Asia Pacific harbours*, pp. 461-476. Springer, Dordrecht, The Netherlands.

WMB 2005, *The health of the aquatic environment in the Darwin Harbour region*, Report No. 5/2005D. Water Monitoring Branch, Natural Resources Management Division, Department of Natural Resources, Environment and the Arts, Darwin, Northern Territory.

Marine Flora and Fauna

Bax N, Hayes K, Marshall A, Parry D and Thresher R 2002, *Man-made marinas as sheltered islands for alien marine organisms: Establishment and eradication of an alien invasive marine species*. In Veitch CR and Clout MN (eds.): *Turning the tide: The eradication of invasive species*. Proceedings of the international conference on eradication of island invasives. World Conservation Union, Gland, Switzerland, pp. 26-39.

Bax N, Williamson A, Aguero M, Gonzalez E and Greeves W 2003, *Marine invasive alien species: a threat to global biodiversity*, *Marine Policy* 27(4): 313-323.

BMT WBM 2010, *East Arm, Elizabeth River, Blackmore River and Middle Arm Marine Habitat Survey*, Report to iX Survey Australia Pty Ltd by BMT WBM Pty Ltd.

Brooks L and Pollock K 2014, *Abundance, movements and habitat use of coastal dolphins in the Darwin region: Analysis of the first six primary samples (October 2011 to March 2014)*, Final report to the Northern Territory Government Department of Land Resource Management.

Brooks L, Palmer C, Griffiths AD and Pollock KH 2017, *Monitoring variation in small coastal dolphin populations: An example from Darwin, Northern Territory, Australia*. *Frontiers in Marine Science* 4: 4, doi:10.3389/fmars.2017.00094.

Cardno 2012, *Coral Monitoring Baseline Report – Ichthys Nearshore Environmental Monitoring Program*, Prepared for INPEX.

Cardno 2014a, *Nearshore Environmental Monitoring Summary Report*, Prepared for INPEX, October 2014.

Cardno 2014b, *Turtle and Dugong Monitoring End of Dredging Report Ichthys Nearshore Environmental Monitoring Program*, Prepared for INPEX, September 2014.

Case M, Galaiduk R, Harries S, Biggs J, Radford B and Streten C 2021, *Towed video report for the Darwin Ship Lift EIS*. Report prepared for AECOM. Australian Institute of Marine Science, Perth.

Cavanagh R 2000, *Criteria and Thresholds for Adverse Effects of Underwater Noise on Marine Animals*, Science Applications International, May 2000.

Cribb H, Maher J and Beatty A 2008, *Monitoring for Marine Pests Darwin Harbour 2007-2008 Report*, NT Department of Regional Development, Primary Industry, Fisheries and Resources.

Department of Agriculture Fisheries and Forestry (DAFF) 2009a, *National Biofouling Management Guidance for Commercial Vessels*. Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Department of Agriculture Fisheries and Forestry (DAFF) 2009b, *National Biofouling Management Guidance for Non-Trading Vessels*. Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Department of Agriculture Fisheries and Forestry (DAFF) 2010, *Australian Marine Pest Monitoring Manual*. Version 2.0. Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Department of Agriculture and Water Resources (DAWR) 2017, *Australian Ballast Water Management Requirements*, Version 7, Department of Agriculture and Water Resources, Commonwealth of Australia.

Department of Agriculture Water and Environment (DAWE) 2021, *National Introduced Marine Pest Information System*, Department of Agriculture, Water and the Environment.
<https://nimpis.marinepests.gov.au/>.

Department of Environment Water Heritage and the Arts (DEWHA) 2009, *Approved Conservation Advice for Pristis clavata (Dwarf Sawfish)*, Department of the Environment, Water, Heritage and the Arts, Canberra, ACT.

Department of Industry, Tourism and Trade (DITT) 2020, *Marine Pest Survey – East Arm, Fort Hill and Stokes Hill wharves 2020 Annual Report*, Department of Industry, Tourism and Trade, November 2020.

Department of Infrastructure (DoI) 2014, *Annual Monitoring Report for the Darwin Marine Supply Base Dredging and Dredge Spoil Placement Activities 2013 Reporting Period*. March 204. Prepared by Department of Infrastructure, Northern Territory Government on behalf of Department of Lands, Planning and Environment.

Department of Primary Industry and Fisheries (DPIF) 2016, *Marine Pest Survey East Arm, Fort Hill and Stokes Hill Wharves*, 2015 Annual Report for Darwin Port Corporation and Darwin Waterfront Corporation by Department of Primary Industry and Fisheries, March 2016.

Department of Primary Industry and Resources (DPIR) 2016, *Marine Pest Survey East Arm, Fort Hill and Stokes Hill Wharves*, 2016 Annual Report for Darwin Port Corporation and Darwin Waterfront Corporation by Department of Primary Industry and Resources, November 2016.

Department of Primary Industry and Resources (DPIR) 2017, *Marine Pest Survey East Arm, Fort Hill and Stokes Hill Wharves*, 2017 Annual Report for Darwin Port Corporation and Darwin Waterfront Corporation by Department of Primary Industry and Resources, November 2017.

Department of Primary Industry and Resources (DPIR) 2018, *Marine Pest Survey East Arm, Fort Hill and Stokes Hill Wharves*, 2018 Annual Report for Darwin Port Corporation and Darwin Waterfront Corporation by Department of Primary Industry and Resources, December 2018.

Department of Primary Industry and Resources (DPIR) 2020, *Marine Pest Survey East Arm, Fort Hill and Stokes Hill wharves*. 2019 Annual Report for Darwin Port Corporation and Darwin Waterfront Corporation by Department of Primary Industry and Resources, January 2020.

Dunlop RA, Noad MJ, McCauley RD, Scott-Hayward L, Kniest E, Slade R, Paton D and Cato DH 2017, *Determining the behavioural dose-response relationship of marine mammals to air gun noise and source proximity*, Journal of Experimental Biology 220(16): 2878-2886.

Fabricius K and Alderslade P 2001, *Soft corals and sea fans*, Australian Institute of Marine Science, Townsville, Queensland.

Ferns LW 1996, *Community structure of scleractinian corals and benthic algae on a macrotidal fringing reef, Nightcliff, Northern Territory, Australia*, BSc thesis, Northern Territory University, Darwin.

Galaïduk R, Radford B, Harries S, Case M, Williams D, Low Choy D and Smit N 2019, *Technical Report: Darwin – Bynoe Harbours predictive mapping of benthic communities*, Australian Institute of Marine Science, Perth. pp 42.

Geo Oceans 2011, *Ichthys Gas Field Development Project: Benthic Habitat Mapping of the Darwin region – Methods of Data Collection, Collation, and Map Production*, Technical Appendix S6 to INPEX (2011).

Geo Oceans 2012, *NT Department of Lands and Planning – East Arm Wharf Expansion Project*, Marine Habitat Mapping Survey, Report to URS Australia Pty Ltd, Document code DLPEAWMAP.406, August 2012.

Golder and Cardno 2015, *Marine Pests Monitoring – Post-dredging Report*, prepared for INPEX, May 2015.

Gordon J, Gillespie D, Potter J, Frantzis A, Simmonds MP, Swift R and Thompson D 2004, *A review of the effects of seismic surveys on marine mammals*, Journal of Marine Technology 37:16–3.

Griffiths AD, Groom RA, Low Choy D, Mackarous K. and Brooks L 2020, *Darwin Region Coastal Dolphin Monitoring Program: Final Report – 2011 to 2019*, Department of Environment, Parks and Water Security, Northern Territory Government.

Hallegraeff GM and Bolch CJ 1991, *Transport of toxic dinoflagellate cysts via ships' ballast water*, Marine Pollution Bulletin 22: 27-30.

Harrison L, McGuire L, Ward S, Fisher A, Pavey C, Fegan M and Lynch B, 2009, *Sites of Conservation Significance – Shoal Bay*, Department of Natural Resources, Environment, The Arts and Sport, Biodiversity Conservation Unit, Division of Environment, Heritage and the Arts.

Hastie G, Merchant ND, Götz T, Russell DJF, Thompson P and Janik VM 2019, *Effects of impulsive noise on marine mammals: investigating range-dependent risk*, Ecological Applications 29(5).

INPEX 2010, *Ichthys Gas Field Development Project: Draft Environmental Impact Statement*, Report prepared by INPEX Browse, Ltd.

INPEX 2011, *Ichthys Gas Field Development Project: Supplement to the Draft Environmental Impact Statement*, Report prepared by INPEX Browse, Ltd.

INPEX 2013, *Dredging and Spoil Disposal Management Plan – East Arm*, Prepared by INPEX Ichthys Project, December 2013.

INPEX 2018, *Maintenance Dredging and Spoil Disposal Management Plan*, Prepared by INPEX Ichthys Project, March 2018.

Larson HK and Williams RS 1997, *Darwin Harbour fishes: a survey and annotated checklist*, pp. 339–380 in Hanley JR, Caswell G, Megirian D and Larson HK (eds), *Proceedings of the Sixth International Marine Biological Workshop* (“The marine flora and fauna of Darwin Harbour, Northern Territory, Australia”), Museums and Art Galleries of the Northern Territory and the Australian Marine Sciences Association, Darwin, Northern Territory.

Larson H, Stirrat S and Woinarski J 2006, *Freshwater sawfish *Pristis microdon**, Threatened Species of the Northern Territory. NT Government.

Lawson, E and Beatty A 2013, *Monitoring for Marine Pests Darwin Harbour 2011-2012*. Darwin, NT Department of Primary Industry and Fisheries.

Lawson E, Beatty A and Skarlatos Simoes M 2014, *Monitoring for Marine Pests Darwin Harbour 2012-2013*, Darwin, NT Department of Primary Industry and Fisheries.

Macmahon 2013, *Dredging and Dredge Spoil Placement Management Plan (DDSPMP) End of Phase 1 Environmental Monitoring Report – Revision 0*.

Maher J, Beatty A and Cribb H 2010, *Monitoring for Marine Pests Darwin Harbour 2009-2010*, Darwin, NT Department of Resources.

Maher, J, Beatty A and Cribb H, 2011, *Monitoring for Marine Pests Darwin Harbour 2010-2011*, Darwin, NT Department of Resources.

Marshall AJ, Cribb HN and Thompson MJ 2003, *Exotic Marine Pests: What is Being Done About Preventing Their Introduction?*, Presentation to the Darwin Harbour Plan of Management Workshop.

McCauley R, Fewtrell J, Duncan A, Jenner C, Jenner M-N, Penrose J, Prince R, Adhitya A, Murdoch J and McKabe K 2000, *Marine seismic surveys: analysis and propagation of air-gun signals; and effects of exposure on humpback whales, sea turtles, fishes and squid*, In: *Environmental implications of offshore oil and gas development in Australia: further research: a compilation of three scientific marine studies*, pp. 364-521, Canberra, ACT: Australian Petroleum Production and Exploration Association.

McKinnon AD, Smit N, Townsend S and Duggan S 2006, *Darwin Harbour: water quality and ecosystem structure in a tropical harbour in the early stages of development*, In: ‘The Environment in Asia Pacific Harbours’ (Ed: Wolanski, E). Springer, Dordrecht, the Netherlands.

Millennium Ecosystem Assessment 2005, *Ecosystems and human well-being: Biodiversity synthesis*, World Resources Institute, Washington, DC.

MPSC 2018, *Australian Priority Marine Pest List: process and outcomes*, Prepared by Marine Pest Sectoral Committee, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

Muñoz J and McDonald J 2014, *Potential Eradication and Control Methods for the Management of the Ascidian *Didemnum perlucidum* in Western Australia*, Fisheries Research Report No. 252, Department of Fisheries, Western Australia, 40pp.

National Marine Fisheries Service 2018, *Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*, U.S. Dept. of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 pp.

Northern Territory Government (NTG) & Golder 2011, *Darwin Harbour Marine Pest Surveys*, Northern Territory Department of Resources (Fisheries – Aquatic Biosecurity) and Golder Associates, March 2011.

Padilla DK, Chotokowski MA and Buchan LAJ 1996, *Predicting the spread of Zebra mussels (Dreissena polymorpha) to inland waters using boater movement pattern*, Global Ecological and Biogeographical Letters 5: 353-359.

Palmer C 2008, *Coastal dolphin research in the Northern Territory*, PowerPoint presentation to “Coast to Coast 2008” Conference, Convention Centre, Darwin, 18–22 August 2008.

Palmer C, Fitzgerald P, Wood A, Harley S and McKenzie A 2009, *False killer whales Pseudorca crassidens: regular visitors to Port Essington and Darwin Harbour in the Northern Territory, Australia*. Northern Territory Naturalist 21: 49–53.

Palmer C, Brooks L, Fegan M and Griffiths AD 2017, *Conservation Status of Coastal Dolphins in the Northern Territory: Final Report*, Marine Ecosystems Group, Flora and Fauna Division, Department of Environment and Natural Resources. Darwin.

Parra G J 2006, *Resource partitioning in sympatric delphinids: Space use and habitat preferences of Australian snubfin and Indo-Pacific humpback dolphins*, Journal of Animal Ecology 75: 862–874.

Parra GJ, Schick RS and Corkeron PJ 2006, *Spatial distribution and environmental correlates of Australian snubfin and Indo-Pacific humpback dolphins*, Ecology 87: 396–406.

Peverell SC 2005, *Distribution of sawfishes (Pristidae) in the Queensland Gulf of Carpentaria, Australia, with notes on their ecology*, Environmental Biology of Fishes 73, 391-402.

Peverell S 2007, *Dwarf Sawfish Pristis clavate*, The State of Queensland Department of Primary Industries & Fisheries.

Peverell S, Gribble N, and Larson H 2004, *Sawfish. In: Description of key species groups in the northern Planning Area*, pp, 75-83. National Oceans Office, Hobart.

Ross GJB, 2006 *Review of the Conservation Status of Australia's Smaller Whales and Dolphins*, Australian Government, Canberra, ACT.

Russell BC and Hewitt CL 2000, *Baseline survey of the Port of Darwin for introduced marine species*, A report to the NT Department of Transport and Works by the Museums and Art Galleries of the Northern Territory, Darwin and CSIRO Marine Research, Hobart.

Simão C and Tonin H 2020, *Modelling the sediment plume associated with dredging for the Darwin Ship Lift*, Prepared for AECOM, Australian Institute of Marine Science, Darwin. pp 29, including appendices.

Siwabessy PJW, Tran M, Huang Z, Nichol S and Atkinson I 2015, *Mapping and Classification of Darwin Harbour Seabed*, Record 2015/18, Geoscience Australia, Canberra.

Smit N 2003, *Marine invertebrate life in the Darwin Harbour region and management implications*, pp. 37–64 in Darwin Harbour Region: current knowledge and future needs. Proceedings of public presentations hosted by the Darwin Harbour Advisory Committee at the Northern Territory University, Darwin, on 11, 19 and 26 February 2003, Department of Infrastructure, Planning and Environment, Darwin, Northern Territory.

Smit N, Penny SS and Griffiths AD 2012, *Assessment of marine biodiversity and habitat mapping in the Weddell region, Darwin Harbour*, Report to the Department of Lands, Planning and Environment. Department of Land Resource Management, Palmerston.

Southall BL, Finneran JJ, Reichmuth C, Nachtigall PE, Ketten DR, Bowles A and Tyack PL 2019, *Marine mammal noise exposure criteria: Updated scientific recommendations for residual hearing effects*, Aquatic Mammals 45(2):125–232.

Talis 2021, *SLAMI Underwater Noise Modelling Assessment*, Report for AECOM by Talis Consultants.

Territory Wildlife Park 2006, *Coral spawning*. Friends of Territory Wildlife Park Newsletter, Wet Season 2006, Darwin, Northern Territory.

Thorburn DC, Peverell S, Stevens S, Last JD and Rowland AJ 2003, *Status of freshwater and estuarine elasmobranchs in Northern Australia*, Report to Natural Heritage Trust, Canberra.

Thorburn DC, Morgan DL, Rowland AJ and Gill HS 2007, *Freshwater sawfish Pristis microdon Latham, 1794 (Chondrichthyes: Pristidae) in the Kimberley region of Western Australia*, Zootaxa 1471: 27–41.

URS 2002, *Darwin 10 MTPA LNG facility: public environmental report*, Report prepared by URS Australia Pty Ltd for Phillips Petroleum Company Australia Pty Ltd, Darwin, Northern Territory.

URS 2009, *Ichthys Gas Field Development Project: nearshore marine ecology and benthic communities study*, Report prepared for INPEX Browse, Ltd, R1361, Technical Appendix 8 to INPEX (2010).

Walters S 1996, *Ballast water, hull fouling and exotic marine organism introductions via ships - A Victorian study*, Environment Protection Authority, Victoria Publication 494: 1-143.

Wells FE, McDonald JI and Huisman JM 2009, *Introduced Marine Species in Western Australia*, Department of Fisheries, Perth Fisheries Occasional Publications No. 57: 1-97.

Whiting SD 2002, *Rocky reefs provide foraging habitat for dugongs in the Darwin region of northern Australia*, Australian Mammalogy 24: 147–150.

Whiting SD 2003, *Marine mammals and marine reptiles of Darwin Harbour*, In: Darwin Harbour Region: current knowledge and future needs. Proceedings of public presentations hosted by the Darwin Harbour Advisory Committee at the Northern Territory University, Darwin, on 11, 19 and 26 February 2003, Department of Infrastructure, Planning and Environment, Darwin, Northern Territory.

Whiting SD 2008, *Movements and distribution of dugongs (Dugong dugon) in a macro tidal environment in northern Australia*, Australian Journal of Zoology 56: 215–222.

Willan RC, Russell BC, Mufet NB, Moore KL, McEnnulty FR, Horner SK, Hewitt CL, Dally GM, Campbell ML and Borke ST 2000, *Outbreak of Mytilopsis sallei (Récluz, 1849) (Bivalvia: Dreissenidae) in Australia*, Molluscan Research 20: 25-30.

Wolstenholme J, Dinesen ZD and Alderslade P 1997, *Hard Corals of the Darwin region, Northern Territory, Australia*, In Hanley JR, Caswell G, Megirian D and Larson HK (eds) Proceedings of the Sixth International Marine Biological Workshop ("The marine flora and fauna of Darwin Harbour, Northern Territory, Australia"). Museums and Art Galleries of the Northern Territory and the Australian Marine Sciences Association, Darwin, Northern Territory.

Wyatt ASJ, Hewitt CL, Walker DI and Ward TJ 2005, *Marine introductions in the Shark Bay World Heritage Property, Western Australia: a preliminary assessment*. Diversity and Distributions 11: 33–44.

Air Quality and Greenhouse Gases

Australian Standard AS4114 2020, *Spray painting booths, designated spray painting areas and paint mixing rooms*.

Department of Agriculture Water and Environment (DAWE) 2020a, *National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Compilation No. 12)*, Department of Agriculture, Water and the Environment.

Department of Agriculture Water and Environment (DAWE) 2021, *National Greenhouse Accounts Factors*, August 2021 Australian Government, Department of Agriculture, Water and the Environment.

DISER 2020, *Australian Greenhouse Emissions Information System: State Greenhouse Gas Inventory*. Accessed via <https://ageis.climatechange.gov.au/SGGI.aspx>. Accessed on 22/06/2020.

Golder Associates 2013, *Exposure Risk Assessment and Risk Characterisation to Inform Recommendations for Updating Ambient Air Quality Standards for PM_{2.5}, PM₁₀, O₃, NO₂, SO₂*. Golder Associates for National Environment Protection Council Service Corporation.

Greenhouse Gas Protocol 2013, *Technical Guidance for Calculating Scope 3 Emissions (v1.0)*

Krewski 2009, *Evaluating the Effects of Ambient Air Pollution on Life Expectancy*, The New England Journal of Medicine, 360:413-415, 2009.

Langworthy, L., Bourne, G., Frearson, L., Howard, K., McKenzie, A. and Peake, O 2017, *Roadmap to Renewables*, Prepared for Northern Territory Government.

National Environment Protection Council. (NEPM) 2021, *National Environment Protection (Ambient Air Quality) Measure*, Australian Government.

National Environment Protection Council. (NEPM) 2011, *National Environment Protection (Air Toxics) Measure*, Australian Government.

National Pollutant Inventory (NPI) 2008, *Emission estimation technique manual for combustion engines mining (Version 3.0)*, Canberra: Commonwealth of Australia Department of Sustainability, Environment, Water, Population and Communities (DSEWPC).

National Pollutant Inventory (NPI) 2012, *Emission estimation technique manual for mining (Version 3.1)*, Canberra: Commonwealth of Australia Department of Sustainability, Environment, Water, Population and Communities (DSEWPC).

New South Wales Environment Protection Authority (NSW EPA) 2017, *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*.

Northern Territory Government 2020, *Climate Change Response: Towards 2050*, Accessed November 2020.

Northern Territory Government 2020, *Delivering the Climate Change Response: Towards 2050 - Three-Year Action Plan*.

Northern Territory Department of Lands and Planning (DLP) 2011, *Greenhouse Gas Assessment – Expansion Works at the East Arm Wharf*, Prepared by URS.

Northern Territory Environment Protection Authority (NT EPA) 2017, *Guideline: Recommended Land Use Separation Distances*.

Northern Territory Environment Protection Authority (NT EPA) 2015, *Guidelines to Prevent Pollution from Building Sites*.

Northern Territory Environment Protection Authority (NT EPA) 2018, *Environmental Factors and Objectives*.

Port of Townsville (PoT) 2016, *Townsville Port Expansion Project. Additional Information to the Environmental Impact Statement Section 13 Greenhouse Gas Emissions*.

Queensland Government Environmental Protection (Air) Policy (EPP Air) 2019, *Station overview-Memorial Park*, <https://apps.des.qld.gov.au/air-quality/stations/?station=cgm>, visited 23/08/2021.

South Australia Environment Protection Authority (SA EPA) 2019, *Code of Practice for Vessel and Facility Management (Marine and Inland Waters)*.

United States Environmental Protection Agency (USEPA) 2009, *Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories*.

USEPA, 1995 AP-42 11.9 Western Surface Coal Mining.

USEPA, 2006 AP-42 13.2.5 Industrial Wind Erosion.

Victoria Government Environment Protection Authority 2021, *Reference Standard and the Guideline for Assessing and Minimising Air Pollution in Victoria*.

Vipac Engineers & Scientists Limited (VIPAC) 2019, *Darwin Magnetite Processing Facility EIS Air Quality Assessment*.

RMS 2017a, WestConnex M4-M5 Link Air Quality Impact Assessment.

Social, Economic and Cultural Surroundings

ACIL Allen Consulting Pty Ltd (ACIL Allen) 2019, *Assessment of SLAMI Complex: Preliminary Market, Financial and Economic analysis*, A report prepared for the NT Department of Trade Business and Innovation.

Brewer, T 2015, *Opportunity for Residents to Voice Their Views on Darwin Harbour*, Accessed at Charles Darwin University: Northern Institute: <https://www.cdu.edu.au/newsroom/harbour-survey>. Accessed August 2021.

City of Darwin 2019, *Darwin 2030 City for People. City of Colour: Strategic Plan*, Darwin: City of Darwin. Accessed at https://www.darwin.nt.gov.au/sites/default/files/old_7_publications_files/strategic_plan_2019_web_new_0.pdf. Accessed August 2021.

City of Palmerston 2018, *Community Plan*, Palmerston: City of Palmerston. Accessed at https://www.palmerston.nt.gov.au/sites/default/files/uploads/files/2019/CoP_Community%20Plan.pdf. Accessed August 2021.

Darwin Harbour Advisory Committee (DHAC), 2003, *Darwin Harbour Regional Plan of Management*, Darwin: Northern Territory Government.

Darwin Harbour Advisory Committee (DHAC) 2021, *Darwin Harbour Strategy 2020-2025*, Palmerston: Darwin Harbour Advisory Committee. Accessed at https://nt.gov.au/data/assets/pdf_file/0008/915038/darwin-harbour-strategy-2020-2025.pdf. Accessed August 2021.

Darwin Port 2020, *Darwin Port Development Plan*, Darwin: Landbridge. Accessed at <https://www.darwinport.com.au/sites/default/files/editors/Darwin%20Port%20Port%20Development%20Plan%202020.pdf>. Accessed August 2021.

Deloitte 2020, *Northern Territory Maritime Academy Report*, Darwin: Industry Skills Advisory Council of the NT. Accessed at file:///C:/Users/Jane%20Munday/Downloads/maritime_academy_final_report_10.9.20.pdf. Accessed August 2021.

Department of Industry, Trade and Tourism (DITT) 2021, *Maritime Industry Development Plan Discussion Paper*, Darwin: Northern Territory Government. Accessed at <https://industry.nt.gov.au/industries/maritime-industry>. Accessed August 2021.

Earthsea Pty Ltd (Earthsea) 2011, *Archaeological Survey of the East Arm Wharf Expansion, Darwin NT*, Unpublished Report prepared for URS Corporation and Land Development Corporation, Darwin.

Earthsea Pty Ltd (Earthsea) 2021, *Archaeological and Heritage Assessment: Proposed Darwin Ship Lift, NT*, Report prepared for AECOM Australia,

Environment Centre of the Northern Territory (ECNT) 2021, *Submission to the NTEPA on TNG EIS Supplement*, Darwin: NTEPA. Accessed at https://ntepa.nt.gov.au/data/assets/pdf_file/0008/1009277/ecnt.pdf. Accessed August 2021.

Elton Consulting 2019, *Darwin TIVAN Processing Facility Socio-Economic Impact Assessment: Appendix F*, Darwin: Northern Territory Environment Protection Authority. Accessed at https://ntepa.nt.gov.au/data/assets/pdf_file/0009/761481/draft_eis_darwin_processing_facility_appendixF_socio_economic_impact_assessment.pdf. Accessed August 2021.

Litchfield Council 2018, *Strategic Plan 2018-2022*, Litchfield: Litchfield Council. Accessed at <https://www.litchfield.nt.gov.au/system/files/uploads/files/2020/strategic-plan-2018-2022.pdf>. Accessed August 2021.

MetOcean Solutions 2021, *Current Assessment: Impact of the SLAMI Proposed Reclamation and dredged area on currents and sediment transport*, Report prepared for SMEC and AECOM Australia January 2021.

Munday, J 2020, *Guide to Social Impact Assessment*, Darwin: True North Strategic Communication. Accessed at <https://www.truenorthcomm.com.au/news/guide-to-sia>. Accessed August 2021.

Northern Territory Environment Protection Agency (NT EPA), 2010 *Ecologically Sustainable Development of Darwin Harbour*

Northern Territory Environment Protection Agency (NT EPA), 2013 *Guidance for Economic and Social Impact Assessment*

Northern Territory Government (NTG) 2019, *Territory Benefit Policy*, Darwin: Northern Territory Government. Accessed at https://industry.nt.gov.au/data/assets/pdf_file/0008/664127/territory-benefit-policy.pdf. Accessed August 2021.

Northern Territory Government (NTG) 2021, *Territory Economic Reconstruction Commission Final Report*, Darwin: Northern Territory Government. Accessed at https://ntrebound.nt.gov.au/data/assets/pdf_file/0020/952301/terc-final-report.pdf Northern Territory Planning Commission, 2015. *Darwin Regional Land Use Plan*. Darwin: Northern Territory Planning Commission, Accessed at https://nt.gov.au/data/assets/pdf_file/0019/240247/darwin-regional-land-use-plan-2015.pdf. Accessed August 2021.

NSW Department of Planning Industry and Environment 2021, *Social Impact Assessment Guideline for State Significant Projects*. Sydney: New South Wales Government. Accessed at <https://www.planning.nsw.gov.au/Policy-and-Legislation/Under-review-and-new-Policy-and-Legislation/Social-Impact-Assessment>, Accessed August 2021.

Real Estate Institute of the NT (REINT) 2021, *RELM Magazine*, Darwin: Real Estate Institute of the NT, Accessed at <https://www.reint.com.au/info/reim-magazine>. Accessed August 2021.

Territory Economic Reconstruction Commission 2020, *Final Report*, Darwin: Northern Territory Government, Accessed at https://ntrebound.nt.gov.au/_data/assets/pdf_file/0020/952301/terc-final-report.pdf, Accessed August 2021.

Environment Centre of the Northern Territory 2021, *Submission to the NTEPA on TNG EIS Supplement*, Darwin: NTEPA, Retrieved from https://ntepa.nt.gov.au/_data/assets/pdf_file/0008/1009277/ecnt.pdf

True North Strategic Communication (True North) 2021, *Darwin Ship Lift Project – Social Impact Assessment*, Report prepared for AECOM.

United Nations 2007, *UN Declaration on the Rights of Indigenous Peoples*, New York: United Nations, Accessed at http://www.un.org/esa/socdev/unpfii/documents/DRIPS_en.pdf, Accessed August 2021.

URS 2011, *East Arm Wharf Expansion Draft Environmental Impact Statement*. Darwin: Northern Territory Environment Protection Authority, Accessed at <https://ntepa.nt.gov.au/your-business/public-registers/environmental-impact-assessments-register/completed-assessments/register/east-arm-wharf-expansion>. Accessed August 2021.

Vanclay, F 2003, *International Principles for Social Impact Assessment*, Impact Assessment and Project Appraisal, 21(1), 5-12.

Vanclay, F., Esteves, A., Aucamp, I., & Franks, D 2015, *Social Impact Assessment: Guidance for assessing and managing the social impacts of projects*, Fargo: International Association for Impact Assessment.

Other Key Environmental Factors

Department of Health 2014, *Guidelines for Preventing Biting Insect Problems for Urban Residential Developments or Subdivisions in the Top End of the Northern Territory*, <https://digitallibrary.health.nt.gov.au/prodjsui/bitstream/10137/2686/1/Guidelines%20for%20preventing%20mosquito%20problems%20for%20new%20rural%20residential%2020..pdf>, Accessed February 2021.

Department of Health 2017, *Guidelines for Preventing Breeding Associated with Construction Practice near Tidal Areas in the NT*, Accessed at [https://digitallibrary.health.nt.gov.au/prodjsui/bitstream/10137/2687/2/Construction practice near tidal areas Dec 2017.pdf](https://digitallibrary.health.nt.gov.au/prodjsui/bitstream/10137/2687/2/Construction%20practice%20near%20tidal%20areas%20Dec%202017.pdf), Accessed February 2021.

Department of Health and Family Services 2008, *Constructed Wetlands in the Northern Territory – Guidelines to prevent mosquito breeding*.

Ecological Management Services (EMS) 2011, *East Arm Wharf Expansion Project – Terrestrial Flora and Fauna Assessment*, Report prepared for URA Australia/ Northern Territory department of Lands and Planning.

Kellogg Brown and Root (KBR) 2018, *Notice of Intent – Darwin Ship Lift Facility and Marine Industries Project*, Prepared for Northern Ship Support Pty Ltd.

Kellogg Brown and Root (KBR) 2020, *Darwin Ship Lift and Marine Industries Facility Sediment Sampling and Analysis Plan*, Report prepared for the NT Department of Trade, Business and Innovation, BEN961-TD-EV-REP-0001 Rev. 0. 5 February 2020.

Northern Territory Environmental Protection Agency (NT EPA) 2015, *Waste Management Strategy for the Northern Territory 2015-2022*, Accessed at https://ntepa.nt.gov.au/_data/assets/pdf_file/0008/284948/ntepa_waste_strategy_2015_2022.pdf. Accessed September 2021.

Northern Territory Government 2021, *Declared Weeds in the Northern Territory*, Accessed at https://nt.gov.au/_data/assets/pdf_file/0016/252133/declared-weeds-in-the-nt.pdf. Accessed September 2021.

Warchot, A., and Whelan, P 2011, *East Arm Port Expansion Project Biting Insect Investigation October to December 2010*, Study undertaken on behalf of URS Australia Pty Ltd.

Cumulative impacts

Darwin Harbour Advisory Committee (DHAC) 2021, *Darwin Harbour Strategy 2020-2025*, Palmerston: Darwin Harbour Advisory Committee. Accessed at

https://nt.gov.au/data/assets/pdf_file/0008/915038/darwin-harbour-strategy-2020-2025.pdf, Accessed August 2021.

Darwin Harbour Advisory Committee 2020, *Draft Darwin Harbour Strategy Consultation Report*. Darwin: Darwin Harbour Advisory Committee. Accessed at https://nt.gov.au/data/assets/pdf_file/0009/915039/darwin-harbour-advisory-strategy-consultation-feedback-summary.pdf Ketch 2020, Accessed August 2021.

Department of Infrastructure Planning and Logistics (DIPL) 2021, NT projects, Available at <https://dipl.nt.gov.au/projects> Accessed November 2020, March 2021.

Land Development Corporation (LDC), 2021. Projects and places. Available at <https://landdevcorp.com.au/projects-places/>, Accessed September 2020, November 2020, March 2021.

Northern Territory Environment Protection Authority (NT EPA) 2020b, Environmental impact assessments register, Available at <https://ntepa.nt.gov.au/your-business/public-registers/environmental-impact-assessments-register>, Accessed September 2020.

Northern Territory Environment Protection Authority (NT EPA) 2021, Environmental impact assessments register, Available at <https://ntepa.nt.gov.au/your-business/public-registers/environmental-impact-assessments-register>, Accessed September 2020, March 2021.

Territory Economic Reconstruction Commission (TERC) 2020, *Final Report*, Darwin: Northern Territory Government, Accessed at https://ntrebound.nt.gov.au/data/assets/pdf_file/0020/952301/terc-final-report.pdf, Accessed August 2021.

Environmental Management Framework

Department of Agriculture, Fisheries and Forestry (DAFF) 2009a, *National Biofouling Management Guidance for Commercial Vessels*, Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Department of Agriculture, Fisheries and Forestry (DAFF) 2009b, *National Biofouling Management Guidance for Non-Trading Vessels*, Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Department of Agriculture, Fisheries and Forestry (DAFF) 2010, *Australian Marine Pest Monitoring Manual*, Version 2.0. Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Department of Agriculture and Water Resources (DAWR) 2017, *Australian Ballast Water Management Requirements*, Version 7, Department of Agriculture and Water Resources, Commonwealth of Australia.

Department of Transport (DoT) 2014, *Northern Territory Oil Spill Contingency Plan*.

Department of Infrastructure, Planning and Logistics (DIPL) 2019, *Standard Specification for Environmental Management – Version 2*, Accessed at https://dipl.nt.gov.au/data/assets/pdf_file/0018/241713/ssem-v2.0-01-july-2019.pdf. Accessed March 2021.

International Erosion Control Association (IECA) 2008, *Best Practice Erosion & Sediment Control*, IECA, Picton, NSW. ISBN: 978-0-9806146-0-2.

Landbridge Darwin Port 2020, *Standard Operating Procedure. Oil Spill Contingency Plan*, Accessed at https://www.darwinport.com.au/sites/default/files/uploads/2020/SOP%20-%20SOP_OPS13%20-%20Oil%20Spill%20Contingency%20Plan%20%28OSCP%29%20V8%20-%202020-01-15_0.pdf. Accessed September 2021.

Northern Territory Environment Protection Authority (NT EPA) 2017, *Guideline: Recommended Land Use Separation Distances*, Accessed at https://ntepa.nt.gov.au/data/assets/pdf_file/0006/453192/guideline_recommended_land_separation_distances_oct.pdf, Accessed August 2021.

Northern Territory Environment Protection Authority (NT EPA) 2018a, *Environmental Factors and Objectives*, Version 0.4. Accessed at https://ntepa.nt.gov.au/data/assets/pdf_file/0014/571010/draft_guidance_on_adaptive_management.pdf, Accessed February 2021.

Northern Territory Environment Protection Authority (NT EPA) 2018b, *Guidance on Adaptive Management*, Version 1.0. Accessed at https://ntepa.nt.gov.au/data/assets/pdf_file/0005/546791/guideline_environmental_factors_objectives.pdf, Accessed February 2021.

Northern Territory Environment Protection Authority (NT EPA) 2021, *Environmental Obligations and Duties*, Accessed at https://ntepa.nt.gov.au/data/assets/pdf_file/0005/546791/guideline_environmental_factors_objectives.pdf, Accessed February 2021.