FLANAGAN CONSULTING GROUP
Trusted Advisor to Northern Australia

Ports North

CAIRNS SHIPPING DEVELOPMENT PROJECT

Revised Draft Environmental Impact Statement

Chapter B16: Climate Change and Greenhouse

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B16.1 Introduction

B16.1.1 Scope

The purpose of this chapter is to outline the potential effects of climate change on the Cairns Shipping Development Project (the CSD Project) as well as estimating the Greenhouse Gases (GHG) that it is likely to generate.

Specifically, this assessment is intended to:

- provide a summary of the potential effects of climate change on the project, based on current understanding of climate change science
- provide a GHG footprint calculation for both construction and operation
- outline design and operational control measures to minimise the impacts of climate change and the amount of GHG emissions produced.

The CSD Project is proposed to accommodate larger cruise ships at the Cairns Cruise Liner Terminal (CCLT) and a potential expansion of the HMAS Cairns Navy Base within a nominal planning horizon (discussed in **Sections B16.2.1** and **B16.2.3**). Given the coastal location of the port and proposed Dredge Material Placement Areas (DMPAs), they are expected to be vulnerable to sea level rise and storm tide events in particular. These events are expected to be affected by changes in climate, resulting in potential impacts to the project and/or environment. However, at the completion of the placement campaign, both DMPAs will be subject to previously committed future uses such that long term changes arising from climate change are not relevant. Accordingly, projected changes in climate need to be taken into consideration for the design, operation and maintenance of the permanent landside works.

This chapter explores potential climate change impacts related to proposed infrastructure and shipping operations, as well as considering the contribution of construction and operational activities on climate change by accounting for the production of additional GHG emissions. These are quite different matters and are dealt with separately below.

It should be noted that **Chapter 18** (Cumulative Impacts Assessment) considers potential climate change impacts on the Great Barrier Reef and whether the project may impact on the resilience of the marine habitat. It also summarises consequential impacts of the project and draws from this chapter.

B16.1.2 Study Area and Project Areas

As noted in **Chapter A1** (Introduction), the 'study area' for the EIS varies depending on the issue at hand while various 'project areas' are the immediate footprints of the proposed works. For the consideration of climate change and GHG emissions, the 'local scale' is considered to be appropriate (although climate change drivers and the impact of GHG emissions have global dimension). Elements of the local scale (**Figure B16-1**) relevant to this chapter are the Cairns coastal plain generally between the Wet Tropics World Heritage Area and the coast between Trinity Inlet and Cairns' Northern Beaches. This area is characterised by (from south to north):

- the Trinity Inlet wetlands
- the Cairns CBD (fronting the Cairns foreshore between Trinity Inlet and the Barron River and spreading south-west, west, and north-west) to the coastal ranges
- the Port of Cairns and the allied industrial area east of the CBD and fronting Trinity Inlet
- the Barron River flood plain with its mosaic of agricultural, industrial, and residential developments of the southern Northern Beaches (Machans Beach to Yorkeys Knob)
- the township of Smithfield and the balance of the Northern Beaches.

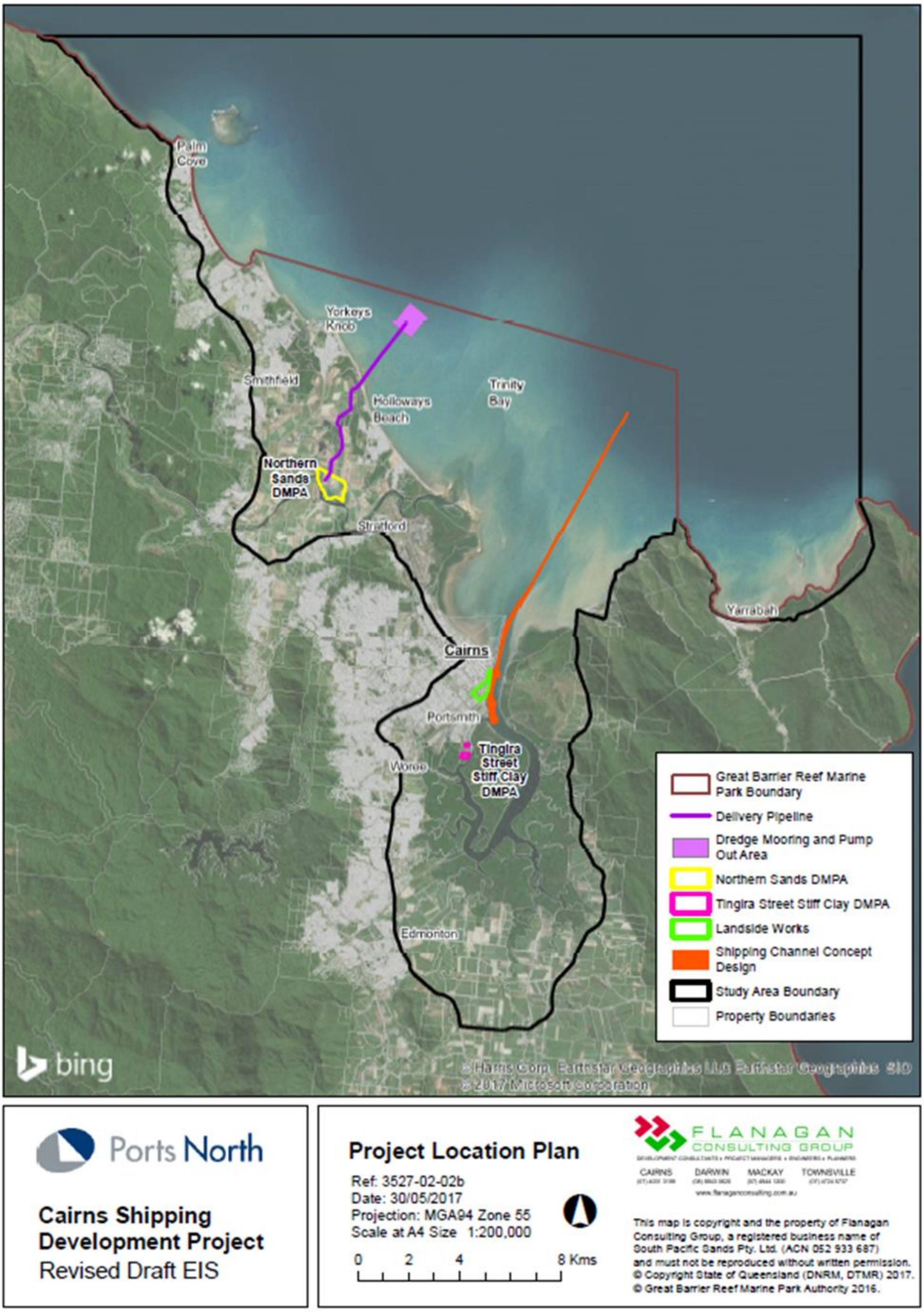

Figure B16-1 Study Area and Project Areas.

Project areas are also shown on **Figure B16-1** and encompass:

- Channel Project Area including the shipping channel and the route to the pump-out point at the seaward end of the pipeline to the Northern Sands DMPA.
- Landside Works Project Area for wharf upgrades and berthing of cruise ships.
- Northern Sands DMPA Project Area (includes the DMPA, delivery pipeline corridor, tailwater ponds, and tailwater outlet works).
- Tingira Street Stiff Clay DMPA Project Area.

B16.1.3 End uses of the DMPAs

B16.1.3.a Northern Sands Project Area

The Northern Sands DMPA contains an operating sand mine and a 25 ha water-filled void that is to be enlarged and used for the placement of soft clays pumped to the site. The current void contains fresh water from groundwater seepage and rainfall.

The soft clay placement campaign will fill all or most of the void over a period of some three months after which it will settle over one wet season. Once this filling is complete, the DMPA will revert to the control of the owner who will then determine subsequent uses. No assumptions can be made about this use although current approvals imply that at some time the void is to be completely filled.

In terms of the CSD Project, the use of the Northern Sands DMPA and the inlet and outlet pipelines will be very short term such that any climate changes will not be relevant.

B16.1.3.b Tingira Street Project Area

The Tingira Street DMPA is currently cleared (although some marine plants have recolonised much of the area not covered by anthropogenic grasslands) and in its past has been filled to above HAT.

The placed stiff clay will be used to fill and preload the site to accelerate settlement. As a separate project, Ports North intends to import additional fill and construct industrial hardstands and other infrastructure. This project has been under consideration for many years and most of the necessary approvals have already been obtained.

In terms of the CSD Project, the use of the Tingira Street DMPA will be very short term such that any climate changes will not be relevant.

B16.2 Methodology

B16.2.1 Detailed Technical Assessments

Several detailed technical assessments were undertaken in support of both the concept design of the project (documented in **Chapter A2** (Project Background)) and this chapter. These are listed in **Table B16-1** below. The final column shows where these reports are located in this Revised Draft EIS.

TABLE B16-1 DETAILED TECHNICAL ASSESSMENTS

STUDY	DETAILS	APPENDIX NO
Greenhouse Gas Emission Calculations	Calculations of likely GHGs (prepared as part of the input to **Chapter B11** (Air))	**Appendix AY**

This study is referred to where appropriate. While all relevant findings have been incorporated into this chapter, readers are referred to the original report for further details if required. This technical study involved:

- calculation of emissions from clearance of vegetation using FullCAM
- preparation of a greenhouse gas inventory for combustion sources including maximum annual greenhouse gas emissions from the proposed construction and operations based on current National Greenhouse Accounts Factors and NGER guidelines.
- modelling of two scenarios (with and without the project) for the years 2018 and 2028.

Summaries are provided below. Many detailed tables are mentioned but not duplicated here. Readers requiring this detailed information are referred to the relevant material where appropriate.

B16.2.2 Climate Change

The climate change assessment for the CSD Project considers the potential impacts that projected changes to aspects of the local climate would have on the various project elements (i.e. those located in the project areas defined in **Section B16.1.2**). This includes infrastructure developed or expanded by the project (e.g. expanded Inner Harbour and Outer Harbour channel and upgraded CCLT facilities), infrastructure experiencing increased use as a result of the project (e.g. port facilities and connecting roads) and operational activities required for or facilitated by the project (e.g. cruise ship movements, maintenance dredging). Climate change impacts during the construction phase are considered to be not applicable as construction will be complete before projected changes begin to be experienced.

The description of the ‘existing situation’ for climate change involves documenting the current projections for the Cairns region, while the assessment of impacts investigates what these could mean for the CSD Project.

The climate change assessment also includes consideration of the impact of the project upon the resilience of the natural environment to projected changes.

B16.2.2.a End Uses of DMPAs – Climate Change Implications

End uses of the two DMPAs have been described in **Sections B16.1.3.a** and **B16.1.3.b**. It is critical to an appreciation of impacts that the use of the two DMPAs and associated pipelines will be very short term, such that any climate changes will not be relevant.

B16.2.2.b Planning Horizon

It is assumed that the Port of Cairns will continue to be an operational port to service the city of Cairns and surrounds, and remain a key cruise ship destination until at least 2090 (the nominal planning horizon for this climate change assessment based on CSIRO and Bureau of Meteorology (2016a)). In regard to this, climate change scenarios have been identified for application to 2090, with the exception of projections for rainfall intensity (2070), storm tide inundation (2100), and tropical cyclones (2100) where projections for 2090 are not available.

B16.2.3 GHG Emissions

The carbon footprint of the CSD Project has been calculated based on the assumption that it will be constructed and fully operational by 2019. Refer to **Chapter A3** (Project Description) for details on the project construction process and timing.

Estimating the GHG emissions from the project includes consideration of both construction and operational phases. Construction phase emissions are associated with emission-producing activities undertaken for the purposes of developing the project (e.g. dredge vessel fuel use, booster pump fuel use, vegetation clearing). Emissions during the operational phase are those that are generated by activities facilitated by or necessary for the operation of the project (e.g. increased cruise ship movements, maintenance dredging).

The description of the 'existing situation' for GHG emissions involves documenting current emissions for the Cairns region, while the assessment of impacts investigates additional emissions during the construction and operation of the CSD Project, recognising that this is not an impact as such.

B16.2.3.a End Uses of DMPAs – GHG Implications

End uses of the two DMPAs are as described in **Sections B16.1.3.a** and **B16.1.3.b**. Construction phase emissions for Tingira Street have not been considered in this assessment as similar activities would need to take place to develop the land for its intended industrial use.

B16.2.3.b GHG Accounting Standards

This assessment has used two international accounting standards:

- World Business Council for Sustainable Development/World Resources Institute for Greenhouse Gas Protocol; A Corporate Accounting and Reporting Standard (the GHG Protocol)
- AS ISO 14064.1 - 2006: Specification with guidance at the organisation level for quantification and reporting of greenhouse gas emissions and removals (AS ISO 14064).

It should be noted that AS ISO 14064 cross-references the GHG Protocol, so these two standards are complementary.

The National Greenhouse and Energy Reporting Scheme Measurement Technical Guidelines for estimation of emissions by facilities in Australia (Department of the Environment and Energy 2016) references these two international standards. Therefore, the selection of these methodologies is consistent with International and Australian practice.

GHGs are gaseous constituents of the atmosphere that influence energy flows by absorbing infra-red radiation. For the purposes of this report, GHGs are the six gases listed in the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs); and sulphur hexafluoride (SF_6).

As different GHGs have different Global Warming Potentials (GWP), the carbon dioxide equivalent (CO_2-e) is used as the universal unit of measurement to evaluate GHGs against a common basis. CO_2-e indicates the global warming potential expressed in terms of the GWP of one unit of CO_2. For that reason, CO_2 is used as a reference as it always has the GWP of one.

The GWP of a GHG is the radiative forcing impact contributing to global warming relative to one unit of CO2. Sourced from the IPCC's Fourth Assessment Report (Forster *et al.* 2007) the GWP of several GHGs are listed in **Table B16-2** below and are consistent with the Australian Government's National Greenhouse and Energy Reporting Measurement Technical Guidelines (DoEE 2016).

TABLE B16-2 GWP OF SEVERAL GHGS

GHGS	CHEMICAL FORMULA	GWP (100 YEARS)
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous oxides	N_2O	298
HFCs	-	92 – 14 800
PFCs	-	7390 – 12 200
Sulphur hexafluoride	SF_6	22 800

Source: Appendix AY (Table 1.1).

Once data is collected, emissions from an organisation's activities are quantified by multiplying activity data (e.g. kWh of electricity used) with the appropriate emission factor (e.g. kg CO_2 e/kWh of electricity).

Emission factors are activity-specific and thus the activity determines which emission factor is used. Identifying the relevant emission factor can depend on several aspects including whether consumption of the input results in GHG emissions directly or indirectly, how the input creates emissions (i.e. consumption or generation) and the location of the activity. For example, the emission factor for the generation of electricity varies from state to state as electricity is generated by various processes using various sources (e.g. Queensland uses a combination of bituminous coal and natural gas/coal seam gas while Victoria predominantly uses brown coal and in Tasmania electricity is generated by hydropower).

B16.3 Existing Situation

B16.3.1 Climate Change

B16.3.1.a Background

The Intergovernmental Panel on Climate Change (IPCC) has reported that climate changes are linked to increased emissions of GHG caused by human activity.

> Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial-era values determined from the testing of ice cores spanning many thousands of years. The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture. (IPCC 2007).

At the current high levels of GHG in the atmosphere, warming of the climate will continue even if emissions are dramatically reduced. Even if emissions from human sources were to cease, slower heat loss from the oceans means temperatures would not drop significantly for at least 1000 years.

In the 2007 Fourth Assessment Report, the IPCC recognised that 'warming of the climate system is unequivocal'; however, there are degrees of uncertainty associated with its impacts (when and to what extent the impact will manifest). This uncertainty is associated with the anticipated rate of GHG emissions in the future and correlations between temperature increases and its associated impact on sea levels, rainfall, extreme weather etc. The latest report (IPCC 2013) confirms scientists are more certain that warming since

1950 has been primarily caused by humans and that the period between 2001 and 2010 was the hottest decade on record. This is causing an increase in the frequency and severity of extreme weather events.

The latest IPCC report on climate change observations, the Fifth Assessment Report (IPCC 2013), known as AR5, states that stabilising the climate will require substantial and sustained reductions in GHG emissions. The report provides a view of the current state of global scientific knowledge relevant to climate change. Major findings include:

- The period 2001-2010 was the hottest decade on record, with many regions, including Australia, experiencing longer and more intense heatwaves. If emissions continue to track at the top of IPCC scenarios, global temperature could rise by up to 5.4ºC by 2100, relative to pre-industrial levels.
- The frequency and severity of extreme events is increasing and rainfall patterns are changing with an increase in the intensity or amount of heavy precipitation events, however this is subject to variation depending on location.
- Sea level has risen by 190 mm over the 1901-2010 period, and at an increased rate over the period since 1993, and the oceans are becoming more acidic. If emissions continue to increase unabated, sea level is predicted to rise by nearly 1 m by 2100, compared to its average level between 1986-2005.

In their 2016 report on the State of the Climate, the CSIRO and BoM (2016b) reports the following changes for climate change in Australia, based on the most recent observations:

- Mean surface air temperature has increased by 1.1ºC since 1910, with daytime maximum and overnight minimum temperatures increasing by 1.0ºC and 1.2ºC respectively over this same period.
- Relative sea level has risen at an average rate of 1.4 mm/yr between 1966 and 2009 which increases to 1.6 mm/yr when the influence of El Niño Southern Oscillation is removed.
- Sea surface temperature have increased significantly.

Other observations (e.g. changes in rainfall, wind, storm frequency) have not been made for this cluster due to unavailability of adequate historical data.

The Australian Maritime College (2009) held a workshop in 2009 to report on climate change risks for ports. In a similar way, the National Climate Change Adaptation Research Facility (NCCARF), working with RMIT University, undertook an extensive study to understand the future climate change risks to Australian seaports generally (McEvoy *et al.* 2013). Both studies concluded that the major potential impacts on Australian ports are:

- Increases in wind speeds and storm frequency which can damage infrastructure and affect berthing ability of vessels. This includes impacts associated with riverine flooding as well as storm tide.
- Sea level rise – while it was agreed that sea level rise will occur gradually, allowing sufficient time to adapt, concerns about conditions outside of ports (e.g. road/rail/electricity supply) were raised as an issue for access/supply of ports.
- Changes in wave and atmospheric conditions, leading to reduced integrity and life of maritime structures (e.g. increased corrosion, heat-based stress).

In this context, the project will need to take this information into account to ensure that:

- The design allows for a changing climate
- Measures to minimise the GHGs produced through its construction, operation and maintenance are identified and implemented.

B16.3.1.b IPCC Emissions Scenarios

To estimate future climate change, the IPCC has adopted representative concentration pathways (RCPs) for GHG concentrations in its Fifth Assessment Report (2014). These are projections describing four possible climate futures, varying basing on GHG emissions in future years. The four RCPs are described in **Table B16-3**.

For purposes of this assessment, the both RPC 4.5 and RPC 8.5, representing intermediate and high GHG concentrations, have been adopted. This is consistent with the reporting of climate futures for the Wet Tropics cluster by CSIRO in the State of the Climate Report (CSIRO and BoM 2016a).

TABLE B16-3 OVERVIEW OF IPCC EMISSIONS SCENARIOS

RCP	DESCRIPTION
RCP 2.6	Represents a GHG concentration leading to radiative forcing in 2100 relative to 1750 of 2.6 W m^2. This is a very low forcing level, based on a GHG emissions mitigation scenario where concentrations peak and then decline before 2100.
RCP 4.5	Represents a GHG concentration leading to radiative forcing in 2100 relative to 1750 of 4.5 W m^2. This is an intermediate forcing level, based on stabilisation of GHG concentrations around 2100.
RCP 6.0	Represents a GHG concentration leading to radiative forcing in 2100 relative to 1750 of 6.0 W m^2. This is an intermediate forcing level, based on stabilisation of GHG concentrations after 2100.
RCP 8.5	Represents a GHG concentration leading to radiative forcing in 2100 relative to 1750 of 8.5 W m^2. This is a high forcing level, based on very high greenhouse gas emissions, with a concentration peak after 2100.

Source: IPCC (2014).

B16.3.1.c Climate Change Projections for Cairns

Table B16-4 presents the climate change projections used to inform this assessment and recommendations. Projects have been primarily sourced from the CSIRO ***State of the Climate Report*** results for the Wet Tropics cluster (CSIRO and BoM 2016a), with other projections used from well-respected sources for any relevant gaps.

The latest report from the IPCC (AR5) provides further details regarding confidence levels; these descriptions of confidence levels and likelihood are included in **Table B16-4**. The descriptions of the impacts are based on the IPCC AR 5 Working Group II, Chapter 25 Australasia.

TABLE B16-4 CLIMATE CHANGE PROJECTIONS FOR THE FAR NORTH QUEENSLAND AREA AND FOR AUSTRALIA

VARIABLE	PROJECTED TIMEFRAME AND SCENARIO	DESCRIPTION OF PROJECTION	CONFIDENCE LEVEL	DESCRIPTION OF IMPACT
CSIRO State of the Climate Report (2016): Projections in meteorological variable change (comparative to 1986-2005 period) for Wet Tropics Cluster*				
Temperature mean (ºC)	2090 – RCP 4.5	+1.4 (+1 to +2)	Very high	Increase in temperatures causing increased strain on infrastructure and environmental values.
	2090 – RCP 8.5	+2.9 (+2.3 to +3.9)	Very high	
Temperature maximum (ºC)	2090 – RCP 4.5	+1.4 (+1.1 to +2.1)	Very high	
	2090 – RCP 8.5	+2.9 (+2.3 to +3.9)	Very high	
Temperature minimum (ºC)	2090 – RCP 4.5	+1.4 (+1.1 to +2.1)	Very high	
	2090 – RCP 8.5	+3 (+2.3 to +4.2)	Very high	
Rainfall (%)	2090 – RCP 4.5	-2 (-12 to +8)	Medium	Reduction in available rainfall
	2090 – RCP 8.5	-2 (-26 to +21)	High	
Solar radiation (%)	2090 – RCP 4.5	+0.1 (-1.6 to +2.2)	Medium	Increase in radiation causing increased strain on infrastructure and environmental values
	2090 – RCP 8.5	-0.3 (-4.7 to +2.2)	Medium	
Relative humidity (%, absolute)	2090 – RCP 4.5	-0.3 (-2.1 to +1.1)	Medium	-
	2090 – RCP 8.5	+0.1 (-1.9 to +1.5)	Medium	
Potential evapotranspiration (%)	2090 – RCP 4.5	+5.1 (+3 to +9.3)	Very high	Reduction in available surface water
	2090 – RCP 8.5	+9.8 (+5.9 to +17)	Very high	
Surface wind speed (%)	2090 – RCP 4.5	+1 (-1.6 to +7.1)	Medium	Increase in wind impacts to infrastructure and increase in wind-generated wave impacts
	2090 – RCP 8.5	+2.2 (-0.6 to +7.7)	High	
Soil moisture (%)	2090 – RCP 4.5	-2.7 (-12.4 to +0.4)	Medium	Reduction in available soil moisture
	2090 – RCP 8.5	-3.9 (-19 to +3.7)	Medium	

(Continued over)

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VARIABLE	PROJECTED TIMEFRAME AND SCENARIO	DESCRIPTION OF PROJECTION	CONFIDENCE LEVEL	DESCRIPTION OF IMPACT
CSIRO State of the Climate Report (2016): Projections in oceanic variable change (comparative to 1986-2005 period) for Cairns*				
Sea level rise (m)	2090 – RCP 4.5	+0.48 (+0.31 to +0.65)	Very high	Pressures on coastal infrastructure and environmental values
	2090 – RCP 8.5	+0.65 (+0.44 to +0.87)	Very high	
Sea allowance (m)	2090 – RCP 4.5	+0.57	n/a	
	2090 – RCP 8.5	+0.79	n/a	
Sea surface temperature (ºC)	2090 – RCP 4.5	+1.3 (+1.1 to +1.8)	Very high	Increase in temperatures causing increased strain on infrastructure and environmental values.
	2090 – RCP 8.5	+2.6 (+2.3 to +3.5)	Very high	
Sea surface salinity	2090 – RCP 4.5	-0.13 (-0.67 to +0.27)	Low	Reduction in oceanic salinity and acid balances causing increased strain on environmental values
	2090 – RCP 8.5	-0.18 (-1.10 to +0.36)	Low	
Ocean acidification	2090 – RCP 4.5	-0.14 (-0.15 to -0.14)	Very high	
	2090 – RCP 8.5	-0.31 (-0.32 to -0.31)	Very high	
Aragonite saturation	2090 – RCP 4.5	-0.77 (-0.79 to -0.73)	Very high	
	2090 – RCP 8.5	-1.53 (-1.61 to -1.49)	Very high	

(Continued over)

VARIABLE	PROJECTED TIMEFRAME AND SCENARIO	DESCRIPTION OF PROJECTION	CONFIDENCE LEVEL	DESCRIPTION OF IMPACT
Other projections				
Rainfall intensity [1]	2070	Increase in rainfall intensity	Medium	Increased extreme rainfall related to flood risk
Storm tide inundation [2]	2100	Storm tide level of: 2.88 m AHD without wave effects 4.04 m AHD with wave effects	Medium	Flood risk projected to increase due to more intense extreme rainfall events
Tropical cyclones [3]	2100	Increase in intensity of 10% Uncertainty in changes of frequency	Low	Tropical cyclones are projected to increase in intensity

Source: Various – see below :

*Projection is described based on the median (50th percentile) with 10th and 90th percentile ranges provided in brackets (where available), except for sea level rise where 5th and 95th percentile ranges are provided

1 Queensland Government 2016 draft Climate Change Projections for Far North Queensland Region – https://www.qld.gov.au/environment/climate/projections/

2 Cairns Storm Tide Study (BMT WBM 2009 and 2013)

3 Coastal Hazards Technical Guideline (EHP 2013)

B16.3.1.d Sea Level

Existing and projected Levels

The following levels derived from the Cairns tide gauge (100280) and the Cairns Storm Tide Study (BMT WBM 2013) are relevant to the study area:

- Existing situation:
  - HAT – 1.86 m AHD (3.50 m LAT)
  - present day 100 yr ARI storm tide (without wave effects) – 1.99 m AHD
  - present day 100 yr ARI storm tide (with wave effects) – 3.15 m AHD
- Projections for year 2100:
  - 2100 100 yr ARI storm tide (without wave effects) – 2.88 m AHD
  - 2100 100 yr ARI storm tide (with wave effects) – 4.04 m AHD.

Terms referred to above are as follows:

- HAT = Highest Astronomical Tide
- LAT = Lowest Astronomical Tide
- AHD = Australian Height Datum (approximately mean sea level)
- ARI = Average Recurrence Interval (years). This is approximately the inverse of Annual Exceedance Probability which is the probability of an event being exceed in any one year.

All four of these parameters can be expected to vary with climate change.

Spatial Effects

The Queensland Government has mapped coastal hazard areas along the Queensland coast. The maps indicate the extent of coastal areas projected to be at risk from coastal hazards to the year 2100. Each map shows areas at risk from:

- Coastal erosion and permanent inundation by sea level rise
- Storm tide inundation for medium hazard and high hazard inundation.

The maps incorporate a sea level rise of 0.8 m by 2100 as a default for both erosion prone areas and storm tide inundation areas. This is approximate to the sea level allowance recommended by CSIRO for the Wet Tropics by 2090 for RCP 8.5 (0.79 m, see **Table B16-4**). In addition, more detailed methodologies available for determining these risk areas (i.e. Coastal Hazards Technical Guideline EHP 2013) require adoption of a sea level rise component of 0.8 m, a southward latitude shift in the tropical cyclone climate of approximately 1.3 degrees, and an increase in cyclone maximum potential intensity of 10% by 2100. These are derived from projections in the Fourth Assessment Report (IPCC 2007) which remain largely unchanged in the Fifth Assessment Report (IPCC 2014).

Figure B16-2 shows areas in the Cairns CBD and Port subject to erosion and permanent tidal inundation due to sea level rise, in accordance with the *Coastal Protection and Management Act 1995* (Qld) (CPM Act). **Figure B16-3** shows that this area is likely to be subject to storm tide inundation of greater than 1.0 m in depth, based on current assessments. As previously noted, both DMPAs and the associated pipelines are short term uses that will not be affected by climate change.

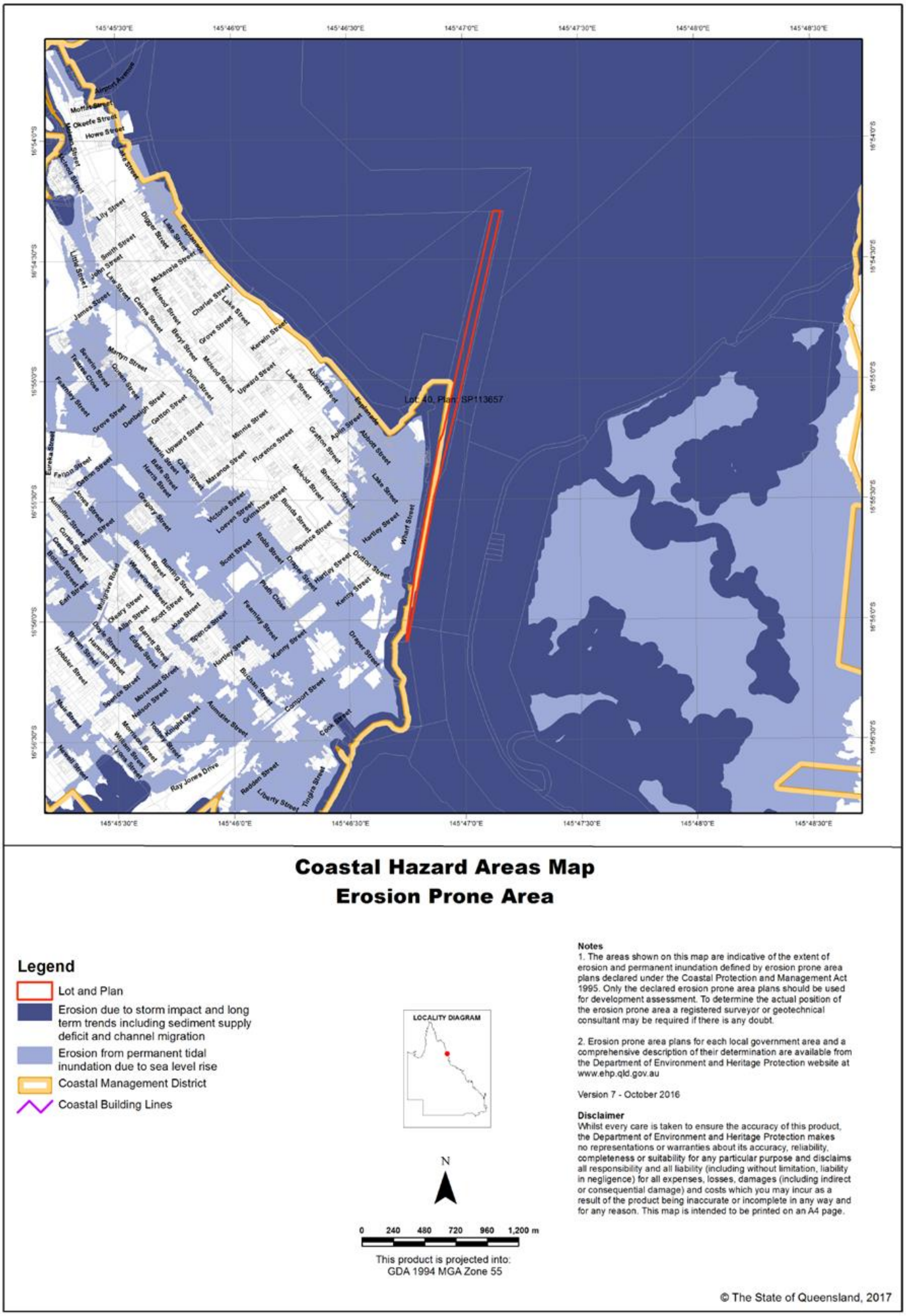

Figure B16-2 Erosion Prone Area Map – Channel and CCLT.

Source: CPM Act mapping.

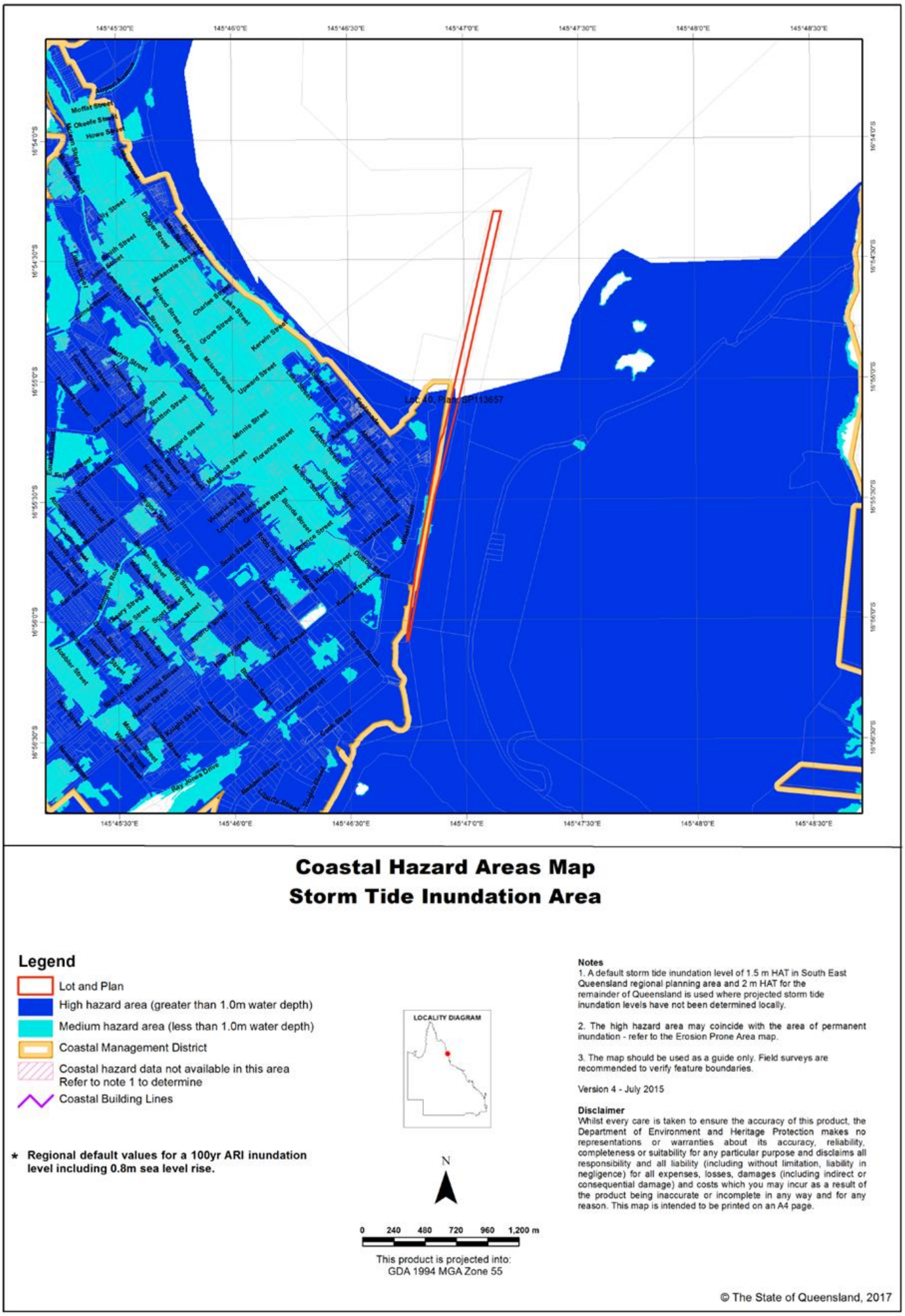

Figure B16-3 Storm Tide Inundation Area Map – Channel and CCLT.

Source: CPM Act mapping.

Erosion prone area mapping indicates the vulnerability of almost all of the Port of Cairns land-side infrastructure, including the CCLT, to erosion from permanent tidal inundation due to sea level rise. Much of the Northern Sands DMPA is also mapped within this erosion prone area. In addition, almost all of the landside aspects of the project area are within the medium or high storm tide inundation areas. This mapping is based on a default storm tide inundation level of 2.0 m at highest astronomical tide (HAT). Noting the current HAT level for the project area is ~3.5 m above lowest astronomical tide (LAT, 1.86 m AHD) this represents a storm tide height of 5.5 m LAT (3.86 m AHD). While more detailed calculations may reduce the extent of inundation areas, the majority of the Landside Works Project Area is vulnerable to storm tide.

B16.3.2 GHG Emissions

B16.3.2.a Cairns Region Emissions

No data is available of current GHG emissions for the Cairns region.

B16.3.2.b Ports North Emissions

Ports North does not currently undertake a formal annual assessment of its GHG emissions for the Port of Cairns. However, it has implemented a number of measures to reduce the GHG emissions footprint. These include:

- offsetting staff air travel through Queensland Government’s travel policy requirements
- switching its workshop fleet to lower emission fuels
- installing energy efficient lighting and air-conditioning plant in offices
- recycling construction and demolition waste and purchasing products with a low carbon intensity where possible.

Some existing activities at the Northern Sands DMPA site are expected to be a minor source of GHG emissions. The approved redevelopment of the Tingira Street DMPA site for port purposes will also cause some GHG emissions, although this has not yet occurred. Emissions from both of these activities are expected to be negligible.

Both DMPA sites may also provide minor current levels of sequestration due to the presence of vegetation.

B16.4 Assessment of Potential Impacts

B16.4.1 Methodology

B16.4.1.a Overall Approach

The following impact assessment has been undertaken for each of the matters described in the previous chapter. It uses the risk-based process adopted for the Revised Draft EIS as outlined in **Chapter A1** (Introduction) and includes an assessment of the following:

- the magnitude of impacts (significance / consequence) as discussed below
- the duration of impact (from **Chapter A1** (Introduction)
- the likelihood of impact (from **Chapter A1** (Introduction)
- risk level (from **Chapter A1** (Introduction).

These are considered together to determine the final level of impact risk, which is defined differently for climate change and GHG. While the above approach applies equally to climate change and GHG, the two are subtly different and are therefore discussed separately. In particular, each has different:

- significance / consequence descriptors
- risk rating descriptions.

B16.4.1.b Climate Change

Impact Significance / Consequence Criteria

In the case of climate change, Australian Standard/New Zealand Standard 5334-2013: Climate Change adaptation for settlements and infrastructure – a risk based approach, outlines a process for the identification and management of risks that infrastructure faces from climate change. It provides risk criteria that are utilised in this study to determine the potential risks to the project from climate change, as shown in **Table B16-5**. This also provides criteria for assessing the potential impact of the CSD Project upon the resilience (i.e. adaptive capacity) of the natural environment to cope with climate change effects.

This approach is used below in place of the more general methodology used in other chapters of this Revised Draft EIS.

TABLE B16-5 SIGNIFICANCE / CONSEQUENCE CRITERIA – CLIMATE CHANGE

SIGNIFICANCE / CONSEQUENCE	ADAPTIVE CAPACITY	INFRASTRUCTURE, SERVICE	SOCIAL / CULTURAL	GOVERNANCE	FINANCIAL	ENVIRONMENTAL	ECONOMY
Very High	Capacity destroyed, redesign required when repairing or renewing asset.	Significant permanent damage and/or complete loss of the infrastructure and the infrastructure service Loss of infrastructure support and translocation of service to other sites Early renewal of infrastructure by 90 percent.	Severe adverse human health effects, leading to multiple events of total disability or fatalities. Total disruption to employees, customers or neighbours. Emergency response at a major level.	Major policy shifts Change to legislative requirements.	Extreme financial loss > 90 percent.	Very significant loss to the environment. May include localised loss of species, habitats or ecosystems. Extensive remedial action essential to prevent further degradation Restoration likely to be required.	Major effect on the local, regional and state economies.
High	Major loss in adaptive capacity. Renewal or repair would need new design to improve adaptive capacity.	Extensive infrastructure damage requiring major repair. Major loss of infrastructure service. Early renewal of infrastructure by 50-90 percent.	Severe adverse human health effects, leading to multiple events of total disability or fatalities. Total disruptions to employees, customers or neighbours. Emergency response at a major level.	Major policy shifts. Change to legislative requirements. Full change of management control.	Extreme financial loss >90 percent.	Very significant loss to the environment. May include localised loss of species, habitats or ecosystems.	Major effect on the local, regional and state economies.

(Continued over)

SIGNIFICANCE / CONSEQUENCE	ADAPTIVE CAPACITY	INFRASTRUCTURE, SERVICE	SOCIAL / CULTURAL	GOVERNANCE	FINANCIAL	ENVIRONMENTAL	ECONOMY
Moderate	Some change in adaptive capacity. Renewal or repair may need new design to improve adaptive capacity.	Limited infrastructure damage and loss of service Damage recoverable by maintenance and minor repair Early renewal of infrastructure by 20-50 percent.	Frequent disruptions to employees, customers or neighbours. Adverse human health effects.	Investigation by regulators. Changes to management actions required.	Moderate financial loss 10-50 percent.	Some damage to the environment, including local ecosystems. Some remedial action may be required.	High impact on the local economy, with some effect on the wider economy.
Minor	Minor decrease to the adaptive capacity of the asset. Capacity easily restored.	Localised infrastructure service disruption. No permanent damage. Some minor restoration work required. Early renewal of infrastructure by 10-20 percent Need for new/ modified ancillary equipment.	Short-term disruption to employees, customers or neighbours. Slight adverse human health effects or general amenity issues.	General concern raised by regulators, requiring response action.	Additional operational costs Financial loss small, <10 percent.	Minimal effects on the natural environment.	Minor effect on the broader economy due to disruption of service provided by the asset.
Negligible	No change.	No infrastructure damage, no change to service.	No adverse human health effects.	No changes to management required.	Little financial loss or increase in operating expenses.	No adverse effects on natural environment.	No effects on the broader economy.

Source: Australian/New Zealand Standard 5334-2013.

Duration of Impact

Table B16-6 shows the general approach to classifying the duration of identified impacts. This applies to both Climate Change and GHGs.

TABLE B16-6 CLASSIFICATIONS OF THE DURATION OF IDENTIFIED IMPACTS

RELATIVE DURATION OF IMPACTS	
Temporary	Days to months
Short Term	Up to one year
Medium Term	From one to five years
Long Term	From five to 50 years
Permanent / Irreversible	In excess of 50 years

Likelihood of Impact

Likelihood of impact is described in **Table B16-7** below. This applies to both Climate Change and GHGs.

TABLE B16-7 LIKELIHOOD OF IMPACT

LIKELIHOOD OF IMPACTS	RISK PROBABILITY CATEGORIES
Highly Unlikely	Highly unlikely to occur but theoretically possible
Unlikely	May occur during construction of the project but probability well below 50%; unlikely, but not negligible
Possible	Less likely than not but still appreciable; probability of about 50%
Likely	Likely to occur during construction or during a 12 month timeframe; probability greater than 50%
Almost Certain	Very likely to occur as a result of the proposed project construction and/or operations; could occur multiple times during relevant impacting period

Risk Matrix

Risk is described as the product of likelihood and consequence as shown in **Table B16-8** below. This applies to both Climate Change and GHGs.

TABLE B16-8 RISK MATRIX

LIKELIHOOD	SIGNIFICANCE				
	NEGLIGIBLE	MINOR	MODERATE	HIGH	VERY HIGH
Highly Unlikely/ Rare	Negligible	Negligible	Low	Medium	High
Unlikely	Negligible	Low	Low	Medium	High
Possible	Negligible	Low	Medium	Medium	High
Likely	Negligible	Medium	Medium	High	Extreme
Almost Certain	Low	Medium	High	Extreme	Extreme

The rating of risk as assessed above is as described in **Table B16-9** below. This table has components that are applicable to both Climate Change and GHGs.

TABLE B16-9 RISK RATING LEGEND

RISK RATING	DESCRIPTION
Extreme Risk	An issue requiring change in project scope: • almost certain to result in unacceptable impacts to project infrastructure and/or sensitive receptors in the natural environment of the project area, OR • almost certain to result in unacceptable GHG emissions (bringing emissions for the port above NGER targets)
High Risk	An issue requiring further detailed investigation and planning to manage and reduce risk • likely to result in unacceptable impacts to project infrastructure and/or sensitive receptors in the natural environment of the project area, OR • likely to cause a significant increase in GHG emissions (bring emissions for the port in excess of 50% of NGER targets)
Medium Risk	An issue requiring project-specific controls and procedures to manage impacts and/or emissions
Low Risk	Manageable by standard mitigation and similar operating procedures
Negligible Risk	No additional management required

B16.4.1.c GHG Emissions Significance / Consequence Criteria

Impact Significance / Criteria

For the purposes of quantifying the likely impact and risk of the proposed project as a result of generated GHG emissions (in construction and operation), significance / consequence criteria have been developed to allow a ranking of impacts and risks in order of severity. The significance / consequence criteria have been based on the reporting thresholds set by the National Greenhouse and Energy Reporting Act 2007 (NGER Act).

It should be noted that the GHG emissions generated from current cruise shipping facilities at the Port of Cairns (e.g. electricity usage of facilities, fuel use for fleet) do not trigger the NGER Act and its reporting requirements. It should also be noted that the facilities under the control of Ports North are only a small subset of the overall port. However, for the purposes of developing criteria for the risk assessment of GHG emissions, the NGER Act reporting thresholds for the whole port have been adopted. This is presented in **Table B16-10**.

TABLE B16-10 SIGNIFICANCE / CONSEQUENCE CRITERIA – GHG EMISSIONS

IMPACT SIGNIFICANCE / CONSEQUENCE	DESCRIPTION OF SIGNIFICANCE
Very High	GHG emissions from a particular activity exceed the NGER Act corporate group threshold of 50 kilotonnes of CO_2-e
High	GHG emissions from a particular activity exceed the NGER Act facility threshold of 25 kilotonnes of CO_2-e
Moderate	GHG emissions from a particular activity are at least 50 per cent of the NGER Act facility threshold of 25 kilotonnes of CO_2-e
Minor	Activity generates GHG emissions, but is below 50 per cent of the NGER Act facility threshold of 25 kilotonnes of CO_2-e
Negligible	Activity has negligible GHG emissions, i.e. less than 1 kilotonne CO_2-e
Beneficial	Activity sequesters or offsets GHG emissions, such as generating renewable energy

Source: NGER Act Reporting Thresholds (NGER Act).

Duration of Impact

Duration of impact is described in **Table B16-6** above. This applies to both Climate Change and GHGs.

Likelihood of Impact

Likelihood of impact is described in **Table B16-7** above. This applies to both Climate Change and GHGs.

Risk Matrix

Risk is described as the product of likelihood and consequence as shown in **Table B16-8** above. This applies to both Climate Change and GHGs.

Risk Rating

The rating of risk as assessed above is as described in **Table B16-9** above. This table has components that are applicable to both Climate Change and GHGs.

The Role of Mitigation

In accordance with the adopted impact assessment process, impacts are assessed below in the absence of mitigation. Recommended mitigation actions are described in **Section B16.5** and mitigated impacts assessed in **Section B16.6**. Certain actions (i.e. such as rehabilitation of cleared areas and standard construction management) are assumed to be in-scope (i.e. not a mitigation recommendation). See 'Assumptions' below.

B16.4.2 Climate Change Impacts

B16.4.2.a Types of Impacts

Table B16-11 below provides an assessment of the potential impacts of climate change on all elements of the project, using the consequence and likelihood ratings from **Table B16-5** and **Table B16-7**. The table considers the potential impacts to new or refurbished infrastructure and services only, without mitigation measures being applied. The climate variables considered include the following, derived from **Table B16-4**:

- sea level rise
- change in annual average temperature, relative humidity, rainfall, evaporation and wind speeds
- sea level temperature rise
- ocean acidification
- change in rainfall intensity
- change in storm tide inundation levels
- change in tropical cyclone intensity and frequency
- change in annual occurrence of days >35ºC.

Not all of these variables will be relevant to each element of the project.

B16.4.2.b Landside Works Project Area

The existing wharves at the CCLT have a deck level of 3.26 m AHD, providing a freeboard of 1.4 m on the existing HAT (1.86 m AHD) and 0.11-1.27 m on the 100 yr ARI storm tide (depending on wave effects). As listed in **Table B16-4** the local sea level allowance for Cairns by 2090 is 0.79 m on HAT, representing a new HAT of 2.65 m AHD, providing a reduced freeboard of 0.61 m. Freeboard above the 100 yr ARI storm tide by 2100 will be 0.38 m without wave forcing, with the wharves expected to be overtopped where wave forcing does occur. Refer to **Chapter B3** (Coastal Processes) and **Chapter B17** (Hazard and Risk) for further description of these terms and concepts.

As the Port of Cairns is located in a cyclone-prone area, existing arrangements are in place for response to storm tide events, as per the Extreme Weather and Cyclone Contingency Plan. This plan will require progressive updates to account for realisation of climate change projections during the planning horizon but is considered to be appropriate for the purposes of present conditions.

In considering impacts from storm tide, and rainfall-induced flooding) it is noted that the CCLT wharves will be retained at a height of 4.9 m LAT (3.26 m AHD). On the basis of these levels, the CCLT wharves are not expected to be overtopped during storm tide or sea level rise events, except where wave forcing applies to the 100 yr ARI storm tide event (see **Section B16.3.1.d**).

NOTE: Future additional maintenance dredging associated with the CSD Project is considered to be negligible (expected to be between 2% and 6%) and will continue to occur at the existing sea disposal site. This is discussed further in **Chapter A3** (Project Description).

In the context of impacts linked directly to a change in tropical cyclone intensity and frequency, likelihood of risk has been identified as 'possible'. This is considered precautionary, due to the uncertainty of climate science in regards to impacts of tropical cyclones.

One of the key risks identified by the assessment is the permanent inundation of berthing structures due to sea level rise. Based on current sea level projections within the planning horizon (and beyond) described in **Table B16-4**, this impact will not occur. If these sea level projections change, however, this risk may become relevant.

The risk assessment indicates the potential for significant impact to infrastructure caused by an increase in tropical cyclone frequency and/or intensity. Climate science around cyclone intensity has a high degree of uncertainty, and further study is required to confirm the impact of climate change on cyclone frequency in Queensland. Cairns is already in a cyclone prone area, and the existing CCLT infrastructure is designed in accordance with appropriate standards. Nevertheless, ongoing monitoring of cyclone risk will be required, using the latest available climate change projections, as well as regular review of cyclone/storm event procedures. Strengthening of infrastructure may be required at some time in the future. Surrounding infrastructure, including power and transport networks, may be disrupted during a tropical cyclone, however, which may in turn impact the ability to service incoming ships until repairs can be made.

In the event of a cyclone, Maritime Safety Queensland (MSQ) and the Regional Harbour Master (RHM) direct shipping traffic, including cruise ships. An Extreme Weather Contingency Plan (MSQ 2016) has been prepared for the Port of Cairns, which sets out cyclone response procedures. Large vessels, such as cruise ships, are directed out to sea and the port is close. It will not reopen until the RHM is satisfied that the pilotage area is safe for vessels to re-enter. Structural assessments of wharf infrastructure are undertaken before the port is declared reopened. It is expected that contingency planning will be adapted over time as required.

B16.4.2.c DMPAs

As noted above, the use of the two DMPAs and associated pipelines will be very short term, such that any climate changes will not be relevant.

B16.4.2.d Climate Change – Risk Assessment

Refer to **Table B16-11** below.

TABLE B16-11 POTENTIAL CLIMATE CHANGE IMPACTS TO PROJECT

Project elements	Climate variable	Potential climate change impact	Risk assessment		
			Consequence	Likelihood	Risk rating
Project construction (i.e. dredging, pump-out, bund construction, filling)	Sea level rise Change in average annual rainfall and wind speeds Change in rainfall intensity Change in storm tide inundation levels Change in tropical cyclone intensity/frequency	No change from existing environment – climate change impacts not expected to be experienced during the construction phase of the project due to its short timeframe.	N/A	N/A	N/A
Berthing structures (see Note 1)	Sea level rise	Permanent inundation of berthing structures	High	Highly Unlikely / Rare	Medium
	Change in annual average temperature and rainfall Change in rainfall intensity Change in storm tide inundation levels Change in annual occurrence of days >35°C	More rapid deterioration of infrastructure over time and requirement for frequent maintenance Temporary storm-based damage to infrastructure	Minor	Possible	Low
	Change in tropical cyclone intensity/frequency	Temporary storm-based damage to infrastructure	High	Possible	Medium
Northern Sands DMPA	Sea level rise Change in annual average rainfall Change in rainfall intensity Change in storm tide inundation levels Change in tropical cyclone intensity/frequency	DMPAs designed to withstand present day 1% AEP storm tide and flood event. This DMPA will not be operational beyond construction phase.	Moderate	Highly Unlikely / Rare	Low

(Continued over)

Project elements	Climate variable	Potential climate change impact	Risk assessment		
Tingira Street DMPA	Sea level rise Change in annual average rainfall Change in rainfall intensity Change in storm tide inundation levels Change in tropical cyclone intensity/frequency	DMPA designed to withstand present day 100 yr ARI storm tide event. This DMPA will not be operational beyond construction phase.	Moderate	Highly Unlikely / Rare	Low
Inner & outer channel	Change in tropical cyclone intensity/frequency	Altered sediment transport patterns and infill of the channel	Moderate	Possible	Medium
Offshore DMPA (maintenance material)	Change in tropical cyclone intensity/frequency	Resuspension of maintenance dredge material at a more rapid rate than predicted	Minor	Possible	Low
Ship berthing & movements (see Note 1)	Change in average annual wind speeds	Delays or obstruction of cruise ship berthing and movements	Minor	Possible	Low
	Change in tropical cyclone intensity/frequency		High	Possible	Medium
	Sea level rise	Potential misalignment of level of wharves with cruise ship requirements	Minor	Possible	Low
CCLT services/supply	Change in average annual temperature Change in annual occurrence of days >35°C	Disruption of provision of services or supplies to cruise ships, causing delays	Minor	Unlikely	Low
	Change in tropical cyclone intensity/frequency		High	Possible	Medium
Terrestrial ecology	Sea level rise Change in annual average rainfall Change in rainfall intensity Change in storm tide inundation levels Change in tropical cyclone intensity/frequency	Smothering or other threats to ecological values from sediment discharge from Northern Sands DMPA during overtopping. However, this DMPA will not be operational beyond construction phase so this impact is not applicable.	Minor	Highly Unlikely / Rare	Low
Freshwater & estuarine ecology	Sea level rise Change in annual average rainfall Change in rainfall intensity Change in storm tide inundation levels Change in tropical cyclone intensity/frequency	Smothering or other threats to ecological values from sediment discharge from DMPAs during overtopping. However, DMPAs will not be operational beyond construction phase so this impact is not applicable.	Minor	Highly Unlikely / Rare	Low

Project elements	Climate variable	Potential climate change impact	Risk assessment		
Marine ecology	Sea level rise Change in annual average rainfall Change in rainfall intensity Change in storm tide inundation levels Change in tropical cyclone intensity/frequency	Turbidity impacts caused by sediment discharge from Tingira Street DMPA during overtopping. However, DMPAs will not be operational beyond construction phase so this impact is not applicable.	Minor	Highly Unlikely / Rare	Low

Note 1: While the noted consequences of climate change on Landside Works Project Area infrastructure have been assessed as Medium for sea level rise and cyclonic winds, these are both areas where adaptation is feasible. Refer **Section B16.5.2**.

B16.4.3 GHG Impacts

B16.4.3.a Emission Factors

Impacts per se are not assessed as these are global in extent. The following discussion is in terms of emissions of GHG. Emission factors used in this report are generated from the National Greenhouse Accounts Factors 2016 (August). The National Greenhouse and Energy Reporting Measurement Technical Guidelines (DoEE 2016) contain the latest methods for estimating emissions.

Vegetation Clearing Factors

While some vegetation clearing is expected as part of the preparation of the DMPAs and pump-out pipeline corridor, this is expected to cause negligible emissions and therefore individual emission factors have not been ascribed. **Chapter B8** (Terrestrial Ecology) estimates that a total of 17.4 ha will be cleared. Of this approximately 1.2 ha is remnant vegetation. Approximately 0.4 ha will be rehabilitated. These are very small areas.

The decay or combustion of vegetation will emit both CO_2 and, in anaerobic conditions, CH_4. The molecular weight of carbon is 12 and that of CO_2 is 22. This allows for a conversion factor of 44/12/1000 for total carbon mass (from vegetation cleared) to kilotonnes CO_2-e.

Fuel Consumption Factors

As a large proportion of GHG emissions will be associated with the direct burning of fuel (particularly in ship engines and for dredging tasks), a range of fuel consumption factors were assumed. **Table B16-12** below details the fuel consumption factors assumed based on different fuel types, i.e. diesel, petrol and heavy fuel oil (HFO).

TABLE B16-12 GHG EMISSION FACTORS FOR FUEL TYPES

FUEL TYPE	ENERGY CONTENT	SCOPE 1 EMISSION FACTOR (KG CO2-E/GJ)1,2	GHG EMISSION FACTOR (TONNES CO_2-E/KL)[3]
Diesel	38.6	70.5	2.72
Fuel oil	39.7	74.3	2.95
Petrol	34.2	67.6	2.31

Source: Appendix AY (Table 2.1).

1. Energy content of diesel is sourced from Table 3 of DoEE (2016)
2. Emissions factors include contributions from CO_2, CH_4 and N_2O from Table 4 of DoEE (2016)
3. GHG emission factor is the energy content multiplied by Scope 1 emission factor.

B16.4.3.b Explanation of Scopes 1, 2 and 3

The separation of emissions into direct and indirect is fundamental to both the GHG Protocol and AS ISO 14064 accounting standards. To help distinguish between direct and indirect emission sources, provide transparency and avoid double counting, the proposed project's emissions are categories as follows:

- Scope 1 – Direct GHG emissions owned or controlled by Ports North (including contractors for the project), which include:
  - Fuel combustion in plant, dredge equipment, booster pumps and site vehicles.
- Scope 2 – Indirect GHG emissions associated with electricity supplied from external sources.
- Scope 3 – Indirect GHG emissions not owned or in control of Ports North, which include:
  - Embodied energy of materials
  - Transport of materials and equipment to and from site
  - Extraction, production and supply of fossil fuels.

Scope 3 emissions also included emissions from activities facilitated by the project. To this extent, Scope 3 emissions include consequential impacts. In relation to the project, these consequential emissions include the increased vehicle movement that would be required to service the upgraded CCLT (e.g. loading and unloading of cruise ships). Consequential emissions are not considered to include emissions associated with increased cruise ship movements as these cruise ships would be in operation without the project; the project simply provides opportunity for more cruise ships to visit Cairns rather than other destinations.

Scope 3 emissions are not considered further in this assessment as they are either considered negligible (e.g. embodied energy of materials) or are subject to significant uncertainty. See further Chapter B18, Cumulative Impact Assessment for a consideration of consequential impacts.

Figure B16-4 provides a visual representation of Scope 1, 2 and 3 emissions categories and the types of activities that can contribute to their creation.

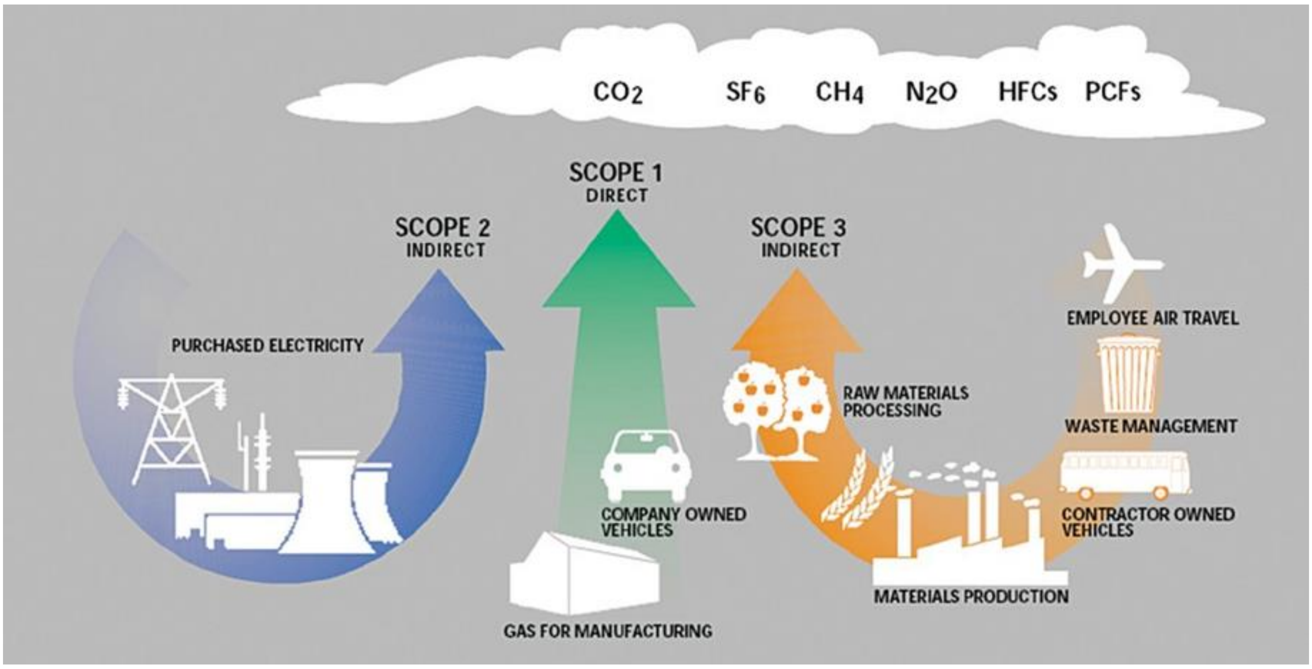

Figure B16-4 Explanation of emissions categories as scopes.

Source: NZBCSD (2002).

B16.4.3.c Operational Boundaries

The GHG Protocol uses this term to describe the parts of the proponent's activities that are to be included in an inventory. Establishing boundaries from the outset is important to ensure consistency is maintained across the footprint and to ensure the boundary is restricted to GHG emissions that are within the control of the proponent.

- Spatial Boundaries – All activities and components considered to be occurring outside the scope of the EIS process are excluded from the carbon footprint. For this investigation, fuel consumption of ships travelling to and from the port as a result of greater navigational access is excluded as these emissions are considered 'inevitable', i.e. they would occur regardless of the CSD Project as these cruise ships would continue to operate even if the project was not undertaken.
- Temporal Boundaries – The construction carbon footprint represents an approximation of the total GHG emissions associated with construction activities. This allows a 80 day dredging campaign and a 12 month construction timeframe for the installation of land-based infrastructure, including the DMPAs. The operational GHG footprint is based on the approximate GHG emissions generated at the port for the period 2018-2021.

Table B16-13 and **Table B16-14** outline the main facilities/infrastructure included for the construction and operational carbon footprints respectively, along with the likely emission sources from the construction/operation of the facilities.

NOTE: While the CSD Project facilitates the expansion of the HMAS Cairns Navy Base and the use of the Tingira Street DMPA for port activities, these future expansions are not included within this assessment as they will be subject to a separate assessment and approvals process. As noted above, emissions associated with cruise ships are also not included as the project will not facilitate an increase in global cruise ship emissions.

TABLE B16-13 CONSTRUCTION GHG FOOTPRINT SCOPE SUMMARY

FACILITIES/INFRASTRUCTURE	EMISSIONS SCOPE	SOURCES
Preparation of onshore DMPAs Capital dredging and placement of material Construction of the wharf berthing infrastructure Installation of cruise ship services (e.g. water)	Scope 1 (direct)	Fuel consumption in dredge plant, booster pump and other construction equipment (e.g. piling barge, piling, earthmoving) Emissions from vegetation clearing from DMPA (and pipeline) preparation
	Scope 2 (indirect)	Purchased electricity for use during land-side infrastructure construction
	Scope 3 (indirect)	n/a – not included in this assessment

TABLE B16-14 OPERATIONAL GHG FOOTPRINT SCOPE SUMMARY

FACILITIES/INFRASTRUCTURE	EMISSIONS SCOPE	SOURCES
Tugs Electricity consumed by cruise ships while alongside at port of general operations (e.g. lighting) Maintenance dredging	Scope 1 (direct)	Fuel combustion in plant equipment. Note that pumping of fuel for intermediate fuel oil (IFO) supply is excluded based on materiality.
	Scope 2 (indirect)	Electricity consumed onsite (i.e. lighting and electricity use within the CCLT).
	Scope 3 (indirect)	n/a – not included in this assessment

The projected emissions for the CSD Project is later compared against the current base case for the number of vessels that use the existing CCLT and Yorkeys Knob.

B16.4.3.d Uncertainty

The carbon footprint analysis is based on equipment and usage data provided by Ports North and its subconsultants. No direct measurements or site surveys were conducted. In undertaking GHG accounting, there is inevitably some uncertainty in emission data resulting from any causal factor, such as the application of non-representative factors or methods and incomplete data on emission sources. The collection of accurate activity data is generally the largest challenge facing the development of comprehensive and representative GHG inventories.

B16.4.3.e Materiality

Materiality is defined as to whether an error or omission in the calculation of the carbon footprint is a material discrepancy or not. Emission sources that contribute less than five per cent to either the construction or operational footprint are considered immaterial. These include emissions associated with refrigerant gas usage (Scope 1).

B16.4.3.f Data Sources

All equipment and usage data provided for the calculation of this carbon footprint was sourced through published literature, reports, Ports North and its subconsultants.

B16.4.3.g GHG Emissions

Construction

GHG emissions for the construction phase of the project will predominantly be produced through diesel and fuel oil for equipment and vehicles including dredging machinery, piling equipment and smaller plant used for infrastructure upgrades, together with some emissions from vegetation clearing. These are all Scope 1 emissions. Mains electricity is not expected to be utilised (or negligible usage only) for construction activity; therefore there are no Scope 2 emissions for the project.

Table B16-15 provides the carbon emissions from vegetation clearing, using the conversion factor noted in **Section B16.2.3.b**. The total GHG emissions from clearing during the construction phase are estimated to be 0.29 ktCO_2-e for pipeline Option 1 and 0.33 ktCO_2-e for pipeline Option 2 (see **Chapter A3 (**Project Description) for more detail on pipeline options).

TABLE B16-15 GHG EMISSIONS FROM CONSTRUCTION PHASE VEGETATION CLEARING

PROJECT ELEMENT	VEGETATION TYPE	AREA TO BE CLEARED (HA)	NET CARBON MASS (TONNES)	GHG EMISSIONS (KTCO_2-E)
Pipeline (Option 1)	Mangrove (RE1.1.1)	0.16	14	0.05
Pipeline (Option 2)	Mangrove (RE1.1.1)	0.11	24	0.09
Pipeline (both options)	Melaleuca wetland (RE7.29a/7.3.25a)	0.14	13	0.05
Northern Sands DMPA	Grassland	12.05	53	0.19
Total Option 1			80	0.29
Total Option 2			90	0.33

Source: Appendix AY (Table 3.1 and 3.2).

GHG emissions for the construction phase of the project will predominantly be produced through fuel usage for equipment and vehicles including dredging machinery, piling equipment, and smaller plant used for infrastructure upgrades. Emissions generated from diesel usage are direct emissions and fall under Scope 1 emissions. The range of diesel/HFO-fuelled plant likely to be used during the construction phase is detailed in **Chapter A3** (Project Description) and includes:

- TSHD
- backhoe dredge
- tugs
- booster pumps
- piling crane and hammer
- work boats
- work vehicles
- construction plant.

The total GHG emissions from equipment used for the different construction phases of the project are provided in **Table B16-16**. This is based on an assessment of plant requirements, fuel consumption and the GHG emission factors in **Table B16-12**. Based on this assessment, the project contributes to an overall estimated GHG emissions of 22.62 ktCO_2-e. The majority of emissions are associated with TSHD operation (5.00 ktCO_2-e) and booster pumps (10.85 ktCO_2-e).

Taking the GHG emissions from both vegetation clearing and equipment use, the total construction phase emissions of the project are estimated to be 22.91 ktCO_2-e or 22.95 ktCO_2-e, depending on which pipeline option is used.

Putting this in context, the total scope 1 greenhouse gas emissions in 2015/2016 from corporations that had to report to NGER was 90 Megatonnes CO2-e in Queensland and 334 Megatonnes CO2-e in Australia (Clean Energy Regulator 2017). At 22.95 ktCO_2-e, the CSD Project emissions are 0.03% of the Queensland total and 0.01% of the Australia total.

Note: Both of the above emission calculations exclude emissions related to landside development of the Tingira Street DMPA as construction activities that have already been approved are expected to cause the same level of emissions as those required for the project. Emissions from vegetation clearing for the pipeline are included as emissions will occur from clearing, despite the intention to rehabilitate this area in the future.

Emissions will also be caused by clearing of vegetation for the purposes of developing the Northern Sands DMPA.

These emissions are considered Scope 1 emissions but are likely to be negligible due to the limited amount of vegetation to be cleared and the subsequent rehabilitation. As previously noted, a total of 17.4 ha will be cleared. Of this approximately 1.2 ha is natural vegetation and approximately 0.4 ha will be rehabilitated.

Mains electricity is not expected to be utilised (or negligible usage only) for construction activity; therefore there are no Scope 2 emissions for the project.

TABLE B16-16 ESTIMATED CONSTRUCTION PHASE GHG EMISSIONS

EQUIPMENT	NO.	HRS/ DAY	OPERATING DURATION (DAYS)	OPERATING TIME (HRS)	FUEL CONSUMPTION (L/H)	TOTAL FUEL CONSUMED (KL)	FUEL TYPE	GHG EMISSION FACTOR (TONNES CO_2-E/KL)	TOTAL EMISSIONS ($KTCO_2$-E)
Wharf construction									
35-80 t crane	2	12	193	2 314	40	185	Diesel	2.72	0.50
20 t franna crane	3	12	193	2 314	20	139	Diesel	2.72	0.38
20 t excavator	2	12	193	2 314	20	93	Diesel	2.72	0.25
Concrete trucks	11	12	193	2 314	11.1	283	Diesel	2.72	0.77
Dump trucks	2	12	193	2 314	30	139	Diesel	2.72	0.38
Site vehicles*	23	25*	193	4 821*	12.5*	14	Diesel	2.72	0.04
Booster pump									
Onshore boosters	3	24	72	1 730	440	2 284	Diesel	2.72	6.21
Offshore boosters	1	24	72	1 730	985	1 704	Diesel	2.72	4.63
Soft clay dredging									
TSHD	1	24	72	1 730	979.8	1 695	Fuel oil	2.95	5.00
Backhoe dredge	1	24	30	720	352.6	254	Fuel oil	2.95	0.75
Hopper barges and tugs	3	24	30	720	164.7	356	Fuel oil	2.95	1.05
Survey and crew boats	2	24	72	1 728	119.9	414	Diesel	2.72	1.13
Northern Sands DMPA and pipeline construction									
Front end loader	2	24	72	1 730	20	69	Diesel	2.72	0.19
40 t excavator	2	24	72	1 730	20	69	Diesel	2.72	0.19
Dump trucks	2	24	72	1 730	30	104	Diesel	2.72	0.28
Dozer	2	24	72	1 730	38	132	Diesel	2.72	0.36
Dewatering pumps	-	24	72	1 730	101	175	Diesel	2.72	0.48
Site vehicles (operation)*	23	25*	72	1 803*	12.5*	5	Petrol	2.31	0.01

EQUIPMENT	NO.	HRS/ DAY	OPERATING DURATION (DAYS)	OPERATING TIME (HRS)	FUEL CONSUMPTION (L/H)	TOTAL FUEL CONSUMED (KL)	FUEL TYPE	GHG EMISSION FACTOR (TONNES CO_2-E/KL)	TOTAL EMISSIONS ($KTCO_2$-E)
Site vehicles (construction decommission)*	23	25*	84	2100*	12.5*	6	Petrol	2.31	0.01
Pipe delivery trucks	450 trips	1	-	-	11.1	5	Petrol	2.31	0.01
Total GHG construction phase GHG emissions									22.62

Source: Appendix AY (Table 2.2, 2.3, 2.4, 2.5).

*Fuel consumption estimates for site vehicles are based on distance. This alters the following: hrs/day = km/day, Operating time (hrs) = Operating distance (km), Fuel consumption (l/h) = Fuel consumption (L/100 km).

Operations

Energy use during operational activities will include both Scope 1 and 2 emissions, as follows:

- Scope 1 emissions will result from fuel usage in port-related equipment, including tugs, maintenance dredging equipment and port vehicles
- Scope 2 emissions will be generated through use of electricity in common user areas provided by the port for passengers (e.g. wharf lighting, CCLT electricity supply), additional to the current baseline usage.

The estimated operational emissions contain the following assumptions:

- Emissions from maintenance dredging are proportional to construction-related dredging (not including emissions associated with pump-out), based on the amount of material dredged per year.
- Additional maintenance dredging requirements are equivalent to an extra seven operating days per annum, representing an increase in total fuel consumption of 67 kL/yr.
- The port facilities (such as wharf lighting and the terminal electricity supply) contribute to 10 per cent of the Port of Cairns electricity consumption in the baseline year of 2018. This remains constant regardless of project or year, as the facilities operate at consistent hours.

Table B16-17 below provides a breakdown of operational emissions for three scenarios:

1. A baseline condition (2018, i.e. the year the project would be constructed) without any port improvements
2. A future condition (2028) without any port improvements
3. A project scenario (2018) and future project scenario (2028).

TABLE B16-17 ESTIMATED OPERATIONAL PHASE GHG EMISSIONS

Emissions source	Baseline condition		Project scenario	
	2018	2028	2018	2028
	(tCO_2-e)	(tCO_2-e)	(tCO_2-e)	(tCO_2-e)
Scope 1 emissions				
• Maintenance dredging	0.66	0.66	0.66	0.86
Scope 2 emissions				
• Port facility electricity	0.06	0.06	0.08	0.11
Total	**0.72**	**0.72**	**0.74**	**0.97**

Source: Appendix AY (Table 6.3).

Estimated operational GHG emissions are expected to increase as a result of the project. In 2028, the project scenario compared to a no-project scenario, a 35% increase in emissions is expected, mostly from the additional maintenance dredging that is to be carried out.

B16.4.3.h GHG Emissions – Risk Assessment

Table B16-18 provides a summary of the significance of impacts, based on the criteria described in **Section B16.2.3**. The table assesses the significance of each emission source and its projected GHG emissions, during construction or during 2028 (the 10^{th} operational year of the project).

The table highlights that there is no single activity or carbon emission source that is assessed as a high risk rating. However, in total for construction and operational emissions, these indicate a medium risk rating. It should be noted that the operational GHG emissions for the port with the project do not exceed the NGER Act facility threshold (refer to **Section B16.2.3**) as they are estimated to be less than 25 $ktCO_2$-e in a given year, and hence below the reporting thresholds, indicating the activities are a low emission source.

TABLE B16-18 SUMMARY OF GHG EMISSIONS IMPACT SIGNIFICANCE

Emissions source	Carbon emissions ($ktCO_2e$-)	Risk assessment		
		Consequence	Likelihood	Risk rating
Construction phase	22.95	Minor	Almost Certain	Medium
Additional operational phase emissions (2028 with project)	0.25	Negligible	Almost Certain	Low

B16.4.4 Ecosystem Resilience

Project activities that may cause an impact on the resilience of terrestrial, freshwater and estuarine, and marine ecosystems to climate change are:

- maintenance dredging
- placement of additional maintenance dredged material at the Offshore DMPA
- increased shipping movements.

The impacts of these activities to the environment are described in **Chapter B7** (Marine Ecology) and are expected to cause resilience impacts to seagrass meadows and marine megafauna. Construction phase impacts (e.g. capital dredging) have not been considered on the basis that environmental values are expected to have recovered from these impacts before climate change stressors occur and therefore there would be no net impact on resilience.

Table B16-19 presents the assessment of the significant of this resilience loss, based on the 'adaptive capacity' thresholds in **Table B16-5** and an assessment of likelihood from **Table B16-7**, assuming no mitigation measures are applied.

TABLE B16-19 PROJECT IMPACTS ON ECOSYSTEM RESILIENCE TO CLIMATE CHANGE

VALUE	PROJECT IMPACT	RISK ASSESSMENT OF IMPACT TO RESILIENCE		
		Consequence	**Likelihood**	**Overall**
Seagrass meadows	Smothering and growth impacts caused by turbid plumes during maintenance dredging, and resuspension from Offshore DMPA.	Moderate	Highly Unlikely	Low
Marine megafauna	Vessel strike associated with maintenance dredging and increased cruise ship traffic.	Moderate	Highly Unlikely	Low
	Impacts to feeding habitat (i.e. seagrass meadows) from turbid plumes during maintenance dredging and resuspension from Offshore DMPA.	Minor	Possible	Low

It is relevant to note that this Revised Draft EIS is required to consider the impact of future additional maintenance dredging associated with the CSD Project. As previously discussed, this is considered to be negligible (expected to be between 2% and 6%) and will continue to occur at the existing Offshore DMPA. The risk assessment above is for all maintenance dredging – the risk of additional maintenance dredging on resilience can be expected to be reduced to negligible.

B16.5 Recommended Mitigation Measures

B16.5.1 The Nature of Mitigation

Mitigation can also be thought of as 'risk treatment'. The national standard for risk management is AS/NZS ISO 31000:2009 Risk management—Principles and guidelines. AS/NZS ISO 31000:2009 defines risk treatment as a 'process to modify risk'. It notes that risk treatment can involve:

- avoiding the risk by deciding not to start or continue with the activity that gives rise to the risk
- taking or increasing risk in order to pursue an opportunity
- removing the risk source
- changing the likelihood
- changing the consequences
- sharing the risk with another party or parties (including contracts and risk financing)
- retaining the risk by informed decision.

It also notes that:

- Risk treatments that deal with negative consequences are sometimes referred to as 'risk mitigation', 'risk elimination', 'risk prevention' and 'risk reduction'.
- Risk treatment can create new risks or modify existing risks.

B16.5.2 Climate Change

Generally there are four possible approaches in responding to climate change:

- **Avoid** e.g. avoid locating assets in vulnerable areas
- **Adapt** e.g. design and/or operating standards relevant to predicted climate conditions
- **Defend** e.g. install defences at or around critical infrastructure
- **Retreat** e.g. develop and implement plans to relocate from vulnerable areas.

It is considered that risks identified in this assessment can be readily managed under existing operating procedures at the port and/or by application of the design standards described in **Chapter A3** (Project Description). Therefore, it is appropriate to consider mitigation measures as <u>adaptation</u> measures, as opposed to avoid, defend or retreat measures.

In order to address potential impacts and inform further design and operational considerations, the following mitigation measures will be applied:

- Sea levels and other climate change related data will continue to be monitored, and a review of the berthing and wharf infrastructure will be undertaken should sea level rise and/or storm tide levels exceed current predictions.
- As is the case in many wharves around the world, berthing and mooring structures are built as low as possible, and often as separate structures to the operating wharf deck structures, so as not to interfere with operations. Submergence of this is not of concern. However, mooring line attachments do however need to be accessed.
- Other landside works will be designed to current cyclone requirements under Australian Standards and to withstand a storm tide event. There is opportunity, however, to increase the levels of this structure to exceed predicted inundation levels (as discussed in **Section B16.3.1.d**).
- The infrastructure associated with the Northern Sands and Tingira Street DMPAs (e.g. bunds) will be designed in accordance with Australian Standards to withstand both the current 100 yr ARI storm tide and flood event, with an additional freeboard. As the Northern Sands DMPA will not be used as a DMPA beyond the construction phase of the project, further immunity is not considered necessary. Further information on this issue is included in **Chapter B17** (Hazard and Risk).

- Regular inspections of infrastructure will be undertaken; should excessive deterioration be identified, minor or more regular maintenance activities may be required within the design life of the permanent infrastructure associated with the project.
- The Port of Cairns Extreme Weather Contingency Plan (MSQ 2016) is expected to be regularly reviewed and updated.

Measures to mitigate the potential impacts of the project on the resilience of ecological features are discussed in **Chapter B7** (Marine Ecology) and are included in the **Chapter C2 (**Dredge Management Plan). These consist of operational management of dredging and pump-out activities to minimise impacts to sensitive receptors (e.g. minimising dredge vessel overflow, redirecting tailwater discharge).

B16.5.3 GHG Emissions

Although there are no construction or operational phase activities that cause a significant amount of GHG emissions, both construction and operational activities do contribute to an increase in GHG emissions above the existing baseline. There is opportunity in both the construction and operational phases to reduce or reduce the impact of GHG emissions. The following hierarchy of principles, based on the Environmental Protection Authority (EPA) Victoria carbon management principles (EPA Victoria 2014) have been adopted for identifying available mitigation measures:

- Measure and set objectives – a process of measuring, setting objectives or targets and reviewing GHG emissions to identify further opportunities to manage emissions.
- Avoid – avoid undertaking activities that generate GHG emissions.
- Reduce – modify activities to reduce GHG emissions, or undertake actions to reduce the intensity of activities.
- Switch – changing fuel or energy sources for those that are less GHG intensive.
- Sequester – undertake options to sequester GHG emissions.
- Offset – purchase or undertake projects that offset residual GHG emissions (after mitigation actions have been undertaken).

Based on these principles, a range of mitigation measures will be implemented for construction and operational phase activities. This is expected to take place in the context of Ports North’s ongoing environmental management system (EMS).

B16.5.3.a Construction Phase

Activities to reduce GHG emission impacts for particular construction activities are as follows:

- Energy and fuel management – Undertake periodic energy and fuel audits to monitor energy and fuel use to identify areas for reduction or more efficient energy or fuel use. Implement reduction strategies as appropriate.
- GHG management – Develop an ongoing GHG emissions inventory for the construction stage to monitor, report and identify opportunities to reduce emissions. Implement reduction strategies as appropriate.
- Dredging efficiencies – Select or purchase equipment with newer or more efficient engines. Ensure that engines are regularly maintained to perform optimally for fuel consumption. These requirements should be included in tender documentation for dredging.
- Efficiencies for landside construction large vehicles (e.g. concrete trucks) – Identify and provide routes that minimise haul distances for trucks. Provide driver and employee training to ensure fuel-efficient practices, such as efficient driving practices and the turning off of engines when not in use or on standby. Select or prefer more fuel-efficient vehicles that are fit-for-purpose, and identify opportunities to use less carbon-intensive fuels. Ensure vehicles are regularly maintained to perform optimally for fuel consumption. These requirements should be included in tender documentation for construction.
- Efficiencies for landside construction small vehicles (e.g. utilities and personnel cars) – Select fit-for-purpose vehicles that are more fuel efficient, or use less carbon-intensive fuels. These requirements should be included in tender documentation for construction.

- Construction equipment maintenance – Regularly inspect and maintain equipment to ensure optimal energy or fuel efficiency.

B16.5.3.b Operational Phase

Regarding operational GHG emissions, the major emissions source is maintenance dredging (Scope 1 emissions). In regard to Scope 2 emissions, Ports North will only have operational control (or the ability to manage) common areas, such as port lighting and office areas, and will have limited control on the extent and usage of generators used to power cruise ships while docked. Therefore, the following mitigation measures focus only on Scope 2 emissions within the operational control of the Port, as well as Scope 1 emissions:

- Maintenance dredging efficiencies – Select or purchase equipment with newer or more efficient engines within contractual negotiations. Ensure that engines are regularly maintained to perform optimally for fuel consumption. Refine maintenance dredging routes to ensure efficient use of fuels. Provide training to staff to minimise energy and fuel consumption where practical. These requirements should be included in tender documentation for dredging.
- Awareness – Provide training or awareness programs to berthed ships on energy-efficient practices, particularly regarding energy usage.
- Port facility efficiencies – Install energy-efficiency measures, such as lighting controls and sensors for office spaces. Replace inefficient lamps with energy efficient alternatives. Identify opportunities to generate renewable energy and offset the use of grid electricity from non-renewable sources.

B16.6 Residual impacts and Assessment Summary

B16.6.1 Climate Change

Table B16-20 presents an amended climate change risk assessment based on the mitigation measures described in **Section B16.5.2**. This overall risk rating represents the residual risk for the project in the context of climate change. The table combines the project element, climate variable and potential climate change impact columns of **Table B16-11** into a single ‘impact’ column. This lists the asset/service to be impacted and, if there are multiple impacts, the key variable driving an impact. Where there are multiple variables, these are described as ‘various’. Impacts have been grouped based on mitigation measures and are therefore presented in a different order from that used in **Table B16-11**. The table also presents the changed risk to the resilience of ecological values to climate change.

Some of the key findings to note in regard to residual risk are:

- All risks are reduced to Negligible or Low. Implicit in this rating is the fact that if sea level rises to a level where inundation is of concern occur, reconstruction of structures to appropriate levels and standards are possible.
- No change in risk profile (significance and likelihood) for a number of impacts. This is due to the project having mitigation measures inherently included in design or initial risks being considered to not require further control.

TABLE B16-20 RESIDUAL RISKS – CLIMATE CHANGE

IMPACT	INITIAL RISK			MITIGATION	RESIDUAL RISK		
	Significance	**Likelihood**	**Risk rating**		**Significance**	**Likelihood**	**Risk rating**
			Impacts to project				
Project construction	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Berthing structures – sea level rise	High	Highly Unlikely / Rare	Medium	No mitigation – monitor sea level rise projections and upgrade structures if necessary	Minor	Highly Unlikely / Rare	Negligible
Berthing structure – cyclones	High	Possible	Medium	Structures designed to cyclone requirement as per Australian Standards Ongoing monitoring and adaptive maintenance and/or change of design Regular review of *Extreme Weather Contingency Plan* for Port of Cairns	Minor	Unlikely	Low
Ship berthing & movement – cyclones	High	Possible	Medium		Minor	Unlikely	Low
Ship berthing & movement – sea level rise	Mino	Possible	Low		Minor	Possible	Low
CCLT supply & services – cyclones	High	Possible	Medium		Minor	Unlikely	Low
Inner & Outer Channel	Moderate	Possible	Medium		Moderate	Unlikely	Low
Offshore DMPA	Minor	Possible	Low		Moderate	Possible	Low
Berthing structures – various	Minor	Possible	Low	Structures and operational procedures designed to storm and other requirement as per Australian Standards	Minor	Unlikely	Low
Ship berthing & movement – winds	Minor	Possible	Low		Minor	Possible	Low
CCLT supply & services – various	Minor	Unlikely	Low		Minor	Unlikely	Low

(Continued over)

IMPACT	INITIAL RISK			MITIGATION	RESIDUAL RISK		
Northern Sands DMPA	Moderate	Highly Unlikely / Rare	Low	DMPAs designed to withstand present day 100 yr ARI storm tide event. DMPAs will not be operational beyond construction phase.	Moderate	Highly Unlikely / Rare	Low
Tingira Street DMPA	Moderate	Highly Unlikely / Rare	Low		Moderate	Highly Unlikely / Rare	Low
Terrestrial ecology	Moderate	Highly Unlikely / Rare	Low		Moderate	Highly Unlikely / Rare	Low
Freshwater & estuarine ecology	Moderate	Highly Unlikely / Rare	Low		Moderate	Highly Unlikely / Rare	Low
Marine ecology – overtopping	Moderate	Highly Unlikely / Rare	Low		Moderate	Highly Unlikely / Rare	Low
Impacts to Climate Change Resilience							
Seagrass meadows – turbidity impacts from maintenance dredging and resuspension at Offshore DMPA	Moderate	Highly Unlikely	Low	Operational management of dredge vessel to minimise plumes	Minor	Highly Unlikely / Rare	Negligible
Marine megafauna – vessel strike	Moderate	Highly Unlikely	Low	Port marine megafauna procedures	Minor	Highly Unlikely / Rare	Negligible
Marine megafauna – turbidity impacts to seagrass meadows	Minor	Possible	Low	Operational management of dredge vessel to minimise plumes	Minor	Highly Unlikely / Rare	Negligible

B16.6.2 GHG Emissions

Table B16-21 presents the residual risk of GHG emissions for both construction and operational phases, accounting for mitigation measures discussed in **Section B16.5.3**. As the overall reductions in GHG emissions from the proposed mitigation measures cannot be known for certain (as it is subject to available technologies, contracting processes etc.) the significant ratings are assumed to remain the same but likelihood has been reduced in both cases.

The overall risk rating for the construction phase remains at a Medium level as a result of higher emissions from these works, while residual impacts during the operational phase are considered Negligible.

TABLE B16-21 RESIDUAL RISK ASSESSMENT – GHG EMISSIONS

INITIAL RISK ASSESSMENT			MITIGATION	RESIDUAL RISK ASSESSMENT		
CONSEQUENCE	LIKELIHOOD	RISK RATING		CONSEQUENCE	LIKELIHOOD	RISK RATING
Construction phase activities						
Negligible	Almost Certain	Low	Efficient energy and fuel practices and training Selection of efficient or lower emission plant Regular maintenance of equipment and engines	Negligible	Likely	Negligible
Operational phase activities						
Negligible	Almost Certain	Low	Selection of efficient or lower emission plant Regular maintenance of equipment and engines Review of dredging routes Training and awareness for berthed ships on energy efficient practices Install energy efficient appliances and measures, replace inefficient lighting, identify opportunities for renewable energy use	Negligible	Likely	Negligible

B16.6.3 Conclusion

The assessment of both climate change impacts and GHG emissions from construction activities and resulting operational impacts have been undertaken, and no High or Medium risk impacts have been identified. However, some Low risks have been identified as follows:

- Due to potential increase in cyclone intensity and frequency, there may be increased deterioration or damage on berthing infrastructure and services supporting the CCLT, as well as increased sedimentation in the inner and outer channels. This may lead to more frequent maintenance on infrastructure (including maintenance dredging) as well as temporary delays in shipping traffic, and will require ongoing monitoring and adaptive responses, such as adaptation to new standards and levels.
- Emissions will be generated during the construction phase, primarily from the use of dredge vessels and booster pumps, as well as heavy and light construction vehicles and very minor vegetation clearing. Putting this in context, the total scope 1 greenhouse gas emissions in 2015/2016 from corporations that had to report to NGER was 90 Megatonnes CO2-e in Queensland and 334 Megatonnes CO2-e in Australia (Clean Energy Regulator 2017). At 22.95 ktCO_2-e, the CSD Project emissions are 0.03% of the Queensland total and 0.01% of the Australia total. %%
- Changes in emissions from an operational perspective are considered to be negligible.

Climate change is not expected to have a significant impact on the proposed DMPAs as these facilities will not be operational as DMPAs beyond the construction phase. In addition, sea level rise is not expected to cause the permanent inundation of any project infrastructure based on current projections.

In order to respond to the climate change impacts associated with the project, infrastructure has been and will continue to be designed to current cyclone and storm tide requirements under Australian Standards. Adaptive management and redesign will also be undertaken, based on ongoing inspections of infrastructure. Furthermore, relevant climate data is expected to be kept up-to-date and the Extreme Weather Contingency Plan for the Port of Cairns continually updated by MSQ.

While GHG emissions from the project are not anticipated to be significant, measures are available to minimise contribution to emissions above a 'no project' scenario. These include refinement and optimisation of both capital and maintenance dredging activities as well as associated construction activities, introduction of energy-efficient technologies at the CCLT, and provision of awareness training for port users regarding energy efficiency.

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