PORT of TOWNSVILLE

North Queensland

Section 3
Environmental values and management of impacts

Townsville Marine Precinct Project

Environmental Impact Statement

GHD

3. Environmental values and management of impacts

3.1 Introduction

This section addresses all elements of the environment, such as land, water, air, noise, nature conservation, cultural heritage, waste, health and safety. In presenting this information this section:

- Describes the existing environmental values of the area that may be affected by the proposal. Environmental values are described by reference to background information and studies;
- Describes the potential adverse and beneficial impacts of the proposal on the identified environmental values. Any likely environmental harm on the environmental values are described;
- Describes any cumulative impacts on environmental values caused by the proposal, either in isolation or by combination with other known existing or planned sources of contamination; and
- Examines viable alternative strategies for managing or mitigating identified potential impacts.

Special attention is given to those mitigation strategies designed to protect the values of any sensitive areas and any identified ecosystems of high conservation value within the area of possible proposal impact.

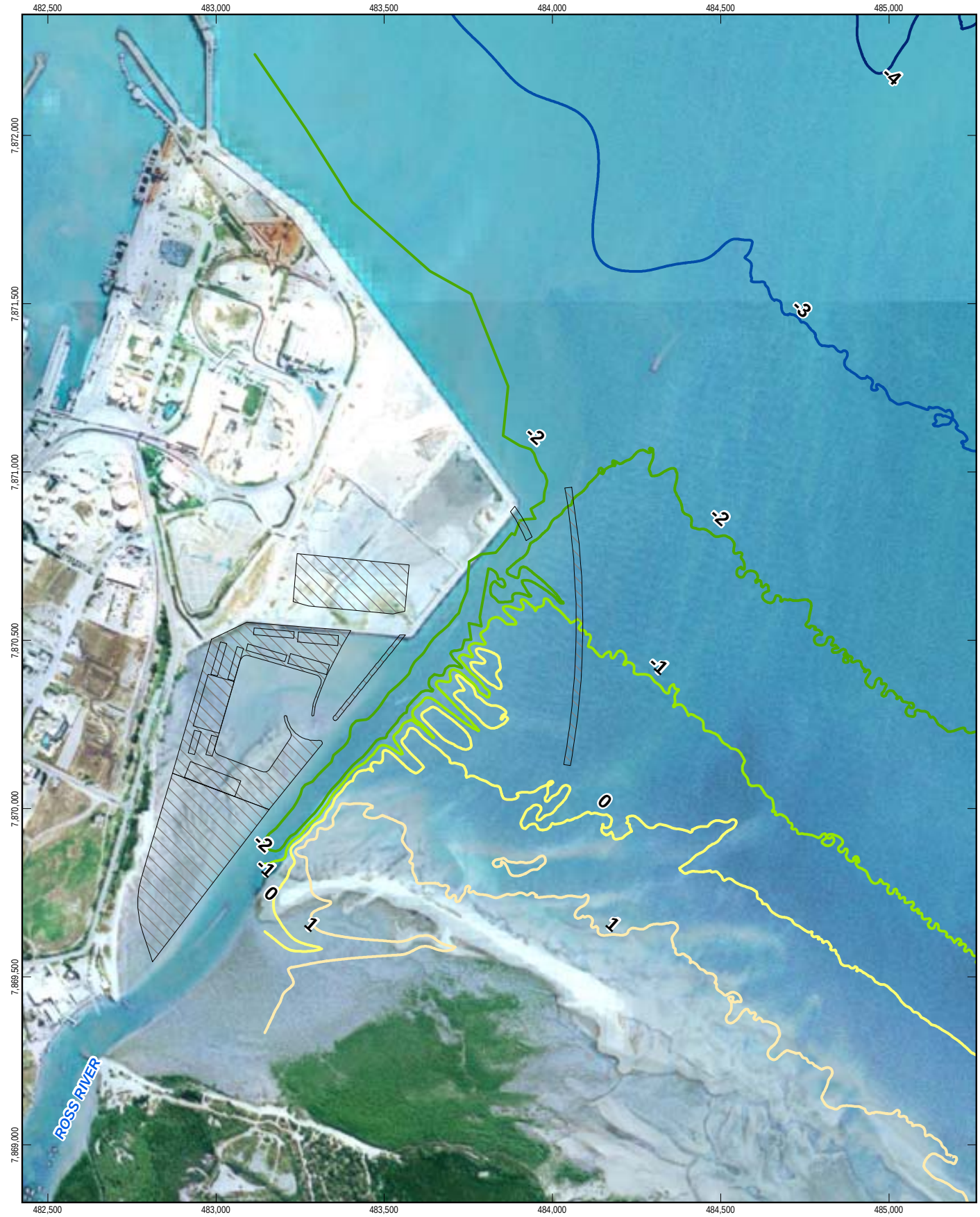
Any requirements and recommendations of the relevant State planning policies, environmental protection policies, national environmental protection measures and integrated catchment management plans are addressed. Cumulative impacts on the environmental values are described and discussed. Control, monitoring and auditing programs are described where appropriate and mitigation and management strategies are described to provide environmental protection. The source of the information given under each element is provided and any uncertainties in the information are discussed.

3.2 Land

3.2.1 Description of environmental values

3.2.1.1 Topography and geomorphology

Collated topography and bathymetry, prepared by GHD, is shown in Figure 3-1. The map shows the elevation of ground surface at Lot 773 is typically between 0 and 3.5 m LAT and shows that area of reclaimed POTL land (Eastern Reclamation Area) immediately north of Lot 773 is built on flat, low lying coastal sediments and has been reclaimed to typically 4.5 to 5.5 m LAT. Note that elevation in m LAT minus 1.856 m gives elevation in m AHD. The majority of Lot 773 is intertidal. To the south lies the mouth of Ross River, sand dunes and tidal mud flats with mangroves close to shore.



LEGEND

Proposed Marine Precinct and Breakwater

Bathymetry Elevation (metres LAT)

1
0
-1
-2
-3
-4

1:15,000 (at A4)

0 100 200 300 400 500

Meters

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Job Number 42-15399
Revision A
Date 01 July 2009

Precinct Collated Bathymetry

Figure 3-1

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3.2.1.2 Geology and soils

The 1:100,000 scale digital geological map for Townsville (Tile 8259, DME) indicates the near-surface lithology in the vicinity of the project area are Quaternary-age sediments including mud, silt and sand deposits (described as coastal tidal flats, supratidal flats and mangrove flats) and sand (beach) deposits immediately to the west and south of Lot 773 (see Figure 3-2). Alluvial and flood plain deposits (silt, sand, clay and gravel) have been mapped a few hundred metres west of area Lot 773. The underlying bedrock is indicated to be Permian-age granite on the geological map.

It is understood that some of the material placed in the Eastern Reclamation Area, north of Lot 773, was sourced from nearby off-shore areas. The geological log for monitoring bore TPA9, reports a layer of sand underlain by silty sand to 6 m below ground level immediately west of Lot 773.

Geological bore logs for TPA-14 to TPA-18 (Golder Associates 2008) suggest bedrock is at least 16.5 m below the seabed in the vicinity of Lot 773. The bore logs, which start from between around 4.4 and 6.5 m depth suggest that the shallow sediments typically consist of layers of sandy clay (1 to 8 m thick) and clay, with some clayey sand (1 to 6 m thick). The bore log for TPA-17 starts at the sea bed and shows silty sand underlain by sandy silt up to around 3 m depth.

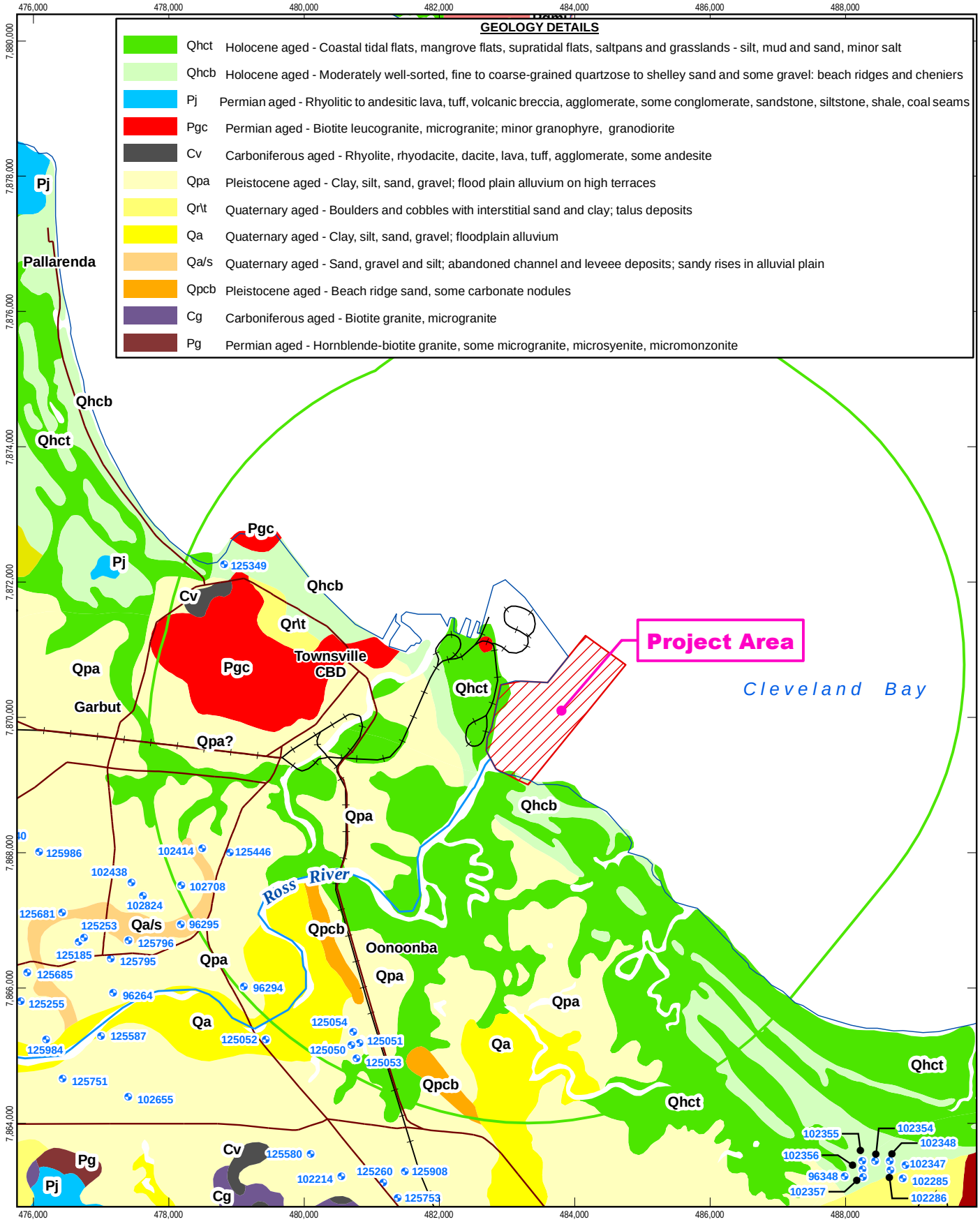
3.2.1.3 Acid sulfate soils

An Acid Sulfate Soils Investigation Report and an Acid Sulfate Soils Management Plan were prepared by GHD in 2009 and are included as Appendix H.

Reporting areas for the field observations defined as Lot 773, Outer Harbour Area 1 and Outer Harbour Area 2 are shown in Figure 3-3.

PASS has been identified across the Precinct in all of the main material types encountered at various depths below the sea bed in 77% of samples analysed, based on values of S_{POS}. However, no AASS (i.e. no existing acidity) has been identified. The origin of the oxidisable sulfur detected at the site is from both inorganic sulfur compounds (such as pyrite) and from organic matter and/or sulfate minerals (such as gypsum) predominantly identified in materials containing significant proportions of clay (including silty clay/clayey silt, sandy silty clay and silty clay).

The ability of sediment to buffer acidity is measured by its acid neutralising capacity (ANC) and for the samples analysed, 80% had more neutralising capacity than acid (organic and/or inorganic) generated, indicated by a reported net acidity of <0.02%S for these samples. Environmental factors (such as grain size, water through flow and precipitates) however, influence the ability of the sediment to fully neutralise the acidity generated. A reported net acidity of <0.02%S does not necessarily mean that all acid generated would be neutralised in reality because not all of the reported capacity may be available as the neutralising agent. For example, shell material can become coated in reaction products (such as gypsum and iron oxide precipitates) that can reduce the effectiveness of buffering and/or the acid generated with the matrix can be removed from the system faster than the neutralising reactions can complete



1:75,000 (at A4)
0 0.5 1 1.5 2
kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Mapped Geology and
Registered Groundwater Bores

Job Number 42-15399
Revision A
Date 01 July 2009

Figure 3-2

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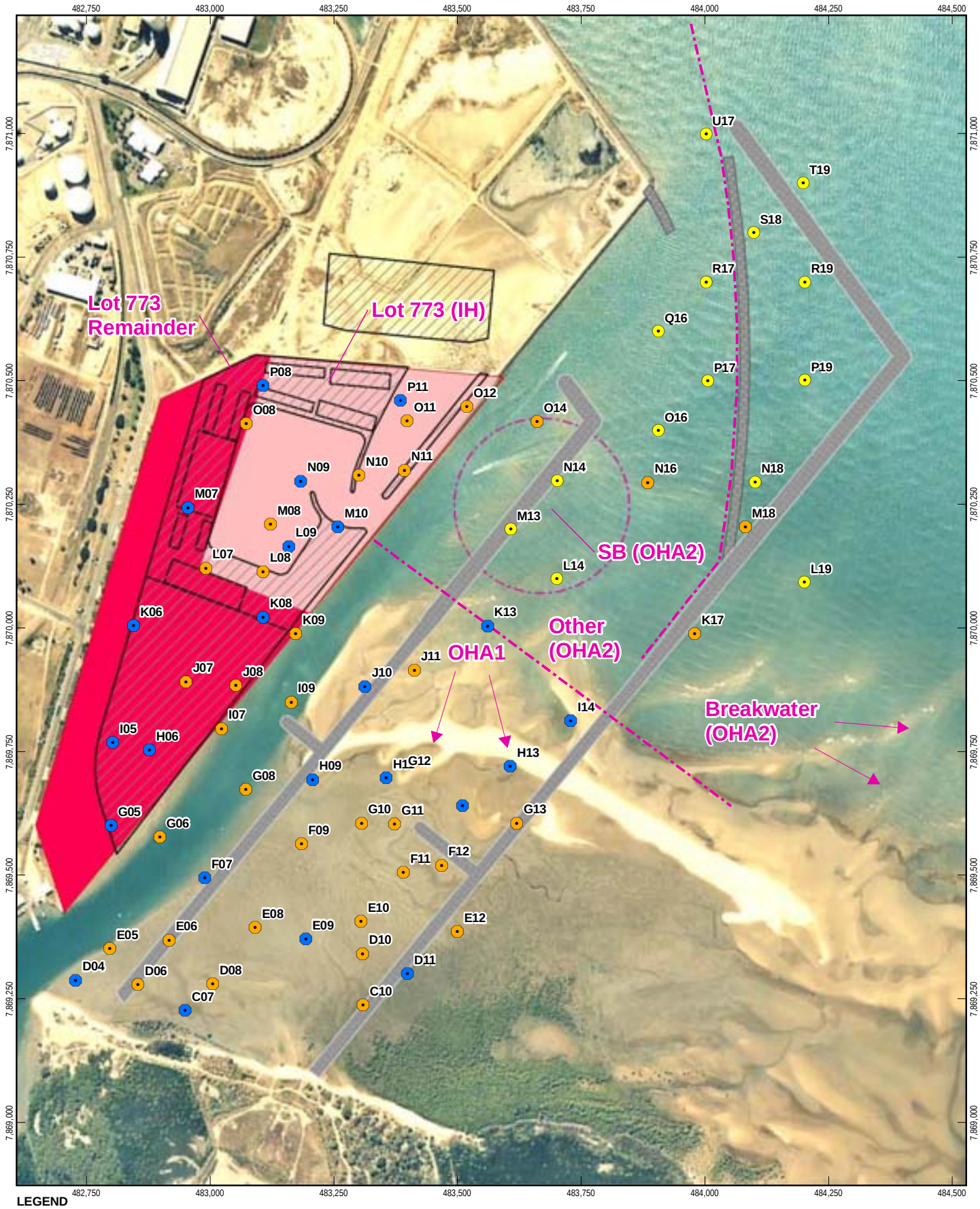
Data source: Marine Precinct - ©The State of QLD (Port of Townsville LTD) 2009; Groundwater Bore - ©The State of Queensland (Department of Environment and Resource Management); 250K Topo Data - ©Commonwealth of Australia (Geoscience Australia) 2007. Created by: JVC



LEGEND

- Vibra-Core Sample Locations - Phase 1
- Vibra-Core Sample Locations - Phase 2
- Vibra-Core Sample Locations - Phase 3
- Precinct Layout
- Breakwater Min Max Option
- Breakwater Option C (Preferred)
- Lot 773 Inner Harbour and Trawler Basin
- Lot 773 Remainder
- Reporting Areas:
  - OHA1-Outer Harbour Area 1
  - OHA2-Outer Harbour Area 2

1:10,000 (at A4)

0 50 100 150 200 250

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Vibra-core Sample Locations and Reporting Areas

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Revision A
Date 01 July 2009

Figure 3-3

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Data source: Vibra Core Locations - ©GHD; Marine Precinct - ©The State of QLD (Port of Townsville LTD) 2009; Aerial (flown 2004) - ©The State of Queensland (Department of Environment and Resource Management). Created by: TH

The amount of "spare neutralising capacity" (ANC / S_{POS}) gives an indication of the likelihood that acidity generated will be neutralised. For the samples analysed, 41% had an ANC less than two times the value of S_{POS} (maximum oxidisable sulfur), and present moderate to high risks from acid generation while 59% of the samples analysed present a low risk. However, given that results suggest all of the main material types encountered present a range of risk no one material type, or types can be classed as presenting a low, moderate or high risk from acid generation.

Mixing of materials during the dredging process may help to distribute the materials with more ANC and thus could potentially reduce the risk of acid generation overall, however the dredging process can separate fines (which typically have a higher potential for ASS) from the coarser components (which can have a lower potential for ASS) thus potentially counteracting the benefit of mixing.

Analysis of the swing basin sample results suggest that the potential for environmental harm as a result of oxidation of PASS material is less likely than in other areas of the site. The level of ANC is twice that of S_{POS} which indicates a low risk potential. Note that this interpretation is based on analysis of only 14 samples from the swing basin, which does not meet ASSMAC sampling guidelines.

Based on the ratio of the calculated average ANC to average S_{POS}, for samples obtained from each reporting area, the Inner Harbour and Trawler Basin (Lot 773), Breakwater (Outer Harbour Area 2), 'other' including channel (Outer Harbour Area 2) and Swing Basin reporting areas, present a low risk from acid generation assuming full mixing of each sample (see Table 3-1). Note that although the samples, on average, present a low risk from acid generation for these reporting areas, full neutralisation of any acid generated is not guaranteed to occur. In addition, 'hot spots' of material with in-sufficient capacity to neutralise acidity have been identified in these areas, except for the proposed swing basin and therefore the likelihood of the presence of other 'hot spots' (as yet unidentified) should also be considered.

Table 3-1 Ratio of ANC to SPOS by reporting area

Reporting Area Name	Ratio[1] of ANC to S_{POS}	Presented Risk
Lot 773 - Inner Harbour and Trawler Basin	2.84	Low
Lot 773 - Remainder of Lot 773	0.61	High
Outer Harbour Area 1	0.85	High
Breakwater (Outer Harbour Area 2)	2.56	Low
Other, including channel (Outer Harbour Area 2)	3.28	Low
Swing Basin (Outer Harbour Area 2)	5.77	Low

[1] Based on the average ANC and average S_{POS} calculated for samples from each 'reporting area'

3.2.1.4 Land contamination

A description of any possible land contamination from the Precinct is detailed further in Section 3.9 Water and Sediment Quality, and discusses the following land contamination issues:

- Mapping of any areas listed on the Environmental Management Register or Contaminated Land Register under the *Environmental Protection Act 1994*;
- Identification of any potentially contaminated sites not on the registers which may need remediation; and
- A description of the nature and extent of contamination at each site.

3.2.1.5 Land use

Land tenure

All the proposed works lie within the declared Port Limits of the POTL. The proposed project area of Lot 773 on EP 2211 is under a Perpetual Lease to POTL. This came into effect following vesting of EP 221 in 1987 from the Governor of Queensland to the Townsville Port Authority. A Lease in Perpetuity was granted by the Department of Natural Resources and Water commencing on 30/11/2000 for port and transport related purposes.

An area across the mouth of Ross River adjacent to Lot 773 will also be required for a breakwater and pile moorings. POTL is in discussions with the Department of Natural Resources and Water in relation to tenure for the seabed associated with the footprint of this facility.

Public use of Lot 773

A Public Use and Traffic Surveys report was undertaken by GHD for the TMPP (Lot 773 and Benwell Road) in June 2008. This report identified the majority (48%) of all activities undertaken in the area was boating. Most of these were recreational boats with a minor proportion made up of commercial vessels. The subsequent most popular activities were walking dogs (20% of all activities), walking or jogging (13% of all activities), fishing (8% of all activities), activities undertaken in cars (e.g. talking, eating meals, enjoying the view) (5% of all activities) and other activities (e.g. taking pictures, kayaking, kids playing) (4% of all activities). Additional information in regards to public use of Lot 773 is available under Section 4 of this document.

3.2.1.6 Precinct land holdings

The following Table 3-2 provides a description of the existing and proposed uses for each lot (shown on Figure 3-4) and the works proposed for the Project.

Lot 773 forms the basis for the TMPP footprint. The northern adjacent land, Lot 791, is reclaimed Strategic Port Land, often referred to as the Townsville Port Eastern Reclaim Area. The relevance of this land to the TMPP is that the breakwater will adjoin this area and it may temporarily provide a hardstand area associated with Stage 1 of the Precinct during construction of Stage 2 of the Precinct if required (refer Section 1 for a description of the TMPP stages). Lot 791 will only be used by Precinct occupants, if required, until Stage 1 is completed and will be returned to POTL in its existing state by June 2011. Beyond Stage 1 completion no continued use of Lot 791 is expected.

Lot 791, being reclaimed land, has no previous land uses. Lot 773 will become reclaimed land. It is currently intertidal and during low tide is used by the public for recreational activities. No other uses of Lot 773 currently occur.

Table 3-2 Precinct land holdings

Property Description	Tenure	Existing Use	Proposed Use	Land Use Designation POTL Land Use Plan
Lot 773 on EP 2211	Perpetual Lease	◗ Strategic Port Land ◗ Sea Bed (reclamation area). ◗ Public access to foreshore area currently allowed by POTL	◗ Precinct	Port Dependent Industry
Lot 791 on EP2348	Perpetual Lease	◗ Strategic Port Land ◗ Port-dependent industry, reclamation, land development	◗ The breakwater will adjoin this land ◗ Temporary hardstand area while Stage 1 developed	Port Dependent Industry

3.2.1.7 POTL land use planning

Both Lots 773 and 791 are designated as 'Port Dependent Industry' within the POTL Land Use Plan 1996.

'Port Dependent Industry' designation is for uses:

> *"which are not part of the core port operations of the port but which are intimately associated with and dependent upon being conducted in proximity to the land/sea interface and core port operations. They include stockpiles, granaries, silos and container storage. Facilities included in this category are those which;*
>
> ◗ *handle bulk material either sourced by sea transport or dispatched by sea transport*
>
> ◗ *generate such significant sea trade as to positively enhance the usage of the port".*

As discussed in Section 1.7.4.2, the Project is considered to be consistent with this land use designation.

LEGEND

- Townsville State Development Area
- Proposed Marine Precinct and Breakwater
- Cadastre
- Road
- Water
- Breakwater
- Education, Heritage And Business Park
- Central Business District
- Centre Frame
- Core Industry
- Business And Industry
- Traditional Residential
- Neighbourhood Residential
- Mixed Residential
- City View Slopes Residential
- Medium Density Residential
- Community And Government
- Not Subject to Planning Scheme
- Green Space

1:25,000 (at A4)

0 250 500 750 1,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Land uses

Job Number	42-15399
Revision	A
Date	01 July 2009

Figure 3-4

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3.2.1.8 Port of Townsville

Land uses

The majority of the Port Lands are used for industrial-based operations. Existing uses include; wharves, cargo consolidation, marine-related industries, buffers, storage of dry bulk materials and bulk liquids, container handling, product stockpiles, transit and transport area, and screening facilities.

The POTL envisages that the existing uses on Port land will expand to meet the growing demands of future trade forecasts for the Port of Townsville. They have identified the importance of clustering related industrial type land uses within the Port, to ensure that an adequate area is provided for future growth and minimise the occurrence of incompatible land use.

The areas immediately adjoining the wharf are used as short-term lay-down areas for the loading and unloading of ships.

The Port area is in close proximity to the South Townsville residential community. Currently land uses are separated by physical barriers including, but not limited to, open space (Port Environmental Park), transport corridors (roads) and benign development (such as warehousing).

Transport

The Port of Townsville is a commercial, industrial multi-cargo Port. Activities undertaken within the Port have the potential to generate noise, odours, dust or light emissions, or may impact traffic movements and visual amenity of the surrounding land uses.

Rail access to the Port is via the rail corridor located along Perkins Street. Townsville City Council City Plan 2005 identifies that this transport route is part of the Rail Freight Network and is designated as ‘Other Freight’ on Map 3.3(b). It is envisaged that this route will continue as a rail transport corridor to and from the Port, however, development of the TPAR corridor is expected to eventually provide an alternative rail transport corridor to and from the Port.

Road access to the Port of Townsville is primarily via Boundary Street and Benwell Road. Boundary Street is bounded by a mix of residential and non-residential uses, including industrial, commercial and shop-type uses. Both Boundary Street and Benwell Road form part of the ‘Principal Road Freight Network’ as defined in Townsville City Council’s City Plan 2005. A connection to the Port also exists via McIlwraith Street and Perkins Street to Ross Street which forms part of the ‘Secondary Road Freight Network’ and further on to Lennon Drive which is part of the ‘Principal Road Freight Network’ as defined in Townsville City Council’s City Plan 2005.

A future access route to the site will be via the Stuart Bypass and proposed Eastern Access Corridor. The proposed Eastern Access Corridor will provide a direct transport connection along part of Benwell Road and across Ross River to the State Development Area. This route will also include a future rail corridor for movement of rail carriages primarily from the south and west of Townsville and potential for product services corridor such as conveyor and pipeline.

Facilities

Port facilities include all land, transport infrastructure, wharves, shipping navigation infrastructure and product storage and handling facilities required to operate the Port.

The Port of Townsville is easily accessible by road, rail and sea. It has a dedicated rail network within the port area, which is provided by Queensland Rail, POTL and port tenants. Road networks to the port are a combination of state and local roads. Roads within the port boundaries are developed, owned, managed and maintained by POTL. Navigational access to the port is via access channels, swing basin and berth pockets. Development and maintenance of these is a core function of POTL.

The access channels to the Port of Townsville have a total length of 6.4 nautical miles. The Platypus Channel is 92 metres wide and has a depth of approximately 11.7 metres below the Lowest Astronomical Tide (LAT). Depths along the wharves vary from 12.3 metres to 9.8 metres according to the requirements of the individual trade using the berth.

The Port of Townsville has nine operational wharves. Wharves are equipped with bulk handling facilities including pipelines for fuel, oil, gas, chemicals, cement and molasses, shiploaders for sugar, mineral and metal concentrates and fertiliser, cranes for containers, refined metals, nickel ore, fertilisers and breakbulk cargo and RORO ramps for rolling stock.

3.2.1.9 Surrounding land use

The existing land uses surrounding the PoT and the Precinct are shown in Figure 3-4. This shows that the areas surrounding the Project area are heavily developed urban area.

The Project is directly located between the PoT and the Ross River. Land to the south west of the Project site (not within the PoT) is residential. The areas to the west of the project area (not within the PoT) include the commercial and industry centre of Townville.

The land across the Ross River includes environmental reserve and the proposed Townsville State Development Area.

3.2.1.10 Environmentally sensitive areas

The Project is located within Cleveland Bay which is protected by the Great Barrier Reef. Areas of specific ecological significance within the Project area include:

- The Great Barrier Reef Marine Park;
- The Great Barrier Reef World Heritage Area (GBRWHA);
- Dugong Protected Areas;
- Fish Habitat Areas;
- RAMSAR – Bowling Green Bay; and
- Magnetic Island.

Environmentally Sensitive areas are discussed further in Section 3.10 Nature Conservation of this EIS.

3.2.1.11 Native Title

During the establishment of the perpetual lease for Lot 773, Native Title was determined to have been suppressed in accordance with the non-extinguishment principle. Provided the existing

tenure arrangements (perpetual lease) are maintained, the Project may be carried out and maintained in accordance with the purpose of the lease.

Figure 3-5 illustrates the areas covered by applications for Native Title claims or Native Title determinations.

3.2.2 Potential impacts and mitigation measures

3.2.2.1 Overview

The Precinct and Breakwater will be developed wholly within port limits and within the Ross River. The land based components of the Project will be developed on reclaimed land with limited existing use except for some public recreation.

The proposed works are consistent with the POTL Land Use Plan 1996. The Plan identifies the reclaimed land as Strategic Port Land and necessary for the provision of the Precinct and Breakwater development.

3.2.2.2 Potential impacts

Direct land use

The proposed works are not expected to have any direct impacts in relation to land use and land use planning as the project is located on reclaimed land wholly within port limits for a port related industry and is consistent with the POTL Land Use Plan 1996.

Public access

There will be impacts on the public use of Lot 773; however the public has only been allowed to access the beach and mudflats of this strategic port land area for recreation purposes until such time as the land is required for Port related purposes.

Current uses include fishing, yabbying, walking and dog exercise. These are detailed further under the social impact assessment section of this study (refer Section 4).

The TMPP will form an industrial marine facility within which maritime fabrication, boat maintenance and commercial barge operations will occur. This will include the use of forklifts, trucks, operational cranes for heavy lifting, welding, abrasive blasting and other machinery. The facility will, as appropriate, be bound by workplace health and safety regulations including required use of Personal Protective Equipment such as hard hats, eye protection, work boots and ear protection for the safety of employees. Public access to the full operational facility may be unsafe and, therefore, inappropriate.

To maintain public access to the coast, consideration is being given to inclusion of areas within the Precinct that may be open to the public. This may include opportunity for direct purchase from seafood suppliers or provision of access points along the external face of the rock revetment. The detailed design of the Precinct will need to address these considerations against the safe operation of the Precinct facility and the safety of the public.

Upstream industrial lands may be vacated by industries relocating to the Precinct. The desired planning outcome of the redevelopment of any upstream lands will be to provide enhanced public access to the coast that offsets losses experienced through development of the Precinct. These upstream lands are currently inaccessible to the public because they are working

commercial sites. When they are redeveloped in accordance with any approval from Council it is anticipated that increased opportunities for public access and recreation will be provided e.g. riverside boardwalk, seafood sales outlet, possible fishing locations and potentially a fenced dog exercise area in the existing environmental park.

Ecologically sensitive areas

Seagrass meadows, roost sites for wading and migratory birds, mangroves and mud flats are in the immediate vicinity of the Precinct and considered to be sensitive ecological receptors. The direct impacts on any areas of high conservation value identified during studies, such as these, is discussed further in Section 3.10 Nature Conservation. The mitigation management measures identified to cope with any identified impacts are also addressed below and Section 8.

Surrounding land uses

As discussed above the Project is directly located between the PoT and the Ross River. The Ross River provides a natural buffer to the environmental reserve and State Development Area on the eastern side of the Ross River.

Potential visual impacts from the project are described in Section 3.3.

The Noise and Vibration Assessment undertaken for the project is included as Appendix K. This report found that noise impacts on surrounding land uses will not significantly impact on the amenity of sensitive receivers provided appropriate management procedures as outlined in the report are implemented.

An Air Quality Assessment was undertaken for the Precinct and is included as Appendix L. This report found that the construction related dust from the TMPP would not significantly impact on the amenity of sensitive receivers provided appropriate management procedures as outlined in this report are implemented. An Environmental Management Plan will need to be implemented for the construction phase to control dust in the nearby residential area to the south. This is addressed in detail under Section 8 of this document.

The report also concluded that air emission from proposed operational activities, consisting of abrasive blasting, fuel storage and fishing trawlers, will not have a significant impact on any nearby sensitive receivers and air quality objectives will be achieved.

The PoT is surrounded by a heavily developed urban area, and is located wholly within port limits and is consistent with the POTL Land Use Plan 1996. Therefore the Project is not likely to impact significantly on the surrounding land uses.

LEGEND

- Register of Native Title Claims
- Registered and Notified Indigenous Landuse Agreements
- Proposed Marine Precinct
- Proposed Breakwater

1:75,000 (at A4)

0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Native Title

Job Number	42-15399
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Figure 3-5

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Impacts on Infrastructure, Roads and Rail

A Traffic Impact Assessment has been undertaken by GHD and is included as Appendix M. This report investigated the potential impacts of the proposed development on roads. The report found that the all of the aforementioned existing intersections are currently providing acceptable service conditions under existing peak hour traffic loading. The report concluded that development can take place with little significant impact on the external road network.

Existing access to the Project site is via Benwell Road, South Townville. No transport infrastructure currently exists on the Project site. Construction of the Stuart Bypass and Port Access Road commenced in August 2008. This includes a road/rail link to be built over the mouth of Ross River

Further information regarding transport impacts and management measures are detailed further in Section 3.4 Transport and associated infrastructure.

Sediment erosion

The sources of sediment that could affect this area of Cleveland Bay are Cleveland Bay itself, the Ross River, and the foreshore areas south-east of the site. Mechanisms for moving sediment are wave action, tidal currents, flood flow currents, wind driven currents, and longshore sediment transport. The effect of coastal processes on sedimentation is described and discussed in detail under Section 3.8.

Hydrodynamic modelling (refer to Section 0) was undertaken to describe the circulation patterns in the vicinity of the proposed marina and breakwater development directly across the mouth of the Ross River. The main aim of this exercise was to assess the relative impact of the proposed development in terms of flushing potential and changes in bed shear stresses leading to the potential for sediment accretion of erosion. Refer to Section 0 for a full discussion of the findings of this study. The following key results of relevance to erosion potential were identified as follows:

- Absolute values of bed shear stress appear to remain relatively low (i.e. less than the 1 N/m2 threshold for erosion) under the majority of conditions, with increases in bed shear typically less than 0.5 N/m^2. Hence, under the majority of conditions, changes to stresses appear unlikely to require mitigation; and
- Under flood conditions, bed shear stresses could potentially increase by 5 – 8 N/m2 in the entrance and at the tail of the eastern breakwater. This imposes a risk of scour, which will need to be addressed during design.

Acid sulfate soils

Potential impacts have been identified in relation to the proposed development based on current information presented in this study and will be addressed in the ASS Management Plan (ASSMP). In addition to the list below there will also be potential impacts related to the options for the management of ASS material, discussed in the ASS Management Plan.

Excavation of Dredge Spoil (All 'Reporting' Areas)

- Potential for the generation of acid from dredge spoil if saturation of the material is not maintained throughout the dredging process; and

- Separation of sulfidic fines from granular material during the dredging and fill placement process could result in concentration of PASS materials, for example this could occur when spoil is pumped into a holding vessel and/or when dredge spoil is placed as fill.

Lot 773

Potential for:

- Acidification of groundwater within fill material in Lot 773 if dredge spoil is placed above the permanent water table and hence exposed to the atmosphere. Percolation of water through oxidised ASS material above the permanent water table could result in the generation of acid within the unsaturated fill which, when it reaches the water table, could lower the pH of the groundwater (i.e. make it more acidic). It is likely that a proportion of the acid generated will be neutralised within the soil matrix however full neutralisation cannot be guaranteed;
- Mobilisation of metals such as aluminium and iron from the fill material as a result of increased acidity and hence potential for an increase in metals concentrations in groundwater within reclaimed Lot 773;
- Migration of acidic groundwater to Cleveland Bay from Lot 773 containing elevated concentrations of metals;
- Precipitation of metals including iron, arsenic and manganese out of solution when acidic groundwater containing elevated concentrations of iron in solution mixes with sea water, given that sands are proposed to be used as reclaim fill for Lot 773 and that the oxidisable sulfur reported appears to be inorganic (i.e. likely to be pyritic) for this material. The groundwater will become less acidic on mixing with seawater and can result in precipitation of iron, thus the potential to create extensive red/orange iron staining in the water, on infrastructure and vessels;
- Iron staining at ground surface if dredge spoil is placed at ground surface, where it will dry out, oxidise, generate acid and mobilise iron from within the sediments and result in precipitation of iron;
- Fish kills and algal blooms as a result of increased levels of nutrients produced from reactions within acid sulfate soils and discharge of the nutrient rich water to the sea. The impacts of elevated nutrients are likely to be most significant in the inner harbour and trawler basin where flushing with ‘fresh’ seawater may be limited and hence potential for limited dilution of any nutrients discharged to sea;
- Discolouration and noxious odours emitted from open water bodies which are not regularly flushed (e.g. inner harbour);
- Generation of acid within in-situ sediments (identified as PASS) if they are exposed to the atmosphere (and oxidised) such as through dewatering or through excavation during future development on Lot 773;
- Lateral flow of groundwater away from Lot 773 into the surrounding material when in-situ sediments, which include material identified as PASS, are compacted during reclamation (such as placement of fill and bund construction) and hence the potential to temporarily increase groundwater levels in materials adjacent to Lot 773. No AASS were identified within Lot 773 and the majority of the site lies within the intertidal zone. Therefore in-situ material will generally be saturated for much of the time. Water displaced from the in-situ

- Degradation/corrosion of concrete and steel structures founded in dredge material or founded in material where groundwater has become acidic as a result of oxidation of overlying materials; and
- Cracking, shrinking and subsidence of PASS material that are allowed to dry out.

Recommendations

Based on the results of this ASS investigation, the following recommendations were made with regard to the development of the site:

- Given the identification of PASS in samples obtained across the Precinct site, an ASS Management Plan (ASSMP) will be required in accordance with QASSMAC Guidelines (2002) specific to site development, in addition to the ASSMP prepared as part of the EIS, and may require the incorporation of additional sampling for ASS; and
- Given the above points and to minimise the potential for environmental harm, all of the material disturbed as part of the development should be assumed to be PASS and managed accordingly, unless more detailed assessment, either pre- or post- dredging and placement, can confirm the material is non-ASS.

Land contamination

Under the EP Act contamination is recognised to be the release of a contaminant into the environment. Contaminants may be in various states (liquid, gas, solid) or may include via noise, radiation or organism introduction (among other mechanisms). The potential contamination impacts from construction and operation of the Precinct are the:

- Resuspension of particles into the water column causing generation and migration of turbid plumes resulting from capital and maintenance dredging;
- Mobilisation of sediment bound contaminants into the water column (including nutrients and acid sulfate soils) during capital and maintenance dredging; and
- Release of contaminants from various marine industries into Ross River.

The proposed mitigation measures to deal with these impacts are detailed further in the Section 3.9 Water and Sediment Quality and in Sections 3.14 and 6 (Waste management and Hazards and Risks).

3.2.2.3 Mitigation Measures

Direct Land Use

As the Precinct is to be developed on reclaimed land wholly within port limits, no mitigation measures are considered necessary in relation to land use and land use planning as the Precinct is consistent with the approved land use in the TPALUP and perpetual lease for the site.

Public Access

The TMPP will provide some public access to the coast where it is safe and won't interfere with the operation of the Precinct.

The desired planning outcome of the redevelopment of any upstream lands will be to provide enhanced public access to the coast. For example these lands are currently inaccessible to the public because they are working commercial sites. However when they are redeveloped in accordance with any approval from Council it is anticipated that increased opportunities for public access will be provided e.g. boardwalk, seafood sales outlet, and possible fishing locations.

At this point it cannot be guaranteed that upstream redevelopment will be able to meet inclusion of all potentially desirable public facilities. For instance, replacement of an off-lease dog walking facility upstream should be considered but cannot be guaranteed for any redeveloped lands. However, POTL will endeavour to provide alternative recreation opportunities as identified above.

An Aboriginal Cultural History story board will be located at the environmental park that recognises the significance of the area to Indigenous Traditional Owners.

Management of Construction

The proposed management measures for construction are covered within the Environmental Management Plan, and are included as Section 8 of this EIS. The EMP details the management measures of the immediate environs of the project including approaches as to how potential noise and dust impacts on sensitive environmental areas and residential areas will be minimised.

Operation

The proposed management measures for operation of the Project are covered within the Environmental Management Plan, and are included as Section 8 of this EIS. The EMP details the management measures of the immediate environs of the project and information on how to avoid impacts to the surrounding sensitive environmental and residential areas.

Sediment erosion

The coastal erosion aspects of the Project and mitigation measures for potential impacts identified are discussed further in Section 3.8. A project specific Environmental Management Plan has been developed for the construction and operation phases of the project to appropriately manage and mitigate any impacts caused by sediment erosion.

Acid sulfate soils

An Acid Sulfate Soil Management Plan (ASSMP) has been provided as Appendix H and is designed to cover acid sulfate soil (ASS) management during the construction phase of the Precinct, any future expansions, activities within the reclamation areas and recommended on-going monitoring.

3.3 Landscape character and visual amenity

3.3.1 Overview

A Landscape and Visual Character Assessment for the Precinct Reference Design has been undertaken by GHD and is included as Appendix N.

This section describes the landscape and visual character of the area surrounding the TMPP, assesses the potential impacts that the project may have on these values and recommends mitigation measures where appropriate.

The assessment of the potential landscape impacts of a project is carried out as an impact on an environmental resource (i.e. the landscape) whereas visual impacts are assessed as one of the interrelated impacts of a project on the viewing population.

Landscape features and elements are determined and/or influenced by physical, biological and cultural factors and may include soils, vegetation, and land uses. As such, landscape effects occur from changes in the physical landscape, which may give rise to changes in its visual character and how this is experienced. This may in turn affect the perceived value of the landscape.

This visual impact assessment (VIA) describes the existing landscape and visual character within the visual catchment of the project, identifies and assesses the existing visual context and viewpoints, undertakes an assessment of the significance of the impacts on the visual landscape and identifies the extent to which mitigation of impacts is required.

This visual impact assessment addresses the potential landscape and visual impacts associated with the TMPP including:

- Review of existing information including planning and statutory requirements;
- A description of the project and its visual components;
- Identifying the limitations and assumptions of this method;
- An evaluation of the existing landscape and visual environment;
- Discussion of visual receptor sensitivity within the study area through the use of viewpoints;
- Assessment of the significance of impacts on landscape character and visual amenity at the viewpoints as a direct result of the project;
- Identification of residual and cumulative impacts;
- Proposed mitigation strategies; and
- A summary of the findings of the assessment.

The methodology for this study, including impacts and proposed mitigation measures, has been derived from the *Guidelines for Landscape and Visual Impact Assessment, Second Edition*, published by The Landscape Institute and Institute of Environmental Management and Assessment (2002) and the Forest Practice Board of Tasmania's *A Manual for Forest Landscape Management*. The methodology is detailed further in the Landscape and Visual Character Assessment included as Appendix N.

3.3.2 Description of environmental values

Landform

The Townsville area is characterised by a low-lying coastal landform bounded by Cleveland Bay and the Paluma and Hervey mountain ranges (Queensland Government, 2007). Castle Hill (refer Figure 3-6) and Mt Stuart (refer Figure 3-7) are key landform elements within the wider landscape rising above the urban areas of the city.

Magnetic Island located off the coast of Townsville, has steep landform with numerous bays and inlets, and provides a visual backdrop to the east of the city.

Figure 3-6 Castle Hill landscape Feature

Figure 3-7 Mt Stuart Landscape Feature

Mt Stuart, located on the south-west edge of Townsville, is another dominant landscape feature and provides a visual backdrop to the city

Land Use and Statutory Requirements

Townsville is a major regional Queensland centre providing a range of services and facilities to the city and surrounding communities. The project site is located within the Port of Townsville precinct, which incorporates large scale industrial development, port facilities, and areas undergoing reclamation. The site is also located within close proximity to the South Townsville residential area and the commercial and residential development in the city centre area. The area on the eastern bank of Ross River is largely an undeveloped inter-tidal coastal area.

Townsville – Thuringowa Strategy Plan

The 2007 Townsville – Thuringowa Strategy Plan is the framework for managing growth and development in the region and while it is not a statutory document it provides a guiding framework for population growth. This plan states that "the region's dominant features including its mountainous and hilly areas, coastline, rivers and creeks combine to present a strong physical image. The landscape and seascape values should be protected for the long-term benefit and enjoyment of the region and its visitors".

The Townsville Port area is identified as Major Industry while the area on the eastern bank of Ross River is identified as Critical Conservation Area outside Reserves, and Special Uses.

State Coastal Management Plan

No regional coast plan has been developed for this area therefore for this site the provisions of the State Coastal Management Plan have been assessed in relation to landscape value. Under that management plan Townsville is recognised as being an area of High Scenic Management Priority. The plan incorporates three principles relating to coastal landscapes:

- The values of coastal landscapes are conserved and recognised for their importance to the quality of life of both residents and visitors, as well as to the economic development and growth of Queensland;
- The dominance of the natural character of the coast (excluding developed urban areas) is retained, including elements of landscape and vegetation; and
- The cultural and spiritual values of coastal landscapes are recognised and conserved through the involvement of the relevant Indigenous Traditional Owner communities.

Townsville Port Authority Statement of Proposal 2006

Townsville Port Authority Statement of Proposal 2006 identifies the following features within Port limits that are considered to have high scenic value:

- Port of Townsville port facilities including active berths;
- Ross River (sandy beaches, boat ramps and recreational fishing areas);
- Ross Creek;
- Tracts of vegetation along the coast;
- The Strand;
- Magnetic Island coastline;
- Townsville Maritime Museum;

- Port Environmental Park; and
- Cape Cleveland Coastline.

Port facilities and operations at the Port of Townsville are visible from many points in Townsville, including Castle Hill, Townsville City and built structures.

Vegetation

Three State bioregions meet in the Townsville region, the Brigalow Belt North, the Einasleigh Uplands, and the Wet Tropics. This is representative of the diversity in the natural characteristics, such as landform and vegetation, of the region.

The Townsville – Thuringowa Strategy Plan identifies that the main vegetation type in the region is Eucalypt dominated savannah woodland and grasslands. However, the region also includes significant examples of other vegetation communities such as beach ridge vine thickets, riparian forests along creeks and rivers, mangrove forests in estuarine areas, and samphire communities associated with saltpans (Queensland Government, 2007).

On the eastern side of Ross River, mangroves dominate while the area between the mangroves and the areas above the tidal influence contains saline mudflat including salt couch (*Sporobolus virginicus*). The most abundant vegetation community in the vicinity of the site is located above the tidal reach and includes sclerophyll woodland dominated by Moreton Bay ash (*Corymbia tessellaris*) or grey paperbark (*Melaleuca dealbata*) (primarily in the swales).

Of the project site on the western side of the river there is approximately 1.5 hectares of vegetation characterised by a low shrub layer dominated by grey mangrove (*Avicennia marina*) and club mangrove (*Aegialitis annulata*) and a ground layer of predominately typical saline system plants. Further detail in regard to the vegetation in this area is provided in Section 3.10 of this report.

Visual catchment

The topography in the vicinity of the site limits the viewpoints from which the site will be visible, thereby limiting the visual exposure of the project. The identification of the visual catchment of the project provides an assessment tool used to define the area from which the project may be visible. Site assessment further defines the location from which the project site is visible within the identified visual catchment and the viewpoints from which detailed assessment will be undertaken.

The visual catchment for the proposed port works extends over the ridges and high points of the city and incorporates both residential and commercial development, recreation areas and lookouts. The topography of the region means that areas distant from the site, such as Mt Stuart, are part of the visual catchment. While these areas are within the visual catchment, due to the distance from the project area they are not considered to be viewpoints.

The visual catchment for the project includes:

- South West to Mount Stuart;
- Castle Hill to the north;
- Residential areas to the north and west; and
- Cleveland Bay and Ross River.

The extent of the visual catchment of the project is shown on Figure 3-8.

Viewpoints and sensitive receptors

The visual catchment provides the basis upon which viewpoints and sensitive visual receptors can be identified and further assessment undertaken. The viewpoints are areas where full or screened views of the site are possible and there is human activity being undertaken. This activity may include residential, business, recreation. In addition, viewpoints also include areas where the only views are transient such as vehicles using a road or views from trains.

The identification of viewpoints for this assessment excluded views from Mount Stuart and the surrounding area due to the separation distance from the site and therefore the background nature of the view. The viewpoints that have been identified and assessed in this report are:

- Castle Hill;
- Townsville City Residential East;
- Townsville City Residential and Commercial West;
- Boundary Street, Archer Street and Benwell Road; and
- Ross River and Cleveland Bay.

The viewpoints are described, including visually, below.

	Label
1	Castle Hill
2	Townsville City Residential East
3	Townsville City Residential and Commercial West
4a	Benwell Road
4b	Archer Street
5	Ross River and Cleveland Bay

LEGEND

View Points and View Direction | View Catchment | Proposed Marine Precinct | Breakwater Option

1:30,000 (at A4)

0 250 500 750 1,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Visual Catchment and Viewpoints

Job Number 42-15399
Revision A
Date 01 July 2009

Figure 3-8

G:\42\15399\GIS\Projects\EIS\42-15399_805_rev_a.mxd

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Data source: Marine Precinct - ©The State of QLD (Port of Townsville LTD) 2009; Aerial (flown 2004) - ©The State of Queensland (Department of Environment and Resource Management); 250K Topo Data - ©Commonwealth of Australia (Geoscience Australia) 2007. Created by: TH

Viewpoint 1 –Castle Hill

Castle Hill is a dominant landscape feature of Townsville rising above the city centre and surrounding suburbs. This location is frequently visited by both residents and visitors and provides extensive views of Townsville, Cleveland Bay, and Magnetic Island. A description of this viewpoint is contained in Table 3-3.

Table 3-3 Viewpoint 1 – Castle Hill

Typical local landscape character	 View of the city centre and south east proposed reclamation site from Castle Hill
Landform	Castle Hill is a granite monolith that is located close to the Townsville CBD and the eastern suburbs of the city. The hill rises steeply from the largely flat landform of the city.
Vegetation	The vegetation of Castle Hill is dominated by indigenous species in particular mixed Eucalyptus species. There are small areas of notophyll vine thickets, and grassed slopes with kangaroo grass and giant spear grass. Specialised flora also occur on the cliffs and rocky outcrops (EPA, 2009)
Land Use	Residential and commercial development is located on the lower slopes of the hill with the upper parts used primarily as a lookout with associated facilities, including car parking, lookouts, interpretative material, and walking tracks.
Visual Context	Visually dominant landscape feature providing extensive views of Townville urban area, Cleveland Bay and Magnetic Island. Views from this location are experienced by: ◗ Visitors; ◗ Recreation users accessing the walking tracks and road for recreation activities; and ◗ Road uses.

Viewpoint 2 – Townsville City Residential East

This residential area located in the north-east suburbs of the city provides elevated house site and the opportunities for views of the surrounding urban development and over Cleveland Bay to Magnetic Island. This is predominately an area of single detached houses. This viewpoint is described in Table 3-4.

Table 3-4 Viewpoint 2 – Townsville City Residential East

Typical local landscape character	 View towards the site from an elevated residential area in the eastern part of the Townsville
Landform	These residential areas rise to an elevation of approximately 55 m AHD providing views of the surrounding built and natural environment.
Vegetation	Urban landscape and residential planting.
Land Use	Primarily residential development comprised of detached housing.
Visual Context	This location provides one of the few elevated residential locations in Townsville, therefore providing residents with views of the surrounding urban environment and of Cleveland Bay and Magnetic Island. The mature vegetation and buildings in this location provides screening of some views and limits outlooks from some locations within this area. Views from this location are experienced by: ◗ Residential properties with both screened and unscreened views. These residents have long viewing periods; and ◗ Road uses travelling through the area.

Viewpoint 3 – Townsville City Residential and Commercial West

The development that has occurred on the southern slopes of Castle Hill, including both residential development and commercial development associated with the city centre has views that encompass the southern and eastern suburbs of Townsville. The characteristics of this viewpoint are detailed in Table 3-5.

Table 3-5 Viewpoint 3 – Townsville City Residential and Commercial West

Typical local landscape character	 Residential and commercial development located on the south-east slopes of Castle Hill. Views from this viewpoint are generally to the south-east.
Landform	Sloping land that forms the lower slopes of Castle Hill.
Vegetation	Urban landscape and residential planting.
Land Use	Residential and commercial land uses.
Visual Context	The commercial and residential development located within this viewpoint. Due to the landform the views from this location are focused to the south-east. The mature vegetation and buildings in this location provides screening of some views and limits outlooks from some locations within this area. Views from this location are experienced by: ◗ Residential properties with both screened and unscreened views; ◗ Activity focused workers in commercial buildings; and ◗ Road users visiting or passing through the area.

Viewpoint 4 – Boundary Street, Archer Street and Benwell Road

This South Townsville location is immediately adjacent to the reclamation area. The roads in this location provide access to industrial development with the main Townsville Port access on Benwell Road. This area is described in Table 3-6.

Table 3-6 Viewpoint 4 – Boundary Street, Archer Street and Benwell Road

Typical local landscape character	 Existing Ross River foreshore and Benwell Road
	 View of Ross River and reclamation site from Archer Street (intersection with Benwell Road
Landform	The landform at this viewpoint is largely flat with some small rises in elevation.
Vegetation	Urban and industrial landscaping, and intertidal vegetation including mangroves.

Land Use	The area is comprised of industrial development and vacant industrial land. The industrial development includes activities in large buildings and storage tanks.
Visual Context	The landform of this viewpoint is flat with the visual outlook dominated by the existing industrial development and the waterfront fringing vegetation. Views from this location are experienced by: ◗ Activity focused workers on industrial sites; and ◗ Local road users accessing the port and other industrial developments and visiting the foreshore.

Viewpoint 5 – Ross River and Cleveland Bay

Ross River and Cleveland Bay near the mouth of the river provide water access and water based recreation use for commercial craft, recreation boats and other water based activities. Water craft travelling through this area have extensive views of the site and the surrounding built and natural environment. The characteristics of this viewpoint are described in Table 3-7.

Table 3-7 Viewpoint 5 – Ross River and Cleveland Bay

Typical local landscape character	 View of reclamation site from Cleveland Bay at the entrance to Ross River. Castle Hill is the dominant landscape feature from this location.
Landform	The land immediately surrounding the entrance to the Ross River and this part of Cleveland Bay is generally low-lying with Castle Hill being the only significant landscape feature when viewing to the north and north-west.
Vegetation	The vegetation of this view point is characterised by mangroves and saline mudflats.
Land Use	The land uses in the vicinity of this viewpoint are characterised by large industrial development and low-lying undeveloped foreshore areas.
Visual Context	The site is located at the entrance to the Ross River with this viewpoint providing the closet views of the bunds and reclamation works. The existing port reclamation area is visible from this location with the existing fringing mangroves providing a narrow vegetated strip along the western bank of the river. The view from this location to the north and north-west is dominated by Castle Hill while Mt Stuart provides the background view to the south-west. Views from this viewpoint are experienced by: ◗ Water based recreation users including people fishing and using recreational water craft; and ◗ Commercial water based users largely activity focused.

3.3.3 Potential impacts and mitigation measures

3.3.3.1 Introduction

The potential visual impacts have been considered in the context of the sensitivity of the surrounding visual environment and the potential for viewing of the areas that have had changes to their visual outlook due to site works.

3.3.3.2 Construction stage

The construction stage of the project will be undertaken as pre-construction activities and 3 stages. Construction activities are described in detail in Section 2.4.

The visual impacts that will occur during the construction stage include:

- Construction of the breakwater resulting in a new linear element in the visual landscape;
- Creation of the new land area through the reclamation process. This will incorporate heavy machinery with the possibility of dust during the construction state. The full extent of these activities will be clearly visible from some viewpoints;
- Construction and security lighting. The extent of lighting during construction will result in some increased sky glow in this part of the city; and
- Building construction and other associated site development works. The extent of visibility of these activities depends on the viewing location.

These impacts are addressed in more detail for each of the viewpoints in the Section 3.3.3.4.

3.3.3.3 Operation stage

The proposed operational activities to be undertaken on the site are described in detail in Section 2.5.

Operating times will reflect existing businesses hours, and some proposed uses will require 24 hour, seven day a week operation, as required (e.g. police and emergency vessels).

A future access route to the site will be via the Stuart Bypass and proposed TPAR. The proposed TPAR will provide a direct transport connection along part of Benwell Road and across Ross River to the State Development Area.

At the completion of construction operations the site will be used for industrial and port related development. Additional activities that will occur as a result of the operation of the port facilities include:

- Security and night lighting;
- Increased vehicle movements, including both cars and heavy vehicles;
- On-going building construction and site development works;
- Increased possibility of reflection from the large industrial buildings; and
- Outside storage areas and loading and unloading areas.

These impacts are addressed in more detail for each of the viewpoints in Section 3.3.3.4.

3.3.3.4 Visual impact and viewpoints

The visual impact on the viewpoints have been assessed for the construction and operational phases of the project. These impacts are addressed below in Table 3-8 to Table 3-12.

Table 3-8 Visual impact to viewpoint 1 – Castle Hill

Project Elements	**Construction** All construction operations will be visible from the Castle Hill lookout that provide views to the south-east **Operation** ◗ All buildings and other structures on the site; ◗ Vessels and port related activities; and ◗ Most outdoor industrial and storage related activities.
Visualisation	 Existing view of the project area from Castle Hill  Visualisation of the view from Castle Hill incorporating the proposed land reclamation area and constructed buildings. The major components of the project will be clearly visible from this location.
Landscape Impact Construction and Operation	The reclamation area will be a prominent landscape feature when viewed from Castle Hill. The proximity of this viewpoint to the site (approximately 3.5 km) along with the addition of the new linear elements in the reclamation area and breakwater will have an impact on the landscape amenity. The project will result in the following changes to the landscape character from this viewpoint:

	◗ Introduction of an additional linear element into the landscape particularly when viewed in association with the existing port facility; ◗ Creation of a new constructed landscape feature in the breakwater. This element will be situated in a position where the background is largely natural adding to the landscape impact; ◗ Creation of additional features that will alter the appearance of the entrance to the Ross River. This will reduce the naturalness of the current landscape in this location and create an area having an engineered appearance; and ◗ Introduction of additional industrial elements into the landscape decreasing the degree of naturalness when viewing to the south-east from this location. The landscape character visible from this view point will also be impacted on the proposed construction of the road and rail crossing of Ross Creek adjacent to the reclamation area. While the bridge is not part of this project, this new constructed feature of the visual landscape will visually be closely linked with the port development and will add to the perceived loss of naturalness of the landscape from this viewpoint. The bridge has been added to the above visualisation to enable a full understanding of the cumulative impact of the works proposed to occur in this area. It is assessed that the project will have a **moderate adverse landscape impact** from this viewpoint.
Visual Impact Construction and Operation	The view from this location will be experienced by visitors to Castle Hill. This view point has a high level of visual impact due to the extensive views offered from this location. As it is a landscape feature and a popular attraction for both visitors and residents the visual impact will be experienced by a large number of people. Viewing times vary depending on the nature of the activity, but would largely be of short duration. The project will result in some changes to the visual outlook during both construction and operation. Visual impacts during construction include: ◗ Gradual loss of naturalness of the landscape in this area with the creation of the breakwater and associated dredging and reclamation activities; ◗ Construction lighting; and ◗ Increase in the activity occurring in this location with the operation of large machinery and the construction work site operations. Visual impacts during operation include: ◗ Introduction of new linear elements in the reclamation area and the breakwater that provide a new edge to the Ross River and extend into the mangrove and inter-tidal area on the western side of the river; ◗ Visual extension of the South Townsville industrial development with the appearance of this development extending into Cleveland Bay; ◗ Security and other operational lighting; and ◗ Creation of a new development edge to the city in this location. The change in view will be experienced by: ◗ Visitors to Castle Hill at lookout points that have views to the south-east will have unscreened views of both the construction operations

	the parts of Castle Hill with views to the south-east will also experience unscreened views as well as some vegetation screened views of all the construction and operation activities on the site; and ◗ Road users travelling to and from the top of Castle Hill will have views to the construction site. These views are of short duration due to the transient nature of the viewing opportunity. It is assessed that the project will have a **medium adverse visual impact** from this viewpoint.
Significance of Visual Impact	**Moderate Significance**

Table 3-9 Viewpoint 2 – Townsville City Residential East

Project Elements	**Construction** ◗ Breakwater and parts of the reclamation area; ◗ Site equipment, particularly elevated structures such as cranes; and ◗ Construction lighting. ◗ **Operation** ◗ Buildings and other structures on the site with the extent of the visibility of the building depending on viewing location and surrounding vegetation. The height of the proposed buildings is such that a large proportion will be screened by foreground buildings; ◗ Vessels and elevated port related activities; and ◗ Operational lighting.
Visualisation	 An example of the existing views from this viewpoint.

	 The residential properties in this location will have screened views of the project area as shown from this visualisation. The location of the project works are included within the red area with the extent of available view dependent on the specific viewing location, surrounding vegetation and buildings.
Landscape Impact Construction and Operation	The residences in this location are elevated above the level of the site with this ranging from about 20-55m AHD providing views from some properties. The proposed construction works will not be a prominent landscape feature from the residences in this location as: ◗ Screening by vegetation and other buildings limit the view from many of the residential locations; ◗ The site works and completed reclamation area does not incorporate any elevated structures which would be a feature of the landscape when viewed from this location; ◗ The distance from this viewpoint to the site of approximately 2 km places it in the middleground view. Between this viewpoint and the site there is both commercial and industrial development, incorporating both buildings and tanks, which are evident in the landscape from this location; and ◗ Background views, including the distant landscape features are visible from this location and draw the visual interest away from the middleground. It is assessed that the project will have a **small adverse landscape impact** from this viewpoint.
Visual Impact Construction and Operation	The view from this location is experienced by some residents and visitors to the area. Residents with screened or unscreened views are sensitive receptors that have long viewing periods and therefore a higher sensitivity to the visual environment. The project will result in some changes to the visual outlook during both construction and operation. Visual impacts during construction include: ◗ Increased visible activity through machinery (particularly tall equipment); ◗ Breakwater construction and the increase in vessels at the entrance to the Ross River; and ◗ Additional lighting. Visual impacts during operation include:

	◗ Additional buildings in the landscape that provide a visual extension to the industrial nature of this view although the extent of visibility of the buildings is dependent on viewing location and the foreground buildings and structures; ◗ Reduction in the view of Cleveland Bay due to extension of the land area through reclamation and the buildings and other activities on the site; and ◗ Increased lighting. The change in view will be experienced by: ◗ The residents located at elevation with either partially screened or unscreened views will have views of completed buildings located and other structures located on the site. The views of reclamation and site will works will be limited due to level at which these works will be undertaken. ◗ Road users travelling in a southerly direction will have some views of both construction operations and completed site development. The extent of these views and the impact depend on location and extent of visual screening offered by building and vegetation. For this viewpoint is therefore assessed as having **low visual sensitivity.**
Significance of Visual Impact	**Not Significant**

Table 3-10 Viewpoint 3 – Townsville City Residential and Commercial West

Project Elements	**Construction** ◗ Breakwater and parts of the reclamation area; ◗ Site equipment, particularly elevated structures such as cranes; and ◗ Construction lighting. **Operation** ◗ Buildings and other structures on the site with the extent of the view of increasing with height of the building from which it is viewed; ◗ Vessels and elevated port related activities; and ◗ Operational lighting.
Landscape Impact Construction and Operation	The residences and commercial buildings in this location are elevated above the level of the site up to approximately 60m AHD providing views to the south-east from some of the properties. The distance from this viewpoint to the site is approximately 2 km, which places it in the middleground view. Between this viewpoint and the site there is both commercial and industrial development, incorporating both buildings and tanks, which are evident in the landscape from this location. Background views, including the distant landscape features are visible from this location and draw the visual interest away from the middleground. The landscape impact of the proposed construction and operation works will vary from site to site with this being largely dependant on the elevation, existing vegetation and vegetation which influence the current visual landscape.

	The proposed development will generally not be a prominent feature in the visual landscape, however the project will cause some change in the landscape character through: ◗ Introduction of an additional linear element into the landscape particularly when viewed in association with the existing port facility; ◗ Create a new constructed landscape feature in the breakwater. This element will be situated in a position where the background is largely natural adding to the landscape impact; ◗ Creation of additional features that will alter the appearance of the entrance to the Ross River. This will reduce the naturalness of the current landscape in this location and create an area having an engineered appearance; and ◗ Introduction of additional industrial elements into the landscape decreasing the degree of naturalness when viewing to the south-east from elevated positions in this viewpoint. It is assessed that the project will have a **moderate landscape impact** from this viewpoint.
Visual Impact Construction and Operation	The view from this location is experienced by some residents and visitors to the area, and workers in commercial buildings. Residents with screened or unscreened views are sensitive receptors that have long viewing periods and therefore a higher sensitivity to the visual environment. Activity focused workers will also have views over the site. The project will result in some changes to the visual outlook during both construction and operation. Visual impacts during construction include: ◗ Increased visible activity through machinery (particularly tall equipment) and site construction buildings; ◗ Breakwater construction and the increase in vessels at the entrance to the Ross River; and ◗ Additional lighting. Visual impacts during operation include: ◗ Additional buildings in the landscape that provide a visual extension to the industrial nature of this view; ◗ Reduction in the view of Cleveland Bay due to extension of the land area through reclamation and the buildings and other activities on the site; ◗ The buildings constructed on the site will be visible although the extent of visibility will depend on viewing height and the nature of the foreground structures. The buildings are unlikely to impact on the appearance of the mountains in the background view although it is expected that there will be increased focus on the middleground view with the increased development; and ◗ Increased lighting. The change in view will be experienced by: ◗ The residents located at elevation with either partially screened or unscreened views will have views of completed buildings located and other structures located on the site. The views of reclamation and site works will be limited due to the level at which these works will be undertaken; ◗ Activity focused workers in commercial buildings; and ◗ Road users travelling through the area will have some views of both

	construction operations and completed site development. The extent of these views depend on location and extent of visual screening offered by building and vegetation and are only experienced for very short duration due to the transient nature of the viewing opportunity. For this viewpoint is therefore assessed as having **medium visual sensitivity.**
Significance of Visual Impact	**Moderate Significance**

Table 3-11 Viewpoint 4 – Boundary Street, Archer Street and Benwell Road

Project Elements	**Construction** » Most of the construction operations. **Operation** » All buildings and other structures on the site; » Vessels and port related activities; and » Most outdoor industrial and storage related activities.
Visualisation	 Existing Ross River foreshore and Benwell Road  Visualisation of the site from near the intersection of Benwell Road – The land reclamation and buildings will be clearly visible from this

	location. There will also be loss of the existing vegetation adjacent to the water.
Landscape Impact Construction and Operation	During both construction and operation the project will have a permanent impact on the visual landscape from this viewpoint. This impact needs to be assessed in the context of the existing landscape of the viewpoint. The existing and approved industrial and port related development, which these roads are part of, is changing the nature of the landscape and visual environment. It is assessed that the project will have a **large adverse landscape impact** from this viewpoint.
Visual Impact Construction and Operation	The project will result in permanent changes to the visual outlook during both construction and operation. Visual impacts during construction include: ◗ Gradual loss of naturalness of the landscape in this area with the creation of the breakwater and associated dredging and reclamation activities; ◗ Construction lighting; and ◗ Increase in the activity occurring in this location with the operation of large machinery and the construction work site operations. Visual impacts during operation include: ◗ Introduction of new linear elements, in the reclamation area and the breakwater that provide a new edge to the Ross River and extend into the mangrove and inter-tidal area on the western side of the river; ◗ The construction of new buildings on the reclaimed site will permanently alter the outlook from this viewpoint and block some of the views that are currently available of the water and background mountains; ◗ Security and other operational lighting; and ◗ Creation of a new development edge to the city in this location. The landscape character visible from this view point will also be impacted on the proposed construction of the road and rail crossing of Ross Creek adjacent to the reclamation area. While the bridge is not part of this project, this new constructed feature of the visual landscape will visually be closely linked with the port development and will add to the perceived loss of naturalness of the landscape from this viewpoint. The bridge has been considered for the above visualisation to enable a full understanding of the cumulative impact of the works proposed to occur in this area. For this project this viewpoint is therefore assessed as having **medium visual sensitivity**.
Significance of Visual Impact	**High Significance**

Table 3-12 Viewpoint 5 – Ross River and Cleveland Bay

Project Elements	Construction ◗ All construction activities occurring seaward of the existing western

	foreshore of the Ross River; and ◗ Storage and land based construction related activities, in particular, activities that higher than the foreshore vegetation. Operation ◗ Breakwater; ◗ Dredging ; and ◗ Land reclamation area and industrial and port activities and buildings located on the site.
Visualisation	 Existing view of the site from Cleveland Bay.
	 Visualisation of the view of the site from Cleveland Bay – building bulk and scale is representative of that proposed for the site.
Landscape Impact Construction and Operation	During both construction and operation the project will have a permanent impact on the visual landscape from this viewpoint. This impact needs to be assessed in the context of the existing landscape of the viewpoint. The existing and approved industrial and port related development, which these roads are part of, is changing the nature of the landscape and visual environment. Castle Hill is a significant landscape feature from this viewpoint and will continue be the dominant visual element in the landscape. It is assessed that the project will have a **moderate adverse landscape impact** from this viewpoint.
Visual Impact Construction and Operation	The visual environment from this viewpoint will be impacted on both during construction and operation stages. The change in the view will be experienced by water based recreation users including people fishing and using recreational water craft and commercial water based users and will be a permanent visual change. The middleground views to Castle Hill will still be available, but the foreground view from water level will be modified with the introduction of the breakwater, the new landform and industrial and port related development. Views to the east and south will not be substantially different during construction or at the completion of the works when vessels are located outside the breakwater.

	As this project represents an extension of the existing port facility there are existing impacts on the visual amenity of this location due to land reclamation activities and the construction of industrial development. When viewed from water level there will be a visual intensification of these uses and an increase in the night lighting. The project will result in some changes to the visual outlook during both construction and operation. Visual impacts during construction include: ◗ Gradual loss of naturalness of the landscape in this area with the creation of the breakwater and associated dredging and reclamation activities; ◗ Construction lighting; and ◗ Increase in the activity occurring in this location with the operation of large machinery and the construction work site operations. Visual impacts during operation include: ◗ Introduction of new linear elements, in the reclamation area and the breakwater that provide a new edge to the Ross River and extend into the mangrove and inter-tidal area on the western side of the river; ◗ Security and other operational lighting; and ◗ Creation of a new development edge to the city in this location. The landscape character visible from this view point will also be impacted on the proposed construction of the road and rail crossing of Ross Creek adjacent to the reclamation area. While the bridge is not part of this project, this new constructed feature of the visual landscape will visually be closely linked with the port development and will add to the perceived loss of naturalness of the view from this location. The bridge has been considered for the above visualisation to enable a full understanding of the cumulative impact of the works proposed to occur in this area. For the project this viewpoint is therefore assessed as having **medium visual sensitivity**.
Significance of Visual Impact	**Moderate Significance**

3.3.3.5 Cumulative and residual impacts

Cumulative impacts

The project site is located within an area that has existing industrial development including both port and land based activities. While individual developments may have a minimal impact on the visual landscape the cumulative impact is a continuing industrialisation of the visual environment of this area. This is particularly the case with the land reclamation, which will create additional land beyond that currently available or which has been intended for industrial development.

In addition to the changes proposed as part of this development the visual landscape in the vicinity of the site will also be impacted on by the proposed construction of the road and rail crossing of Ross Creek. This new constructed feature of the visual landscape will visually be

closely linked with the port development and will add to the perceived loss of naturalness of this area.

While the ongoing industrial and port development diminishes the naturalness of the visual outlook in this sector of the visual landscape, this development also provides a unique landscape that combines the background of the mountains with the inter-tidal zone of Cleveland Bay and the Ross River.

Residual impacts – construction

It is not anticipated that there will be any residual landscape or visual impacts arising from the construction phase of the project.

Residual impacts – operation

Some impacts resulting from the project are unavoidable and cannot be mitigated for during operation. The project will alter the surrounding landscape and the visual experience of the visual receptors. However, these changes must be seen within the context of the existing local environment.

Foremost amongst residual visual impacts is the creation of a new land area within Ross River adding to the existing port facilities, and the creation of the breakwater facilities. In addition the construction of industrial and port related development will increase the extent of this type of use in the visual landscape. As industrial and port development is located immediately adjacent to the site it is not considered to be a new element in the visual outlook.

The change in view will be permanent form all viewpoints with increased prominence when viewed from viewpoints 1, 4 and 5 as these either provide extensive uninterrupted outlooks over the site, or are located within close proximity and therefore not visually or physically separated from the impacts.

Site wide, in terms of the assessment criteria this equates to a moderate adverse residual landscape impact, with medium visual sensitivity due to proximity of the receptors to the site. Therefore, the assessment of significance of residual impacts is considered to be of moderate significance.

3.3.4 Mitigation measures

The intent of this section of the VIA is to identify mitigation measures that will reduce and/or manage adverse visual impacts of construction and operation on landscape and visual amenity.

3.3.4.1 Construction phase

To achieve construction without causing undue visual disruption to existing receptors the following mitigation measures are recommended:

- Avoid loss or damage to landscape features. Where possible, protect trees prior to construction and/or trim vegetation to avoid total removal. This includes vegetation that makes a significant and positive contribution to landscape character and/or has significant value in terms of biodiversity;
- Temporary hoardings, barriers, traffic management and signage to be removed when no longer required;

- Materials and machinery to be stored tidily during the works;
- Lighting of work sites is restricted to approved working hours and those that are necessary for security (additional lighting impacts in relation to flora and fauna are addressed under Section 3.10);
- Roads providing access to the site and work areas to be maintained free of dust and mud as far as reasonably practicable, and dust management techniques to be used (additional air quality impacts are addressed under Section 0; and
- Use of appropriate soil erosion prevention techniques (addressed in additional detail under Sections 2.4 and 3.14.

3.3.4.2 Operation phase

Mitigation of landscape and visual impacts as a result of the project seeks to achieve a balance between the site design and use requirements and achieving an optimal visual outcome. The mitigation strategy for the project is to minimise the detrimental effects on the landscape and visual character. Operation phase mitigation measures are:

- Building and structure design should respond to the surrounding environment with consideration to viewpoints through consideration of:
  - Building form and style;
  - Finish, including use of less reflective materials, appropriate colours, textures, and roofing; and
  - Building bulk and location.
- Establishment of landscaping works as soon as possible after the completion of construction operations, or if appropriate, during the construction stage;
- Mitigation of pollution from lighting through:
  - Appropriate lighting design to ensure the site is not over-lit;
  - Use of specifically design lighting that minimises the spread of light and glare towards visual receptors (also refer Section 3.10 for discussion on lighting impacts to fauna);
  - Specify appropriate luminaries to reduce light spill, sky glow and glare;
  - Consider the potential for solar power for lighting in accordance with the Solar Cities program; and
- Sensitive placement and specification of lighting to minimise any potential increase in light pollution within the natural environment.

3.3.5 Summary

Landscape and visual impacts of the project both during construction and when the site is available for industrial and port related development are assessed as being of moderate adverse significance. Due to the nature of the project there will be a permanent impact on the visual landscape and amenity of the area, particularly when viewed from the identified view points.

The construction effects of the project on landscape and visual amenity will be moderate due to the nature of the proposed works, the proximity of the site to residential areas and Castle Hill,

which provides extensive views over this location. The assessment of a moderate impact on the landscape and visual amenity, and not higher, considers the natural of the surrounding industrial development in this location, the duration of viewing opportunities, and the nature of the proposed works.

The management of the construction process through the site EMP and the requirements of the environmental approval will help ensure that any adverse impacts resulting from the construction of the project on landscape and visual amenity are minimised or mitigated.

3.4 Transport and associated infrastructure

3.4.1 Overview

Given Lot 773 is currently an intertidal marine sand/mud flat there are no existing services and infrastructure in this area. Construction of the Precinct is expected to require supply of energy, water, sewerage, telecommunications and waste management and stormwater management infrastructure. These infrastructure needs are discussed under Section 2.6.

A Services Corridor exists between the Precinct boundary and Benwell Road. POTL will be undertaking reclamation of this area. There may be benefit in performing concurrent reclamation works to the development of the Precinct and this should be given consideration.

The developer will be required to provide all infrastructure services to site users within the Precinct from the boundary of the Precinct. POTL will provide services to the western boundary of the Precinct site, adjacent to the at-grade access road north of Archer Street (Figure 2-2). Services to be provided to the boundary of the Precinct by POTL and within the Precinct by the developer include:

- Underground electricity (developer to advise POTL of expected maximum power requirements over the life of the Precinct);
- Water;
- Sewerage; and
- Telecommunications (ducting only).

Further information regarding these required services is provided under Section 2.6.

A Traffic Impact Assessment (TIA), including infrastructure of relevance, was undertaken by GHD and is included as Appendix M. This assessment provides details of potential traffic and transport infrastructure impact and mitigation measures that may result from the development of the Precinct.

3.4.2 Description of environmental values

3.4.2.1 Existing and planned transport infrastructure

Operational completion of the first stage of the development will coincide with completion of the TPAR in December 2011. The relationship between location of the TPAR and the proposed development is shown in Figure 3-9.

It is expected that following completion of the TPAR construction traffic will be mobilised to the Precinct via the TPAR. This will facilitate completion of Stages 2 and 3 of the Precinct. Until that access is operational traffic routes through South Townsville have been considered.

The primary routes for haulage of construction materials and for operations until the TPAR is completed are highlighted in Figure 3-10.

The growth rate for roads within the vicinity of the port has been assumed at 7% p.a. Roads around the port relevant to the potential traffic related impacts of this development include:

- Benwell Road;
- Archer Street; and
- Eastern Access Road.

A summary of the existing traffic counts for the areas of relevance to the Precinct were sourced from the Department of Main Roads and have been used to assess how existing infrastructure is expected to perform during and post construction of the Precinct. Details of these traffic counts and background data are provided in Appendix M.

3.4.2.2 Proposed transport infrastructure development

The proposed development is an industrial reclaim consisting of approximately 18.8 hectares of trip generating land. The development will be constructed in three separate stages with the opening of the first stage to correspond to the completion of the Eastern Access Road scheduled for late 2011.

Analysis of transport infrastructure performance has been undertaken for the completion of all three stages with an anticipated opening year of all three stages by 2017 as well as the 10 year horizon analysis of 2027. Further analysis has been undertaken for 2011 to understand the impact construction traffic will have on intersections within Townsville prior to opening of the TPAR.

The site currently has frontage to Benwell Road. By late 2011, the site frontage will be primarily to the TPAR and interaction with Boundary Road. The Reference Design for the Precinct (and documents that support it) proposes access to the external road network via two new intersections to the site frontage located:

- A three-way intersection with Eastern Access Road to the north of Archer Street; and,
- A four way intersection with Boundary Street/Eastern Access Road.

LEGEND

- State Controlled Road
- Road
- Potential Temp. Hardstand Site
- Marine Precinct
- Stage 3
- Open Hardstand
- Breakwater
- Innerwall
- Industrial Shed

1:10,000 (at A4)

0 50 100 150 200 250

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Eastern Access Road Corridor

Job Number	42-15399
Revision	A
Date	01 July 2009

Figure 3-9

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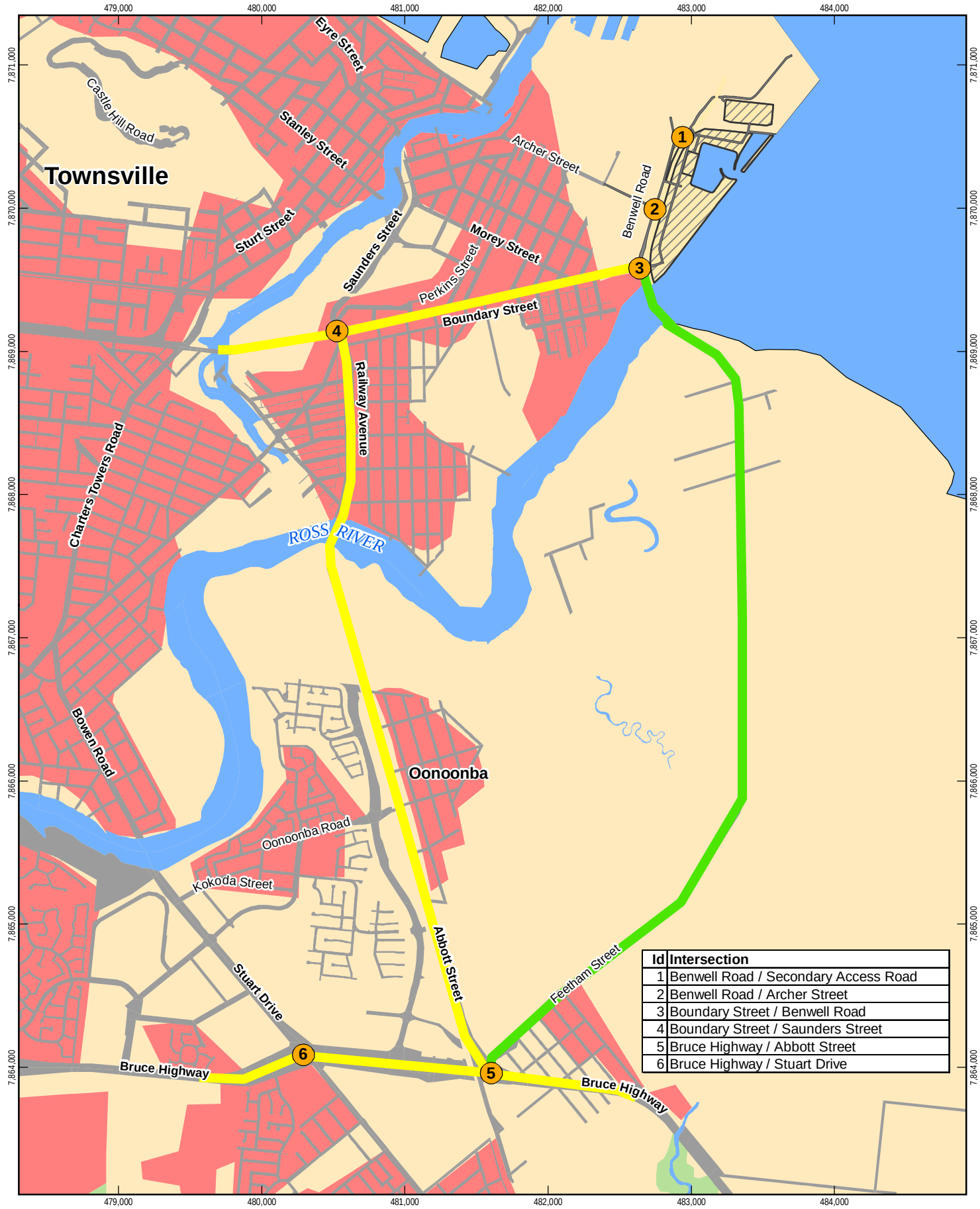
Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 4496 **F** +61 7 3316 333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

Data source: Marine Precinct, Aerial Imagery, Road Layout - ©The State of QLD (Port of Townsville LTD) 2009. Created by: TH



Id	Intersection
1	Benwell Road / Secondary Access Road
2	Benwell Road / Archer Street
3	Boundary Street / Benwell Road
4	Boundary Street / Saunders Street
5	Bruce Highway / Abbott Street
6	Bruce Highway / Stuart Drive

LEGEND

- Intersection
- **Primary Haulage Route**
  - Existing Transport Route
  - Proposed Eastern Access Road
- Proposed Marine Precinct
- Builtup Area

1:35,000 (at A4)

0 250 500 750 1,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Job Number	42-15399
Revision	A
Date	01 July 2009

Intersection Location and Indicative Road Network Assignment

Figure 3-10

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Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 4496 **F** +61 7 3316 333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

Data source: Haulage Route - GHD 2009; Marine Precinct - ©The State of QLD (Port of Townsville LTD) 2009; 250K Topo Data - ©Commonwealth of Australia (Geoscience Australia) 2007. Created by: TH

3.4.3 Potential impacts and mitigation measures

3.4.3.1 Construction traffic generation

Table 3-13 shows the additional traffic due to Precinct construction works expected on the external road network. It has been assumed that all construction workers will arrive in the adjacent road network corresponding AM peak and will depart in the PM peak whilst heavy vehicles from the quarry will operate at 8 vehicles per hour in both directions between 6:30am and 6:30pm. The daily peak in construction workforce during the entire period of construction is expected to be 100 workers on-site at any point in time.

Table 3-13 Additional traffic due to construction

Construction Workers	Vehicle Occupancy	Heavy Vehicles	Total Vehicles AM		Total Vehicles PM	
			In	Out	In	Out
100	1.5	8	75	8	8	75

3.4.3.2 Construction traffic splits and distribution

Analysis of expected traffic volumes during construction demonstrates the haulage route for construction traffic associated with Stage 1 is likely to impact the following intersections prior to the completion of the Eastern Access Road:

- Bruce Highway/Stuart Drive;
- Bruce Highway/Abbott Street; and
- Boundary Street/Saunders Street.

3.4.3.3 Operational traffic generation

Table 3-14 is a summary of the range of peak hour and daily trip generation rates for industrial land uses. The generation rates are sourced from the *Design for Subdivisional Streetworks by Queensland Streets*.

Table 3-14 Range of Trip Generation Rates for Industrial Land Uses

	Peak Rate (per $100m^2$)	Daily Rate (per $100m^2$)	Source
Factories	1.0	5	RTA
Large Factories	N/A	4-5	QT
Warehouses	0.5	4	RTA
Warehouses	1.1	N/A	BCC
Light Industry	0.9	9	QT

The Light Industry land use was the most appropriate land use type and has been used to estimate the number of trips generated by the site as shown in Table 3-15. The rates are based

on Gross Floor Area (GFA) and *Design for Subdivisional Streetworks* stipulates that for light industry, typically 45% of the site area is GFA.

Table 3-15 Light industrial trip generation rates

Area (GFA) m^2	Trip Generation Rate (per $100m^2$)		Trips Generated (Two-way)	
			Peak Hour	Daily
84,600	0.9 trips per peak	9 trips per day	762	7,620

3.4.3.4 Operational Traffic Splits and Distribution

The following directional splits, shown in Table 3-16, for the AM and PM peak hour periods for the development traffic have been adopted from the "*Institute of Transportation Engineers – Trip Generation 7th Edition*".

Table 3-16 Development traffic directional splits

Direction	OUT	IN
AM Peak Hour Light Industrial	17% (130 Trips)	83% (632 Trips)
PM Peak Hour Light Industrial	79% (602 Trips)	21% (160 Trips)

Note: Number of trips have been rounded up.

The assumed trip distributions as a percentage for the development and surrounding roads have been analysed in conjunction with expected development traffic movements, based on existing traffic patterns, to determine expected traffic volumes for 2017 and 2027 with and without development scenarios. Table 3-17 highlights the percentage contribution of construction and operational traffic on the existing road network based on traffic volumes.

Table 3-17 Contribution of Development Traffic to Intersections

Scenario			Bruce Hwy / Stuart Dr	Bruce Hwy / Abbott St	Boundary St / Saunders St	Boundary St / Benwell Rd	Benwell Rd / Archer St
2011 With Construction	AM	Background	4001	2292	3907	N/A	N/A
		Additional	50	56	143	N/A	N/A
		% Addition	1%	2%	4%	N/A	N/A
	PM	Background	3908	2387	3784	N/A	N/A
		Additional	50	56	143	N/A	N/A
		% Addition	1%	2%	4%	N/A	N/A
2017 With Development	AM	Background	N/A	N/A	5195	572	736
		Additional	N/A	N/A	143	742	121

Scenario			Bruce Hwy / Stuart Dr	Bruce Hwy / Abbott St	Boundary St / Saunders St	Boundary St / Benwell Rd	Benwell Rd / Archer St
		% Addition	N/A	N/A	3%	130%	16%
	PM	Background	N/A	N/A	5013	572	742
		Additional	N/A	N/A	143	742	121
		% Addition	N/A	N/A	3%	130%	16%
2027 With Development	AM	Background	N/A	N/A	8358	1125	1447
		Additional	N/A	N/A	143	742	136
		% Addition	N/A	N/A	2%	66%	9%
	PM	Background	N/A	N/A	8021	1125	1459
		Additional	N/A	N/A	143	742	136
		% Addition	N/A	N/A	2%	66%	9%

Table 3-17 highlights that the contribution of development traffic is less than 5% for the following intersections:

- Bruce Highway/Stuart Drive;
- Bruce Highway/Abbott Street; and,
- Boundary Street/Saunders Street.

Although under DMR's Guide for Assessment of Road Impacts of Development (GARID), the traffic generated by the development does not trigger the need for assessment of the impacts at these intersections. For the purpose of completeness in this assessment, these intersections have been assessed.

3.4.3.5 Northern Access Rail Crossing

The rail crossing on the northern access to the Precinct was analysed to determine likely queue lengths produced by vehicles accessing the site. Queue lengths are expected to be less than 40m (refer Appendix M) and, accordingly, provision for queuing of approximately 40m should be made on both approaches to the rail crossing so as to minimise the likelihood of queue spillback to adjacent roads. This will minimise any potential flow on impacts.

3.4.3.6 Intersection Analysis

The analysis of the intersections expected to be impacted directly by the construction and operational traffic has been undertaken using SIDRA Intersection 3.2 for existing traffic, construction traffic and future traffic with and without development conditions following the planning guidelines stipulated in Section 13.4.4 of the DMR *Road Planning and Design Manual*. 2011 is the anticipated year that construction traffic will have the greatest impact on the road network, which is prior to the completion of the TPAR. After 2011, construction traffic for Stages

2 and 3 is assumed to use the TPAR for trips to and from the Precinct and will have a lesser impact on the adjacent road network. 2017 is the anticipated year of opening and 2027 has been used to assess the 10-year traffic horizon.

The layouts used for this analysis and detailed findings from the analysis, including descriptions of the background traffic and performance of the intersections with Precinct traffic, are provided within Appendix M. Summarised findings for the operational performance of the intersections are provided here.

It should be noted that traffic generated by the development contributed less than 5% of the total intersection volumes for a number of these intersections, which, therefore, does not trigger the need for assessment. However, all relevant intersections have been considered for completeness.

Bruce Highway / Stuart Drive

The intersection is a four-leg signalised intersection with pedestrian crossings provided on all legs. Studies indicate that while the intersection is operating near capacity without construction traffic, the addition of construction traffic has a negligible impact on the intersection. Notably queue lengths are within acceptable limits and don't encroach on neighbouring intersections.

The impact of the development generated traffic is not considered to be significant on the intersection by DMR guidelines.

Bruce Highway / Abbott Street

The intersection is a three-leg priority controlled junction with approaches from the East and West having priority. Studies indicate that the existing intersection layout and control will continue to operate satisfactorily in 2011 with the addition of construction related traffic. Queue lengths are within acceptable limits and do not encroach on neighbouring intersections; and the impact of the development generated traffic is not considered to be significant on the intersection by DMR guidelines.

Boundary Street / Saunders Street

The intersection is a four-leg signalised intersection with the major traffic movement being north-south. Studies indicate that the intersection isn't operating satisfactorily currently. However, when compared to the analysis without construction traffic it is suggested that the additional traffic doesn't significantly increase the adverse effects.

The results of the 2011 with construction traffic scenario indicate that queue lengths are within acceptable limits and don't encroach on neighbouring intersections. Consideration will need to be given to upgrading the intersection to continue to achieve acceptable traffic flow under the 2017 with development traffic scenario. However, this is not a Precinct specific result but related to growth in background traffic volumes. The additional traffic due to the development does not have a significant impact on the intersections performance.

Without upgrade the intersection will continue to operate sub-optimally towards 2027 with development traffic loads. Considerable delays for approaches are expected to be realised. However, this also relates to increased background traffic volumes and is not a Precinct specific result. The impact of the development generated traffic is not considered to be significant on the intersection by DMR guidelines.

Boundary Street / Benwell Road

The layout used for the analysis of the new intersection between Boundary Street / Benwell Road for the with development traffic scenario is based on the proposed intersection layout as shown in the Conceptual Design Report produced by Maunsell for the Port of Townsville.

The layout for the without development scenario is based on the Eastern Access Road as a two lane two direction road. Turning lane lengths are as required by the 2027 analysis.

Results for both the 2017 and 2027 analysis of scenarios with development traffic indicate that the intersection will continue to perform within expected parameters and queue lengths will be within acceptable limits. Traffic movements of relevance to the Precinct are not predicted to encroach on neighbouring intersections.

Benwell Road / Archer Street

The capacity of this intersection has been assessed as both a priority and signal controlled intersection and as a roundabout to consider flexible options and performance of traffic infrastructure.

As a Priority intersection this intersection is expected to perform with development traffic up until 2017, but will require upgrade to continue to perform out to 2027. Without upgrade from a Priority intersection queue lengths on the western approach are expected to interfere with accesses on Archer Street.

If Signalised this intersection is predicted to perform satisfactorily under both the 2017 and 2027 developed traffic volume scenarios. If Signalised queue lengths are not expected to encroach on neighbouring intersections and average delays will be within acceptable limits

Similarly, as a Roundabout this intersection is predicted to perform adequately under both the 2017 and 2027 development scenario traffic volumes.

The results of the options testing for upgrade of this intersection beyond 2017 shows that a Roundabout or Signalised intersection will provide adequate capacity to accommodate forecast traffic volumes at this location but that a Priority intersection will not.

Benwell Road / Secondary Access (Proposed Access)

This intersection will be a new intersection that will provide a secondary access location to the development. This intersection will cross rail and road associated with the TPAR and has been assessed as a Signalised intersection, a Priority access and a Roundabout. All scenarios demonstrate acceptable operational limits for the intersection with queue lengths that do not encroach on neighbouring intersections at both the 2017 and 2027 development horizons.

3.4.4 Summary

This section has investigated the potential construction and operational traffic related impacts of the proposed development by conducting intersection analyses at the following locations:

- Bruce Highway / Stuart Drive (Existing);
- Bruce Highway / Abbott Street (Existing);
- Boundary Street / Saunders Street (Existing);

- Boundary Street / Benwell Road (Proposed);
- Benwell Road / Archer Street (Existing); and
- Benwell Road / Secondary Access (Proposed).

The analysis has shown that the Boundary Street / Saunders Street intersection is expected to perform sub-optimally by 2011 due to continued growth in background traffic in the area. As a result of the significant growth in traffic realised to 2027, a feasible upgrade alternative was unable to be achieved and so further investigation is recommended on the capacity of the future road network.

An enhanced at-grade Boundary Street / Saunders Street intersection to accommodate the forecast traffic volumes is unlikely to be achieved without major rail relocations on the western side and property acquisitions on the eastern side.

From the traffic impact study, the following conclusions are made:

- The impact of the traffic generated by the development is not considered by DMR guidelines to be significant at the following existing intersections because the development traffic contributes less than 5% of the background traffic:
  - Bruce Highway / Stuart Drive (Existing);
  - Bruce Highway / Abbott Street (Existing);
  - Boundary Street / Saunders Street (Existing);
- Construction related traffic generated by the site will have a negligible impact on the adjacent road network at the 2011 horizon;
- An upgrade of the Benwell Road / Archer Street intersection is required some time between 2017 and 2027 as a result primarily of increased background traffic (right turn from Archer Street to Benwell Road). A signalised and roundabout control have been tested and both show that they can accommodate the forecast traffic volumes to 2027 in their simplest form;
- The analysis of the Benwell Road / Secondary Access intersection shows that the intersection will provide satisfactory operating conditions for all approaches with either a priority control, a roundabout or signals;
- An upgrade of the Benwell Road / Boundary Street intersection will be required with the addition of a fourth leg which will be the primary access to the site. An enhanced signalised intersection form will be required at this location; and
- Based on a 90/10 split between the two access locations, an average 37.2 metre queue is expected for traffic entering the site and an average 35.4 metre queue is expected for vehicles exiting resulting from the closure of the proposed level crossing on the northern (secondary) access to the site.

The assessment has demonstrated that there are no foreseeable traffic related impacts that are related directly to the Precinct and, hence, no impacts that should prohibit the proposed development from proceeding.

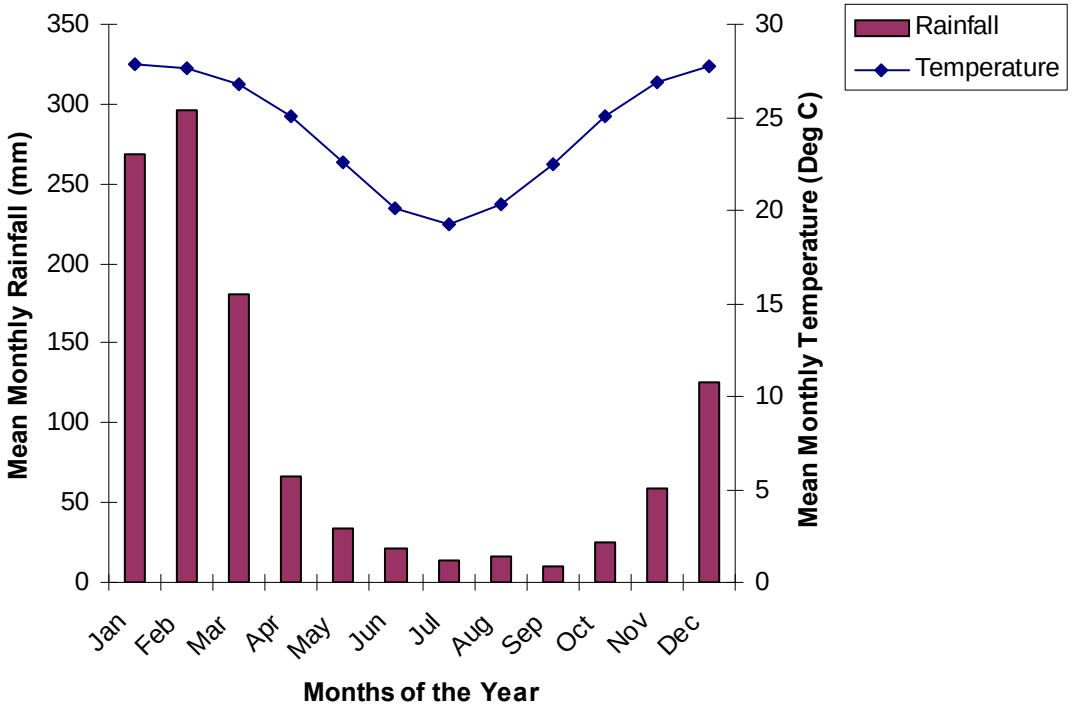
3.5 Climate and climate change

3.5.1 Rainfall and temperature

Average annual rain at Townsville is over 1m; with a recorded mean of 1115.3 mm for the past 68 years at the Townsville Airport BoM AWS. As indicated in Figure 3-11, April through to November is noticeably drier than other times of the year. On average, close to 66 days per year have recorded more than 1 mm of rain. This averages one in 5.5 days, although the 'dry season' months have fewer days with about three per month compared with 10 to 11 days per month for other months. This has implications for dust management, addressed in Section 0 as rainfall suppresses dust generation.

Temperature follows a tropical climatic pattern with summer months experiencing average temperatures approaching 30°C and winter months experiencing average temperatures around 20°C. Exceedances of average temperatures do occur during summer periods with maximum temperatures during daytime occasionally reaching 35°C.

Figure 3-11 Mean Monthly Rainfall and Temperature for Townsville (BoM 2009)



3.5.2 Wind

The Townsville Port meteorological monitoring station records indicate the wind speed classes for the Townsville Port shown in Figure 3-12, the most common occurrences fall between 1.5 and 3.0 m/s. The highest observed hourly-averaged wind speed was 6.7m/s and an overall average wind speed of 2.6m/s. This is lower than would normally be expected on a coast

exposed to the south-east trade winds (albeit with Cape Cleveland in that direction) but may be influenced by the surrounding port infrastructure to the east and south, and the Jupiters Townsville Hotel and Casino to the west of the weather station.

The wind rose plot for the meteorological data (Figure 3-13) shows the predominant wind directions being from the NE, E, SE, and S. The stronger winds (>3m/s) are from the NE, E and SE directions, with most light winds (<3.0m/s) with a southerly component.

Figure 3-12 Wind speed frequencies at Townsville Port TEOM Weather Station

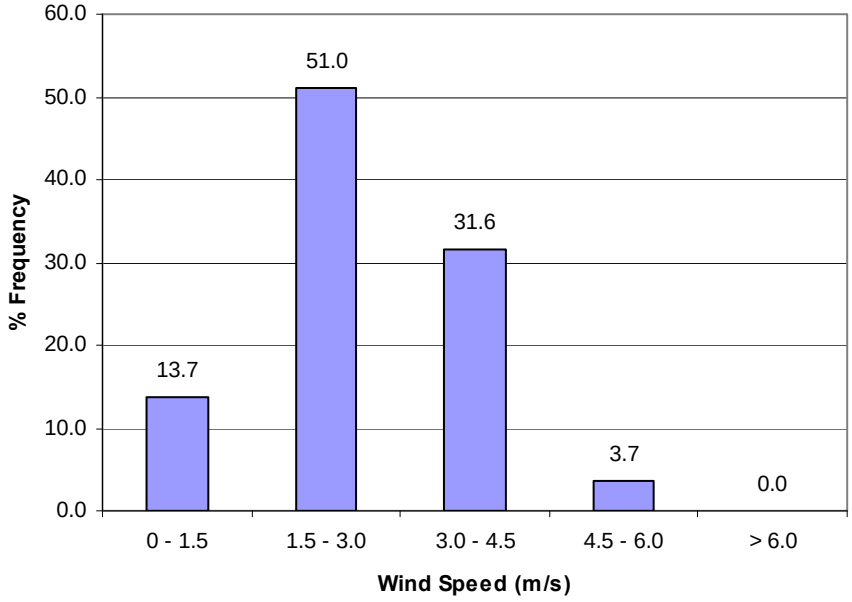
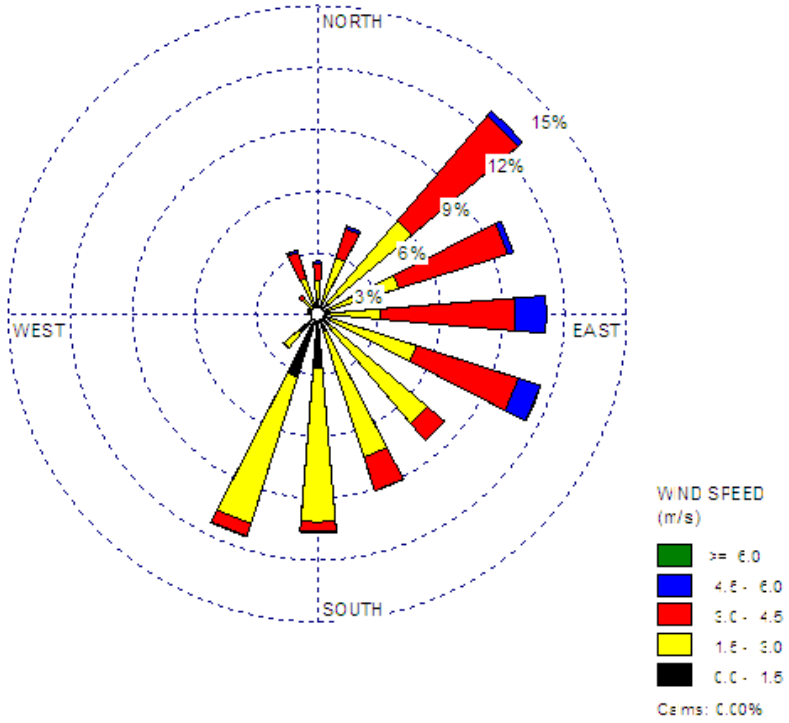


Figure 3-13 Speed and direction wind rose for Townsville Port TEOM Weather Station



3.5.3 Climate Change Projections – Temperature

Average annual temperatures for the Townsville region are expected to increase, with warming being greatest in the autumn and summer. The number of hot days is extremely likely to increase with major increases in the number of days over 30°C, and with increases of up to 24% more days over 35°C by 2070 under a high emission scenario.

Table 3-18 Projected Changes in Average Annual Temperature (relative to 1980-1999) for the Townsville Region

Projections (°C)	Current	2070 (High emission scenario)
CSIRO 2008	21 - 24	+2.7 (-0.9 to +1.1)

(Figures in brackets respond to the °C of uncertainty from the average annual temperature projected).

Table 3-19 Projected changes in annual average numbers of hot days for the townsville region (CSIRO 2008)

Annual average number of days over:	1971-2000 Baseline	2070 (High emission scenario)
30°C	43%	63 - 83%
35°C	1%	5 - 24%
40°C.	0	0.3 - 0.6%

3.5.4 Climate change projections – rainfall (intensity, timing and distribution)

Projections for rainfall (Table 3-20) are more uncertain then the projections for temperature changes. Changes in annual average rainfall are likely to decrease in the Townsville region by 2030 and 2070, although the ranges of uncertainty for all projections include decreases and increases in annual averages. Slightly fewer rain days are likely, but again the range of uncertainty includes increases in rain days. The intensity of heavy daily rainfall is also likely to decrease slightly, although projections are highly uncertain. OzClim, the CSIRO's online climate change scenario generator, projects the greatest decrease in seasonal rainfall in the winter months (Table 3-21).

Table 3-20 Projected changes in rainfall statistics for the Townsville Region (CSIRO 2008)

Change in:	Current	2070 (High emission scenario)
Average Annual Rainfall %	1117mm	-8% (-32 to +18%)
Number of Rain Days	73	-3 (-17 to +7)
Rainfall Intensity		+1% (-30 to +20%)

Table 3-21 OzClim projections for seasonal change in rainfall (%) from baseline 1990 for the Townsville Region

Rainfall	2070 (%) (High emission scenario)
Summer	-5 to 0
Autumn	-20 to -10
Winter	-30 to -20
Spring	-20 to -10

3.5.5 Climate change projections – sea level rise

Some planning and policy documents are now recommending 0.8m as the sea level rise to be planned for projects that are expected to have a lifespan beyond 2070. This level is a combination of the upper estimate of the high emissions scenario from the IPCC Fourth Assessment Report (2007) of 0.59m, combined with the suggested additional 0.2m to take into account potential accelerations in ice flow from glaciers.

Current examples where these recommendations have been implemented are:

- The DERM Guidelines for Preparing a Climate Change Impact Statement (CCIS) which recommends assessing potential impacts and adapting for the effects of a 0.79m rise in sea level for projects expected to exist beyond 2070 that require a cabinet submission; and
- The Victorian Coastal Strategy 2008 which recommends policy to plan for sea level rise of not less than 0.8m by 2100, and to allow for the combined effects of tides, storm surges, coastal processes and local conditions, such as topography and geology when assessing risks and impacts associated with climate change.

For the purposes of this EIS a potential rise of 0.8m above existing sea levels for the Townsville region has been considered, as a conservative estimate, in the climate impact assessment. Design considerations for the Precinct post this assessment have adopted an appropriate Reference Level for the Precinct to ameliorate anticipated impacts (refer Section 2).

3.5.6 Climate change projections – extreme events

3.5.6.1 Storm surge

It is very likely that Townsville will experience increases in storm tide height due to mean sea level rise and increases in tropical cyclone intensity. Higher mean sea levels (Table 3-22) will enable inundation and waves resulting from storm surges to penetrate further inland, increasing flooding, erosion and damage to infrastructure.

Table 3-22 Semidiurnal tidal planes for the Port of Townsville

Tidal Plane	Abbreviation	m AHD	Projected 2100 m AHD (+0.79m)
Highest Astronomical Tide	HAT	+2.15	+2.94
Mean High Water Springs	MHWS	+1.21	+2.00
Mean High Water Neap	MHWN	+0.36	+1.15
Mean Sea Level	MSL	+0.10	+0.89
Mean Low Water Neap	MLWN	-0.27	+0.52
Mean Low Water Springs	MLWS	-1.13	-0.34
Lowest Astronomical Tide	LAT	-1.86	-1.07

The *Townsville-Thuringowa Storm Tide Study* report, produced for the Townsville and Thuringowa City Councils (2007), estimated the increase in total storm tide levels (storm surge plus tide including wave set-up) for selected return periods under an enhanced greenhouse scenario for the years 2050 and 2100. These estimates are summarised in Table 3-23 for the Ross River.

Table 3-23 Estimated Increase in Total Storm Tide Level (m AHD) under Enhanced Greenhouse Scenarios (Townsville/Thuringowa City Council 2007)

Location – Ross River	50y	100y	500y	1000y
Current	2.9	3.0	3.2	3.7
2050	+0.1	+0.1	+0.6	+0.8
2100	+0.4	+0.5	+1.4	+1.7

3.5.6.2 Tropical cyclones

For the Townsville region the CSIRO (2008) projects that little change is likely in the annual average number of cyclone days, although severe cyclones may occur more often.

3.5.6.3 Fire

For eastern Australia, increases in fire risk are likely, along with an increase in the number of extreme high fire days and the fire season is likely to become longer, starting earlier then at present.

3.5.7 Summary of projected climate changes for the Townsville Region

A summary of projected climate changes for the Townsville region is provided in Table 3-24. Adaptation measures are discussed in the following section.

Table 3-24 Overview of projected climate changes for the Townsville Region

Climate Variable	Current Average	Source	Climate Change Projection	Scenario / Info	Source
Sea Level	HAT: +2.15 m, relative to AHD	Hardy *et al.* 2004, p.20	Sea Level: +0.59 (+0.2) Total +0.79	2090 - 2099 relative to 1980 - 1999 High emissions (A1FI) emissions scenario High range model result (plus 0.2m to account for additional contribution from ice sheets)	IPCC 2007
Wind and	100 year	Townsville	100 year	Climate change	Townsville

Wave Climate	return period for storm surge plus tide: +3.00 m, relative to AHD	and Thuringowa City Councils 2007, p.63	return period for storm surge plus tide: +0.5 m (+3.5 m relative to AHD)	scenarios include: Increase in cyclone MPI of 20%, Increase in frequency of tropical cyclones of 10% Mean Sea Level rise of 0.9m (based on the upper level IPCC (2001) prediction of MSL rise for 2100)	and Thuringowa City Councils 2007, p.96
Rainfall/Runoff (Highest Daily Rainfall 548.8 mm 11 Jan 98)	Annual average rainfall: 1117 mm	BoM	-8%	2070 A1FI emission scenario with high climate sensitivity (IPCC 2001 global warming values)	CSIRO 2008
	Average summer monthly rainfall 230.3 mm		-5%		
	Average winter monthly rainfall 17.0 mm		-4%		
Air Temp	Annual mean max temp: 28.9°C	BoM	Average temp increase: +2.7°C	2070 A1FI emission scenario with high climate sensitivity (IPCC 2001 global warming values)	CSIRO 2008
	Annual mean min temp: 19.8°C				
	Highest temp recorded: 44.3°C				
	Lowest temp recorded: 1.1°C				
	Annual average number of hot days (over 35°C): 3.5	BoM	Increase in number of days over 35°C : +38 days (+18 to +86)		

3.5.8 Climate change adaptation

3.5.8.1 Background

In 2007 the Intergovernmental Panel on Climate Change (IPCC) released its fourth assessment report on climate change, which stated that warming of the climate system is now unequivocal. Changes in the global climate system, as a result of this warming, are likely to result in:

- Fewer cold days and nights and an increased frequency of heat waves over most land areas;
- An increase in the proportion of total rainfall from heavy falls;
- An increase in area effected by drought; and
- Increased intensity of tropical cyclones and incidences of extreme high sea level.

Increases in global average air and ocean temperatures and rising global average sea level are already evident from observations during the late twentieth century. For example, over the period from 1961 to 2003, global average sea level rose at a rate of 1.8 (1.3 to 2.3) mm per year and during the period from 1993 to 2003, the rate was faster at approximately 3.1 (2.3 to 3.8) mm per year (IPCC 2007).

The QLD Government developed a methodology for *Climate Change Impact Statements* (CCIS) in July 2008 to consider climate change in decision making and to provide an assessment of the climate change impacts associated with projects. The guideline for a CCIS outlines a qualitative methodology for undertaking:

- A greenhouse gas (GHG) emissions assessment which measures the potential contribution of the project to the State's emissions profile; and
- A climate change adaptation assessment, which analyses the physical risks to the project from climate change and identifies measures to reduce these risks.

The impacts of climate change are likely to affect many infrastructure projects with a projected lifespan greater than 30 years. Therefore an assessment of this project's vulnerabilities to climate change was undertaken. This report encompasses a *Climate Change Adaptation Assessment* (CCAA), which includes an analysis of the risks to the proposal from climate change impacts and a description of adaptation measures to minimise these risks.

The main potential impacts identified and where sufficient information was available the consequence, likelihood and risk level of each impact was evaluated. The assessment and findings are described in detail in Appendix O) and summarised following. These findings have, since completion, been used to support design studies and construction assessments described in Section 2 of this report. Accordingly, the identified impacts are ameliorated.

This risk assessment has assessed the impacts of climate change on this project over a 100 year timeframe. This timeframe was chosen as it represents the projected design life of the project. The following risk evaluation framework (Table 3-25) was used to assign risk levels to identified impacts. These have been sourced from Port of Townsville risk assessment framework, with the addition of likelihood ratings adapted to a time scale for a design life of 100 years.

Table 3-25 Likelihood Ratings for CCAA (adapted Port of Townsville)

Rating	*Port of Townsville*
Almost Certain	*Expected to occur in most circumstances (more than once a year)*
Likely	*Will probably occur in most circumstances (once in 1-10 years)*
Possible	*Might occur at some time (once in 10-50 years)*
Unlikely	*Could occur at some time (once in 50-100 years)*
Rare	*May only occur in exceptional circumstances (less than once in 100 years)*

Overall, 11 main potential impacts to the TMPP as a result of projected changes in climate were identified. These are listed in Table 3-26.

Table 3-26 Potential Project Impacts from Climate Change Identified

ID	Project Impact
MSL1	Ground water rise impacts on foundations and services leading to asset deterioration
W1	Wind impacts on buildings and structures - potential operational restrictions on lifting operations (Not applicable to project as the design and construction of structures is not included within the project scope – therefore risk level not assessed)
ST1	Increased ship queuing due to interruptions of on-shore services eg. ship lift/rack & stack
ST2	Restrictions on accessing the harbour facilities (no impact considered likely once inside the breakwater, therefore no risk level assessed)
ST3	Breakwaters - overtopping Potential degradation of breakwater structure
ST4	Breakwaters - Reduced harbour tranquillity leading to interruption to service and potential injuries to people and property moored at breakwater
ST5	Reclamation and pavement areas- Potential degradation of assets installed in reclaimed areas
ST6	Reclamation and pavement areas- Environment Overtopping and run-off - water quality impacts
ST7	Reclamation and pavement areas- Safety Potential for health issues associated with inundation of reclamation and pavement area
RR1	Environmental impact due to water pollutant loadings in stormwater

ID	Project	Impact
T1		Increases in ambient temperatures will result in greater thermal movement of concrete pavements, increasing the risk of cracking and subsequent degradation. Bitumen binder in pavements will be more at risk of soften at higher temperatures leading to excessive deformation and rutting of the road surfaces

3.5.8.2 CCA Risks Analysed

Of the impacts identified, two (W1 and ST2) were noted as key considerations, but, as noted in Table 3-26 the level of risk was not assessed due to the conclusion that the impact was outside the scope of this study. Of the remaining nine impacts identified, two were assessed as having a 'low' risk level, two as having a 'medium' risk level, four as having a 'substantial' risk level and one as having a 'high' risk level. Risk rankings are summarised in Table 3-27.

Table 3-27 Summary of CCAA Risk Ratings

		Consequence				
		Insignificant	Minor	Serious	Disastrous	Catastrophic
Likelihood	Almost Certain					
	Likely			**T1**	**ST6**	
	Possible	**ST1**		**MSL1**	**ST3, ST4, ST5**	
	Unlikely		**RR1**		**ST7**	
	Rare					

Based on the risk level treatments identified in Port of Townsville's risk framework, potential impacts that are assigned a risk level of substantial, high or extreme are required to document action plans to reduce the risk level. Potential impacts that are identified as low or medium levels of risk are considered acceptable without review and with review respectively.

3.5.8.3 Risks Evaluated and Reviewed

For impacts that were assigned a risk level of 'high' or 'substantial', current and potential controls and adaptation measures that could reduce the potential risk level over the life of the project were identified. All of the impacts assigned these higher levels of risk were related to the effect of increased sea level on the height and recurrence interval of storm tide events in the project area. The main areas for potential impacts from this variable will be the breakwater structures and the reclamation and pavement areas.

Breakwater

Impacts ST3 and ST4 were both related to the event of a high storm tide leading to overtopping of the breakwater structure. The risk of this event was assessed, taking into account the projected increase in sea level due to climate change (refer Appendix O). Specific impacts including degradation of the structure, reduced harbour tranquillity, disruption of services and

potential injuries to people and property moored at the breakwater were assessed as having a 'substantial' level of risk.

Current Controls in Place

At the time of the workshop, it was understood that the breakwater structure was being designed for a current day 1 in 100 year event. The Queensland Coastal Plan consisting of the new State Planning Policy for Coastal Protection and the new Coastal Management Policy is currently being drafted but is yet to be finalised and, according to release timing, details contained within that policy may need to be taken into consideration for the design of this project. To adopt a conservative approach for the project for assessment purposes a potential sea level rise of 0.8m for a design life of 100 years was adopted for this project and it is expected this will be accordance with any new policies which are yet to be finalised.

Information from this component of the EIS has supported construction studies for the breakwater and, accordingly, the Reference Design has adopted conservative estimates to account for potential climatic impacts (refer Section 2). The approach of conducting the study and identifying potential impacts under current scenarios provided opportunity to identify areas to which additional consideration needed to be given. These areas, and the suggested approaches for addressing, are documented following and have informed the construction approach for the EIS to ameliorate expected impacts.

Potential Control Actions

Implementation of the new coastal management policy.

Reclamation and Pavement Areas

Impacts ST5, ST6 and T1 were related to the reclamation and pavement areas.

Impact ST5 related to the potential for more frequent inundation of the reclamation area during storm tide events leading to degradation of assets stored in these areas. This impact was assessed as having a 'substantial' risk for asset loss.

Impact ST6 was related to the potential for inundation of the reclamation and pavement areas during storm tide events leading to spills from dangerous chemicals stored in facilities within the reclamation area, which would then impact on water quality. The risk of this impact was assessed as being 'high'.

Impact T1 regarded the impacts of increases in ambient temperatures on the concrete and bitumen used for the pavement area and roads. Greater thermal movement of concrete pavements will increase the risk of cracking and subsequent degradation of the concrete. Bitumen binder in pavements will also be more at risk to soften at higher temperatures leading to excessive deformation and rutting of the road surfaces.

Current controls

At the time of the workshop a design height of 5m LAT for the height of the reclamation and pavement areas was considered for this impact assessment. Recognising that, based on this assessment, this level is likely to be insufficient construction and design considerations for the Precinct have adopted a design level of 5.5m LAT. The new Reference Level is considered adequate to ameliorate the risks noted.

Australian Standards for material specifications do not currently take potential changes in temperature over the design life of the project into account

Potential control actions:

ST5 and ST6: The Climate studies indicated that the 5m design height for the reclamation and pavement areas should be reviewed to reduce the risk associated with storm tide events inundating these areas. This has been achieved, as noted in Section 2, with a revised Reference Level of 5.5m LAT carried through the EIS. This new level is considered appropriate for amelioration of potential impacts.

T1. Concrete: Adequate allowance for predicted thermal movements during the design stage. This could be the inclusion of more joints in the pavement to relieve stresses and reduce the risk of damage. Detailed design of the Precinct will be required to consider this.

T1. Bitumen: Evaluate different bitumen formulation to suit projected climate conditions. This may include higher penetration grade bitumen, alternate mix designs or the use of polymer modified bitumen. Detailed design of the Precinct will be required to consider this.

3.5.8.4 Climate change adaptation assessment

Table 3-28 provides a summary if the climate adaptation measures recommended to mitigate risks identified in Section 3.5.8.3.

Table 3-28 Summary of adaptation assessment against 5m LAT Reference Level

Risk Level	Risk	Adaptation Option	Management
High	ST6 - Reclamation and pavement areas- Environment Overtopping and run-off - water quality impacts	Consideration for design of 0.8m SLR as a conservative height to account for potential sea level change, Consideration for the projected increase in total storm surge and tide figures for the 100 year return period of 0.5m.	Reference Design Level of Precinct adopted to be 5.5m LAT to achieve amelioration of potential impacts
Substantial	ST5 - Reclamation and pavement areas- Potential degradation of assets installed in reclaimed areas		Reference Design Level of Precinct adopted to be 5.5m LAT to achieve amelioration of potential impacts.
Substantial	ST3 - Breakwaters - overtopping Potential degradation of breakwater structure	Current design standard to be revised to the 1 in 100 year event for the year 2100, rather than to current conditions.	Reference Design Level of Precinct adopted to be 5.5m LAT to achieve amelioration of potential impacts.

Risk Level	Risk	Adaptation Option	Management
Substantial	ST4 - Breakwaters - Reduced harbour tranquillity leading to interruption to service and potential injuries to people and property moored at breakwater		Hazard and Risk assessment addressed potential impacts and provided mitigation strategies to address.

The risk level of impact ST6 was re-assessed during a workshop taking into account the identified adaptation options. The revised risk level was assessed as medium as the likelihood rank decreased to unlikely.

This risk assessment highlighted that some existing standards need to be updated to reflect projected climate changes. The design for the Precinct and the construction studies for this EIS have, accordingly, adopted a Reference Level of 5.5m LAT to accommodate potential climatic impacts.

This assessment has been used to inform relevant areas of this study. Construction levels, as detailed under Section 2.4, have used this information as appropriate in consideration of design levels against 100 year climate change scenarios. Hazard and risk assessments and the Environmental Management Plan for the TMPP have also incorporated this information when undertaking assessment of potential impacts like inundation of pavement areas and mitigation measures against these impacts are identified in Sections 6 and 8 of this document. Under the adopted mitigation strategies it is not anticipated that climatic impacts will negatively effect the TMPP.

3.6 Surface waterways

A description of the existing environment for surface waterways that may be effected by the Precinct, including Ross River, is provided under Section 3.8 – Coastal Environment and Section 3.9 – Water and Sediment Quality. These two sections address in detail the existing environment for surface waterways, which may be affected by the Precinct in the context of environmental values as defined by the EP Act and environmental protection policies.

A description is given in Section 3.8 and Section 3.9 of the waterways associated with the Precinct, their quality and quantity in the area affected by the project and an outline of the significance of these waters to the river catchments system in which they occur. This includes a characterisation of the water quality of the area from a baseline monitoring program.

The Queensland Water Quality Guidelines (2006, QWQG), the Australian and New Zealand Environment and Conservation Council (ANZECC) National Water Quality Management Strategy, the Australian Water Quality Guidelines for Fresh and Marine Waters (November 1992) and the Environmental Protection (Water) Policy 1997 are used as a reference for evaluating the effects of various levels of contamination.

Options for mitigation and the effectiveness of mitigation measures are discussed with particular reference to sediment, acidity, salinity and other emissions of a hazardous or toxic nature to human health, flora or fauna.