ENVIRONMENTAL VALUES AND MANAGEMENT OF IMPACTS - PART 2

TABLE OF CONTENTS

This page to be left intentionally blank

4.8 Air

An air quality assessment was undertaken by Air Noise Environment Pty Ltd (ANE) including a review of available data on air quality in Townsville, monitoring of ambient air quality and dispersion modelling of potential air quality impacts arising from the project and from relevant emission sources.

4.8.1 Description of Environmental Values

Existing and Future Sensitive Receptors

At present the nearest receptors with a potential sensitivity to air quality impacts are located at the Casino Peninsula and Mariners Drive Peninsula. Residential and commercial activities at these locations could be affected by construction and/or operational emissions from the TOT project.

The TOT project will also introduce residential and commercial receptors with a potential to be affected by air quality emissions at the project site. These receptors will be in closer proximity to the existing Port of Townsville than existing commercial and residential developments in the area. The receptors at the TOT project will also be in close proximity to the proposed cruise ship terminal and will therefore have potential to be affected by these operations.

Potential Amenity Impacts

Criteria air pollutants' is a term used internationally to describe air pollutants that have been regulated and are used as indicators of air quality. The regulations or standards are based on criteria that relate to health and/or environmental effects. One key feature of criteria air pollutants is that they are generally widely distributed across the country.

The following criteria pollutants have been identified as key indicators of air quality in urban environments:

- Fine particulate matter (PM_{10});
- Photochemical oxidants (particularly ozone, O_3);
- Oxides of nitrogen (NO_x);
- Carbon monoxide (CO);
- Lead (Pb); and
- Sulphur dioxide (SO_2).

The potential impacts of existing Port operations on the project site have been assessed through a comprehensive air quality monitoring program. Monitoring of particulates, oxides of nitrogen, sulphur dioxide and hydrocarbons has been undertaken at positions representative of the project site.

The Queensland Environmental Protection Agency has also undertaken extensive monitoring of the so-called ‘black dust’ identified by some in the community as resulting from emissions from the Port.

Of these pollutants, those most likely to be emitted in measurable quantities from activities at the Townsville Port include fine particulate matter (from combustion processes and loss of material during loading operations) and gaseous pollutants including nitrogen dioxide and sulphur dioxide (primarily from the combustion of fossil fuels). The following sections provide an overview of each of these criteria pollutants including potential impacts and major sources.

ANE's analysis of the impacts of Port activities on air quality is discussed in Section 2.2 of this EIS.

Nitrogen Dioxide

The major source of nitrogen dioxide in Australia is the burning of fossil fuels: coal, oil and gas. Most of the nitrogen dioxide in cities comes from motor vehicle exhaust (about 80% v/v). Other sources of nitrogen dioxide are petrol and metal refining, electricity generation from power stations, other manufacturing industries and food processing. For the purposes of the assessment primary sources of nitrogen dioxide include:

- Motor vehicle traffic in the Townsville area;
- Marine craft using the Townsville Port area; and
- Railway locomotives transporting materials to and from the Townsville Port site.

Sulphur Dioxide

Sulphur dioxide is present in emissions from transportation sources, as the result of fuel combustion. The concentration of sulphur oxides (including sulphur dioxide) in vehicle exhausts is related to the concentration of sulphur present in the fuel. Industrial emissions of sulphur dioxide as a result of coal burning were, historically, the most significant source of emissions. Presently, transport sources are estimated to contribute less than 5 % of total emissions of sulphur oxides. With recent changes to national legislation to reduce the sulphur content in fuel, future emissions are expected to reduce further in coming years.

For the purposes of the assessment, primary sources of sulphur dioxide include:

- Motor vehicle traffic in the Townsville area;
- Marine craft using the Townsville Port area; and
- Railway locomotives transporting materials to and from the Townsville Port site.

Particulates

Airborne particles are often referred to as 'particulate matter' or 'PM'. They include dust, dirt, soot, smoke, and liquid droplets. Some particles are large enough or dark enough to be seen as soot or smoke, while others are so small they can only be detected individually with a microscope.

Some particles are emitted directly into the air from a variety of sources that are either natural or related to human activity. Natural sources include bushfires, dust storms, pollens and sea spray. Those related to human activity include motor vehicle emissions, industrial processes (eg electricity generation, incinerators and stone crushing), bulk loading operations and unpaved roads.

In terms of health impacts the focus is placed on fine particles. These particles are small enough to potentially impact on the respiratory tract and lungs and are the focus of both national and state legislation. For the purposes of the assessment sources of fine particulates include:

- Bulk loading activities in the Townsville Port area;
- Salt spray;
- Emissions from unsurfaced land (including holding yards);
- Motor vehicle traffic in the Townsville area;

- Marine craft using the Townsville Port area; and
- Railway locomotives transporting materials to and from the Townsville Port site.

A common source of 'nuisance' complaints is deposited dust or suspended particles that cause a reduction in visual amenity. Deposited dust is comprised of particles with sufficient mass to fall out of the atmosphere under normal gravitational forces. Dust deposition can cause soiling of surfaces (e.g. window sills and balconies) but is very unlikely to cause a health risk. Sources of course particulates that may contribute to deposition at the proposed development site include:

- Bulk loading of materials at the Port; and
- Emissions from open unsealed land.

Climatic Conditions

Meteorological monitoring is completed at Townsville Airport and the Port of Townsville. These data indicate that the climate at the project site is dominated by sea breezes for much of the year, as would be expected given the coastal location.

The Queensland EPA has prepared an Ausplume meteorological data file containing a full year of prognostic data for the Townsville area. The file has been created using historical monitoring data and is intended to provide a set of data containing the typical range of meteorological conditions experienced in the Townsville area.

A wind rose generated from the EPA meteorological data file shows that the dominant wind direction in the Townsville area is from the easterly sectors, with approximately 74% of winds from the year from these directions.

Existing Sources of Air Emissions

Potential air emissions that could affect the TOT project are primarily associated with existing activities at the Townsville Port. The results of ANE's monitoring and analysis of these emissions are presented in Section 2.2 of this EIS.

4.8.1.1 Greenhouse Gas Emissions

The TOT Project has the potential for Greenhouse Gas (GHG) Emissions during both the construction and operational phases.

Estimates of the potential for direct (e.g. emissions during energy consumption) and indirect (e.g. emissions during energy production) GHG emissions have been completed by ANE. These estimates indicate an estimated aggregate GHG emission (as $CO_{2\text{-}e}$) of 163,364 tonnes for the construction phase and 51,353 tonnes per annum for the operational phase.

The change in land use from marine to reclaimed land has also been considered. The current estimated GHG sequestration for the marine land area to be reclaimed is estimated at 98.25 tonnes per year (as $CO_{2\text{-}e}$). Once the reclaimed land is developed and the proposed landscaped areas to be incorporated into the development are in place, the landscaped areas are expected to result in sequestration rates of more than 108.6 tonnes per year (as $CO_{2\text{-}e}$) for the first 100 years of the project. As such, the change in land use is expected to result in a net increase in sequestration for the first one hundred years, relative to the existing sequestration rate of the marine area that will be reclaimed.

4.8.2 Potential Impacts and Mitigation Measures

Air Dispersion Modelling

To allow analysis of the potential for emissions from the construction of the TOT and for future activities to affect the TOT Project, air dispersion modelling was undertaken.

To provide suitable data inputs to the air dispersion model, information relating to terrain, landuse and prevailing surface and upper atmosphere meteorology was compiled.

These data have been utilised in the TAPM and CALMET meteorological models to develop a site-specific prognostic meteorological dataset for use in the air dispersion modelling.

The CALPUFF atmospheric dispersion model has been utilised for the prediction of construction impacts and future air quality at the TOT Project. This model allows for consideration of terrain features, temperature inversions, land-sea breeze effects at coastal interfaces and strong convective conditions.

Modelling has also been completed to assess the air quality risk posed by existing cattle export activities.

Emission Data Incorporated into the Air Dispersion Model

Emissions have been estimated by referencing published databases, environmental licences and by completing emissions monitoring. Emissions estimates have been completed for both the construction phase (for nuisance dust amenity impacts) and the operational phase when residents, visitors and staff at the TOT could be affected by adverse air quality.

For the construction phase, particulate emissions associated with earth moving, stockpiling and removal activities are the primary issue. Emissions estimates have accounted for the expected moisture content of these materials. The largest quantity of earth moving is associated with the material used for the land reclamation, the majority of which will be dredged and placed while wet.

Predicted Construction Impacts

The majority of the construction works for the project involves the construction of rock walls and bunds, using rocks typically >1 tonne, and excavation of clay materials from the canal areas to fill the reclaimed land to a suitable level. Up to the final profiling stage, the majority of the fill material used on the site will be wet during excavation and working and, as such, emissions from these activities are expected to be minimal.

It is possible that there could be emissions from the site following the final profiling of the reclaimed land areas prior to landscaping. This phase of the project is expected to be relatively short with dust emissions controlled through the use of on-site management measures such as site watering and restriction of vehicle haul routes.

To provide estimates of the potential impacts of wind erosion of soil from unsealed finished sections of the site, estimates of emissions were made in accordance with the methodology detailed in the National Pollutant Inventory Emissoins Estimation Technique Manual for Mining.

The estimate emissions on the basis of this methodology are shown in the Table below.

Table: Estimated Emissoins of Wind Eroded Dust (KG/Hour)

Year	TSP	PM10
1	*	*
2	21.6**	10.8**
3	21.6**	10.8**

*It is expected that all materials handled in the first year of construction will be either large rock material or excavated clay with high moisture content.

**Assumes the entire Project Site is exposed to eroding winds and covered with material with low moisture content able to be eroded.

In addition to dust generated during project construction, there is potential for emissions from the exhausts of the range of equipment to be used during the construction phase. Such equipment could include the following:

- Sheet piling
- Driven Piles
- Barges
- Dewatering pump
- Pile breakers
- 100 tonne digger
- 12G Grader
- 16G Grader
- 30 tonne excavator
- 40 tonne excavator
- 65 tonne excavator
- Wheel compactor
- Wheel loader
- Articulated trucks
- D6 Dozer
- D6 LGP Swamp dozer
- HD 465 Rigid Dump Truck
- Self Propelled Roller
- Tandem water truck

- 40 tonne crane
- Franna crane
- Excavators
- Backhoes
- Ditch Witch Trencher
- Dozers/Drots
- Various rollers
- Clamshell digger/drag line

Potential emission to air from vehicle engines have been calculated on the basis of the estimation methods contained in the Commonwealth Government National Pollution Inventory and sourced from the NPI Emission Estimation Technique Manuals for Combustion Engines. For determination of boat emission rates, estimations have been made on the basis of the NPI Manual for Maritime Operations.

The emission estimates are summarised in the Table below. It should be noted that as a result of improvements in combustion engine emission controls, the emission factors presented in the Combustion Engines manual are likely to be dated and therefore, are expected to be highly conservative.

Table: Estimated Combined Exhaust Emissions from Construction Plant and Equipment (KG/hr)

Year	CO	Formaldehyde	NO_x	PM_{10}	SO_2	VOCs
1	5.534	0.305	13.717	2.008	1.349	1.004
2	8.837	0.491	21.367	1.487	2.145	1.413
3	12.612	0.720	30.047	1.975	3.114	1.717

The air dispersion modelling for the construction phase indicates that, without mitigation, particulate concentrations at existing receptors in the surroundings of the site could approach, or exceed, the appropriate air quality guide values for health amenity and nuisance dust impacts.

Dispersion modelling was undertaken of potential impacts during the construction phase. The modelling presents maximum ground level concentrations of emitted contaminants including total suspended particulate, PM_{10}, sulphur dioxide and volatile organic compounds. The table below shows the maximum predicted ground level receptor concentrations for the third year of construction. This year is predicted to represent the worst-case situation.

Table: maximum predicted ground level receptor concentrations for the third year of construction

Contaminant	Averaging Period	Maximum predicted ground level concentration	Existing ambient concentration	Maximum predicted cumulative concentratoin	Criteria
Total	1 year	243.3	34.8	278.1	90

suspended particulate					
PM_{10}	24 hours 1 year	963.4 131.9	37.1 17.4	1000.5 149.3	50 50
SO_2	1 hour 24 hours 1 year	238.8 234.8 32.1	45.9 45.9 5.1	284.7 280.7 37.2	571 228 57
NO_2	1 hour 1 year	230.4 31.0	34.1 11.7	264.5 42.7	246 63
VOC	1 year	131.7	-	131.7	-
Formaldehyde	30 minutes	63.4	-	63.4	100

The modelling indentifies potential for exceedances of the criteria levels for PM10 in all years, TSP in years 2 and 3 and SO2 and NO2 in year 3. All other compounds are predicted to comply with the criteria throughout the construction period. It should be noted that these predictions assume worst case uncontrolled emissions and, as such, are likely to represent a significant over-prediction compared to a construction site operating in accordance with an effective environmental management plan.

The use of on-site mitigation measures is expected to provide an effective means of control for both dust emissions (PM_{10} and TSP) and gaseous emissions (NO_2 and SO_2) from the site.

TOT Emissions

In addition to emissions during the construction of the project, the operations of the Townsville Ocean Terminal precict is anticipated to cause emissions to the air. The following Table presents maximum predicted ground level cumulative concentrations assuming a large cruise ship is berthed at the ocean terminal. The modelled results assume that the ship is berthed continuously throughout the year; as such, the maximum predicted ground level concentrations represent a worst case assessment.

Table: maximum predicted ground level cumulative concentrations for TOT operations (ug/m^3)

Contaminant	Average period	Maximum predicted ground level concentration	Existing ambient concentration	Maximum predicted cumulative concentration	Criteria
PM_{10}	24 hours	5.9	37.1	43	50
SO_2	1 hour 24 hours 1 year	167.7 34.8 3.1	45.9 45.9 5.1	213.6 80.7 8.2	571 228 57
NO_x	1 hour 1 year	110 2.04	34.1 11.7	144.1 13.74	246 63

As can be seen, no exceedances are predicted for TOT operations.

Mitigation

Construction

Mitigation measures for the construction phase have been identified for management of suspended and deposited particulates. These mitigation measures are incorporated in the construction Environmental Management Plan for the Project. These measures include:

Restricted construction vehicles to designated access tracks and a speed limit of no greater than 20km/hour

Operating and maintaining all plant and equipment in accordance with best practice measures or manufacturer's instructions to minimise potential exhaust emissions;

Inclusion of dust control measures such as water spraying, wood chip layers, wind breaks etc., on all processes that may generate dust (including all exposed areas and access roads);

Restrict potential dust generating activities to low wind periods;

Cover all loads such that dust generation is minimised;

Minimise the potential storage time of material stockpiles. Where stockpiles are required to be stored for extended periods stabilise the surface to prvent wind erosion;

Stabilise completed construction stages as soon as practical after completion;

New equipment purchased for construction shall be selected with regard for fuel and energy efficiency;

Equipment shall be maintained to retain high levels of fuel and energy efficiency;

Material transport distances shall be minimised by selecting local suppliers to minimise emission of greenhouse gases in transport of materials; and

Disturbed areas within the construction site shall be progressively stabilised as construction of land fingers proceed to minimise airborne dust.

4.8.2.1 Greenhouse Gas Abatement

Opportunities for managing and minimising GHG have been identified for the construction phase of the project, and are implemented through the Construction Environment Management Plan. These are as follows:

- Schedule deliveries of construction materials and/or disposal of waste materials to minimise length and number of trips required, by ensuring full loads and sourcing materials locally where practicable;
- Carpooling and buses will be used to transport workers to the site;
- Ensure that the construction camp is located as close as practicable to the construction site.
- Ensure that on-site vehicles are maintained and operated according to manufacturers instructions to maximise efficiency;
- Program works to minimise double handling and materials transfer;
- Ensure that vehicles are turned off when not in use;
- Where possible, select vehicles and equipment that are efficient (eg avoid using older, less energy efficient vehicles);
- Where possible, dispose of wastes to local disposal facilities;
    - Ensure that equipment is appropriately sized for the task;
    - Turn electrical equipment off when not in use;
    - Where practicable, purchase electricity from a renewable or lower emissions source;

- Ensure that equipment is well maintained.

In addition, the project team will encourage selection of biofuels and green energy where possible during the construction phase. A number of initiatives relating sustainable transport have been included in the development proposals. These include:

- Pedestrians – footpaths and walkways are to be provided on footpath areas and within open space zones;
- Bicycles – bicycle routes shall be accommodated in a combination of ongrade pathways and within road corridors;
- Bus set down – bus set down areas will service the main thoroughfare to the Breakwater Cove, TOT and open space areas. The set down areas will service the eastern end of the residential peninsulas;
- Taxi – taxi set down areas will service both the TOT and Breakwater Cove Precincts.

Further opportunities for offsetting or reducing GHG emissions during the design and operation of the TOT Project have also been identified for inclusion in the operational plans and final designs for the proposed buildings. These are as follows:

- A focus on selection of low energy use designs, particularly utilising natural ventilation where possible.
- Installation of low or zero GHG energy sources such as solar, in line with Townsville's status as the first Solar City in Queensland.
- Selection of green energy sources, such as electricity sourced from renewable supplies.
- Complete energy efficiency analysis of all plant and equipment requirements for the commercial and multi-unit apartment buildings to ensure energy efficiency during operations is maximised.
- Select building products from renewable sources where relevant, and/or sources where life cycle analysis indicates that greenhouse gas emissions are lower than for other products.
- Consider purchasing off-site sequestration credits to offset GHG emissions from the facility during construction and operation.

4.9 Visual Amenity and Lighting

4.9.1 Description of Environmental Values

4.9.1.1 Landscape Character

Townsville is a distinctly tropical city with a close relationship to its coastline and river, but is in a dry climatic zone. The City's landscape responds to this location and climate, in particular the combination of coastal plain and rocky hills. The dominant landform comprises Castle Hill and the background mountains, as well as Cleveland Bay framed by Magnetic Island, and Capes Pallarenda and Cleveland. The surrounding coastal plain is relatively flat and includes Ross River and its floodplain, and the Town's Common wetlands. The City's historical development and current character have been influenced by industry and transport, serving as the port for an extensive North Queensland hinterland area, as well as by its role as a business hub, military base and University centre. The residential areas once fringed the city centre, coastline, river and transport routes, but now sprawl across the plains and valleys.

Much of the character of the City is associated with the relationship between the hills and the bay. The distinctively tropical character of the City is emphasised by the large tropical shade trees and The Strand waterfront interface with Cleveland Bay, and the landform frame of Castle Hill and Magnetic Island give the City its unique sense of place. The craggy peak of Castle Hill, with its exposed red granite rock and dry sparse vegetation in the middle of a city, is one of Queensland's most distinctive natural features. Views across Ross Creek and the city to this landmark are among Townsville's most iconic imagery, with Castle Hill dominating all levels of development below.

The panoramic views from Castle Hill over the CBD, Ross Creek and the Port area to Cleveland Bay and Magnetic Island are equally renowned. The various lookout opportunities also include views in all directions, taking in the long gently curved coastline from Cape Pallarenda to Cape Cleveland, surrounding lowlands and mountains to the west, and the extent of urban growth across the coastal plains.

Views north and east also include the waters around and beyond Magnetic Island, within the Great Barrier Reef Marine Park. This is a World Heritage Area recognised for exceptional beauty as well as for other scientific and geomorphologic values. Although the Reef waters and distant islands are an important background part of views from Castle Hill, they do not contribute significantly to the visual character of Townsville *per se*.

The Project Site is an open body of water defined by existing breakwaters, with no landscape values *per se*.

The Project Site has a somewhat 'unfinished' character and does not currently contribute to the character or visual amenity of Townsville. However it is located at the interface of several areas each with distinctive characters:

- The Strand with its shady avenues and recreational foreshore;
- the busy Port of Townsville with associated industry and warehousing where Ross Creek joins Cleveland Bay, and the existing Casino and Hotel Complex, Breakwater marina and Entertainment Centre, with the CBD nearby.

4.9.1.2 Visual Amenity

The overall elements of the TOT Project are set out in detail in Section 3.

The site is visible at a short distance only from Ross Creek and the Magnetic Island ferry route, from the Port, the end of Palmer Street and from the Casino and Hotel Complex/Entertainment Centre area at the end of Breakwater Drive. None of these viewpoints are elevated, except the upper floors of the Casino and Hotel Complex.

Middle distance views are from The Strand foreshore, the ferry route, Melton Hill and the Harbourtown units; with longer views available from the upper floors of CBD Buildings, from Castle Hill and elevated parts of North Ward, it is visible from the Pallarenda shoreline. Of these, only the views over the site from Castle Hill Lookout and North Ward hillside houses are part of significant views, and in both cases the site is seen in the context of the Port (with tall cranes and large buildings) immediately adjacent.

This is particularly so at night, when the bright lights of the Port form an attractive indicator of its economic importance to Townsville, and a valuable navigational aid to the Ross Creek channel. See Plates 4.9.1.2.1 and 4.9.1.2.2 below.

Plate 4.9.1.2.1 – View of Development from Magnetic Island Ferry

Plate 4.9.1.2.2 – View of Development from Strand Headland

From other viewpoints at low elevation, the site currently comprises no more than a thin line of rock breakwater walls seen against a backdrop of either the Port (as seen from the Strand or Pallarenda) or Melton Hill, Castle Hill and the CBD (as seen from offshore).

4.9.2 Potential Impacts and Mitigation Measures

4.9.2.1 Landscape Character

The proposed TOT Project, and any large ship berthed at the Terminal, will markedly change the character of this part of Townsville by creating a large reclaimed landform by extending the urban built form into the bay, by part-screening the Port, by creating a new residential precinct in a previously mixed industrial/tourist area, and by marking the City's ocean gateway.

The height of buildings and ships will not be out of context in their setting, which includes the Port ships and gantry cranes, and existing tall buildings.

As discussed in the Visual Impact Assessment Report in Appendix 16, these changes will generally be positive, and will in some ways 'fill in' a missing part of the existing land use mix to form a more cohesive urban form than currently exists, although the scale and geometry of the reclaimed areas will initially appear to be artificially imposed on the current informal 'jumble' of coastline development as seen from Castle Hill. See Plates 4.9.1.2.3 and 4.9.1.2.4.

Plate 4.9.1.2.3 – View from Castle Hill

Plate 4.9.1.2.4 – View from above

In time, as buildings of various heights are constructed, boats fill the marina and the landscape trees mature, the development will appear to 'belong' in its setting and merge into the surrounding environment. As indicated in Plate 4.9.1.2.5 below when viewed from the Tobruk Pool nearby, only the larger buildings are visible.

Plate 4.9.1.2.5 – View from Tobruk Pool

This integration will be aided by a 'green edge' of tall Hoop Pines and dense Fig trees proposed for the perimeter and on a terminal screening mound, planned to continue the foreshore landscape character and them of The Strand foreshore, especially as viewed from offshore.

Within Breakwater Cove Precinct area, the 'canal estate' character will be softened by rows of private jetties with a variety of boats screening the revetment walls, and by landscape and building articulation to soften and break up an uniformity of built form. Other mitigation measures include distinctive perimeter lighting along the outer public access road with colour and tone to help define the residential area and offset the bright Port lights, a 3m acoustic barrier with Hoop Pines atop a 3m terminal screening mound and by the marina facilities and boats which will extend the existing marina waterfront character.

The proposed public open space with pedestrian/cycle links to The Strand and CBD, and recreational facilities providing opportunities for residents and visitors to experience the bay more directly than at present, will also integrate the character of the TOT Project with that of the City.

4.9.2.2 Visual Amenity

The entire Project will be confined within the limits of pre-existing breakwaters, at the mouth of a shipping channel and adjacent to a working Port with wharves and large ships. Any impacts of the Project on visual amenity are accordingly reduced by the element of expectation, in that development of this nature has long been anticipated by the Townsville community. Local residents and visitors will naturally also expect to see a terminal-type facility at the mouth of Ross Creek, and future residents of the Breakwater Cove Precinct will have full prior knowledge of the scale and nature of development.

Cross sections of the TOT Project located in the Visual Assessment Report in Appendix 16 indicate that the mound and landscape planting (together with the curved street alignments) are likely to screen most future 2-storey houses from views of the terminal and Port. The design of the Breakwater Cove Precinct also ensures that most views from residences will be orientated to the bay, marina and City, rather than towards the terminal and Prot. In time, as buildings are constructed and the landscape matures(and as boats fill the marina and yacht basin), the Project will appear as a considerable enhancement of visual amenity as viewed from all angles.

As seen from offshore, and from The Strand foreshore, the new development will balance the appearance of the existing Port in both daytime and night-time views. The taller buildings will appear as part of a cohesive group of dense built form on the waterfront, except for the 5-storey building proposed for the outer breakwater, which it will define the outer edge of the Precinct. In

closer range views, the development will have a high standard of built form and landscaping internally, and will be sub-divided into small visual catchments and neighbourhoods by the arrangement of islands and water bodies.

Overall, the impacts on visual amenity will be beneficial, replacing the existing 'vacant' area of enclosed waters and linear breakwaters with a waterfront development which reinforces the relationship of the city to the bay.

4.9.2.3 Lighting

The TOT Precinct will be characterised by a high level of lighting, generally similar to but more downward-directed (less glare spillage) than the existing Port operations. The Breakwater Cove Precinct will have 'warmer' and less "industrial' lighting associated with streets, jetties, houses and parkland. Perimeter lighting along the main public access road will be intermediate in height, colour and tone.

Standard road lighting, in accordance with Australian Standards and local Council guidelines.

The overall visual effect will be an increase in lighting which will add to the attractiveness of Townsville's 'nightscape' as seen from The Strand, Castle Hill and offshore, in that there will be more of a transition between the foreshore and the Port. Internally, the 3m mound and 3m acoustic barrier (plus tall trees) will diffuse and part-screen lights from the terminal and any berthed ship, such that visual intrusion to the residential areas is minimised.

As discussed in Section 3.1 of this EIS, the TOT Project Site is directly adjoining a 24 hour, 7 day active Port environment, and the Townsville CBD and greater urban area. Environmentally as identified in the Nature Conservation Report in Appendix 19, the conjunction of a large coastal city with an active export and import Port within zones of Marine National Parks and World Heritage Areas, is unusual. In terms of the receiving environment for lighting impacts the surrounding environment is already heavily impacted by these adjoining uses regardless of these protective arrangements. See Plate 4.9.2.3.1 below.

Plate 4.9.2.3.1 – Existing Lighting Environment

As identified in the Nature Conservation Report in Appendix 12, one of the major impacts usually associated with coastal development is the impact of lighting on turtle hatchlings on adjacent beaches. In this instance, however, the seaward location of the Project Site, and proximity to the active section of the Port of Townsville operations, minimises the potential for additional impact to be experienced along the preferred turtle laying sections of the Townsville Strand.

The Project Site is also wholly within the State waters with no environmentally significant surrounding terrestrial environment, as such nocturnal fauna will not be effected.

At night, lighting associated with both the TOT and Breakwater Cove Precincts will be visible from The Strand foreshore, Castle Hill the hillside parts of North Ward, and from offshore. However the lights will generally be seen in front of and add to the effect of Port lighting, which already provides much of the city's 'sky glow' at night and is an attractive focus of Townsville's 'nightscape' as seen from the above Plate 4.9.2.3.1 The visual impacts at night of lighting – both of the Breakwater Cove Precinct and the berthing facilities of the TOT Precinct, including vessels - on the aesthetics and scenic amenity from Castle Hill is anticipated to be minimal on account of the viewing distance, and may actually serve to increase the value of the scenery from this vantage-point.

The additional lighting of the project will have a generally beneficial visual impact in reducing the contrast of and providing a foreground context for the Port lights behind. Perimeter lighting will also define the water's edge in a continuation of similar themed lighting from The Strand, and will add to the 'sky glow' as seen from offshore.

As identified in the Visual Impact Assessment Report in Appendix 16, the TOT Precinct will have a high level of lighting requirements similar to that of the existing docks area, but will be controlled and ameliorated by selective directional lighting and their intermittent use, only when a ship is berthed. The bright lights of the Port and the terminal have potential to affect the amenity of proposed residential areas. These potential impacts will also be ameliorated by the landscaped mound and through appropriate lighting design, building orientation and landscape screening that will contribute to light filtering and softening without impacting on the safe navigation and operations of the Port and terminal.

Vessels using the TOT wharf will utilise existing navigational channels for access to the Port. It is not expected that additional markers and beacons will be required for this purpose, however small marina entrance lighting to access the Breakwater Cove Marina entranceway may be required.

As discussed previously in Section 4.3, it is not expected that the TOT Project will have any impact on the existing navigational lighting for the Port, however if in consultation with the Harbour Master it is determined that there is an issue, then the issue can be resolved at detailed design stage.

In the residential areas of the Breakwater Cove Precinct, design of lighting fixtures to direct light down-wards will minimise glare and 'escaped' light impacts, while contributing to a 'warm' character internally.

4.10 Noise and Vibration

The Proponent has attended to the an assessment of the existing environment of sensitive receptors in the vicinity of the Project Site and has identified potential impacts of noise and vibration generated during construction and operation of the TOT Project. The Noise and Vibration Assessment (NVA) report is contained in Section 7, Appendix 17 and the results are summarised here.

4.10.1 Description of Environmental Values

Project Description

The site proposed for development of the TOT Project is located adjacent to the Townsville Hotel and Casino Complex and the Townsville Entertainment Centre as identified in the Breakwater Island Casino Agreement Act (BICA) as the "Future Development Area". The TOT project is the reclamation of land to the north of Sir Leslie Thiess Drive for development of two precincts:

(1) The TOT Precinct: will be developed for construction of a dedicated ocean terminal and ancillary facilities for use by cruise ships and naval vessels. Naval vessels currently utilise the existing Townsville Port facilities.

(2) The Breakwater Cove Precinct: a residential area providing for a range of uses including apartments, attached dwellings, detached dwellings, commercial and retail facilities services, landscaping and public utilities. The Breakwater Cove Precinct will be constructed on reclaimed land to the west of the Townsville Ocean Terminal and will provide waterfront residential properties including attached and detached dwellings and apartment buildings.

Existing Noise and Vibration Receptors

The TOT Project has the potential to impact the following receptors:

- Existing houses to the south and south west 0.8km to 1.2km distance;
- Existing residences along haul routes;
- Future Breakwater Cove precinct residents;

- The Port of Townsville;
- The CBD;
- The Jupiters casino precinct; and
- Marine Fauna in Cleveland Bay.

Environmental noise data loggers were installed at six localities from Thursday 19 October to Thursday 2 November 2006 to measure existing ambient noise levels. As the Breakwater Cove precinct has not yet been constructed, measured noise levels at Jupiters Casino have been used to represent those at the Breakwater Cove precinct.

Observations from site inspections confirmed that the existing noise environment is due to port activities, general road traffic, freight trains, aircraft from commercial and military airports and natural environment such as waves, wind in trees and fauna.

Data logging provided the following ambient noise levels at the Jupiters Casino receptor, which are within the relevant maximum planning noise level for the area in question.

	Measures Noise Level	Maximum Planning Noise Level
Daytime	56 dB(A)	60 dB(A)
Evening	53 dB(A)	65 dB(A)
Night	50 dB(A)	50 dB(A)

4.10.2 Potential Impacts and Mitigation Measures

Predicted TOT Construction Noise Impacts

Noise impacts from the TOT project are possible during the construction phase, including:

- Bulk earthworks phase;
- TOT construction work phase;
- Civil work phase;
- Loading activity at the Riverside Marine site; and
- Combined construction activities.

Construction noise and vibration impacts on existing residences to the south and south-west of the project site are unlikely to be significant, given the distance between them.

The highest construction noise impact would be at residences near the Riverside Marine site (west of Ross River) primarily because these activities would extend outside the daytime period. However, this will only be significant if the temporary bridge haul route option is not adopted, as this option is expected to significantly reduce loading activities at the Riverside Marine Site.

For daytime noise impact, the Casino accommodation is likely to be the most affected. There are no quantitative criteria for construction noise impact between the hours of 6.30am and 6pm in

Queensland. Therefore the best practice mitigation measures detailed in the acoustic report are recommended to mitigate construction noise impact on the nearby receivers.

If the Riverside Marine haul route is adopted, the noise control measures proposed could provide a noise reduction of up to 10dB(A) at the Ross River residences, resulting in external construction noise levels of 40-45dB(A). With windows open adequate for ventilation, the difference between the external and internal noise levels is typically 10dB(A). Hence, construction noise levels inside the residences' bedrooms would be in the order of 30-35dB(A) and are within the internal noise levels recommended by Australian Standard AS2107:2000.

Construction noise may have the potential to cause initial disturbance to bird species such as temporary displacement, abandonment of nests and breeding areas. It is considered unlikely that construction noise will cause long-term impact on bird species.

The predicted increases in road traffic noise levels as a result of construction traffic are within 2dB(A), except for residences along Archer Street, Ross Street, Oxley Street and The Strand. For residences along these streets, the increases in road traffic noise levels are within 3-4dB(A). Subjectively, an increase in 2dB(A) is generally considered just noticeable and an increase of 3-5dB(A) is clearly noticeable.

Haulage Contractors will be requested to maintain delivery vehicles properly and operate efficiently to minimise noise impact from construction traffic.

Impacts on receiver located near to the temporary bridge haul route have also been assessed. This assessment has determined that the predicted noise levels from construction traffic associated with the temporary bridge over Ross Creek comply with the noise assessment objective of 60dB(A) LA10,18hr at the nearest residential buildings located at the end of The Strand and Sir Leslie Thiess Drive.

Predicted TOT Operational Noise Impacts

Noise emissions from the TOT ship operations have the potential to exceed the recommended levels at the future residential development within the Breakwater Cove Precinct.

Maximum noise levels from ship horns are expected to exceed the assessment guideline at Jupiter's Casino and residential development within the Breakwater Cove Precinct.

In order to control these emissions, an Operational Noise Management Plan is proposed and ship horn operations would be limited during night-time. Proposed measures to be implemented by the Port Protection Codes should be appropriate to achieve acceptable levels within the Breakwater Cove residences. In addition to the Port Protection Codes, design mitigation measures could include property boundary fences, minimum building envelope constructions, or glazing for exposed windows and doors and appropriate window/ door orientations.

Sleep Disturbance

Given the predicted noise levels for the project, the results of which have been summarised in 4.3 above, the only significant impact from the Port noise is considered to be sleep disturbance.

Sleep disturbance is related to the degree to which maximum single noise events exceed the ambient noise environment for an area.

The Qld EPA Planning for Noise Control Guidelines recommend that for good sleep conditions, noise levels should not exceed 45dBA more than 10-15 times a night. This corresponds to various levels of external noise depending on the window conditions. To satisfy the EPA target external noise would need to be at or below the following levels:

	External L_{Amax}
□ı Wide open	47
□□ Partially open	52
□□ Fully closed	62
□□ Fully closed and double glazed	67

Part 6.2 "Accommodation Building Code" and Part 6.9 "Multiple Dwelling Code" of the Townville City Plan 2005 provide guidelines for residential development located near a high level noise source such as major roads, railway line or noise generating activities and industries.

For habitable areas of buildings on land adjoining state controlled roads, the codes recommend that where the external noise level objectives cannot be achieved, internal maximum design noise levels should be designed to achieve the recommendations in the Australian Standard AS2107:1987.

It is noted that AS2107:1987 has been superseded by AS2107:2000. Although the codes do not specify internal noise objectives for development potentially affected by commercial or industrial noise sources, it is considered that the recommendations in AS2107:2000 should be adopted for the Breakwater Cove Precinct potentially affected by the proposal and existing and future Townsville Port Facilities. As a guide, internal LAeq noise levels of typically 40dB(A) and 35dB(A) should be adopted for sleeping areas during daytime and night-time respectively. For other habitable areas such as lounge/living rooms and kitchens, design noise levels of 5dB(A) higher should be considered. The codes of the Townsville City Plan 2005 recommend that possible noise reduction measures could include:

- Any private opening space or balcony be located away from the noise source of incorporates design elements to buffer noise;
- Doors incorporating an enclosed porch;
- Non-habitable room be located between the noise source and bedrooms;
- Exhaust vents to be insulated or vented into the ceiling space away from the noise source; and
- Facades facing the noise source adopt construction techniques and materials, which buffer the dwelling from the noise source.

Additionally, where development within the Breakwater Cove Precinct facilitates multi-story residential buildings, acoustic privacy will need to satisfy the requirements of the Building Code of Australia (BCA). Appropriate construction materials and methods will need to be determined by the developer at the design phase of the development.

Acoustic Barrier Effect

The TOT Project incorporates a 6m high acoustic barrier around the western side of the Ocean Terminal.

It is anticipated that the acoustic barrier can reduce noise levels by 5 to 10 dBA for the residences closest to the barrier. These noise levels will subsequently reduce further west due to the effect of distance and the sheltering effect of adjacent dwellings to the east.

This expectation is being verified through additional data collection and modelling, and will be provided in a supplementary acoustic report.

Vibration Impacts

Vibration levels generated from construction activities would mainly be due to piling activities, earthworks and soil compaction. Vibration levels from construction equipment will vary widely depending on a number of factors including geology and ground conditions. In terms of Peak Particle Velocity measures (mm/s), the assessment anticipates that this will not exceed 2mm/s at 1200m for any of the key equipment and activities.

Given construction activities at the site are in the order of 1,000m from existing residences to the south and south-west, it is unlikely that construction vibration levels would be felt at these residences.

Residences near the Riverside Marine site (west of Ross River) are approximately 200m from the materials loading point. However, loading rock materials onto barges using an excavator or a front end loader is considered to generate low vibration levels and hence, unlikely to cause significant impacts at the residences.

Existing commercial properties such as Jupiters Casino and Convention Centre are nearer to the construction site and would be exposed to higher vibration levels. However, the levels are unlikely to exceed the safety limit of 15-20mm/s for commercial/industrial buildings when equipment operates further than 20-30m from the buildings.

Dilapidation surveys are recommended for these buildings prior to construction activities. Monitoring of construction vibrations at these buildings at critical stages is also recommended.

Impacts on Fauna

Construction noise may have the potential to cause initial disturbance to bird species such as temporary displacement, abandonment of nests and breeding areas. It is considered unlikely that construction noise would cause long-term impact on bird species. This notwithstanding, monitoring of bird visitation/behaviour during construction and operation as recommended in the ecological study would help to determine short-term and long-term noise impact on bird environment.

Additionally, mitigation measures including prevention, monitoring and remediation recommended in the ecological study would help to minimise the noise impact on bird environment.

Dugong and many cetaceans live in an environment where vision is not the primary sense as light does not penetrate far beneath the surface of the ocean. These animals inhabit underwater environments that restrict visibility further, such as turbid rivers and estuaries or plankton rich oceanic waters.

Marine animals use sound for echolocation to determine their surroundings, navigation, communication and preying. Research shows that noise from military sonars, seismic surveys, shipping and boat traffic, oceanographic experiments has the potential to impact on marine animals. Such impacts include damage to body tissues including ears, temporary and permanent threshold shift, induction of bends, masking of communication, interference with ability to acoustically interpret environment, behaviour modification, increased stress etc.

Noise sources with the potential to impact on bird and marine environment include land based and underwater noise sources. Land based noise sources that could impact on birds are mainly equipment used during construction. Underwater noise sources associated with the proposed development that could impact on marine animals include:

- Dredging activities associated with construction of the Breakwater Cove Precinct;
- Piling activities associated with construction of the Townsville Ocean Terminal;
- Increase in commercial and private watercraft due to the Breakwater Cove Precinct development;
- Increase in operation and berthing of cruise and military vessels at the Townsville Port Terminal; and
- Increase sea traffic movements.

Noise from ships dominates the marine waters and is mainly due to propellers, machinery, hull interaction with water and the use of sonar and depth sounders. Most shipping emanates noise at frequencies below 1,000Hz which is in the frequency range used by baleen whales for communication and other biological activities.

Small leisure craft generate noise from 1,000Hz – 50,000Hz which have the potential to impact toothed whales. Propellers on these vessels may also cause cavitation which generates noise at higher frequencies and could impact smaller cetaceans.

Naval vessels use active sonar (which emits short pulses of high sound levels) on exercises and during routine activities. Noise generated by naval activities ranges from 100Hz – 200,000Hz. As military information is usually classified, military sonar systems used may generate frequencies outside this range.

Piling activities generate underwater noise at frequencies from 45Hz –7000Hz. There are studies on the effects of underwater noise on cetaceans due to piling and dredging operations. For example, whales were displaced from the areas where piling and dredging operations occurred for a number of years after the operations. Piling and dredging operations may also affect feeding, vocalisations, surfacing, respiration and diving patterns of whales.

A number of mitigation measures are proposed as practical safeguards against adverse impacts on local fauna, including:

- Establishing a cetacean safety zone prior to construction of the project, with a possible safety radius from noise sources in the order of 500m to 3,000m;
- Restriction of vessel speeds to protect marine life;
- Ongoing site monitoring so that noisy activities can be managed or suspended when cetaceans are detected, to recommence when the area is clear of cetaceans;
- Consider the adoption of ‘ramp-up’ or ‘soft start’ of noise generating activities;
- Consider the adoption of bubble screening (further investigations will be required to determine suitability and effectiveness).

A number of mitigation measures have been proposed to mitigate potential construction-related noise. These are:

- Provision of engineering controls for stationary noise sources such as acoustic enclosures for diesel engines and silences for engine exhausts;
- Construction/maintenance of barriers and/or stockpiles during material deliveries to act as acoustic screening between the noise sensitive residences and noise sources;

- Fitting of warning lights instead of audible alarms on mobile equipment (excavator/front end loader) during night-time operations whee safety measures are not compromised;
- Maintenance and operation of equipment in proper and efficient condition/manner; and
- Turning equipment off when not in use rather than leaving them on idle.

These measures are anticipated to provide a noise reduction of typically up to 10dB(A) resulting in external construction noise levels of 40-45dB(A). With windows open adequate for ventilation, the difference between the external and internal noise levels is typically 10dB(A). As such, construction noise levels inside the residences would be in the order of 30-35dB(A) and are within the internal noise levels recommended by Australian Standard AS2107:2000.

4.11 Nature Conservation

This section of the EIS presents the results of the Nature Conservation Study conducted by C&R Consulting Pty Ltd (C&R) and assesses the existing ecological status of Cleveland Bay. The Nature Conservation study included identification of environmentally sensitive habitats and species, identification of potential impacts of the development, compilation of a risk assessment, and recommendations for mitigation methods and a monitoring program.

The Nature Conservation Report and EPBC Report are contained in Appendices 19 and 3 respectively and the results and recommendations are summarised here.

The Nature Conservation Study, data evaluation and subsequent risk assessment has established that high ecological values exist in certain parts of the Cleveland Bay system. These areas contain a number of sensitive habitats and dependent species.

The proximity of the Bay to Townsville adds to the value of this ecosystem, due to the ease of access and use for recreation, scientific research and education. However, the ease of access to this resource simultaneously adds to its vulnerability to anthropogenic causes. Consequently, new developments in this area must carefully consider the values of Cleveland Bay, and all reasonable measures must be taken not to detract from the quality of this resource. It is the ecological value of this resource that gives the TOT Project its economic value.

Thus, in order to preserve these values, the Proponents overall aims and objectives of the Impact Reduction and Remediation Strategies are to –

- Prevent significant damage to species and ecosystems in Cleveland Bay, consistent with the current biodiversity of the area;
- Ensure that the development causes no significant proportional decreases in ambient environmental health conditions within Cleveland Bay overall;
- Mitigate any significant impacts of the TOT Project activities; and
- Should significant impacts occur, appropriate amelioration and remediation measures should be undertaken as necessary. Consistent with the Precautionary Principle this should involve immediate review and investigation of the activity, normally followed by appropriate intervention. In extreme cases, this may include cessation of the activities until the impact risk has been fully assessed and appropriate amelioration measures implemented.

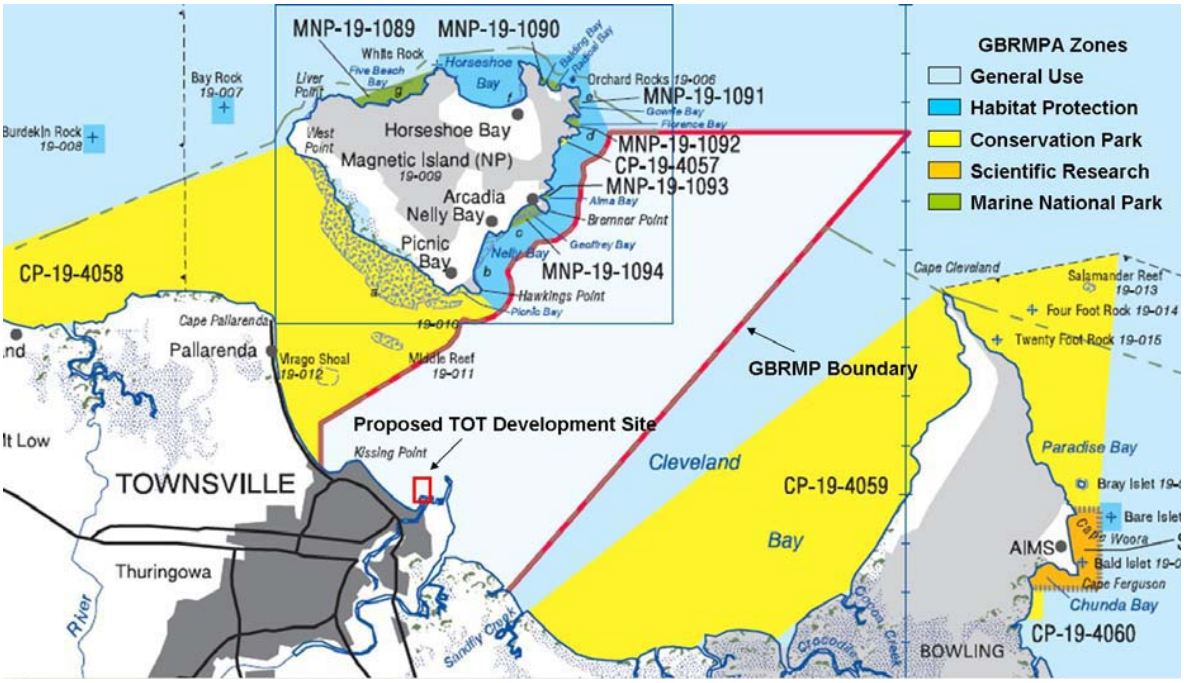
It should be remembered that the Project Site is within an area of complex interactions between Local, State and Federal jurisdictions, each with their own specific, and often inconsistent, environmental assessment criteria. The most contentious points of conflict possibly result from the existence of a relatively large coastal city with an active export and import Port within zones of Marine National Parks and World Heritage Areas. The anthropogenic settlement and associated activities imply a degree of impact, whereas National Parks and World Heritage Areas imply

relatively pristine conditions. This contradiction means that while the TOT Project itself has to be assessed against the stringent conditions relating to developments in protected areas, these conditions themselves have to be assessed against the background impacted conditions. It is believed that in these circumstances that a criteria of "no significant proportional increase over existing ambient conditions in Cleveland Bay" should be used as an assessment criteria.

The location of the Project Site in relation to surrounding land uses, protected and environmental areas is identified in the following Plates 4.11.1 and 4.11.2.

The entire Project Site, Cleveland Bay and adjacent North Queensland coastline is included in the Great Barrier Reef World Heritage area Is noted that the site is not within the Great Barrier Reef Marine Park whose boundaries differ to that of the Great Barrier Reef World Heritage Area, however the Great Barrier Reef Marine Park Zoning for surrounding State waters of Cleveland Bay is identified in Plate 4.11.2.

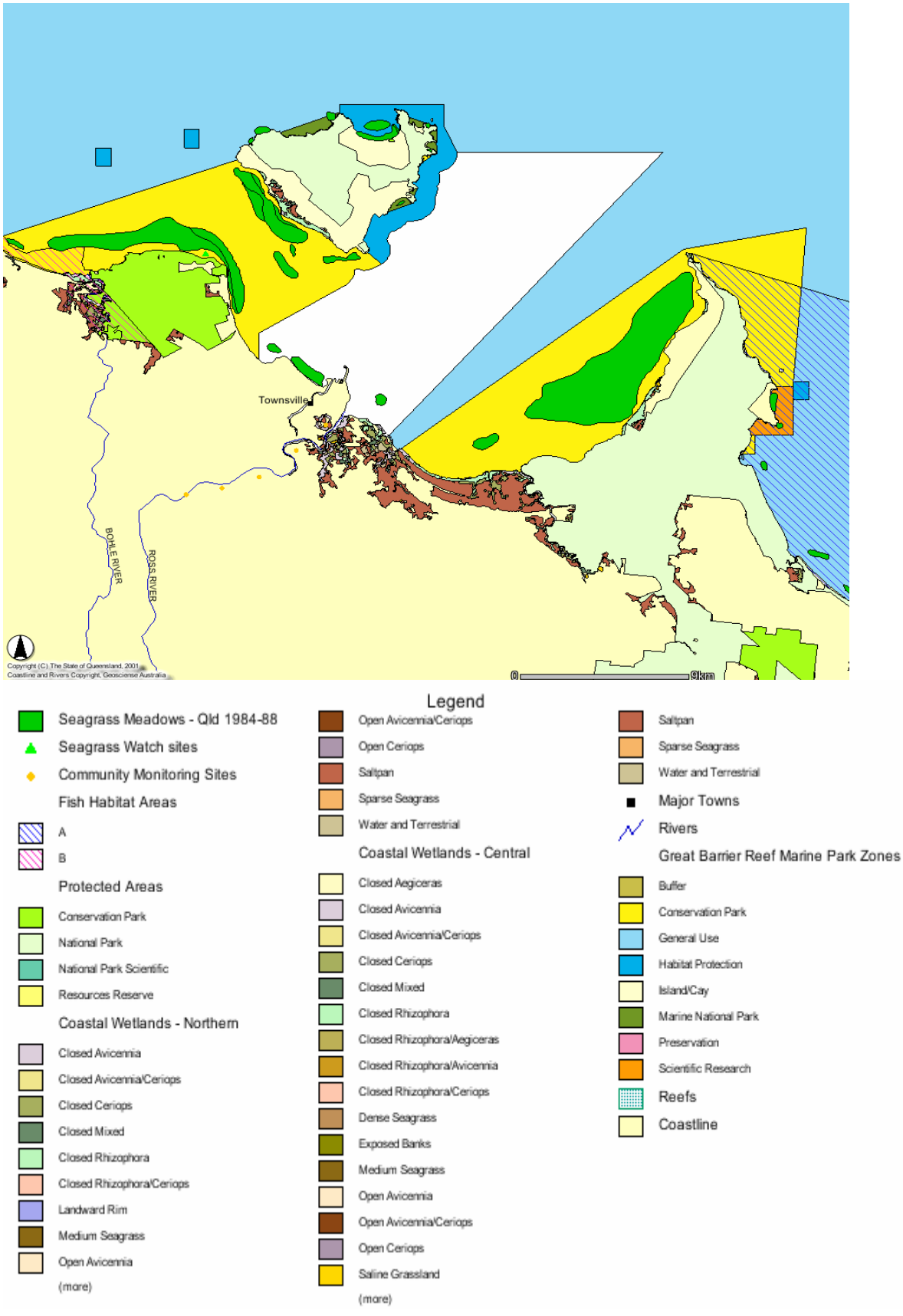
Plate 4.11.1 Great Barrier Reef Marine Park Zoning



As identified in Plate 4.11.2, in summary the Project Site is:-

- Not contained in declared fish habitat area;
- Not contained within the Great Barrier Reef Marine Park;
- Contained within a Dugong Conservation Area.

Plate 4.11.2 Cleveland Bay Protected Areas



4.11.1 Description of Environmental Values

4.11.1.1 Flora

The Project Site and receiving environments consists almost entirely of marine habitats, therefore assessment of flora communities is restricted to aquatic species.

4.11.1.2 Terrestrial Fauna

The Project Site and receiving environments consists almost entirely of marine habitats. Therefore assessment of terrestrial fauna is limited to seabirds that may fly over or occasionally use habitats above sea level.

4.11.1.3 Aquatic Biology and Fisheries

Freshwater Ecosystems

No freshwater habitats occur within or downstream of the Project Site. Significant wetland habitats are located at considerable distance from the Project Site and impacts as a result of Project activities are not expected to occur.

Benthic Communities

Sampling of invertebrate species undertaken by C&R indicated that greater density and species richness is found at impact sites including the Project Site, the Strand and Pallarenda than at the control sites at Shelly Beach and Cape Cleveland. Invertebrate species are a significant component of the diets of many fishes of commercial and conservation significance.

Seagrass Beds

The primary locations of subtidal seagrass beds in Cleveland Bay occur in areas shallower than 4m, between the mainland (The Strand, Rowes Bay and Pallarenda) and Magnetic Island (Cockle Bay, Picnic Bay), and adjacent to Cape Cleveland in the vicinity of Alligator Creek and Crocodile Creek see Table 4.11.1.3.1.

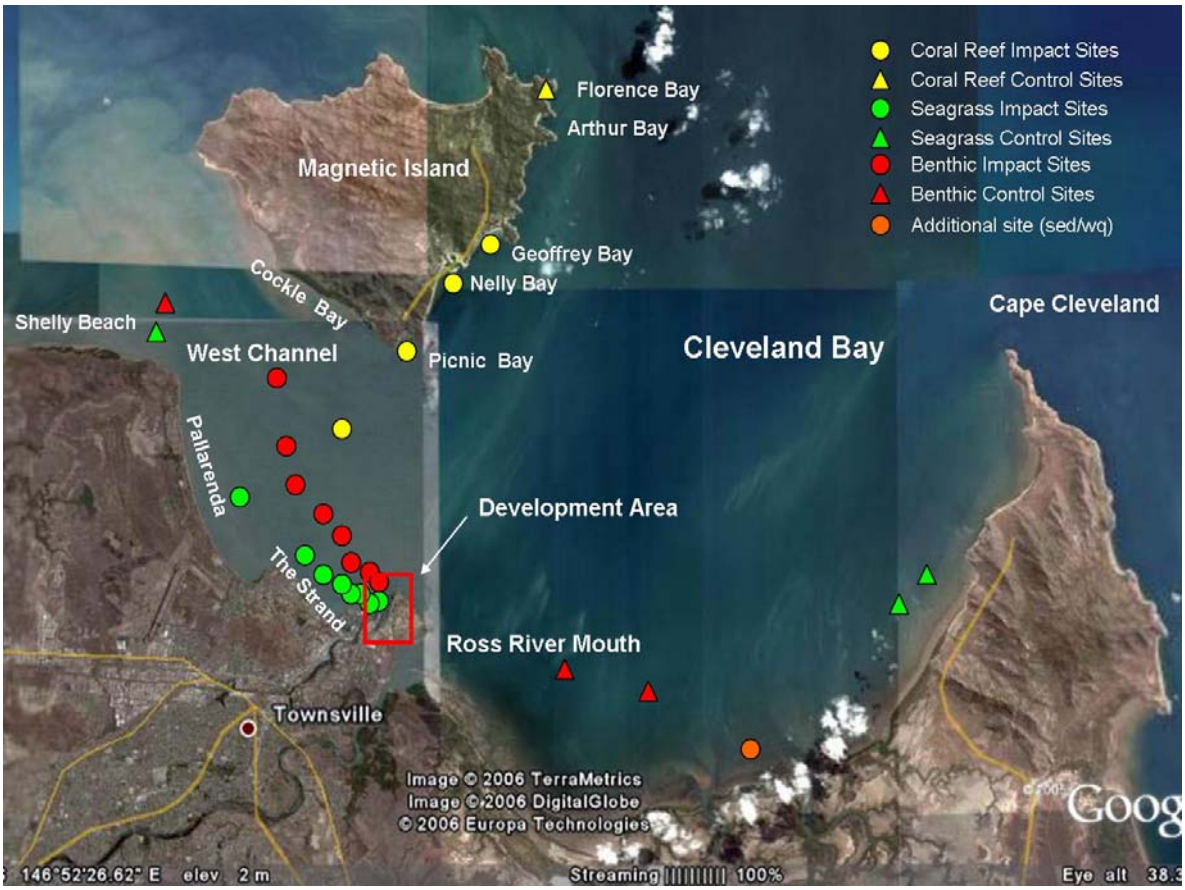
As identified in the Nature Conservation Report in Appendix 19, aerial surveys targeting Dugongs have found that the largest Dugong populations in Cleveland Bay frequent the seagrass beds adjacent to Cape Cleveland. The existence of large patches of seagrass throughout the Bay, however, has contributed to the establishment of the Dugong Protection Area which encompasses the entire Bay, including Magnetic Island.

Table 4.11.1.3.1: Seagrass species found in intertidal areas of Cleveland Bay

Seagrass species	Areas found
Halodule uninervis	Bushland Beach, Shelley Beach, Rowes Bay, Picnic Bay, Cockle Bay
Halodule pinifolia	Cleveland Bay, Magnetic Island
Halophila decipiens	Cleveland Bay, Magnetic Island
Halophila ovalis	Bushland Beach, Shelley Beach, Rowes Bay, Picnic Bay, Cockle Bay
Halophila ovata	Cleveland Bay, Magnetic Island
Halophila tricostata	Magnetic Island
Zostera capricorni	Shelley Beach, Sandfly Creek, Picnic Bay
Halophila spinulosa	Shelley Beach
Cymodocea serrulata	Picnic Bay, Cockle Bay
Cymodocea rotundata	Magnetic Island
Thalassia hemprichii	Picnic Bay, Cockle Bay
Syringodium isoetofolium	Picnic Bay, Cockle Bay

For the purpose of this EIS, sampling sites were selected to encompass the areas of most extensive subtidal seagrass density. Nine Impact sites were surveyed (established with increasing distance from the Development site on a logarithmic distance scale) and nine Control sites (in areas not expected to be affected by the TOT Project), as shown in Plate 4.11.1.3.1

Plate 4.11.1.3.1 – Seagrass Bed Location Map



The density of seagrasses in the sampled areas was significantly higher at the Control sites than at the Impact site (Table 4.11.1.3.2), but variability was also higher between the individual Impact sites (Table 4.11.1.3.3). Along the impact gradient, the highest seagrass densities were found around the Kissing Point and Pallarenda Beach areas, where there was also the highest substratum complexity (i.e. coarser sediments). Areas closer to the TOT Project Site were patchier and had lower overall densities.

Inside the Development site, high-density *Halophila spinulosa* patches alternated with the green alga *Caulerpa taxifolia*, whereby the individual shoots of *H. spinulosa* were larger than any other specimens observed in Cleveland Bay. This is potentially due to the protected, and therefore relatively stable, physical conditions in the TOT Project Site.

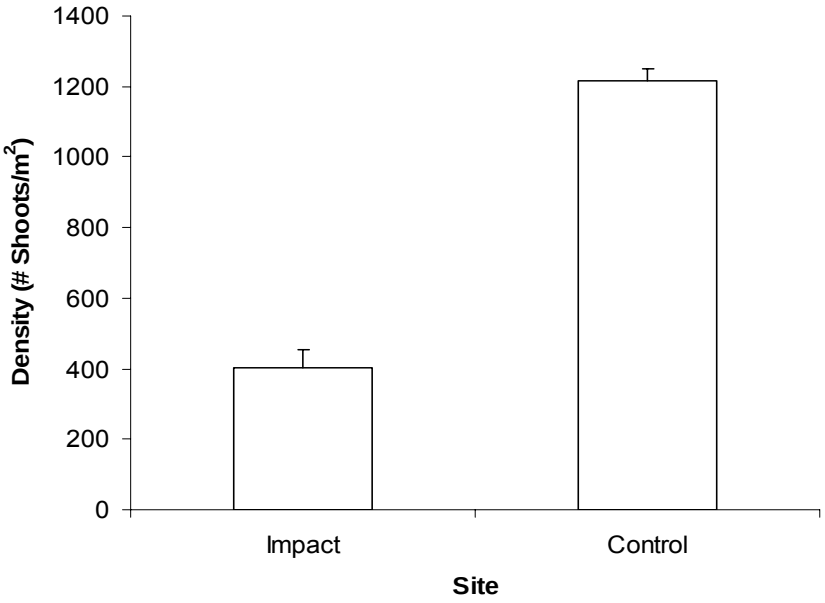


Table 4.11.1.3.2 Total density of seagrasses at combined Impact and Control sites in Cleveland Bay (+/- 1 S.E.). ANOVA $F_{1,178} = 17.89$, $p < 0.001$.

Seagrass densities at the Control sites were approximately three times higher than at the Impact sites, although a five-fold variability also existed within the Control sites. The primary differences in seagrass density between Control sites were between the Shelly Beach site (where densities were relatively low) and the two high-density Cape Cleveland sites.

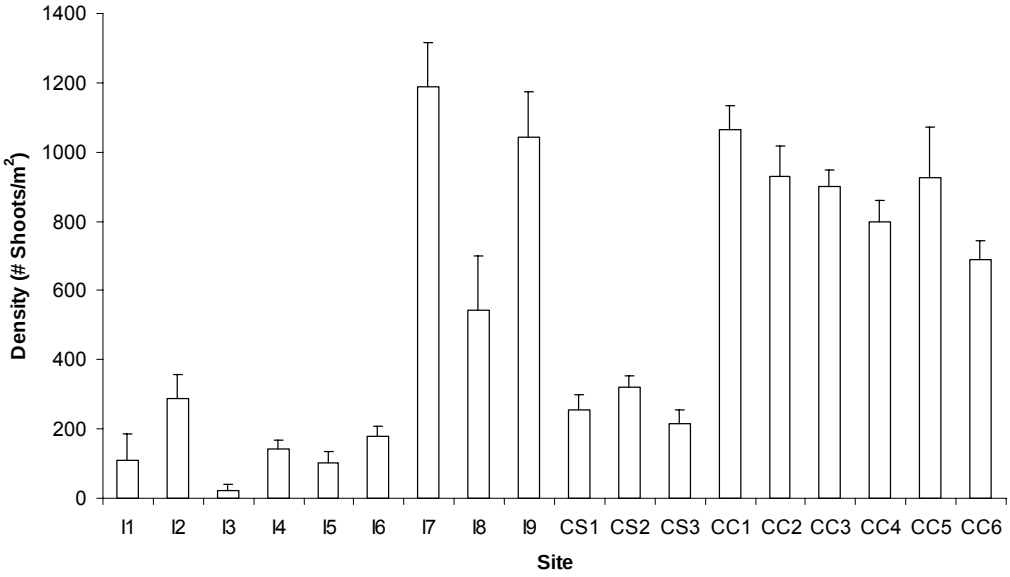


Table 4.11.1.3.3. Total density of seagrasses at each Impact and Control site. I = Impact site, CS = Shelly Beach Control site, CC = Cape Cleveland Control site (+/- 1 S.E.).

Species composition varied significantly between sites, and between combined Control and Impact sites. The very fine sediments inside and directly outside the Development site (I1 and I2)

were dominated by *H. spinulosa*, while sites I3 to I6, in coarser sediments offshore from the Strand, were characterised by sparse *H. ovalis* and *H. decipiens* (Table 4.11.1.3.4). Closer inshore, dense stands of *Cymodocea* spp. were observed (but not at designated sampling sites). Sites adjacent to Kissing Point and Rowes Bay had varied benthic communities, including hard corals, soft corals, sponges, ascidians, bryozoans and *Sargassum* sp. These sites, and site I9 (Pallarenda), had the highest density of seagrasses and were dominated by *Halodule uninervis*, *Halophila ovalis* and *H. spinulosa*.

All Control sites were dominated by *H. spinulosa*, but the Cape Cleveland sites had higher species richness and density than the Shelly Beach site. All four abundant species were found in almost all quadrats at the Cape Cleveland sites, while the Shelly Beach site had almost only *H. spinulosa* and *H. ovalis*.

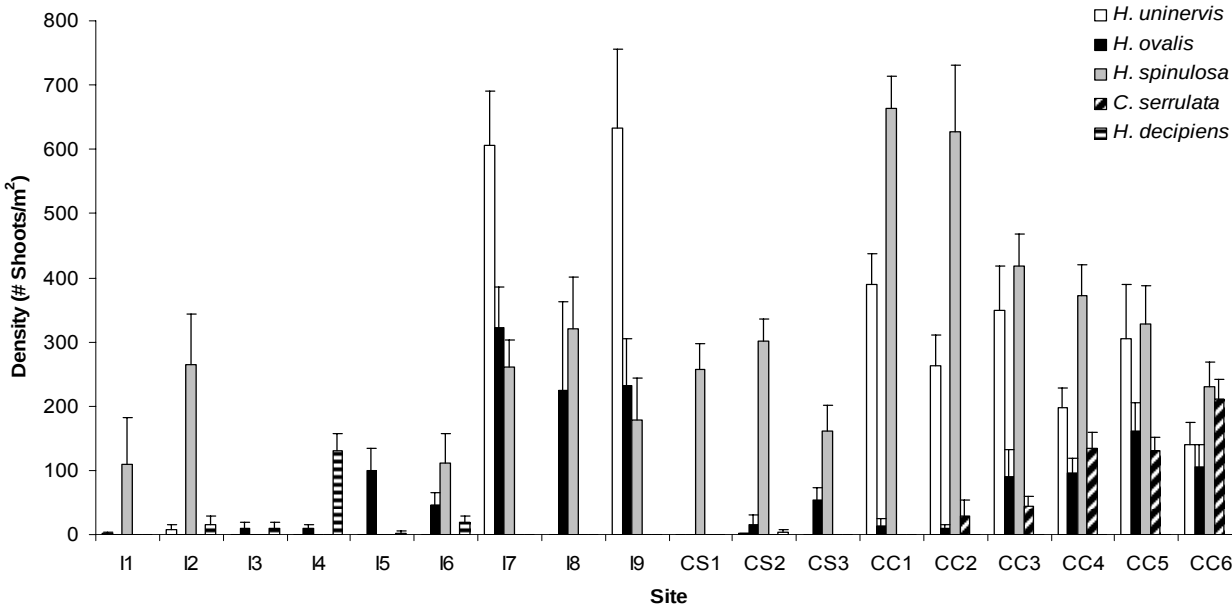


Table 4.11.1.3.4. Density of each seagrass species found at sampling sites in Cleveland Bay.

I = Impact site, CS = Shelly Beach Control site, CC = Cape Cleveland Control site (+/- 1 S.E.). Individual site analysis: MANOVA F_{80} = 14.007, $p < 0.001$. Combined Impact vs. Control analysis: MANOVA F_5 = 151.416, $p < 0.001$.

Cleveland Bay is a highly turbid environment, due to its shallow water depth, and very fine sediments that are easily resuspended. Turbid conditions limit seagrass growth to the shallower and calmer portions of the Bay.

Seagrass species differ in their adaptability to light reduction caused by increased turbidity. Halophila ovalis and Halodule species are highly resilient to sediment deposition and variable light conditions. These species are abundant in Cleveland Bay and are usually the first to recover after disturbance events.

Intertidal Communities

The intertidal invertebrate fauna in the vicinity of the Project Site was dominated by bivalves and gastropods. These communities provide a significant food source for fishes and birds. Intertidal communities are sensitive to changes in water quality changes and to accumulation of waste and

debris. Intertidal habitats in Cleveland Bay range from mangrove forests and rocky shores to sand, mud and coral reef flats. These habitats provide feeding grounds for birds and fish.

Coral Reefs

The reefs in Cleveland Bay support high coral cover, despite past damage from cyclones and bleaching events. Middle Reef supports the highest coral cover and is the most likely reef to suffer impacts from the development.

Fish and Fisheries

Fish

Many of the fish species found in Cleveland Bay, Ross River and Ross Creek are of value to commercial and recreational fisheries, the aquarium trade and the aquaculture industry. Over 40 of the 253 species found in the area migrate between freshwater and marine habitats. These species are vulnerable because they rely on adequate access between these habitats.

Fisheries

Over one half of the species known to occur in Cleveland Bay, Ross River and Ross Creek are of low to medium value for commercial fisheries. Over 60 species are of recreational fishing value, and 34 and 25 species, respectively, are of value for the aquaculture and aquarium industry. Both commercial and recreational fisheries operate in or just outside Cleveland Bay. The Port Western breakwater is a popular location for land-based recreational fishing.

The Breakwater that is destined to become the Ocean Terminal and associated land is a popular location for land-based recreational line fishers, while the edges of the Platypus (main shipping) Channel are often frequented by fishers in small boats. It is difficult to quantify the current market value of the recreational fishing industry, because it supports a wide network of businesses and tourism-related operations in Townsville and on Magnetic Island. However, it is likely to be considerable more than the commercial fishing industry. Due to the Dugong Protection Area status of Cleveland Bay, set mesh netting offshore and on the foreshore, and mesh nets that are not fixed or hauled, are prohibited. It is considered unlikely that the TOT Project will have any impact on the commercial fishing industry.

The value of fishing species for cultural heritage purposes has been resolved as part of the Cultural heritage management Plan with the Traditional owners. This is discussed in Section 4.12 of this EIS.

Fish Habitat

Cleveland Bay hosts a number of important fish habitats and has high connectivity to the Bowling Green Bay Fish Habitat Area. The habitats in Cleveland Bay are valuable to fish communities as permanent habitat, nursery grounds, migration pathways and foraging grounds.

Pest Species

No significant populations of pest species were recorded within the vicinity of the Project Site. Two bird species were recorded as introduced pests but are not present in large numbers at the site. As urban pests, these species may increase through human habitation of the Project Site.

In 2001, the Port Baseline Survey for the Port of Townsville found no marine pest species that are of concern to the Australian Quarantine Inspection Service.

Ecosystem Integrity

Despite the heavily disturbed nature of the Project Site, it supports species which provide food or habitat for fish, dugongs, turtles, seabirds and dolphins. The TOT Project will remove seagrasses from within the Project Site, and although they may be regenerated during the operational phase, the ecology of the Project Site will be significantly altered.

There is currently a high connectivity between the Project Site and Cleveland Bay. Despite the frequent high levels of turbidity within the Bay, significant seagrass beds, fish habitat, critical dugong habitat, whale migration pathways and high coral cover occurs here.

Protected Habitats

Great Barrier Reef World Heritage Area

The TOT Project Site is located adjacent to the Great Barrier Reef World Heritage Area (GBRWHA), which is listed as a 'Protected Matter' under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The GBRWHA supports soft-sediment benthic communities, seagrass beds and coral reefs.

The marine water of Cleveland Bay is considered to be of high quality. The quality of groundwater beneath the Bay is within the range of similar waters found elsewhere in the Townsville region.

Coral reefs around Magnetic Island support a high coral cover. Coral cover and community structure has been shown to recover rapidly after disturbance events, despite declining water quality in these environments. However, coral reefs at Picnic Bay, Cockle Bay and Middle Reef will be at greater risk from turbidity arising from the development and further declines in water quality may affect the ability of coastal reefs to recover from disturbance.

Overall, the habitat value of Cleveland Bay to turtles, dugongs, dolphins and whales is considered to be high. The seagrass beds and coral reefs and the pelagic environments of the Bay provide important habitat for these species. The habitat value of the Project Site itself is reduced by its small size and its modified nature, but the loss of the seagrass bed within the site is likely to affect localized individuals and populations of these species.

Matters of National Environmental Significance, protection under the EPBC Act are discussed in Section 1.7 of this EIS and the stand-alone Report of Potential Impacts on matters of national Environmental Significance (EPBC Act) contained in Section 7, Appendix 3

Bowling Green Bay Ramsar wetlands

A small portion of the Ramsar-listed Bowling Green Bay wetlands adjoins the southern portion of Cleveland Bay. Because the wetlands are located upstream of the Project Site, they are considered at minimal risk of impacts from the TOT Project, and are therefore not described or considered in detail.

Protected Species

Database searches conducted by C&R identified 95 species listed as Protected Matters under the EPBC Act. These include 22 seabirds, 12 marine mammals, 22 marine reptiles and 39 ray-finned fish species.

The species listed as requiring the highest levels of protection are the leatherback turtle the blue whale, the loggerhead turtle, the green turtle and the Olive Ridley turtle, followed by the red goshawk, the dugong, the humpback whale, the hawksbill turtle, the flatback turtle and the yellow seahorse. These species are susceptible to increased pollution, increasing noise and the risk of increased boat strikes.

Marine mammals and reptiles

Thirteen species of marine mammals and seven species of marine reptile have been recorded in Cleveland Bay. A further 15 species of seasnakes are also likely to use habitats within the Bay. Some marine mammal species use the Bay as a feeding ground or as an important part of their migration routes. The snubfin dolphin occurs within Cleveland Bay and was first recorded and described here. Marine turtles are associated with coral reefs or seagrass beds in the Bay. Protected estuarine crocodiles are also found in the vicinity within estuaries and mangrove creeks.

Snubfin Dolphin

The Project Site and surrounding areas within Cleveland Bay form part of the key habitat for the snubfin dolphin. Australian snubfin dolphins are considered of high conservation priority and are susceptible to accidental catch in shark control and commercial fishing nets, habitat loss, overfishing of prey, noise pollution and vessel strike. The TOT Project may cause an increase in existing pressures such as noise, habitat loss and vessel strike.

It is possible the proposed Strand breakwater may replace the existing rocky headland type habitat currently associated with the Project Site, although this has yet to be confirmed. This breakwater may be constructed in a manner that closely resembles a naturally occurring rocky headland. This strategy may provide replacement habitat for a recently described species that is endemic to Australian waters.

Dugong

The dugong is found primarily in tropical waters from the Queensland/New South Wales border in the east to Shark Bay on the Western Australian coast. Eastern Cleveland Bay (near Cape Cleveland) is recognized as a core dugong habitat. Boat traffic is relatively high in Cleveland Bay, and is likely to increase as a result of the TOT Project. The primary cause of Dugong population decline is the vulnerability of the seagrass habitats. Seagrass beds may be impacted by activities that cause increases in sedimentation and turbidity.

Humpback Whale

The Humpback Whale migrates between high-latitude summer feeding grounds and low-latitude winter calving grounds and occur throughout Australian Antarctic waters, Commonwealth offshore waters, and all State waters. Humpback Whales have been sighted in Cleveland Bay between July and September. Mating and calving seasons in Australian waters are between June and October. Cleveland Bay is an important part of the annual migration of Humpback Whales north and south along the Australian east coast.

Indo-Pacific Humpbacked Dolphin

The Indo-Pacific humpbacked dolphin is found from southern China through the Indo–Malay Archipelago to northern Australia. These dolphins are generally distributed in coastal, estuarine and occasionally riverine habitats where they feed primarily on fish. Research suggests that Cleveland Bay does not provide permanent habitat for the dolphins, but they are often present in the Bay.

Bryde's Whale

Bryde's whales occur in tropical and subtropical waters. There are almost no records of Bryde's whales in the Cleveland Bay area and is not currently considered a key habitat for this species.

Blue Whale

Blue Whales migrate between polar feeding grounds and tropical breeding and calving grounds. There are currently no records of Blue Whales in Cleveland Bay, and it is possible that they may not to enter into the Bay. It is unlikely that the construction phase of the TOT Development will affect Blue Whale populations, although increased large vessel traffic may interfere with migration routes.

Flatback Turtle

Although the Flatback Turtle can feed as far north as Papua New Guinea and Indonesia, the only recorded nesting sites are in Australia. Flatback turtles forage in soft-bottomed habitats, and six major nesting aggregations are known in Australia including the southern Great Barrier Reef. Cleveland Bay forms part of the range of the Flatback Turtle, and provides favourable soft-bottom foraging habitat. Although not identified as a key nesting area, Flatback Turtles have been recorded to nest at Pallarenda Beach and on the Strand.

Green Turtle

Green turtles occur along the eastern, western and northern coastlines, feeding in shallow seagrass meadows and migrating through deeper and oceanic waters. Green turtles are highly dependent on seagrass beds for their food source. Although Cleveland Bay is not recorded as a major nesting area for Green turtles along the Australian east coast, both nesting and feeding occur on the beaches and seagrass beds in this area.

Estuarine Crocodile

Estuarine crocodiles are associated with estuaries north of Gladstone. They are most commonly seen in tidal reaches of rivers, but can sometimes be found in freshwater lagoons, rivers, swamps and on beaches and offshore islands. Crocodiles occasionally frequent marine areas in close proximity to the TOT Project Site, but this does not form part of their usual habitat.

Loggerhead Turtle

Loggerhead turtles have been recorded in the coastal waters of all Australian states. The species feeds on a wide variety of benthic and pelagic organisms, allowing them to exploit a range of habitats, including rocky and coral reefs, muddy bays, sandflats, estuaries and seagrass beds. Although Cleveland Bay is within the range of both their migratory routes and contains favourable foraging habitats, no direct records have been found of Loggerhead turtles feeding or nesting in the area.

Leatherback Turtle

Leatherback turtles feed and nest within the GBRWHA with nesting recorded at Wreck Rock and adjacent beaches near Bundaberg. The species is primarily carnivorous and feeds on jellyfish and other soft-bodied pelagic organisms. No direct records have been found of Leatherback turtles feeding or nesting in Cleveland Bay (but see TCC 2007).

Hawksbill Turtle

There are two major nesting populations of Hawksbill Turtle in Australia including the islands of the Great Barrier Reef. No direct records have been found of Hawksbill turtles feeding or nesting in Cleveland Bay, and it is not considered an important habitat for this species.

Olive Ridley Turtle

The Olive Ridley turtle occurs in shallow, protected waters along the coast from southern Queensland and the Great Barrier Reef to Western Australia. The species is carnivorous and feeds primarily on shellfish and crustaceans. No direct records have been found of Olive Ridley turtles feeding or nesting in Cleveland Bay.

Birds

Seabirds and terrestrial birds have been observed between Pallarenda and Kissing Point, and on the Cape Cleveland side of the Port. A number of these rely on benthic communities with Cleveland Bay. Two of the 136 species observed during bird counts are reported as pests. Little terns and Sooty oystercatchers have been observed feeding within the Project Site.

Red Goshawk

The Red goshawk is endemic to Australia and is considered one of the world's rarest birds of prey and preys primarily on large birds. The Project Site and open areas above Cleveland Bay do not form part of the Red goshawk's preferred habitat. However, it is likely that this species is present in terrestrial areas surrounding Cleveland Bay.

White-bellied Sea-eagle

White-bellied sea-eagles occur around Australia and distribution is closely linked to freshwater and marine environments. White-bellied sea-eagles often fish for their prey in these habitats. White-bellied sea-eagles are common in the Townsville area and can often be seen fishing in Cleveland Bay.

White-throated Needletail

The White-throated needletail migrates to eastern and northern Australia over winter. The birds do not breed in Australia, but may roost in trees and shrubs. These birds feed on flying insects. They have been recorded from terrestrial and wetland habitats in Townsville, but there are no records them using coastal habitats around Cleveland Bay.

Barn swallow

The Barn swallow occurs in coastal areas of Queensland and undertakes long-distance migrations between the northern and southern hemispheres. They feed on insects while in flight, and are known to land only infrequently during their overwintering period. This species has often been observed in the Townsville area, both inland and in coastal habitats; however, they are expected to land very infrequently. It is possible that Barn swallows overfly the TOT Project Site, but this area is not expected to be key habitat for this species.

Black-faced monarch

The Black-faced monarch is native to Australia and Papua New Guinea and occurs along the entire Australian east coast. The Black-faced monarch is relatively abundant in the Townsville region, and has been observed overflying nearshore marine areas. It is possible that this species overflies the TOT Project Site for foraging purposes, but this area is not expected to be key habitat for this species.

Australian painted snipe

The Australian painted snipe is thought to be endemic to Australia, and generally inhabits inland wetlands throughout the eastern half of the country. The species feeds at the water's edge and on mudflats, primarily in inland wetlands and occasionally in coastal habitats. The Townsville region is well within the range of the Australian painted snipe, and it has been recorded in nearby

wetlands and coastal mudflats. It is unlikely that favourable habitat occurs within or adjacent to the TOT Project Site.

4.11.2 Potential Impacts and Mitigation Measures

Dredging

Dredging activities affect water quality (e.g. turbidity), and if contaminated sediments are disturbed and transported, dredging activities will also affect sediment quality. Declines in both sediment and water quality are likely to have their greatest negative effect on seagrass beds (e.g. contamination, macroalgal growth, smothering, shading), benthic invertebrates (e.g. contamination) and coral reefs (e.g. light attenuation, sediment deposition, pollution).

Declines in the quality and health of seagrasses, benthic invertebrates and corals will have flow-on effects on all dependent species, such as Green Turtles, Dugongs and commercially important fish species.

Initial construction requirements for the TOT Project will require the dredging of an external access channel as discussed in the Construction Methodology in Section 3.4 of this EIS. Modelling of flushing and water quality indicates that regular annual maintenance dredging will also be required in the internal access channel and canals. This will ensure that water and sediment quality are maintained to the recommended investigation and intervention levels provided in the Impact of TOT on Water Quality of Cleveland Bay Report by C&R Consulting. See Section 7, Appendix 12, principally in Appendices 1a and 1b. All annual maintenance dredging will be conducted within the marina areas of the Development itself, except for the TOT precinct berth Pocket, which will once operational become a TPA responsibility.

The Construction Methodology is such that the area of the Development will be totally dewatered during construction, with all flora and fauna removed. Thus in practical terms no impacts will be sustained to the marina basin as a consequence of dredging. Since both flushing and water and sediment quality modelling indicate that appropriate guideline levels will be met, it is likely that marine flora and fauna will begin to re-establish in the marina areas although species type and composition may vary within the sediments. However, in order to maintain both water and sediment quality, annual maintenance dredging is vital, therefore any flora and fauna present will be disrupted on an annual basis

Oil and Chemical Spills

Accidental spills (oil or chemicals) can occur during both the construction and operation phases of the Development. Due to the proximity of the TOT to the GBRWHA, even a small spill can be damaging in certain weather and tidal conditions. A large oil or chemical spill can cause a slick, trapping inshore-dwelling organisms in a situation where their exposure to toxic compounds could be prolonged. The potential risk to wide-ranging pelagic species, such as whales, is smaller as they are less likely to suffer significant exposure and any lasting toxic effects. However, marine mammals and reptiles may be particularly vulnerable to the effects of oil pollution, as they spend time on the ocean's surface to breathe.

Noise

Noise from dredging, construction machinery and ships may have adverse effects on a variety of marine fauna. The most common negative reactions of marine species to noise are:

- Cessation of feeding, resting or social interactions
- Changes in surfacing, respiration or diving cycles
- Onset of avoidance of noise source

Incessant or repeated acoustic disturbance could cause abandonment of important habitats such as narrow migration paths, breeding and nursery sites and feeding areas.

Mitigation measures for noise is discussed in Section 4.10 of this EIS.

Litter and Debris

Construction, operation and increased shipping and human habitation associated with the TOT Project are highly likely to produce garbage that may find its way into the sea. Litter and debris that is dispersed into marine environments poses a threat to marine fauna and fisheries and can act as a vector for pests.

Marine fauna coming into contact with garbage and debris may be subject to entanglement and ingestion. Marine debris can also smother benthic communities, leading to degradation of feeding and breeding habitats. Tourism and fisheries can also be negatively affected by accumulations of garbage and marine debris.

Pests

During operation and construction of the TOT Project, there is the potential for pest introduction through:

- Introduction of urbanised species;
- Human introduction of domestic pets;
- Marine structures that attract sessile pests;
- Disturbance of the seabed leading to pest incursions; and
- Increased marine traffic that can introduce pests through ballast water or hull fouling.

Increased shipping

Increased shipping within the TOT Project may result in increased underwater noise levels, ship strikes of threatened species, increased risk of spills of oil and other contaminants, increase in pollution, and increase in the risk of marine pest introduction.

Increased Visitation

Increased boating activity and recreational fishing is likely to occur during operational phases of the development and can lead to habitat destruction and increased incidences of boat strikes.

4.11.2.1 Flora and Fauna

The Project Site and receiving environments consists almost entirely of marine habitats. Therefore assessment of terrestrial flora and fauna is limited to seabirds that may fly over or occasionally use habitats above sea level.

4.11.2.2 Aquatic Ecology and Fisheries

Seagrass Beds

The initial construction of the TOT Project will remove any existing seagrass beds within the Project Site area. This is a necessary action on the basis that the Construction methodology outlined in Section 3.4 requires, for the better protection of the surrounding marine environment, the total bunding and dewatering of the Project Site Area.

Seagrasses and benthic organisms may recolonise the Project Site once water is reintroduced, but the community structure of marine species is likely to be altered and annual maintenance dredging will cause regular disturbance. This may affect species that feed in the marine sectors of the Project Site especially dugongs, turtles and some species of seabirds. Fish that use this site, and may be of some importance to recreational fishers, will also be affected in the short term.

The proposed construction methodology will significantly reduce the risks of sedimentation and turbidity impacts of sea grass beds, providing that dewatering sites are chosen to minimise environmental impact, are shifted on a regular basis to reduce duration of turbidity plumes, and are (if possible) sited along the northern breakwater in preference to the western breakwater. Once encapsulated, other than from water permeating into the site from beneath the sheet piling, and necessitating continuous dewatering of an estimated 90 to 500m3 per day, the surrounding marine environment will be 'cut off' from the main excavation of land reclamation activities on site.

The main negative effects on seagrasses from the operation of the TOT Project proposed are not new to the Area. Regardless of this Development, maintenance dredging of an access channel to the existing marina basin, and by the Townville Port Authority within the Platypus Channel and swing basin (adjacent to the proposed TOT berth) already occur and therefore this proposed dredging operation is not a "new" impact solely caused by this Development. The annual maintenance dredging of the internal access channel and canals, needed to maintain adequate flushing and water quality, will only be of the order of 1000m3 per annum. This is less than 0.5% of the maintenance dredging undertaken by the Townsville Port Authority.

The most common prevention mechanisms successfully used against sediment plumes during dredging are silt curtains. These are devices that control suspended solids and turbidity generated by dredging and disposal of dredged material. It is likely that the most useful configuration of a silt curtain in this situation is an elliptical curtain surrounding the dredge. A number of additional preventative mechanisms may be added to the implementation of the silt curtain:

- Dredging should not occur during times of strong wind-driven currents.
- Dredging should not occur during known migration or breeding times for marine mammals.
- Subsequent to the initial dredging required for the construction of the berth pocket and the external access channel, maintenance dredging will be the responsibility of the new commercial marina operator. That operator will be responsible for obtaining appropriate approval for maintenance dredging works in future, subject to assessment and in accordance with proper environmental assessment regimes at any given time.

Measures

In practical terms, construction must impact on the seagrasses currently existing within the Project Site. However, the value of these grasses to local fauna is minimal compared to the more established meadows nominated within the Bay. While an off-set programme is a possibility, it is considered that the size and distribution of the grasses in the Project Site does not warrant such a programme.

In relation to the operational phase of the Development, should an impact on the established seagrass meadows external to the site be determined and is found to be linked to dredging activities associated with this Development, such as a reduction in seagrass densities greater than 20%, dredging activities should be reviewed. Remediation activities must include the following components:

- More frequent sampling of seagrass density and species composition at the impacted sites, until a statistically significant increase is measured.

- The implementation of methods to stimulate seagrass growth, such as the addition of iron to sediments surrounding the active root zones of seagrasses can be considered in the case of seagrass density losses of over 50%;

Fauna

Benthic organisms may recolonise the completed site once water is reintroduced, but the community structure of marine species is likely to be altered. Organisms favouring immobile structures within the water column (oysters, barnacles, etc) will quickly colonise the additional surfaces. Overall, the waters in the Project Site area will be shallow with a maximum depth of approximately 5.0m. This is ecologically comparable to depths already existing in the current impounded area. Consequently, there will be little change in the light attenuation down through the water column. Thus, it is anticipated that new organisms will rapidly re-establish and become an additional food source for local marine fauna, including birds, crabs and fishes.

The primary negative effect on benthic communities from the TOT Project will be the risk of contaminating their habitat with disturbed, potentially polluted sediments during any dredging activities associated with the Development. Benthic invertebrates readily absorb contaminants from the water and sediments surrounding them, causing mortality to the organisms themselves and the transmission and concentration of contaminants through the food chain when they are consumed by larger organisms (e.g. fishes). The most effective ways to avoid this is the detailed analysis of sediments in all areas where dredging is proposed, and the use of silt curtain. Provided the silt curtains are suitable to the particular operation, and are correctly installed, it is envisaged that the use of these curtains will negate the necessity to undertake sediment plume modelling as the silt will be contained within the perimeter of the curtain.

Preventative mechanisms for safeguarding the integrity, biodiversity and abundance of benthic communities are as follows:

- Maps should be produced detailing the exact location and extent of areas to be dredged, and/or disturbed, during other construction works;
- Sediment sampling should occur in a manner that adequately covers the areas subject to dredging and construction works (refer to Water and Sediment Quality report for details);
- Silt curtains should be used during all dredging operations; and
- Dredging protocols should be established to ensure that dredging operates only during appropriate weather conditions (e.g. no dredging during times of strong SE winds).
- Ensuring adequate flushing and maintenance dredging occurs.
- Ensuring water quality is maintained by
- The prevention of sediment plumes from dredging, by using silt curtains and regulating the timing of dredging activities (see prevention section for Seagrass Beds), and by avoiding the dredging of contaminated sediments;
    - The disposal of all dredge spoil on land;
    - The prevention and containment of accidental spills;
    - The setting of conservative water quality investigation and intervention levels to determine when dredging, and all other activities, must cease; and
    - A policy of no off-site movement of chemicals, building materials, sewerage, ballast water, etc.

Measures

Remediation mechanisms will be implemented in the event that monitoring indicates impacts. In this case, development activities will cease immediately and reactive monitoring will begin.

If changes in benthic community density or composition occurs due to a decline in the predator community, it will be necessary to establish whether other impacts have occurred and remediation actions will be taken to address those impacts.

Coral Reefs

The potential impacts of turbidity on coral reefs can be largely prevented by using silt curtains and by avoiding dredging and other activities that cause turbidity at key times in the tidal cycle and during certain weather conditions (see Seagrass Bed Section above). It may be more important to manage the timing of dredging activities, by ceasing dredging during periods of strong currents that may carry suspended sediment towards reefs. The following prevention measures will need to be implemented:

- Silt curtains should be employed during all dredging activities;
- Dredging protocols should be established to ensure that dredging operates only during appropriate weather conditions (e.g. no dredging during times of strong SE winds);
- Dredging should not occur during times of strong wind-driven currents flowing in the direction of any of the reefs in Cleveland Bay and Magnetic Island;
- Maintenance of water quality exiting the Development site; and
- During operation of the Development, visitation will need to be managed through education of visitors, training of staff associated with visitor activities, and by placing strict restrictions on activities of residents of the proposed Development.

Remediation Measures

Remediation measures should be implemented as soon as there are statistically significant declines in coral cover or signs of coral stress (refer above) related to the development activities. Specific remediation measures may include:

- The application of mechanical flushing in the area of impact;
- Removal of excess macroalgal growth in the event of a macroalgal bloom caused by excess nutrients as a result of Development activities

Fish Communities

Monitoring of seagrass beds, benthic communities and coral reefs will indicate changes in fish habitat quality. Remediation of impacts on fish communities will include remediation of key habitats as described in the Nature Conservation Report and the Project EMP.

Intertidal Communities

Intertidal communities can be most effectively protected through the maintenance of good water and sediment quality. The potential impacts of water quality deterioration and sediment contamination on intertidal communities can be largely prevented by:

- Using silt curtains (prevention section for Seagrass Beds);
- Avoiding dredging in contaminated sediments (prevention section for Benthic Communities);

- Dredging protocols should be established to ensure that dredging operates only during appropriate weather conditions (e.g. no dredging during times of strong SE winds);
- Dredging should not occur during times of strong onshore winds

Remediation Measures

The Remediation of Impacts on intertidal communities caused by low water quality or the tidal and wave transport of contaminated sediments can only be carried out by ceasing all dredging and construction activities causing the water or sediment contamination. The high degrees of changing conditions and tidal flushing experienced by intertidal communities can often ameliorate detrimental conditions caused by human activities. Active remediation measures may be necessary in the event of a spill, including:

- The containment of the spill at sea if possible, to prevent it washing onto intertidal areas;
- The use of currently accepted, biodegradable dispersants

If the damage, or potential damage is severe, the following actions should be considered:

- Direct washing of affected sediments;
- The removal, rescue, cleaning and/or care for affected fauna, and subsequent reintroduction to the rehabilitated habitat.
- Project.

Pests

Impacts from introduced species on native fauna will be controlled by:

- Introduce a covenant for the residential development relating to the management of cats and dogs; and
- Reduce the extent of open lawn area, which attracts non-native bird species, and instead use native plantings to create habitat for native birds.

The hulls of smaller vessels using the marina associated with the TOT Project will conform to AQIS standards.

Remediation Measures

Eradication of non-native birds and marine species is problematic. Control programs currently have a low rate of success. Prevention is usually the only useful measure for ensuring the integrity of native populations and communities. Early detection of invasive species and setting investigation and intervention levels can contribute to the successful application of an eradication program.

Marine Mammals and Reptiles

The Impacts of development of the TOT Project will be mitigated by:

- Contingency plans for the prevention, containment and remediation of accidental spills;
- Contingency plans for the prevention, containment and remediation of garbage and debris impacts; and
- Effective construction and operation staff, public and visitor education.

Remediation Measures

Remediation of impacts on marine mammals and reptiles involves primarily the remediation of their habitats and food resources (see sections on remediation of Seagrass Beds, Coral Reefs and Water Quality in the Nature Conservation study) and the cessation of detrimental activities. Specific remediation activities for mammals and reptiles include:

- Cleaning up and fencing off nesting beaches of sea turtles during nesting periods;
- Containing and cleaning up accidental spills;
- Cleaning up of all plastic debris found in or adjacent to marine environments; and
- Effective public and staff education.

Birds

The impacts of development of the TOT Project on birds will be mitigated by safeguarding food resources and habitat. This will include:

- The education of visitors and residents; and
- Planting of native vegetation appropriate for nesting and feeding of birds.

Remediation Measures

Remediation of impacts on birds will involve remediation of habitats and food resources. This will be conducted in accordance with the EPBC Report and the Project EMP and will include:

- Cleaning and nursing affected birds; and
- Rehabilitation of damaged habitat.

Project Site

All organisms growing on the substratum or living within the Project Site will be removed through site earthworks and dewatering of the site. Seagrasses and benthic organisms may recolonise the reclaimed site once water is reintroduced, but the community structure of marine species is likely to be altered. Any organisms trapped inside the site once it is sealed off and dewatered will be collected and relocated.

Impact control measures within the Project Site will include:

- A visual survey of the site directly before it is sealed off to detect the presence of marine mammals or reptiles;
- Using a motorized vessel to disperse species that are sensitive to noise;
- Using appropriate, non-destructive fishing gear to extract as many fish as possible;
- A spotter/catcher will be present during the dewatering process to capture and release any remaining marine organisms; and
- Collection of large benthic or sessile species for relocation outside the site during the final stages of dewatering.

Following completion of earthworks and re-introduction of water into the Project Site, water quality and ecological communities inside the site will be surveyed visually.

The remediation of impacts within the Project Site will focus on the recovery of marine communities after earthworks are complete. This will be achieved by maintaining water quality in accordance with the Water and Sediment Quality Report and prevention of spills, garbage and marine pest incursions.

Monitoring Programme

The Proponent has proposed, on the advice of its expert consultations a comprehensive monitoring programme:

The fundamental tenet upon which this Monitoring Programme is based is the continuous monitoring of water quality, both within and exiting from the Developed Canal Estate of the Breakwater Precinct. If the water quality is maintained to the high standards specified in the Water Quality Report (identified below) then it is considered that most, if not all other impacts will be avoided and that the Development will be ecologically sustainable. Specific impacts during the Construction Phase will be short-term and will also be specifically identified by the continuous water quality, and other monitoring programmes carried out during the construction phase.

In particular, the time periods for monitoring should be:

- The water quality monitoring using permanent data loggers will continue for the life of the Project.

- The other monitoring programmes should continue for at least 5 years after the completion of the entire Project.

While it will be important to monitor the conditions of seagrass beds, coral reefs and intertidal and benthic communities during the construction period of the Development, for the future operation of the Development, the 'early warning system' will be the regular sampling of water and sediment quality in the vicinity of the habitats most susceptible to damage. Rather than monitoring on a seasonal, regular, or calendar-drive basis, the 'event sampling' method is proposed, as this is much more meaningful in the seasonally arid tropics. Monitoring all ecological and physical variables would therefore occur at the annual thermal maximum (January-February) and minimum (July-August), at the end of the wet season (e.g. March) and after unusual climatic conditions or events (e.g. intense rainfall events, extended periods of high turbidity, cyclones, etc.).

Coral Reefs and Seagrass Beds

Monitoring of coral reefs and seagrass beds should be conducted by event sampling at locations close to the Project Site (Impact sites) and locations further away (Control sites). Sampling locations used in this baseline study should be used to assess the most useful sites for ongoing monitoring.

Coral reef monitoring should include:

- Sampling at Middle Reef, Virago Shoal, Cockle Bay, Picnic Bay, Nelly Bay, Geoffrey Bay, Arthur Bay and Florence Bay;

- Use of the same sampling sites used in the baseline study and by previous studies conducted by Dr. Tony Ayling, plus additional sites established at Virago Shoal and Cockle Bay;

- Whenever possible, employing the same surveyors used for the baseline study to ensure observer fidelity with previous datasets;

- Monitoring of benthic composition and coral cover (including marine pest species) using the line intersect transect (LIT) method;

- Collecting and cataloguing of any garbage or debris found during coral reef surveys;

- Annual (summer) monitoring of coral reef fishes along the same transects used for benthic community surveys; and

- Bi-annual reporting on coral reef condition.

Seagrass bed monitoring should include:

- Sampling at sites to the west of the Project Site, stratified into areas defined by the baseline study sites I2 to I4, I4 to I6, and I6 to I9. Within these areas, monitoring sites should be established both inshore and offshore, as seagrass communities differ at different depths. Seagrass surveys inside the Development site should commence as soon as possible after the completion of construction works;

- Control sites to be established in areas of high water quality, in the Shelly Beach area;

- Monitoring of seagrass species composition and shoot density using the methodology described in this study;

- Surveying of all other organisms present in and around the sampling units (quadrats) at the time of sampling, including percent cover estimates of macroalgae, and estimates of marine pest species;

- Collecting and cataloguing of any garbage or debris found during seagrass surveys;

- Bi-annual reporting on seagrass bed condition.

Intertidal and Benthic Communities

Benthic community structure is likely to undergo smaller seasonal variability than coral reefs and seagrass beds, as the fauna is largely found living within the sediments, and therefore subject to a more stable physical environment than communities directly subject to the water column. Monitoring of these communities can therefore be restricted to thermal maximum (January-February) and minimum (July-August) sampling, as well as sampling after unusual climatic events.

Intertidal monitoring should include:

- Sites to the west of the Development site, including Rowes Bay, Pallarenda (including mangroves at Three Mile Creek), and Cockle Bay (including mangroves);

- Sites inside the Development site to be surveyed after the completion of construction works;

- Control sites located in areas of mangroves and sand / mud flats to the east of the Development site;

- Collection and sorting of samples, and species identification, to be carried out by the same surveyors used for the baseline study to ensure observer fidelity;

- During sample collection, visual surveys should be conducted along long transects (e.g. 500m), and all flora and fauna encountered should be recorded, especially introduced species, shorebirds and macroinvertebrates; and

- Bi-annual reporting of intertidal community condition.

Subtidal benthic community monitoring should include:

- Sampling at sites to the west of the Development site, stratified into areas defined by the baseline study sites I2 to I4, I4 to I6, and I6 to I9. Within these areas, monitoring sites should be established both inshore and offshore;
- Sites inside the Development site to be surveyed after the completion of construction works;
- Control sites should be established to the east of the Development site;
- Benthic monitoring to include replicate Van Veen grab samples at each location, to be processed and sorted as described in this baseline study, to be carried out by the same surveyors used for the baseline study to ensure observer fidelity;
- All garbage and debris should be collected and catalogued;
- Monitoring should be conducted in summer and winter; and
- Reporting of intertidal community condition in summer and winter.

Listed species

Listed and threatened species inhabiting Cleveland Bay are those most directly at risk from potential impacts of the TOT Development, and will attract the most attention from conservation agencies (government and non-government), the media and the public. However, due to the existence of other contributing factors including those of anthropogenic origin, it will be extremely difficult to assign direct cause and effect to any impacts relating specifically to the TOT itself. However, in recognition of the precautionary principle, and in light of the absence of long term data (specifically in relation to the Snubfin Dolphin), then numerical monitoring for this specific species may be considered. It is therefore recommended, that in addition to the habitat and water quality monitoring strategies outlined above, consideration be given to a boat based monitoring programme designed to target dolphin populations, but also records other listed species in Cleveland Bay.

It must be identified, however, that should such numerical monitoring occur, it is unlikely that any direct causal correlation between species numbers and direct TOT activities could be discerned from other factors existing in Cleveland Bay.

Conclusion

The TOT Development is in close proximity to the GBRWHA. The marine environment in Cleveland Bay harbours a host of valuable and vulnerable ecological communities and species that are easily accessible to residents and visitors of Townsville and Magnetic Island. The presence of marine mammals and reptiles, the access to popular recreational fishing grounds, the relatively unpolluted beaches, and the opportunity to visit coral reefs, are resources highly valued by the resident communities. This ease of access, and high levels of use, also adds to the vulnerability of these communities and species, as they already exist under the high levels of pressure associated with coastal environments in the vicinity of large human settlements. New developments must therefore be assessed, not as discreet impacts, but together with the cumulative impacts of a large city and a busy port.

The proposed development is sited within an area of complex interactions between Local, State and Federal jurisdictions, each with their own specific, and often inconsistent, environmental assessment criteria. The most contentious points of conflict possibly result from the existence of a relatively large coastal city with an active export and import Port within zones of Marine National Parks and World Heritage Areas. The anthropogenic settlement and associated activities imply a degree of impact, whereas National Parks and World Heritage Areas imply relatively pristine conditions. This contradiction means that while the Development itself has to be assessed against the stringent conditions relating to developments in protected areas, these conditions themselves have to be assessed against the background impacted conditions. Thus, in these

circumstances, it is believed that a criteria of "no significant proportional increase over existing ambient conditions in Cleveland Bay" should be used as an assessment criteria.

Despite the already heavily modified nature of the Development site, it supports seagrasses, algae and benthic invertebrates, which offer additional food or habitat for fish, dugongs, turtles, seabirds and dolphins. While the development of the TOT will remove these resources, it is probable that the construction of the Strand breakwater on the western side of the Development will recreate this environment. A new population of marine molluscs, fish etc, is expected to inhabit the Development site after construction, but the contribution of the new resource to the species currently inhabiting the area is not known.

To ensure that the environmental health and sustainability of the Development is maintained as independently as possible from its immediately adjacent environments, it is essential that the Development adopt the highest possible environmental standards. This means that the potential for contamination and algal blooms within the Development must be minimised by adequate flushing and suitable Operational Management Strategies. This flushing must be such that it can cope with the inputs from small freshwater storm in-flow events. This has been modelled to be the case.

If these qualities are maintained, then water and sediment quality concerns do not provide grounds for the Development to be disallowed.

4.12 Cultural Heritage

Native Title

The terms of an Indigenous Land Use Agreement (ILUA) for the TOT Project:

- Have been agreed and executed between the Proponent and Traditional Owners;
- Are confidential between the Proponent and Traditional Owners;
- Been lodged in accord with the *Native Title Act* 1993 (Cth).

Native Title within the TOT will surrender as a result of the registration of the ILUA.

4.12.1 Description of environmental values

The TOT exhibits environmental cultural heritage values as it is to be constructed/reclaimed from sea bed covered by tidal sea.

The environmental cultural heritage values of the Project Site as:

- Is part of *Gurambilbarra* traditional homelands and Traditional Owners maintain an enduring 'connection to country' ('homelands' refers to both land and sea country, thereby incorporating the offshore TOT);
- Locations within or close to the TOT have Aboriginal language names (eg: Ross Creek, Ross River and Ross Island);
- The adjoining Ross Creek and Ross River are integral components of the local Townsville Aboriginal creation story – the Gabul (carpet python) myth cycle;
- It was used traditionally for foraging, camping and for other cultural purposes such as meeting places and corroborees;
- Areas surrounding the Project Site contain tangible archaeological evidence in the form of shell middens, stone artefact scatters, scarred trees, rock shelters with paintings, ceremonial

sites and a burial ground; current archaeological evidence indicates that Aboriginal people occupied the Cleveland Bay coastline and the adjacent coastal plains of Townsville for at least the last 4,000 years;

- Ross Creek, Ross River and Ross Island represented one of the frontiers between European and Aboriginal societies in the first decade's of Townsville's existence;

- The Project Site continues to be visited by local Aboriginal people/Traditional Owners mainly for fishing and leisure.

4.12.1.1. Indigenous cultural heritage

The Proponent will take all reasonable and practical measures to prevent harm to Indigenous cultural heritage during construction of the TOT Project.

Searches have been conducted of the Queensland Heritage Register and Department of Natural Resources and Water (DNRW) Cultural Heritage Register and Database, and Commonwealth National Australian Heritage Database and Register of the National Estate and no listings were recorded of Indigenous cultural heritage places or materials within the Project Site.

Liaison was undertaken with the participation by Traditional Owners to identify any places or materials of Indigenous cultural heritage significance within the Project Site.

Due to the Project Site being under water and hard clay layers being covered by 1-3m of soft silty clay, a systematic field survey of the Project Site was undertaken. Instead, Northern Archaeology Consultancy Pty Ltd: Michele Bird with the participation of Traditional Owners, undertook a detailed historical investigation of the Traditional Owners involvement with the Project Site. Details of this have been incorporated into the Cultural Heritage Report in Appendix 20.

The investigation determined:

- There is clear evidence that the overall Cleveland Bay coastline including the Project Sites retain significant Indigenous cultural heritage values;

- Consultation with Traditional Owners indicated there are no major cultural heritage objections or constraints to the development of the TOT Project;

- It is highly unlikely that the TOT Project will have any major detrimental impact on the Aboriginal archaeological record of Cleveland Bay (either along the coastal fringe and foreshore, or within the sub-tidal marine zone);

- The potential for finds of Indigenous cultural heritage places or materials based on the available archaeological, geomorphological and historical information is extremely low;

- Recommendations to address concerns of Traditional Owners, should there be a finding of Indigenous cultural heritage significance of Aboriginal archaeological places or materials being located within sub-tidal marine deposits, during construction, are determined through the implementation of the Indigenous cultural heritage monitoring program, incorporated within the CHMP.

Simultaneously with the cultural heritage investigation being completed a CHMP was developed which involved:

- Notification of the Chief Executive of DNRW, the Townsville City Council and participation by Traditional Owners;

- Endorsement of Traditional Owners who respond to notification;

- Consultation with Traditional Owners about involvement in the EIS;
- Compliance with the Duty of Care Guidelines and the CHMP Guidelines as gazetted;
- Requirements by Traditional Owners relating to confidentiality of cultural heritage places or materials;
- The impact of the TOT Project on Indigenous cultural heritage values.

Relevant Legislation

The legislation that is relevant to the protection of Indigenous and non-Indigenous cultural heritage value is:

- *Aboriginal Cultural Heritage Act* 2003
- *Queensland Heritage Act* 1992
- *Environmental Protection and Biodiversity Conservation Act* 1999
- *Aboriginal and Torres Strait Islander Heritage Protection Act* 1984
- *Environmental Protection Act* 1994
- *Native Title Act* 1993 (Cth)

4.12.1.2 Non-Indigenous cultural heritage

The TOT Project was formerly known as Future Development Area (FDA) identified in the BICA Act. The FDA was incorporated within BICA with a view to future development. The original Lessee did not give notice of acceptance of the terms of a development Lease to the State Government within the time detailed in the BICA Act and the ability to develop the land was therefore lost.

The Proponent has a contractual agreement for the development of the TOT Project with the State Government dated March 2006.

CPL investigated the possibility of non-Indigenous cultural heritage within the TOT. Discussions were entered into with an expert in non-Indigenous cultural heritage, who advised that in light of the location of the site underwater the likelihood of there being any non-Indigenous cultural heritage issues was remote. This view is supported by CPL who also formed the view that there was no non-Indigenous cultural heritage within the TOT as a result of numerous developments on the coastline that have altered the natural landscape.

CPL determined there would be no need for a report to be completed as a result of the location of the TOT within Cleveland Bay.

Searches were conducted of the Queensland Heritage Register and DNRW Cultural Heritage Register and Database, and Commonwealth National Australian Heritage Database and Register of the National Estate and no listings recorded of non-Indigenous cultural heritage within the TOT Project.

The TOT Project:

- Is within the Western Breakwater of the Port of Townsville;
- Is to be constructed on reclaimed seabed covered by tidal sea ;

- Has had no prior historical use or occupation;
- Has no non-Indigenous cultural heritage values.

Should any non-Indigenous cultural heritage places or material be identified during construction of the TOT Project, the Proponent will mitigate, manage and protect the same in accord with its duty of care under the relevant legislation.

Non-Indigenous people will be able to maintain their connections to the seabed and land within the TOT, once reclaimed, by unfettered access to public areas.

4.12.2 Potential impacts and mitigation measures

CPL will protect and enhance environmental cultural heritage values within the TOT.

The standards and indicators for cultural heritage management of the TOT Project together with monitoring, management, auditing will be completed through a CHMP.

The CHMP includes:

- A process for including Traditional Owners in protection and management of Indigenous cultural heritage;
- Processes for mitigation, management and protection of identified cultural heritage places or material in the Project Site, including associated infrastructure developments, both during the construction and operational phases of the TOT Project;
- Provisions for the management of Indigenous cultural heritage places or material during construction;
- The monitoring of drainage excavations and other associated activities for possible sub-tidal cultural places or material;
- Cultural awareness training or programs for TOT Precinct staff;
- A conflict resolution process;
- Any collection of cultural heritage material as part of a mitigation strategy will be completed by Traditional Owners in conjunction with Northern Archaeology Consultancy Pty Ltd: Michele Bird if required;
- Developed in conjunction with Traditional Owners and is in accord with information collated from the field survey together with all recommendations within the field survey report prepared by Northern Archaeology Consultancy Pty Ltd.
- Agreement for protecting and enhancing cultural heritage environmental values;
- Execution on 10 August 2007 by CPL and the Traditional Owners.
- An approval from the Chief Executive of DNRW on 7 September 2007 and entered in the State register.

The Proponent and the Traditional Owners have agreed that the terms and conditions of the CHMP remain confidential and not be disclosed to the public.

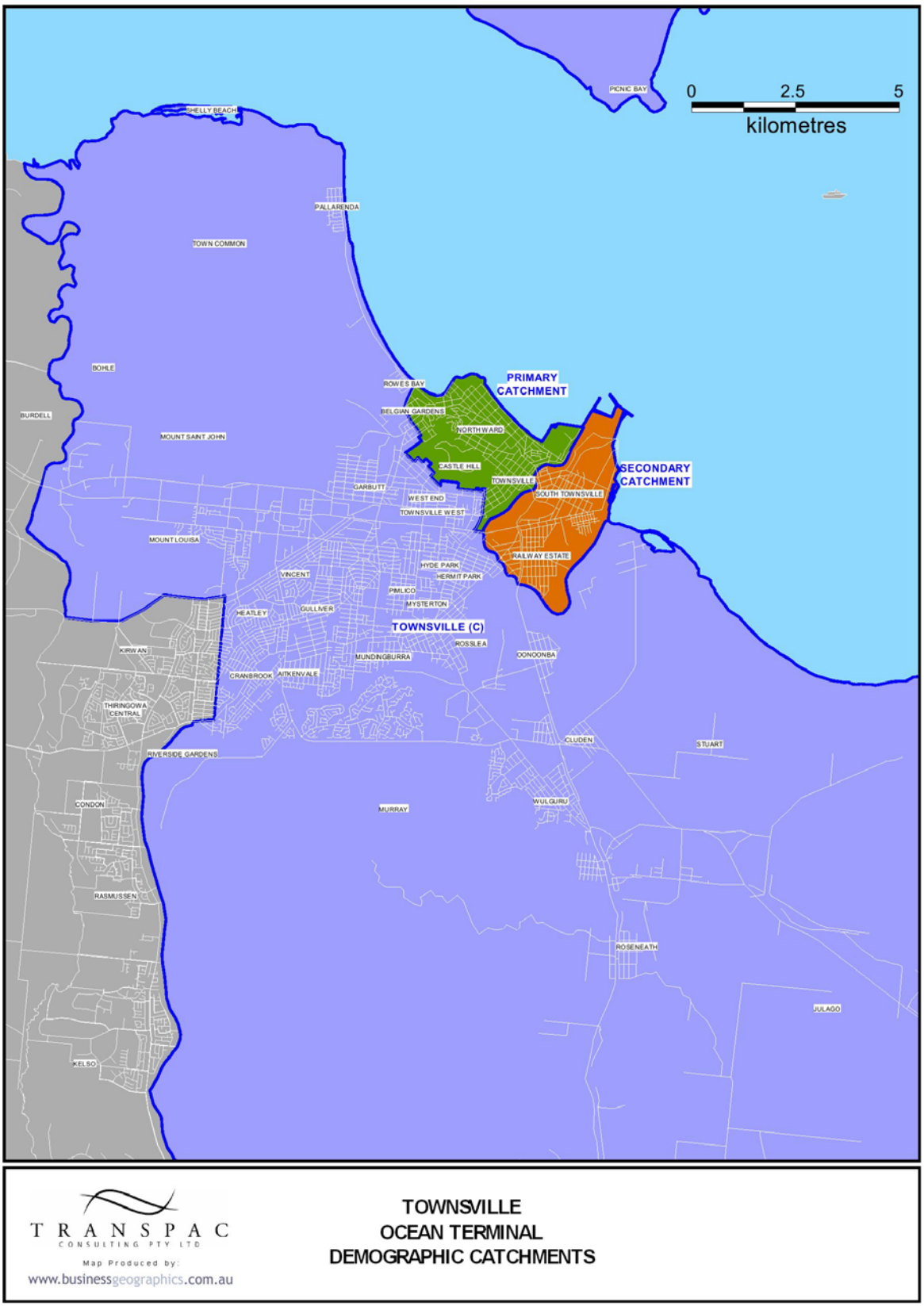
4.13 Social

4.13.1 Description of Environmental Values

Within the immediate Primary Catchment surrounding the TOT Project, there are a range of community infrastructure and services including education services, retail and leisure services (the CBD, Flinders Street East entertainment precinct and Palmer Street restaurant precinct) and a range of outdoor recreational infrastructure including The Strand and Queens Gardens. Access to and from this infrastructure from the Project Site is convenient and can be achieved by vehicle or by pedestrians.

See Plate 4.13.1 - Demographic Catchments

Plate 4.13.1 - Demographic Catchments



There are approximately 12,000 residents in the Primary Catchment, which includes the suburbs of the City (CBD), North Ward and Belgian Gardens. Compared to the rest of the city, the Primary Catchment's population is older though there has been recent growth in the number of younger persons (aged 30 years or less), reflecting a process of inner city renewal and gentrification. The Primary Catchment also tends to be wealthier than the rest of the city as a whole, and has a lower proportion of families with dependent children and single parent families.

The local community in Townsville values the city's economic opportunity and lifestyle. The city combines the benefits of larger cosmopolitan centres without the perceived dis-amenities associated with larger cities such as crime and traffic congestion. The community on the whole supports ongoing economic dynamism and prosperity in the region and believes that the city governance is achieving a suitable balance between economic, social and environmental sustainability. Located in the dry tropics, a great deal of leisure time in Townsville is spent outdoors. The proximity of the TOT Project to the award-winning Strand foreshore facility reinforces the aspect of local lifestyle.

The TOT Project is located nearby to a range of recreational, cultural, leisure and sporting facilities and activities including The Strand and other outdoor spaces such as Queens Gardens. It is also within reasonable walking distance to the Palmer Street Restaurant precinct, the Flinders Street East entertainment precinct and the CBD generally. The TOT Project is immediately adjacent to the Townsville Casino and Entertainment Centre complex. The marina is also adjacent to the TOT Project.

Within the Primary Catchment surrounding the proposed TOT Project, there are a number of primary schools and high schools, as well as the CBD campus of TAFE. The Townsville Hospital was relocated from the Primary Catchment to Douglas, where the centre of population gravity for the greater Townsville region lies.

Property values have been consistently rising over the past five years throughout Townsville. This has been reflected in the inner-city area, and particularly in suburbs in the Primary Catchment. The redevelopment of The Strand in 1999 has also contributed to property value growth. Values of units/apartments near to the Port of Townsville (The Strand and on Sir Leslie Thiess Drive) have increased faster over the last five years than have unit/apartment values in Townsville as a whole.

There are approximately 4,000 dwellings in the Primary Catchment, and 12,000 residents.

There are approximately 600 couple families with children (both dependent and non-dependent), 1,100 couple families without children and 250 one parent families within the Primary Catchment. It is not anticipated that the Project workforce (and their families) will live on site. The TOT Project is expected to create 1,900 full-time equivalent jobs over the 3-year construction period.

The resident community has ready access to a range of social and community services and infrastructure both within the Primary Catchment and also across the city at large.

4.13.2 Potential impacts and mitigation measures

The interactions of the various uses within the Project will require appropriate management to ensure sustainability. The most significant risk relates to the potential impact on residential amenity resulting from nearby port activities. Evidence indicates that residents living within close proximity to the Port make an active trade-off preference decision in favour of the amenity of living near the ocean and the CBD against the dis-amenity of noise and dust from the port. As such, while there is likely to be residential complaints from time to time about port activities, it is unlikely that all other things being equal, this will result in adverse changes to the regulatory or legislative environment governing port activities.

The Proponent, through its consultant Transpac Pty Ltd undertook independent survey of the community's perspective on the TOT Project. As discussed in detail in volume 2 of the Social

Impact Assessment in Section 7, Appendix 21. The positive economic impact on Townsville of the integrated proposal (32.6%) and the Ocean Terminal (32.2%) and the residential and marina complex (37.6%) as components of it, was the most consistent driver of support for the Project. Furthermore, the potential boost to tourism was nominated as the main driver of support for the integrated proposal (34.1%) and the Ocean Terminal (39.1%) as a component of it.

The potential negative impact on the environment was the most recurrent reason given for opposing the integrated proposal (31.7%) and both the Ocean Terminal (29.0%) and the residential and marina complex (26.7%) as components of it. An increase in traffic congestion in The Strand precinct and increased pressure on essential services and infrastructure also figured prominently as reasons for opposing the integrated development and each of its components. Community concerns about conflict between the proposed TOT and the existing port infrastructure was raised by no more than approximately 12% of those that opposed the integrated Project. More significantly, no more than 6.5% of respondents that opposed the residential development per se (i.e. not including the Ocean Terminal facility) nominated conflict with operations at the port as their reason for their unfavourable view.

When asked specifically about the compatibility of the Ocean Terminal development with the port, the survey found that 68% of respondents believed that the proposed TOT would complement the Townsville port infrastructure.

Thus, while there are some in the community that have concerns about the interaction between the TOT Project and the existing port infrastructure, the majority of residents believe that the Project will be complementary and will, in fact, be a key driver of future economic growth and prosperity especially in relation to boosting the region's tourism sector.

There will be minimal impacts on people who live, recreate, travel along or work near the affected areas by the Project, during the construction period. The distance of the construction site from established residents will go a long way towards mitigating how noise etc. will impact on The Strand user and nearby residents.

The results from this survey suggest that overall, the TOT Project will have minimal impact on people's use of either The Strand or the Breakwater precinct. In both cases less than 20% of respondents anticipated either a significant or slight impact on their use of these areas during construction. Approximately 50% of all respondents were of the opinion that their use of the area would remain unaffected by the construction activities of the integrated development and its various components.

The proposed haulage of materials via a temporary bridge across Ross Creek will further minimise the scope of impacts on residents and road users. A number of residences at the southern end of The Strand and Sir Leslie Thiess Drive will be impacted by truck movements on this route options. Approximately 120 dwellings are affected in this regard.

When completed additional permanent residents as well as cruise ship passengers will lead to an increase in demand on local infrastructure, such as The Strand. However, this increase may be possibly offset by reduced Strand usage by residents from the inner suburbs and Thuringowa as a range of suburban recreational facilities and amenities are developed e.g. Riverway.

There will be some impacts that may reduce amenity during construction. During construction public access to the existing breakwater will be denied. However, when the TOT Project is completed public access to an enhanced breakwater amenity and pier (with fishing platforms) will result in a net improvement in amenity in the area.

The community survey found that the majority of respondents believed that the TOT Project would improve and sustain the quality of life in Townsville through the creation of new jobs (67.2%), contribute positively to quality of life in the city by increasing the recreational opportunities available to its residents (59.1%) and complement the redeveloped Strand (64.5%), which is already a widely used recreational asset.

There are no anticipated severance impacts as a result of the TOT Project in terms of access to services in the area. In terms of impacts and 'sense of place' and 'identity' the Project the majority of the community anticipates that the Project will enhance public perceptions about Townsville and reinforce the belief that Townsville is a dynamic progressive city.

Results from the community survey suggest a mixed but generally positive outcome in terms of potential community severance aspects of the proposed integrated development. The majority of respondents believed that the TOT Project would result in improvements to their sense of place and identity. Overall, based on survey findings 55% of residents are favourable towards the proposed TOT with a further 20.5% indifferent. Net favourability for the integrated Project is +34.2%.

Through the creation of employment as well as providing new ocean-based recreational and leisure facilities for the public, the TOT Project is expected to generate positive impacts on the overall quality of life for local residents. The proposed Breakwater Cove residential development will provide additional accommodation in the inner-city area to meet the aspirations and preferences of a distinct segment in the market that demands and prefers this kind of residential and lifestyle option.

The results of the survey suggest the proposed integrated TOT Precinct and the Breakwater Cove Precinct residential and marina development will have a positive impact on the greater Townsville lifestyle and the sense of place of its inhabitants. The TOT Project is seen as enhancing social capital and social cohesion through its contribution to increasing diversity and multi-culturalism and the cosmopolitan nature of the city and through its recognising the newfound maturity and sophistication that prevails in the city.

The TOT Project is also regarded as having a positive impact in terms of contributing to the growth of Townsville, but without impinging on the positive lifestyle aspects of greater Townsville. It is expected the TOT Project will augment existing recreational assets and opportunities but not at the expense of being "out of character with existing lifestyles" or "at odds with the goals of balancing growth and lifestyle".

Lastly, the integrated development and its various components are seen in the community as being able to deliver economic benefits through investment and additional jobs and economic well-being and stability in the local economy through increased tourism expenditure. More importantly the development is seen as being capable of doing so without compromising lifestyle benefits of the local area.

The design of the Project meets relevant Australian Standards on disability access. The public spaces will be accessible to people with disabilities, as well as other disadvantaged groups.

The design of the Project meets relevant Australian Standards in terms of safety and security. Appropriate levels of lighting are provided for in and around areas of safety risk such as carparks.

The Townsville residential market is characterised as tight. Rental vacancy rates are approximately 1%. This situation is expected to continue into the foreseeable future. As such, the ability of the local housing market to meet the housing needs of anticipated population growth is constrained on the supply side. This situation will be the case in the face of population growth in general, which is fuelled by sustained economic growth and opportunity in the city and the region. However, while the housing market is tight (and possibly under-supplied at present), the situation in Townsville has been characterised by the UDIA as exhibiting "some affordability pressures" as opposed to cities like Mackay that are experiencing an affordability crisis.

The Townsville housing market situation is analysed in more detail in the Economic Impact Assessment report in Section 7, Appendix 23.

Recreational angler access to the existing Port Western and Northern Breakwater will be impaired during the construction period. Public access to The Strand will not be impacted. The survey

found that the majority of residents did not believe the TOT Project would have any impact on their current usage of The Strand and breakwater recreational areas, either during or after construction.

For the past four years, approximately 60% of greater Townsville's population growth has come from net migration. The city has effectively absorbed this influx of migrants. In this context, we do not anticipated any unique impacts that may arise from the attraction of additional workers to the city as a result of the TOT Project that would not otherwise take place due to general population growth.

With additional marina berths resulting from the Project, it may be possible that the future will witness increased activity from recreational boat owners and users. This would further reinforce and expand on Townsville's reputation as a relaxed tropical city that values its outdoor lifestyle.

Increased shipping frequency, particularly as a result of growth in cruise ship visits to the city, will create additional employment (refer to Economic Impact Assessment report in Appendix 23) and add to the cosmopolitan and cultural pluralism of Townsville.

Overall public amenity is expected to be enhanced once the Project is completed and operational. Impacts on local traffic once the development is complete are not expected to be excessive, particularly given the possible enhancements of road connectivity resulting from the Ross Creek Bridge.

Enhanced public amenity will result from improvements made to the breakwater public spaces, the addition of a pier with dedicated recreational fishing platforms and new boutique retail and leisure offerings.

The overall tenor of the community survey results indicate that the majority of residents believe that the TOT Project will lead to improvements in public amenity, particularly in term of enhanced recreational facilities accessible to the public.

At a broader level, improvements that the Project is expected to bring to general economic wellbeing and 'quality of life' would contribute to enhanced amenity in terms of how residents experience their lives in Townsville.

The master plan was modified to improve the interface between the residential development component of the TOT Project and anticipated and expressed concerns from port users.

Ongoing consultation with stakeholders has also resulted in innovative approaches to quarry materials haulage route options. The preferred option involves the construction—at the cost of City Pacific Limited—of a temporary bridge across Ross Creek linking South Townsville to The Strand.

Traffic and acoustic analysis conducted separately indicate that such traffic and acoustic-related increases are within acceptable limits.

The Project will draw on the local labour market but is also expected to attract workers to Townsville from elsewhere.

The local rental market is tight, and rents have been rising. It is expected that this general situation will continue into the future irrespective of whether the Project proceeds. A similar situation prevails with the local housing market in terms of the cost of housing for purchase, whereby affordability pressures are expected to continue into the future. New dwelling construction is expected to take place in a number of areas in Townsville-Thuringowa, including the CBD as well as outer suburban areas in Thuringowa City (especially the Northern Beaches).

The community survey was implemented gauged the impacts of the Project on local residents' values and aspirations. In summary, the TOT Project is seen by the majority of Townsville

residents as being consistent with their values that favour sustained economic opportunity and security in the region, in which the TOT Project is seen to contribute significantly, and their aspiration for sustainability in the quality of life offered by the city.

The anticipated impacts on services and recreational activities have been discussed above. It is not anticipated that the Project will give rise to impacts associated with land acquisitions and relocation of residents.

The construction methodology, which involves the encasement of the site for dewatering is expected to minimise the risk of adverse impacts on water quality. Wave modelling analysis indicates that there are likely to be some movements in The Strand beach, with resettling of some beach areas. Resettling is expected to find a new 'equilibrium' in approximately three years at which time appropriate remediation requirements and actions can be undertaken.

No specific education elements have been incorporated into the Project except in relation to educating marine users on practices that are consistent with safety and environmental sustainability for marine life. However, it can be observed that the development of such a facility in Townsville in a way that meets community and industry best-practice expectations and requirements, could indirectly improve public knowledge and appreciation of how contemporary development practice can be pursued in ways that are consistent with modern social and environmental values.

4.14 Health and Safety

Hyder Consulting has conducted an assessment of the potential impacts on the health and safety of the local community within vicinity of the Project Site and the workforce employed in the construction and operation of the TOT Project.

4.14.1 Description of Environmental Values

This section identifies and describes the health and safety values of the existing environment that may be affected by the construction and operation of the TOT Project including ambient air, noise and traffic environments. Potentially affected populations are identified with a focus on sensitive receptors in the vicinity of the Project Site.

4.14.1.1 Existing Air Environment

The existing air environment within the vicinity of the Project Site is influenced by a number of factors including the proximity to existing industrial areas and marine transport, loading/unloading and storage activities associated with the Port of Townsville.

Activities undertaken at the Port of Townsville include the export and import of bulk goods such as Nickel ore and sugar and the loading of general cargo and containers. Material loading and unloading occurs at 9 berths located within the port. Handling and storage of materials distributed through the port is also undertaken within the port precinct. Emission of air pollutants from these sources is regulated by legislative instruments administered by the Environmental Protection Agency (EPA). The Environmental Protection Policy (Air) 1997 (EPP Air) identifies environmental values to be enhanced or protected within Queensland. These values relating to air quality are:

> "*the qualities of the air environment that are conducive to suitability for the life, health and well-being of humans*".

The EPP Air specifies air quality indicators and goals to protect these environmental values and to achieve the object of the Environment Protection Act 1994. In addition the National Environment Protection Measure (NEPM) specifies desired environmental outcomes for adequate protection of human health and well-being. The results of EPA monitoring for 2005 showed that annual mean pollutant loadings were consistently below NEPM standards and EPP Air goals for NO2 and SO2. However, dust storms occurring in February caused exceedences of particulates.

An assessment of the existing air environment in the vicinity of the Project Site and an evaluation of potential impacts on nearby sensitive receptors has been undertaken by Air Noise Environment Pty Ltd (ANE) as part of this EIS and the results are described in detail in Section 4.7.

4.14.1.2 Existing Noise Environment

Existing noise sources within the Project area include activities associated with the Port of Townsville, vehicular traffic around the CBD and the Strand Parkland and periodic events held at the Breakwater Casino Entertainment Centre. Noise generating processes and equipment currently in operation at the Port of Townsville include:

- Bulk loading and unloading of ships by use of mobile cargo handling equipment such as forklifts, tractors, cranes and front end loaders;
- Motor vehicles associated with road transport and railway transport equipment;
- Ship signals, PA system, ship repair workshop and slipway; and
- Bulk goods storage and handling facilities.

(Port of Townsville 2003)

The environmental values relating to noise identified by the Environmental Protection Policy (Noise) 1997 (EPP Noise) include:

- *'the wellbeing of the community or a part of the community, including its social and economic amenity; or*
- *the wellbeing of an individual, including the individual's opportunity to have sleep, relaxation and conversation without unreasonable interference from intrusive noise.'*

An acoustic assessment of the major noise sources within vicinity of the Project Site has been conducted by Hyder Consulting as part of this EIS including monitoring of noise sources and modelling of noise contours across the Project Site. The results of this assessment are described in detail in Section 4.9.

4.14.1.3 Existing Traffic Environment

Vehicular access to the Project Site will be via an extension of Entertainment Drive. The development will generate additional traffic consisting primarily of private vehicles travelling to and from the Breakwater Cove precinct. The TOT precinct will generate increased traffic from tourist transport within the region and traffic associated with servicing of cruise and naval vessels.

The community values which may be affected by the Project due to the increased traffic generation include:

- The safety of pedestrians and motorists;
- Access to the northern and eastern areas of the CBD and nearby residences, retail outlets and commercial premises; and
- The amenity of local businesses and the community.

4.14.3.4 Existing Health Care Services

The Townsville region is well serviced by a comprehensive health care network including the largest hospital in provincial Australia. Health care facilities within the Townsville Health Service District include:

- The Townsville Hospital Complex, Douglas, Townsville: a 460-bed facility providing a comprehensive range of health care services including patient care, medical technology, mental health, specialist and allied health services;
- The Magnetic Island Health Service Centre, Magnetic Island: a primary health care facility providing clinical services to residents and visitors;
- Ingham Health Service, Ingham: a 30-bed facility providing acute patient care, outpatient clinic and general surgery; and
- Joyce Palmer Health Service, Palm Island: a 15-bed facility providing primary level acute care for non critically-ill patients.

(Queensland Health, 2006)

In addition two private hospitals are located in Townsville.

- Mater Private Hospital, Pimlico, Townsville: a 165-bed acute care facility including intensive care, coronary care and cardiac surgery; and
- The Wesley Hospital, Hyde Park, Townsville: an 80-bed acute care facility with a 34-bed medical/surgical unit.

4.14.1.5 Existing Emergency Services

Townsville's local Queensland Ambulance Service is located at Hugh Street, Currajong; the Queensland Fire and Rescue Service is located at Morey Street, South Townsville; and Queensland Police have stations at Townsville City, Kirwan, Hermit Park, Stuart, Deeragun and Magnetic Island.

These services are supported by the Townsville City Council and Thuringowah City Council State Emergency Services (SES) Unit which has facilities at West End, Bluewater, Cungulla, Magnetic Island, Mt Spec and Rollingstone. The Townsville-Thuringowah SES has developed a Counter Disaster Plan to facilitate a coordinated response to cyclone, storm surge, flooding accidents and medical emergencies.

4.14.1.6 Local Disaster Management

Townsville and Thuringowa City Councils (now to be amalgamated) have formed a Local Disaster Management Group have developed a Local Disaster Management Plan (LDMP) under Section 57 of the Disaster Management Act 2003 to manage potential risks to the community during disaster events. This plan identifies the potential threats to communities within the local government areas as summarised in Table 4.13.4 below (TTLDMG 2005).

Potential threats identified by this plan as having a high probability of occurrence include:

- Flooding
- Cyclone, sever storm and storm tide
- Road and rail accidents
- Disease outbreaks

The Townsville Thuringowa Local Disaster Management Group has operational systems for receipt and distribution of disaster event warnings and for alert, standby and activation of the Group in the event of an impending threat. The system for response during a disaster and

recovery of damaged infrastructure and property is also coordinated by the Group (TTLDMG 2005).

4.14.1.7 Identification of Sensitive Receptors

Residential Areas

The nearest residential areas are located at The Strand (low to medium density) at Melton Hill (detached housing and dual occupancy) and within the Mariners Peninsula development (residential apartments) to the south and southwest of the Project Site. Areas of detached housing and mixed residential areas are also located to the southeast of the site on the eastern side of the Ross River. These residential areas may be potentially affected by air, noise and traffic impacts associated with construction and operation of the Project.

Central Business District

The CBD precinct of Townsville is located approximately 700 metres southwest of the Project Site. The nearest land uses to the Project Site within this precinct include areas zoned as 'tourist core' and 'entertainment core' under the Townsville City Plan 2005. To the east of the site, there is an industrial area associated with the Port of Townsville. The location of the Project Site in proximity to the CBD is illustrated in Plate 4.14.1.7.1 in the Health and Safety Report contained in Section 7, Appendix 21.

Health Care Facilities

The nearest hospital to the Project Site is the Wesley Hospital which is approximately 4km southwest of the site. The hospitals nearest to the site include:

- The Wesley Hospital Townsville, 9 Bayswater Rd Hyde Park located approximately 4 km southwest of site;
- The Mater Private Hospital, 21-37 Fulham Rd Pimlico located approximately 6 km southwest of site; and
- Townsville Hospital, 100 Angus Smith Drive Douglas located approximately 10km southwest of site.

The Loreto Home for the Aged is also located at 45 The Strand, North Ward and is approximately 400m west of the site along the coastal frontage. Plate 4.14.1.7.1 illustrates the location of hospitals and aged care facilities in relation to the Project Site.

Educational Facilities

The nearest schools to the TOT site are St Josephs Primary School and St Patricks Secondary School. These schools are located on The Strand approximately 700 metres southwest of the Project Site boundary. Townsville Central Primary School is approximately 1 km west of the development. Townsville South Primary School is approximately 2km south southeast of the site.

There are two childcare centres located in the vicinity of the Project Site. The Kennedy Place Early Childhood Centre lies approximately 2 kms south west of the site and the Koolkuna Kindergarten and Pre School is approximately 2 kms south of the Project Site. plate 4.14.1.7.2 illustrates the location of schools and child care centres in relation to the Project Site.

4.14.1.8 Potentially Affected Populations

Mapping of the sensitive receptors surrounding the site indicates that the Loreto Home for the Aged is the nearest most sensitive receptor and is located approximately 400m from the Project Site. St Patricks and St Josephs schools are the next most sensitive receptors being located

700m from the site. The Townsville CBD is located approximately 700m from the site and will be affected by the increase in traffic flows generated by the TOT Project. Other sensitive receptors including kindergartens and hospitals are located at much greater distances from the site and are not likely to be significantly affected.

4.14.2 Potential Impacts and Mitigation Measures

This section identifies the potential impacts on existing health and safety values and describes the objectives and practical measures for protecting community and occupational health and safety values. In addition, measures for controlling disease vectors within the site are described.

4.14.2.1 Public Health and Safety

Air Quality

The predominant air pollutants within the Project area identified by the ANE air quality assessment include fine particulate matter and gaseous pollutants such as nitrogen dioxide and sulphur dioxide which may be generated by earthworks and construction machinery, construction traffic, traffic associated with operation of the TOT Precinct, marine vessels berthed at the TOT and on-board generators. Health effects associated with these substances include eye irritation, upper respiratory tract infection and exacerbation of cardio-respiratory diseases. Those most at risk of these effects include people with respiratory diseases such as asthma and elderly people (Kjellstrom et al 2002).

Nitrogen Dioxide

The primary sources of nitrogen dioxide emissions identified for the TOT Project include motor vehicle traffic, material transport including road and rail and marine craft. Studies on human populations indicate that long-term exposure to NO2 levels may cause a decrease in lung function and may increase the risk of respiratory symptoms such as acute bronchitis (WHO 2003).

Sulfur Dioxide

The primary emission sources of SO2 for the TOT Project, as for NO2, are likely to include motor vehicle traffic, terminal operation vehicles and marine craft using the terminal and marina areas. Exposure to SO2 may cause a burning sensation in the nose and throat and may result in breathing difficulties (ATSDR 1999). Long term exposure to SO2 can cause changes in lung function and may aggravate existing heart disease. Asthmatics may be sensitive to changes in respiratory effects due to SO2 exposure at even low concentrations (DEH 2006a).

Particulates

The primary sources of particulates identified for the TOT Project include construction activities, vehicular traffic, terminal operation vehicles and marine craft using the terminal and marinas. Exposure to particulates have been linked with acute short-term symptoms such as headache, dizziness, light-headedness, nausea, coughing, difficult breathing, tightness of chest, and irritation of the eyes and nose and throat (FCPC 1998). Long-term exposures can lead to chronic, more serious health problems such as cardiovascular disease, cardiopulmonary disease, and lung cancer (Monforton 2006).

Industrial Emission Controls

Existing ambient levels of air pollutants are not expected to increase significantly as a result of operation the TOT Project and potential impacts are expected to be minimal. Mitigation of air quality impacts from industrial sources is most effective when controlled at the source of emissions. This may include regular maintenance and repair of operational equipment, modification of equipment and processes to reduce emissions

Recommendation for minimising air emission impacts from industrial sources are outlined in Section 4.8.2.

Project Emission Controls

Construction activities may result in localised, short-term impacts on ambient air quality in the vicinity of the site, predominantly through airborne dust emissions. Operation of the TOT may result in airborne pollutants generated from marine vessels and from loading/unloading operations. These impacts will be minimised by adherence to the mitigation measures outlined in the EMP provided in Section 5.

The EMP has been developed in compliance with the Environmental Protection (Air) Policy 1997 (EPP Air) and aims to minimise air-borne pollutants being transported from the site. Impact mitigation measures to be implemented during construction include:

- Progressive stabilisation of disturbed areas within the Project Site that are subject to wind-blown dust;
- Use of dust suppression techniques during earthworks and other ground-disturbing activities including water sprays, erosion control and removal of sediments from public roads; and
- Monitoring of air-borne dust at site boundaries and at sensitive receptors where required.

Recommendation for minimising air emission impacts as a result of the TOT Project are outlined in Section 4.8.2.

Environmental Noise

The primary sources of environmental noise within communities are transportation sources such as road, rail and air traffic and industrial sources. The effects of these noise sources on human health and well-being has been reviewed by the Australian Government Department of Health and Ageing (EnHealth Council 2004).

These effects include reduced performance and learning, sleep disturbance, annoyance, stress, cardiovascular health and mental well-being. The extent to which these effects are experienced by individuals is dependant on the duration and characteristics of the noise. Those most susceptible to health effects from environmental noise include children, the elderly and those with pre-existing physical and mental conditions (EnHealth Council 2004).

Industrial Noise

Urban encroachment in areas adjacent to the Port has resulted in increased sensitive receptors being located in near vicinity of port activities. Any development in close proximity to the Port will be required to implement mitigation measures to ensure that residential amenity is not impacted and port activities can continue to be undertaken in compliance with existing approvals and environmental standards.

The requirements for the development of the Breakwater Cove precinct will be managed by a outlined Port Protection Agreement between the State of Queensland, Port of Townsville and the Proponent. The Proponent will ensure that design standards are outlined in a Community Management Statement to ensure that amenity impacts from the lawful use and operation of the port are appropriately mitigated.

Traffic Noise

Road and rail access routes used by the port and other commercial and industrial premises in the vicinity are identified as ‘freight networks’ by Townsville City Council’s City Plan 2005. During construction traffic will increase along Boundary Rd, Bundock St, the Strand and Sir Leslie Thiess

Drive. Residents along these roads may be impacted by increases in traffic noise. Mitigation measures implemented during construction will include time restrictions on transportation by heavy vehicles and installation of temporary traffic control devices as required.

Following completion of construction, noise generated from traffic on the developed public roads should be in accordance with the planning levels set out in Schedule 1 of the Environmental Protection (Noise) Policy (1997).

Construction Phase Noise

During construction, short-term increases in noise-generating activities may occur. These activities will be controlled by the conditions of future development approvals and by adherence to the measures outlined in the EMP provided in Section 5. Construction noise impacts are also mitigated by restriction of construction working hours. It is expected that construction working hours will be specified in future development approvals for construction of the TOT Precinct and Breakwater Cove precincts.

Traffic Impacts

The impacts of traffic growth in the existing road network surrounding the Project Site may result in the following:

- Increased delays at intersections and within road networks;
- Slower traffic speed for vehicles on roads in the port area and on access routes;
- Increased probability of accidents on the site's access roads as volumes increase; and
- Increased emissions of particulates in the air and increased noise impacts.

To protect community health and safety values from increased traffic and the impacts identified above, the TOT Project has been designed in such a way as to allow for the safety, mobility and access needs of residents and visitors. In order to protect the health and safety of the community from traffic impacts, traffic management objectives include:

- No-worsening of transport efficiency as determined by the change to travel time of motorists and operating costs of transport infrastructure;
- No-worsening of road safety as determined by the occurrence and severity of accidents on the roads approaching the Project Site; and
- Compatibility with strategic planning incentives such as maintaining compatibility between local and regional traffic flows, maintaining urban amenity and meeting future transport needs in and around the Project Site.

Water Quality

Stormwater

Stormwater run-off generated from land development Projects can affect public health and safety by increasing non point source pollutants and degrading surface waters. Stormwater management systems may also create habitat for disease-carrying mosquitoes and other vectors.

A Stormwater Management Plan (SMP) has been developed for the site. The impacts on health and safety which can result from polluted stormwater will be controlled and mitigated through the regulation of stormwater runoff quantity and quality and by the use of best management practices proposed in the SMP to ensure designated water quality objectives for the site are met.

Wastewater

It is proposed that the sewage and grey water reticulation system for the Project Site will be connected into the existing Townsville sewage treatment facilities. Therefore, at this stage there is no plan to treat any wastewater from the development on site as it will be pumped to an external treatment facility.

Ship's Ballast Water

Australia introduced mandatory ballast water management requirements in 2001 which are enforced under the Quarantine Act 1908. Australian ballast water management requirements are consistent the with International Maritime Organisation guidelines for minimising the risk of translocation of harmful aquatic species in ships' ballast water. The Australian Quarantine and Inspection Service (AQIS) is the lead agency for the management of ballast water taken up overseas. All international trading vessels are required to manage their ballast water in accordance with AQIS requirements.

Public Safety during Construction

To maintain site security and ensure public safety during the construction phase, the site will be secured by fencing, hoarding or other suitable barrier to prevent unauthorised entry to the site. Security barriers will be constructed so as to prevent climbing.

Adequate lighting, safety signage and traffic controls will be provided in accordance with Townsville City Council requirements and relevant Australian Standards. All temporary lighting or traffic control devices will be approved by Council prior to installation. Security lighting and surveillance systems will be in place to ensure security of the site when not in operation.

All hazardous substances will be properly stored in secured locations and adequate signage installed to warn of the location of dangerous goods. Signage will also be erected on the site perimeter fence/hoarding to inform of any security measures and advise of a 24 hour contact name and number.

Any damage to footpaths, roadways, stormwater drains or other public infrastructure that is caused by construction activities will be immediately repaired to prevent impacts on pedestrians, cyclists or motorists. Existing bicycle paths, pedestrian paths and site access points will be maintained unless otherwise permitted and will be free of any tripping hazards.

Public Safety during Operation

Public safety will be promoted through incorporation of Crime Prevention through Environmental Design Principles (CPTED). CPTED strategies are incorporated into the site design to allow for casual surveillance and management of access to various land uses.

The following safety and security factors have been incorporated into the site layout to ensure safety of residents and visitors to the site during operation:

- Maximising clear sightlines and appropriate lighting of public areas to provide opportunities for casual surveillance;
- Minimising entrapment spots and isolation of public areas including carparks and open space areas;
- Location of compatible activities together to avoid isolation of public uses and placement of activity generators to promote casual surveillance; and
- Use of signage and barriers to clearly define ownership and intended uses.

Liaison with the Queensland Police Service and relevant emergency service agencies will be undertaken from time to time in relation to crime prevention.

Cumulative Impacts on Public Health

The impacts of air emissions from the Project in combination with existing and future Port of Townsville emissions is being undertaken by ANE to determine potential health impacts at nearby residential areas. Existing air emissions from the Port were monitored during baseline studies and the potential emissions due to increased visitation by cruise and naval vessels has been determined by pollution dispersion modelling. The results of this study are presented in Section 4.8 of the EIS.

Noise monitoring has been conducted to establish baseline noise levels at the site and surrounding areas. The potential increase in noise levels due to visiting cruise and naval vessels and future Port expansions has been assessed by modelling of noise levels across the site. The results of this study are presented in Section 4.10 of the EIS.

4.14.2.2 Occupational Health & Safety

The operator of the TOT Precinct will be required to prepare a site-specific Workplace Health and Safety Plan (WHSP) to ensure protection of employees and visitors to the ocean terminal. During the construction phase, the principal contractor will be required to provide a WHSP to ensure implementation of health and safety principles for all contractors engaged to work on the construction site. Occupational health and safety hazards associated with the TOT Project are outlined below.

Hazardous Substances and Dangerous Goods

Hazardous substances and dangerous goods may be stored at or transported to and from the Project Site. These materials will be managed in accordance with the Hazardous Substances Regulation 1997, the Dangerous Good Safety Management Act 2001 (DGSM Act) and the Dangerous Goods Safety Management Regulation 2001 (DGSM Reg).

The requirements for hazardous or dangerous cargoes are detailed in the Transport Operations (Marine Safety) Act 1994 and the Transport Operations (Marine Safety) Regulation 1995. The Australian Standard AS3846, The Handling and Transport of Dangerous Cargoes in Port Areas, documents the requirements and recommendations for safe handling and transport of dangerous goods in port areas.

Dangerous goods and combustible liquids stored and handled at the Project Site will be recorded within a register, providing product names of all stated dangerous goods and combustible liquids stored and handled at the terminal accompanied by the current Material Safety Data Sheet (MSDS) for each of those goods.

Any fuel storage tanks installed at the TOT will be required to comply with the Australian Standard AS 1940:1993 The Storage and Handling of Flammable and Combustible Liquids. Adequate signage providing visual warning of the hazards associated with dangerous goods present at the TOT will be displayed if stated dangerous goods or combustible liquids are stored in tanks.

Staff Training

The occupational health and safety of employees will be protected by the implementation of effective and appropriate induction and/or training programs. An induction program will be conducted to ensure that all new workers receive basic information on common hazards, first aid and evacuation procedures in addition to other workplace policies and procedures. Contractors working on theTOT Project, will also be required to undertake a general induction to ensure that they remain safe while working at the site.

Hearing Protection

Continuous exposure to noise above 85 decibels during an eight hour day is considered to be excessive noise. Exposure to excessive noise in the work environment may cause a number of physiological and psychological responses. Noise can have the following effects:

- Annoyance and speech interference;
- Interference with concentration and thought processes;
- Reduced immune response; and
- Heart disease.

These effects may occur with exposure to both high and low level noise in the workplace. With frequent exposures, this can lead to loss of hearing. Low level noise experienced by the individual as annoying or as interfering with activities or concentration can cause stress and similar health effects as high level noise.

Personal hearing protectors will be used when levels of excessive noise cannot be reduced by using other control measures. Workers will be supplied with personal hearing protectors appropriate for the work conditions. Administrative noise control measures including limiting the time of exposure of employees to excessive noise will be used during operation of the ocean terminal facility when it is not possible to reduce noise exposure through engineering noise control measures.

Equipment maintenance and servicing programs will be developed as machines and equipment maintained in good condition will reduce noise. This may include modifications or additions such as noise mufflers, vibration isolators, or duct silencers.

Port Access

In order to ensure the health and safety of the ocean terminal workforce, access will be limited to the site and adequate security measures will be in place. For safety reasons the wharf area will not be a public space and only those authorised to work or visit the area will be allowed entry.

Vehicles and Equipment

Employees will be protected from accidents that may result from vehicle and equipment movements at the ocean terminal. Speed limits will be determined and strictly adhered to when vehicles are driving through operational areas. Heavy cargo handling equipment (e.g. forklifts and mobile container cranes) will be operational at the TOT during loading and unloading of the cruise and naval vessels. Cargo handling equipment has restricted visibility and other vehicles will be required to pull over, give way or stop to ensure maximum clearance.

Vehicles which have to enter operational areas will use extreme caution and it is recommended that they be equipped with a flashing hazard light on top of the vehicle. Parking will be confined to designated parking areas and vehicle access to berths will be by designated access ways. Vehicles will not be permitted entry to the terminal operational area without the prior consent of the Terminal Supervisor.

Severe Weather Events

Severe weather conditions can impact on the health and safety of the Project workforce and may include events such as cyclones, severe storms, storm surge or high winds. At present, Townsville Port Authority, in conjunction with the Regional Harbour Master, is responsible for coordinating activities in preparation of, during and after a cyclone or other severe weather

condition (Port of Townsville, 2006a). Precautions to be implemented during extreme weather events will include:

- A nominated emergency coordinator will be trained in emergency control and will be responsible for monitoring the whereabouts of all persons on site;
- All personnel will be trained in emergency evacuation procedures; and
- Periodic emergency evacuation procedure drills will be conducted.

Access and Walkways

Currently the Port of Townsville has yellow painted walkways located on all berths, pathways and around the port area to help staff and guests move safely through operational areas (Port of Townsville, 2006). Employees, shipping agents, crew and visitors are encouraged to use these walkways at all times when moving through an operational area/berth. Safety directions are also given by berth operators. The Townsville Ocean Terminal will develop a similar system to ensure walkways and paths in and around the terminal area provide safe passage for employees and all other persons.

Fire Safety

Adequate and effective emergency response systems and services will be developed for the ocean terminal to minimise any potential consequences of a fire to the health and safety of employees. The terminal will have a fire main system in order to allow staff to carry out an initial response if safe to do so. For a marine fire, the tugs at Townsville Port can provide a major fire fighting resource through the provision of water pumps/cannons on the tugs. Precautions to be implemented to mitigate the adverse impacts on workers' health and safety in the even of a fire will include:

- Representative staff members will be trained in the use of first aid including the location of fire alarms and fire extinguishers, their uses and operation;
- Emergency facilities (e.g. fire fighting equipment, portable spill containment devices, first aid equipment) will be located where required, installed correctly, regularly maintained, and access maintained; and
- Local emergency services will be kept informed of changes to the TOT Project that could affect their call out procedures.

Ergonomics and Manual Handling

Loading and unloading material to and from the cruise ships and naval vessels will generally be conducted by a mechanical forklift or conveyor system. However, there may be some tasks which require employees at the ocean terminal to engage in manual handling.

To avoid workers suffering from the injuries described above training is to be provided to ensure staff are protected against workplace injuries. Tasks will be designed in such a way that manual handling involves carrying smaller loads; reducing carry distances and heights; reducing unnecessary lifting, excessive pushing, pulling or carrying; and developing material flows which avoid double handling.

4.14.4.3 Policing and Management of Visitors to the TOT

An emergency response plan shall be prepared in consultation with local emergency services prior to the commencement of operation of the TOT Precinct. A means of communication with terminal visitors shall be established to allow public announcements and conveyance of directions. A central communication area shall be established to allow communication by

emergency services. A plan shall be provided to all security and emergency personnel identifying the building layout, entrances and exits, restricted access areas, first-aid points and any potential hazards.

Security personnel shall be employed for control of access, control of vehicle traffic, conducting security searches and assisting emergency services. Security personnel shall be stationed at strategic observation points including monitoring of security surveillance cameras. Personnel shall be adequately trained in emergency and evacuation plans, protocols for raising alarms and engaging emergency services.

In the event that a larger than usual crowd is expected, local fire and rescue services, ambulance services and local hospitals shall be advised of the nature of the event and expected crowd numbers. Additional security personnel shall be on stand-by and police services advised.

In order to maintain crowd control, the operator shall pre-establish maximum crowd numbers and this shall be monitored by security personnel. Designated entrances shall be clearly signed and provide for disabled and emergency access and are to be kept clear of other activities. Check-in and security control points should be positioned separate to the entrance points so as not to affect crowd movement. Effective use of barriers should be considered if required to direct crowd movement and prevent congestion of thoroughfares.

4.14.4.4 Disease Vectors

Mosquitoes and Biting Midges in North Queensland

Mosquitoes breed in salt, brackish or fresh water and prefer standing (stagnant) water to lay their eggs. Midges breed in substrate generally associated with wetlands such as intertidal areas and the sides of streams and rivers.

Townsville City is characterised predominantly as a coastal savannah landscape incorporating low lying tidal and fresh water wetlands. Both landscapes are capable of supporting extensive mosquito populations during summer (due to tidal action and wet season activity), and to a lesser extent in the drier winter months.

In Queensland the dengue virus can be transmitted by the Ae. aegypti mosquito This species is adapted to urban environments and commonly finds habitat in residential areas including backyard rubbish sites and breeds primarily in artificial containers holding water inside and outside the home.

Mosquito and Biting Midge Management during Construction

There is the possibility during construction that pools of standing water may establish on the construction site. Measures will be taken to ensure any pools do not remain for more than 5 days to prevent the formation of mosquito breeding sites or otherwise mitigation measures will be undertaken. If sediment traps are to be used they will be designed so that they are free draining within a period of 5 days after flooding and are maintained by silt and vegetation removal.

Mosquito and Biting Midge Management during Operation

Water holding devices

Following construction there is the potential for mosquito breeding sites to be established in any water holding device such as buckets, pot plant bases, blocked roof gutters, drains, and certain plants. This poses no additional risk than other developments in the Townsville region and can be managed in accordance with the Queensland Government's Mosquito Management Code of Practice and the Townsville City Council's Mosquito Management Plan. Standard measures will be implemented if rainwater tanks are to be installed. These will be adequately screened to prevent the entry of mosquitoes.

Landscaping

Appropriate landscaping is proposed to be provided within the TOT Project to prevent the creation of any areas capable of ponding water for more than three days. This will include appropriate contouring of landscaped surfaces to allow efficient runoff of stormwater into nearby drains. Appropriate vegetation will be chosen to minimise the potential for provision of mosquito breeding sites. Plants with leaf axils that hold water, such as Bromeliad species, should be avoided.

The Body Corporate is to be encouraged to advise residents of suitable vegetation selection to minimise mosquito breeding.

4.14.4.5 Recycled Water

The Breakwater Cove precinct will be connected to the Townsville municipal potable water supply. Water will be supplied to each lot and each super yacht berth. It is proposed that all sewage and grey water generated in Breakwater Cove will be connected into Townsville's existing sewage treatment facilities with adequate sewage pumping capacity provided for the Projected maximum demand. Recycled water is not envisaged to be used in the Breakwater Cove Precinct and therefore the potential for the use of recycled water to cause infection by the transmission of bacteria and/or viruses is negligible.

4.14.4.6 Monitoring Regimes

Monitoring regimes for air quality, noise emission and water quality are outlined in the EMP contained in Section 5.

4.15 Economy

4.15.1 Description of environmental values

The Townsville regional economy has exhibited sustained growth for the past decade. The economy is diverse and is expected to continue its solid performance into the future.

Over the past decade the Townsville region has experienced a number of significant projects including the development of the zinc refinery and other minerals processing facilities. As well, the city has experienced significant growth in construction and industry activity with numerous residential and commercial developments taking place or in the planning process.

At the same time, The Strand redevelopment has delivered sustained economic and social benefits to the city and the region. It has been able to assist in the growth in regional tourism and improved city livability for residents across the Twin Cities.

As a result of these projects, the region and city's economy have sustained strong economic growth and employment growth, fuelling above-average levels of population growth.

Like all construction projects, the TOT project requires access to a range of factor inputs from labour and resource/materials markets. The present study concludes that the regional labour market is tight in terms of supply and demand. Recent growth in employment in construction-related areas points to the attractiveness of the city to skilled workers, and it is likely that the workforce required by the project will be drawn from a combination of locally supplied labour and migrant labour.

There is limited dedicated cruise shipping infrastructure in Queensland. This is particularly the case in Townsville. There is an acknowledged need for such infrastructure to be developed in various areas of Queensland including Townsville so as to position the State to capture the potential that is inherent in the growth of the international cruising industry.

The superyacht sector has experienced rapid growth (from a small base) over the past five years, with significant activity evident in Darwin, Cairns and the Whitsundays. Additional superyacht facilities are needed, in light of the ongoing growth of the sector.

There is a significant undersupply of general marina facilities in Queensland. Available data indicates that there are at least 2,000 people on waiting lists (as of 2004-05) for marina berths in Queensland. We anticipate that this waiting list has increased since that time. Additional marina facilities along the Queensland coast would go a long way towards meeting this need. Facilities being proposed or currently being developed in North and Far North Queensland are a clear response to this market shortage.

Queensland as a whole and the Townsville region specifically, has been experiencing rapid population growth. This has placed considerable pressure on urban infrastructure and services including housing. In the Townsville region, while the housing market reflects general tight conditions (between supply and demand) via increased prices for housing, the situation in the city is less dire than other areas of Queensland where there is a demonstrable affordability 'crisis' (e.g. Mackay). However, as in all local markets where there are tight supply conditions, the development of additional housing stock would assist in meeting future demand.

The Port of Townsville is located south of the project site, separated by Ross Creek. Adjacent to the project site is the Townsville Casino and Entertainment Complex and future residential development land. The port is expected to grow into the future, and has prepared a master plan to cater for this growth.

4.15.2 Potential impacts and mitigation measures

The Townsville regional residential rental market is tight, with vacancy rates of less than 1%. Any additional workforce would contribute to anticipated demand for rental accommodation.

This report has considered known proposals for future expansion of the port and the potential impacts of the TOT on such expansion plans. Core concerns amongst port users relate to what are described as political risks associated with residential/community complaints about port and/or port user activities; that is, changes to the legislative or regulatory environment in direct response to increased complaint activity from residents.

Based on an assessment of available evidence on community or residential complaints about port or port user activities, technical reports on noise and air quality impacts from current and future port operations, together with a spatial assessment of the proximity of the TOT residential elements and future port growth, our conclusion is that while complaints from residents are to be expected into the future along similar volumes to recent experience, all other things remaining equal, we do not believe that the likelihood of regulatory changes occasioned by residential complaints in the foreseeable future is high.

The project will give rise to substantial direct and indirect (flow-on) economic impacts cutting across a broad range of economic sectors in the region. Businesses operating in these sectors will face opportunities to capture some of this activity.

The downstream economic impacts of the TOT project will generate opportunities for future businesses resulting from demand for a range of products and services from various industries (the details are in the Input-Output tables). The opportunity for future businesses lies in responding to this demand. More broadly the project could have catalytic long-term effects on investment and growth in the city's ocean-based tourism sector e.g. mini-cruisers etc. similar to the sector that emerged in the Whitsundays.

The project in and of itself offers little new commercial space. However, should downstream economic impacts drive local business growth, demand for commercial premises may increase.

Similarly, the release of additional ocean-front land for residential development will create significant opportunities for the local development and construction sector.

The table summarises the estimated direct and flow-on economic impact of the project for 2008 and 2009 (construction phases).

TOT Construction Impacts 2008-09	Direct Effects	Indirect Effects	Induced	Total Impacts
Output ($)	209,349,980	87,452,184	74,272,443	371,074,601
Value added ($)	96,701,528	38,364,115	39,808,281	174,873,922
Labour income ($)	62,803,244	20,896,586	17,341,939	101,041,770
Employment*	1,048	446	419	1,913

* Number of jobs (full-time equivalent)

The Ocean Terminal facility will contribute an important piece of tourism economic infrastructure, which will assist in attracting increased visitations by passenger and naval vessels to Townsville. It is also conceivable that such a facility could catalyse the diversification and deepening of the marine-oriented tourism sector in Townsville similar to the development of the cruising tourism product in places such as Airlie Beach (the Whitsundays). The net annual economic impacts of increased cruise tourism (medium scenario – 15 visiting ships per year) are as follows:

Cruise Tourism Annual Impacts	Direct Effects	Indirect Effects	Induced	Total Impacts
Output ($)	3,970,496	1,768,161	1,282,741	7,021,398
Value added ($)	1,913,512	803,247	687,519	3,404,279
Labour income ($)	1,039,337	406,222	299,508	1,745,068
Employment*	23.4	8.2	7	38.6

* Number of jobs (full-time equivalent)

While the construction of the residential elements of Breakwater Cove is not strictly part of the City Pacific Limited investment, we have undertaken an analysis of its economic impacts. The total economic impacts of the construction of residential dwellings on Breakwater Cove (200 detached and 500 units) is as follows:

Breakwater Cove Residential Dwelling Construction	Direct Effects	Indirect Effects	Induced	Total Impacts
Output ($)	168,405,024	168,405,024	38,554,502	283,028,750
Value added ($)	68,575,680	68,575,680	20,664,307	121,816,703
Labour income ($)	25,348,500	25,348,500	9,002,126	52,450,356
Employment*	772.9	772.9	208.9	1,352.10

* Number of jobs (full-time equivalent)

Those seeking to invest in the project can do so indirectly via investing in City Pacific Limited, a public company. Alternatively when development sites become available members of the community will be able to purchase them.

It is not anticipated that there will be costs to government for additional infrastructure.

A number of concepts have been mooted about future developments in and around the Port-CBD interface, particularly Flinders Street East and Palmer Street precinct. The TOT development may act as a catalyst for some of these developments, particularly if a physical connection is established between the TOT/Casino/Entertainment Centre precinct and the south bank.

In terms of distribution effects, a broad range of industries are expected to benefit from the economic activity generated during and after construction. There are no anticipated distribution effects on disadvantaged groups.

A broad range of factors impact on local property values. It is possible that the provision of improved amenity for nearby residents will go towards improving property values within the nearby suburbs. However, the release of additional residential product into the market may also exert some downward pressure on price growth, by altering the demand-supply conditions of the local residential market.

The net gains to the regional economy are in the order of $2-4.7m of annual value added impact and 23 to 53 full-time equivalent jobs as a result of increased cruise ship visitation to the region. The value added impact represents approximately 0.2-0.46% of annual GRP (2006).

Consultation with industry stakeholders have indicated that there are no foreseen adverse impacts on future regional development resulting from the proposed use of significant quantities of quarry material.

In terms of compatibility with the Port, the assessment concludes that there should be a continuing expectation of some complaints from the community about the port and port user activities in line with historical experiences, but that it is unlikely that such complaints will substantially change in volume from present levels or as a direct result of the proposed TOT project or from anticipated port development, provided that noise and air emissions from port users remain within appropriate and mandated levels.

Amenity and reverse amenity issues related to the proximate location of residential and industrial port uses were also considered. While there is a notional conflict, evidence from local residents' experiences indicates that they are willing to trade-off the disamenities against the amenity of proximity to CBD, The Strand and the ocean. Previous port protection instruments utilised to manage the relationship between the port and nearby residents, to provide the port and its users with enhanced certainty, are likely to be effective instruments for the TOT development.

Further, the port enjoys significant levels of goodwill from the vast majority of the residential population in Townsville and therefore, the political risk of complaint-induced regulatory or legislative change is under present circumstances unlikely.

Finally technical assessments of noise and air emission impacts indicate that port growth is not expected to result in increases in noise and air pollution to unacceptable levels; further, mitigation measures have been proposed to effectively address anticipated noise increases resulting from port development.

Cost Benefit Analysis

A cost benefit analysis was undertaken by evaluating the project's economic viability in Net Present Value (NPV) terms. The assessment, undertaken by Transpac Consulting, concluded that the project's viability is significantly enhanced by the inclusion of the Breakwater Cove residential precinct, compared to the economics of an ocean terminal project on its own (that is, without a residential component).

The NPV analysis was undertaken on the basis of a 30-year time horizon. Sensitivity tests were undertaken to validate the robustness of this assessment. The assessment was also undertaken on a range of assumptions concerning:

- Breakwater Cove precinct residential sales values; and
- Annual cruise ship visitations.

The economic analysis, on the basis of conservative Breakwater Cove residential sales and high-range cruise ship visitations (20 per year) found the following Benefit-Cost Ratios (BCR) for the following two alternatives:

- Ocean Terminal only: BCR = 0.94; and
- Integrated Ocean Terminal and Breakwater Cove residential development: BCR = 1.034.

A positive BCR indicates that the project is economically justified. On the analysis, therefore, the integrated development is more viable than a stand-alone ocean terminal facility.

Economic Impact on Ecosystem Services

Planetary species including humans interact with one another in many ways. These interactions among and between species are what define ecosystems.

Ecosystems in turn, provide many 'services' from which humans benefit. Ecosystem services are the transformation of a set of natural assets (soil, plants and animals, air and water) into things that we value. For example, when fungi, worms and bacteria transform the raw 'ingredients' of sunlight, carbon and nitrogen into fertile soil this transformation is an ecosystem service. However, should natural assets decline, so do the benefits. Conversely, if natural assets are effectively maintained, benefits through greater returns can be expected.

Some other examples of ecosystem services that come from nature include:

- Pollination
- Fulfilment of people's cultural spiritual and intellectual needs
- Regulation of climate
- Insect pest control
- Maintenance and provision of genetic resources
- Maintenance and regeneration of habitat
- Provision of shade and shelter
- Prevention of soil erosion
- Maintenance of soil fertility
- Maintenance of soil health
- Maintenance of healthy waterways
- Water filtration
- Regulation of river flows and groundwater levels
- Waste absorption and breakdown

The economic value of such ecosystem services is not well understood. The capacity to ascribe economic value is closely related to the potential for the creation of functional markets for such services, which is very much at an embryonic stage in national public policy formation (see Productivity Commission, 2002, *Creating Markets for Ecosystem Services*).

The TOT project is most likely to have potential to impact on such ecosystem services as:

- Regulation of climate (climate change impacts of Greenhouse Gas emissions)
- Maintenance and regeneration of habitat
- Maintenance of healthy waterways
- Water filtration, and
- River flows.

An assessment of the project's impact on Greenhouse Gases was undertaken. The assessment estimated that there would be:

- Aggregate GHG emission (as CO2-e) of 63,364 tonnes for the construction phase of the project and 51,353tonnes per annum for the operational phase, and

- The change in land use is expected to result in a net increase in sequestration for the first hundred years, relative to the existing sequestration rate of the marine area that will be reclaimed.

A range of measures have been identified to manage and minimise GHG emissions during construction and post-construction.

The various environmental assessments undertaken as part of the EIS investigations have identified that the TOT project site is already a highly modified ecosystem and the development is not expected to significantly adversely affect the capacity of the existing habitat to regenerate.

Hydraulic, tidal and water quality evaluations have found that the TOT project – during and post construction – is not expected to generate adverse impacts on water quality or result in changes to tidal patterns within the area.

On the basis of these assessments, it can reasonably be concluded that current ecosystem services provided in and around the project site will not be adversely or significantly disrupted as a result of the project. Where potential impacts have been identified, a range of management and mitigations measures have been proposed.

4.16 Hazard and Risk

A hazard and risk assessment consistent with the AS/NZS *Risk Management Standard* 4360:2004 has been conducted by Hyder Consulting for the TOT Project. The analysis comprises estimating risk in terms of likelihood of occurrence and the severity consequence, combining these elements to obtain a level of risk and comparing this level against predetermined criteria.

In order to conduct an initial risk assessment, potential impacts have been identified for each aspect of the Project. In this qualitative level of analysis, the magnitude of potential consequences and likelihood of the consequences occurring are described in words. The initial risks were derived from the Project consultants' reports.

4.16.1 Description of Environmental Values

The environmental values that may be affected by hazardous materials and actions associated with the TOT Project include the values of receiving environments as identified below and described by site-specific investigations undertaken during preparation of this EIS. Cross-references to sections of the EIS where relevant environmental values are described are provided in Table 4.16.1.1.

Table 4.16.1.1: Environmental values potentially affected by the Project

Environmental Values	Section of the EIS
Port of Townsville operations	2.2
Soils, geology and adjacent land uses	4.2.1
Traffic and transport infrastructure and marine infrastructure	4.3.1
Local government infrastructure and service providers	4.4.1
Surface water quality, downstream water uses, groundwater resources and coastal environments	4.6.1 and 4.7.1
Local air quality, public amenity and well-being	4.8.1
Visual amenity and landscape character	4.9.1.
Ambient noise levels and noise sensitive receptors	4.10.1
Flora and fauna species, communities and habitats	4.11.1

Environmental Values	Section of the EIS
Areas and objects of cultural heritage significance	4.12.1
Community facilities, social amenity and well-being	4.13.1
Health and safety of community and workforce	4.14.1
Economic activities including Port of Townsville, commercial, tourism, recreation and business activities.	4.15.1

The degree and sensitivity of risk is detailed in the Project Risk Registers contained in the Hazard and Risk Assessment report provided in Appendix 24.

4.16.2 Potential Impacts and Mitigation Measures

Workplace health and safety impacts may occur during both operation of the ocean terminal and during site construction works. Potential impacts associated with workplace emergencies are outlined in the Health & Safety Report in Appendix 22.

Public safety impacts may arise during operation of the ocean terminal. Management of large crowds by security personnel in consultation with local fire and rescue services, police, ambulance services and local hospitals is outlined in the Health and Safety Report in Appendix 22.

Townsville and Thuringowa City Councils have developed a Local Disaster Management Plan (LDMP) to manage potential risks to the community during disaster events. This plan identifies the potential threats to communities within the local government areas as detailed in the Health and Safety Report. These natural and induced emergency situations will be relevant during operation of the Breakwater Cove and Ocean Terminal precincts. The major risks identified by the LDMP included:

- Flooding
- Cyclone, severe storm and storm tide
- Road and rail accidents
- Disease outbreaks

The operator of the TOT facility will be required to prepare a site-specific Workplace Health and Safety Plan (WHSP) to ensure protection of employees and visitors to the ocean terminal. During the construction phase, the principal contractor will be required to provide a WHSP to ensure implementation of health and safety principles for all contractors engaged to work on the construction site.

In order to prevent public safety impacts during operation of the TOT, an emergency response plan will be prepared for the ocean terminal facility. Emergency procedures will include coordination of security personnel with local emergency services, crowd surveillance and control and evacuation processes.

The Townsville Thuringowa Local Disaster Management Group has developed systems for management of disaster events. In addition, a Disaster Action Plan will be developed for the site to provide prevention and response measures for preservation of life and property in the event of a natural hazard such as a storm, flood or cyclone.

The Disaster Action Plan will inform residents of the characteristics of the site and its environs and provide details of the evacuation processes in case of an emergency. The Body Corporate Manager will be responsible for educating the residents in relation to being aware of emergency

agency warnings and monitoring the Bureau of Meteorology and SES reports in relation to possible events and provide timely and adequate advice of such reports to all residents and occupants of the site.

Flood Hazard Management Plan

The minimum design level of R.L 3.2m for the TOT Project is adequate to ensure that no adverse impacts due to flooding up to and including the Q100 year Average Recurrence Interval (ARI). An additional freeboard of 0.3m has been provided for all building platforms during the bulk earthworks design. Townsville City Council has confirmed that the minimum flood immunity design level is R.L 3.2m for immunity up to and including the Q100 year storm event. Flooding from runoff from stormwater events will not effect the proposed site up to and including the Q100 year storm event.

Coastal Engineering Solutions (CES) has confirmed that the Q100 year ARI storm tide and associated wave effects constitutes the Designated Storm Tide Event (DSTE) under the State Coastal Plan Policy 2.2.4. The TOT Project complies with the requirements of State Coastal Plan Policy 2.2.4 as follows.

All dwellings are sited so that floors on all habitable rooms are above the DSTE level and are not located within the high hazard zone. Access roads for emergency evacuation purposes are also above the DSTE level.

The proposed works will not adversely increase the storm tide or the associated waves on adjacent foreshores or properties.

The proposed building work is not sited within the high storm tide hazard zone.

The proposed works will not significantly interfere with tidal flows or alter existing hydrological flows.

Reference is made to the CES report *Townsville Ocean Terminal – Coastal Engineering Studies* dated 14th September 2007 which provides extensive comment on flooding assessment.

Port Emergency/Evacuation Procedures

The Port of Townsville manages emergencies and disasters within the Port through implementation of an Emergency Response Plan (ERP). This ERP includes procedures for evacuation of all personnel and visitors from the Port should an emergency occur.

Appropriate emergency services will be notified and will be responsible for any incident requiring response and evacuation. However, Port Users are required to develop and initiate their own Emergency Plan to control the initial response to an emergency within the Port.

The operator of the TOT Precinct will prepare an Emergency Plan in consultation with the TPA and Townsville City Council. This Plan will include procedures to be followed in the event of accidents or incidents. Actions taken within the TOT Precinct during an emergency will be in accordance with all emergency and evacuation procedures required under the Port of Townsville ERP.

Tropical Cyclones

The TPA is responsible for coordinating activities in the event of a tropical cyclone or other extreme climatic events. The TPA outlines general procedures for cyclones and severe weather conditions for ships in port and for small craft owners.

The TOT Operator will prepare an Emergency Plan detailing emergency, evacuation and recovery procedures in response to extreme events. The TOT Operator will be notified of a potential threat by the TPA and will carry out all directions from the TPA and the relevant response agency.

Fire and Explosion

The Queensland Fire and Rescue Service will be responsible for directing a response to any fire within the Port. The TOT Operator will comply with all instructions from the TPA and the response agency as is the requirement for all port users.

Fire-fighting equipment will be provided within the TOT Precinct and will be maintained in accordance with relevant standards and legislation including requirements for equipment testing and inspections and annual evacuation drills. The TOT Operator will be responsible for preventing and managing impacts from fire and explosion within the TOT Precinct.

In the event of an incident requiring response and/or evacuation of the TOT site, the following general procedure would apply:

- TOT Security officers would contact the relevant emergency services and liaise with the TPA;
- TOT Security officers would notify Port Control, the Regional Harbour Master (if required) and other port users that may be affected by the incident;
- TOT Security officers would assess the location and extent of the incident, conduct a search of the area if safe and initiate evacuation procedures if required;
- TOT Emergency Wardens would direct persons within the site during an evacuation and liaise with emergency services;
- TOT Emergency Wardens would ensure that all instructions delivered by the TPA and the emergency services are carried out;
- TOT Security officers would notify Wardens when clearance is given by TPA for a return to normal operations.

Dangerous Goods and Major Hazard Facilities

Major Hazard Facilities within the Port of Townsville

Dangerous goods and operation of Major Hazard Facilities (MHF) where hazardous materials may be stored or handled are currently managed within the Port of Townsville. These materials are managed in accordance with the Hazardous Substances Regulation 1997, the Dangerous Good Safety Management Act 2001 (DGSM Act) and the Dangerous Goods Safety Management Regulation 2001 (DGSM Reg).

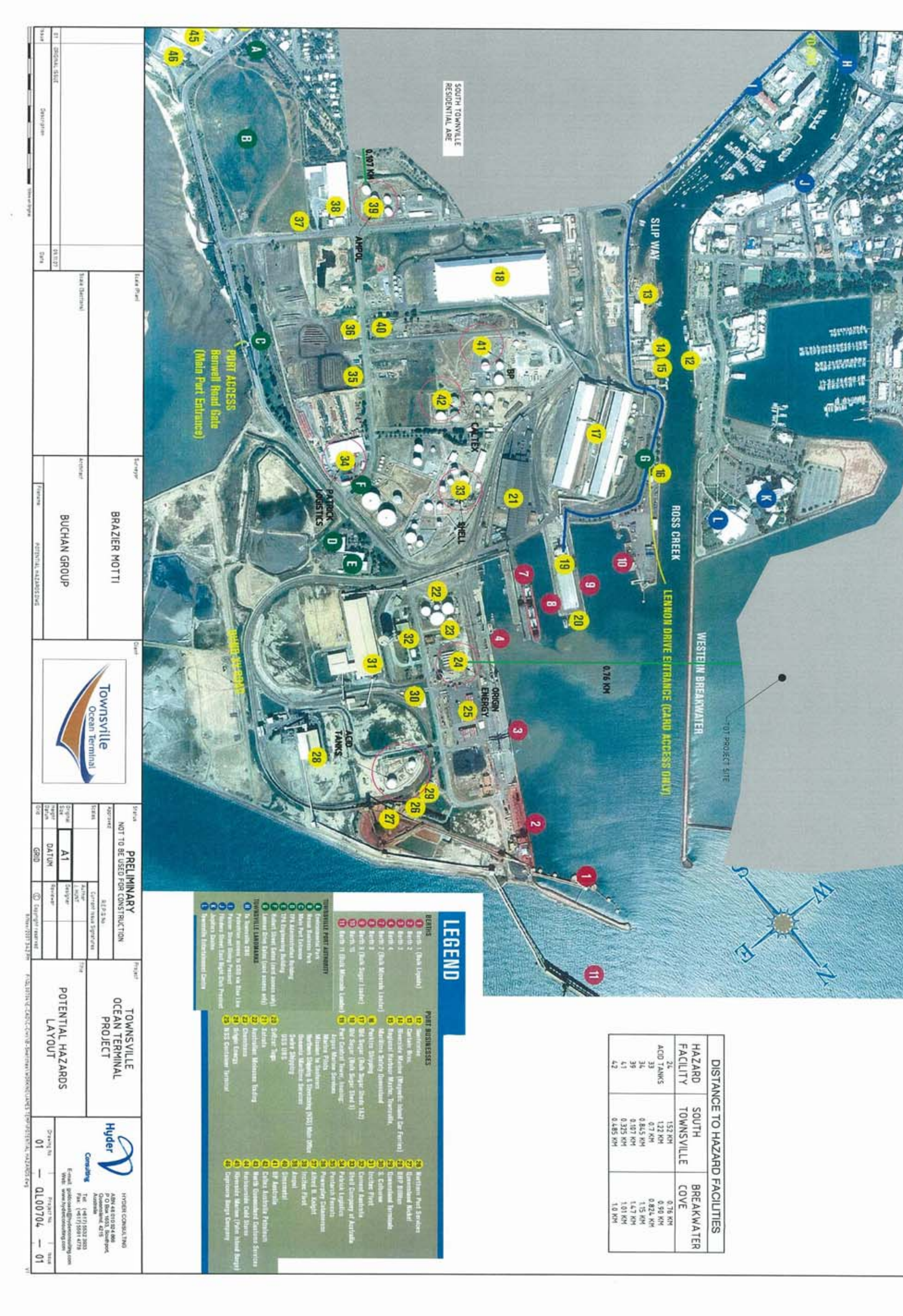
Potential hazards associated with the operation of MHFs include the potential for spillage or accidental release of hazardous substances to air land or water and the potential for fire or explosion as a result of inappropriate storage and handling procedures. These potential hazards present risks to the life and property of future residents within Breakwater Cove as well as other sites within Townsville.

The Origin Energy LPG Terminal within the Port of Townsville is identified as an existing MHF. This facility stores more than 200 tonnes of LPG and is therefore classified as an MHF under the DGSM Act. The facility has operated at the Port for 21 years without major incident. The Origin Energy MHF has recently undergone an audit of safety procedures and management systems by the Queensland Chemical Hazard and Emergency Management (CHEM). The facility was in compliance with all CHEM requirements.

Other storage facilities are classified as Large Dangerous Goods Locations. These include:

- Patrick Logistics;
- Acid storage tanks near Qld Nickel; and
- Ampol, BP, Shell and Caltex fuel storage tanks.

The locations of these facilities and relative distances to the Breakwater Cove Precinct are indicated on Drawing 01-QL00704-01.


PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION
TOWNSVILLE OCEAN TERMINAL PROJECT
POTENTIAL HAZARDS LAYOUT
BRAZIER MOTTI
BUCHAN GROUP
LEGEND
DISTANCE TO HAZARD FACILITIES
ROSS CREEK
WESTERN BREAKWATER
SLIP WAY
SOUTH TOWNSVILLE RESIDENTIAL ARE
PORT ACCESS
Benwell Road Gate
(Main Port Entrance)
LENNON DRIVE ENTRANCE (CARD ACCESS ONLY)

These facilities have the potential to cause accidents that may result in injury, damage to property and the environment and loss of life. The operators of MHFs have obligations under the DGSM Act to minimise the likelihood of accidents and impacts arising from operation of these facilities. Safety obligations include:

- Undertaking systematic risk assessment and risk reduction measures;
- Developing emergency plans and procedures;
- Implementing a safety management system;
- Providing education, training and supervision of MHF personnel; and
- Preparation of safety reports.

It is noted that the proximity of these facilities to the Breakwater Cove Precinct is comparable to the proximity to other potentially impacted residential sites within South Townsville as indicated on Drawing 01-QL00704-01. The risk of fire and explosion impacts impacts from MHFs on residents of Breakwater Cove is assessed as being a 'Moderate' risk.

Dangerous Cargoes at Port of Townsville

The Port of Townsville has approved limits for loading and unloading of Class 1 Explosives and Security Sensitive Ammonium Nitrate at Berths 1 to 4 and 7 to 11. These berths are in closer proximity to the Breakwater Cove Precinct than major hazard facilities and the future residences of Breakwater Cove would be within the zone of influence should an explosion occur at one of these berths.

The Port of Townsville complies with the Australian Standard for the Handling and Transportation of Dangerous Cargoes in Port Areas in order to minimise risks of injury and loss of life or property. The risk of impacts from explosive substances on residents of Breakwater Cove is assessed as being a 'Moderate' risk.

Dangerous Goods Inventory for the TOT Project

Hazardous substances and dangerous goods may be stored at or transported to and from the TOT project site. The requirements for safe handling and transport of dangerous goods within Ports are documented by the Australian Standard AS3846, *The Handling and Transport of Dangerous Cargoes in Port Areas*. The operator of the TOT Precinct will implement these requirements for handling and transport of dangerous goods.

Dangerous goods that are to be stored and handled within the TOT project site will be recorded in a register and will be stored with the relevant Material Safety Data Sheet (MSDS) for each substance. Adequate signage providing visual warning of the hazards associated with dangerous goods present at the TOT project site will be displayed if substances are stored in tanks or if the volume exceeds the quantity specified in Schedule 1 of the DGSM Regulation. Any fuel storage tanks installed within the TOT Precinct will comply with the Australian Standard AS 1940:1993 *The Storage and Handling of Flammable and Combustible Liquids*.

The TOT project will use a number of hazardous substances such as fuel and oil that are regulated by the Australian Dangerous Goods Code, including substances in the following classes.

Class 2.1 - Flammable gases

The construction and operational phases (for domestic uses) may include the following:

- Liquefied petroleum gas (LPG)
- Liquefied natural gas (LNG)
- Acetylene.

Class 2.2 - Non-flammable, non-toxic gases

The construction phase may include mobile units for maintenance of vehicles:

- Compressed air

Class 3 - Flammable liquids

The construction and operational phases (for domestic uses) may include the following in small quantities

- Unleaded petrol
- Kerosene

Class 6.1 - Toxic substances

Examples that may exist on site in small quantities

- Pesticides.

Class 9 - Miscellaneous dangerous goods

Examples of class 9 goods that may be utilised on site for road construction include:

- Molten bitumen.

Risk Assessment

The risk assessment has generated Project Risk Registers for both the construction and operation phases of development. These Registers are provided in the Hazard and Risk Assessment Report contained in Appendix 24. These registers provide a summary of identified risks, risk treatment measures and the residual Project risks that require management. The Project elements with high residual risks are described below.

Climate

Following risk treatment, risks associated with climatic events were predominantly assessed as low to moderate. However, high residual risks include:

- Strong winds caused by tropical cyclones or low pressure systems during construction;
- Increased frequency and intensity of cyclones due to climate change during operation; and
- Strong winds caused by tropical cyclones or low pressure systems during operation.

Climate risks are applicable to all development in the region and appropriate design measures are required to manage potential impacts. All requirements of Townsville City Council are met by the Project in this regard.

Construction Risks

The potential risks associated with construction of the TOT Project will be mitigated by measures provided in the Project EMP. High residual risks associated with construction include:

- Dredge spoil unsuitable as fill material;
- Construction workplace health and safety impacts; and
- Parklands settlement (during operation).

Negotiations with the Townsville Port Authority are being undertaken to determine if dredge spoil disposal may be possible within the Port of Townsville. The construction contractor will be required to prepare a Workplace Health and Safety Plan to prevent health and safety impacts on the construction workforce. Parkland settlements will be monitored and any major settlements will be remediated as required.

Traffic and Transport

Residual risks associated with Project traffic were predominantly assessed as negligible to moderate. However, a high residual risk associated with the construction phase traffic is:

- Noise associated with haul routes.

Elevated noise levels along construction haul routes will be short-term and haulage vehicle noise will be mitigated by adherence to the control measures outlined in the Project EMP.

Air Quality

Construction air emissions can be controlled by implementation of the control measures outlined in the Project EMP. However, high residual risks are associated with airborne pollutants from the Port of Townsville including:

- Emission of gaseous pollutants from existing and future Port operations.

Ongoing monitoring of gaseous substances within the Project Site is being undertaken and design criteria for future buildings within the Project Site will be incorporated into the Port Protection Code.

Other Project Risks

All other Project risks considered during this hazard and risk assessment were able to be mitigated by application of risk treatment measures and the residual risk associated with the following elements were assessed as being negligible to moderate:

- Visual Amenity and Lighting
- Noise and Vibration (excluding construction traffic noise as detailed above)
- Nature Conservation
- Cultural Heritage
- Social Impacts

- Health and Safety
- Economic Impacts
- Non-Transport Infrastructure
- Waste
- Water Resources
- Coastal Resources
- Land
- TOT Operations

All Project hazards and risks will be carefully monitored during both the construction and operation phases and management strategies required by the Project EMP will be reviewed on an ongoing basis and modified where necessary to ensure health and safety aspects are managed.

4.17 Cross Reference with Terms of Reference

Element of the TOR		EIS Section No.	Relevant Expert Report
Executive Summary			
Glossary			
1	**INTRODUCTION**	1	
1.1	Project Proponent	1.1	
1.2	Project Description	1.2, 3.2, 3.3	
1.3	Project objectives and scope	1.3	
1.4	The EIS Process	1.4	
1.5	Public consultation process	1.5, 4.13	Appendix 21
1.6	Project approvals	1.6, 3.3	Appendix 2
1.7	Accredited process for controlled actions under Commonwealth legislation	1.7, 4.11	Appendix 3, Appendix 19
2	**PROJECT NEED AND ALTERNATIVES**	2	
2.1	Project Justification	2.1, 4.15	Appendix 23
2.2	Compatibility with the Port of Townsville	2.2	Appendix 9, Appendix 15, Appendix 16, Appendix 17, Appendix 21, Appendix 22
2.3	Alternatives to the Project	2.3	
3	**DESCRIPTION OF THE PROJECT**	3, 1.2	
3.1	Ecologically Sustainable Development	3.1, 4.13, 4.15	Appendix 21, Appendix 23, Chapter 5
3.2	Location	3.2	
3.3	Concept master plan	3.3	
3.4	Construction	3.4	Appendix 5
3.4.1	Construction methodology and sequencing	3.4.1	Appendix 5
3.4.2	Construction of the TOT precinct	3.4.2	Appendix 5
3.4.3	Construction of the Breakwater Cove precinct	3.4.3, 3.7	Appendix 5
3.4.4	Material extraction and delivery	3.4.4	Appendix 15
3.5	Operations	3.5, 3.6	Appendix 14, Appendix 12
3.5.1	Operation of the Townsville Ocean Terminal precinct	3.5, 3.6	Appendix 14, Appendix 12
3.5.2	Operation of the Breakwater Cove precinct	3.5, 3.6	Appendix 14, Appendix 12
3.6	Rehabilitation and decommissioning	3.6, 4.11	Appendix 19, Appendix 5
3.7	Land Tenure	3.7	
4	**ENVIRONMENTAL VALUES AND MANAGEMENT OF IMPACTS**	4	
4.1	Climate	4.1	Appendix 7

Element of the TOR		EIS Section No.	Relevant Expert Report
4.2	Land	4.2	Appendix 8, Appendix 12
4.2.1	Description of environmental values	4.2.1	
4.2.1.1	*Topography/geomorphology/bathymetry*	4.2.1.1	Appendix 8, Appendix 12, Appendix 13
4.2.1.2	*Geology*	4.2.1.2	Appendix 8
4.2.1.3	*Soils*	4.2.1.3	Appendix 8
4.2.1.4	*Land use*	4.2.1.4	
4.2.1.5	*Acid Sulfate Soils*	4.2.1.5	Appendix 8, Appendix 12
4.2.1.6	*Contaminated Land*	4.2.1.6	Appendix 12
4.2.1.7	*Sensitive environmental areas*	4.2.1.7 and 4.11	Appendix 19
4.2.2	Potential impacts and mitigation measures	4.2.2	Appendix 8
4.2.2.1	*Land use suitability*	4.2.2.1	
4.2.2.2	*Soil erosion*	4.2.2.2	Appendix 8
4.2.2.3	*Settlement*	4.2.2.3	Appendix 8
4.2.2.4	*Acid Sulphate Soils*	4.2.2.4	Appendix 8, Appendix 12
4.2.2.5	*Contaminated Land*	4.2.2.5	Appendix 12
4.3	Traffic and Transport	4.3	Appendix 9
4.3.1	Existing transport infrastructure	4.3.1	Appendix 9
4.3.2	Potential impacts and mitigation measures – land based transport	4.3.2	Appendix 9
4.3.3	Potential impacts and mitigation measures – marine transport	4.3.3	
4.4	Non-transport infrastructure	4.4	Appendix 10
4.4.1	Description of environmental values	4.4.1	Appendix 10
4.4.2	Potential impacts and mitigation measures	4.4.2	Appendix 10
4.4.2.1	*Energy*	4.4.2.1	Appendix 10
4.4.2.2	*Water supply and storage*	4.4.2.2	Appendix 10
4.4.2.3	*Stormwater drainage*	4.4.2.3	Appendix 10
4.4.2.4	*Sewerage*	4.4.2.4	Appendix 10
4.4.2.5	*Telecommunications*	4.4.2.5	Appendix 10
4.4.2.6	*Other infrastructure*	4.4.2.5	Appendix 10
4.5	Waste	4.5	Appendix 11
4.5.1	Character and quantities of waste materials	4.5.1	Appendix 11
4.5.1.1	*Solid waste disposal*	4.5.1.1	Appendix 11
4.5.1.2	*Liquid waste*	4.5.1.2	Appendix 11, Appendix 10, Appendix 12
4.5.2	Description of environmental values	4.5.2	Appendix 11

Element of the TOR		EIS Section No.	Relevant Expert Report
4.5.3	Potential impacts and mitigation measures	4.5.3	Appendix 11
4.6	Water resources	4.6	Appendix 12
4.6.1	Description of environmental values	4.6.1	Appendix 12
4.6.1.1	*Surface waterways*	4.6.1.1	Appendix 12, Appendix 14
4.6.1.2	*Groundwater*	4.6.1.2	Appendix 12
4.6.2	Potential impacts and mitigation measures	4.6.2	Appendix 12
4.6.2.1	*Surface water and water courses*	4.6.2.1	Appendix 12
4.6.2.2	*Groundwater*	4.6.2.2	Appendix 12
4.7	Coastal environment	4.7	Appendix 13
4.7.1	Description of environmental values	4.7.1	Appendix 12, Appendix 13
4.7.1.1	*Water quality*	4.7.1.1	Appendix 12
4.7.1.2	*Coastal processes*	4.7.1.2	Appendix 13
4.7.2	Potential impacts and mitigation measures	4.7.2	Appendix 12, Appendix 13
4.7.2.1	*Water Quality*	4.7.2.1	Appendix 12
4.7.2.2	*Coastal Processes*	4.7.2.2	Appendix 13, Appendix 14
4.8	Air	4.8	Appendix 15
4.8.1	Description of environmental values	4.8.1	Appendix 15
4.8.1.1	*Greenhouse gas emissions*	4.8.1.1	Appendix 15
4.8.2	Potential impacts and mitigation measures	4.8.2	Appendix 15
4.8.2.1	*Greenhouse gas abatement*	4.8.2.1	Appendix 15
4.9	Visual amenity and lighting	4.9	Appendix 16
4.9.1	Description of environmental values	4.9.1	Appendix 16
4.9.1.1	*Landscape character*	4.9.1.1	Appendix 16
4.9.1.2	*Visual amenity*	4.9.1.2	Appendix 16
4.9.2	Potential impacts and mitigation measures	4.9.2	Appendix 16
4.9.2.1	*Landscape character*	4.9.2.1	Appendix 16
4.9.2.2	*Visual amenity*	4.9.2.2	Appendix 16
4.9.2.3	*Lighting*	4.9.2.3	Appendix 16
4.10	Noise and vibration	4.10	Appendix 17
4.10.1	Description of environmental values	4.10.1	Appendix 17
4.10.2	Potential impacts and mitigation measures	4.10.2	Appendix 17
4.11	Nature conservation	4.11	Appendix 19, Appendix 3
4.11.1	Description of environmental values	4.11.1	Appendix 19, Appendix 3
4.11.1.1	*Flora*	4.11.1.1	Appendix 19, Appendix 3

Element of the TOR		EIS Section No.	Relevant Expert Report
4.11.1.2	*Terrestrial fauna*	4.11.1.2	Appendix 19, Appendix 3
4.11.1.3	*Aquatic biology and fisheries*	4.11.1.3	Appendix 19, Appendix 3
4.11.2	Potential impacts and mitigation measures	4.11.2	Appendix 19, Appendix 3
4.11.2.1	*Flora and Fauna*	4.11.2.1	Appendix 19, Appendix 3
4.11.2.2	*Aquatic Ecology and Fisheries*	4.11.2.2	Appendix 19, Appendix 3
4.12	Cultural heritage	4.12	Appendix 20
4.12.1	Description of environmental values	4.12.1	Appendix 20
4.12.1.1	*Indigenous Cultural Heritage*	4.12.1.1	Appendix 20
4.12.1.2	*Non-Indigenous Cultural Heritage*	4.12.1.2	Appendix 20
4.12.2	Potential impacts and mitigation measures	4.12.2	Appendix 20
4.13	Social	4.13	Appendix 21
4.13.1	Description of environmental values	4.13.1	Appendix 21
4.13.2	Potential impacts and mitigation measures	4.13.2	Appendix 21
4.14	Health and safety	4.14	Appendix 22
4.14.1	Description of environmental values	4.14.1	Appendix 22, Appendix 15, Appendix17
4.14.2	Potential impacts and mitigation measures	4.14.2	Appendix 15, Appendix 17, Appendix 22
4.15	Economy	4.15	Appendix 23
4.15.1	Description of environmental values	4.15.1	Appendix 23
4.15.2	Potential impacts and mitigation measures	4.15.2	Appendix 23
4.16	Hazard and risk	4.16	Appendix 24
4.16.1	Description of environmental values	4.16.1	Appendix 24
4.16.2	Potential impacts and mitigation measures	4.16.2	Appendix 24
4.16	Cross-reference with the Terms of Reference	4.16	
5	**ENVIRONMENTAL MANAGEMENT PLAN**	5	
6	**REFERENCES**	6	
7	**APPENDICES (compilation)**	7	