TOWNSVILLE OCEAN TERMINAL: DOLPHINS, DUGONGS AND MARINE TURTLES REPORT

FINAL REPORT

Produced for City Pacific Limited.

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EXECUTIVE SUMMARY

0.1 AES Applied Ecology Solutions Pty Ltd was commissioned by City Pacific Limited to do a detailed ecological impact assessment of the proposed Townsville Ocean Terminal (TOT) project on Australian Snubfin Dolphin *Orcaella heinsonhi*, Indo-Pacific Humpback Dolphin *Sousa chinensis*, Dugong *Dugong dugon* and marine turtles. Marine turtles that regularly occur at the TOT site are Green Turtle *Chelonia mydas* and Flatback Turtle *Natator depressus*.

0.2 Neither dolphin species nor Dugong are thought to occur within the TOT itself. Green Turtles are widespread throughout Cleveland Bay and have been observed within the proposed TOT, although along with Dugongs, this species occurs at highest density in the more permanent seagrass beds in the far east of the Bay, several kilometres from the proposed TOT. Australian Snubfin Dolphin and Indo-Pacific Humpback Dolphins appear to favour the main edge of the Ross River Plume, which rarely if ever extends beyond the shipping channel.

0.3 Habitat within the proposed TOT itself is unlikely to play a significant role in driving primary productivity in areas that may be considered "critical" for dolphins, Dugong and marine turtles. Seagrass within the proposed TOT is ephemeral and the biomass of feeding vertebrates (e.g. seabirds) is very low, compared to areas beyond the Townsville Port Headland.

0.4 Between the areas of highest dolphin density and the proposed TOT is an area of heavy vessel traffic with upwards of 100,000 vessel movements per year. Disturbance / displacement of dolphins is therefore more likely as a result of local traffic (including small vessels launched from the public boat ramp) than it is from the TOT as vessels will enter / exit the TOT site further west and most of those exiting are likely to head north.

0.5 Collision risk is considered one of the major factors affecting population viability of Dugongs in Moreton Bay. A collision risk model for Cleveland Bay suggests that it is an area of much lower risk due to the fact that Dugongs occur principally in only one area and move in a single corridor across the area of heaviest traffic (as opposed to between numerous islands, as in Moreton Bay). The risk of vessel collision as a result of the proposed TOT is extremely small (4×10^{-6}).

0.6 A 'worst-case' noise model for piling predicts relatively rapid decline in noise from the source, due to seabed and sub-surface geology characteristics of the area. Piling within the berth pocket would mean major areas of dolphin activity are shielded from moderate noise levels by the Townsville Port headland. Direct injury from piling noise is not considered possible based on published injury thresholds for this type of noise.

0.7 Other impacts of concern include the introduction of pet-borne lethal pathogens into Cleveland Bay. This can be mitigated by imposing a ban on domestic cats under the body corporate. Maintenance of water quality through appropriate disposal of waste and adequate flushing of the marina is addressed in a separate report on Nature Conservation (C & R Consulting 2007) and would be expected to reduce the consequence to dolphins, Dugongs and marine turtles to a negligible level.

0.8 The potential consequence of fuel / oil spills and introduction of marine pests remains high despite mitigation. These effects are common to all marine projects throughout Australia and cannot be entirely mitigated. It is recommended that existing plans are followed to reduce the likelihood of such events occurring and that response plans are in place to address the outcomes where required.

0.9 If the project proceeds in accordance with the current construction plan and mitigation measures are put in place to minimise environmental effects including ambient lighting and disposal of waste and litter, the impacts from construction and operation are currently considered to be within natural variation or tolerance limits for dolphins, Dugongs and marine turtles.

0.10 In conclusion, the project would appear to be within the limits of sustainability and is not considered likely to give rise to impacts that would be considered to have potential for significant, irreversible or unmanageable impacts on dolphins, Dugongs and marine turtles.

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I. BACKGROUND

I.1 SCOPE OF WORKS

AES Applied Ecology Solutions Pty Ltd was commissioned by City Pacific Limited to do a detailed ecological impact assessment of the proposed Townsville Ocean Terminal (TOT) Project on Australian Snubfin Dolphin *Orcaella heinsonhi*, Indo-Pacific Humpback Dolphin *Sousa chinensis*, Dugong *Dugong dugon* and marine turtles. Marine turtles that occur in the area include Green Turtle *Chelonia mydas*, Loggerhead Turtle *Caretta caretta*, Hawksbill Turtle *Eretmochelys imbricata*, Olive-Ridley Turtle *Lepidochelys olivacea*, Leatherback Turtle *Dermochelys coriacea* and Flatback Turtle *Natator depressus*.

This report particularly focuses on species within the above groups that are listed under Part 3 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) – see section I.2.2.

Figure I.1-1: The site situation with respect to Townsville and the Townsville Port.

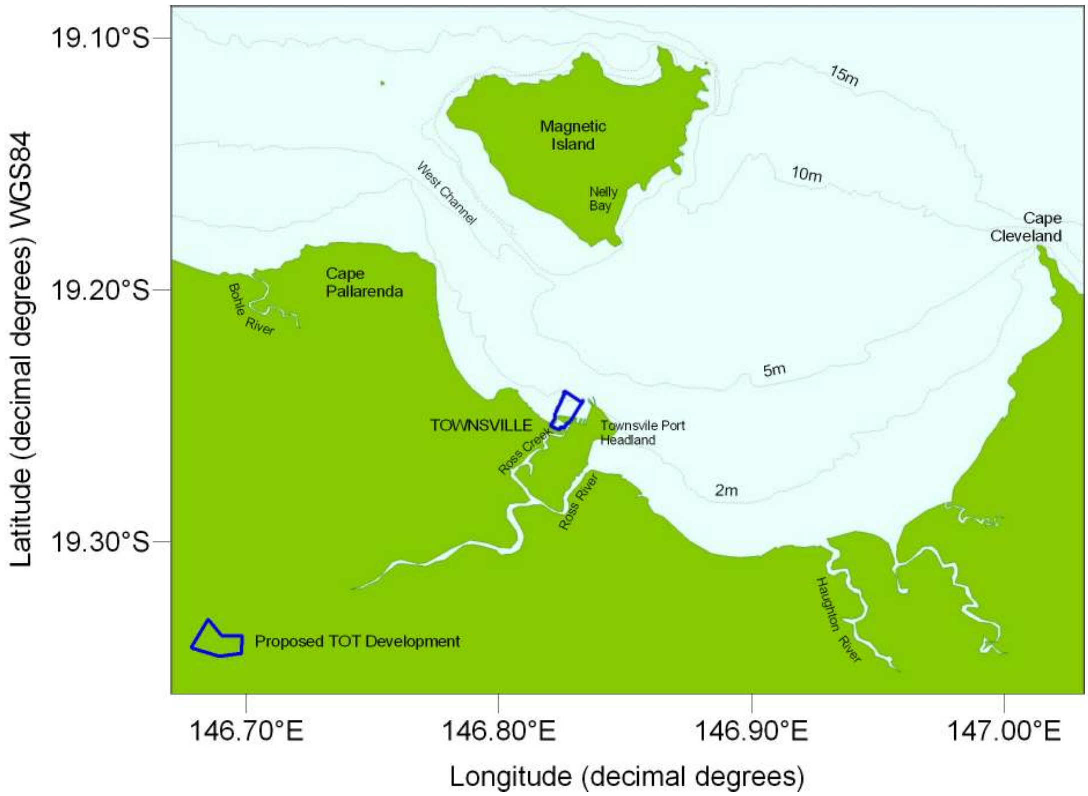


Figure I.1-2: Map of Cleveland Bay

In preparing this report, AES has the Scope of Work detailed in Table I.1-1.

Table I.1-1: Scope of works (with relevant sections of this report in brackets)

Scope of Work
Preparation of the report will include the following key tasks: ▪ An existing conditions section summarising the findings in associated project reports (see section II); ▪ A review of the impacts of the project (summarising the findings in associated project reports, see section III); ▪ A table of impacts (see Table III.8-2) with proposed mitigation strategies (detailed separately in section III.9); ▪ An assessment of post-mitigation [residual] impacts (see section III.10); ▪ Recommendations for monitoring and / or offsets, following discussions with Department of Primary Industries & Fisheries (DPIF) (see section III.9.3); ▪ Response to submissions and incorporation of reasonable comments from third party consultees (see Table I.1-2); ▪ An assessment of significance / sustainability (see section III.11).

I.1.1 EIS Terms of Reference

I.1.1.1 Environmental values and management of impacts

Relevant requirements of the EIS as outlined in the project Terms of Reference:

- Describe the existing environmental values of the area which may be affected by the Project including values and areas that may be affected by any cumulative impacts. It should be explained how the environmental values were derived (e.g. by citing published documents or by following a recognised procedure to derive the values).

- Describe quantitatively the likely impact of the Project on the identified environmental values of the area. The expected cumulative impacts of the Project must be considered over time or in combination with other (all) impacts in the dimensions of scale, intensity, duration or frequency of the impacts. In particular, any requirements and recommendations of relevant State planning policies, environmental protection policies, national environmental protection measures and integrated catchment management plans should be addressed. Examine viable alternative strategies for managing impacts.
- Describe qualitatively and quantitatively the proposed objectives for enhancing or protecting each environmental value. Include proposed indicators to be monitored to demonstrate the extent of achievement of the objective as well as the numerical standard that defines the achievement of the objective (this standard must be auditable). The measurable indicators and standards can be determined from legislation, support policies and government policies as well as the expected performance of control strategies.
- Recommend control strategies for inclusion in the EMP to achieve the objectives: describe the control principals, proposed actions and technologies to be implemented that are likely to achieve the environmental protection objectives; include designs, relevant performance specifications of plant. Details are required to show that the expected performance is achievable and realistic.
- Describe the monitoring parameters, monitoring points, frequency, data interpretation and reporting proposals. Describe how progress towards achievement of the objectives will be measured and reported. Include scope, methods and frequency of auditing proposed.
- State the sources of the information, how recent the information is, how any background studies were undertaken (e.g. intensity of field work sampling), how the reliability of the information was tested, and what uncertainties (if any) are in the information.

I.1.1.2 Assessment of Impacts on Biodiversity

As stated in the project Terms of Reference, the environmental impact statement should describe the values of the affected area in terms of:

- integrity of ecological processes, including habitats of rare and threatened species;
- conservation of resources;
- biological diversity, including habitats of rare and threatened species;
- integrity of landscapes and places including wilderness and similar natural places; and
- aquatic and terrestrial ecosystems.

The EIS should identify issues relevant to sensitive areas, or areas, which may have, low resilience to environmental change. Areas of special sensitivity include the marine environment and wetlands, wildlife breeding or roosting areas, any significant habitat or relevant bird flight paths for migratory species and habitat of threatened plants, animals and communities. The capacity of the environment to assimilate discharges/emissions should be assessed. The Project's proximity to any biologically sensitive areas should be described.

Reference should be made to both State and Commonwealth endangered species legislation and the proximity of the area to the Great Barrier Reef World Heritage Property.

Specific issues to be highlighted include:

- presence of turtles, Dugong, whales, dolphins and other marine mammals within the Project area; and
- an assessment of the value of the marine habitats/ecosystems to fauna of conservation significance such as turtles (including Green Turtle, Leatherback Turtle and Hawksbill Turtle), Dugongs, dolphins (including the Snubfin Dolphin and the Indo-Pacific Humpback Dolphin) and whales.

Short-term and long-term effects should be considered with comment on whether the impacts are reversible or irreversible. Mitigation measures and/or offsets should be proposed for any potential adverse impacts associated with the Project. Any potential net loss of ecological values should be described and justified.

Areas regarded as sensitive with respect to flora and fauna have one or more of the following features (and which should be identified, mapped, avoided or effects minimised):

- sites adjacent to nesting beaches, feeding, resting or calving areas of species of special interest; for example, marine turtles and cetaceans;

Specific issues to be addressed associated with aquatic ecology include:

- describe any loss of seagrasses in relation to the extent and regional significance of seagrass communities and associated impact on fisheries, Dugongs, turtles and dolphins etc;
- discuss the impact of the creation of permanent deep water and the likely colonisation of the marina and marine structures;
- potential impacts associated with dredging and dredge material disposal. Detail the potential environmental harm in the short term to flora and fauna communities from the direct effects of dredging. This should include modelling of the potential effects of the dredge plume (e.g. increased turbidity) and re-suspension and seabed movement of dredge derived sediment on seagrass and other aquatic species within and adjacent to the proposed marina area;
- potential impacts associated with altered tidal conditions (water levels and flows) and degraded water quality;
- a review and risk assessment on noise impacts in relation to marine mammals should be undertaken including a review of previous noise assessments undertaken for the area. The review should concentrate on those species known to be active in the study area (particularly during the proposed periods of dredging and construction activity) and their sensitivity to the expected noise and vibration emission from the proposed activities. Should the risk assessment and the initial review of literature indicate the need for quantitative assessment, a detailed noise and vibration model should be prepared; and
- an assessment of the sensitivity of the receiving environment is to be provided including potential impacts on aquatic fauna (e.g. turtle hatching) and adjacent residents.

I.1.2 EPBC Act Accredited Assessment Process

I.1.2.1 Protected Matters

This project is a controlled action under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Commonwealth has accredited the State's EIS process for the purposes of the Commonwealth's assessment under Part 8 of the EPBC Act.

Matters of National Environmental Significance (NES) that have been identified as controlling provisions include:

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

The matters of NES to be specifically addressed under the requirements of the EPBC Act are, but should not be limited to:

- Humpback Whale *Megaptera novaeangliae*
- Flatback Turtle *Natator depressus*
- Dugong *Dugong dugon*

For listed threatened and migratory species, the description of the environment should include:

- the species' current distribution;
- relevant information about the ecology of the species (habitat, feeding and breeding behaviour etc);
- information about any populations of the species or habitat for the species in the area affected by the proposed action;
- current pressures on the species, especially those in the area to be affected by the proposal; and
- relevant controls or planning regimes already in place.

For further information on EPBC Act controls, see section I.2.2.

I.1.3 Public Submissions

The following comments were received from the public following display of the original EIS. All matters are dealt with in this report. The section of the report which addresses specific issues raised is shown.

Table I.1-2: Summary of relevant public submissions

Source	Public Comment	Response / relevant section of this report
Australian Government Department of the Environment, Water, Heritage and the Arts	Blasting is referred to in the Flora and Fauna EMP (section 5:20) which has not been considered elsewhere.	Blasting is not part of the construction method.
	It is not clear whether there will be sea dumping of excavated materials.	AES were not asked to assess sea

Source	Public Comment	Response / relevant section of this report
		dumping in this report.
University of Queensland researchers.	This public submission presents information on the distribution, abundance and status of the dolphins and Dugong in Cleveland Bay. It also details formally and informally recognised areas of importance for the species nearby.	Section II
	This public submission presents information on existing threats and pressures on the dolphins and Dugongs.	Section III.2
	This public submission lists the following primary potential threats: • Reduction in the area of occupancy of Snubfin and Humpback Dolphins and Dugongs in Cleveland Bay due to construction and operation. • Displacement of dolphins and Dugongs due to: 1) habitat degradation (including loss of prey), direct habitat loss, contamination and sedimentation; and 2) increase in vessel traffic and disturbance. • Noise associated with construction activities and increase in vessel traffic, especially large vessels. • Increased potential for disease (e.g. Toxoplasmosis) from increase of feral and domestic cats, sewage treatment plants, and storm drain runoff. • Increased potential for vessel strike.	Section III
	This public submission presents various suggestions about mitigation measures that could be taken to address the above hazards. (These have been grouped under the relevant heading). **CONSTRUCTION PHASE** **Prevention of serious noise impacts** • 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; • 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 bubble screening (further investigations will be required to determine suitability and effectiveness); and • Establishment of a continuous water quality monitoring program. **USE PHASE** **Prevention of waterborne disease** • 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 • Establishment of a continuous water quality monitoring. **Prevention of vessel strike** • Effective awareness raising for boat operators (including on cruise ships and naval vessels) about the sensitive nature of the habitat and the potential for their activities to cause harm; and	Noise impacts arising from piling in the berth and swing basin are not likely to be at levels requiring mitigation (section III.6.4). Mitigation of these and other potentially serious or minor consequences are addressed in section III.9.

Source	Public Comment	Response / relevant section of this report
	• Provisions for vessel speed restrictions.	
Townsville Local Marine Advisory Committee	…the requirement for frequent dredging to keep the marina channel open makes the proposed canal area unattractive to marine animals which commonly feed in that location. While dislocation of the local Snubfin population from this feeding ground may not be critical it could still have a negative effect on what is seen as an already rare and endangered species.	Marine mammals do not regularly feed in this location (section II).
	The adjacent seagrass beds which contribute to the maintenance of the Cleveland Bay Dugong population would be similarly at risk.	These seagrass beds are several kilometres from the site (Figure II.1-4) and not likely to be affected by the project.
North Queensland Conservation Council	…this development could lead to the localised extinction of [Snubfin Dolphin].	The impact assessment concludes that effects are unlikely to give rise to such consequences, which would be considered "extreme".
	"*Townsville Ocean Terminal Report On Potential Impacts On Matters Of National Environmental Significance* (EPBC Act)." The risk assessment table on page 5 of this document identifies that the TOT proposal is likely to have moderate to catastrophic consequences on key feeding habitat for Australian Snubfin Dolphin.	Marine mammals do not regularly occur within this location. Animals that occur nearby already tolerate existing levels of effect (section II).
	The TOT Development site and areas immediately surrounding it form part of the key habitat for the Australian Snubfin Dolphin. The TOT proposal will also have similar impacts on marine turtles, Dugongs and Indo-Pacific Humpback Dolphins.	See immediately above and section II).

I.2 POLICY AND LEGISLATION

I.2.1 INTERNATIONAL CONVENTIONS AND TREATIES

There are a number of international conventions and treaties that relate to the protection of dolphins, Dugongs and turtles. All are realised in domestic legislation through powers given to the Commonwealth under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

I.2.2 COMMONWEALTH

I.2.2.1 Introduction

The EPBC Act protects matters of national environmental significance (Protected Matters). These are matters that Australia has an international obligation to protect and hence the EPBC act constitutionally overrides State authority.

Protected Matters potentially relevant to this project include:

- Listed threatened species.
- Listed migratory species.
- The Commonwealth Marine Area.
- Listed marine species.
- Listed cetaceans.
- World Heritage Properties

Federal legislation, policy and case history states a clear requirement to assess for any actions that are likely to have a significant impact on a Matter of National Environmental Significance, listed under Part 3 of the EPBC Act (McGrath 2005).

I.2.2.2 Listed Threatened Species

Of the species listed in the scope of works (Table I.1-1), only the marine turtles are listed threatened. Loggerhead Turtle and Olive-Ridley Turtle are both listed as Endangered. The remaining turtle species are listed as Vulnerable.

Box I.2-1: The National Environmental Significance Guidelines (NES Guidelines) (Department of Environment and Heritage 2006) indicate the following thresholds for determining significance in the case of threatened species. (Note, replace with text in square brackets for policy relating to species listed as Vulnerable. Otherwise, text relates to species listed as Endangered).

Significant impact criteria: threatened species

An action is likely to have a significant impact on an Endangered species [or a Vulnerable species] if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of a population / [an important population of a species];
- reduce the area of occupancy of the species / [an important population];
- fragment an existing population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of a population / [an important population];
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to an endangered or vulnerable species becoming established in the species' habitat;
- introduce disease that may cause the species to decline; or
- interfere [substantially] with the recovery of the species.

What is a population of a species?

A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

a) a geographically distinct regional population, or collection of local populations; or
b) a population, or collection of local populations, that occurs within a particular bioregion.

What is an important population of a species? (Vulnerable species only)

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

a) key source populations either for breeding or dispersal;
b) populations that are necessary for maintaining genetic diversity; and/or
c) populations that are near the limit of the species range.

What is an invasive species?

An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

What is habitat critical to the survival of a species or ecological community?

'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:

a) for activities such as foraging, breeding, roosting, or dispersal;
b) for the long-term maintenance of the species or ecological community (including the
c) maintenance of species essential to the survival of the species or ecological community, such as pollinators);
d) to maintain genetic diversity and long term evolutionary development; or
e) for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act.

The policy regarding threatened species is complicated and slightly different conditions apply to Endangered and Vulnerable species. These are summarised in Box I.2-1. There are a number of significant impact criteria that have to be addressed. Additionally, key considerations are whether animals within the affected area represent part of a distinct or bioregional population and in the case of Vulnerable species, whether this population is considered particularly important relative to other populations.

I.2.2.3 Listed Migratory Species

All of the species listed in the scope of works (section I.1) are listed as migratory under the EPBC Act. The Commonwealth of Australia offers fairly clear guidance on migratory animal protection (Box I.2-2). Consistent with the need to consider individual cases on merit, they place emphasis on the quality of ecological information to determine whether impacts are significant.

Box I.2-2: The National Environmental Significance Guidelines (NES Guidelines) (Department of Environment and Heritage 2006) indicate the following thresholds for determining significance in the case of migratory species:

Significant impact criteria: migratory species

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;
- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

What is important habitat for a migratory species?

An area of 'important habitat' for a migratory species is:

a) habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or
b) habitat that is of critical importance to the species at particular life-cycle stages; and/or
c) habitat utilised by a migratory species which is at the limit of the species range; and/or
d) habitat within an area where the species is declining.

What is an ecologically significant proportion?

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates).

The robustness of approvals is therefore dependent on the accuracy and reliability of information and a thorough understanding of population ecology and prediction of the species' sensitivity to environmental impacts.

I.2.2.4 The Commonwealth Marine Area: Listed Marine Species and Listed Cetaceans

Listed Marine Species and listed Cetaceans do not automatically qualify for special protection under the EPBC Act in State waters. For impacts on such species to be controlled by the EPBC Act, the effects have to occur in the Commonwealth Marine Area (CMA). For the purpose of this project, section 24 of the EPBC Act would define the CMA as:

(a) any waters of the sea inside the seaward boundary of the exclusive economic zone, except;
   (i) waters, rights in respect of which have been vested in a State by section 4 of the *Coastal Waters (State Title) Act 1980*;
   (ii) waters within the limits of a State.

Therefore, impacts on species listed as Marine Species or Cetaceans under the EPBC Act are only relevant if the action is likely to have a significant impact on the environment of the Commonwealth Marine Area. The National Environmental Significance Guidelines say this includes where there is "a real chance or possibility that the action will have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (e.g. breeding, feeding, migration behaviour, life expectancy) and spatial distribution".

I.2.2.5 Great Barrier Reef World Heritage Property

The TOT site is contained wholly within the Great Barrier Reef World Heritage Property. Impacts that require approval are those that have, or are likely to have, a significant impact on the world heritage values. These values are listed in Box I.2-3.

Box I.2-3: The National Environmental Significance Guidelines (NES Guidelines) (Department of Environment and Heritage 2006) indicate the following thresholds for determining significance in the case of biological and ecological values of a World Heritage Property:

Significant impact criteria: biological and ecological values

An action is likely to have a significant impact on the World Heritage values of a declared World Heritage property if there is a real chance or possibility that it will cause:

- one or more of the World Heritage values to be lost;
- one or more of the World Heritage values to be degraded or damaged; or
- one or more of the World Heritage values to be notably altered, modified, obscured or diminished.

EXAMPLES

An action is likely to have a significant impact on **natural heritage values** of a World Heritage property if there is a real chance or possibility that the action will:

e) modify or inhibit ecological processes in a World Heritage property;
f) reduce the diversity or modify the composition of plant and animal species in all or part of a World Heritage property;
g) fragment, isolate or substantially damage habitat important for the conservation of biological diversity in a World Heritage property;
h) cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a World Heritage property; or
i) fragment, isolate or substantially damage habitat for rare, endemic or unique animal populations or species in a World Heritage property.

Natural Heritage Values of the Great Barrier Reef World Heritage Property (dolphins, Dugongs and marine turtles)

Criterion: (IX) Outstanding examples of on-going evolution

- marine reptiles (including 6 sea turtle species, 17 sea snake species, and 1 species of crocodile);
- marine mammals (including 1 species of Dugong (Dugong dugon), and 26 species of whales and dolphins);

Criterion: (X) Important habitats for conservation of biological diversity

- seabird and sea turtle rookeries, including breeding populations of green sea turtles and Hawksbill Turtles.

I.2.2.6 Threshold for Assessing Significance under the EPBC Act

Under the Act, likely is not defined as balance of probability but a "real and not remote chance" that a significant impact could occur. In other words, unless it is extremely unlikely, it meets the test and an assessment is required. This has been repeatedly qualified in the courts and is now stated explicitly in government policy (Department of Environment and Heritage 2006). Significance is also well defined. A significant impact is an impact that is "important or notable", given consideration of both the impact's "context *and* intensity". Intensity usually relates to degree of impact, so for example habitat removal may be considered more intense than disturbance. This does not mean minor disturbance is necessarily insignificant, as this may depend on the context (e.g. the sensitivity of the listed species, degree of threat etc).

I.2.3 QUEENSLAND STATE LEGISLATION AND POLICY

I.2.3.1 Great Barrier Reef Marine Park Related Legislation

The proposed TOT site does not include any protected areas under State legislation. The area is not within the Great Barrier Reef Marine Park (Figure I.2-1) and there are no Habitat Protection Areas or Conservation Park Zones within at least 2km.

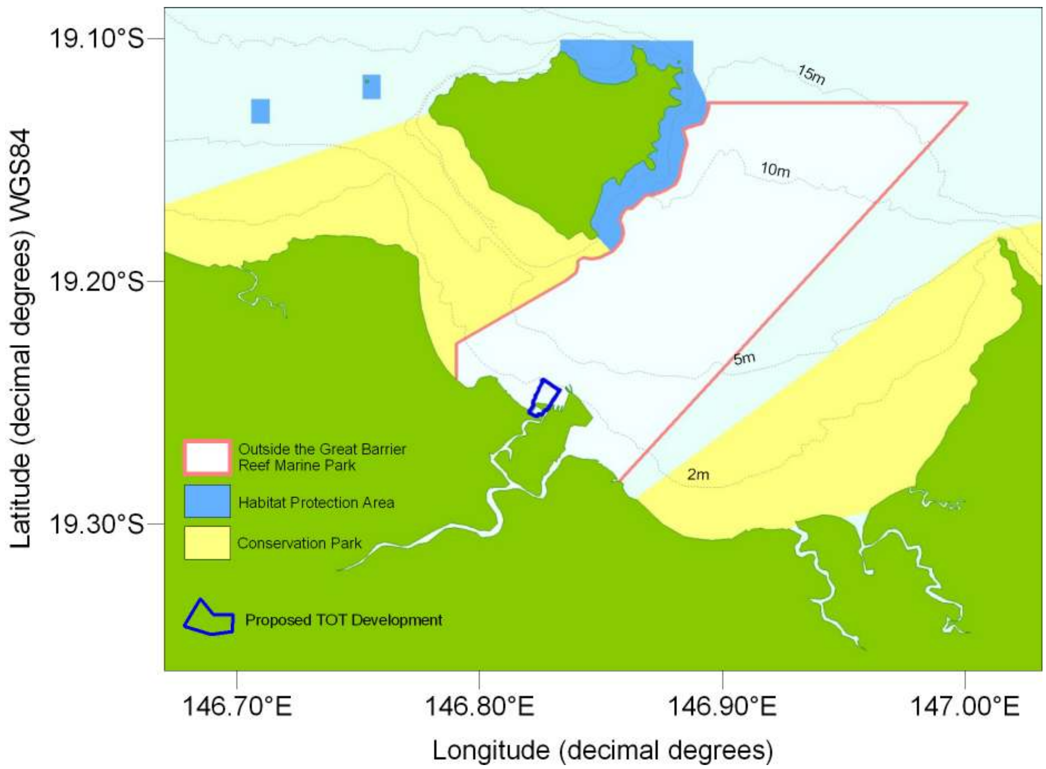


Figure I.2-1: Location of the Proposed TOT Development in the context of the Great Barrier Reef Marine Park. The pale blue area surrounded by the thick red line is outside the Park.

The site is contained within a Species Conservation (Dugong Protection) Special Management Area ("Dugong Protection Area") created under section 46 of the *Great Barrier Reef Marine Park Regulations 1983* (Cth). Section 47 of the regulations specifies restrictions in relation to bait netting. Cleveland Bay is an A class protection area and no baiting or netting is permitted. No further provisions for Dugong protection are contained in this legislation.

A second piece of legislation, the *Nature Conservation (Dugong) Conservation Plan 1999* (Qld), pursuant to the *Nature Conservation Act 1992* (Qld), relates to Dugong Protection Areas and is proposed as a measure to help implement the recovery plan by limiting threatening processes. The legislation restricts the granting of licences and imposes penalties for the accidental take of Dugongs.

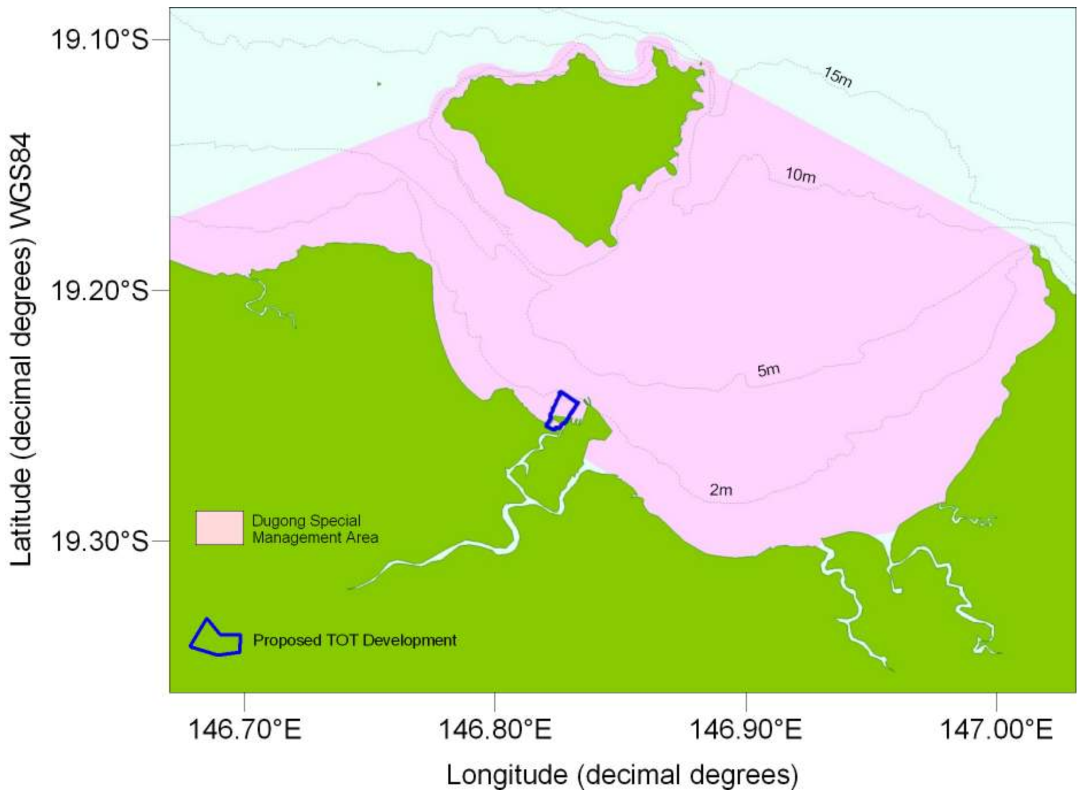


Figure I.2-2: Cleveland Bay Dugong Special Management Area.

All native animals are protected in Queensland from being killed or injured under the *Nature Conservation Act 1992* (Qld). The offence provisions do not apply to the removal of habitat, so long as in removing the habitat reasonable measures were taken to avoid killing and injuring animals.

I.2.3.2 Nature Conservation (Wildlife) Regulations 2004

The following species are listed threatened species on the *Nature Conservation (Wildlife) Regulations 2004* (Qld), pursuant to the *Nature Conservation Act 1992* (Qld).

- Endangered: Loggerhead Turtle, Leatherback Turtle
- Vulnerable: Dugong, Green Turtle, Hawksbill Turtle, Flatback Turtle
- Rare: Australian Snubfin Dolphin, Indo-Pacific Humpback Dolphin

Under section 72 of the *Nature Conservation Act*, management of wildlife is to be done in accordance with:

- the management principles prescribed by this division for the class of the wildlife; and
- the declared management intent for the wildlife; and
- any conservation plan for the wildlife.

Declared management intent also includes general measures described in the *Nature Conservation (Wildlife) Regulations* as “proposed” management intent. These include:

- as a priority, to put into effect recovery plans or conservation plans for the wildlife and its habitat;
- to take action to ensure viable populations of the wildlife in the wild are preserved or re-established;
- to recognise that the habitat of endangered wildlife is likely to be a critical habitat or area of major interest; and
- to monitor and review the adequacy of environmental impact assessment procedures to ensure that they take into account the need to accurately assess the extent of the impact on endangered wildlife and develop effective mitigation measures.

Of note is the need to consider "critical habitat" and the relevance of this to an environmental impact assessment. There is a requirement to consider whether habitat of endangered wildlife is "likely" to be either critical habitat or of "major interest" and this is clearly necessary to accurately assess the extent of the impact. For clarity, critical habitat is defined under the Act as:

- habitat that is essential for the conservation of a viable population of protected wildlife or community of native wildlife, whether or not special management considerations and protection are required.

I.2.3.3 State Coastal Management Plan

The *State Coastal Management Plan* (EPA Queensland 2002) implements a range of considerations for biodiversity protection, pursuant to the *Coastal Protection and Management Act 1995* (Qld). Of key relevance to this study is the need to conserve "the biological diversity of marine, freshwater and terrestrial systems and the ecological processes essential for their continued existence".

I.2.4 RECOVERY PLANS

Commonwealth recovery plans exist for turtles (DEW 2003), an action plan exists for Australian cetaceans (Bannister et al. 1996) and more recently a review of the conservation status of smaller cetaceans (Ross 2006) was completed. There is no Commonwealth recovery plan for Dugongs or specifically for either Australian Snubfin Dolphin or Indo-Pacific Humpback Dolphin.

Queensland has produced a document called the "Conservation and management of the Dugong in Queensland 1999–2004" (EPA Queensland 1999). It is assumed that this is the "Recovery Plan" referred to in the *Nature Conservation (Dugong) Conservation Plan 1999* (Qld) as "Recovery Plan for the Conservation of the Dugong *Dugong dugon* in Queensland 1999–2004".

Information on current pressures and threats, plus additional sensitivities to impacts are discussed in relation to these recovery plans in section III.2.

I.3 INTEGRATION WITH OTHER STUDIES

This impact assessment was done with reference to key technical reports including previous studies on dolphins, Dugongs and marine turtles, and other technical studies for the TOT. AES also met with the Flanagan Consulting Group and C & R Consulting to discuss the details of reports in person.

A full reference list is included at the end of this report. The main internal reference documents are as follows:

C & R Consulting. (2007) Townsville Ocean Terminal Nature Conservation Report: Baseline Study Of Impacts Of The Townsville Ocean Terminal On Ecological Characteristics Of Cleveland Bay. Report For: City Pacific Limited, C&R Consulting Pty Ltd, Townsville.

Gaboury, I., Levy, C. & Erbe, C. (2008) Modelling of Potential Underwater Noise from Pile Driving at the Townsville Ocean Terminal, Jasco Research, Brisbane.

Flanagan Consulting Group. (2008a) Townsville Ocean Terminal and Breakwater Cove: Impacts on Maritime Traffic. Report to City Pacific Ltd, Flanagan Consulting Group, Townsville.

Flanagan Consulting Group. (2008b) Townsville Ocean Terminal and Breakwater Cove: Review of Construction Issues. Revision 3. Report to City Pacific Ltd, Flanagan Consulting Group, Townsville.

GEMS. (2007) Townsville Ocean Terminal Oceanographic Studies and Investigation of the Flushing of the Canal Estate and Marina August 2007 Report 516-07, Global Environmental Modelling Systems, Melbourne.

Hyder Consulting. (2007) Townsville Ocean Terminal Noise and Vibration Assessment. Produced for City Pacific Ltd, Hyder Consulting Pty Ltd, Southport.

Transpac. (2007) Economic Impact Assessment: Townsville Ocean Terminal. Prepared for City Pacific Ltd. Version 1.12, Transpac Consulting Pty Ltd., Townsville.

II. EXISTING CONDITIONS

II.1 Townsville Ecosystem

II.1.1 Ecosystem Drivers and Processes

Townsville is located at the centre of Cleveland Bay (Figure I.1-2), a cup-shaped embayment that faces roughly northeast and is bound on the east side by the 15 km long Cape Cleveland promontory, the west by the more modest Cape Pallarenda and to the northwest by the 55 km^2 Magnetic Island. The 4km wide Western Channel separates Cape Pallarenda from Magnetic Island. East of Cape Pallarenda, Cleveland Bay covers an area of approximately 350km^2.

Prominent headlands (particularly Cape Cleveland), Magnetic Island and rivers such as the Ross River play a significant role in shaping Cleveland Bay's ecology. The dynamics between freshwater inflow, swell-induced mixing, wind and tide-driven currents and sediment transport / deposition in Cleveland Bay are the main ecosystem drivers. The resulting geomorphology further enhances patterns of productivity and faunal distribution.

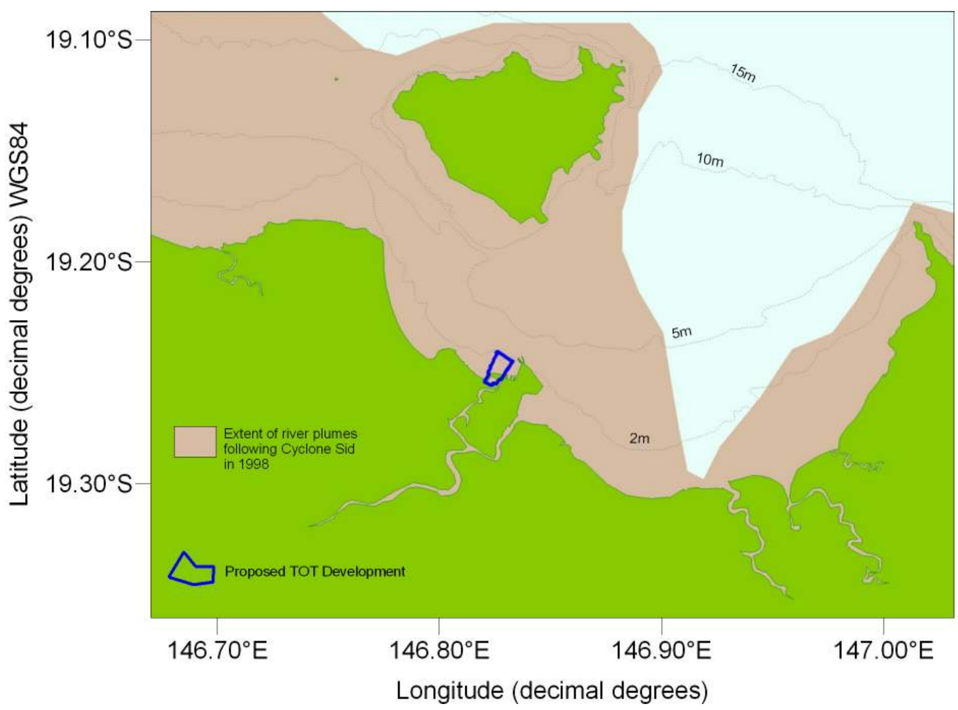


Figure II.1-1: Extent of river plumes following Cyclone Sid in 1998 (adapted from Devlin & Brodie 2005).

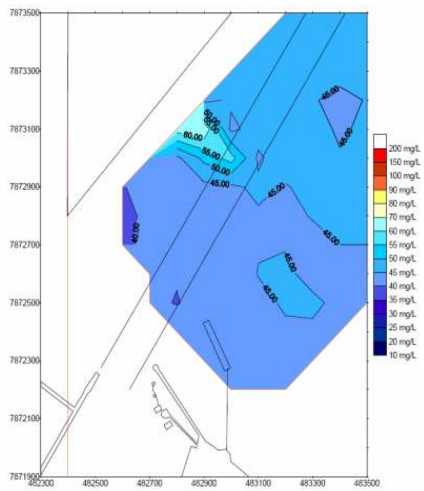


Figure II.1-2: Sample of the total suspended solids measured in the outer harbour by GHD in June, 2001 (GEMS 2007).

Cleveland Bay is an area of relatively high suspended sediment concentration for most of the year. There are three principle sources of sediment in the water column: annual siltation from rivers (Larcombe & Woolfe 1999), bottom sediment resuspension from swell action (Jing & Ridd 1996; Larcombe & Woolfe 1999) and occasional large-scale transport of sediment from rivers inside and outside Cleveland Bay during cyclones and major storms (Devlin & Brodie 2005, Figure II.1-1).

For the best part of the year, southeast winds and sea breezes drive surface water northwest along the coast (Larcombe & Woolfe 1999) and slow ebbing tides create conditions for deposition. Longshore movement of sediment from 4-10 year flood events of the Burkedin River south of Cape Cleveland can cause substantial immigration of suspended material into Cape Cleveland on the incoming tide, along with associated nutrient fronts and fish larvae (Devlin & Brodie 2005). A study in 2001 (In GEMS 2007, see Figure II.1-2) found total suspended solids in the outer harbour near the mouth of the Ross River were between 30 and 60mg/l in 2001. Further into Cleveland Bay, background levels are expected to settle to around 1-10mg/l in average conditions but regularly rise to between 50-100mg/l when swell conditions increase (Jing & Ridd 1996). Around Magnetic Island, levels above 20mg/l for periods of days are considered normal when wave conditions have been in excess of 1m and above 5mg/l for 30-40% of the time (Larcombe et al. 1995).

Figure II.1-1 shows the distribution of river plumes from Cyclone Sid in 1998 (Devlin & Brodie 2005). Although this was an extreme weather event, Cleveland Bay is generally subject to heavy rainfall during the northwest monsoon from December to March when winds drive surface water and plumes further offshore (Larcombe & Woolfe 1999). Figure II.1-1 is likely to be indicative of a general pattern of turbidity in the Bay. The noticeable finger of clear water into Cleveland Bay is the result of an incoming tide pushing sediment-laden river-water to the edges of the Bay. It is quite likely that salinity, temperature and productivity gradients will be created at these edges on the flood tide, concentrating resources needed for fauna like dolphins, turtles and seabirds to feed (Ballance & Pitman 1997).

Figure II.1-3: Townsville Port and the position of the Ross River plume in March 2007 (dark line). The position of this plume is replicated in the diagram in Figure II.1-6. Peak rainfall occurs annually in February, so this image would be representative of the Ross River plume close to peak flood during the wet season.

The build up of sediment in Cleveland Bay means it is very shallow: mostly less than 10m deep (over 50% is less than 5m deep). Data from surveys by the Queensland State government between 1984 and 1988 also show that about 55km^2 of Cleveland Bay is dominated by seagrass. The distribution of seagrass is noticeably correlated with this shallow water (<2m deep – see Figure II.1-4), although in the east of the Bay where water is generally clearer and more depth-tolerant species grow, seagrass extends down to 5m. Seagrass and its associated epiphytes are important drivers of ecological productivity, provide essential structure for fauna and stabilise sediments (see for example, Western Australia EPA 1988). They are also sensitive to changes in light availability, which arise as a consequence of variation in turbidity (Burd & Dunton 2001; Zimmerman 2006). So although the water in Cleveland Bay is turbid during high rainfall events, seagrass beds are mostly situated away from the river outlets or in more sheltered areas near Cape Cleveland where the water is on average clearer (C & R Consulting 2007).

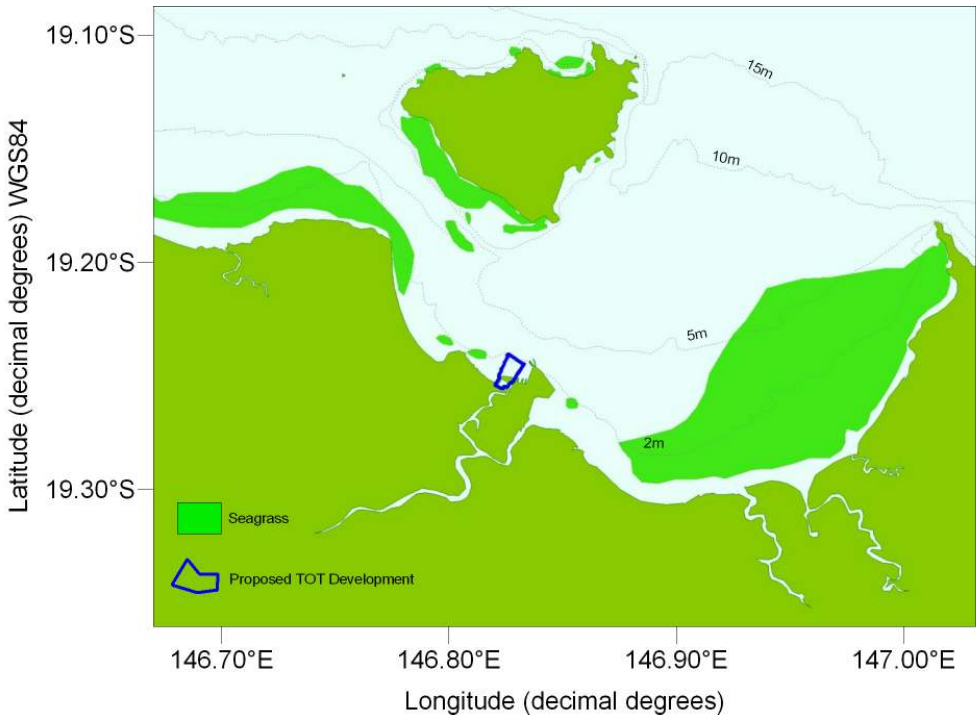


Figure II.1-4: Distribution of seagrass in Cleveland Bay adapted from Townsville State of Environment Report: http://www.soe-townsville.org/marineandcoastal.html last viewed 20 June 2008 and amended for Caulerpa along the strand (C & R Consulting 2007). Note, an area of seagrass off the Strand has been omitted as recent observations have suggested that this is not seagrass but the seaweed *Caulerpa* (C & R Consulting 2007).

Despite the importance of seagrass and shallow reefs for Cleveland Bay, most of the area has a very different ecology based on soft sediment communities. Infaunal nutrient processing by detritivores is expected to be a key source of productivity, with reportedly high densities of burrowing invertebrates (C & R Consulting 2007), dependent on the very fine clay sediment of Cleveland Bay that stores high levels of nutrients. This extremely rapid processing by benthic organisms releases nutrients, not otherwise bioavailable, into the water column. Swell-induced mixing then concentrates nutrients and plankton through the effects of tides, wind and seasonal freshwater inflow. The most important areas of seabed are expected to provide food for demersal fish and crustaceans, that are in turn food for larger prey such as dolphins.

Unfortunately, soft sediment communities are not as well studied as coral reefs or seagrass beds and there is little information available for Cleveland Bay. There appears to be a horizontal zonation from shore to deeper water areas that may in part be to do with sediment grain size. According to Lemmons et al. (1995), inshore areas have a high level of silt and grain size increases further offshore, as does the homogeneity of the substrate. Hence, there are distinct variations in benthic communities at a small scale (within 10km), an expected higher level of variation between communities and perhaps a greater biodiversity value closer to shore, where the sediment is relatively soft.

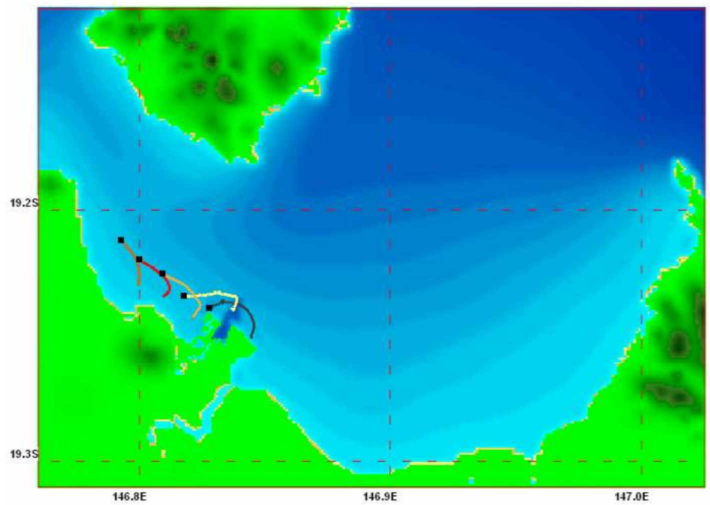


Figure II.1-5: The concurrent tracks of five GPS drifters released (black mark) at 0800 hours on November 14, 2006 and allowed to drift during daylight hours.

Of particular relevance to this study is the behaviour of the sediment plume associated with the Ross River mouth, as this determines the local distribution of Australian Snubfin Dolphin and Indo-Pacific Humpback Dolphin (Figure II.1-6).

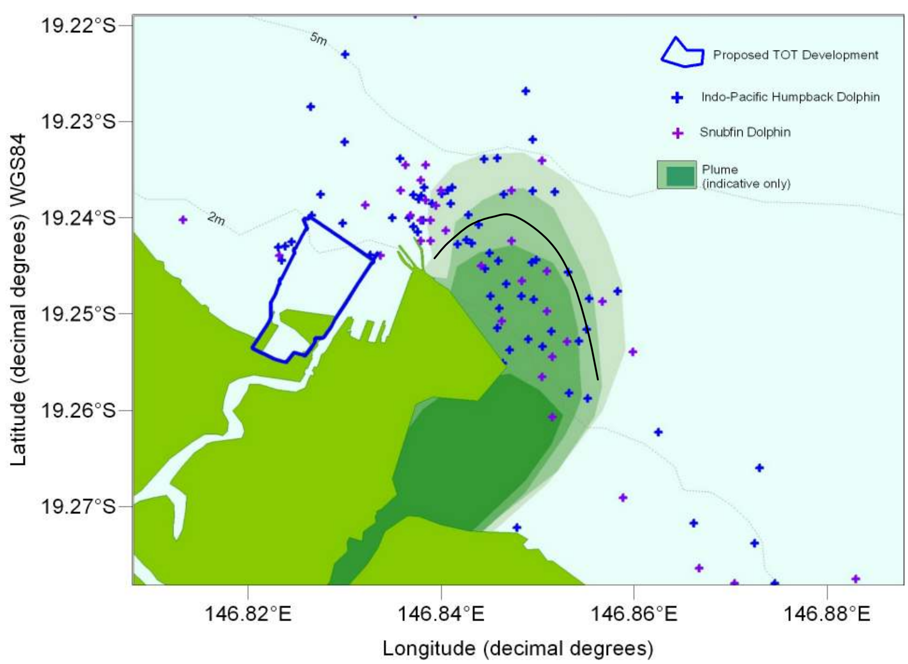


Figure II.1-6: Close up of Townsville Port headland showing the distribution of dolphin sightings, the proposed TOT development and an indicative location for the Ross River plume. Note, the dark line marks the actual position of the plume in the aerial photo taken in March 2007 (see Figure II.1-3, above). Sighting positions for dolphins are from maps in Parra (2005).

GPS (Geographical Positioning System) drifters and hydrodynamic modelling in Cleveland Bay (GEMS 2007) show that near-surface currents flow around the Townsville Port headland towards Cape Pallarenda (Figure II.1-5). This might suggest the plume from the Ross River would head continually northwest but this is not the case. Surface water only moves light sediment fractions around the Townsville Port headland. The heavier sediment however, remains within the plume. For most of the year freshwater inflow is limited so the origin of the sediment is probably resuspension around the river mouth. The strength of this plume varies from day to day and seasonally, depending mostly on wind strength and direction, rather than current movements or rainfall.

During the wet season, sea breezes tend to originate the east (blowing onshore) and will extend the plume farthest offshore. This may seem counter-intuitive but is explained by the fact that sediment sits within the whole water column. Wind blows surface water towards the coast, so the sediment-laden water from underneath moves in the opposite direction (Figure II.1-7). There is expected to be a higher sediment load associated with plumes during the wet season between about November and March, as more sediment is washed into the catchment but anecdotal evidence and observations (see for example, Figure II.1-3) indicate that even then, the plume rarely if ever extends beyond the Townsville Port headland. This is most likely explained by the fact that tidal as a result of the position of the Townsville Port headland, currents both in and out of Cleveland Bay act against the plume, continually pushing it back east. Hence, the plume remains centred mostly around the mouth of the river and explains the higher density of dolphin sightings (Figure II.1-6).

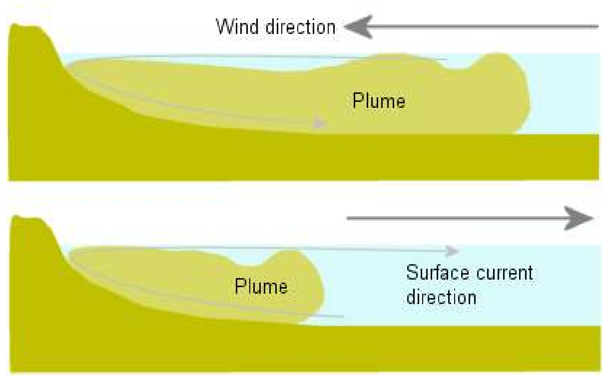


Figure II.1-7: Diagram showing how surface current direction is opposite to the direction of plume movement when winds are perpendicular to the coast.

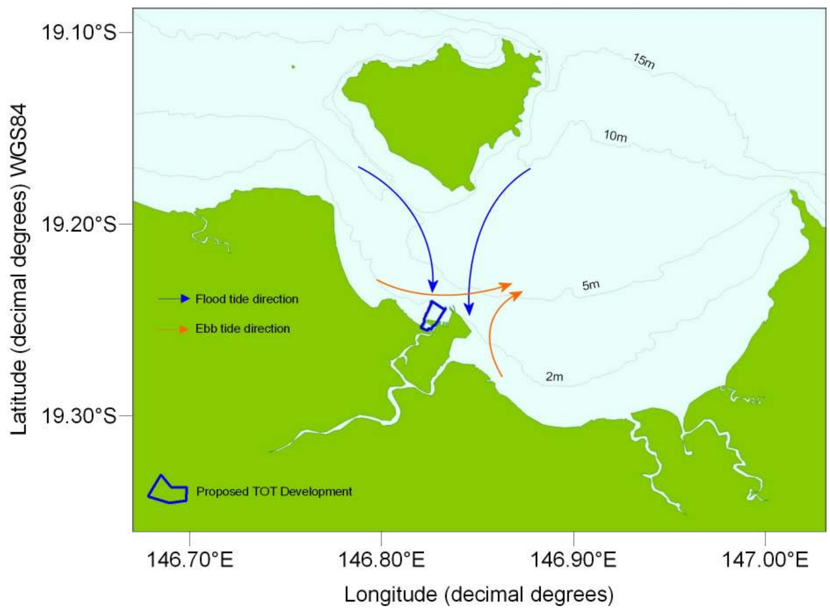


Figure II.1-8: Direction of current flow on an incoming tide (blue) and outgoing tide (orange) (GEMS 2007).

II.2 MARINE TURTLES

II.2.1 INTRODUCTION

Whereas it has already been established that there is habitat in regular use by Australian Snubfin Dolphin, Indo-Pacific Humpback Dolphin and Dugong in the vicinity of the development, this has not been done for marine turtles. This section presents an overview of six species: Green Turtle *Chelonia mydas*, Loggerhead Turtle *Caretta caretta*, Hawksbill Turtle *Eretmochelys imbricata*, Olive-Ridley Turtle *Lepidochelys olivacea*, Leatherback Turtle *Dermochelys coriacea* and Flatback Turtle *Natator depressus,* sufficient to ascertain which should be addressed in the impact assessment chapter of this report. Maps and figures for each species are shown in Appendix A and should be referred to when reading the following sections.

A marine turtle species will be carried forward for assessment if:

- a species is thought to frequently occurs in Cleveland Bay; and
- Cleveland Bay supports an important population of a threatened species (see Box I.2-1); or
- Cleveland Bay supports important habitat for a migratory species (see Box I.2-2).

There are six turtles listed as threatened under the EPBC Act. The two species listed as Endangered are Loggerhead Turtle and Olive-Ridley Turtle.

Olive-Ridley Turtle is thought to breed sparsely in the Gulf of Carpentaria (Wilson 2005; Wilson & Swann 2005) and Northern Territory, with "major Australian nesting records" at the Coburg Peninsula but rarely found in Great Barrier Reef waters (Cogger 2000). Only 0.6% of Queensland turtle strandings between 1999-2002 were this species[1] and it has never been recorded nesting in the Great Barrier Reef[2]. Recent tracking of Olive-Ridley turtles in the Northern Territory has shown that both Gulf of Carpentaria and Coburg Peninsula animals move into areas north and west of Darwin (Whiting et al. 2007). This is not a species that is expected to frequent, or have an ecological dependence on Cleveland Bay.

Loggerhead Turtle is a robust and wide-ranging species that undergoes annual long-distance migration from critical breeding habitat in far southern Queensland (DEW 2003) and regularly moves north along the coast. Specific recovery objectives have been

[1] Data from http://www.epa.qld.gov.au/nature_conservation/wildlife/caring_for_wildlife/marine_strandings/, last viewed 17 June 2008.

[2] From http://www.gbrmpa.gov.au/corp_site/key_issues/conservation/natural_values/marine_turtles/marine_turtle_species_descriptions last viewed 17 June 2008.

set for this east-coast population on account of the substantial breeding population decline (50-80%) since the mid 1970s. Ninety percent of the breeding habitat is now protected and is located between Elliott River and Wreck Rock near Bundaberg (about 900 kilometres south of Townsville). Most of the management objectives relate to either deliberate or incidental fisheries catch / bycatch and protection of breeding sites from foxes and other disturbances. There is no information to quantify the importance of Cleveland Bay to this species, although it is likely to occur annually in very small numbers.

The stranding records in Appendix A are roughly indicative of the breeding distribution of Leatherback Turtle, which is an extremely rare breeding species that occurs further south around Bundaberg. Otherwise Leatherback Turtles are most often seen offshore and are very unlikely to occur, even occasionally, in Cleveland Bay.

Number of stranding records is also a reflection of human population, which explains the paucity of records for Hawksbill Turtles north of latitude 16°S (Appendix A). The species does actually breed near the top of the Cape York Peninsula north of Princess Charlotte Bay. It tends to be associated with relatively clear tropical water and is only likely to occur in Cleveland Bay very occasionally. It accounts for only 6.5% of strandings (ref. footnote #1). This is not a species that is expected to frequent, or have an ecological dependence on Cleveland Bay.

Although all these species may occasionally occur off Townsville, only two: Green Turtle and Flatback Turtle, frequently occur in Cleveland Bay. Loggerhead Turtle is likely to be an annual visitor and individuals may occasionally feed in Cleveland Bay. More detailed accounts of these three species is included below and they are considered in the impact assessment chapter. Juveniles of all three species of turtle mature further out to sea (Musick & Limpus 1997) so except during hatching, animals occurring in Cleveland Bay would be expected to be adults.

No habitat identified as potentially "Critical Habitat" for any of the species in the Commonwealth Marine Turtle Recovery Plan occurs in Cleveland Bay (DEW 2003).

II.2.2 GREEN TURTLE

Breeding population estimates for the Great Barrier Reef (GBR) are 38,000 (8,000 breeding females for the southern GBR and estimates from 30,000 to over 130,000 for the northern GBR (Commonwealth of Australia 2005; Dobbs 2001; Marsh & Saalfeld 1989). Green Turtles both breed and feed in Cleveland Bay.

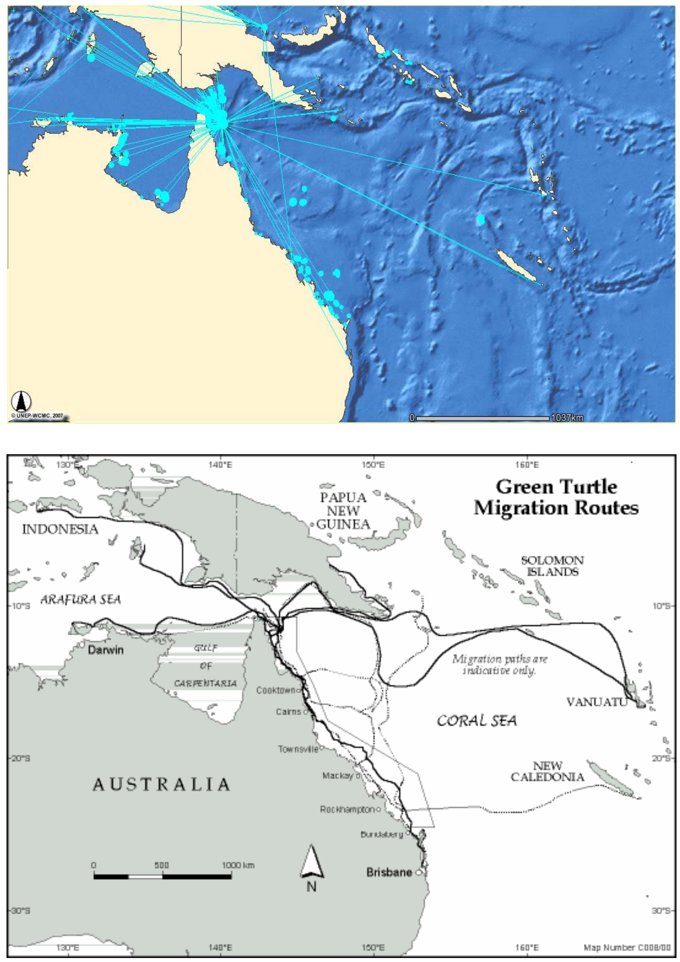


Figure II.2-1: Green Turtle nesting and migration in eastern Australia (Source Top: www.ioseaturtles.org; Source Bottom: Queensland Parks and Wildlife Service Website)

Peak breeding is likely to occur in summer between October and March. It is not certain whether the Cleveland Bay animals form part of the northern or southern GBR genetic stock (Figure II.2-2) but the number of Green Turtles nesting in Cleveland Bay is small. There are only two locations documented on the ioseaturtles.org IMAP system: one on Magnetic Island and the other on Cape Pallarenda (there may be more sites that area occasionally used). The number of turtles nesting at these locations is estimated at 1-10 females.

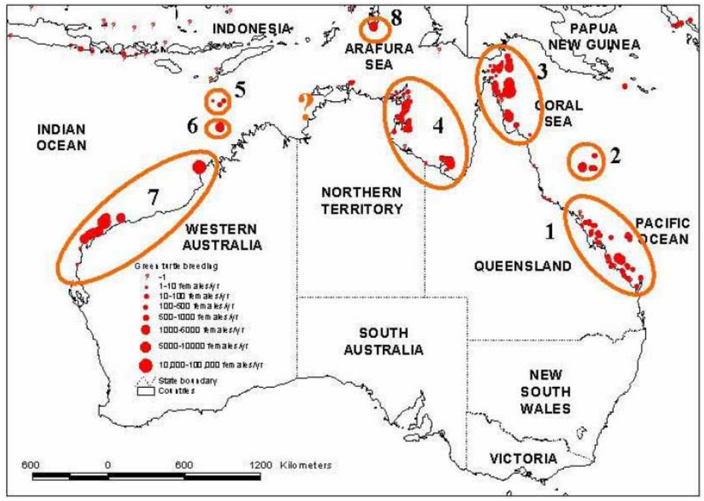


Figure II.2-2: Genetically identifiable Australian Green Turtle breeding stocks: 1 = southern GBR; 2 = Coral Sea; 3 = northern GBR; 4 = Gulf of Carpentaria; 5 = Ashmore Reefs; 6 = Scott Reef; 7 = Northwest Shelf. The Indonesian breeding stock at Aru Islands (8) is another stock in the region (Dutton et al. 2002).

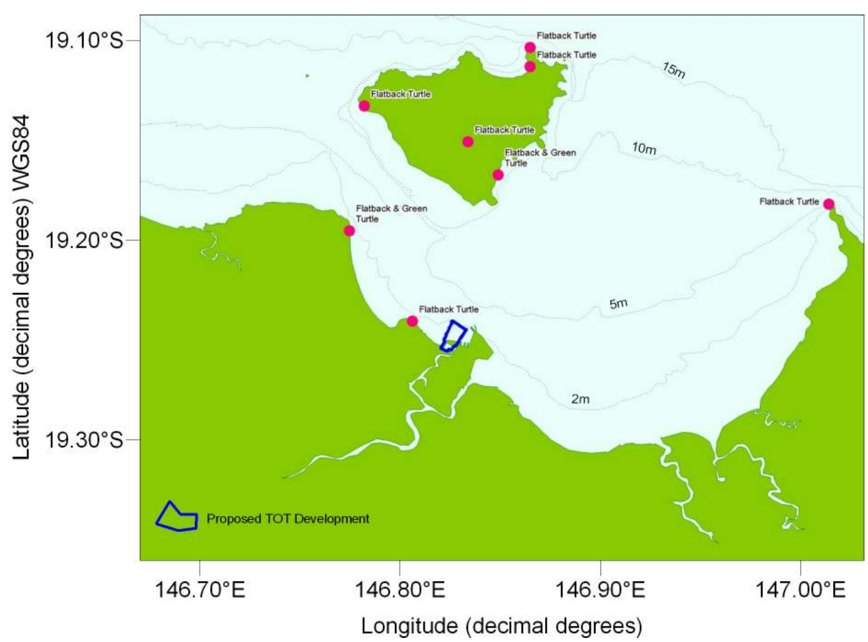


Figure II.2-3: Distribution of known breeding beaches for Flatback and Green Turtles in Cleveland Bay (Source Top: www.ioseaturtles.org).

During adulthood, Green Turtles are herbivorous, feeding on algae and seagrass in mostly shallow water areas[3]. This would include the seagrass areas that surround Magnetic Island, which are also likely to be important internesting areas (areas where females rest between successive clutches). In addition to the local breeding stock, other non-breeding and migrating turtles are expected to occur.

The precise density of Green Turtles in Cleveland Bay is unknown. Very little research has been done to document feeding densities anywhere. One aerial study found an overall density of 1.03 ± 0.08 per km^2 in the northern GBR (total 32,187 ± 2,532 individuals) but this is likely to have been a gross underestimate as many animals would have been invisible underwater (Marsh & Saalfeld 1989). Aerial surveys (Preen 2000) of Cleveland Bay have found between 110-630 (average 416 ± 105 S.E.) individuals but with similar method constraints.

Given the extent of seagrass in Cleveland Bay the density of Green Turtles is expected to be relatively high. The species is reportedly "particularly common" in eastern Cleveland Bay, centred on the shallow water seagrass beds (Preen 2000) (for example, compare seagrass maps Figure II.1-4 with Figure II.2-4).

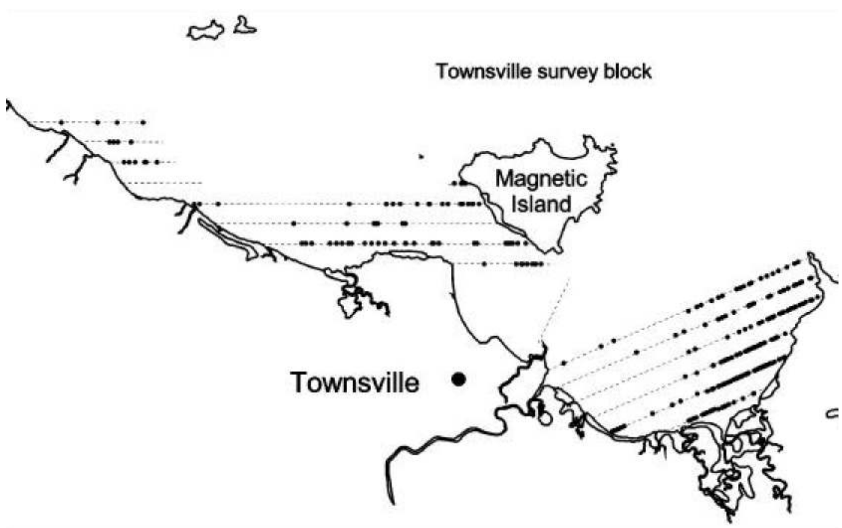


Figure II.2-4: Locations of turtles seen on aerial survey transects 1997-1998 (Preen 2000).

II.2.3 LOGGERHEAD TURTLE

Loggerhead Turtles are rare and declining on the east coast of Australia but they do not breed near Townsville. The main centre of breeding is in southern Queensland (Figure

[3] Australian Government Species Profile and Threats Database: *Chelonia mydas* — Green Turtle http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1765

II.2-5). Population estimates in this region are of less than 500 breeding females having declined by 86% over 10-15 years to 1999, in part to do with a high level of fox predation at the breeding sites (DEW 2003). This species is therefore considered Endangered under the Commonwealth EPBC Act.

Loggerhead Turtles undertake relatively long-distance migration to other parts of Australia, southeast Asia and the South Pacific. Some individuals migrate up the east coast and into the Gulf of Carpentaria (Figure II.2-5). Consequently, Loggerhead Turtles may frequently pass Cleveland Bay but due to their scarcity, numbers are expected to be very small.

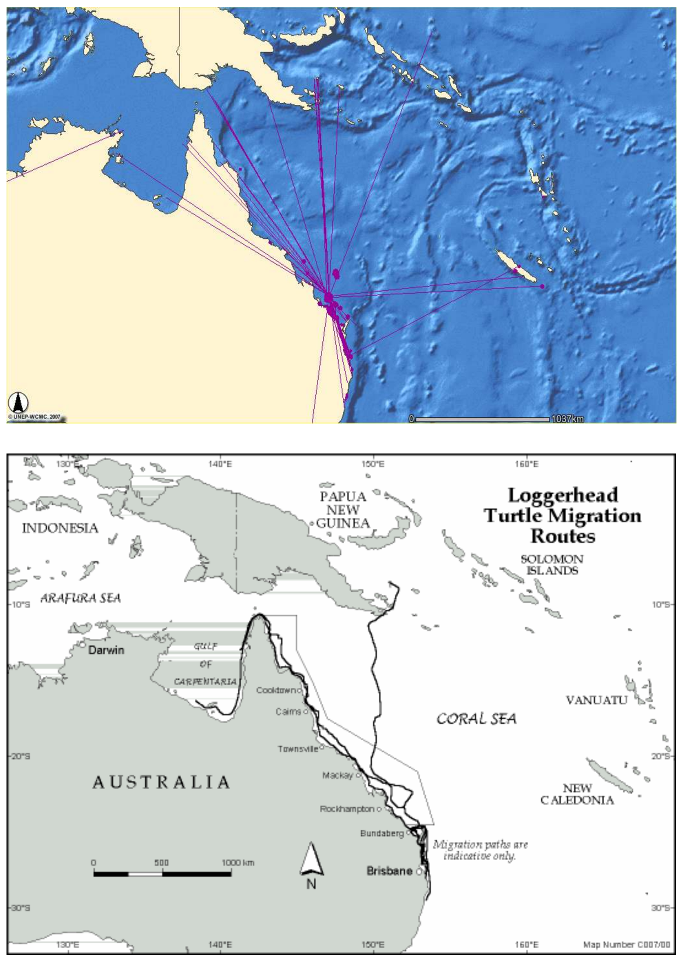


Figure II.2-5: Loggerhead Turtle nesting and migration in eastern Australia (Source Top: www.ioseaturtles.org; Source Bottom: Queensland Parks and Wildlife Service Website)

Unlike Green Turtles, adult loggerheads are carnivorous benthic feeders, taking mainly molluscs but a variety of other available food. Hence, they mostly forage over mud or hard bottom areas as opposed to sandy seagrass areas. There is no information on the areas most likely to be occupied by Loggerhead Turtles or their likely density but in

Cleveland Bay but they were not reported during surveys in 1997-1998 (Preen 2000). Further, anecdotal evidence referenced to Col Limpus by Marsh & Saalfeld (1989) suggests that "most of the turtles seen on reefs and inshore seagrass beds…are Green Turtles".

II.2.4 FLATBACK TURTLE

The Flatback Turtle is a relatively widespread and common nesting species throughout northern Australia including Queensland. It is an Australian endemic turtle and the only species that occurs exclusively on the continental shelf. Townsville breeding animals are included in the Eastern Australia management unit, one of four across Australia based on genetic studies. Breeding in this region occurs late spring / early summer (Limpus 2007). The Eastern Australian population is centred well away from Townsville on rookeries at Peak Island, Wild Duck Island and Avoid Islands, near the north of Cape York.

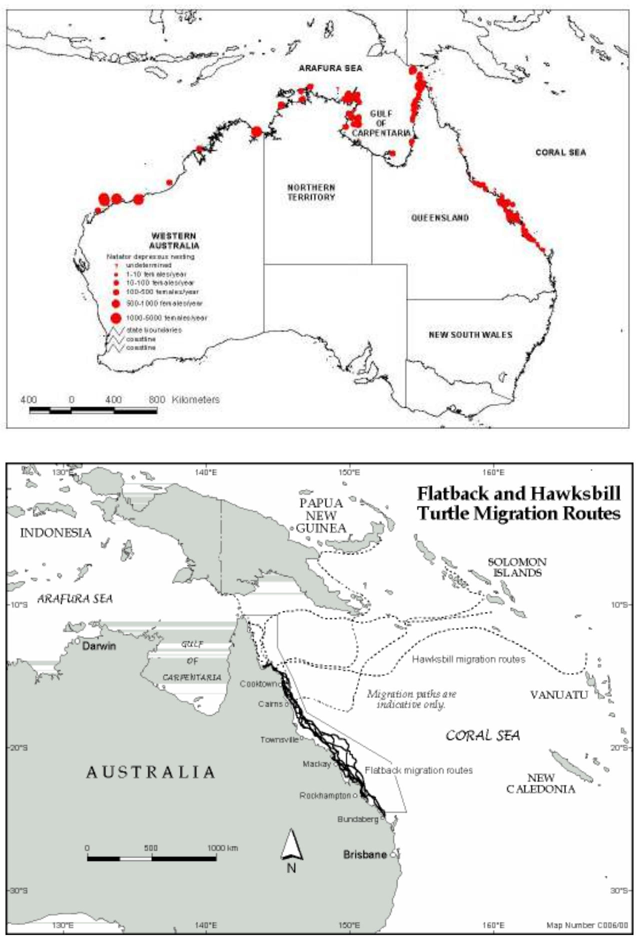


Figure II.2-6: Flatback Turtle nesting and migration in eastern Australia (Source Top: Limpus (2007); Source Bottom: Queensland Parks and Wildlife Service Website)

As is shown in Figure II.2-6, the Queensland breeding distribution of Flatback Turtles is split between southern and northern Queensland. Flatback Turtles mostly nest on island beaches but after nesting they disperse throughout the region (Limpus 2007).

Unlike other species of turtle, juvenile flatbacks have no oceanic stage but are thought to mature out to sea on the continental shelf (Walker & Parmenter 1990). The species lays fewer eggs than other marine turtles but gives rise to more fully developed young less prone to predation (Limpus et al. 1984).

Eight nesting beaches in Cleveland Bay are shown on the ioseaturtles.org IMAP website (see Figure II.2-3), indicating that Flatback Turtles are the most commonly nesting turtle species in the Bay. The species is also known to occasionally use other beaches and has even attempted nesting on the Strand at Townsville, at Pallarenda beach and near the marina.[4] Being a sporadic breeder, it is probably more widespread than the data indicate.

Outside the nesting season, Flatback Turtles are usually seen in relatively turbid water. They are exclusively carnivorous and are thought to feed in soft sediments in relatively shallow water. Flatback Turtles could occur throughout Cleveland Bay anywhere beyond the main seagrass beds.

[4] http://www.soe-townsville.org/marineandcoastal.html last viewed 20 June 2008.

II.3 DOLPHINS AND DUGONGS

Three species have been identified as relevant to this assessment. Australian Snubfin Dolphin *Orcaella heinsohni*, Indo-Pacific Humpback Dolphin *Sousa chinensis* and Dugong *Dugong dugon* are all resident in Cleveland Bay.

II.3.1 AUSTRALIAN SNUBFIN DOLPHIN

Genetic studies of *Orcaella* in Australia recently saw Australian Snubfin Dolphin split from the closely related Southeast Asian Irrawaddy Dolphin. There is incomplete knowledge about the distribution of Snubfin Dolphins but it is thought they could range from Shark Bay (Western Australia), through Northern Territory, Papua New Guinea and Queensland to just south of the Brisbane River (Parra et al. 2002; Ross 2006). There are however large gaps in knowledge, notably around most of Cape York peninsula, the Gulf of Carpentaria, Northern Kimberley and the Pilbara (Parra et al. 2002). Evidence from aerial surveys of other large mammal fauna in the Great Barrier Reef suggests that Snubfin Dolphins have occurred up to 23 km from the coast (Parra 2005).

Despite a wide distribution, Snubfin Dolphins are only sighted in relatively small groups of 1-10 animals and although it appears reasonable to assume they are relatively uncommon, they may have been overlooked through most of their range. There is little dedicated effort to finding them and opportunistic sightings are likely to be confused with other coastal dolphins (Parra et al. 2002).

The only detailed study of this species has been done in Cleveland Bay, where sighting-resighting models were used to determine a minimum population from field data over three years, based upon well-marked animals. This resulted in estimates of 67 (95% CI 51-88) individuals. Though the actual population (including poorly marked individuals) would be higher, it is considered likely to be below 100 (Parra 2005).[5] However, Cleveland Bay is not the boundary of the population. Although there is strong evidence for site faithfulness amongst marked animals, the species is not a permanent resident of Cleveland Bay and spends periods of days to a month or more outside the study area (Parra et al. 2006). Studies have concentrated on the nearshore areas of Cleveland Bay, generally within 2-3km of the coast. It is likely that Snubfin Dolphins range north and south of Cleveland Bay and overlap with other populations along the coast (Parra 2005).

[5] See also, footnote #6

Snubfin Dolphins forage mostly within 5km of the coast and have a preference for feeding around river mouths (Marsh et al. 1989; Parra 2005; Reeves et al. 2002; Ross et al. 1994). They occur predictably at the edges of river plumes often at particular times of the tide and usually at the edge of, or within obvious sediment plume gradients. Data gathered for sighting-resighting studies by Parra (2005) illustrates the distribution of Snubfin Dolphins in Cleveland Bay. There is a distinct concentration of animals near the mouth of the Ross River, as well as others around the entrance to Bohle River, on the far side of Cape Pallarenda (Figure II.3-1). The density of sighting locations is likely to be misleading, as these reflect vessel effort as much as dolphin distribution, especially as fieldwork originated from Townsville each day. Nevertheless, the scattering of sightings around the Port of Townsville, especially to its east, is notable. This is expected to be an area of importance for the species, as the Ross River is the largest source of sediment into Cleveland Bay and the species uses areas of high turbidity particularly around river mouths, to feed. Although sediment input from rivers is considered relatively insignificant in terms of direct nutrients, effects at the boundary of the plume promote ecological productivity. Hence, such areas tend to be important drivers for marine biodiversity (see section II.1.1).

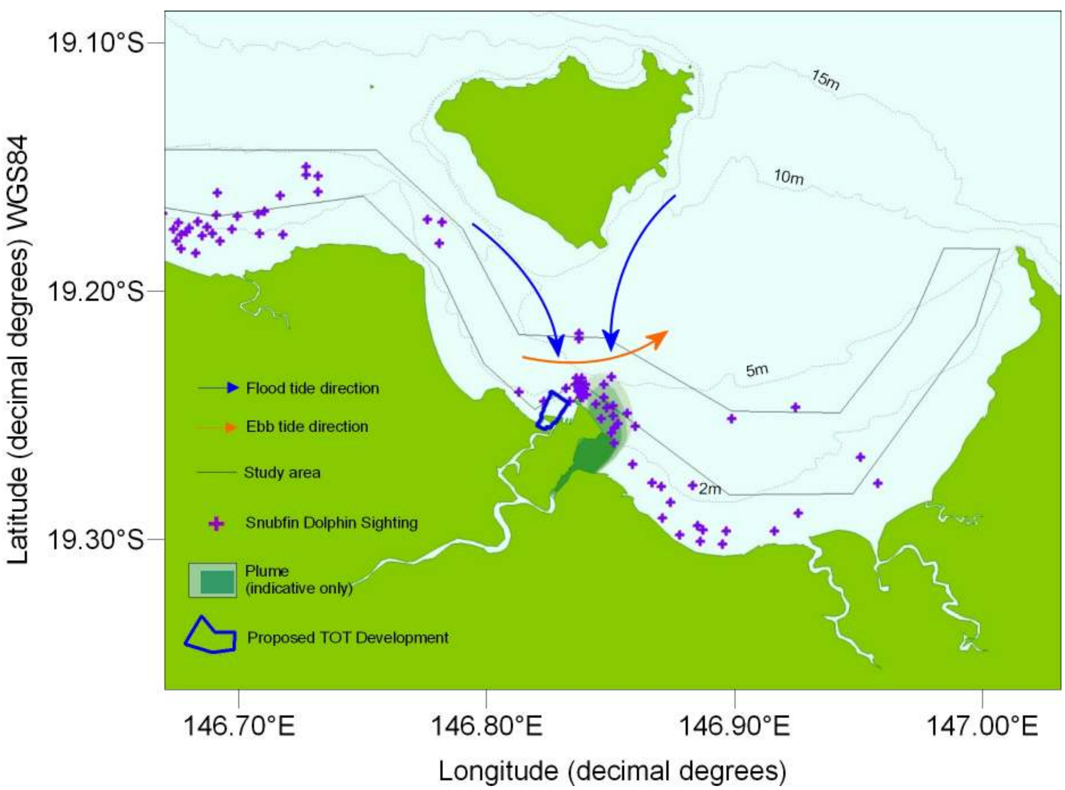


Figure II.3-1: Position of Snubfin Dolphin sightings and study area (positions were extracted from maps in Parra (2005). The position of the Ross River plume is indicative only. The highest density distribution of Snubfin Dolphins is expected to be found near the leading edge of this plume, which will vary in position day by day and seasonally. The blue and orange arrows show the direction of the flood and ebb tides respectively.

> The "study area" referred to is the area defined for study in Parra (2005). Although observations were made inshore of this area, it is assumed that the edge furthest from shore defined the limit of the study. A close up map of the Townsville Port area is also shown in Figure II.1-6.

Most of the Snubfin Dolphin fieldwork (80%) was done in the dry season (Parra 2005) when it was likely that the plume was quite close to shore. This may explain the clusters of sightings near the mouth of the river and in the vicinity of the entrance of the Townsville Port. The action of the tides in this part of the Bay also appears to explain why there are few sightings of Snubfin Dolphin further west (see section II.1.1). Both the flood tide and the ebb tide act against the leading edge of the plume (GEMS 2007). When the plume extends further during the wet season, it is likely to be to the north and east. Current modelling, aerial photos of the plume and the position of dolphin sightings themselves indicate that the leading edge of this plume rarely extends beyond the tip of the Townsville Port headland.

Therefore, it appears likely that Snubfin Dolphins do not regularly occupy the marine area that makes up the proposed TOT development site. In 630 hours of observation, no dolphins were seen within this area (Parra 2005). Nevertheless, being free-ranging animals they undoubtedly forage from time to time throughout Cleveland Bay and as shown in Figure II.3-1, are sighted in the vicinity and could come into range of potential effects arising from the construction and use of the site. It is unlikely that the Cleveland Bay dolphins are isolated from surrounding populations but the extent of immigration / emigration is unknown. The total Queensland population can only be guessed but has been estimated as numbering in the thousands. Whether the species' population is stable or in decline is uncertain as there are no data to compare populations or distribution over time. However, it is likely to have declined as there are a number of existing pressures that would be expected to have locally significant effects throughout the species' range (see Table III.8-2). Australian Snubfin Dolphin remains a primary conservation concern for the region.

II.3.2 INDO-PACIFIC HUMPBACK DOLPHIN

Indo-Pacific Humpback Dolphins are widespread and relatively common throughout Australian tropical waters from Shark Bay (Western Australia) north through the whole of Northern Territory, Queensland and northern New South Wales. Evidence from aerial surveys of other large mammal fauna in the Great Barrier Reef suggests that the species is mostly found within about 5km of the coast (Parra 2005). Indo-Pacific Humpback Dolphins forage mostly within 5km of the coast and have a preference for feeding around river mouths (Parra 2005; Reeves et al. 2002; Ross et al. 1994). Depth may limit their distribution to areas with water depths less than 20-25m although sightings have occurred well offshore, up to 56km from the coast (Parra 2005). They are one of the more regularly encountered cetaceans in shallow continental shelf waters off northern Australia (Simon Mustoe, personal observations), although they usually occur in small groups of 1-10 individuals.

One of the only detailed population studies of Indo-Pacific Humpback Dolphins was done in Cleveland Bay where sighting-resighting models were used to determine a minimum population from field data over three years, based upon well-marked animals. This resulted in estimates of 54 (95% CI 38-77) individuals, though the actual population (including poorly marked individuals) would be higher but is considered likely to be below 100 (Parra 2005).[6] As with Snubfin Dolphin however, the population ranges beyond Cleveland Bay. Although there is evidence for site faithfulness amongst marked animals, the species is not a permanent resident of Cleveland Bay and spends periods of days to a month or more outside the study area (Parra et al. 2006). Studies have concentrated on the nearshore areas of Cleveland Bay, generally within 2-3km of the coast. It is likely that Indo-Pacific Humpback Dolphins range north and south of Cleveland Bay and overlap with other populations along the coast (Parra 2005). There are no data on the coastal populations of this species in Australia. Indo-Pacific Humpback Dolphins occur in very similar areas to Snubfin Dolphins but appear to be less site-specific, occurring over a wider range of habitats and areas of Cleveland Bay (Parra 2005).

[6] Note, although on these numbers Indo-Pacific Humpback Dolphins would appear less abundant than Snubfin Dolphins (see section II.3.1), this may not be the case. Indo-Pacific Humpback Dolphins were encountered about 40% more often by Parra (2005). One possible explanation is that fewer Humpback Dolphins had markings that could be used in the sighting-resighting method. In an aerials survey by Preen (2000), Humpback Dolphins were 2.5 times as common as Snubfin Dolphins. Hence, these population estimates should be interpreted as indexes of abundance. They do not represent absolute numbers of animals and the populations of one species and another cannot be directly compared.

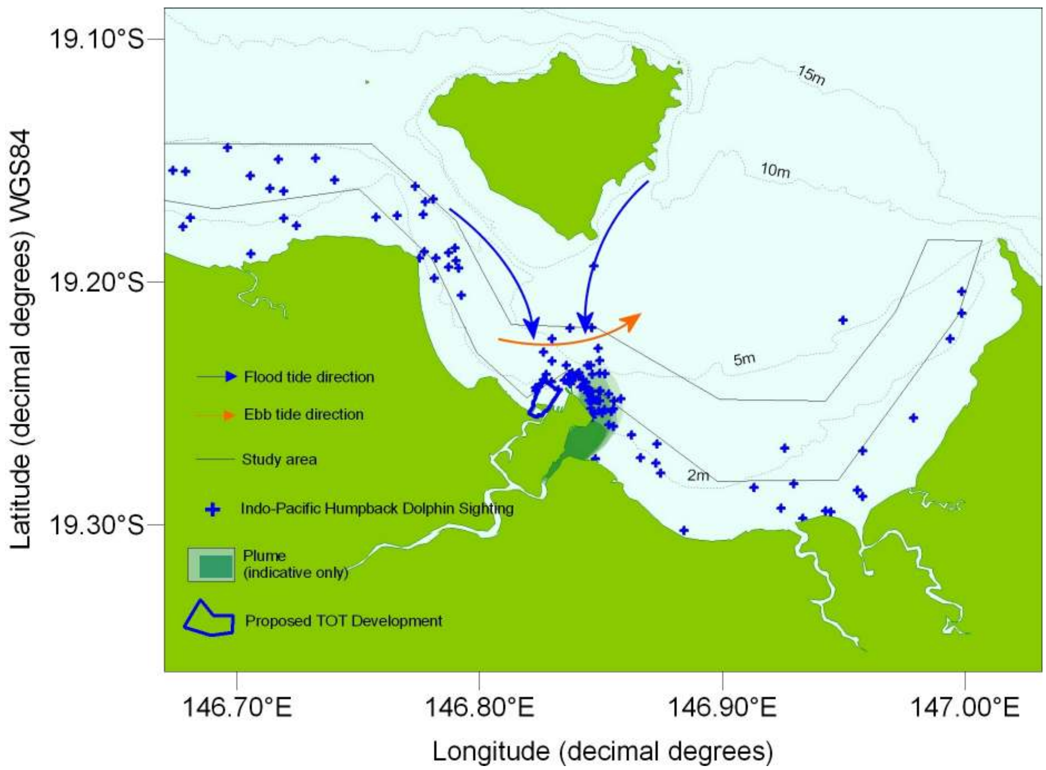


Figure II.3-2: Position of Indo-Pacific Humpback Dolphin sightings and study area (positions were extracted from maps in Parra 2005). The position of the Ross River plume is indicative only. The highest density distribution of dolphins is expected to be found near the leading edge of this plume, which will vary in position day by day and seasonally. The blue and orange arrows show the direction of the flood and ebb tides respectively. A close up map of the Townsville Port area is shown in Figure II.1-6.

As with Snubfin Dolphins, the area around the Ross River mouth represents a core habitat area within Cleveland Bay. However, their distribution at a more local scale is determined by the behaviour of the Ross River plume (section II.1.1). Current modelling, aerial photos of the plume and the position of dolphin sightings themselves indicate that the leading edge of this plume rarely extends beyond the tip of the Townsville Port headland.

Therefore, it appears likely that Indo-Pacific Humpback Dolphins do not depend on the marine area that makes up the proposed TOT development site. Nevertheless, being free-ranging animals they undoubtedly forage from time to time throughout Cleveland Bay and as shown in Figure II.3-2, are sighted in the vicinity of the TOT. It is unlikely that these riverine populations are isolated from surrounding populations (Parra 2005) but the extent of immigration / emigration is unknown. Whether the species' population is stable or in decline is uncertain as there are no reliable data to compare populations or distribution over time. Although the species remains a primary conservation concern for the region, it is relatively common throughout its range and found throughout coastal and some offshore waters of the Great Barrier Reef. It also has a more diverse distribution and ecology within Cleveland Bay (Parra 2005).

II.3.3 DUGONG

Estimates for Dugong populations in the northern Great Barrier Reef are between about 8,000 and 10,500 individuals (EPA Queensland 1999) and for the southern Great Barrier Reef region south of Cape Bedford (which includes Cleveland Bay), 3,479 ± 459 Dugongs (Marsh & Saalfeld 1990).

Cleveland Bay is considered to be an important area for Dugong, on account of the relatively high density of animals and a decline in numbers in the southern Great Barrier Reef (Lawler et al. 2002). Estimates of Dugong numbers in Cleveland Bay range from 106 (± 56 Standard Error) to 400 (± 97 Standard Error) (Preen 2000). The area is therefore recognised as one of seven Dugong Special Management Area 'A', which impose a ban on the use of gill nets by fisheries (see Figure I.2-2).

Within Cleveland Bay, Dugongs are almost exclusively associated with their preferred food, seagrass (Figure II.3-3). They are most frequent along the southwest shore of Magnetic Island and the eastern and southeastern shores of Cleveland Bay near Cape Cleveland (Anderson & Birtles 1978) where the most extensive seagrass beds occur. This pattern of distribution has been repeatedly confirmed by aerial surveys over several independent years (Figure II.3-4) as well as by studies of satellite tracked Dugongs (Marsh & Lawler 2006; Preen 2000). This latter study also discovered that the eastern part of Cleveland Bay formed a habitat area with Bowling Green Bay which is to the east of the Cape Cleveland (i.e. to the east of the high density area marked in Figure II.3-3) and that Dugongs regularly cross Cleveland Bay towards Hinchinbrook Island.

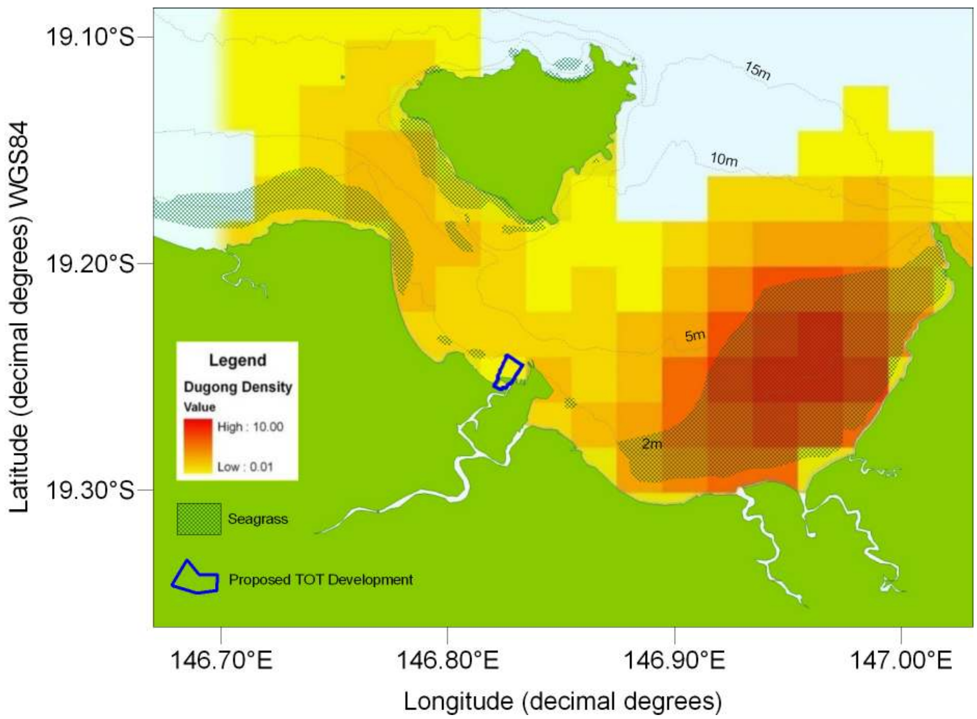


Figure II.3-3: Dugong density in Cleveland Bay and the approximate extent of seagrass beds. Dugong data adapted from Grech & Marsh (2007). Distribution of seagrass in Cleveland Bay adapted from Townsville State of Environment Report: http://www.soe-townsville.org/marineandcoastal.html last viewed 20 June 2008 and amended for Caulerpa along the strand (C & R Consulting 2007).

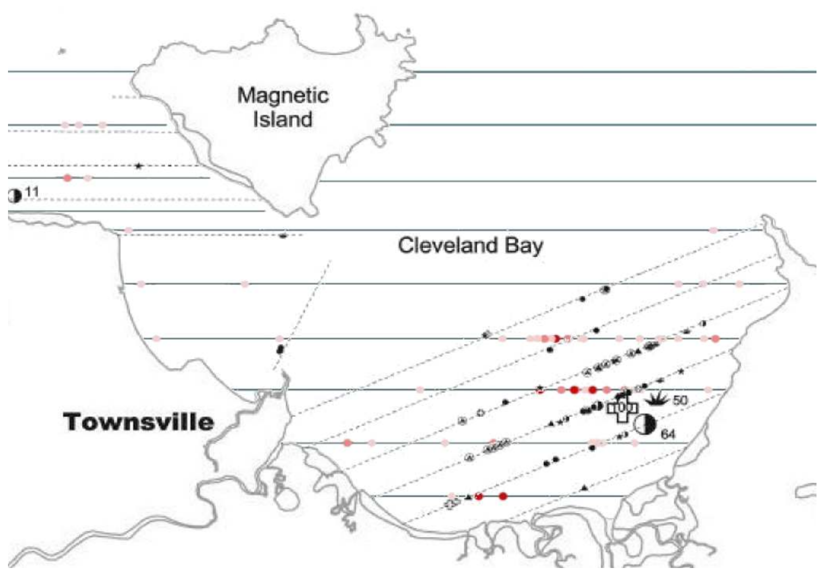


Figure II.3-4: Dugong groups seen on aerial transects in 1997-1998 (Preen 2000) (black shapes) overlain on Dugong groups seen over six surveys between 1986 – 2006 (Marsh & Lawler 2006) (red to pink shapes, indicating high to low group size respectively).

Although Cleveland Bay is recognised as an important area for Dugongs, the main centre of the population is in the southeast of the Bay and according to Preen (2000) most Dugong movement is probably eastward from here. There is relatively little Dugong habitat around Townsville itself even through seagrass beds do occur throughout coastal areas, including off the strand. Being a large free-ranging animal however, sightings could occur throughout Cleveland Bay and Dugongs have been seen in the vicinity of the Port. The proposed TOT development area however, does not represent important feeding habitat for Dugongs.

II.4 SUMMARY OF EXISTING CONDITIONS

II.4.1 AUSTRALIAN SNUBFIN DOLPHIN AND INDO-PACIFIC HUMPBACK DOLPHIN

Australian Snubfin Dolphin and Indo-Pacific Humpback Dolphin are inclined to forage in rivers, estuaries and otherwise turbid water (Marsh et al. 1989; Parra 2005; Reeves et al. 2002; Ross et al. 1994). Areas of highest abundance are likely to be locations with regular productivity gradients, such as those associated with river mouths. Although Cleveland Bay has a modest maximum tidal range of 3.8 m, this is relatively large compared to the average water depth and the tides are weak, so the only regular productivity gradients are likely to be associated with riparian sediment plumes. The Ross River is the major source of input to Cleveland Bay.

The distribution of both species is centred on the Ross River plume, which regularly extends north and west towards the Townsville Port headland. The distribution of dolphins is heavily influenced by this feature, which will vary day to day and between seasons though it appears to rarely, if ever, extend beyond the Port headland.

The population of either species regularly using Cleveland Bay is likely to number less than 100 individuals but these individuals may range for periods of a day and up to a month beyond Cleveland Bay and their populations are likely to be continuous along the coast north and south of Cleveland Bay. Cleveland Bay does not represent an isolated population of either species.

The proposed TOT development is situated outside the main feeding areas for both species. Both species are likely to feed very regularly (daily) within a short distance of the development but are very unlikely to feed within its footprint.

II.4.2 DUGONG

Cleveland Bay contains important habitat for Dugongs but this is located about 10 kilometres from the proposed TOT development. Evidence from satellite tracking indicates that Dugongs tend to move east into Bowling Green Bay on the opposite side of Cape Cleveland. The proposed TOT development is situated entirely outside the main feeding areas for this species, though they are likely to pass through / forage occasionally in the vicinity.

II.4.3 MARINE TURTLES

Three species are likely to occur regularly in Cleveland Bay but only one, Green Turtle, occurs in abundance and regularly within the proposed TOT site. Green Turtles breed nearby and are found feeding and internesting primarily in seagrass areas. Surveys have shown that they occur at highest density in the main seagrass areas, therefore most of the core habitat for this species is 10km from the proposed TOT development.

The other species: Flatback Turtle and Loggerhead Turtle are far less common. Loggerhead Turtle may occur in very small numbers during annual migration but is not generally associated with shallow coastal waters. Individual of the species are very unlikely to be affected by the development. Flatback Turtles breed in Cleveland Bay, mostly on Magnetic Island but may nest almost anywhere on local beaches and have even attempted nesting at the Strand beach in Townsville. Outside the nesting season, Flatback Turtles are usually seen in relatively turbid shallow water feeding on fauna prey in soft sediments. The proposed TOT development comprises mainly sandy substrate with seagrass and therefore, is not likely to represent habitat for this species, though individuals may forage in the general vicinity, along with Green Turtles.

TOWNSVILLE OCEAN TERMINAL: DOLPHINS, DUGONGS AND MARINE TURTLES

III. IMPACT AND RISK ASSESSMENT

III.1 Environmental Assessment Approach

III.1.1 Key Environmental Values for Impact Assessment

This assessment determines the likely impacts of the Townsville Ocean Terminal development on:

- Australian Snubfin Dolphin;
- Indo-Pacific Humpback Dolphin;
- Dugong; and
- Marine turtles.

For reasons discussed in section II.2, only the following three marine turtle species are specifically addressed in this impact assessment:

- Green Turtle;
- Flatback Turtle; and
- Loggerhead Turtle.

III.1.2 Impact Assessment Approach

The approach follows a generally accepted method for ecological impact assessment, as defined in several professional publications referenced throughout this section of the report (e.g. Hill et al. 2005; Institute of Ecology and Environmental Management 2005; Treweek 1999).

III.1.2.1 Identification of Key Hazards

An initial list of key hazards is first presented in section III.3. This draws on information about existing pressures and threats from government legislation and policy (section I.2), comments from public submissions (Table I.1-2) and reports from other consultants on the likely scale, intensity, frequency, duration and periodicity of effects. Note, effects are described in further detail later (sections III.6 and III.7) so the identification of hazards has been somewhat iterative. When the assessment of effects led to additional hazards being identified (e.g. red tides), they were added to the list and the process rerun from the start.

III.1.2.2 Establishing Sensitivity to Effects

Before attempting to determine the consequence of any potential impact from a given hazard, it is necessary to discuss the sensitivity of individual species' to impacts and their vulnerability (in the context of a species population) to the effects. This puts any assessment of impacts into a necessary context for evaluating likely outcome scenarios.

III.1.2.3 Description of Environmental Effects

Environmental effects (construction methods, timings, equipment used, intensity of effect etc.) are presented in sections III.6 and III.7 and summarised in Table III.8-1. This satisfies the need to describe potential risks and hazards that might affect dolphins, Dugongs and marine turtles in the vicinity of Townsville, as determined by section 4.16 of the project Terms of Reference. It also provides the quantitative basis for the impact assessment. Environmental effects need to be translated into a format that is ecologically coherent i.e. not necessarily based on a given threshold. Neither should it be assumed that there is a linear relationship between the level of additional effect and the resulting impact.

As stated in the project Terms of Reference (section 4, Page 18, Para. 5), impacts need to be considered "in the dimensions of scale, intensity, duration or frequency". A necessary method for ecological impact assessment is to relate effects to natural variation and existing conditions. Depending on the characteristics of the environment a species occupies, disturbance can be additive or can be absorbed by existing conditions. For example, if the ability of a visual predator to see prey is limited at a certain turbidity level and this level is always exceeded, adding extra sediment into the water column is unlikely to have any additional impact. However, if this turbidity threshold is never exceeded naturally, additional sediment may begin to affect the species' ability to feed (additive). In reality, levels of existing effect vary in time and space, hence the timing of additional effects can also vary the outcome. Levels of turbidity may rise predictably during regular storm events, or may be higher in one season than another. All these factors need to be considered when assessing the likely consequence of environmental effects on a species' ecology.

As described by the Institute of Ecology and Environmental Management (2005): when describing changes/activities and impacts on ecosystem structure and function, reference should be made to the following parameters:

- positive or negative (whether the impact benefits or detracts from net biodiversity value of the feature);
- extent (area affected and percent of total area of the feature);
- magnitude (level of severity of influence on the feature)
- duration (measured time interval for the activity and likely duration of impact on the receptor);
- reversibility (reversible or irreversible? - Can the impact be reversed, whether this is planned or not?);
- timing (when will the effect occur?); and
- frequency (constant or intermittent - the interval and variation in level of activity should be stated if possible).

III.1.2.4 Description of Environmental Impact and Consequence

The assessment is grouped under hazard headings (section III.3.1). For example, the impacts from all light-related effects, from whatever source, are discussed under the same heading. Weight of consideration given to any particular hazard is determined by dual consideration of the intensity of the effect and the likelihood of the impact given its context (spatial scale, sensitivity and distribution of the species). Environmental impacts are described so their consequences can be determined. Consequence is described in accordance with evaluation criteria in the Project Terms of Reference and the relevant legislation and policy, including species recovery plans (see I.1 and I.2). These consequence criteria can be adapted to feed into the project risk assessment.

III.1.3 Residual Impacts and Significance

III.1.3.1 Mitigation and Monitoring

Monitoring and mitigation criteria are primarily developed, where possible, to address impact consequences that may otherwise be evaluated as a significant or potentially unacceptable risk based on formal evaluation criteria (below).

III.1.4 Final Evaluation Criteria

The criteria by which consequences are described are generally established by the legislation and associated policy in terms of “significance”. For example, the EPBC Act describes criteria for assessing significance (see section I.2.2 of this report) and the *Nature Conservation Act 1994* (Qld) proposes management criteria, including the assessment of critical habitat (section I.2.3.2 of this report). The final significance assessment process is detailed in section III.11 of this report.

Taking into account these requirements and for the purpose of this report, a significant *indirect* impact is defined as:

- Substantial alteration of ecosystem structure, function and composition; or displacement of important prey in areas that support high densities of dolphins, Dugongs or marine turtles that is likely to result in a reduction in Cleveland Bay's carrying capacity and irreversible impacts on population viability of these species.

For assessment of these indirect impacts, we rely on the findings from the Nature Conservation Report (C & R Consulting 2007).

For all indirect and direct impacts assessed in this report the following criteria, based on the state and Federal government requirements, are used to determine the potential impact on dolphins, Dugongs and marine turtles:

- whether the habitat that is likely to be affected by the development comprises “critical habitat” (as defined in section I.2.3.2);
- whether there is likely to be serious loss / displacement of animals from this habitat;
- whether impacts on this habitat (if they occur) can be managed;
- whether the population is isolated enough to warrant consideration as a genetically unique single unit or whether it forms part of a larger population, likely to number in the thousands; and

- whether any resulting sustained level of annual mortality is likely to be more than a very small percentage of the population (an overview of population levels for dolphins and Dugong in Cleveland Bay is given in section II.3).

In order to assess the seriousness of impacts, existing conditions are considered, and whether changes that may arise from the development are likely to be within or beyond natural variation (see section III.1.2.3).

III.2 EXISTING PRESSURES AND THREATS

III.2.1 INTRODUCTION

Table III.2-1 lists information on current and potential pressures and threats in northern Queensland, that have been identified in recovery documents and action plans for the Commonwealth and Queensland. Reference to these key threatening processes is needed to address the requirements of the EPBC Act threatened species process (see Box I.2-1) and the *Nature Conservation (Dugong) Conservation Plan 1999* (Qld).

Table III.2-1: Current / potential pressures identified and listed from recovery documents and action plans.

Current / potential pressures in northern Queensland	Australian Snubfin Dolphin	Indo-Pacific Humpback Dolphin	Dugong	Marine Turtles
Incidental capture in nets (fishing nets, shark nets)	■	■	■	■
Overfishing of prey species	■	■		
Pollution (organochlorines, particularly PCBs)	■	■		
Habitat loss and degradation, including noise pollution, harassment and resort developments	■	■	■	■
Epizootics: pathogen-induced mortality	■	■	■	
Boat strike			■	■
Ingestion of marine debris				■
Light pollution				■
Predation of eggs by faunal animals				■
Oil spills				■

Public responses from experts following submission of the original EIS have identified the following list of key existing pressures affecting dolphins, Dugongs and marine turtles in Cleveland Bay:

- Habitat loss and degradation;
- Pathogen-induced mortality;
- Incidental capture in fishing nets; and
- Boat strike.

In addition, light is likely to be a key effect for nesting turtles.

Habitat loss and degradation encompass a wide range of factors. There is no substantial threat from direct loss of habitat i.e. removal of the seabed and associated flora and fauna. Although this occurs as a result of ongoing maintenance dredging for the port channel, dredging has been done since 1901[7]. Existing causes of habitat loss are more

[7] Townsville Port History: http://www.townsville-port.com.au/component/option,com_content/task,view/id,137/Itemid,110/. Last viewed 24 June 2008.

likely to be associated with disturbance, which can make prey less available. Because of the high density human population, the proximity of the city of Townsville and the Port of Townsville, background levels of disturbance from activities such as recreational and commercial vessel use are expected to be relatively high compared to the surrounding coastline. Potential for disturbance from vessels and associated vessel strike is high for Dugongs but can also affect dolphins and turtles. All species assessed in this report are relatively inconspicuous, can remain submerged just below the surface for periods of minutes and can occupy turbid water.

The occurrence of potentially lethal pathogens has been reported for Cleveland Bay, with three Indo-Pacific Humpback Dolphins infected with the parasitic protozoan *Toxoplasmosis gondii* (Bowater et al. 2003). Although there is no definitive science on the source of the infection, it is commonly associated with cat faeces, leading to the widely held view that this is a primary source of infection in coastal waters. For reasons unknown but perhaps associated with fish migration, it has also spread throughout the world's oceans and has been found in a significant number of dead animals of numerous species (Dubey et al. 2003). Contamination of the environment with pet faeces is a recognised environmental health problem, with huge quantities of faecal material entering waterways after rain, bypassing the sewerage processes associated with human waste and leading to increased risk of waterborne parasitic infection (for example, Locking et al. 2001; Robertson et al. 2000).

Netting and bait netting, particularly using single filament nets, have the potential to impact dolphins, Dugongs and marine turtles. Background levels of impact are controlled in Cleveland Bay through the imposition of the Dugong Special Management Area 'A', which prohibits netting and bait netting without a licence, in accordance with *Fisheries Regulations 2008* (Qld). Nevertheless, netting and bait netting is allowed outside this area and the regulations are less stringent for Bowling Green Bay, into which Dugongs from Cleveland Bay regularly move. Halifax Bay to the north has no restrictions at all. Background levels of mortality from fishery bycatch outside Cleveland Bay could also affect dolphins within the Bay, as their population viability is dependent on movement of animals along the coast to the north and south.

Anthropogenic light effects are not considered likely to give rise to impacts on foraging turtles, dolphins or Dugongs but can have serious effects on nesting turtles. Given the high level of ambient lighting in the coastal environment already, it is likely that turtle nesting in the vicinity of the Strand beach is already constrained. Impacts can occur from disturbance of egg-laying females and at hatching, when young turtles are prone to wander towards inland lighting instead of towards the sea.

The antifoulant TBT (Tributyl Tin) is also an existing threat not raised in public submissions. This compound has been banned from small vessels in Queensland for many years and is due to be banned from all vessels in Australia this year. It will not represent a risk to dolphins, Dugongs and marine turtles from the TOT but could still be present in surrounding sediment.

III.2.2 SUMMARY

The most serious existing pressures and threats to dolphins, Dugongs and marine turtles in Cleveland Bay result from habitat loss and degradation, which is mostly a function of disturbance from boat traffic, and the associated risk of vessel strike. In addition, there is evidence of background levels of pathogen-induced mortality arising from protozoan parasites, probably from cat faeces washed into watercourse in Townsville. Individuals of all species assessed in this report range both within and beyond Cleveland Bay, so although netting is banned in Cleveland Bay as a Dugong Special Management Area, still represents a key existing pressure. Finally, lighting from street lamps, housing, the Port and ships are an existing threat to nesting turtles.

III.3 IDENTIFICATION OF HAZARDS

III.3.1 LIST OF HAZARDS

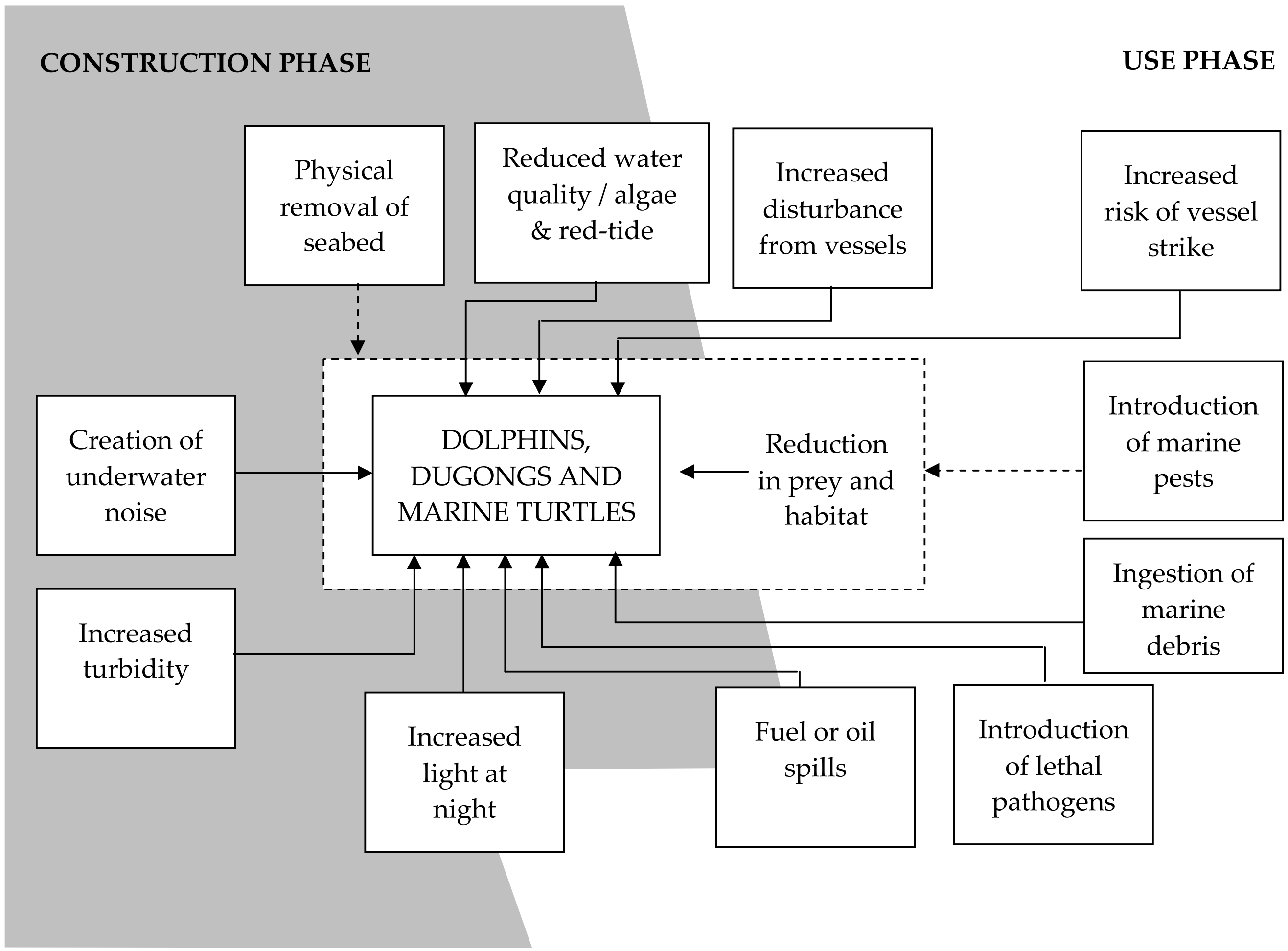
The following hazards are those that could arise as a consequence of the TOT project. In arriving at this list we have referred to government legislation and policy (section I.2), public submissions (Table I.1-2) information about environmental effects documented by other project consultants, and our own technical expertise.

- Reduction in availability of prey or habitat;
- Disturbance (various forms, possibly leading indirectly to habitat loss);
- Underwater noise (direct impacts from piling - for indirect impacts, see Disturbance);
- Introduction of lethal pathogens;
- Vessel strike;
- Littering (leading to ingestion of marine debris);
- Light pollution;
- Introduction of marine pests;
- Increased turbidity (leading to reduced ability to find prey);
- Fuel or oil spills;
- Reduction in water quality; and
- Algal blooms (e.g. red tide).

Hazards are divided into those that would give rise *directly* to impacts on dolphins, Dugongs and marine turtles, and those that would give rise to impacts *indirectly*, by affecting their habitat or prey (see Figure III.3-1).

In the following sections, a review of sensitivity of dolphins, Dugongs and marine turtles to the potential direct impacts is given. Indirect impacts are the subject of reports by other ecological consultants (e.g. the extent and significance of loss of seagrass). The following sections also consider the sensitivity of species in relation to existing threats and pressures.

Figure III.3-1: Simplified impact pathways (only key impact pathways are shown)



III.4 Species Sensitivity and Vulnerability

This section details the sensitivity of the species in question to particular hazards. Note however, that because a species is potentially sensitive to one of the hazards discussed in this section does not mean that an impact from the TOT is certain to occur. The impact assessment depends on the local ecology of the species (including its seasonal distribution), plus the timing, duration, intensity and frequency of the environmental effect at the TOT location. This is covered in the impact assessment results in section III.6 and III.7 and III.10.

III.4.1 Noise and Disturbance

III.4.1.1 Introduction

Disturbance and noise are considered together here as noise is the key component in most disturbance events. However, disturbance is hardly ever determined by one factor alone and whilst noise can elicit a response, it is not likely to be biologically significant at any level unless the consequence of the response seriously affects survival. For the purpose of this assessment, we have used a model for disturbance assessment based on Hill et al. (1997) (Figure III.4-1). In this paper, it is shown that disturbance effects (e.g. local site movements) and disturbance impacts (where a population is affected) are often confused. In other words, just because an animal responds to an effect does not necessarily mean that an impact occurs.

III.4.1.2 Direct Injury Effects from Piling Noise

Marine mammals are considered particularly sensitive to noise because they rely to a large extent on hearing for feeding and socialising. It is possible that intense sounds may cause hearing damage by causing Temporary Threshold Shift (TTS) leading eventually to Permanent Threshold Shift (PTS). Temporary Threshold Shift (TTS) is a temporary effect where sounds need to be louder in order to be heard, due to temporary damage to hearing cells. If the effect causes loss of hearing cells and the 'threshold' at which sounds can be heard is raised permanently, then this is called Permanent Threshold Shift (PTS). PTS would amount to injury.

In the United States, a "do not exceed" exposure criterion of 180 dB re 1µPa (Sound Pressure Level *rms*) is often used for cetaceans exposed to sequences of pulsed sounds, and 190 dB for seals and sealions. For the most conservative hearing threshold (40dB) an Inferred Auditory Damage Risk Criteria by Richardson et al. (1995) found that PTS is likely after about 100 long (>200ms) pulses at a similar sound level. TTS is not simply a consequence of the sound level but also of the duration of exposure. According to Richardson et al. (1995), in order for marine mammals to be permanently affected by noise, a level of 180 dB re 1µPa is likely to need to be exceeded for about 50 minutes (based on a pile strike rate "duty cycle" of about once every 30 seconds). Marine mammals are considered most sensitive to underwater noise and marine turtles less so. This assessment is done on marine mammals and presumes that this is a conservative level of assessment for marine turtles.

These thresholds have been recently revised. An exhaustively peer-reviewed reassessment of noise thresholds published in Aquatic Mammals (Southall et al. 2007) deduced a threshold injury level of 198 dB re 1µPa²s[8] Sound Exposure Level for cetaceans exposed to multiple pulses as during pile driving. To place these levels in some context, the noise from storm force winds would be expected to exceed 80 dB; shipping / large fast vessels are commonly in the region of 100-140dB at source; and overhead aircraft may create underwater noise in excess of 100dB.

III.4.1.3 Behavioural Disturbance Effects

There is no single threshold of underwater noise disturbance for marine animals as the subject, as with all behavioural issues, is highly complex and largely inconclusive. For instance, Evans & Nice (1996) cites ranges of 130 – 170 dB re 1µPa for behavioural avoidance based on studies that showed a reaction to noise. However, the extent of disturbance depends on the species, how well it can hear (e.g. how old it is), and its behaviour e.g. whether it is feeding (or if it is starving), migrating, resting or socialising (Hockin et al. 1992; National Research Council 2003). For example, McCauley et al. (1998) reported 'resting' Humpback Whales would remain 7-12 km away from seismic airgun noise whilst male Humpback Whales were reported to approach, perhaps mistaking the sound for whale breaches which have similar source levels and characteristics. Changes in behaviour of migrating Humpback Whales were alsi recorded at a shorter distance of 5-8 km and avoidance at about 3km. Similarly, although bowhead whales have been shown to be highly sensitive to seismic noise at levels as low as 116 dB re 1µPa, Richardson et al. (1995) report that they continue to pass through areas with sound projecting at levels of 131 dB re 1µPa during spring migration.

[8] Note, some of these units differ. The *rms* value referred to at the start of the paragraph is the energy measured over 90% of the duration of the pulse. Sound exposure level is the energy over the entire pulse duration.

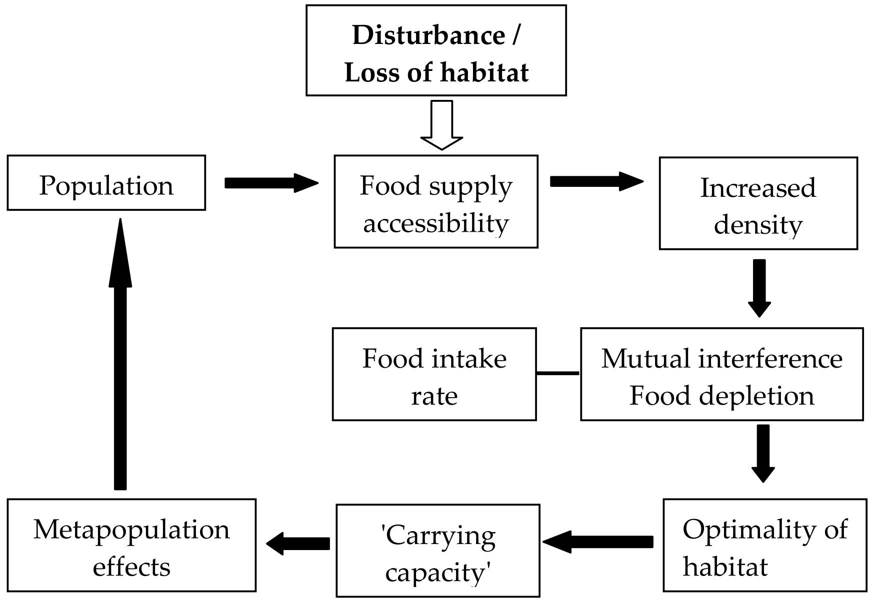


Figure III.4-1: A schematic model of the relationship between disturbance, food supply, intake rate, carrying capacity and importance to metapopulations (Hill et al. 1997**)**

Generally speaking, loud sounds that are sudden are more likely to elicit a response than those that build up relatively slowly. Equally, if a sound is not associated with any additional harmful effects, it seems less likely to be avoided and habituation is more likely. For example, Beluga *Delphinapterus leucas* showed less reaction to stationary dredges than to moving barges despite similar noise characteristics (Ford 1977; Fraker 1977b; Fraker 1977a cited in Richardson et al. 1995). Gordon et al. (1998) also suggest that structured and repeated sounds may have built-in redundancy, i.e. animals are likely to be adapted to ignore such sounds.

There are very many documented cases of reactions of marine mammals to marine construction activity. A study of piling operations in San Francisco (Anon 2001) observed sea lions reacting but not moving away at the edge of a 'safety' zone of 500 metres, where linear peak noise was likely to be about 170 dB. Wursig et al. (2000) studied the behavioural response of Indo-Pacific Humpback Dolphins to percussive piling in Hong Kong harbour. Dolphins were sighted within 300-500m of the operation before, during and after piling. Though there was no conclusive evidence for avoidance, the average swim speed of dolphins was over twice as fast (statistically significant difference, $p<0.001$) during active piling compared to periods when piling was not being done. This reaction could be construed as positive avoidance, which would actually reduce the risk of direct impacts.

As well as causing behavioural change, vessel noise also has the potential to mask marine mammals' ability to hear one another, impinging on social activity (Mann et al.

2000). Dolphins and Dugongs produce sounds in the mid to high frequencies (see Table III.4-1). Noise from small boats with outboard engines tends to dominate the mid-range frequencies (Richardson et al. 1995) as these are the frequencies at which the propellers spin e.g. Kipple & Gabriele (2003) show source levels of 150-165 dB re1μPa at 1m at frequencies between 1 – 10 kHz.

Table III.4-1: Marine mammal vocalisation frequency ranges (Ketten 1998; Parijs et al. 2000).

Species	Frequency range (kHz)	Frequency at Maximum Energy (kHz)
Orcaella sp.	1.0 – 8.0 (whistles) >22.0 (clicks)	Not reported
Indo-Pacific Humpback Dolphin	1.2 – 16.0	Not reported
Dugong	1.0 – 18.0	1.0 – 8.0

By contrast, ships produce peak noise at frequencies below the peak vocalisation ranges of dolphins and Dugongs (Figure III.4-2) so large vessel noise may be less of a constraint. Though this depends on the source level, which can be relatively high for very large vessels, and ships do produce some higher frequency noise from equipment inside the hull and propeller cavitations.

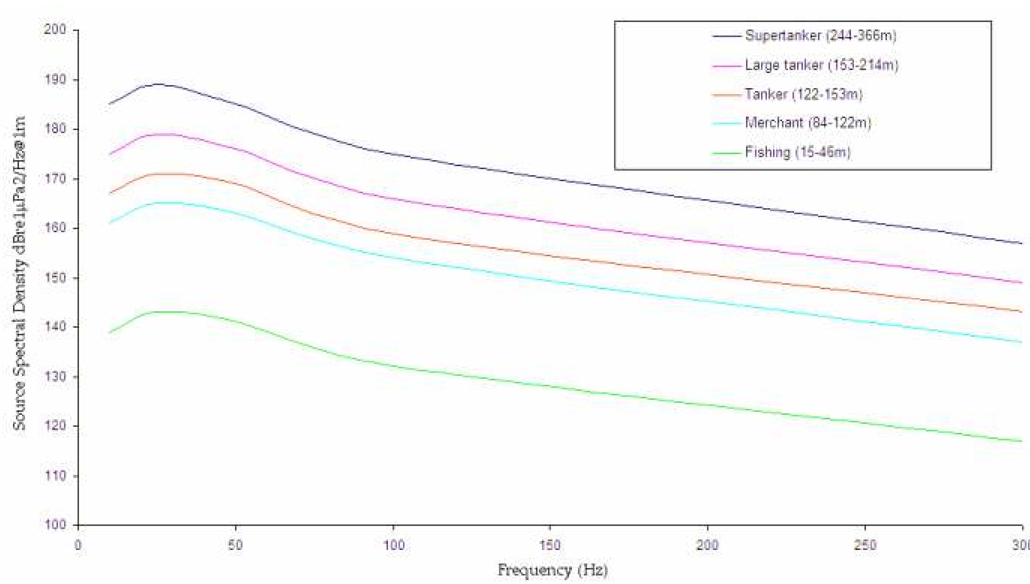


Figure III.4-2: Graph showing the Source Spectral Density (dB level at given frequencies, measured in 1 Hz bands) for ships of various size and frequencies between 10 Hz and 300 Hz, adapted from RANDI source level model (Emery *et al.* 2001; Mazzuca 2001, in National Research Council 2003, p56).

III.4.2 Introduction of Lethal Pathogens

Lethal pathogens associated with human or animal waste have the potential to cause mortality in marine mammals. This subject is discussed as part of existing pressures and threats (section III.2), concluding that it has the potential to increase mortality.

III.4.3 Vessel Strike

Dolphins, Dugongs and turtles all need to surface to breathe and are prone to collision with vessels. Dugong is particularly sensitive to impacts as it is slow moving and has a habit of foraging in shallow water. Dolphins and turtles are considered less prone to vessel collision but it still represents a risk.

Dugong is a sirenian and another sirenian species, the West Indian Manatee *Trichechus manatus*, found in the US has been more extensively studied in terms of vessel strikes. In Florida, 15-31% (mean=25%) of Manatee deaths are attributed to vessel strike (Ackerman et al. 1995). Approximately half of these are caused by blunt force trauma (collision with the hull) and the remainder from propeller damage (Brook Van Meter 1989). Not all Manatees die from collisions but most animals bear scars, suggesting that vessel collision is far more common than would be evident by just assessing mortality (Brook Van Meter 1989). Further, the number of deaths appears to be in direct correlation with the number of vessels (r^2=0.87; p=0.0001) (Ackerman et al. 1995).

Vessel collision risk has been documented as a key constraint for population viability (section III.4.11) amongst Dugongs in Moreton Bay and throughout the species' range (EPA Queensland 1999; Groom et al. 2004; Preen 2000).

III.4.4 Increased Light at Night

Light has some potential to impact on nesting turtles. Detail of the potential consequences is given in section III.2 e.g. disturbance of egg-laying females and hatchlings wandering inland towards lighting instead of towards the sea. Lighting at night is unlikely to affect dolphins, Dugongs or turtles foraging in open water areas of Cleveland Bay.

III.4.5 Littering (Marine Debris Ingestion)

Spillage of litter and other marine debris into the surrounding environment has the potential for mortality impacts. This is likely to particularly affect turtles which are prone to ingesting objects such as plastic bags.

III.4.6 Fuel and Oil Spills

The potential for fuel or oil spills to impact marine animals is well known. Impacts are typically greatest on animals that spend a significant amount of time at the surface, which is a key criterion for assessing vulnerability to surface pollutants (Williams et al.

1995). Impacts on marine mammals are less understood but have capacity to cause serious injury to individuals.

For the purpose of this report, it is not necessary to review in detail the numerous potential acute effects of oil spills at sea, as the effects are widely accepted as potentially serious. If exposure occurs, the consequence of an incident will depend on the number of animals affected, the severity / intensity of effect and the capacity for any given population to recover. Since the precise duration, intensity and effect of fuel or oil spills is unpredictable according to the size of vessel, extent of damage, prevailing weather conditions and seasonal species sensitivity, it is impossible to accurately predict the severity of any individual event.

There are very little data available on the impact of oil spills on marine mammals and marine turtles, though being surface breathing, there is a possibility that they may inhale toxic compounds or clog structures in the lungs. Nonetheless, in some parts of the world such as the Gulf of Mexico, cetaceans seemingly tolerate oil slicks caused by natural seepage from the seabed (Simon Mustoe, personal observations). In the absence of further information, it is assumed that a major spill in the vicinity of Townsville could have an adverse impact on those dolphins, Dugongs or marine turtles that come into contact with it.

III.4.7 REDUCTION IN WATER QUALITY

III.4.7.1 Uptake of Contaminants – Plausible Pathways

Initial water quality advice provided to AES indicates the following plausible pathways for contamination to affect dolphins, Dugongs and turtles.

1. Dredging and / or dewatering of the site may cause release of ammonia, which can directly affect marine organisms resulting in loss of habitat or indirectly impact habitat and prey.

2. Stormwater run off or sewerage discharged from the site into surrounding water may result in nutrient enrichment and changes to the structure, function and composition of the surrounding environment, leading to potentially negative changes for prey species.

III.4.7.2 Potential Consequences of Contamination

Bioaccumulation of contaminants is a complex topic and knowledge of its impacts is limited in part by the ethical difficulties of carrying out studies, particularly on marine mammals. Contaminant pathways through tissue are not well known and there is a lack of baseline data with which to compare a 'normal' level of contamination with raised levels due to anthropogenic effects. We do, however, know that predators such as marine mammals are more likely to be significantly affected than those at the bottom of the food chain as pollutants tend to concentrate up the food chain.

III.4.8 Algal Blooms / Red-Tide

Algal blooms, some of which are toxic, are difficult to predict and do occur naturally from time to time. Toxic algal blooms have the potential to cause mortality in vertebrates, for instance between 1946-1947 and 1953-1955, two events in central and southwest Florida were implicated in the deaths of bottlenose dolphins.[9] It is often difficult to ascertain the precise cause of mass mortality events and so–called 'red tides' (*Trichodesmium* blooms) have also been implicated in mortality of Manatees (Ackerman et al. 1995). There is evidence that the toxins formed when the organisms break down can persist in the environment and may be directly or indirectly ingested by fish and marine mammals. Direct mortality is possible but it is difficult to predict when a bloom may occur, whether this would have occurred naturally and what the consequences may be.

III.4.9 Reduction in Underwater Visibility

Vision in dolphins is well developed and there is evidence that vision plays an important role in predator avoidance and social interaction. Its benefit for prey detection may be limited since, although dolphins have good underwater vision, unlike seabirds and seals, their eyes do not point forward so pursuit of prey is done using their echolocation adaptations. Dolphins use echolocation extensively to detect prey and are commonly observed in turbid water where vision would not be of any significant benefit. For example, bottlenose dolphins have been observed apparently feeding in plumes created by vessels in Adelaide, where they may be exploiting demersal fish species that are exposed by propeller wash (Mike Bosley, Australian Dolphin Research Foundation pers. comm.). Contrastingly, there is evidence in Cardigan Bay, Wales (UK) for avoidance of dredge plumes when underwater visibility averages less than about 1m (Cardigan Bay Special Area of Conservation Management Plan, UK). Dolphins may also avoid areas of high turbidity in warmer waters where there might be potential shark predators (Cockcroft 1992), which they need to detect visually in order to avoid.

It is unlikely however, that Australian Snubfin Dolphins and Indo-Pacific Humpback Dolphins would be substantially affected by increased turbidity as a result of the proposed TOT. These species commonly inhabit highly turbid water and natural conditions in Cleveland Bay often limit underwater visibility to less than 1m (Walker 1981).

III.4.10 Reduction in Availability of Prey or Habitat

Effects on habitat and prey are interlinked, as significant effects on ecosystem processes that support the pelagic food web can impact prey, which in turn form part of the

[9] Florida Fish and Wildlife Research Institute http://www.floridamarine.org/features/view_article.asp?id=5964 last viewed 17 October 2006.

habitat for predators. Impacts on prey species or habitat could occur due to any of the impact pathways illustrated in Figure III.3-1. Only direct effects (solid lines) are considered here. Indirect impacts on habitat and prey are dealt with in other consultant reports but their significance is discussed in relevant sections of the impact assessment, by drawing on the results of the other studies.

III.4.10.1 Physical Removal of Seabed

The TOT construction would result in the loss of about 1km^2 of seabed and changes to the geomorphology, structure and function of areas immediately surrounding the site. There are two potential indirect consequences of such changes:

1. loss of habitat for dolphin, Dugong or marine turtle food / prey, leading to a reduction in food / prey availability for dolphins, Dugong or marine turtles either on the site or as a result of off site effects further up the food chain; and

2. loss of primary production capacity leading to a change in the ecological functioning of Cleveland Bay.

III.4.10.2 Introduction of Marine Pests

Impacts from marine pests could occur indirectly if a pest species affects food or prey for dolphins, Dugongs or marine turtles, or causes a change in Cleveland Bay's ecosystem resulting in a reduction in carrying capacity for these species. Changes could occur for example, due to competition with and predation on native species, changes to trophodynamics, changes to habitat structure, alteration to or displacement of existing biological communities and impacts on denitrification.

III.4.11 Population Viability

The primary roles for animal Population Viability Analysis (PVA) are to predict the consequences of human actions for populations and to assist in the design of research and monitoring programs (Burgman 2000). PVA is now widely used by conservation biologists and wildlife managers and has been recommended as one of the criteria for compiling the IUCN threatened species list (IUCN. 1994, Taylor 1995).

PVA is particularly valuable to assist in understanding populations when assessing the likely consequence of effects (Figure III.4-1) but data to accurately populate such models is rarely available. Even when it is, caution is advised in interpretation of such phenomenological models, as they have a tendency to give over-pessimistic predictions of extinction risk (Sutherland 2006).

Nevertheless, such models are a valuable source of understanding and essential to the process of impact and risk assessment. Dolphins, Dugongs and marine turtles are all long-lived animals with low reproduction and mortality rates and fall into an evolutionary category of species known as k-selected. K-selected species are usually large with low reproductive rates but stable populations that are thought to occur at carrying capacity (the threshold at which the maximum number can survive in the environment). K-selected species tend to utilise predictable resources, whether that be breeding sites or feeding areas (hence site fidelity, see Parra 2005), so knowing where these critical habitats are located is particularly important. However, for such populations to become evolutionarily stable and even to exist at all, they also have to deal with natural variations in environmental conditions. For example, cyclones regularly destroy large areas of seagrass along the Queensland coast but Dugongs have not gone extinct as a result.

Large-bodied marine mammals have the energy-storage ability to cope with the effects of temporary changes in the environment but this is not to say that they can permanently, or for extended periods, move elsewhere without reducing their population. Since an evolutionarily stable strategy is to congregate close to the best primary feeding locations with the greatest return on energy and / or food availability (Mcnamara et al. 2006; Pyke 1984). Locations of greatest importance are those where the fittest breeders survive. The best sites will tend to hold the largest number of animals and as individuals are outcompeted (or habitat is lost), they are forced to move to sites that provide less return on energy expenditure (Dolman & Sutherland 1995) and lower survival probability.

Ultimately, population viability is determined by the probability of extinction due to stochastic events and population size: so-called Minimum Viable Populations (MVP). Traill et al. (2007) drew some broad generalisations based on a meta-analysis of animal populations. This found that most viable populations number in the few thousand (mammals = 2,261-5,095) though the study also identified a lack of predictability of MVP based on plausible (and measurable) correlates with extinction risk. As described by Sutherland (2006) there is a risk that such estimates are overly pessimistic due to underestimates of the intrinsic growth rate. Nevertheless, it is plausible to assume that small populations in the order of hundreds of individuals may be prone to extinction risk due to the variability of the local environment (Traill et al. 2007).

Of the species considered in this report, Dugong and Australian Snubfin Dolphin are likely to be the most vulnerable to reductions in population viability. Commonly, their populations are dependent on maintaining certain levels of survivorship amongst breeding adults (Marsh et al. 2003) and an unquantifiably small increase in mortality, particularly amongst breeding females, is expected to result in population decline.

III.5 CONSTRUCTION METHOD

III.5.1 SIMPLIFIED OVERVIEW

For the purpose of this assessment, a simplified description of the proposed construction method is adequate. This is because the first phase of construction sees the site bunded, largely containing the scope of environmental effects within the site. There are five relevant phases (Table III.5-1).

Table III.5-1: Construction phases for development

Phase and Timing (Flanagan Consulting Group 2008b)	Detail
Site Containment Duration: 8 mths Timing: Sep – Aug 2010	The site will be contained by constructing a temporary rock wall: the "Strand Breakwater" (see Figure III.5-1). It may take only about 6 months of this time to complete containment of the site.
TOT berth / swing basin construction sheet piling Duration: 4 mths Timing: Jan – Apr 2009	Sheet piling will be necessary to contain the berth and swing basin in preparation for excavation to the required depth.
Dewatering Duration: 1 wk Timing: Apr 2009	Approximately 75% of seawater from within the site will be pumped out into Cleveland Bay using floating "skimmer" pumps. This surface water will be similar in quality to water in Cleveland Bay. As the depth drops (to ~0.4m), suspended sediment levels are expected to increase and when turbidity reaches a given threshold, seawater will no longer be pumped directly to sea but placed in a series of settling ponds (W1-W4 in Figure III.5-1), enabling sediment to further settle and seaward pumping done when water clears. Note: during this process and throughout subsequent construction within the sea walls (for over two years), there is expected to be some seepage of sediment through the rock walls. This is only expected to be minor and can be "plugged" as necessary. However, at present very large quantities of sediment are regularly transported in and out of the proposed TOT site on tides (Figure III.5-2) and the quantity likely to seep through the rock wall is expected to be negligible compared to background levels in the immediate surroundings.
Dredge outer entrance channel Duration: 2 mths Timing: Apr – May 2011	Approximately 15,000m^3 of dredged material will need to be removed from the marina entrance (to be located in the northwest corner of the site). A clam-shell bucket dredge or drag line is proposed, which would result in a 'wet' volume of dredge material of about 20,000m^3. This is not expected to produce a substantial plume footprint, particularly as current speeds in Cleveland Bay are slow and the equipment proposed has little potential to produce extensive turbid plumes.
Removal of temporary bunds and breakwaters Duration: Several weeks Timing: After May 2011	Following completion of the marina basin and Breakwater Cove precinct, approximately 42,000m^3 of temporary rock bund is to be recovered by an excavator and trucked to the northern breakwater. This is expected to create some limited underwater

Phase and Timing (Flanagan Consulting Group 2008b)	Detail
	noise and turbidity from the placement of rocks on the seabed.

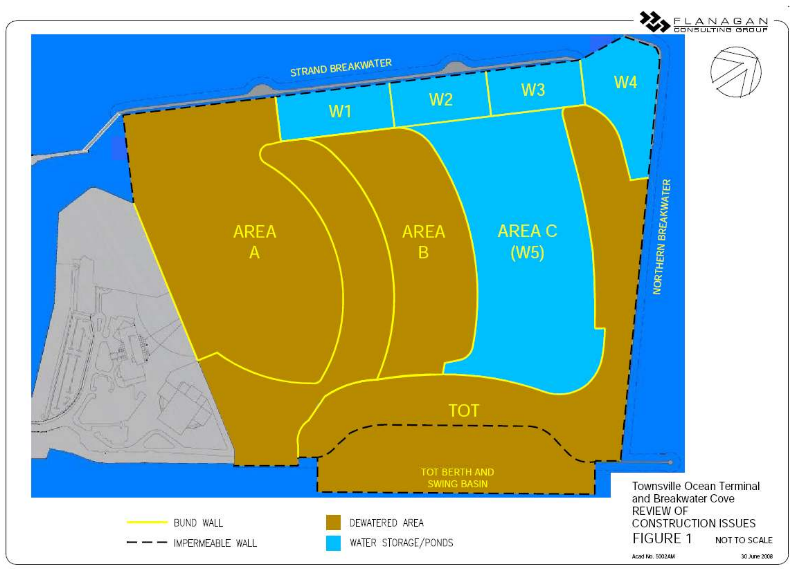


Figure III.5-1: Proposed construction areas

Figure III.5-2: The current “duckpond” (proposed TOT area) showing the extent of turbidity already present within and just beyond the site. Note the difference in suspended sediment levels inside the TOT compared to the area just north and in the port, where sediment is regularly resuspended by shipping.

Impacts may also arise from use of the development. Both construction and use-phase impacts are assessed in the following sections.

III.6 Construction Phase Effects and Impacts

III.6.1 Reduction in Availability of Prey or Habitat: Direct Onsite Loss

The proposed TOT site does not appear to represent key habitat for dolphins, Dugongs or marine turtles. Except during particularly high tides, water depth over the majority of the site is less than 1.5m mean low water (according to Office of Naval Hydrography charts). There is no evidence that Dugongs or dolphins regularly or even occasionally enter the proposed TOT site itself.

The substrate in the proposed TOT is dominated by a mixture of *Halophila* seagrass and soft sediment communities. There is some grazing by Green Turtles, which are common and widespread throughout Cleveland Bay but like Dugongs, far more abundant and dependent on the main seagrass beds several kilometres to the east. It is notable that these seagrass beds are dominated by a different seagrass species. The species in the TOT footprint (*Halophila*) is a primary succession species and its distribution often changes over short periods of time. It is capable of rapid recolonisation, which is important because shallow water areas in the centre of Cleveland Bay are naturally highly turbid.

Other evidence for the relative insignificance of this site compared to other areas of Cleveland Bay can be seen by observing the sea and coastal birds that use the site. Over a period of three days observation in mid-July 2008, feeding by Crested Terns *Sterna bergii* was observed on a couple of occasions and the only species regularly feeding in the site were between Darters *Anhinga melanogaster* (usually between 3-6 individuals). This species feeds on small fish, usually between 7-16 cm in length (Marchant & Higgins 1990). There were also a number of Eastern Reef Egrets *Egretta sacra* and Green-backed Herons *Butorides striata* feeding along the rock walls. By contrast, the area around the Ross River plume where the majority of dolphin sightings occur was dominated by large numbers of Brown Boobies *Sula leucogaster*, Silver Gulls *Larus novaehollandiae* and terns including Crested Tern and Lesser-crested Tern *Sterna bengalensis.* A White-bellied Sea Eagle *Haliaeetus leucogaster* was also seen foraging here.

III.6.2 Offsite Water Quality

Initial water quality advice provided verbally to AES by consultants at Hydrobiology indicates that sediments associated with dredging are unlikely to contain significant levels of contaminants. Also, the effects of the development are confined to within a virtually impermeable construction and waterborne sediment transport to and from the site will be greatly reduced compared to existing conditions (see Table III.5-1 and Figure III.5-2)

During construction, offsite effects from water quality are likely to be negligible. The site will initially be contained through construction of a seawall (the Strand Breakwater), which will almost completely remove current suspended sediment effects from the area immediately west of the site. At present, this area is prone to high levels of turbidity as the soft sediment within the shallow TOT site is stirred up by wind and washed in and out on tides. Residual levels of turbidity from seepage out of the site and as a result of dewatering are expected to be minor. It is extremely unlikely there will be any direct impact on dolphin, Dugong or marine turtle feeding ability.

Note, the antifoulant TBT (Tributyl Tin) is not considered to be a potential risk. This compound has been banned from small vessels in Queensland for many years and is due to be banned from all vessels in Australia this year. As dredge spoil is being disposed of to land, existing TBT in the environment has not been considered as a water quality issue likely to be exacerbated by the project (Susi Vardy, Hydrobiology In litt., 26 June 2008). Nevertheless, it is possible that there may be residue left in existing sediment.

III.6.3 Algal Blooms / Red Tide

As discussed in section III.4.8, it is almost impossible to predict the likelihood or consequence of these phenomena. Red tides (*Trichodesmium* blooms) occur occasionally in Cleveland Bay and on Magnetic Island. They have the potential to cause mortality of turtles and marine mammals. More information is available in the TOT EIS Nature Conservation study (C & R Consulting 2007) and readers are referred there for recommendations on management. The immediate area around the proposed site and the shorelines (where red tides may occur) are not considered to be core habitat areas for dolphins, Dugongs or marine turtles in Cleveland Bay. For the purpose of this assessment, it is considered unlikely that any resulting direct or indirect impacts would be serious.

III.6.4 Underwater Noise

The main sources of construction noise likely to be associated with the project are: piling, dredging and seawall rock placement. Rock placement and dredging using clam-shell dredgers will not create significant levels of underwater noise. Piling does however have the potential to create loud underwater noise.

Therefore, a noise modelling study (Gaboury et al. 2008) was commissioned to examine this risk. The precise piling method cannot be determined before detailed design phase of the project. This is normal. Modelling provides a conservative basis for impact and risk assessment but field testing at the immediate start of construction is recommended to ensure the results are as predicted. The main source of uncertainty is the precise source level but also the effect of sub-surface geology. Models are expected to be reasonably accurate but there remains the option to implement some mitigation at the time, which is possible to implement as a contingency at the last minute.

Published pile driving source spectra were researched to derive a high and low estimate of source level. Sound propagation through the water was modelled incorporating information about surface and sub-surface geology, the properties of seawater in Cleveland Bay and bathymetry. These data came from other technical studies and publications. A single model was run for a location where water depths were greatest, which is expected to result in the highest levels of sound transmission and is least shielded by existing breakwaters and the Townsville Port headland.

The results from the noise modelling study are given in Figure III.6-1 and Table III.6-1. Neither alternatives would be expected to achieve a level of noise at source capable of causing injury to marine mammals (see section III.4.1.2). As discussed in section III.4.1.3, there is no level at which to quantify “disturbance”. This is best considered in relation to existing conditions.

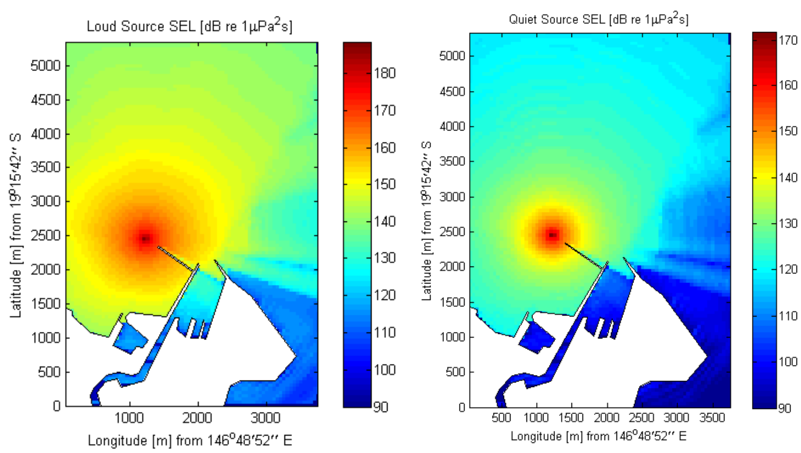


Figure III.6-1: Received SEL from a loud source (left) and quiet source (right). Plotted are the maximum SEL over all depths at each coordinate. Colours represent SEL in dB re 1μPa²s.

Table III.6-1: Summary of results from noise modelling

Source	SEL dB re 1μPa²s	Maximum radius (m) at the given dB level
Loud	170	191
	140	3307
Quiet	170	20
	140	456

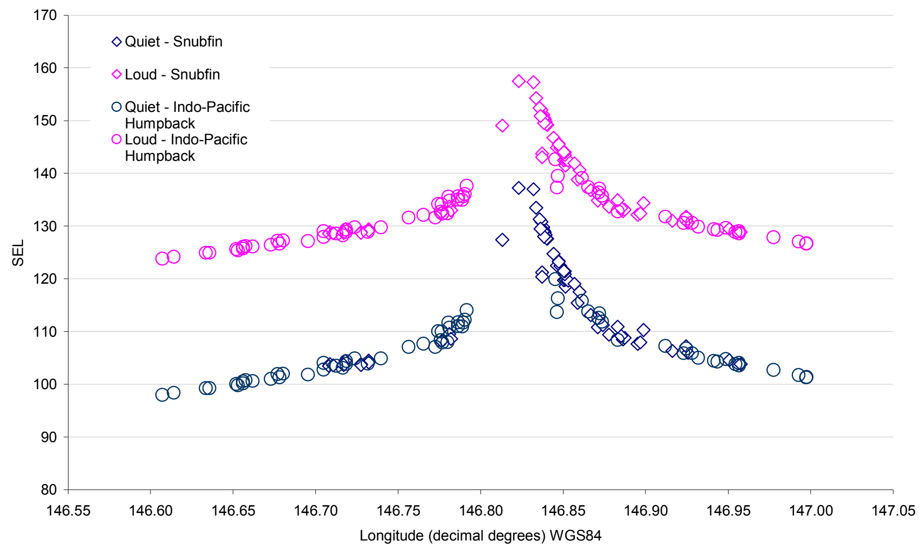


Figure III.6-2: Distribution of Snubfin Dolphin and Indo-Pacific Humpback Dolphin data (Parra 2005) and the predicted received sound levels (maximum radius) from piling based on noise propagation modelling (Gaboury et al. 2008). The peak in data is associated with the higher density of sightings around the Townsville Port Headland, near the location for modelling.

The main receptor species of concern are dolphins. If we take the data on Australian Snubfin Dolphins, approximately half the sightings are within 4km of the modelled point. The lower estimate of received noise levels predicts that for piling at the modelled location received Sound Exposure Levels (SEL) would be between 140 and 160 re 1μPa^2s (Figure III.6-2). This assumes piling is done at the end of the northern breakwater and animals are distributed according to data from Parra (2005).

Background continuous noise levels between 120 and 140dB are likely as a result of port activity, particularly during the regular movement of vessels in and out of the shipping channel, which passes through and immediately adjacent to the area of greatest dolphin activity (see for example, Figure III.4-2 minus 40dB for transmission loss at 100m due to the rough "cylindrical spreading" rule). As discussed above, these data are deliberately conservative.

At present piling is proposed for the berth and swing basin (see Figure III.5-1). This is inside the Ross Creek so the real noise levels are expected to be substantially lower, since this is in the lee of the Townsville Port headland, when a noise "shadow" is expected to almost remove the noise effect (see dark blue area in Figure III.6-1). There is considered to be virtually no risk of direct injury to dolphins, Dugongs or turtles due to underwater noise, even within very close proximity of this piling (in the order of metres). There is the possibility of some behavioural avoidance / disturbance and although this cannot be quantified directly, the fact animals already tolerate heavy vessel traffic regularly passing through their feeding area is a strong indication that they will tolerate piling noise at predicted levels. Piling within the TOT berth and swing basin will result in noise levels to Cleveland Bay well below those modelled above due to the Townsville Port headland acting as a noise shield.

III.7 USE PHASE EFFECTS AND IMPACTS

III.7.1 LETHAL PATHOGENS

The effects of pet-borne pathogens are potentially serious and could give rise to impacts discussed in section III.4.2. These impacts are therefore addressed in project mitigation (section III.9.1.3).

III.7.2 WATER QUALITY

Sources of potential water quality problems within the TOT could arise from:

- inadequate flushing of the marina and the increased risk of ammonia release from anoxic sediments;
- run-off from sewerage; and
- run-off from use of fertilisers on garden beds in recreational and residential areas.

The most serious potential effect would be from the toxic effects of ammonia but this compound rapidly oxidises and is therefore unlikely to have more than localised impacts on the environment (Susi Vardy, Hydrobiology, pers comm.). It is unlikely that this would have more than a negligible effect on dolphins, Dugongs and marine turtles, which largely occur some distance from the TOT and do not rely on the immediate surrounds for foraging. Similarly, the effects of fertiliser use is unlikely to have significant impacts on dolphins, Dugongs and marine turtles as it is unlikely to substantially alter Cleveland Bay's ecology and effects will be limited to areas within relatively close proximity to the site. Sewerage is expected to be sent to Townsville for treatment and therefore, will be dealt with off site using existing infrastructure.

III.7.3 VESSELS, COLLISION RISK AND VESSEL-RELATED DISTURBANCE

III.7.3.1 Large Ship Movements

The TOT precinct is being proposed as a dedicated ocean terminal for use by cruise ships and naval vessels. The latter currently use the existing Townsville Port facilities but the TOT would cater for additional visits. Table III.7-1 summarises estimates for the increase in shipping both as a result of the TOT and background increases (Hyder Consulting 2007). Note, for each ship there is expected to be two shipping movements (one out and one into the port). In addition, each ship movement requires a fast pilot vessel and up to two tug boats.

Table III.7-1: Estimate of shipping level increases in Cleveland Bay. All data are from Hyder Consulting (2007).

Type	Current ship visits / yr (multiply by two for movements)	2030[1] / yr	TOT total

Type	Current ship visits / yr (multiply by two for movements)	2030[1] / yr	TOT total
Naval	30	60	40-50
Cruise ships	7-8	14-16	20
Total shipping[3]	600-700	1,200 – 1,400	23-27[2]

1. These figures are based on an estimated doubling of vessel traffic into the Port of Townsville by 2030 (Hyder Consulting 2007).
2. Based on predictions that the TOT will result in a 3.8% increase in vessel traffic per year.
3. Total shipping is a variety of ships but mostly cargo vessels using the port.

Based on the data above, the TOT is thought to represent an immediate increase of 3.8% in large vessel traffic but this percentage quota would half by 2030. However, some of the predicted increase by 2030 may be absorbed by the TOT, if it provides better alternative berthing for cruise ships and naval ships that currently use the Townsville Port. It is possible that the actual increase in shipping movements will be limited to vessels over 238m, which would be specifically catered for by the TOT and not currently by the Port (Flanagan Consulting Group 2008a). All ship movements from the TOT would be to and from the existing Ross Creek mouth and use the shipping channel through Cleveland Bay.

III.7.3.2 Small to Medium-sized Vessel Movements

There are three principal vessel routes from the Townsville Port area into Cleveland Bay:

- from the Townsville Marina passing west of the proposed TOT site;
- from Ross Creek passing just west of the shipping channel towards Nelly Bay and Magnetic Island; and
- from the mouth of Ross River passing to the east of the Townsville Port headland.

A survey of vessel traffic in the upper section of Ross Creek (excluding ships) in May 2008 found 195 vessel movements over a period of a week (Flanagan Consulting Group 2008a). It should be noted that this did not include vessels using the public boat ramp further down river. On weekends and during periods of good weather, this could add hundreds of smaller 'tinnies' and speed boats per week.

In mid-July 2008, we surveyed the mouth of the Ross Creek and the proposed TOT site for one day and found there to be 27 vessel movements over 8.5 hours but seven of these (26%) were from the Townsville marina. Two of the 7 movements were between the marina and Ross Creek. There were twenty vessel movements to or from Ross River, which would translate into 140 per week, similar to the number of movements reported in Flanagan Consulting Group (2008). Nevertheless, this is unlikely to be indicative of general use as there are few vessel movements during the week and it was sampled mid-winter. The number of vessels transiting to and from the Breakwater Marina and the public boat ramps would be much greater at other times of year.

The Breakwater Marina harbours about 110 vessels. In the absence of more precise data, we have assumed 25% of these are used weekly, 50% monthly and the remainder yearly. This would mean about 4,200 vessel movements per year assuming vessels always depart and arrive back at the marina (or visa versa).

Similarly, in the absence of more precise data, we can only guess at the number of recreational vessels likely to use the public boat ramps. There are over 10,000 registered vessels on trailers in the Townsville area. If we assume that other boat ramps are also used and that each vessel is used on average 1.5 times per year from the Ross Creek boat ramp, the weekly total would be in the order of 300 per week.

There are 38 vessel movements per day made by Suncat fast ferries between Townsville and Magnetic Island and 16 movements per day by the slower Fantasea car carrier (a total of 2,808 movements per year for both ferry companies). These vessels mostly move between the entrance to the Townsville Port and Nelly Bay, Magnetic Island. Occasional private charters also operate and there are weekly trips from Townsville Port to the Great Barrier Reef. We have assumed an extra four movements per week for these trips, or 200 in total.

Finally, ship movements in and out of the Townsville Port require the use of a pilot and tug vessels. We have assumed the pilot would accompany all vessels but may use the same trip to accompany one ship out and another in, so three pilot movements for every vessel. We have assumed the same quotient for tug boats. Ships entering the TOT will also require assistance but we do not have a precise estimate for the number of ships that construction of the TOT would add to the current number of movements. We have assumed this would be 10 additional ships per annum.

Table III.7-2: Rough estimate of small to medium-sized vessel movements transiting from Townsville into Cleveland Bay and back.

Category	Vessel movements Current / yr	2030 / yr	TOT total
Vessels from the public boat ramp	31,200	93,600[1]	0
Other vessels from Ross Creek	10,140	10,140	0
Vessels exiting from the Breakwater Marina side of the TOT	4,200	4,200	12,705
Ferries	3,008	3,008	0
Pilot and tug boats	2,640	5,240	40
TOTAL	**51,188**	**116,188**	**12,745**

1. A tripling of vessel numbers by 2030 is based on a historic 5% increase in vessel registrations per year reported by Maritime Safety Victoria (Queensland Transport 2007). Note, this is only applied to vessels

from the public boat ramp. It is assumed that other vessels are moored and therefore, the number of vessel berths available limits the number of boat movements.

The number of berths in the proposed TOT is 200 associated with dwellings and an additional 460 for long-term lease including room for up to 10 "superyachts" (Transpac 2007). If we apply the same assumptions as for the Breakwater Marina, this would translate into 12,705 vessel movements per year. Adding the increase in pilot and tug vessel movements associated with large ships would mean an increase of 25% on current estimated vessel movements and 11% on future (2030) movements (Table III.7-2).

However, an increase in the number of vessels does not automatically translate into a proportional increase in vessel strike risk. Key factors in determining vessel strike risk include:

- vessel speed;
- vessel size (draft and mass); and
- seabed depth profile of the area.

These three factors are interrelated. The distance between the hull / propellers of a vessel and the seabed affects the likelihood of boat strike. When there is inadequate room, animals may become trapped at the seabed and become crushed.

The majority of vessels using the proposed TOT marina would be expected to have a draft greater than 1.2m, restricting them to relatively deep-water. The marina is not expected to harbour small 'tinnies' and speedboats. It is unlikely therefore, that vessels harboured by the TOT would be able to travel into shallow seagrass areas in the east of Cleveland Bay where Dugong densities are highest. Similarly shallow areas in the west of Cleveland Bay are treacherous for navigation and generally avoided by such vessels. The majority of vessel traffic leaving the TOT marina would be expected to pass northward i.e. towards Magnetic Island. Indeed, the majority of vessel movements (63%) from Townsville recorded on one day in July 2008 were on a direct line to Magnetic Island or back. Other vessels would be expected to move northwest and pass to the south of Magnetic Island using the Western Channel. Of the 27 vessel movements recorded, four (15%) were motor cruisers with planing hulls and all were travelling towards Magnetic Island across the deepest parts of Cleveland Bay.

Studies of Dugong in Australia have suggested that animals are at greatest risk of being struck when vessels are at planing speed (usually in the vicinity of 15-25 knots) and otherwise, in most cases, Dugongs appear to be able to move away (Hodgson 2004). All the yachts observed in July 2008 were travelling slowly and it is assumed that due to their slow speed, they would represent a negligible risk of mortality to Dugongs and dolphins from vessel strike.

Therefore we consider that *relevant impacts* from the TOT do not include small speedboats and tinnies. The assessment in this document has been done on shipping

and larger recreational vessels, with a particular emphasis on planing hulls. These vessels are mostly limited to deep water channels north of Townsville.

The next thing to consider is the relative proportion of yachts to planing hull cruisers. In one study of Cleveland Bay (Preen 2000) sail boats were found to comprise 8.8% of vessel traffic with large planing hulls / cruisers making up 3.5%. Similar figures were found for other nearby areas including Hinchinbrook Island.

Hence, if we assume that large planing hulls / cruisers originating from the TOT are likely to be half as common at sea than yachts (Preen 2000) then the number of vessel movements with the potential for injuring marine mammals is 6,393, similar to the number of pilot and tug boat movements annually and 12.5% of current total vessel movements (6% of 2030 estimates). Most of these movements are expected to be in a north south direction.

Dugongs regularly move between Cleveland Bay and adjacent Bowling Green Bay but also Hinchinbrook Island, a distance of about 120 km. These have been described as purposeful single-hop movements (Preen 2000) and mean that Dugongs are expected to occasionally cross the shipping channel.

III.7.3.3 Collision Risk Model

The probability of collision can be modelled with reasonable simplicity in Cleveland Bay for vessels passing between Townsville and Magnetic Island. This is because the main shipping channel runs north to south, whilst the major Dugong foraging areas are to the east and west (Figure II.3-3 and Figure II.3-4).

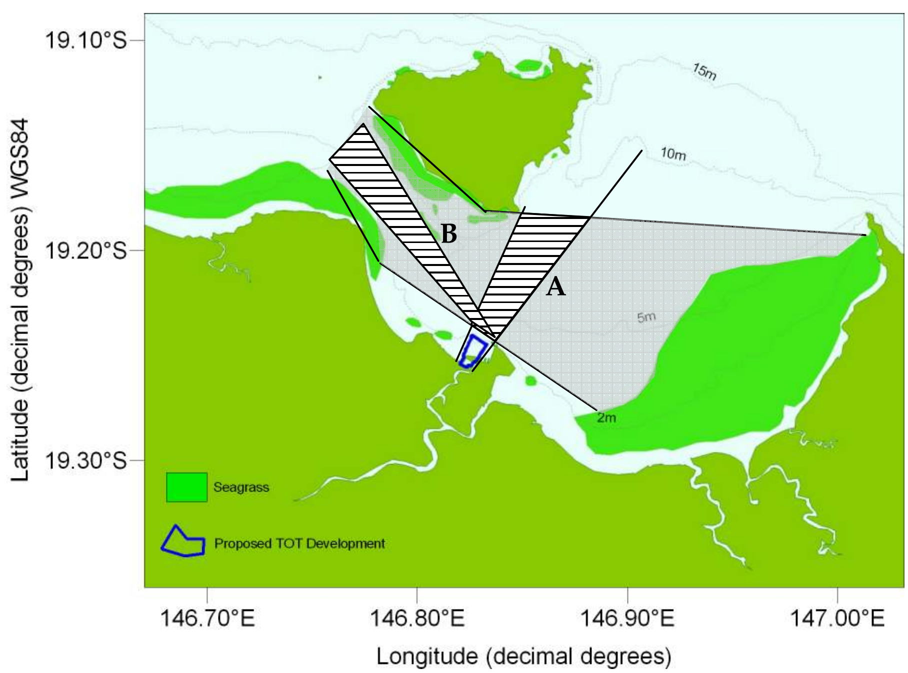


Figure III.7-1: Corridor of Dugong movements between east and west Cleveland Bay and vessel traffic corridor from the proposed TOT to Magnetic Island (including the main shipping channel) and from the proposed TOT down the Western Channel. The area where these two corridors overlap (A) is approx. 20 km^2 and (B) approx. 23 km^2.

Starting with area (A) (Figure III.7-1). The north-south length of the corridor for vessel movement is between 7-8.6 km including the main shipping channel. Based on the location of seagrass beds and satellite tracking data (Preen 2000) the east-west corridor for transiting Dugongs that overlaps with the vessel corridor is between 1.3 and 4.1 km wide. This results in an overlap area of about 20 km^2 (Figure III.7-1). Satellite tracking data shows that animals move across the shipping channel roughly perpendicular to the direction of vessel travel (Figure III.7-2).

Since Dugongs from the vicinity of Hinchinbrook Island also move into and through Cleveland Bay, we have assumed this population is also relevant to the collision risk model. To ensure we use a conservative approach, we have opted for Preen's highest estimate plus the published standard error, which gives us a total of 748 (se 218) = 966 individuals.

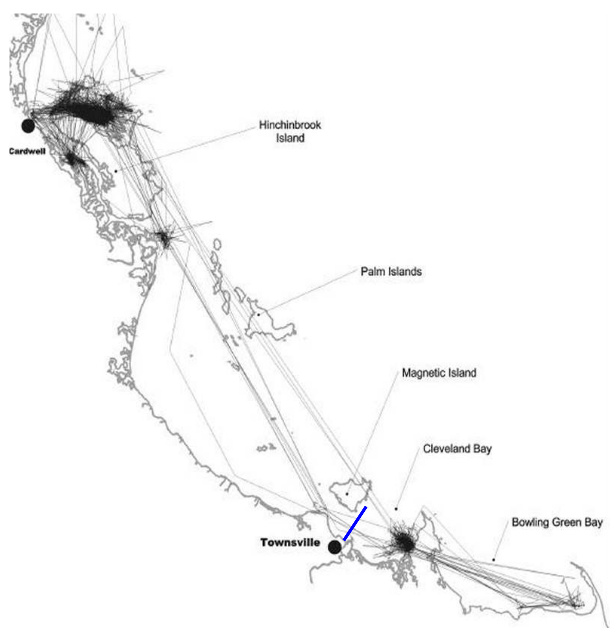


Figure III.7-2: Satellite tracking of Dugongs between Hinchinbrook Island, Cleveland Bay and Bowling Green Bay (Preen 2000). The Townsville Port shipping channel is indicated by a blue line.

Our estimate of vessel speed is realistic, based on an average of 15 knots (27.8 kph) with a relatively small variation. Although it is likely that some vessels would travel more quickly, our model increases the time that vessels would spend in the overlap zone and is therefore conservative. Similarly, Dugong are capable of swimming at speeds greater than one knot (1.85 kph).

Preen (2000) satellite tracked 13 Dugongs in Cleveland Bay and Hinchinbrook Island, recording 14 movements over 19 months. If we assume a population of 966 animals, the number of movements per year would be 657. We have also added a standard deviation of 20% variation around the mean to account for the possibility that Preen's tracking underestimated movements. Similarly, we have added a large standard deviation of 60% of the mean on top of the predicted estimate of vessel movements.

With this information, we can calculate the probability that a Dugong and vessel would be present within the area the two movement corridors overlap.

Where:

- Number of Dugong movements = N_d
- Speed of Dugong = S_d
- Number of vessel movements = N_v
- Speed of vessel = S_v
- Number of hours in a year = 24 x 365 = 8,760

The number of hours that Dugong spend crossing the vessel corridor =

$$H_d = \left(N_d \left(\frac{1}{S_d} \right) \div 8760 \right)$$

e.g. 966 x (2.7 / 1) / 8760 = 0.298*

Number of hours that vessels spend crossing the vessel corridor =

$$H_v = \left(N_v \left(\frac{6}{S_v} \right) \div 8760 \right)$$

e.g. 6,393 * (7.8 / 27.8) / 8760 = 0.205*

Probability that Dugongs and vessels are present at the same time = H_d x H_v

e.g. 0.298 x 0.205 = 0.061 (see note[10]).

This is only the probability that the vessel and animal is present at the same time. We also need to calculate the probability that the two coincide on the vessel track. We assume that a Dugong travelling perpendicular to a vessel presents a potential strike

[10] Note, these figures are for guidance only - the actual model is based on a normal distribution and the results, with 95% confidence limits are shown below.

width of 3m and that this must be in the exact location that the vessel passes through at that moment. The probability is Dugong length D_l divided by the corridor width for Dugongs passing through the vessel corridor D_{cw}. This is derived from a random sample of swim paths through the corridor, which varies in width from top to bottom. As an example, the median width is 2.7km, so the probability of vessel strike at this point would be 3 / 2700 = 0.0011.

The final collision risk therefore is:

$$\left(H_d \times H_v \times \left(\frac{D_l}{D_{cw}} \right) \right)$$

In the example above, this is 0.298 x 0.205 x 0.0011 = 0.000067199.

Using the figures in Table III.7-3 we generated normal distributions where relevant, or in the case of corridor width / length, randomly selected crossing points and iterated the calculations 10,000 times using the variables summarised in Table III.7-3. The results as follows are presented as a mean strike risk ± 95% confidence limits:

Table III.7-3: Variables used in the collision risk model

Variable	Mean	Standard Deviation
Speed of vessel (kph)	27.80	4.00
Speed of Dugong (kph)	1.83	0.75
Number of Dugong movements per year	657	132
Number of vessel movements per year, with potential to kill Dugongs	6,393	4,000
Width of Dugong corridor (km) Area A	1.30 – 4.10	NA
Length of vessel corridor (km) Area A	7.00 – 8.60	NA
Width of Dugong corridor (km) Area B	0.48 – 3.20	NA
Length of vessel corridor (km) Area B	14.00	NA

Mean strike risk (likelihood) = 0.00004064 (95% confidence limits 0.00002751-0.00005377)

If we use the same model but instead assume vessels are moving down the Western Channel, then the width of the corridor for Dugongs varies from 0.48 km to 3.2 km and for vessels is a standard 14 km. This roughly doubles the strike risk or likelihood to 0.00008378 (95% confidence limits 0.00006187-0.00010570). Therefore, the actual collision risk is likely to be somewhere between the two.

III.7.3.4 Discussion

The collision risk model is only an empirical model but serves to illustrate that vessel strike risk in this part of Cleveland Bay is low and predicts that collisions from vessels using the TOT would be very rare. This is mostly because the number of Dugongs crossing the shipping channel is relatively small even compared to the amount of boat traffic.

At locations like Moreton Bay vessel strikes are common (Groom et al. 2004) but the geography is very different. From a risk management perspective, strike risk is often attributed to vessel traffic density and Dugong density without acknowledging that Dugongs move through primary vessel corridors and this is the key driver for impacts.

In Moreton Bay, there is a complex of tight-fitting islands surrounded by seagrass beds and despite the relatively small number of Dugongs, strike risk is still high as movements between adjacent islands see animals regularly crossing channels used by a large number of boats.

Cleveland Bay does not have such island formations, the main shipping channels and vessel routes pass over relatively deep water several kilometres from the nearest seagrass beds and vessel numbers are much smaller. Hence, the risk of vessel strike on Dugongs is likely to be relatively low compared to Moreton Bay.

This model should not be used to suggest that vessel strike risk in Cleveland Bay as a whole is insignificant. The TOT presents only a small proportion of overall vessel movements and only certain vessel types. The model would need to be substantially altered if it were to include smaller vessels operating in shallow water areas where there is a higher density of Dugongs and include a larger area of Cleveland Bay.

We believe we have used a conservative approach and determined that strike risk associated with the TOT is extremely low for Dugongs, which are considered to be the main focus for vessel strike risk in Cleveland Bay. Even if a limited number of vessels from the TOT marina do venture into other areas of the Bay, it is likely that the conservative approach to modelling would absorb this variation.

As for dolphins, it is also unlikely the TOT would present a significant risk. Apart from a small number of additional ship transfers, which are already tolerated by dolphins using the area, the remaining traffic would depart from the northwest corner of the proposed TOT, which is west of the main area of density for Australian Snubfin Dolphins and Indo-Pacific Humpback Dolphins. Between here and the proposed TOT is the Ross Creek. This is where the vast majority of existing vessel traffic occurs, including 31,000 private vessel movements per year by speedboats and tinnies using the public boat ramps. Compared to Dugongs, dolphins are also considered more capable of moving in response to approaching boats.

Despite all this, incorporating some guidance and awareness-raising material for vessels that use the site would be prudent and is discussed in the mitigation recommendations (section III.9.2).

III.7.3.5 Disclaimer

The information about vessel numbers and movements above is based on the best information immediately and rapidly available. For other purposes, more precise data may be needed and these figures should not be relied upon. For modelling Dugong collision risk however, the model yields an extremely small likelihood. Unless these data were found to be *very* imprecise, it is unlikely that the result would change by more than a couple of orders of magnitude.

III.7.4 Littering

The cumulative impact of debris in the marine environment is substantial but the effects from the TOT alone could be considered negligible. However, common standards for waste disposal should be given high regard, including appropriate disposal and treatment of waste. These impacts are therefore addressed in project mitigation (section III.9.2.4).

III.7.5 Introduction of Marine Pests

Impacts from marine pests could occur indirectly if a pest species directly affects prey for dolphins, Dugongs or turtles, or causes a change in Cleveland Bay's ecosystem that results in a reduction in its carrying capacity for those species. For example, changes could occur due to competition with, and predation on, native species, changes to trophodynamics, changes to habitat structure; alteration to or displacement of existing biological communities.

As there are not likely to be any direct impacts on dolphins, Dugongs and sea turtles from introduced pests, the consequence of potential indirect impacts from marine pests are considered in the Nature Conservation Report (C & R Consulting 2007) and readers are referred there.

III.7.6 Light Pollution

Site works with plant will be active from 6am to 6pm Monday to Friday and 6am to 12pm Saturday. Pumping for initial dewatering will occur throughout day and night but minimal lighting will be required. The main limitation to night time and weekend site activities is disturbance due to on-site/off-site truck movements and the need to minimise noise disturbance to residential areas.

There is already considerable overnight lighting evident from the Townsville Port and Townsville itself. It is not anticipated that broad floodlighting will be required overnight and as such, there should be no direct light spillage onto adjacent beaches at the strand. Mitigating potential effects of lighting on the immediate environment is generally straightforward so this matter is dealt with in the project mitigation plan (section III.9.2.4).

An alternative materials delivery methodology using barges has been discussed which would avoid disturbance to nearby residences and may allow 24 hour delivery of fill. If this occurs, the barges would berth in Ross Creek directly adjacent to the Townsville Port. In this case, the amount of additional lighting is unlikely to be a significant addition to the existing ambient light.

III.7.7 FUEL OR OIL SPILLS

The impact of fuel and oil spills is considered potentially serious. These impacts are addressed in project mitigation (section III.9.1.1).

III.7.8 MAINTENANCE DREDGING

Occasional dredging of the proposed TOT marina entrance is expected to involve sediment quantities far lower than the initial dredging discussed in section III.6.2. For the same reasons, it is not anticipated to pose more than a negligible risk to dolphins, Dugongs and marine turtles.

III.8 IMPACTS SUMMARY

III.8.1 ENVIRONMENTAL EFFECTS

Key characteristics of the potential effects relevant to impacts on dolphins, Dugongs and marine turtles, are described as follows:

Table III.8-1: Summary of potential environmental effects

Name	Activity	Initiating event	Effect
Construction Phase	Site Containment	Construction of temporary rock wall	8 months, between Sep 09 – Aug 10. Placement of rocks on seabed. Negligible noise effects and minor sediment suspension.
	Berth / Swing Basin Construction	Sheet piling	Underwater noise. Impact largely concealed from Cleveland Bay by shielding effect of Townsville Port Headland. Worse case scenario, noise levels in the immediate port entrance may be 140-160 dB $re1\mu Pa^2s$ but probably <130 dB $re1\mu Pa^2s$ outside. Duration 4 months Jan – Apr.
	Dewatering	Export of seawater to Cleveland Bay	Pumping surface water from site to about 400mm depth. Duration approximately one week. Very small quantities of turbidity are anticipated to be well within background since surface water in the proposed TOT is just enclosed seawater (that would be naturally very shallow and turbid). Potential for minor seepage of turbid water from base of rock walls (also within natural conditions).
	Dredge Outer Entrance Channel	Clam-shell dredge used to dig out channel	Suspension of sediment from seafloor. Duration of approximately two months done in winter. Approximately $15,000m^3$ of material to be dug, translates into $20,000m^3$ of wet material. Very small turbid plume expected to be well within background levels most of the time.
	Removal of temporary bunds and breakwater	Construction of small area of rock wall	Several weeks after completion of other works. Placement of rocks on seabed. Negligible noise effects and minor sediment suspension.
Use Phase	Habitation	Occupation of dwellings by private residents	Use of fertilizers could result in nutrient run-off creating risk of algal bloom or potential ammonia release into immediate environment but rapid oxidization so no lasting effects. Pet-keeping may result in transferal of pathogens to seawater. More generally, increased risk of litter reaching the sea. Increased light from buildings.
	Shipping	Docking of cruise ships and naval ships	Increased risk of marine pest introduction from overseas. Increased lighting from vessel and cabins. Potential risk of fuel or oil spills e.g. due to vessel collisions.

Name	Activity	Initiating event	Effect
	Use of Marina	Private vessel use outside the marina	Potential increase in vessel collision risk for dolphins and Dugongs, although the effect is considered to be negligible for Dugongs as the probability of vessel-Dugong encounter is extremely small. Short-term disturbance and displacement of dolphins is possible but well within existing variation. Most vessel movements avoid the core habitat areas and the port is already subject to existing heavy traffic levels.
	Maintenance Dredging	Clam-shell dredge used to dig out channel	Suspension of sediment from seafloor. Occasionally required. Effects only a fraction of what would be expected from the construction works. Well within natural variation.

III.8.2 Impact Assessment

The impacts discussed in previous sections are highlighted in Table III.8-2, along with their consequences. Consequences considered to be more than a "minor" impact on dolphins, Dugongs and marine turtles are the subject of mitigation recommendations.

Table III.8-2: Impacts and consequences arising from environmental effects. Consequences are ranked from Negligible to Minor, Moderate, Heavy and Extreme.

Source	Intensity	Frequency	Duration and timing	Impact	Risk Consequence
Loss of habitat from containment of site.	Loss / alteration of existing habitat up to $1km^2$.	Once.	Likely to be permanent loss / alteration.	Area does not represent an important feeding area for dolphins or Dugongs. No evidence that marine mammals have been seen within the site footprint. Green Turtles likely to feed regularly within the site but this species is widespread and far more common elsewhere in Cleveland Bay.	Negligible
Creation of sediment plumes from placement of rock on seabed.	Patches of low level turbidity, well within existing background conditions.	Occasional / regular.	Two or more years (duration of containment and internal construction).	The existing site is shallow and turbid flushing into surrounding waters on each outgoing tide. Surrounding waters are also highly turbid (regularly >20 mg/l) The amount of turbidity created by the development may be evident following containment (as this will improve underwater	Negligible

Source	Intensity	Frequency	Duration and timing	Impact	Risk Consequence
				visibility around the site by reducing the flush of sediment from within the site) but will be well within existing levels and rapidly dilute. Impacts on dolphins, Dugongs and turtles is expected to be negligible.	
Piling noise from berth and swing basin construction.	Relatively loud impulsive underwater noise at source but levels within metres of source likely to drop to below published injury thresholds for dolphins, Dugongs and marine turtles (e.g. <180 dBre1μPa²s SEL). Noise propagation into Cleveland Bay will be shielded by the Townsville Port Headland. In underwater noise terms, low levels (<130 dBre1μPa²s SEL) are likely to reach areas of highest dolphin density.	Duty cycle (no. strikes per hour) unknown but likely to be very slow and more or less continuous during daylight hours.	Four months, Jan – Apr.	According to published thresholds, no potential for direct injury. Potential for some disturbance / displacement but this cannot be quantified. However, the main receptors of interest are dolphins. Australian Snubfin Dolphins and Indo-Pacific Humpback Dolphins occupy habitat within metres of the shipping channel. Existing noise from the Port and from vessel traffic regularly entering through the shipping channel is expected to equal piling noise at those locations. Dolphins already appear to tolerate these levels.	Negligible
Noise created by placement of rock on seabed and on other rocks.	Underwater noise level expected to be very low. Expected to attenuate rapidly away from the site.	Regular during containme-nt phase. Also during final removal of temporary rock bunds.	Several months.	Levels of noise well below piling and not expected to create a substantial effect in areas where dolphins and Dugongs occur.	Negligible
Creation of sediment plume from dewatering the site.	Patches of low level turbidity, within existing background conditions.	Periodic.	One week for initial dewatering then periodically	The existing site is shallow and turbid flushing into surrounding waters on each tide. Surrounding waters are also highly	

Source	Intensity	Frequency	Duration and timing	Impact	Risk Consequence
			throughout the 3 year construction for additional dewatering of settling ponds.	turbid (regularly >20 mg/l) The amount of turbidity created by the development may be evident following containment (as this will improve underwater visibility around the site by reducing the flush of sediment from within the site) but will be well within existing levels and rapidly dilute. Impacts on dolphins, Dugongs and turtles is expected to be negligible.	
Sediment plume from dredging of outer entrance channel.	Small turbid plume. Slow current speeds mean heavy material will settle fast and some finer material may drift west.	Initially plus mainten-ance dredging up to every year.	Initial dredging for 2 months during winter (dry season). Maintenance dredging over shorter periods.	The existing site is shallow and turbid flushing into surrounding waters on each outgoing tide. Surrounding waters are also highly turbid (regularly >20 mg/l) The amount of turbidity created by dredging using a Clam Shell Dredge is expected to be within natural variation. Areas immediately to the west of the site are not considered core feeding habitat for dolphins or Dugongs. Individual Green Turtles, more common elsewhere in the Bay, regularly feed in the vicinity.	Negligible
Light from construction equipment.	Security lighting for buildings on site. Possible lighting associated with barge in Ross Creek. Construction otherwise only happening during daylight hours.	Through-out project.	Throughout project.	Light effects well within existing ambient conditions of port and Townsville.	Negligible
Creation of algal blooms / red tides associated with poor flushing of the	Potential for creation of toxic floating red tides and uptake of toxins into food	Permanent potential.	Unpredictable.	Potential to cause mortality of dolphins, Dugongs and marine turtles, prey species and other food sources. TOT located away from	Minor

Source	Intensity	Frequency	Duration and timing	Impact	Risk Consequence
marina.	chain.			core areas for all these species, so unlikely to affect large numbers.	
Domestic animals (particularly cats) being housed in residential areas of the TOT.	Release of potentially lethal pathogens into marine environment	Permanent potential.	Unpredictable.	Potential to cause mortality of dolphins and possibly Dugongs. Effect has been reported in Indo-Pacific Humpback Dolphins in Cleveland Bay.	Heavy (Negligible post mitigation – see section III.9.1.3)
Reduction in water quality associated with use of chemicals and sewerage disposal.	Release of potentially lethal pathogens and pollutants.	Permanent potential.	Permanent potential.	Potential to alter water quality in habitat within and immediately beyond the entrance to the marina. TOT located away from core areas for dolphins, Dugongs and marine turtles.	Minor (Likely to be Negligible post mitigation – see section III.9.2.2)
Loss of litter to sea.	Release of plastic bags and other rubbish into water column.	Permanent potential.	Permanent potential.	Potential for ingestion by turtles and resulting mortality.	Negligible
Shipping introduces marine pests.	Serious change to trophodynamics, changes to habitat structure; alteration to or displacement of existing biological communities.	Permanent potential.	Permanent potential.	Negligible direct consequence for dolphins, Dugongs or marine turtles. Potential for indirect impact depends on species concerned and seriousness of ecological change. Unpredictable.	Heavy
Shipping-related collision or incidental spill of oil / fuel.	Depends on the nature of the oil. Heavy fractions may create lasting floating oil slicks. Lighter fractions likely to disperse quickly.	Permanent potential.	Permanent potential.	Potential ingestion of surface oil leading to mortality through poisoning.	Heavy
Increased ambient light from vessels.	Lighting from cruise ships and naval vessels docked in the TOT.	20 times per year.	Periods of a day to several days at any time of year.	Light effects well within existing ambient conditions of port and Townsville.	Negligible
Increased number of vessels leading to increased risk of collision with marine mammals.	Relatively small additional ship transfers per year associated with the TOT. Most vessels in marina would have draft >1.2m, principally	Permanent potential.	Permanent potential.	Collision risk is highest for Dugong but because they only likely to cross perpendicular to the line that the majority of vessels from the TOT would take, the risk is very small. Dolphins near the TOT are	Minor

Source	Intensity	Frequency	Duration and timing	Impact	Risk Consequence
	visit outer islands heading north-south and avoid main density areas for Dugong (high risk collision species). Collision risk extremely small (2 x 10^{-6}-1 x 10^{-5}). Vessels leaving the TOT will do from a location further west than the core distributions of dolphins.			already accustomed to much larger amountsof small and fast recreational boat traffic from public boat ramps which will not be associated with the proposed TOT. Disturbance / displacement therefore, is likely to be of no more than minor consequence.	

III.9 IMPACT MITIGATION AND MONITORING

Whether mitigation is considered necessary depends on the predicted impact / risk consequence. Mitigation may be necessary when consequences are predicted *moderate* or higher and may be desirable when they are *minor* or lower. The aim of mitigation is to reduce project consequence to either minor or negligible.

III.9.1 HEAVY CONSEQUENCES

No "extreme" consequences are predicted.

The following effects have the potential to create heavy consequences for dolphins, Dugongs and marine turtles. These are:

- fuel or oil spills;
- introduction of marine pests; and
- introduction of lethal pathogens

We cannot guarantee that any of these matters can be adequately mitigated by treating the consequence. If the effect occurs, this remains unpredictable. The best way to address these problems is by directing mitigation to reducing the likelihood of occurrence. All these matters are common to marine and coastal projects anywhere in the world. In the case of the first two, the appropriate method of managing impacts is to accord with standard operating procedures, where these exist. In the case of the third, we have made recommendations below.

III.9.1.1 Fuel or Oil Spills

Piloting arrangements for the Port of Townsville are developed to reduce the risk of vessel strike and spills. Shipping for the TOT will operate in accordance with these existing requirements. If a spill were to occur, then the appropriate strategy would be the Oil Spill Response Plan for the Port of Townsville plus relevant sections of the project Construction and Operation Environmental Management Plans.

III.9.1.2 Introduction of Marine Pests

The TOT should operate in accordance with any operational requirements that already exist for the Port of Townsville, the Great Barrier Reef Marine Park, the State of Queensland and the Commonwealth. These should reflect the provisions of the *Intergovernmental Agreement on a National System for the Prevention and Management of*

Marine Pest Incursions[11], including the treatment of ballast water, biofouling and other measures detailed in the Nature Conservation Study (C & R Consulting 2007).

III.9.1.3 Lethal Pathogens

To reduce the potential consequences from the TOT, it is recommended that a ban on domestic cats is built into the body corporate for the development. This will reduce the consequence from this potential effect to negligible.

III.9.2 Moderate / Minor Consequences

No "moderate" consequences are predicted.

The following effects have the potential to create minor consequences for dolphins, Dugongs and marine turtles. These are:

- algal blooms / red tides;
- reduction in water quality from use of the site; and
- increased risk of vessel collisions

III.9.2.1 Algal blooms / Red tides

Mitigation of red tides is covered in the Nature Conservation study (C & R Consulting 2007). Maintaining regular flushing of the TOT by appropriate maintenance of entrance channels should be sufficient to reduce this risk to a minimum. This matter is not considered further here.

III.9.2.2 Reduction in water quality from use of the site

Consequences of poor water quality have the potential for indirect effects on marine mammals. Mitigation of poor water quality is addressed in the Nature Conservation report (C & R Consulting 2007). If adequately addressed, it is unlikely that the consequence to dolphins, Dugongs and marine turtles would be more than negligible.

III.9.2.3 Increased risk of vessel collision

Although the risk of vessel collision is considered minor, it is prudent to adopt some recommendations to raise awareness amongst vessel users of the existence of dolphins, Dugongs and marine turtles in Cleveland Bay, and their importance. This would help contribute to any wider plan to conserve the resources into the future.

[11] http://www.environment.gov.au/coasts/imps/publications/pubs/intergovernmental-agreement.pdf

III.9.2.4 Other Measures

The need to minimise environmental effect throughout the project is inherent in the construction plan. In addition to the measures above, normal levels of environmental management apply, such as the need to minimise light spilling off the site, managing rubbish and sewerage (including from boats) through appropriate disposal infrastructure.

III.9.3 MONITORING

The low level of risk associated with the project does not imply the need for substantial monitoring. These matters are however to be discussed with the Queensland and State government regulators. Any monitoring that may be required would be detailed separately to this report.

III.10 Residual Impact Assessment

With the obvious exception of fuel / oil spills and introduction of marine pests, that could still have a significant impact on dolphins, Dugongs and marine turtles in Cleveland Bay, residual impacts are otherwise minor or negligible. This is mostly because:

1. the site is to be immediately contained so that almost all effects are within its boundary;

2. the core range of dolphins, Dugongs and marine turtles would be largely beyond the radius of any serious impacts from the proposed TOT;

3. the proposed TOT site itself does not represent feeding habitat for marine mammals and although Green Turtles do feed there, they are widespread with their highest densities elsewhere; and

4. the Townsville Port area is already subject to heavy effects of human use including noise and vessel traffic movements.

III.11 Assessment of Significance and Conclusion

The assessment of significance is done in accordance with evaluation criteria described in section III.1.4.

Criteria	Response
Does construction / operation of the TOT have the potential to substantially alter the ecosystem structure, function and composition; or displace important prey in areas that support high densities of dolphins, Dugongs or marine turtles?	All core feeding areas are located at a distance beyond serious impacts from the development. The project does not have the potential to cause the effect described (left).
Does the habitat that is likely to be affected by the development comprise "critical habitat"?	Habitat that could be considered "critical" is not located within the impact footprint of the TOT development.
Are populations isolated enough to warrant consideration as a genetically unique single unit or do they form part of a larger population, likely to number in the "thousands"?	It is unlikely that any of the species of dolphin, Dugong or marine turtle in Cleveland Bay are genetically distinct within Cleveland Bay. Movement beyond the Bay occurs in all species.
Is there likely to be any sustained level of mortality annually affecting more than a very small percentage of the population	The main effect of concern is vessel collision. It has been shown that the TOT is unlikely to contribute significantly to this. There is unlikely to be any sustained mortality.

In conclusion, it is considered unlikely that the effects derived from the construction or operation of the Townsville Ocean Terminal will have significant consequences on dolphins, Dugongs or marine turtles.

TOWNSVILLE OCEAN TERMINAL: DOLPHINS, DUGONGS AND MARINE TURTLES

IV. REFERENCES AND APPENDIX

IV.1 REFERENCES

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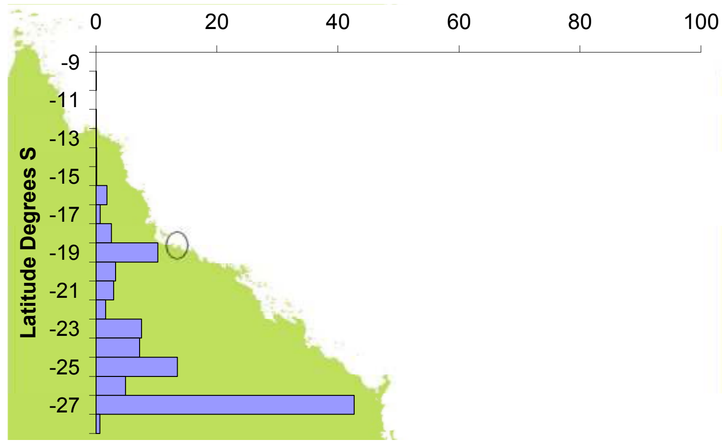
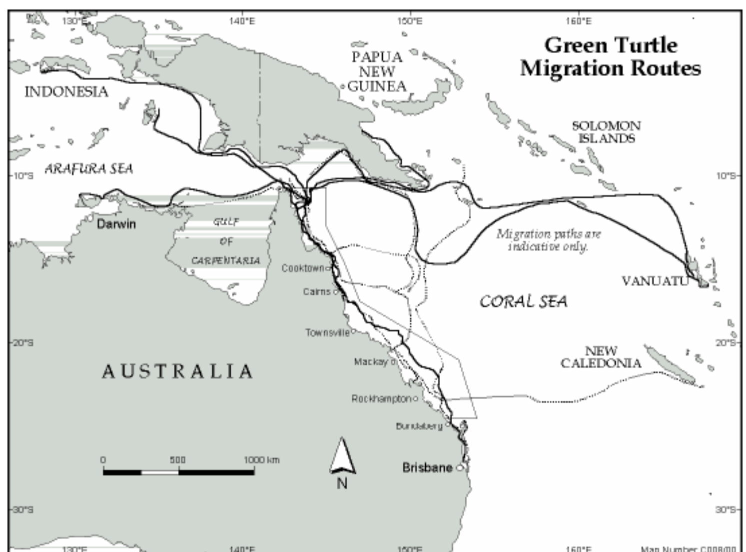
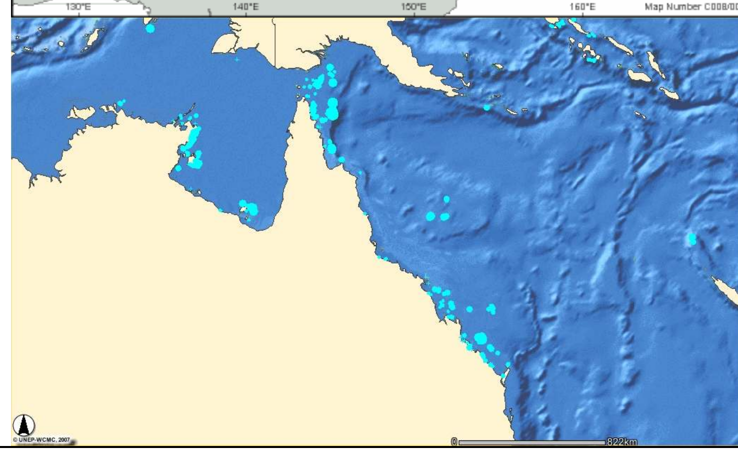
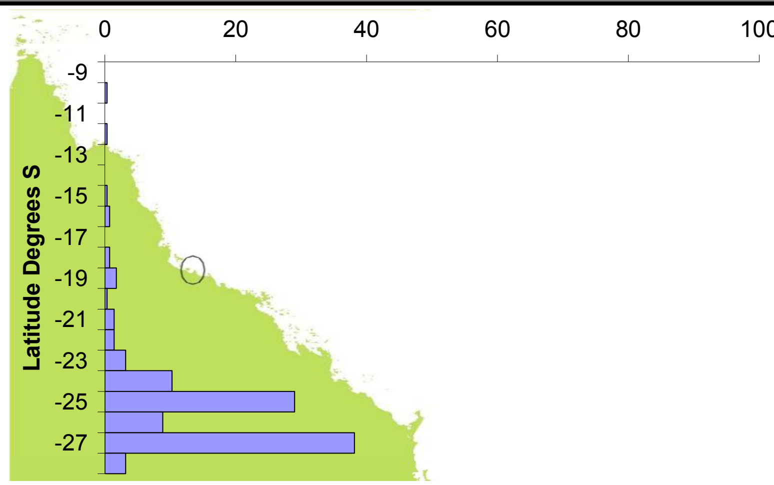
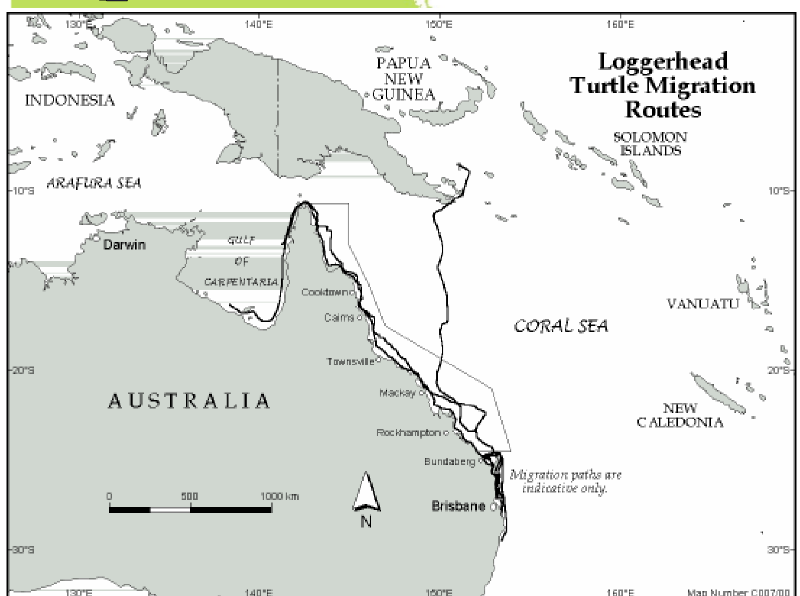
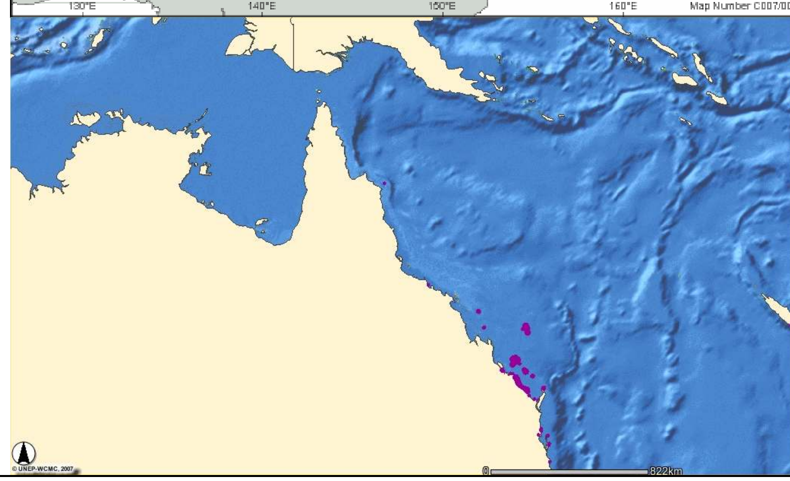
IV.2 APPENDIX

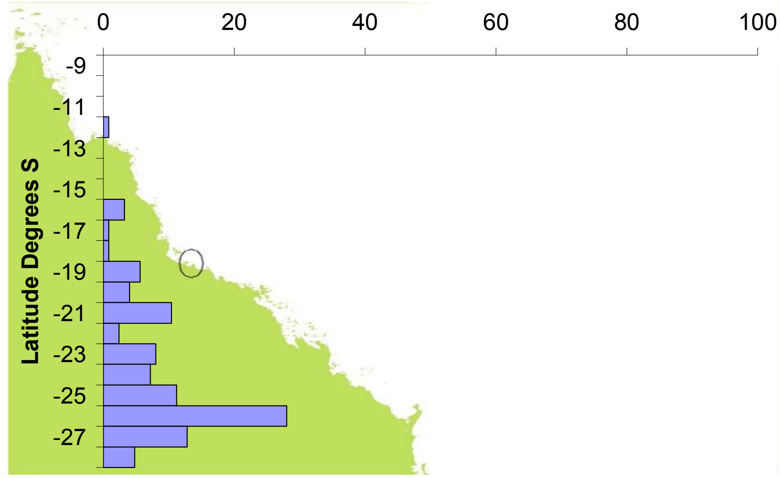
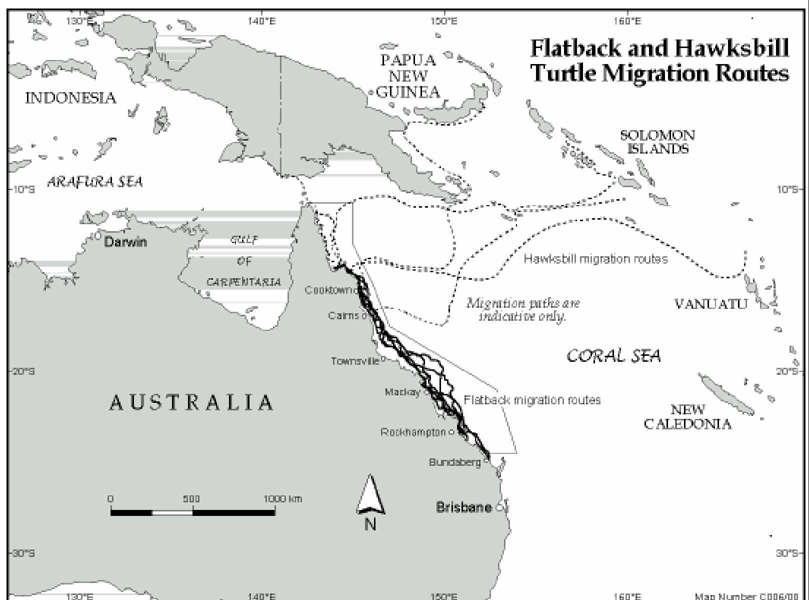
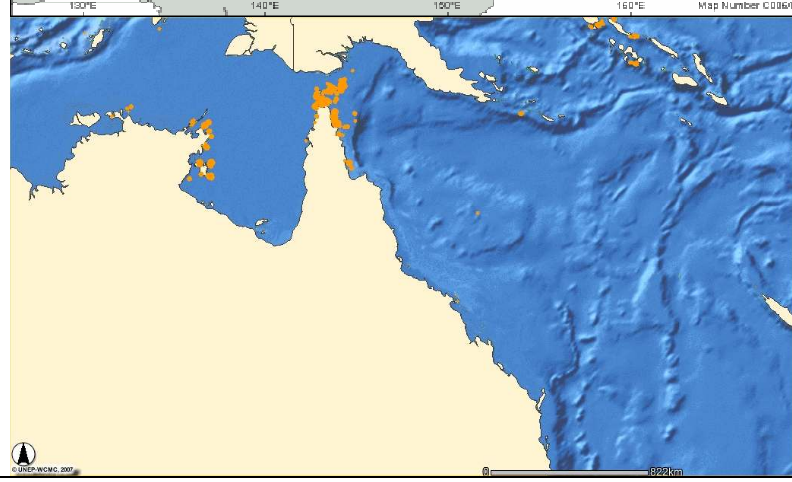
Appendix A: Turtle distribution, movement and abundance off Queensland: Maps and Figures.

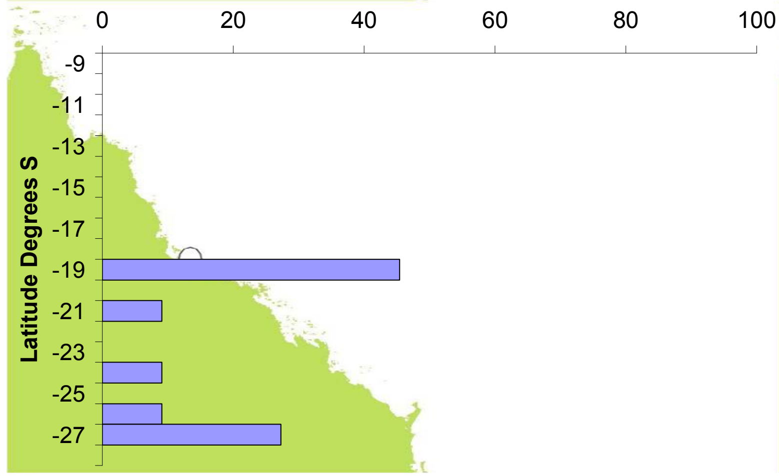
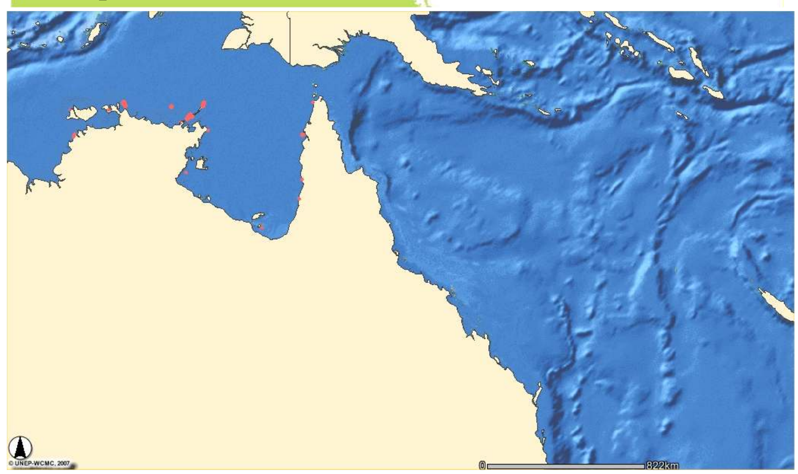
<table>
<tr><th>Species</th><th>Information</th><th></th></tr>
<tr><td>Green Turtle
Chelonia mydas

EPBC: Vulnerable, Migratory</td><td>Percentage strandings at given latitude from 1999-2002. Data from QPWS website (see footnote 1 in body of report).</td><td>
</td></tr>
<tr><td></td><td>Dashed lines represent movements of southern Great Barrier Reef Green Turtles; solid lines represent movements of northern Great Barrier Reef Green Turtles.

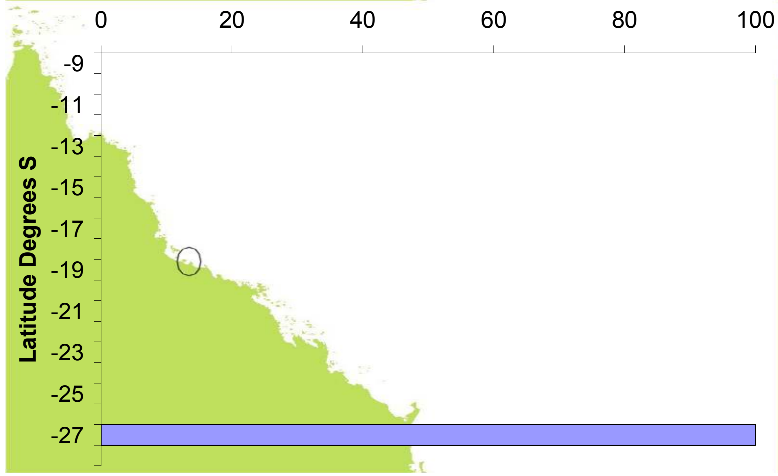
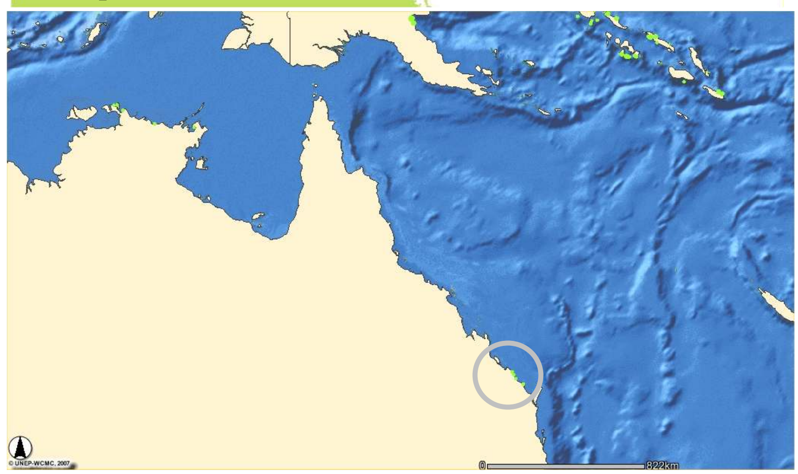
Data from QPWS website. (see footnote 2 in body of report)</td><td>
</td></tr>
<tr><td></td><td>Breeding distribution. Data from the Marine Turtle Interactive Mapping System at http://stort.unep-wcmc.org/imaps/indturtles/viewer.htm</td><td></td></tr>
</table>

Species	Information	
Loggerhead Turtle *Caretta caretta* EPBC Act: Endangered, Migratory	Percentage strandings at given latitude from 1999-2002. Data from QPWS website (see footnote 1 in body of report).	
	Data from QPWS website (see footnote 2 in body of report).	
	Breeding distribution. Data from the Marine Turtle Interactive Mapping System at http://stort.unep-wcmc.org/imaps/indturtles/viewer.htm	

Species	Information	
Hawksbill Turtle ***Eretmochelys imbricate*** EPBC Act: Vulnerable, Migratory	Percentage strandings at given latitude from 1999-2002. Data from QPWS website (see footnote 1 in body of report).	
	Hawksbill migration routes are shown as dashed lines. Data from QPWS website (see footnote 2 in body of report).	
	Breeding distribution. Data from the Marine Turtle Interactive Mapping System at http://stort.unep-wcmc.org/imaps/indturtles/viewer.htm	

Species	Information	
Olive-Ridley Turtle ***Lepidochelys olivacea*** EPBC Act: Endangered, Migratory	Percentage strandings at given latitude from 1999-2002. Data from QPWS website (see footnote 1 in body of report).	
	Breeding distribution. Data from the Marine Turtle Interactive Mapping System at http://stort.unep-wcmc.org/imaps/indturtles/viewer.htm	

<table>
<tr><th>Species</th><th>Information</th><th></th></tr>
<tr><td rowspan="2">Leatherback Turtle
Dermochelys coriacea

EPBC Act: Vulnerable, Migratory</td><td>Percentage strandings at given latitude from 1999-2002. Data from QPWS website (see footnote 1 in body of report).</td><td>
</td></tr>
<tr><td>Breeding distribution. Data from the Marine Turtle Interactive Mapping System at http://stort.unep-wcmc.org/imaps/indturtles/viewer.htm</td><td></td></tr>
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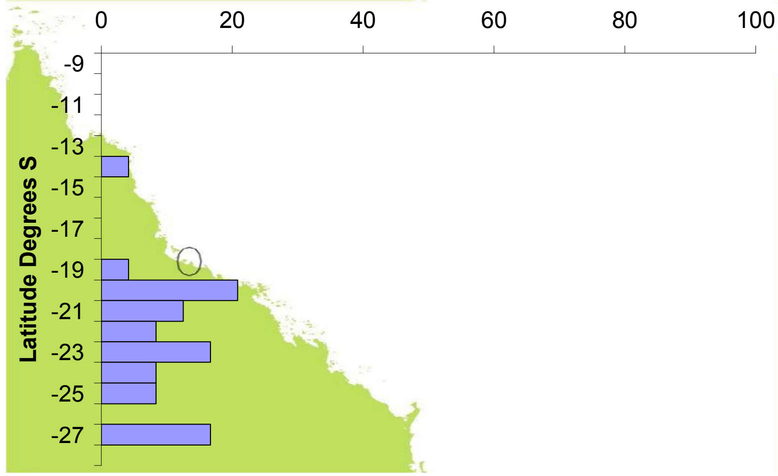
<table>
<tr><th>Species</th><th>Information</th><th></th></tr>
<tr><td rowspan="3">Flatback Turtle
Natator depressus

EPBC Act: Vulnerable, Migratory</td><td>Percentage strandings at given latitude from 1999-2002. Data from QPWS website (see footnote 1 in body of report).</td><td>
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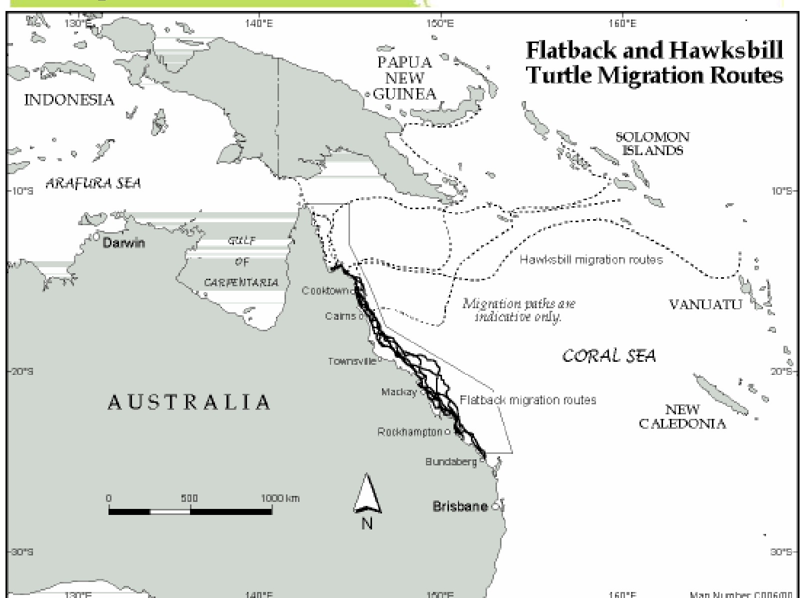
<tr><td>Flatback Turtle migration routes are shown as solid lines. Data from QPWS website (see footnote 2 in body of report)</td><td>
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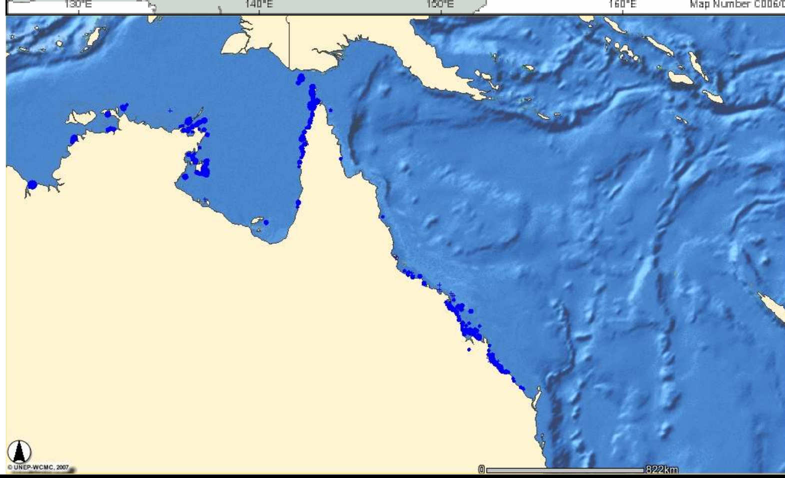
<tr><td>Breeding distribution. Data from the Marine Turtle Interactive Mapping System at http://stort.unep-wcmc.org/imaps/indturtles/viewer.htm</td><td></td></tr>
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