CAIRNS SHIPPING DEVELOPMENT PROJECT

Revised Draft Environmental Impact Statement

Chapter A2: Project Background

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A2.1 The Cairns Shipping Channel

Following the ports declaration in 1876, the first capital dredging works were undertaken within the access channel and berths by the Platypus dredge in 1887. Unable to keep up with the task of maintaining required depths, the Trinity Bay dredge took up operations from 1913, deepening the channel and increasing its width to 45 m by 1929.

By the early 1940s the channel had been widened progressively to 60 m. During the 1970s a dredging contractor undertook a further widening of the channel (75 m) and deepened the entrance to 8.2 m. The *Sir Thomas Hiley* dredge replaced the Trinity Bay dredge during the early 1970s, and conducted the most recent capital dredging expansion during 1990, widening the channel to 90 m and a design depth of 8.3 m.

The *Brisbane* dredge replaced the *Sir Thomas Hiley* dredge in 2001 and has continued to provide dredging to the Port of Cairns annually since that time. Maintenance dredging by the *Brisbane* has been augmented with the *Willunga* dredge (stationed in Cairns) since 1989 to dredge the berthing pockets and others areas constrained by space.

Maintenance dredging is undertaken annually at Port of Cairns. Average annual in-situ quantity dredged is approximately 350 000 m^3 of which 90 percent is removed from the channel and 10 percent is removed from the inner port area.

The Cairns Cruise Liner Terminal (CCLT) and heritage listed wharf, together with other cargo handling berths, lie on the western bank of Trinity Inlet adjacent to the Cairns Central Business District. The current shipping channel includes an outer channel and an inner harbour channel. The inner harbour channel terminates at the Main Turning (Swing) Basin, while the outer channel commences at the channel bend adjacent to beacon number 20 and extends out to sea, to the end of the channel.

The outer channel is approximately 9.8 km in length, typically 90 m wide with a design declared depth of -8.3 m below Lowest Astronomical Tide (LAT). This profile was achieved during the last capital dredging program in 1990 and maintained by annual maintenance dredging. Maintenance dredging of the channel requires utilisation of a Trailing Suction Hopper Dredge which is engaged for typically 4 weeks per year from the Port of Brisbane under a combined long term contract with all the Queensland Port Authorities. In order to retain the design declared depth throughout the year (between the annual maintenance dredging campaigns) ongoing natural siltation needs to be accommodated below the design declared depth. As the accretion of siltation occurs to varying thicknesses along the channel, a series of ‘Target Dredge Depths’ have been derived and approved along the channel length. These currently range from 0.3 m to 1.7 m below the Design Declared Depth. As these are set based on long term averages it is not uncommon, as a result of wetter seasons, cyclonic events in the region, or general weather variations, for the port to incur loss of declared depth. The channel depths are monitored routinely throughout the year by hydrographic survey and checked by the Regional Harbour Master who may re-declare to lesser depths if necessary for the safety of navigation. This results in constraints and inefficiencies to normal shipping activities, such as tidal windows or short loading of cargoes.

The inner channel extends for 2.5 km in length, with variable widths adjacent to the swing basins and berths. The two current swing basins are the Main Swing Basin (310 m in diameter and -8.3 m LAT) and the Crystal Swing Basin (360 m at -7m LAT design depth and 380 m at -6.3 m LAT design depth (Department of Transport and Main Roads 2015. The Crystal Swing Basin is the principal swing basin currently used by cruise ships to access Wharves 1–5. The Main Swing Basin is primarily used by cargo ships berthing at the general cargo wharves, fuel berth and sugar wharf as well as vessels berthing at the Cairns Naval Base (HMAS Cairns). The existing location of the Main Swing Basin restricts future opportunity for HMAS Cairns to expand its berthing capacity.

In 2012 Ports North proposed upgrading of infrastructure for the Port of Cairns, essentially to accommodate larger cruise ships and potential future expansions of HMAS Cairns Navy base operations. The project was identified as the Cairns Shipping Development Project (CSDP) and included the following scope of works:

- dredging of the existing shipping channel and shipping channel swing basin, requiring a dredge volume of 4.4 M m^3 and associated placement at sea
- placement of maintenance dredge material at sea
- establishment of a new swing basin to support future expansion of the HMAS Cairns Navy base
- structural upgrade of the existing shipping wharves
- provision and upgrade of services to the wharves.

PN prepared a Draft EIS for the CSDP which concluded:

- Overall, the two preferred dredge material placement options were as follows:
  - Land placement option – East Trinity site.
  - Marine placement option – Option 1A (a new DMPA x 1 km seaward of the existing DMPA), subject to government legislative changes.
- The cost of Marine placement was estimated to be approximately $100 m compared to the cost of land placement of >$350 m.
- Marine placement was preferred to the best of the land placement options and the detailed assessment proceeded on that basis.

Since the completion of the Draft EIS, a number of key circumstances have changed:

- The Commonwealth Government determined that placement of capital dredge material would no longer be permitted within the Great Barrier Reef Marine Park (GBRMP) (given effect under Regulation 88RA of the *Great Barrier Reef Marine Park Regulations 1983*).
- The Queensland Government passed the *Sustainable Ports Development Act 2015* (Qld) which prohibits capital dredging above a certain threshold for the Port of Cairns (except under this current EIS process) and requires, under section 36(2), that any subtidal placement options or reclamation of land options within the Great Barrier Reef World Heritage Area (GBRWHA) will need to meet a 'beneficial reuse' test. The current EIS process is being undertaken under a transitional arrangement of the SPDA, as the Draft EIS was in progress prior to the commencement of the Act.

Following the change of Commonwealth and Queensland legislation which mandated the placement of future capital dredge materials in an onshore facility, Ports North undertook a recalibration of the project to review channel upgrade opportunities which would optimise cruise ship numbers, whilst limiting required dredging volumes.

The recalibration of the project involved conduct of the following detailed investigation and assessments to define at the revised CSD Project to be considered in the revised Draft EIS :

- History of dredging in Cairns.
- Conduct of Ship simulations by the Department of Transport and Main Roads (Maritime Safety Queensland).
- Revised Channel design.
- Updated Demand Analysis based on the revised channel capacity.
- Dredge Material Placement Options study.
- Dredge Material Characterisation.
- Assessment for Placement Precincts.
- Review of Placement Area Constraints and Opportunities.

A2.2 History of Dredging in Cairns

A2.2.1 History of Land Reclamation in Cairns

The Cairns Port Authority owned and operated its own dredge *The Trinity Bay* from around 1913 to 1974. This dredge was routinely used for land reclamation projects within the inner port and Portsmith areas. In general, dredge material would be placed onshore ‘when required’ with the majority still being placed at sea. Records indicate that around 100 000 tonnes of dredge material would be brought ashore annually, out of a total annual volume of 600 000 – 700 000 tonnes, when land reclamation projects were in progress. This material would be placed in dredge ponds ranging in size from 5 to 20 ha with a typical fill depth of 1.5 m. After settlement, the final fill depth would be around 1.1 to 1.2 m. No known treatment of PASS material was undertaken to mitigate the effects of acid runoff.

It is estimated that the volume of dredge material placed for land reclamation projects in Cairns over the past 100 years is between two million and three million m^3. The reclamation projects were undertaken over a number of decades and after completion of placement, a capping layer of sand or other suitable fill was used to complete the reclamation. Considerable time was still required for settlement of the material prior to site development.

A2.2.2 Marine Placement of Dredge Material

The existing Cairns Port DMPA is located at S16°47’24’ E145°48’48’ which is approximately 14 km north of the Port of Cairns entrance. The DMPA diameter is one nautical mile (1852 m) and covers approximately 269 ha. This site has been in use since 1991 for placement of mainly maintenance dredge material and minor volumes of capital dredge material from the port.

Initially, the existing DMPA was located outside the Great Barrier Reef Marine Park; however, the park boundaries were expanded in 2001 by the Great Barrier Reef Marine Park Authority (GBRMPA) and now include the existing DMPA which is located within a General Use Zone (Worley Parsons 2010).

Prior to 1991, the DMPA was located approximately two km to the south west (S16°48’12’ E145°48’00’) of the existing DMPA. This site was used between 1978 and 1990. Use of this previous DMPA ceased in 1990 when an overlying depth of seven m was reached. Following a detailed material ground site selection study by Connell Wagner (1991), the DMPA was re-located to the existing site.

One of the key parameters in selecting the existing DMPA over the historical DMPA was that of increased depth and the reduction in wind-derived subsurface currents that resulted in resuspension of placed material (Connell Wagner 1991).

Prior to 1978, dredge material was placed at a DMPA to the east of the channel, approximately eight km to the south- east of the DMPA used from 1978 to 1990.

Worley Parsons (2010) indicated that the existing DMPA would have remaining capacity to store the maintenance and contingency dredging requirements of the existing channel geometry beyond 2020. Preliminary analysis shows that there is approximately 7.6 M m^3 remaining capacity at the existing DMPA. It was noted in the Draft EIS that this could potentially accommodate the capital dredge material from the then proposed project (approximately 4.4 M m^3) but would provide limited capacity for future annual maintenance. In this context another DMPA or an expansion of the existing site would ultimately be required for the maintenance dredging material resulting from the proposed improved navigational channel which is estimated to be in the order of 450 000 m^3 and the investigations for a ‘new’ site were undertaken on that basis.

The raised bathymetry within the current and former DMPAs indicates that they are significantly retentive of placed dredge material in the short and long term. The former DMPA is located in the vicinity of the surrounding -12 m AHD contour and rises locally to around -9 m AHD, while the existing DMPA is centred around the surrounding -13.5 m AHD contour and rises to around -10.0 m AHD along its inshore extent.

The ongoing monitoring and assessment of the performance of the existing DMPA has been overseen by the Technical Advisory Consultative Committee (TACC) consisting of representatives from relevant Queensland Government Departments (Department of Environment and Heritage Protection, Department of Agriculture, Fisheries and Forestry, Department of National Parks, Recreational Sport and Racing and Maritime Safety Queensland), Commonwealth Government Departments (Department of Environment and the Great Barrier Reef Marine Park Authority) as well as community and industry stakeholders. Surveys of the existing DMPA have been undertaken to investigate potential impacts and indicate that placing dredged material over the years has not had any significant long term environmental effects (Carter *et al.* 2002, Neil *et al.* 2003 and WorleyParsons 2009). Hydrographic surveys undertaken by Ports North as part of their monitoring program similarly indicates that the topographic profiles of the DMPA areas have remained consistent over time, demonstrating retention of the deposited material.

A2.3 Previous Dredge Material Placement Studies

A2.3.1 Introduction

The existing marine placement site and a number of alternative placement options, both land and marine, have been investigated as part of previous studies for maintenance and capital dredging projects in the Cairns area.

The character of the accumulated (maintenance dredging) and in-situ (capital dredging) dredge material in Cairns is generally similar and consists of fine muds and clays with only a small proportion of sand (<10 percent). Key studies include the following:

- Connell Wagner (1990) – Cairns Harbour and Channel Spoil Disposal Study - Phase 1 – Site Selection
- Connell Wagner (1992) – Cairns Harbour and Channel Spoil Disposal Study - Phase 2 – Site Selection
- GHD (2000) – HMAS Cairns Dredge Spoil Disposal Options
- Carter et al. (2002) – The Environmental Sedimentology of Trinity Bay
- Environment North (2005) – Cairns Harbour Dredging Long Term Dredge Spoil Disposal Management Plan
- Worley Parsons (2009) – Cairns Port Ocean Disposal Site Benthic Macro-invertebrate Infauna and Introduced Pest Monitoring Survey 2009
- Worley Parsons (2010) – Cairns Port Long Term Management Plan Dredging and Dredge Spoil Management (2010-2020)
- SKM (2013) – Literature Review and Cost Analysis of Land-based Dredge Material Re-use and Disposal Options
- SKM/APASA (2013a) – Identification of Alternative Sites for the Placement of Dredge Material at Sea
- SKM/APASA (2013b) – Sensitive Receptor Risk Assessment of Alternative and Current Dredge Material Placement Sites
- Ports North (2014) – Draft EIS for the CSD Project.

A2.3.2 Connell Wagner (1990, 1991)

These studies (Connell Wagner 1990 and 1992) addressed the history of and need for dredging, the nature and quantity of dredge material, and a major commission to search for on-shore and off-shore placement sites. Associated with this work was a suite of modelling and monitoring studies in support of the site selection process for marine sites.

The second stage screening resulted in the selection of two terrestrial sites (T5 and T7) and three marine sites (M3, M4 and M5) (refer to **Figure A2-1**).

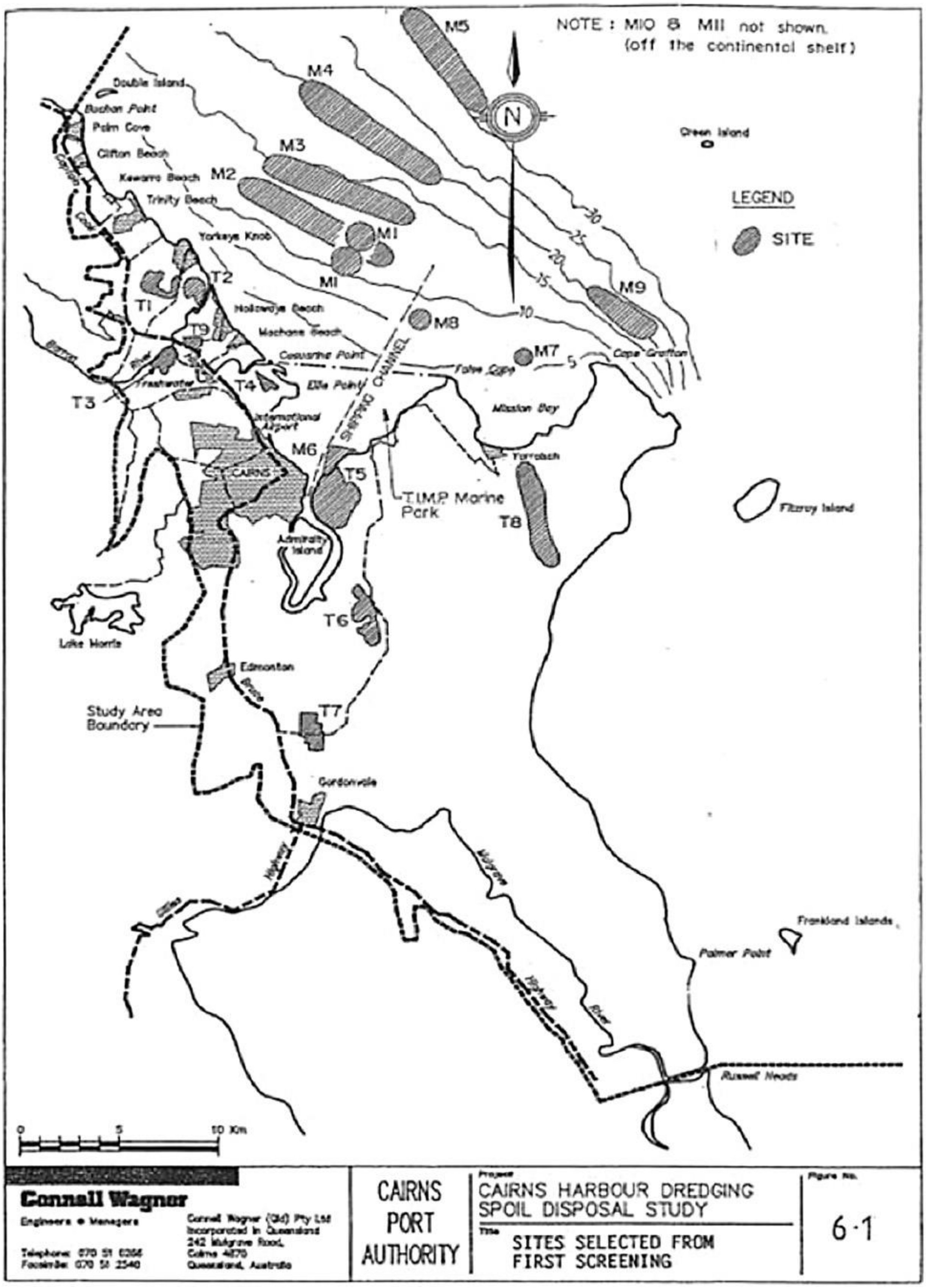


Figure A2-1 Sites investigated in 1990.

Source: Connell Wagner (1990) – Figure A3.4.1a of Ports North (2014).

Key conclusions from the Connell Wagner (1990, 1992) studies are:

- Modern dredge material placement has been largely off-shore while in earlier years material was used for reclamation of urban areas and future industrial land.
- Dredge material is chemically benign for both sea and land placement[1], although acidification following land placement has potential to release elevated concentrations of heavy metals (but still below threshold values).
- Dredge material is weak and difficult to handle on land, consolidates slowly, and contains large volumes of water which, together with runoff from rainfall, would require treatment prior to discharge into sensitive areas.
- Due to significant wet season rainfall, the Cairns climate is only marginally suitable for evaporative drying of dredge material and site drainage is critical.
- Limited beneficial uses of dredge material exist because of material properties and restrictions on land use and availability within the study area.
- Rehabilitation options exist, although the material does not represent an attractive agricultural or structural medium.
- The onshore areas available in the Cairns area for placement of dredge material are heavily constrained by:
  - residential development
  - habitat, heritage, and resource protection areas
  - Aboriginal land
  - high value agricultural land
  - scenic and recreational areas
  - flood-prone land.
- Further investigations were found to be warranted, particularly on the marine sites which appear the more favourable.

In terms of placement sites, the Connell Wagner reports determined that the preferred land and marine sites were as follows:

- The preferred marine site was in the M1/M2/M3 area (similar to the existing DMPA area).
- The preferred terrestrial site was T5 (East Trinity site).
- The marine site was preferred to the terrestrial site.

In July 1992, the Queensland Government provided comments on the Connell Wagner (1992) study findings. In regard to the identification of T5 (East Trinity) as the preferred terrestrial site, the Queensland Department of the Premier, Economic and Trade Development and Office of the Cabinet advised that:

> '… the dumping of spoil with engineering characteristics indicated in the report could render the site unsuitable for urban development for very many years. For this reason the use of site T5 could not be supported.'

Sediment testing undertaken since the Connell Wagner (1990, 1992) reports has indicated the dredge material is potential acid sulfate soil (PASS) and would require significant treatment for land disposal.

A2.3.3 GHD (2000)

GHD was commissioned in 2000 to undertake an investigation into options for land placement of dredge material from dredging of the outer and inner basins at HMAS Cairns. Key findings from this study are:

- Placement of dredge material will continue to pose a problem particularly if a land-based option is sought
- Land-based placement sites require pre-treatment before final end use. This includes mechanical dewatering, passive or solar drying or encapsulation
- Overall the most cost effective option for dredge material placement is marine placement followed by placement at the East Trinity site. Land placement costs incur considerable additional costs to those of marine placement
- Continued marine placement at the current or a nearby site is the most feasible and cost effective option
- Deep sea placement is also more cost effective than land placement
- Land placement options incur considerable extra costs and studies as well as a significant timeframe to implement
- There are limited land sites in the Cairns area available for placement of dredge material
- There are limited existing potential sites outside the Cairns area.

Based on the above conclusions, GHD concluded that marine placement of dredge material is the preferred option.

A2.3.4 Carter *et al.* (2002)

Carter *et al.* (2002) presents the findings of a study aimed at describing the environmental sedimentology of Trinity Bay. This was a five-year Australian Research Council funded joint scientific study between James Cook University (JCU) and Cairns Port Authority to determine the 'sedimentology of Trinity Bay and address many of the contemporary issues around sediment movement, including dredge material management'. Carter *et al.* (2002) reviewed adverse anthropogenic changes which have been claimed to affect the Cairns region, including:

- seabed chemical pollution
- beach damage (erosion, mud pollution)
- dredge material ground contamination
- mud suffocation of offshore coral reefs.

Key findings from Carter *et al.* (2002) are:

- Pollutant levels for most sediment samples from Trinity Bay and Inlet fall within currently recommended environmental limits.
- Tidal flows through the mouth of Trinity Inlet are ebb-dominated, which results in the transport into Trinity Bay of potentially polluted sediments from the Smith's Creek/Port of Cairns area, and their dispersion within the natural system.
- There is no significant threat to Green Island or other offshore reefs by coast-derived sediment from the Trinity Bay area.
- The Cairns Esplanade beach-mudflat system is 'stable', apart from naturally encroaching sand (and mud trapped behind it) from Ellie Point, and its vulnerability to erosion during a major cyclone.
- Neither the high turbidity in coastal waters nor the presences of mud-lumps on the Northern Beaches are related to the presence of the offshore Dredge Material Grounds (current or disused).
- Material deposited at the existing DMPA forms a lensoid mass on the seafloor.
- Transport of the dredge material is largely long-shelf to the north, or seawards.

- Sediment which is reworked from the present Dredge Material Ground has no discernible geochemical effect at distant locations, and its volume is insignificant compared with the natural sediment flux through the system.
- The location of the current dredge material placement area is close to optimum.

A2.3.5 Environment North (2005)

In 2005, the Cairns Port Authority (CPA) commissioned Environment North to develop the Long-Term Dredge Material Disposal Management Plan (LTDMDMP). The purpose of the document was to guide CPA in future management of dredge material placement, and to support applications for on-going dredging and dredge material placement activities.

Key conclusions from the Environment North (2005) study include the following:

- Robust environmental and other assessments have been undertaken at the marine DMPA and these confirm the suitability of the current site.
- Comprehensive studies have confirmed that there is no practical alternative to marine placement and that the current DMPA is well-located.
- Studies at the current DMPA suggest that it is showing only small signs of adverse impacts (such as subtle evidence of impact on benthic assemblage). While it is likely that the area will recover following cessation of dumping, monitoring of the previous Material Ground was recommended to confirm this.

A2.3.6 WorleyParsons (2009)

WorleyParsons (2009) investigated impacts of dredge material placement on benthic macro-invertebrate assemblages at the current DMPA relative to reference locations radiating from the DMPA in the direction of prevailing currents.

A2.3.7 WorleyParsons (2010)

WorleyParsons (2010) developed the Long Term Management Plan - Dredging and Dredge Spoil Management to guide dredging and dredge material management. This plan included a review of existing environment and dredging activities, an evaluation of monitoring results, and a description of impacts and management actions for a subsequent Sea Dumping Permit period.

Key findings presented by WorleyParsons (2010) are:

- Monitoring surveys undertaken identify that the DMPA is functioning well, with minimal apparent environmental impact. The rate of deposition and accumulation of dredge material between the five year period of 2004 and 2008 (inclusive) at the DMPA was very consistent across the site.
- The accumulation rate for the five years is approximately 0.5-0.6 m, equating to an average annual maximum of 0.12 m (12 cm). Such minor changes are evident in the consistency of hydrographic survey results between pre- and post- dredging surveys in 2007 and 2008.
- Future management options to maximise the life of the DMPA, particularly if the DMPA is approaching capacity, could include placement only in the deeper sectors of the DMPA, or through selective placement of dredge material within each sector. However, this management would not be required within the 2010-2020 LTMP period.
- Constraints on further development (where dredge material could possibly be used as fill) within low lying areas are now further enhanced due to the impending implementation of the Queensland Coastal Plan in 2010 which recognises the need for planning to account for coastal hazards and has greater recognition of coastal zone environmental values.

A2.3.8 SKM (2013)

SKM and Asia-Pacific Applied Science Associates (APASA) were commissioned to complete the 'Improved Dredge Material Management for the Great Barrier Reef Region' project, which encompasses three tasks:

- Task 1: Perform a literature review and cost-benefit analysis that synthesises the available literature on the environmental and financial costs associated with land-based re-use and land-based placement options for dredge material at six locations (Port of Gladstone, Rosslyn Bay Boat Harbour, the Port of Hay Point, the Port of Abbot Point, the Port of Townsville, and the Port of Cairns).
- Task 2: Develop a generic water quality monitoring framework that can be applied to developing a water quality monitoring and management program for any dredge material placement site.
- Task 3: Identify potential alternative dredge material placement areas within 50km based on environmental, economic, operational, and social considerations and hydrodynamic modelling, and conduct hydrodynamic sediment migration and plume modelling for 13 model placement sites to assess risks to environmental values.

A review of the types of beneficial re-use of dredge material that have successfully or unsuccessfully been employed in Australia and overseas was undertaken with a view to identifying the considerations that need to be taken into account in evaluating each option.

SKM (2013) found that the only land-based use of dredge material considered feasible in Cairns is construction fill. SKM (2013) also noted however that this option would only be suitable if there was a requirement, if any ASS had been treated and if there were no contaminants present. SKM (2013) found that other land-based options are highly constrained due to a lack of available land and due to the nature of sediments to be dredged, which are unsuitable for beach nourishment or construction purposes.

A2.3.9 SKM/APASA (2013A)

The SKM/APASA (2013a) draft report presents the findings of Task 3 as mentioned above, that is, the identification of potential alternative dredge material placement areas. The assessment took into consideration expected future capital and maintenance dredging requirements.

For the Port of Cairns, two preferred areas for material placement were identified, both to the north- east of the port near the 20 m depth contour. Options for dredge material placement sites at Cairns are found to be very constrained due to reefs, non-General Use marine park zones, and shipping activity. Both of the preferred areas avoid interactions with sensitive environmental receptors and navigational routes.

A2.3.10 SKM/APASA (2013B)

The SKM/APASA (2013b) draft report assessed the risk to sensitive ecological receptors from placement of dredge material in the current and alternative DMPAs. It should be noted that SKM/APASA (2013b) acknowledge that there are limitations in their modelling, and that results should only be used to compare placement areas and not for quantitative impact assessment. That is, the magnitude and extent of turbid dredge plumes may not be accurately represented.

Notwithstanding the above limitations, the key findings for the Port of Cairns are:

- The two alternative material placement sites were assessed as having similar levels of environmental risk to the current site, with the exception of short-term sediment deposition rates.
- Model Case 2 presents an option to reduce sediment deposition arising from material placement activities along the inshore coastal environments north of Cairns, with sediment predicted to drift further north to the Cape Kimberley region before reaching the near shore depositional environment.
- However, monitoring of previous dredging projects utilising the current material placement site has revealed minimal impacts on sensitive receptors surrounding the Port of Cairns.

A2.4 Draft EIS (2014)

A2.4.1 Multi-criteria Analysis

The Draft EIS conducted an assessment of suitable placement sites for the material to be extracted from the main shipping channel to support the desired channel widening and deepening and included both terrestrial and marine placement sites. It used a Multi-criteria Analysis (MCA) approach, undertaken separately for marine and terrestrial sites. Categories and criteria used for land and marine options are presented in **Table A2-1**. While these broad assessment categories were identical for land and marine placement options the MCA criteria within these categories differed slightly as some were applicable to land options but not applicable to marine options, and vice versa.

TABLE A2-1 DRAFT EIS MCA ASSESSMENT CATEGORIES AND CRITERIA

MCA Category	MCA Criteria	
	Land Placement	Marine Placement
Environmental	Water quality impacts (tailwater and groundwater) Habitat values/habitat loss, Acid Sulfate Soil (ASS) issues, Air/noise/ odour impacts, Pest introduction/attraction	Water quality impacts/Re-suspension potential Sensitive ecological receptors and world heritage values Seabed substrate and benthic ecology
Social	Cultural heritage/native title Traffic Community benefit Amenity issues	Fisheries Amenity and tourism
Legislative/Planning	Land use planning/approvals/tenure	Marine Park Planning
Economic/Logistics	Area available/volume able to be accepted Pumping equipment and distance Impact on length of dredge campaign Costs	Bathymetry/capacity Shipping and navigation Distance from dredge area Costs

Source: Ports North (2014) Table A3.2.1.1a.

A2.4.2 Land Placement

Five potential land placement sites were selected based on previous dredge material placement studies in Cairns and assessed using MCA techniques as described above. These were divided into a number of types and sub-types based on certain characteristics, namely:

- placement only
- future development:
- urban use
- development (airport expansion) use
- land reclamation development / open space use.

Each acceptable land placement site was assumed to be capable of providing an area to dewater material and establish associated infrastructure (including transport access) and have the following general characteristics:

- be on relatively flat land
- be close to existing tidal drainage or creek lines to enable saline tailwater discharge
- be distant from areas subject to coastal erosion or storm surge, or capable of being otherwise engineered to be resistant to such impacts
- be within a reasonable distance (<11 km) to enable pumping of the dredged material from a mooring site
- secure dewatering areas need to be fenced and made secure as there are inherent public safety issues with the soft nature of the material while it is in the process of dewatering
- be on undeveloped land
- have adequate storage area.

The Draft EIS included reference to previous reports and in particular Connell Wagner (1990, 1992). This included two of the sites ultimately selected for the draft EIS. The adopted sites are shown on **Figure A2-2** below (extracted from the Draft EIS). After consideration of the limitations imposed by treatment / end use considerations, five potential placement sites were identified for further assessment. It was noted that each of the five placement sites shown on **Figure A2-2** could potentially be used for either 'disposal' or 'future development' purposes. The Draft EIS project team assessed the most appropriate end use for each of the sites below and the concept design for each site was developed accordingly:

- East Trinity Site – Connell Wagner site T5 – potential for both a placement-only site or a future development (urban use) site.
- Cane land development near to Connell Wagner site T7 – most suitable for future urban use.
- Admiralty Island – most suitable for 'placement only' site. Future development of this site would require major geotechnical improvements which would be a separate project.
- Airport – potential for future expansion of existing development area.
- Esplanade – potential for land reclamation for future development or use as public open space.

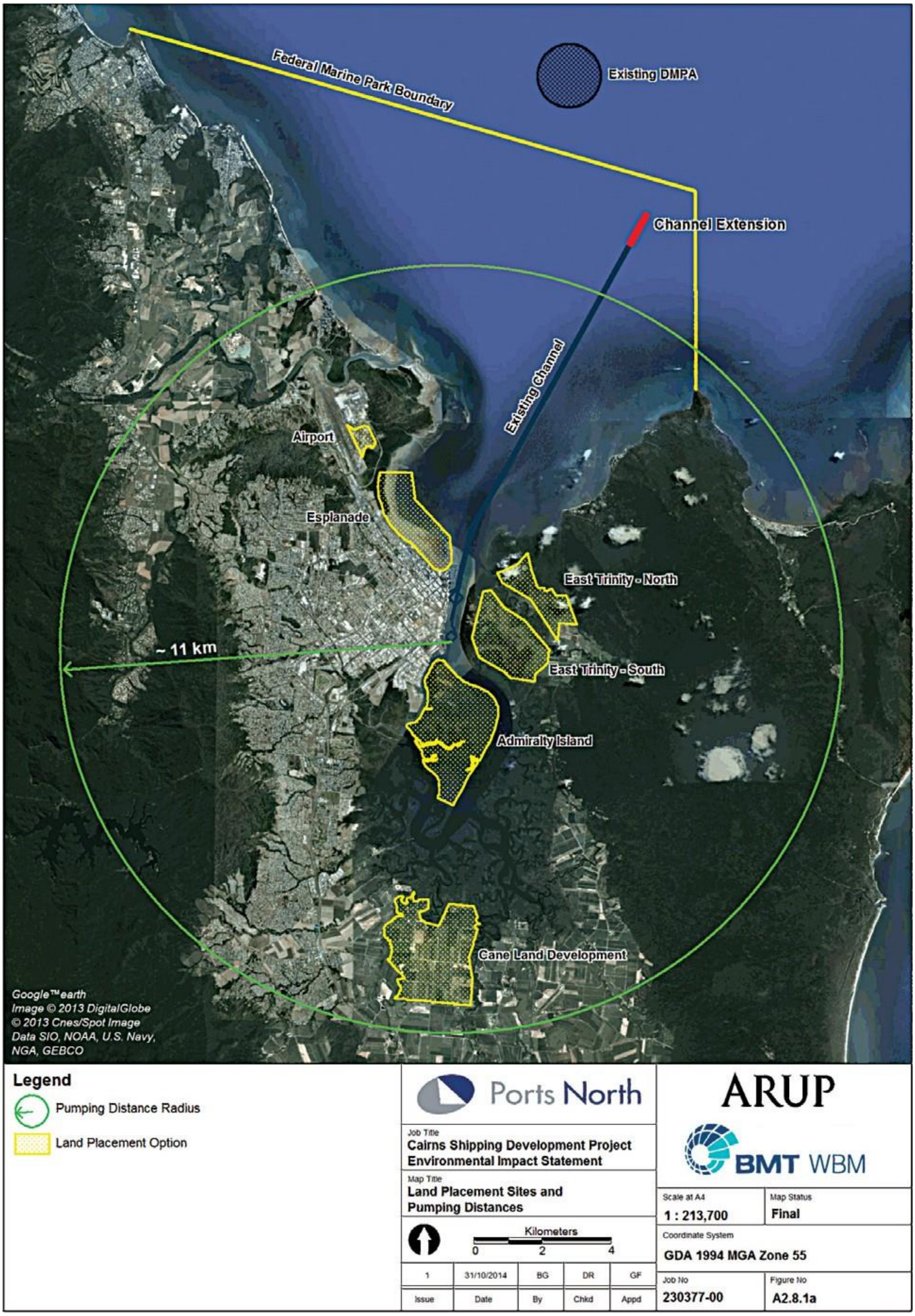


Figure A2-2 Land placement sites and pumping distances.

Source: Ports North (2014) Figure A3.8.1a.

A2.4.3 Final Evaluation

Based on an assessment of five land placement options using various selection criteria, and using the category and criteria weightings determined by the core project team and feedback from regulators, the most suitable land placement option was found to be the East Trinity site. With weightings biased toward other categories (except social and economic), East Trinity remained the preferred land-based option. The appropriateness of placing dredge material at this location was further considered in Chapter A3 of the Draft EIS. This is not of relevance to the recalibrated project.

Overall, the two preferred dredge material placement options were as follows:

- Land placement option – East Trinity site.
- Marine placement option – Option 1A (a new DMPA x km seaward of the existing DMPA), subject to government legislative changes.

The cost of Marine placement was estimated to be approximately **$100 m** compared to the cost of land placement of **>$350 m**.

The Draft EIS concluded that, overall, marine placement was preferred to the best of the land placement options and the detailed assessment proceeded on that basis.

A2.5 Revisions to the Project

A2.5.1 Ship Simulations

Following the change of Commonwealth and Queensland legislation which mandated the placement of future capital dredge materials in an onshore facility, Ports North commissioned the Department of Transport and Main Roads (Maritime Safety Queensland), to undertake cruise ship navigation simulations to identify the channel characteristics that would optimise cruise ship numbers, whilst limiting required dredging volumes. Simulations focussed on minimising channel widening and deepening to facilitate usage of the channel by Vista and Grand Class vessels, without compromising safety.

The output of the MSQ simulations (DTMR, 2015) refer **Appendix G,** determined that a recalibrated channel with the following characteristics would permit safe usage of the channel by cruise ship vessel classes up to and including Vista and Grand Classes:

- -8.8 m Declared Channel depth
- Expanded Crystal Swing Basin to 380 m
- Smiths Creek Swing Basin to 310 m
- Outer Channel width 90 -100 m
- Inner Channel width generally to 110 m (outer bend to 180 m).

A2.5.2 Revised Channel Design

A design for the channel upgrade and associated infrastructure has been prepared. The design has aimed to minimise the extent of dredging to the minimum required, whilst still maintaining safe navigation standards for cruise ships. Originally, the outer and inner channels were proposed to be up to 130 m and 180 m wide respectively to accommodate vessel sizes up to Voyager class, but these have been reduced through a number of design iterations for lesser vessel sizes with target cruise ships up to 300 m, to generally 90-110 m width. This has significantly reduced the amount of dredge material requiring placement at an onshore placement facility.

The channel design has been developed with input from experienced maritime and port engineers, mariners, hydrographic surveyors and cruise ship masters at Ports North, Arup, Maritime Safety Queensland (MSQ) and cruise ship companies.. The design has also been developed and verified by a series of simulation runs over a number of days using a simulator at Smartship Australia, a Brisbane-based navigation simulator.

In developing the design, a key consideration was to provide safe access for the reduced targeted range of mega class cruise ships (up to 300m) while minimising the overall dredge volumes to limit both project cost and environmental impacts. This iterative design process resulted in a reduction of channel dredge volumes, initially predicted to be 10 M m^3 to a dredge volume of 4.4 M m^3 in the Draft EIS and further reduced to 1 M m^3 for this Revised Draft EIS. This significant reduction was achieved through the optimisation of channel width, and more critically, by establishing an optimum workable channel depth, whilst introducing some tidal constraints for access by the largest ships in the targeted range cruise ship classes.

Details of the recalibrated channel are shown on Figure A2-3. Preliminary channel designs based on these characteristics identified a preliminary estimate of in-situ dredge material requirement 830 000 m^3 between current maintenance target dredging depths and the widened channel target depths,.

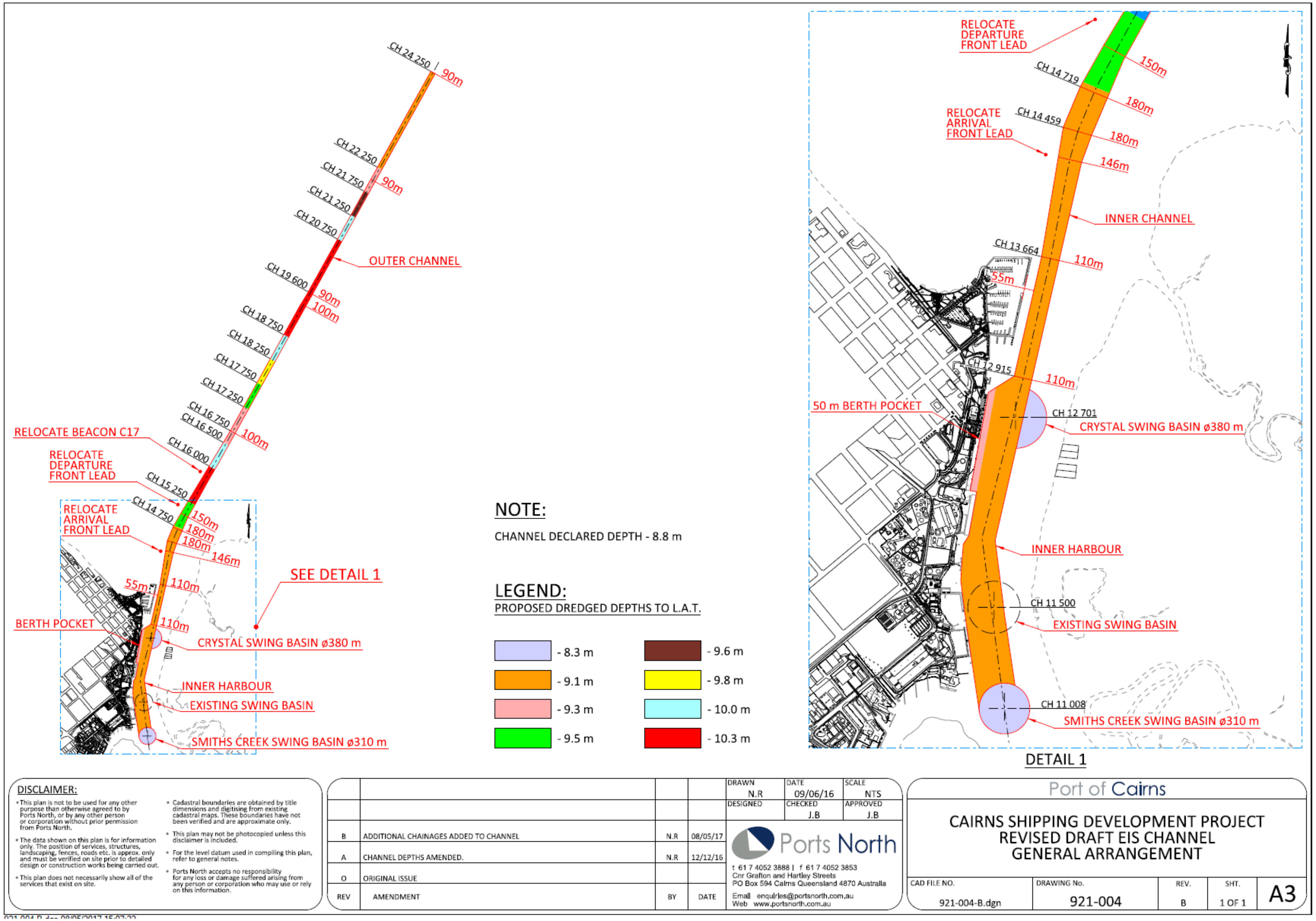


Figure A2-3 2017 Channel Widening Proposal – 90 m outer channel with bend widening.

Source: Ports North (2017).

The channel design increases the design declared depth from 8.3 m to 8.8 m to cater for large-size cruise ships, as shown in **Table A2-2**.

TABLE A2-2 MEGA CLASS CRUISE SHIPS CATERED FOR BY THE PROJECT

SHIP CLASS	SHIP NAME	OVERALL LENGTH (m)	BEAM (m)	DRAFT (m)
Vista	*Queen Victoria*	294.0	32.3	8.1
Grand	*Emerald Princess*	290.0	36.0	8.5

Source: Ports North.

Relocation of the Main Swing Basin to a new location adjacent to Senrab Point and the Tropical Reef Shipyard (designated as the Smith's Creek Swing Basin) will enable future expansion of HMAS Cairns and provide a wider and deeper inner channel for the full length of the inner port. It has been positioned to utilise an existing, self-clearing, deep area of water with minimal additional capital dredging.

The Defence Force Posture Review (Hawke & Smith 2012) recommends upgraded or expanded bases at Cairns and Darwin to accommodate future Offshore Combatant Vessels (OCV) and replacement Heavy Landing Craft (HLC).

There has been no decision from the Commonwealth Government regarding approval of this HMAS Cairns expansion at the time of writing. This directive and consultation with Navy has determined that the ships within **Table A2-3** could potentially visit Cairns.

TABLE A2-3 POTENTIAL NAVY SHIP REQUIREMENTS

SHIP NAME	OVERALL LENGTH (m)	BEAM (m)	DRAFT (m)
HMAS Choules	176	26.4	6.0
HMAS Canberra (new Landing Helicopter Dock Class)	231	32	7.5
USS Boxer (Mid-size US Navy Carrier)	257	32	8.5

Australian Navy ships could be accommodated by the existing shipping channel and swing basin, however, the wider and deeper channel provided for cruise shipping will also provide safer access for the new Landing Helicopter Dock (LHD) Class ships, with reduced operational restrictions. The larger US Navy Carriers that cannot currently berth at the Port of Cairns could also be accommodated by the proposed channel upgrade (as per **Table A2-3**.

Consequently, the upgrade of the Main Swing Basin and channel south of the Crystal Swing Basin included as part of this project would provide potential opportunities for expansion of the naval facilities in Cairns. The proposed concept design relocates the Main Swing Basin adjacent to HMAS Cairns to a new location adjacent to the Smith's Creek entrance (see **Figure A2-3**). All cruise ships will manoeuvre at the larger 380 m diameter Crystal Swing Basin, while navy ships and general cargo ships will swing at the new Smiths Creek Swing Basin. The expansion includes the following components:

- the design extends the existing 90 m wide inner harbour channel to the proposed Smith Creek Swing Basin to 110 m (providing 80 m clearance between the channel and the existing navy infrastructure as advised by the RHM)
- the inner part of the channel will widen to 180 m wide, and 240 m adjacent to the main Wharf area to provide access to the various adjacent berth positions ending in the new Smith's Creek Swing Basin with a diameter of 310 m
- the extended inner channel and outer channel Design Declared Depth will be consistent at -8.8 m LAT.

A2.5.3 Updated Demand Analysis

AEC were commissioned by Ports North to review projected cruise ship visits for Cairns based on emerging changes in the Australian cruise industry and allocation of those cruise ship visits between Trinity Wharf and Yorkeys Knob anchorage based on revised channel modifications to Trinity Inlet to accommodate Grand and Vista Class vessels and Voyager class vessels anchoring at Yorkeys Knob.

The AEC Demand Study Update 2016 (refer **Appendix H**) provides an update shipping projections previously undertaken in 2011 and 2014.

AEC reported that since 2011 and 2014 the cruise shipping industry has continued to grow globally and in Australia. In 2015 over 1 million Australians went ocean cruising, an increase of 14.6% from 2014, with 71.3% departing from an Australian port to cruise in the South Pacific, Australia or New Zealand. The number of passengers represents a market penetration of 4.5% the second year in a row that a cruising region has broken through the 4% barrier. The South Pacific/Australia/New Zealand region represents 6.1% of total global available lower berth days.

As demand for cruising grows cruise lines have been adding capacity to the global fleet by building larger capacity ships to take advantage of economies of scale. As these new ships are added, older smaller ships are either refurbished and orientated to a particular market or decommissioned. Of the 81 ocean cruise ships for delivery between 2016-2026 59 are mega class ships and more than 60% of these are voyager class. No new regal or sun class ships are on order.

In the 2015-16 season 46 cruise ships visited and/or operated in Australia, up from 42 in 2010-11 and 16 in 2004-05. Whilst the number of ships has increased so has their average size and capacity. Globally the majority of new ships on order are of the voyager class and these will replace smaller and older ships over time.

There were 1,015 cruise ship visits to Australian ports/destinations in 2015-16, an increase of 139 visits, or 15.9%, from the 2014-15 total of 876. Sydney (308), Brisbane (148), Melbourne (75), Fremantle (58), Cairns (50), Darwin (45), Moreton is (33) and Hobart (32) were the most frequently visited ports/destinations in 2015-16.

Sydney is regarded as a marquee port by the cruise lines, however, it is rapidly becoming constrained with the Overseas Passenger Terminal fully booked for eight months of the year (October to April). Whilst there is still capacity at the White Bay Cruise Terminal, access is limited to those cruise ships that can fit under the Sydney Harbour Bridge. Collectively, Sydney cruise berth bookings were 365 for 2016-17 and 369 for 2017-18 as at 13 October 2016.

Australia's second most visited port Brisbane, is also constrained by the Gateway Bridges and the turning basin at Portside Cruise Terminal. However, Brisbane Port has recently announced the development of the Brisbane Cruise Terminal (BCT) at Luggage Point supported by both Carnival Australia and Royal Caribbean Cruise Lines (RCCL). It is expected that the BCT will be operational from 2019 and will triple the size of the Brisbane cruise industry by 2035 although the development is still subject to commercial negotiations. Cruise lines have indicated that this facility could see the home porting of four ships in Brisbane. This increased traffic will have significant implications for visits to Cairns.

The total number of cruise ship visits to Cairns in 2015 was 43, which has grown from 34 in 2010 or a CAGR of 4.8%.

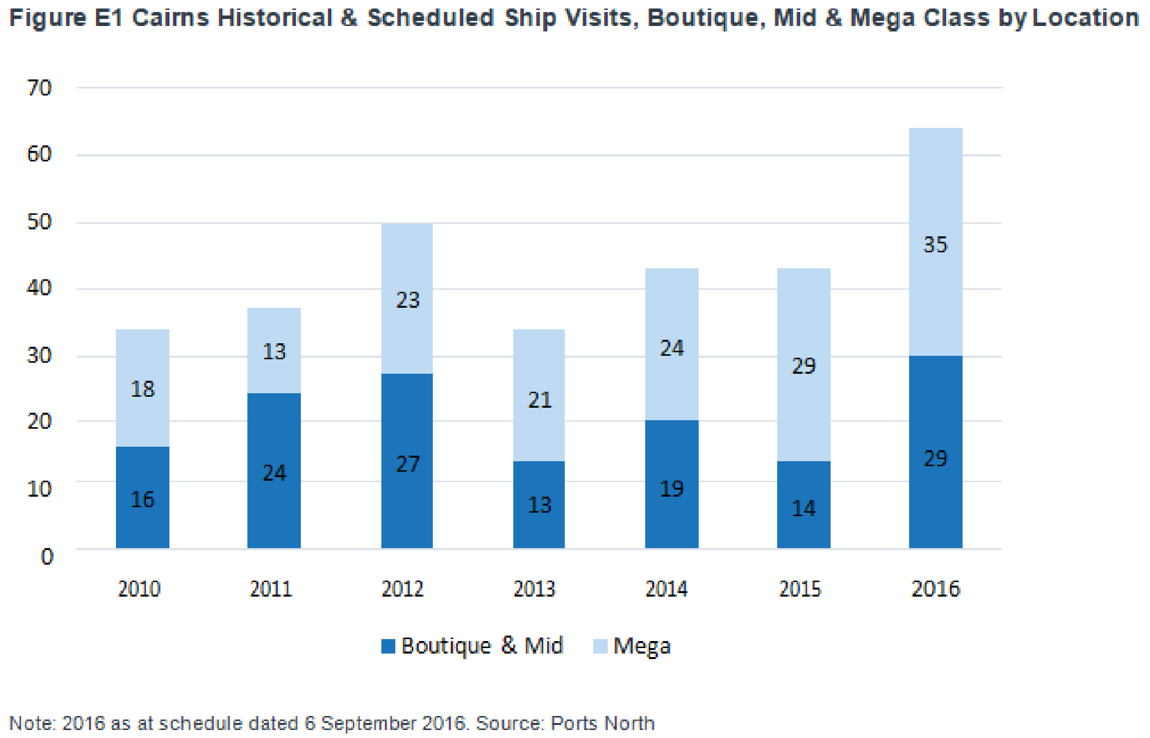


Figure A2-4 Cairns historical & scheduled ship visits, Boutique, Mid & Mega Class by location.

Source: Appendix H.

The number of cruise ships (excluding Adventure class) visiting Trinity Wharf in 2015 was 20, which was up from 19 in 2010 (CAGR 1.0%). This number is scheduled to rise to 40 in 2016 due to:

- An additional 17 visits by P&O mid/sub-regal class ships (Pacific Eden & Pacific Aria), which are recent acquisitions to the P&O fleet.
- An additional 7 visits by Sun class (mega) ships, which have been diverted from the Yorkeys Knob anchorage following successful simulation outcomes.

In comparison the share of ships to the Yorkeys Knob anchorage increased from 15 visits to 21 visits from 2010 to 2015 (a compound annual growth rate (CAGR) of 7.0%). The number was scheduled to increase to 24 for 2016 increasing the CAGR to 8.1% over the six-year period. This pattern reflects the increasing size of cruise ships visiting Cairns that cannot access the port.

For 2016, the scheduled total ship visits to Cairns is 64 (CAGR of 11.1% since 2010). This large increase in visitation reflects the transit and home porting of the P&O mid/sub-regal class ships, however even omitting these ships (17 visits) from the analysis, there is still significant extra growth in Cairns in 2016 with 48 other scheduled visits representing an CAGR of 5.5% since 2010.

More significant growth again is currently forecast for Cairns in 2017 with 80 ships (excluding adventure class) scheduled as at 6 September 2016.

Previous projections of cruise ship visits were undertaken in 2011 and 2014. These projections were based on a channel upgrade that could accommodate sun, vista, grand and voyager class vessels. The current study considered a channel upgrade that can accommodate vista and grand class vessels noting that sun class vessels can now enter the port following recent successful simulation outcomes.

This study also considered the following emerging changes in the cruise industry that were not foreseen by the earlier studies:

- home porting of mid classified ships in Cairns commencing in 2016
- potential for future home porting of vista class vessels in Cairns
- relocation of additional larger cruise ships to the Australian market
- impacts associated with other port constraints/developments, in particular the proposed BCT.

The projection methodology AEC used in Demand Update is different from that used in the 2011 and 2014 studies in that many more scenarios have been considered. The assumptions used in the projections were informed through previous studies, consultation and AEC's experience in the sector.

The basic approach to undertaking the projections was to project cruise ship visits to Cairns and then determine whether they can berth or have to anchor based on ship length. With no channel modifications, only ships of 240m or less are typically assumed to berth, subject to the following:

- Due to limited manoeuvrability, no P&O regal class ships can berth but other regal class ships can. Sun class ships can now berth following successful simulation outcomes.
- The fleet mix of visiting cruise ships that may visit Cairns has been modelled on the existing mix of cruise ships based in or visiting Australia modified for the known and expected change in fleet composition. For example, the replacement of P&O regal class ships with a larger class of ship, retirement of sun class ships as they reach their useful life and additions of grand class (approximately one every four years) and voyager class ships (one every second year).

A base line projection of ship visit growth (excluding home porting ships) was established at 5% per annum on which alternative scenarios are applied. Four alternatives to the base case are incorporated in the projections. The combination of alternatives gives sixteen scenarios. The alternatives are:

- With or without development of the BCT (expected to be in place by 2019.)
- With or without home porting.
- With or without channel modifications.
- With or without availability of bunker.

Assumptions used in the projections are as follows:

- Growth in cruise ship visits from the BCT is estimated to triple from 2019 to 2035 in a linear fashion based on mega class ships accounting for increases in the average size of cruise ships. Cairns is assumed to receive visits from 30% of these cruise ships.
- Home porting is assumed to number 20 ships visits per annum of sub-regal class with no channel modifications changing to 16 of vista class with channel modifications.
- Channel modifications will allow port access to vista and grand class ships commencing in 2021. Without channel modifications, only sub-regal, regal and sun class ships can enter the port. The additional access to the port is estimated to increase mega class visits to Cairns by 20% for regal, vista and grand class ships.
- Availability of bunker is estimated to increase all cruise ship visits for those that can access the port by 10%.

The logistical constraints associated with ships anchoring and tendering passengers to Yorkeys Knob, especially as ship passenger capacity increases, have been estimated to reduce unconstrained ship visit projections to Yorkeys Knob by 35%. This reduction factor was phased in linearly from 2019 to 2025.

The alternatives present a total of 16 scenarios with both low, medium and high projections. The most pessimistic scenario of business as usual (BaU, no BCT, no homeporting and no channel modifications) still sees growth in ship visits reaching 97 in 2031 but with 43 of these at Yorkeys Knob versus 54 at Trinity Wharf. However, construction of the revised channel and bunker availability not only sees the total increase by 27 to 124 but 19 at Yorkeys Knob compared to 105 ships at Trinity Wharf (see **Table A2-4**).

TABLE A2-4 PROJECTED SHIP VISITS (BUSINESS AS USUAL), MEDIUM PROJECTION

Table E1 Projected Ship Visits (Business as Usual), Medium Projection

Scenario	Class	Trinity Wharf			Yorkey's Knob			Total Cairns		
		2021	2026	2031	2021	2026	2031	2021	2026	2031
Existing Channel										
Scenario 1 BaU, no homeporting	Sub-Regal	25	33	42				25	33	42
	Regal	3	2	2				3	2	2
	Sun	16	14	10				16	14	10
	Vista				15	15	11	15	15	11
	Grand				2	6	13	2	6	13
	Voyager				7	9	19	7	9	19
	Total	**44**	**49**	**54**	**24**	**30**	**43**	**68**	**79**	**97**
Revised Channel										
Scenario 4 BaU, no homeporting, channel modifications, bunker	Sub-Regal	28	36	45				28	36	45
	Regal	3	2	3				3	2	3
	Sun	18	15	11				18	15	11
	Vista	23	29	21				23	29	21
	Grand	3	11	25				3	11	25
	Voyager				7	9	19	7	9	19
	Total	**75**	**93**	**105**	**7**	**9**	**19**	**82**	**102**	**124**
Difference		*31*	*44*	*51*	*-17*	*-21*	*-24*	*14*	*23*	*27*

Source: AEC

Source: Appendix H.

Looking at the more optimistic scenario of the BCT and homeporting in Cairns, the overall number of ships visits is projected to reach 151 with 69 at Yorkeys Knob and 82 at Trinity Wharf. With construction of the revised channel and bunker availability the overall number is projected to increase by 33 to 183 with the Yorkeys Knob/ Trinity Wharf balance shifting to 31/152. An additional 85 Mega Class vessels will be able to dock at Trinity Wharf (see **Table A2-3**).

TABLE A2-5 PROJECTED SHIP VISITS (WITH BRISBANE CRUISE TERMINAL & HOME PORTING), MEDIUM PROJECTION

Table E2 Projected Ship Visits (with Brisbane Cruise Terminal & Home Porting), Medium Projection

Scenario	Class	Trinity Wharf			Yorkey's Knob			Total Cairns		
		2021	2026	2031	2021	2026	2031	2021	2026	2031
Existing Channel										
Scenario 13 BCT, homeporting	Sub-Regal	45	53	62				45	53	62
	Regal	5	3	4				5	3	4
	Sun	31	25	16				31	25	16
	Vista				30	27	17	30	27	17
	Grand				4	10	21	4	10	21
	Voyager				13	16	31	13	16	31
	Total	**81**	**81**	**82**	**47**	**53**	**69**	**128**	**134**	**151**
Revised Channel										
Scenario 16 BCT, homeporting, channel modifications, bunker	Sub-Regal	28	36	45				28	36	45
	Regal	6	4	5				6	4	5
	Sun	33	26	17				33	26	17
	Vista	56	64	47				56	64	47
	Grand	6	18	38				6	18	38
	Voyager				13	16	31	13	16	31
	Total	**129**	**148**	**152**	**13**	**16**	**31**	**142**	**164**	**183**
Difference		*48*	*67*	*70*	*-34*	*-37*	*-38*	*14*	*30*	*32*

Note: Sub-Regal home porting has been replaced by vista class home porting with the revised channel.
Source: AEC

Source: Appendix H.

The Demand Update based on the revised channel configuration reveals that the substantial majority (83%) of the 2031 projected demand can be accommodated at Trinity Wharf as a result of the revised channel configuration.

The total cost of dredging and land placement of dredge material is closely correlated with cost i.e. there are no significant economies of scale that can be achieved in larger dredging projects. The volume of dredging required is therefore a useful surrogate for cost. The revised channel (1 000 000 m^3) requires approximately 22% of the dredge volume (4 400 000m^3) required to provide a channel to accommodate all potential mega class vessels.

A comparison of the potential ship visits versus volume of dredging required is shown on **Figure A2-5**. The number of ship visits is closely correlated with and is a useful surrogate for economic benefits to the region.

The substantial majority of the potential increases in ships visits can be achieved with a channel upgrade involving significant lower cost than the original proposal considered in the Draft EIS (2014). The Benefit / Cost ratio is relatively high (steep slope of curve)

The substantial marginal cost increase (approximately $250 M) to accommodate the balance 17% of the potential demand represents a relatively low cost benefit ratio (flat slope of the curve) for marginal increase in ship visits as shown on **Figure A2-5**.

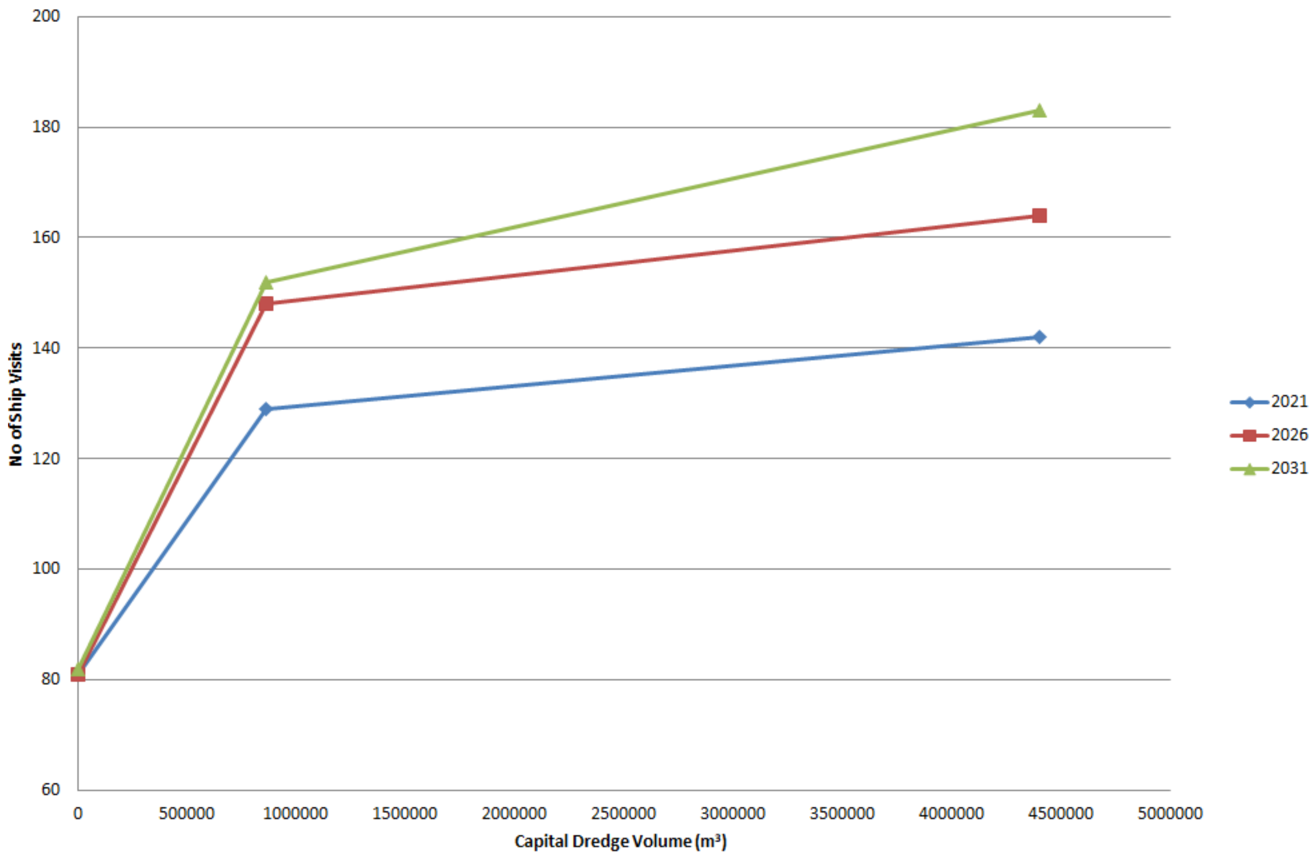


Figure A2-5 – Comparison of ship visits v dredge volume.

It is noted that the provision of a channel to accommodate Voyager Class vessels may result in a marginal increase in the number of Voyager class vessels that would be attracted to Cairns. However this marginal increase would not result in a significant increase in the Benefit Cost ratio for the substantial cost increase required to provide the larger channel.

The demand analysis and comparison of ship visits versus the scale of the channel upgrade indicates that the revised channel profile provides a much greater rate of return on investment at a substantially lower capital cost than the original channel upgrade proposed in the Draft EIS.

A2.5.4 Dredge Material Placement Options Study (2016)

The recalibration of the project to cater for Grand and Vista Class vessels resulted in a substantial reduction to the scale of dredging required (from 4 400 000 m^3 to a theoretical design volume of 860 000 m^3) and consequently land placement opportunities in addition to those considered in the Draft EIS have become potentially viable. Ports North commissioned Flanagan Consulting Group to undertake work to redefine the dredging and land placement project. In particular the Dredge Material Placement Options Study (refer **Appendix I**) was commissioned to expand the land placement site selection work documented in the Draft EIS to inform the Revised Draft EIS for the CSD Project.

The selection process used to identify a preferred site (or a small group of sites) to be assessed in detail as part of the revised Draft EIS process involved four main tasks as follows:

- **Site Selection (SS**) – high level screening to define locations (Placement Precincts) where possible sites and types of sites could be located. The high level screening did not include existing legislative/planning constraints.
- **Concept Design (CD)** – preliminary concept design to produce a suite of potential sites within Placement Precincts. These are nominal sites representative of the Placement Precincts.

- **Site Evaluation (SE)** – evaluation of potential sites using Multi-criteria Analysis (MCA) techniques.
- **Suitability Assessment (SA)** – assessment of the findings of the SE task on a Placement Precinct level and further refinement through consideration of planning constraints, cost, and other considerations including strengths, weaknesses and any serious deficiencies to produce a shortlist of Placement Precincts for detailed assessment via the EIS.

Ports North identified two potential channel development options being widening only (430 000 m^3 in-situ material volume) and widening and deepening (860 000 m^3 in-situ material volume) for the first phase of the Options Study consideration. During the Options Study further work was undertaken on the channel design and it was determined that the project scope would be based on channel deepening and widening with an overall in-situ volume of 860 000 m^3.

These were solid measures. Placement sites needed to have capacity to allow for bulking of the dredged material, as well as the substantial volumes of water associated with the dredging process (this can be up to four times the solid measure volumes). For this study, it was assumed that the bulking factor of 2.2 applies for land placement, i.e. the solid measure volume will bulk to 1.9 M m^3 and ideally all sites will be able to accommodate this volume and handle the associated water.

An assessment of the types of sites resulted in the following being considered:

- existing voids (former sand quarries in the Barron River delta)
- reclamation (beneficial reuse is required in order to comply with the *Sustainable Ports Development Act 2015* (Qld))
- terrestrial (treatment of ASS is required on all sites and tailwater on some).

A site selection (SS) process was undertaken that involved a high level filtering of the Cairns district based on four attributes within the adopted 'triple bottom line + performance' hierarchy (i.e. *Cost*, *Environmental*, *Performance*, and *Social*) as identified by the corresponding prefix (i.e. E = Environmental):

- E1 – Maximum elevation
- E2 – Barron River flooding
- P1 – Maximum transport distance
- S1 – Remoteness from incompatible land use.

There were no Cost attributes as cost was not considered relevant to SS.

A composite map (**Figure A2-6**) was produced showing areas where suitable placement sites could be located.

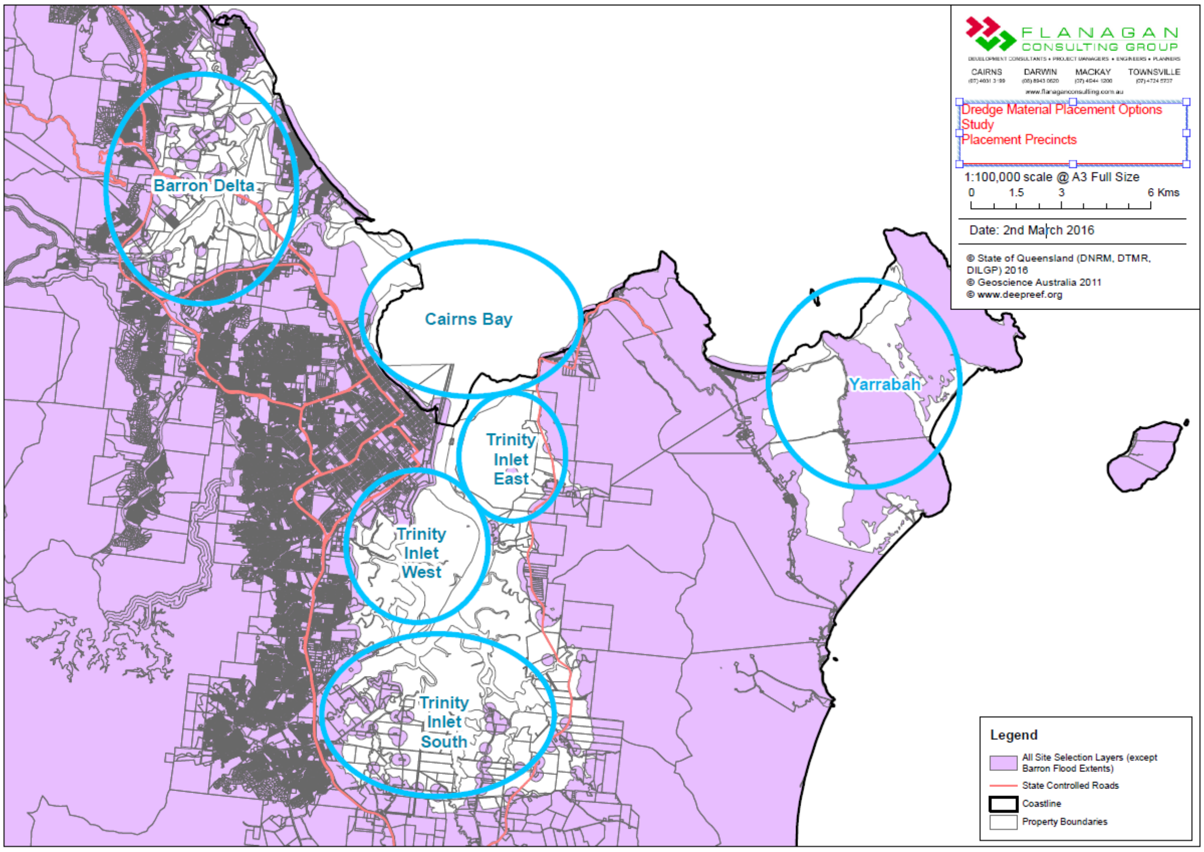


Figure A2-6 Placement Precincts.

This shows there are five available Placement Precincts, namely:

- **Barron Delta.** The Barron Delta Placement Precinct is highly constrained by Barron River flooding and potentially acceptable placement options are restricted to existing voids, existing bunded areas already compliant with the flood code, and new voids.
- **Cairns Bay.** The Cairns Bay Placement Precinct covers the protected waters adjacent to the Cairns Esplanade between the Ellie Point in the north and Bessie Point in the south. It extends seaward to approximately low water. This area contains potentially acceptable sites for various types of sub-tidal reclamation.
- **Trinity Inlet East.** The Trinity Inlet East Placement Precinct contains land east of Trinity Inlet and bounded by Pine Creek Road. This area is locally known as East Trinity and provides opportunities for a number of possible terrestrial placement options on different types of land.
- **Trinity Inlet West.** The Trinity Inlet West Placement Precinct includes Admiralty Island and land adjacent to Smiths Creek south of the Portsmith industrial area. This provides opportunities for both terrestrial and reclamation options.
- **Trinity Inlet South.** The Trinity Inlet South Placement Precinct includes a suite of possible sites on cane land south of Trinity Inlet.
- **Yarrabah.** The Yarrabah Placement Precinct includes two possible sites on unoccupied land south at Yarrabah.

Within these Placement Precincts, locations for placement areas of various types were identified and this resulted in 14 nominal sites as shown on **Figure A2-7** consisting of:

- 2 existing voids on the Barron delta
- 2 existing bunded areas on the Barron delta
- 3 reclamation sites, two in Cairns Bay (beneficial reuse of bird habitat) and one in Trinity Inlet (beneficial reuse as a foundation for future additional reclamation for port use)
- 7 terrestrial sites east, west and south of Trinity Inlet and at Yarrabah.

Some of the above sites are typical of a suite of potential sites. In particular:

- although the two voids in the Barron Delta Placement Precinct are existing, it may be feasible to construct new voids that would be similar in performance
- the three Trinity Inlet East sites (Sites 10, 11, 12) are three examples of many possible sites that could be located at East Trinity
- the cane farm site (Site 13) is one of many placement sites that could be located on cane land south of Trinity Inlet at the limit of practical pumping.

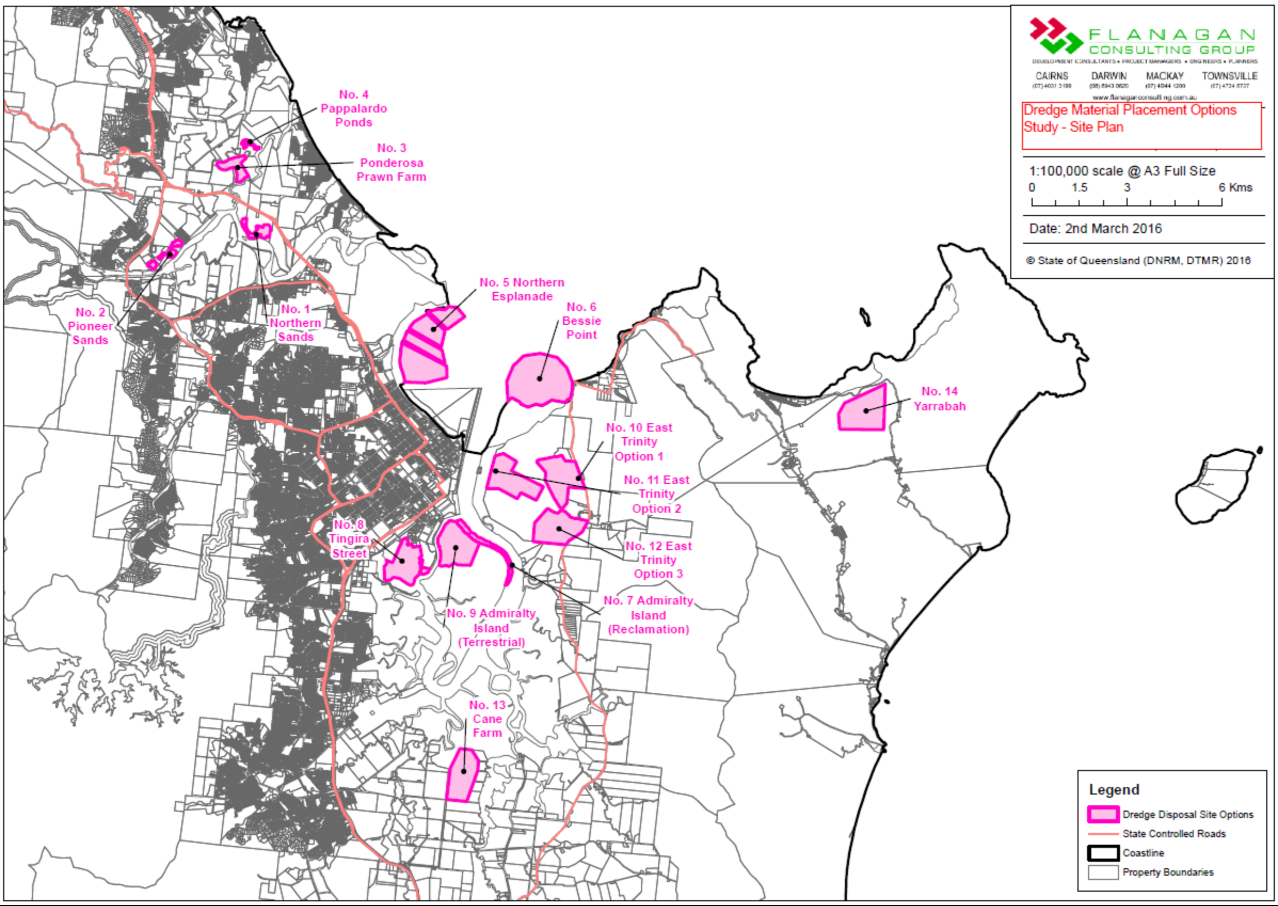


Figure A2-7 Placement Sites.

Concept designs were undertaken for the purposes of identifying available placement volume, required treatment and tailwater handling areas (where required), spoil delivery and tailwater discharge infrastructure (where required) and footprint for the purposes of measuring impacts (e.g. clearing) for scoring in the site evaluation (SE) process.

Placement volume was not included as a site selection attribute and was measured separately. While the SC process sought to create projects on sites with the target placement volume of 1.9 M m^3, this was not always possible.

There are four different situations for placement capacity:

- Void – the volumes of existing voids are already determined. While these voids could be enlarged, this has not been considered at this time. The two voids (Site 1 Northern Sands and Site 2 Pioneer Sands) have volumes between 50% and 75% of the bulked up capacity. In the case of establishing a new void, this would be constructed such that it provided 100% of the capacity.
- Reclamation – sites were designed to accommodate disposal of the target volume. The three reclamation sites have volumes between 52% and 100% of the bulked up capacity. The Northern Esplanade (Site 5) and Bessie Point (Site 6) sites can be constructed to provide 100% of capacity whereas the Admiralty Island reclamation (Site 7) is constrained by the presence of the adjacent waterway.
- Terrestrial: New sites were designed to accommodate the target volume by storage of dredged material, management of tailwater, and treatment of dredged material where required. The six terrestrial sites have volumes between 53% and 100% of the bulked up capacity. Site 8 (Tingira Street) may be able to be enlarged to reach 100% and in any case may be suitable if used in combination with other sites or if placement is in stages that allow some consolidation of the initial placement before the subsequent material is added.
- Terrestrial: The volumes of existing bunded areas on the Barron delta (Site 3 – Ponderosa Prawn Farm and Site 4 – Pappalardo Ponds) are already determined. The two sites have volumes between 10% and 13% of the bulked up capacity.

All sites were evaluated using the SE process. This involved the 'triple bottom line + performance' hierarchy as used in the SS process, but with an expanded suite of attributes:

- Cost
  - C1 – Cost
- Environmental
  - E1 – Surface Water
  - E2 – Groundwater
  - E3 – Biodiversity Values
  - E4 – Acid Sulfate Soil
  - E5 – Birdstrike
  - E6 – Coastal Hazards
- Performance
  - P1 – Pumping Head
  - P2 – Placement Capacity
  - P3 – Tailwater Discharge
  - P4 – Ground Conditions & Stability
- Social
  - S1 – Remoteness from Incompatible Land Use [deleted]
  - S2 – Important Agricultural Areas
  - S3 – Traffic
  - S4 – Appropriate tenure (ownership).

Sites were scored for each attribute and raw scores were standardised to a scale of 0 to 1, where 1 represented the 'best' site (this includes cases where a high score is warranted directly by the scoring in the case of a 'benefit' attribute or where a 'cost' attribute did not apply to a site). The results were discussed on an attribute-by-attribute basis.

Standardised scores were accumulated on a number of levels to test sensitivity:

- overall (unweighted)
- by non-cost criteria (e.g. *Environment*, *Performance*, *Social*)
- overall (criteria weighted based on a suite of technical and non-technical profiles).

Because many of the 14 sites were nominal projects selected within the various Placement Precincts, the Suitability Assessment considered performance on a Placement Precinct basis considering the planning constraints, costs and other considerations including strengths, weaknesses and any serious deficiencies and made recommendations as to which of these should proceed to the EIS.

The Dredge Placement Options study drew the following conclusions.

The site selection process identified six placement precincts with fourteen individual sites identified within these precincts.

The fourteen identified sites were evaluated using Multi-Criteria Analysis techniques. Ignoring cost, existing legislative and planning constraints and without weighting the evaluation determined that:

- Voids – the void sites on Northern Sands (Site 1) and Pioneer Sands (Site 2) scored well on most attributes with the main weaknesses being pumping head and the fact that they are in private ownership. Northern Sands does not quite have enough capacity (75% of target) to score well in this regard and, similarly, Pioneer Sands has only 50% capacity. A new void would be constructed to deliver 100% of the capacity.
- Reclamation – As reclamation sites in seawater, Northern Esplanade (Site 5), Bessie Point (Site 6), and Admiralty Island Reclamation (Site 7) scored well on tailwater and ground-related issues and, due to close proximity to the channel, have minimal pumping head. They score poorly on several environmental attributes and coastal hazards. It was assumed that Site 7 cannot achieve the target placement capacity (52%) due to waterway restrictions.
- Terrestrial – The Admiralty Island (Site 9) scored well on most attributes but poorly on biodiversity, acid sulfate soil and ground conditions. It is well-located with respect to pumping head and traffic and is under state control. The best East Trinity site (Site 11) scored similarly to Site 9 but, whilst being able to provide the required capacity and having favourable biodiversity and pumping head scores, its attractiveness is diminished by acid sulfate soil, ground stability, traffic, and to a lesser degree, coastal hazards.

Separate analyses (sensitivity testing) were undertaken with the result that the top ranking sites remained the top level sites after the sensitivity testing although the order changes depending on weighting.

Weighting of attributes based on technical and non-technical sensitivity profiles changed the outcome slightly but not significantly. Overall, the sensitivity testing demonstrates that the SE process is relatively robust and reveals many learnings that can be applied to the final site selection based on overall suitability. The site with the most volatility in performance was Tingira Street (Site 8) which dropped six positions from the *Technical* profile to the *Cost* profile and five for *Environment.*

he overall suitability of the placement precincts was assessed by considering beneficial reuse, and site feasibility and suitability. This process considered the planning constraints, costs and other considerations including strengths, weaknesses, and any serious deficiencies.

The suitability assessment determined that:

- Barron River delta voids score well due to their relatively low infrastructure costs (they require simply delivering and placing material in existing holes) and are attractive in that they are not subject to Barron River flooding, are remote from storm surge and tsunami effects, and do not have existing land uses that would be deleteriously affected by placement (the ‘lakes’ would remain and just be shallower). Management of groundwater and tailwater would be required.

- The nominal reclamation options considered have excellent performance due to proximity to the channel (i.e. minimal pumping head) but suffer from surface water and biodiversity impacts and coastal hazards. Beneficial reuse is a challenge in the case of the Northern Esplanade and Bessie Point sites (Sites 5 and 6) where net gain in habitat value would be difficult to achieve. Site 7 (Admiralty Island Reclamation) suffers from capacity limitations and lack of a demonstrated need for the reclaimed land.
- The nominal terrestrial options offer opportunities in terms of placement volume but all require treatment of placed material and tailwater. Environmental performance varies depending on the site in question but in all cases land placement will replace existing values of some sort (biodiversity or agricultural) and possibly involve management of in-situ soils and groundwater.

The suitability assessment determined that the following precincts warranted further investigation:

- **Barron Delta Placement Precinct**: Site 1 possibly expanded and or in conjunction with Site 2 or a new void.
- **Trinity East Placement Precinct**: a site to be determined based on impact avoidance and minimisation and the opportunities and constraints considered in Sites 10, 11 and 12.

Beneficial reuse of terrestrial bunded sites is problematic in that it involves:

- production of sites that could take 30 years to be able to be developed without surcharge or the use of piled structures
- a land mass of perhaps 60 ha that would have little in the way of commercial yield to offset development cost
- a revenue stream that is so far into the future as to be almost insignificant in terms of net present value
- land that is not in a location supported by regional planning.

The separate analysis of cost reveals that:

- Voids can be filled at a unit rate of around \$91-\$96 / m^3 (solid measure).
- The corresponding figure for terrestrial sites varies widely between \$109 and nearly \$130 / m^3.
- Based on a total volume of 860 000 m^3 to be dredged the total cost for dredging, placement and treatment is estimated to be
- Barron Delta Placement precinct: \$80 - \$86 Million
- Trinity Inlet East Placement Precinct: \$90 - \$100 Million

When the cost of landside infrastructure, other project costs including design and project management and an allowance for ongoing monitoring and offsets are added to the dredging costs, the preliminary estimate of overall project costs for the purposes of comparing the alternatives were estimated to be:

- Barron Delta Placement precinct \$100 - \$110 Million
- Trinity Inlet East Placement Precinct: \$110 - \$120 Million

The analysis revealed several opportunities associated with voids, including expansion of voids, construction of new voids, staging, and the export of treated material to ‘free-up’ terrestrial bunded sites for reuse may be feasible but this requires:

- investigations into underlying geology / soils
- market research to identify potential buyers of this material
- concept design and impact assessment.

A terrestrial site could have spare capacity once tailwater has been discharged and consolidation is achieved. This may be able to be exploited such that the site could be used for future placement. However, any new placement would have tailwater that also needs treatment (unless material removed by backhoe is to be considered) but perhaps the opportunity exists for a small volume to be placed in a second or subsequent stage.

It is possible that, following treatment, the material within terrestrial bunded areas could have some use as a low grade fill. Even if the cost-recovery value is small, the fact is that the export of treated material will allow the bunded area to be reused for further placement should staging considerations allow. This may be cheaper than creating new sites.

Following consideration of the channel design and dredge material characteristics and volume required to achieve the desired channel profile and the conduct of a rigorous consideration of options for dredge material placement and feasible locations, the Options Study made the following recommendations:

- Early investigations are undertaken to confirm geotechnical properties of the dredge material including bulking factor, the proportion of ASS / PASS material, and the proportion of clay.
- Placement Precincts that should be further considered in the revised draft EIS are:
  - **Barron Delta Placement Precinct** based on utilising either Northern Sands (Site 1) (with further expansion or possibly in conjunction with Pioneer Sands (Site 2)) separately or possibly in conjunction with a new void in the Barron Delta Placement Precinct. The actual placement volume should be confirmed by survey.
  - **Trinity Inlet East Placement Precinct** using the best features of the East Trinity Sites 10, 11, and 12. This will require a planning exercise be undertaken during the early stages of the EIS to create the 'best' East Trinity site, based on a detailed understanding of opportunities and constraints of the precinct.

A2.5.5 Dredge Material Characterization

A2.5.5.a Initial Assessment

Ports North commissioned Golder Associates Pty Ltd (Golder) to provide geotechnical advice related to the assessment of geotechnical properties of the dredge material including:

- Assessment of subsurface conditions likely to be encountered in the proposed dredging;
- Assessment of the geotechnical properties of the dredged materials;
- Assessment of the ASS properties of the dredged materials.
- Preparation of a 3D model of ground conditions relevant to the proposed dredging.

The Golders Dredge Material Properties Report is attached in **Appendix J**

Volume Assessment

To establish the volume of material; to be dredged an interpreted 3-dimensional (3D) triangulated surface model of ground conditions was developed using the VulcanTM geological modelling software.

Volumetric calculations within Vulcan are based on a comparison of the relative vertical positions of two triangulated surfaces, within the area of overlap between the two surfaces. The total volume of capital dredge material has been taken as the volume between maintenance dredge level and capital dredge level.

Calculated volumes of dredge materials are as follows:

- total volume of capital dredge material – 824 242 m^3
- volume of 'soft' clays in capital dredge volume – 697 346 m^3
- volume of 'stiff' clays in capital dredge volume – 126 896 m^3

Previous investigations have indicated that in general terms the dredged materials will mainly comprise very soft to firm silty clays, with a relatively small quantity of stiff to hard clays and an even smaller quantity of sands. Golder had previously indicated that the very soft to firm clays include a quantity of transported sediment materials as well as insitu marine clays.

The inferred presence of the transported sediment materials had been based on the following:

- a layer of silty material was noted above the soft to firm silty clays in most of the 2012 test pits by Golder
- although the results of laboratory classification testing indicate that these materials were clays their properties were different from the underlying soft to firm silty clays
- these test pits were located within the existing channel.

The results of recent investigations confirm the above (at least in some aspects) and also provide additional information to support the above, namely:

- the insitu bulk densities of materials inferred to be sediments (i.e. those from 'deepening' investigation locations) are generally significantly lower than other very soft to soft materials (i.e. those from 'widening' investigation locations
- the insitu shear strengths of materials inferred to be sediments (i.e. those from 'deepening' investigation locations) are generally significantly lower than other very soft to soft materials (i.e. those from 'widening' investigation locations).

Based on the above the following general material types have been adopted for the purposes of reporting:

- very soft to soft transported materials – 'sediments'
- very soft to soft insitu materials – 'mud'
- stiff to hard insitu materials – 'stiff clays'.

In addition to these general materials indications are that relatively isolated layers or zones of sandy and/or gravelly materials are also likely to be present.

The location and/or extent of each of the mud and sediments has not been quantified, however based on the information available the properties of these materials and other dredge materials are as follows:

- The sediments appear to be mainly confined to the existing dredged channel and are inferred to generally range in thickness from 0.2 – 1 m. The sediments comprise predominantly silt and clay size material. Available information indicates insitu dry densities around 0.7 t/m^3 (range 0.43 to 1.12 t/m^3).
- The mud generally underlies the sediment in the existing dredged channel and is expected to be present in most areas where channel widening is proposed, particularly CH 17000 to 20000. The mud comprises predominantly silt and clay size material. Available information indicates insitu dry densities around 0.9 t/m^3 (range 0.55 to 1.24 t/m^3).
- The stiff clays generally underlie the mud in the existing dredged channel and in areas where channel widening is proposed. Stiff clays are expected to be encountered within the channel widening and deepening from CH 13500 to 15000. Available information indicates insitu dry densities around 1.6 t/m3 (range 1.42 to 1.72 t/m^3).
- Sands were encountered at number of inner harbour investigation locations – namely GS1, GS3, GS4, GS5, GS21, and GS10 at CH 17500 to depths ranging from 0.2 to 0.75 m. This unit is typically underlain by very soft to soft silt/ clay at depth. Shell contents are inferred to range from about 20 to 40 % of the total mass based on visual observations.

ASS Assessment

Interpretation of the results of current and previous sampling and testing is summarised below:

- Sediment and mud materials have potential acidity (chromium reducible sulfur) levels which would classify these materials as PASS. The total volume of these materials was calculated as 697 346 m^3.
- The majority of these PASS materials have sufficient neutralising capacity to classify them as self-neutralising PASS. The volume of these materials was calculated as 467 633 m^3.

- Locations where PASS materials (without sufficient neutralising capacity) have been identified and The volume of these materials was calculated as 229 713 m^3 made up as follows:
  - Main Swing Basin – 33,379 m3 with an indicative treatment rate of 85 kg lime/m^3
  - Crystal Swing Basin – 1,463 m3 with an indicative treatment rate of 40 kg lime/m^3
  - CH14750-CH15250 - 19,943 m3 with an indicative treatment rate of 85 kg lime/m^3
  - CH15250-CH16250 - 105,699 m3 with an indicative treatment rate of 30 kg lime/m^3
  - CH17500-CH18000 - 69,229 m3 with an indicative treatment rate of 70 kg lime/m^3
  - PASS was also detected at isolated investigation locations beyond CH19 250 but at depths of 2m to 3 m below the base of the channel. These results have not been considered further.
  - stiff clays have been confirmed as non-ASS.

A2.5.5.b Revised Channel design

Golder was subsequently commissioned to re-assess the materials likely to be encountered during dredging based on a revised channel design information provided by Ports North with the aim of reducing the volume of higher cost and risk stiff clay dredging. The revised channel removed previously designed toe trenches, which were designed for additional insurance against siltation adjacent shallow banks in segments of higher historical annual depth loss. In most cases these extended the dredge depth into the stiff clay layer. The reduction in stiff clay design dredge volume was also pursued to enable two potential land placement sites to be more viable in terms of their capacity constraints.

Revised Volume Assessment

Based on the revised model the re-calculated volumes of materials to be dredged are summarised below.

TABLE A2-6 VOLUMES OF MATERIALS TO BE DREDGED

MATERIAL TYPE	VOLUME (m3)
Soft clays	698,755
Stiff clays	92,309
Total	791,064

The distribution of materials within the capital dredging was also calculated by chainage and is summarised below.

TABLE A2-7 DISTRIBUTION OF MATERIALS TO BE DREDGED BY CHAINAGE

CHAINAGE	VOLUME OF SOFT CLAYS (m^3)	VOLUME OF STIFF CLAYS (m^3)	TOTAL VOLUME (m^3)
11000-11500	42,558	2783	45,340
11500-12000	356	0	356
12000-12500	880	2316	3196
12500-13000	21,346	2160	23,506
13000-13500	13,812	579	14,391
13500-14000	3337	1923	5260
14000-14500	6419	9541	15,960
14500-15000	12,923	30687	43,610
15000-15500	31,136	1280	32,416
15500-16000	44,424	15965	60,390
16000-16500	47,187	2997	50,184

CHAINAGE	VOLUME OF SOFT CLAYS (m^3)	VOLUME OF STIFF CLAYS (m^3)	TOTAL VOLUME (m^3)
16500-17000	34,641	380	35,021
17000-17500	43,571	6213	49,784
17500-18000	57,749	12499	70,248
18000-18500	89,979	2382	92,361
18500-19000	77,999	43	78,041
19000-19500	71,070	485	71,555
19500-20000	34,862	1	34,863
20000-20500	16,182	16	16,198
20500-21000	18,504	57	18,562
21000-21500	10,539	2	10,541
21500-22000	8018	0	8018
22000-22500	4516	0	4516
22500-23000	1192	0	1192
23000-23500	1478	0	1478
23500-24000	3007	0	3007
24000-24500	1071	0	1071
Totals	**698,755**	**92,309**	**791,064**

Acid Sulfate Soils (ASS)

The soft clays have potential acidity (chromium reducible sulfur) levels which would classify them as PASS. The total volume of these materials has been re-calculated as 698 755 m^3.

Most of the PASS materials have sufficient neutralising capacity to classify them as self-neutralising PASS (SNP). The volume of these SNP materials has been re-calculated as 450,863 m^3.

The locations where PASS materials (without sufficient neutralising capacity) have been identified and the volume of these materials has been re-calculated as 247,892 m^3 made up as follows:

- Main Swing Basin – 42 914 m^3
- Crystal Swing Basin – 8456 m^3
- CH14750-CH15250 – 31 136 m^3
- CH15250-CH16250 – 91 611 m^3
- CH17500-CH18000 – 73 775 m^3.

PASS was also detected at isolated investigation locations beyond CH19250 but at depths of 2 m to 3 m below the base of the channel. These results have not been considered further as these materials will not be disturbed by the proposed capital dredging. The stiff clays have been confirmed as non-ASS.

Stiff Clays

The locations where more significant volumes of stiff clays are likely to be encountered in the capital dredging are summarised below:

- CH14000-CH14500 – 9541 m^3
- CH14500-CH15000 – 30 687 m^3
- CH15500-CH16000 – 15 965 m^3
- CH17000-CH17500 – 6213 m^3
- CH17500-CH18000 – 12 499 m^3

The volume of stiff clays encountered during capital dredging in the outer channel beyond CH18500 is likely to be ~600 m^3.

Sands

Sands were encountered at a number of inner harbour investigation locations. The sands have not been assessed. It is noted that shell contents within the sands were inferred to range from about 20 to 40 % of the total mass based on visual observations.

A2.6 Assessment of Placement Precincts

A2.6.1 Introduction

As noted in the Options Study (FCG 2016) (refer **Appendix I**), the precincts subject to the site selection and suitability assessments were *nominal* sites, i.e. typical of the precinct. This section describes the process by which specific sites within the preferred precincts were identified, compared, followed by development of concept designs for the preferred site for the purposes of impact assessment.

The process involved the following steps for each of the Placement Precincts (Trinity East and Barron Delta):

- review of findings of the Options Study
- review of site history
- initial gap assessment of potential sites prior to commencement of the Values Assessment stage of the EIS process (needed to define scope of the studies)
- identification of values, threats (Values Assessment) and associated opportunities and constraints for consideration in the preliminary design refinement exercise

A2.6.2 Barron Delta DMPA Option Development

A2.6.2.a Precinct and Site Overview

The Options Study found that the Barron Delta Placement Precinct is constrained by Barron River flooding and sites evaluated consisted of:

- existing voids (Site 1 – Northern Sands and Site 2 – Pioneer North Queensland)
- existing bunded areas already compliant with the Barron Delta Flood Code (Site 3 – Ponderosa Prawn Farm and Site 4 – Pappalardo Farm ponds).

Other voids could possibly be developed, subject to further feasibility and environmental assessments. Of these sites, Site 1 was selected for assessment in the Revised Draft EIS due to its existing capacity being able to accept a substantial proportion of the dredged volume, the ability of the void to be expanded as part f ongoing sand extraction and the sites reduced pumping distance compared to Site 2

The initial concept design for the Northern Sands site is shown on **Figure A2-8** below. Initial options for the dredge material delivery pipelines to Sites 1 and 2 and are shown on **Figure A2-9**.

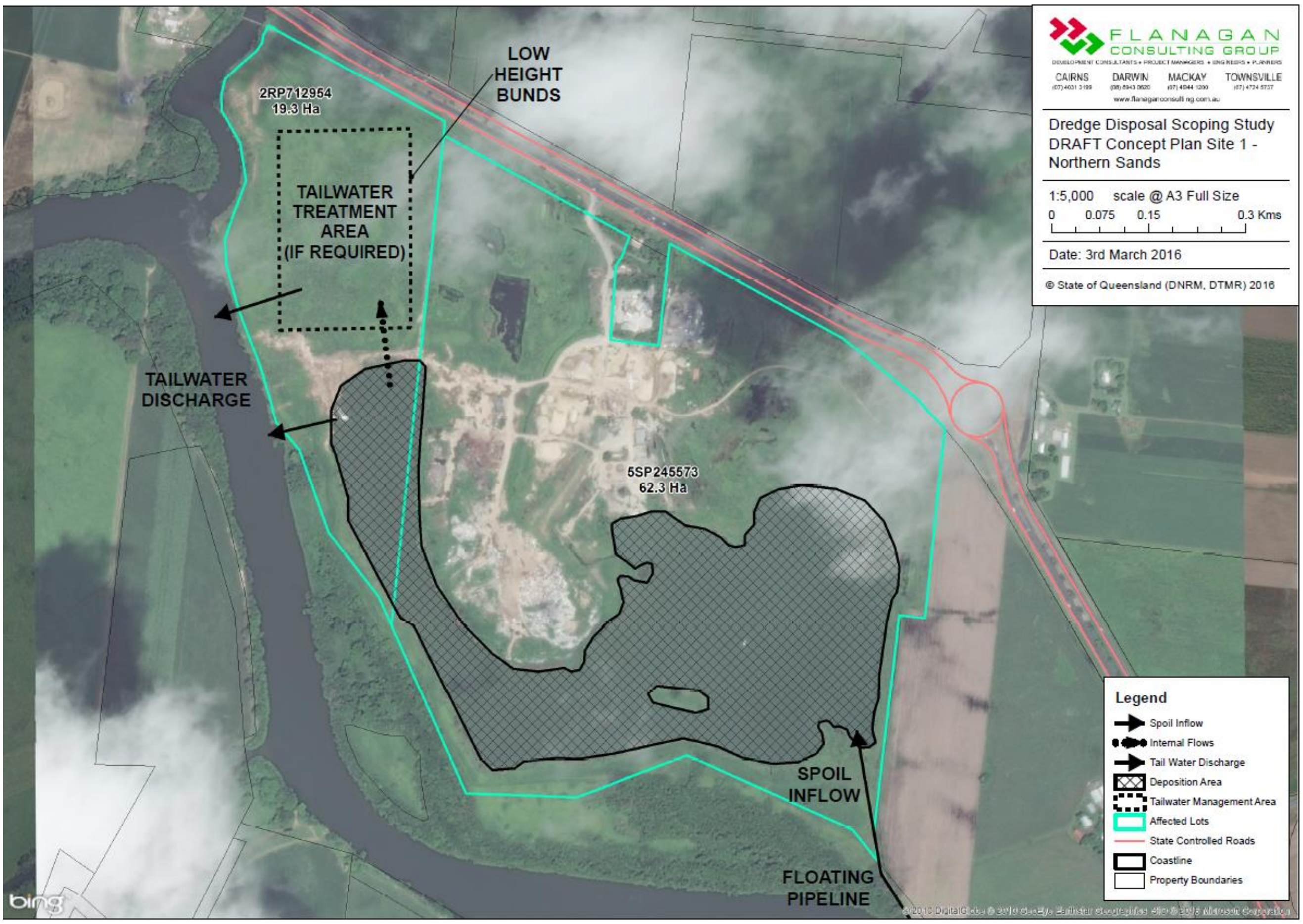


Figure A2-8 Preliminary Concept design of Barron Delta Precinct from Options Study.

Source: Appendix I Appendix C.

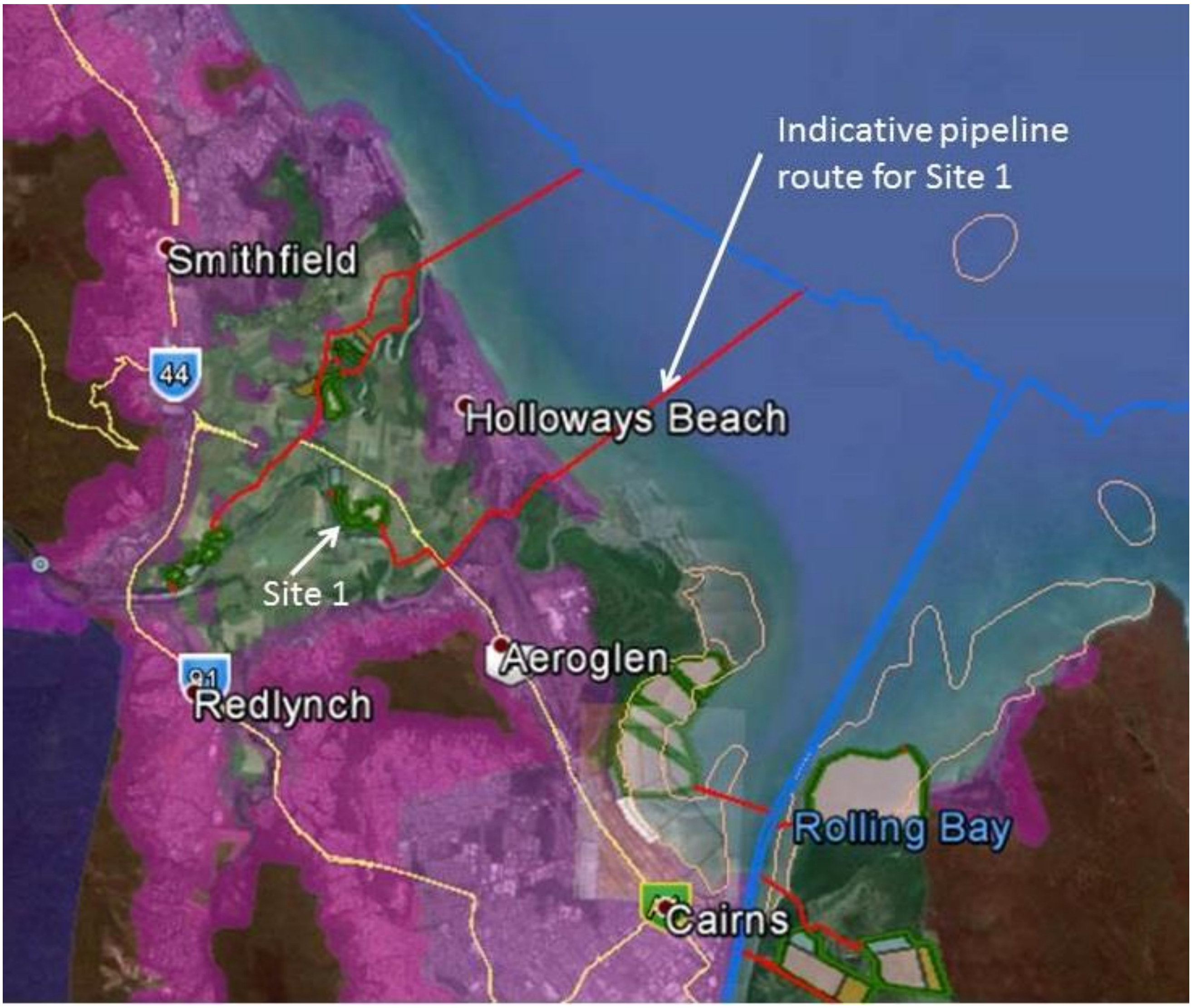


Figure A2-9 Concept design of Barron Sands Precinct delivery pipeline from Options Study.

Source: Appendix I (figure not published).

The Options Study made the following assessment:

- As a Barron delta void, Site 1 scored well to very well for most attributes except for pumping head, as it is remote from the channel. As it lies a substantial distance upstream from the coast, tailwater management will require attention (probably by timing releases to coincide with higher salinity in the receiving waters or when higher dilution is available).
- No beneficial reuse was contemplated, and once the available void has been filled, the site would be left as-is. All placed material will be below the water table and no treatment is required. For all intents and purposes, the site will continue to be a freshwater lake, albeit somewhat shallower than at present. This will have some biodiversity values for birds in particular. It is of note that this site is currently mapped as a lacustrine wetland under Queensland Government mapping. The site could have the potential to be used for open space or outdoor recreational pursuits when placement is complete.
- Based on assumed dimensions, the volume of Site 1 is about 75% of the target. It is possible that this has been underestimated and a survey early in the EIS would confirm the actual placement capacity and perhaps remove this deficiency. Further, the assumed bulking factor of 2.2 may also be conservative and it is assumed that placement will take place in one episode. Once the tailwater is discharged and some settlement takes place, the void will develop 'additional capacity' for future placement.

It was recommended that this site be retained for further consideration, and that the EIS investigate:

- actual placement volume
- opportunities to expand the existing void
- effects of reduced bulking factor and placement regime
- possibility of using Site 1 in conjunction with Site 2 (i.e. another Barron delta void, Pioneer Sands).

A2.6.2.b History of Site

The site has been operating as an approved sand quarry since the early 1990s; prior to this the site was used for sugarcane production. Boral Resources (Qld) Pty Ltd successfully applied to the then Mulgrave Shire council for a town planning consent permit for an extractive industry and extractive industry permit in May 1989 and a Concrete Batching Plant was later approved by appeal through a rezoning to 'Special Facilities (Concrete Batching Plant) Zone. Total resource estimates at the time were substantial, in the order of 900,000 tonnes and given its close proximity to Cairns the importance of site resources was recognised through its designation as a Key Resource Area in 2007, under State Planning Policy 2/07 Protection of Extractive Resources. Depth of extraction was generally between 5m and 6 m below the prevailing water levels of the pond using a cutter suction dredge. Further resource investigations and site exploration identified deeper deposits in the southern section of the void below a 3m-6m thick layer of clay and extraction depth in this area was advanced to the current maximum depth of 15m below water level. Current site layout is shown on **Figure A2-10**.

Figure A2-10 Current Northern Sands site layout (2017).

A key approval condition was the maintenance of a buffer strip of 40 m (minimum) between the high bank of the Barron River and the operations. More recent resource investigations by Northern Sands has identified an additional sand resource in the southern and northern parts of the void below the clay layer (1 400 000 m^3) to a depth of 25 m.

In 2004 the Cairns City Council approved a Material Change of Use application for the site (Lot 5/RP906407) for Hazardous and/or Offensive Industry (Disposal of Construction and Demolition Material, Manufacture of Soil Conditioning Material) and Bulk Landscaping Supplies.

This approval allows the disposal of inert construction and demolition waste in the void, including up to 5000 m^3/annum of Potential Acid Sulfate Soil; recent recycling operations has significantly restricted the volume of material being placed in the void to the point that operational life of the waste disposal operation is greater than 30 years.

More recent resource investigations by Northern Sands in 2016 has identified an extension of shallow sand resource adjacent to the current northern extent of the void, which will extend business as usual operations by at least 6 years, depending on market conditions. The extent of this resource is shown on **Figure A2-11**. Northern Sands lodged an application in late 2016 to amend the current Environmental Authority for Lot 5 to extract this resource.

Figure A2-11 Proposed 'Business as Usual' Northern Void Resource Expansion.

Source: GEO Investigate (2016).

A2.6.2.c Gap Analysis and Preliminary Design Concepts

One of the first tasks in producing this Revised Draft EIS was attention to the points above (essentially capacity and material bulking properties). Additional tasks included:

- review of available resource analysis of Barron delta sand deposits (to identify potential new voids or expansions of existing voids)
- estimation of in-situ and placed material volumes including bulking factor to estimate required DMPA capacity
- identify and review available information sources.

Key Site Parameters

The existing capacity of the void was determined by survey using a boat-mounted depth sounder with survey control. a Digital Terrain Model (DTM) was built from this data and the capacity determined for different depths of placement (refer **Figure A2-12**).

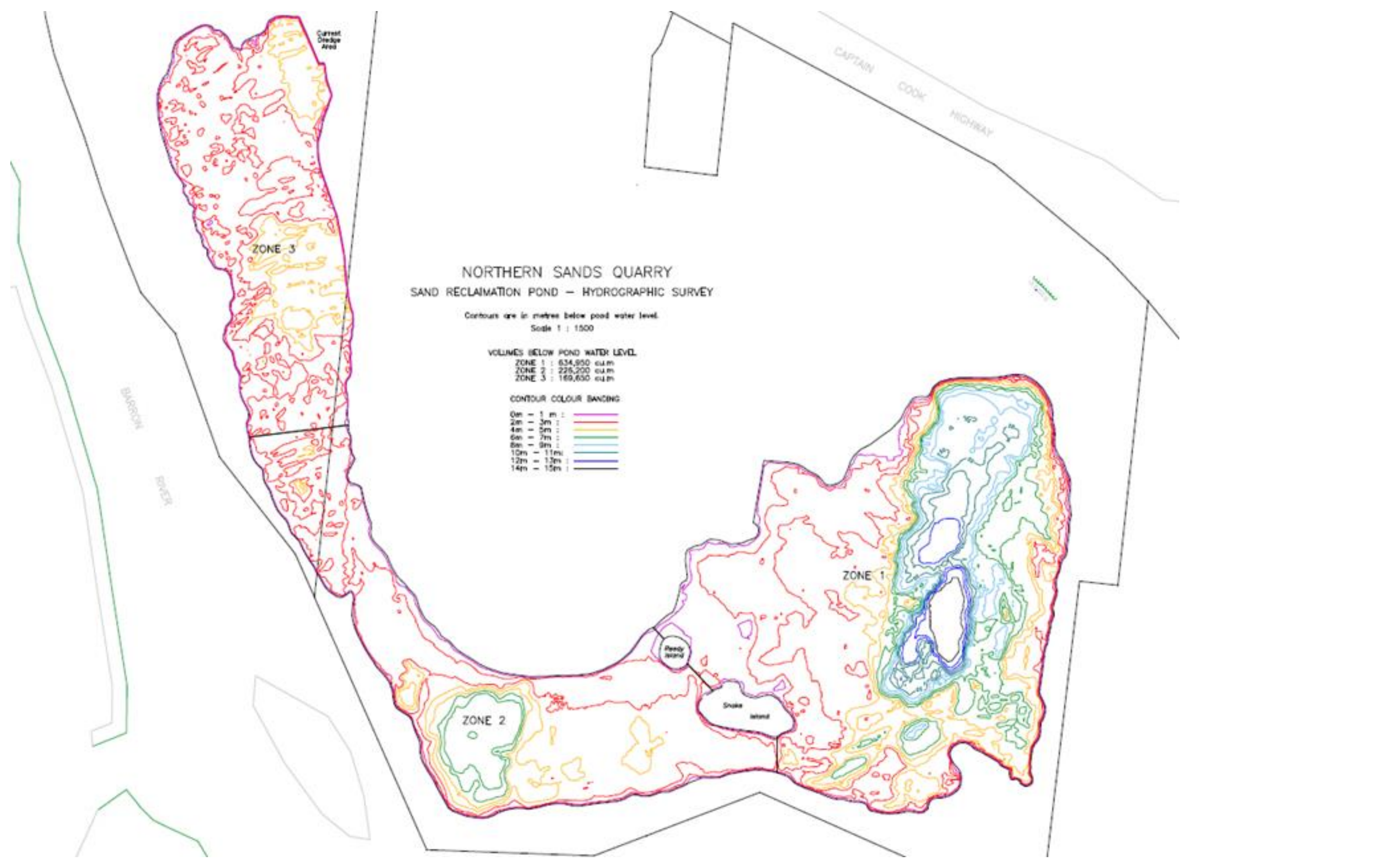


Figure A2-12 Northern Sands hydrographic survey.

Source: Ports North (2016).

Pipeline Route Selection

Further investigation of Barron Delta constraints and opportunities led to the early identification of pipeline route through Holloways Beach (**Figure A2-13**), which was later superseded by more northern route options in order to shorten the length of the marine section of the pipeline.

Figure A2-13 Initial Holloways Beach pipeline route option.

Literature Research and Desktop Analysis

In addition to review of the Draft EIS a range of online database searches and spatial dataset interrogations were performed (**Table A2-8**) prior to ground survey to inform the survey focus for the Northern Sands study area from an environmental perspective. To meet the desktop research requirements in the Guidelines for Flora Survey & Assessment (Wannan 2012), EPBC Protected Matters Search and Wildlife Online, searches were undertaken with a buffer of 10km (central co-ordinates: -16.8581, 145.722:). However due to the small size of the site and to obtain a more accurate determination of the species most likely to be found in the close vicinity of the site, a further set of searches were undertaken with a buffer of 1km. The same co-ordinates were used for this second set of searches.

TABLE A2-8 DATABASES/DATA SETS UTILISED FOR DESKTOP ASSESSMENT AT BARON DELTA PRECINCT

Database/set	Relevant Legislation / Purpose of Dataset Review
Queensland NCA Wildlife Online	Nature Conservation Act 1992 / Nature Conservation (Wildlife) Regulation 2006
EPBC Protected Matters Search Tool (PMST)	Environment Protection and Biodiversity Conservation Act 1999
Regional ecosystem and remnant map – Version 8.0 (RE)	Vegetation Management Act 1999
Matters of State Environmental Significance –Version 4.1 (MSES)	State Planning Policy / Sustainable Planning Act 2009
Protected plants flora survey trigger map - Version 4	Nature Conservation Act 1992
Regulated vegetation management map – Version 1.32	Vegetation Management Act 1999
Directory of Nationally Important Wetlands	Non-statutory
Queensland waterways for waterway barrier works	Fisheries Act 1994 and Sustainable Planning Act 2009
Queensland DCDB 2016 (Tenure)	Land Act 1994
Great Barrier Reef Coast State Marine Park Zoning Map	Queensland Marine Parks Act 2004
Wetland Protection Area wetlands and trigger zones	Environment Protection Regulation 2008
CairnsPlan 2016	Sustainable Planning Act 2009
Atlas of Groundwater Dependent Ecosystems (BOM)	Non-statutory Databases/

Key Material Properties

A summary of preliminary test results of the dredged material and other geotechnical aspects influencing early concept development indicated that:

- the soils consist of approximately 10% sand and approximately 90% silt
- small volumes of stiffer basal clays (approx. 150 000 m^3)
- some of the material has ASS / PASS properties that in most circumstances will require lime treatment
- delivery to land placement sites will involve large volumes of water that will need to be returned to the Cairns Inlet/ Trinity Bay
- feasible placement options include disposal into existing or new Barron Delta extractive industry voids below dry season water table, holding ponds for subsequent drying and lime treatment, as well as reuse as controlled or 'engineered' fill for land development.

Initial concept development works assumed a total of 860, 000 m^3 of insitu dredge material. In the absence of laboratory assessment, a bulking factor of 2.2 was assumed i.e. the solid measure volume will bulk to 1.9 M m^3 when tailwater is included and ideally, all sites should be able to accommodate this volume and handle the associated water. Once tailwater is discharged, the volume would reduce and so for sizing treatment areas, a bulking factor of 1.0 was assumed.

A2.6.2.d Values and Baseline Assessments

Overview

The following is a brief summary of precinct values and baseline conditions as they are relevant to design optimisation process. It applies to both the Barron Delta site itself and the delivery pipeline.

Several potential pipeline route options were proposed for further analysis as part of the values and preliminary impact assessments (refer **Figure A2-14**).

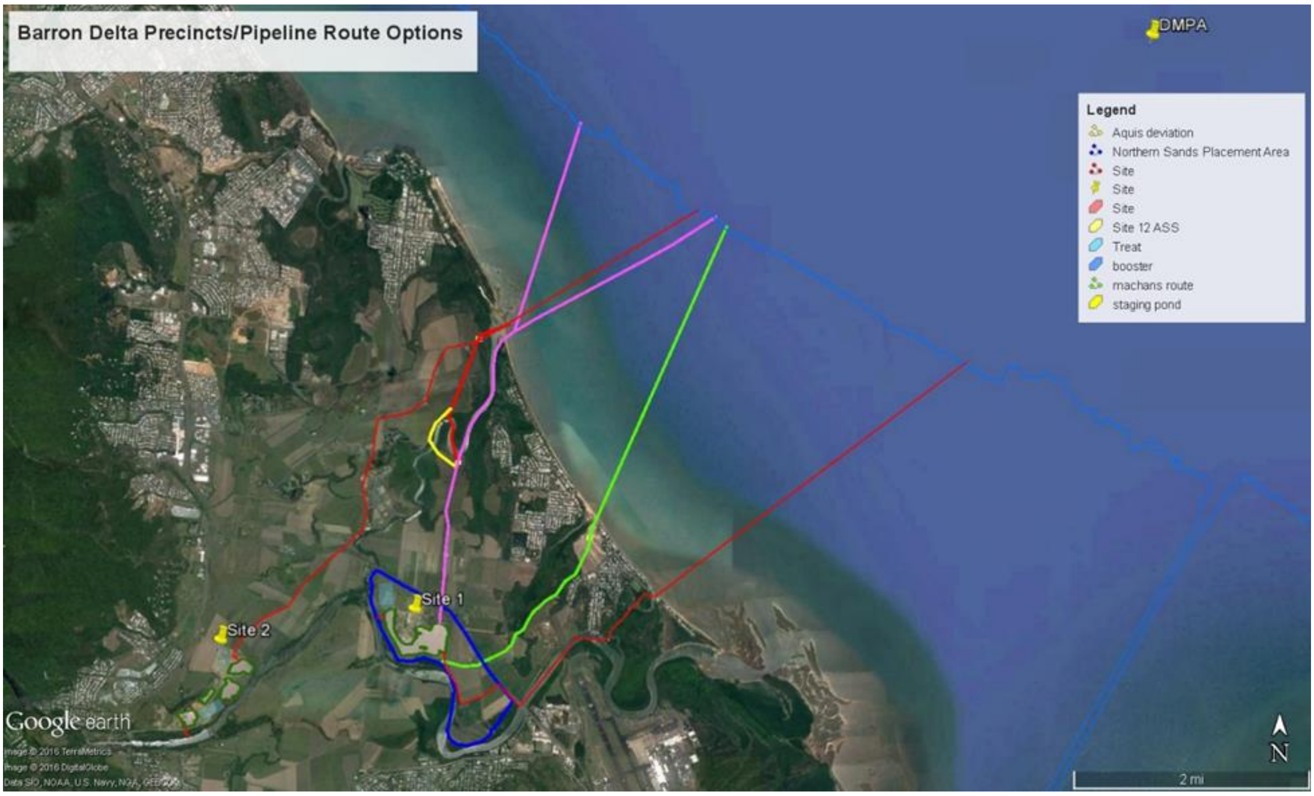


Figure A2-14 Preliminary dredge material delivery pipeline options.

Soils and Geology

Golder Associates investigation of the Soils and Geology (refer **Appendix K**) revealed that the Northern Sands site and potential delivery pipeline routes are located in an area dominated by Holocene aged alluvial deposits of sand, silt and mud sediments. Some of these sediments are ASS. Surrounding the pit, strongly acidic soil conditions (pH >4.0 to ≤5.0) are indicated from the surface (this does not indicate the presence of ASS). A PASS layer is generally indicated within 4 to 5m of the surface and within 1m to 2 m of the surface around the southern and eastern margins of the pit.

Ground surface levels across the Northern Sand site typically range from about 5.5 m to 2 m AHD. The existing sand pit has been excavated to levels typically in the range of -1.5m to -4.5m AHD across the majority of the pit and to levels in the range from -6.5 m to -14.5 m AHD in the southern and eastern portions of the pit.

Insitu ASS materials are unlikely to be disturbed by placement of dredged materials in the existing pit. Excavations to depths greater than 1m in the areas south and east of the sand pit and to depths of more than about 4 m to the north of the sand pit may disturb/encounter ASS materials. Excavations in ASS materials will need to be managed appropriately. Placement of PASS dredged materials in the pit, below the permanent water table and covered by self-neutralising dredged materials will negate the need for treatment of PASS dredged materials.

Construction of containment bunds and/or ponds/channels to manage tailwater quality will need to be carried out using clayey materials. Some of the near surface soils around the existing pit are expected to be generally clayey in nature, however they may not be suitable for construction of bunds or channels and liners may be required.

Potential delivery pipeline routes traverse across low lying areas at levels between 1 m and 2 m AHD near the shoreline, before rising to traverse across cane fields with surface levels at about 4m AHD to the north of the Captain Cook Highway. If no significant excavations are carried out along the pipeline route, ASS materials are unlikely to be disturbed. Confirmation sampling would be required to confirm ASS conditions at staging ponds or excavations proposed near Richters Creek or Barr Creek.

Some areas along the proposed alignments of the delivery pipeline comprise soft clays at or near the surface. The presence of these soils may make access difficult for heavy machinery if required.

Hydrogeology

Golder Associates groundwater investigations (refer **Appendix L)** identified that the Northern Sands site is located on the alluvial fan and delta of the Barron River. Unconsolidated sediments reach thicknesses of up to around 90 m, in the area to the immediate north-east of the site.

There are two major aquifers in the Barron River delta within the unconsolidated sediments (QLD Water Resources Commission, 1982):

- An upper, unconfined aquifer varying in thickness from about 2 m to 11 m, which is overlain by up to 5 m of beach ridge deposits or clayey strata.
- A lower, confined or semi-confined aquifer, separated from the upper aquifer by a clay layer of varying thickness from around 3 m to around 25 m. The lower aquifer includes numerous interfingering clay layers.

Measured groundwater levels at Northern Sands generally vary between -0.3 m AHD and 1.0 m AHD and long term average groundwater levels close to the river, and the lake level, are similar to the average river level.

Twenty-four registered bores are located within 2 km of the Northern Sands site as shown on **Figure A2-15**. Pumping tests carried out for the QLD Water Resources Commission 1982 study indicate transmissivities in the range of around 1500 to 6800 m2/day for the upper unconfined aquifer (corresponding to values of hydraulic conductivity in the range of $2x10^{-3}$ to $4x10^{-3}$ m/s), and around 550 to 3900 m^2/day for the lower confined aquifer.

The electrical conductivity in the lake between September 2011 and March 2016 varied between 200 uS/cm and 1000 uS/cm. It is noted that registered groundwater bores 11000049 and 11000033 to the immediate east of the lake have high recorded electrical conductivity ranging from 19000 uS/cm to 38000 uS/cm. The measured electrical conductivity at these two registered groundwater bores is higher than at all other registered groundwater bores within a 2 km radius and where water quality measurements are available.

The National Atlas of Groundwater Dependent Ecosystems indicates a high potential for groundwater interaction between the Northern Sands void and the Barron River along the western and southern boundaries of the lake. The reaches of Thomatis Creek and Barron River in the vicinity of the Northern Sands site are indicated to have moderate potential for groundwater interaction.

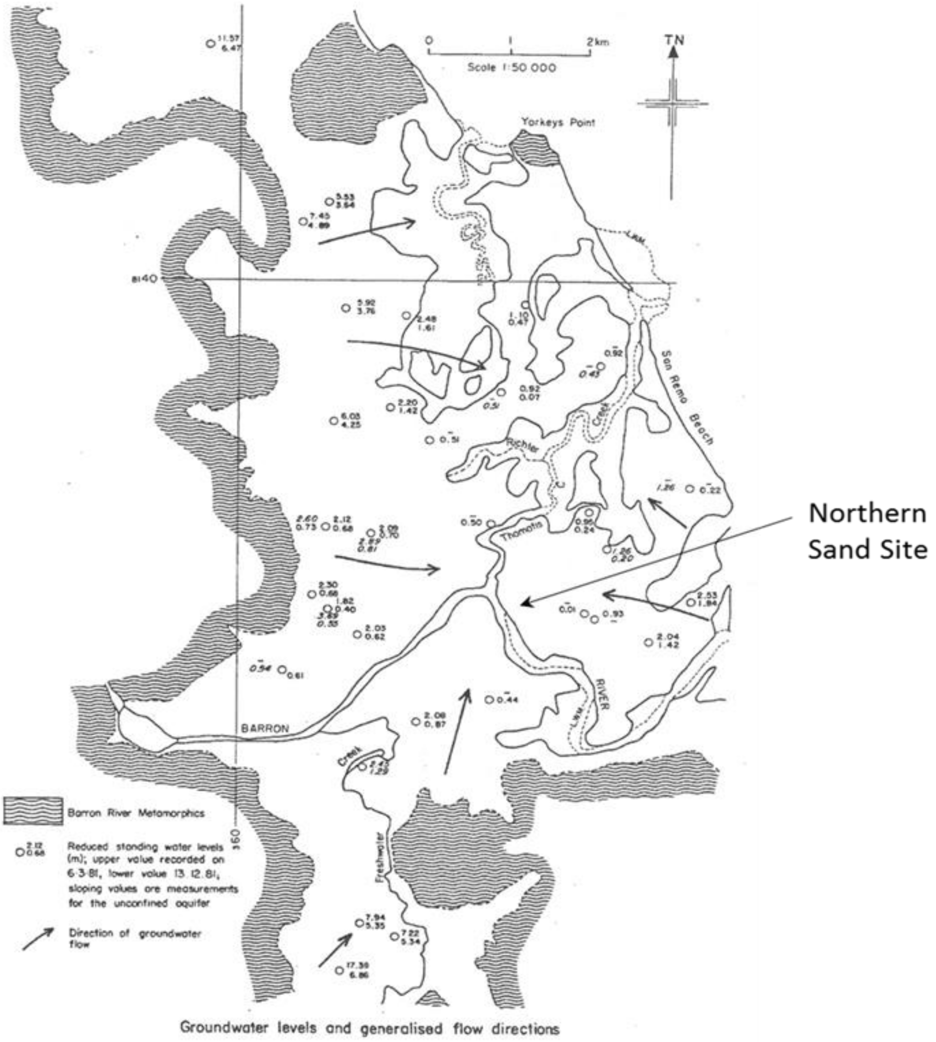


Figure A2-15 Groundwater flow across the Barron Delta.

Coastal Processes

The BMT- WBM Coastal Processes Report (refer **Appendix M**) shows that the Barron River adjacent to the Northern Sands site is a relatively poorly flushed salt-wedge estuary. Preliminary indications indicate that tailwater discharge within the Barron River has the potential to change the salinity and turbidity regime due to tailwater discharge rates being comparable to base fluvial flows and around a factor ten less than peak tidal flows. Discharge as far as practicable downstream from the site is preferred to maximise mixing.

The TUFOW FV hydrodynamic and receiving water quality model developed for the CSD Draft EIS was substantially upgraded in order to enable it to assess the impact of land based placement tailwater discharges on the receiving environments within the Barron River estuary. Tailwater discharge locations assessed during the values assessments are shown on **Figure A2-16**.

As Barron River coastal processes baseline monitoring was not complete at the time of the value assessments findings were considered preliminary; notwithstanding this, key findings are:

- Tailwater discharge into the upstream Barron River site (Location 5) results in a median tailwater concentration within the river of approximately 30%. Associated median salinity increases exceed 7 PSU. Median turbidity increases are predicted to exceed 12 NTU above background within the Barron River.

- Tailwater discharge into the middle Barron River site (Location 6) results in a median tailwater concentration within the river of approximately 25%. Associated median salinity increases exceed 5 PSU. Median turbidity increases are predicted to exceed 12 NTU above background within the River.
- Tailwater discharge (of 1.0 m^3/s) into the Barron River site at the highway bridge (Location 7) results in a median tailwater concentration within the river of approximately 8%. Associated median salinity increases are approximately 1 PSU. Median turbidity increases are predicted to exceed 5 NTU above background within the River.
- Significantly improved flushing of tailwater from the Barron River was achieved with the 1.0 m^3/s rate at the bridge location. This might be in part due to less reinforcing of the baroclinically driven salt wedge intrusion for the lower flow rate (i.e. it is quite possible that the flushing behaviour is non-linear with flow rate).
- The downstream Barron River site is preferred compared with the upstream site near the confluence with Thomatis Creek.

Flooding Stormwater and Hydrology

A qualitative and quantitative hydrological, hydraulic and preliminary water quality assessment of the proposed dredge material placement was undertaken by WBM BMT (2016) (refer **Appendix N**) to assist in determining the preferred facility location whilst ensuring no adverse off-site flooding and water quality impacts. Key findings are:

- Placement within the Northern Sands will require the dredge material to be located within a bunded area to prevent the loss of material and protect the material from being released during flooding.
- The Northern Sands site will require a temporary moving bund during construction to limit adverse off-site flood impacts, with optimisation of this bund level to be commensurate with the appropriate flood risk during a dry season dredge campaign. It should be appreciated that the flood bund has the potential to cause adverse off-site flood impacts should a flood occur during the dredge campaign (i.e. during the dry season); however these impacts are considered to manageable and temporary.
- A final dredge placement land form at a level of RL 3.5 m AHD (i.e. 0.5m below the 2 year ARI Barron River flood) could be achieved without causing adverse off-site flood impacts. Optimisation of the finished height by providing preferential flow paths within the site boundary could provide further opportunity to increase the fill volume if necessary.
- The bund will require a minimum freeboard in the order of 400 mm to contain direct rainfall based on a 10 year ARI 24 storm event. If environmental assessments indicate a sensitive environment to overflows, then additional freeboard would be required to be commensurate with the acceptable risk criteria.
- Direct rainfall within the northern sands placement area would be contained by the proposed Barron River temporary flood bund. Excess water from rainfall is expected to be treated in a similar manner to the dredge tailwater. A final landform, if above the groundwater table, would need to be appropriately treated (i.e. via capping and re-vegetating) and would be deemed necessary since the site has Barron River low flood immunity (i.e. <2 year ARI).

Marine Water Quality

As with coastal processes assessments, baseline water quality monitoring was conducted by BMT WBM (refer **Appendix O**). As these commenced at the outset of values assessment studies, the following findings are considered preliminary.

The existing water quality in the vicinity of Northern Sands can be characterised as follows:

- The water quality within the void is relatively fresh (historically 200 – 1000 µs/cm), pH is neutral and turbidity is between 20 and 70 NTU. Concentrations of metals/metalloids and hydrocarbons are low, however nutrients are elevated, in particular NOx (nitrite and nitrate).
- The salinity in the Barron River near the Northern Sands site (where tailwater would most likely be discharged) is dependent on tidal phase and freshwater runoff. Salinity levels are similar to marine water at certain times and relatively fresh at other times. Indications are that there is a salt water wedge in effect, with saline water near the bottom and freshwater runoff in surface layers.

Key findings of the preliminary constraints and opportunities assessment are:

- During the initial stages of dredge material placement, overflow of displaced void water with elevated nutrients may impact on Barron River. Also, the relatively fresh void water may be difficult to flocculate, resulting in discharge of more turbid tailwater.
- Once the initial void water has been displaced, discharge of more saline tailwater into Barron River may change the salinity regime, with saline water possibly mobilising upstream during flooding tides
- Tailwater should be discharged as far downstream towards the river mouth as practicable – this will decrease the risk of saline waters being mobilised upstream.

Figure A2-16 Preliminary Barron River Tailwater Discharge Locations.

Marine Ecology

As part of the values assessment BMT- WBM prepared a Marine Ecology Report (refer **Appendix P**) Key findings of baseline marine ecology assessments of the Barron River, dredge material delivery pipeline and pumpout facility locations are:

- Sites located in the downstream reaches of the Barron River generally had higher catches of fish and crabs than other sites, but species richness was highest at the major creek entrance at site BF2.
- Fish assemblages were comprised of marine and estuarine species, including sites in the upstream reaches of the Barron River. Most species would have adaptations that allow them to cope with temporary reductions in salinity, as occurs during rain events. No freshwater species that are intolerant of saline conditions were recorded.
- The structure of riparian vegetation communities in the lower reaches of the Barron River varied on different sections of meander bends. Red mangrove (Rhizophora) tended to dominate on the outside meander bends, whereas grey mangrove (Avicennia) and mangrove apple (Sonneratia alba) tended to dominate on the inside meanders.
- A change in riparian vegetation community structure occurred upstream of the Bruce Highway Bridge, with Melaleuca and Hibiscus becoming more prevalent amongst the mangroves. This change in community structure most likely reflects reduced tidal influence and greater freshwater input in these upstream reaches. No extensive areas of recent or historic dieback were observed.
- No seagrass was recorded along the dredger pump-out at Richters Creek or on transects at the northern beaches.
- Subtidal habitat mapping offshore from Richters Creek shows a sandy shoreline becoming muddy with shell grit with distance offshore.

Constraints and opportunities assessment identified in the Marine Ecology Report are:

- Tailwater discharges of saline water to the Barron River upstream of Bruce Highway Bridge could adversely impact on brackish water, salt sensitive riparian vegetation species (e.g. Melaleuca and Hibiscus). It is possible that vegetation stress and dieback could occur in the mixing zone, depending on the location, intensity, frequency and duration of tailwater discharges.
- Increased salinity in the central reaches of the Barron River (upstream of the Bruce Highway) may result in changes in fish communities, which could result in temporary changes to fauna community structure within the mixing zone of tailwater discharges.
- The area in the vicinity of the dredger pump-out, has naturally highly turbid waters and mobile sediments, and on this basis, it is considered unlikely that this area supports species and habitats that are highly sensitive to sediments (e.g. reef building corals). No seagrass has been recorded at this location, and habitat conditions (high water depths, high turbidity, mobile sediments) are considered for sub-optimal for meadow development.
- Tailwater should be discharged as far downstream towards the river mouth as practicable to minimise the potential for impacts to aquatic biodiversity values in upstream estuarine environments, noting the riparian assessment indicated a change to more freshwater species upstream of the Bruce Highway Bridge.
- Tailwater discharge during ebbing tides may also assist in reducing the extent of saline water penetrating upstream.

Terrestrial Ecology

A dry season study of the Northern Sands and Pipeline corridor undertaken by Biotropica (refer **Appendix Q**) noted a small number of conservation significant species listed under the *Environmental Protection and Biodiversity Conservation Act (1999)* (**Table A2-9**) and *Nature Conservation Act (1992)* (**Table A2-10**) utilising the sites or adjacent areas from time to time, however the project was considered unlikely to negatively impact any of the species.

TABLE A2-9 EPBC ACT LISTED SPECIES RECORDED AT BARRON DELTA PRECINCT

Common Name	Scientific Name	EPBC Act (Cwlth)
Spectacled Flying-fox	*Pteropus conspicillatus*	V
Eastern Osprey	*Pandion cristatus*	M
Rufous Fantail	*Rhipidura rufifrons*	M
Spectacled Monarch	*Symposiachrus trivirgatus*	M

TABLE A2-10 NC ACT LISTED SPECIES RECORDED AT BARRON DELTA PRECINCT

Common Name	Scientific Name	NC Act (Qld)
Double-eyed Fig-Parrot (Macleay's)	*Cyclopsitta diophthalma macleayana*	V
Spectacled Flying-fox	*Pteropus conspicillatus*	V
Eastern Osprey	*Pandion cristatus*	S
Rufous Fantail	*Rhipidura rufifrons*	S
Spectacled Monarch	*Symposiachrus trivirgatus*	S

Key findings of the preliminary constraints and opportunities assessment are:

- The dredge slurry inbound pipe to Northern Sands may result in the loss of riparian vegetation along Richters Creek.
- There are a number of ecological constraints associated with this loss of vegetation. *Myrmecodia beccarri* (V – NC Act /EPBC Act) are common within the mangroves of Richters Creek and loss of riparian vegetation may entail concomitant disturbance to this species. Relocation and offsets would be required.
- Richters Creek may support as yet undiscovered populations of Haines orange mangrove (*Bruguiera hainesii*) (Endangered – IUCN Red List). Field survey would be required to ensure the species was not present. The Estuarine crocodile (*Crocodylus porosus*) (V –NC Act, Migratory EPBC Act) is present in Richters Creek.
- The boundary of the GBRWHAis mapped as the waters in the Barron River adjacent to the southern edge of the Northern Sands study area. The waters in the Barron River adjacent to the western boundary of the site are outside of the GBRWHA boundary. The preferred pipeline route crosses Richters Creek in an area that is mapped as GBRWHA.
- The Northern Sands site is considered a suitable site for dredge material placement from a terrestrial ecology perspective. The site displays low ecological value, and its setting within an area of widespread anthropogenic disturbance also suggests a lower ecological impact. The options for the inbound / tailwater pipelines are less well understood and are likely to have higher ecological values. However, any options which limit the degree of disturbance to the riparian vegetation of Richters Creek should be preferred, and locating the pipeline along the Barron River may be the least intrusive option.
- The impacts associated with the Northern Sands site are limited in the most part to the vegetation associated with the mangroves on the southern edge of the site. Avoidance of this area will limit the constraints to development of the site. There are also constraints associated with the pipeline routes, most particularly with the plan to affect Richters Creek in an area where the waters are mapped as the Great Barrier Reef World Heritage Area. Movement of the crossing location to the south west may limit the direct impacts of the pipeline; however indirect impacts would still have to be considered.

Noise and Vibration

Noise monitoring was undertaken by ASK as part of preparation of a baseline Noise Constraints Assessment (refer **Appendix R**) to assess the existing noise environment in the various projects areas and at the location of sensitive receptors in the vicinity of the preferred pipeline corridor and Baron Delta DMPA. Sensitive noise receptors in the vicinity of the Barron Delta DMPA and pipeline route options are shown on **Figure A2-17**. Location of sensitive noise and air quality receptors in the Yorkeys and Pappalardo pipeline (marine booster) options are shown in **Figure A2-18** and **Figure A2-19**.

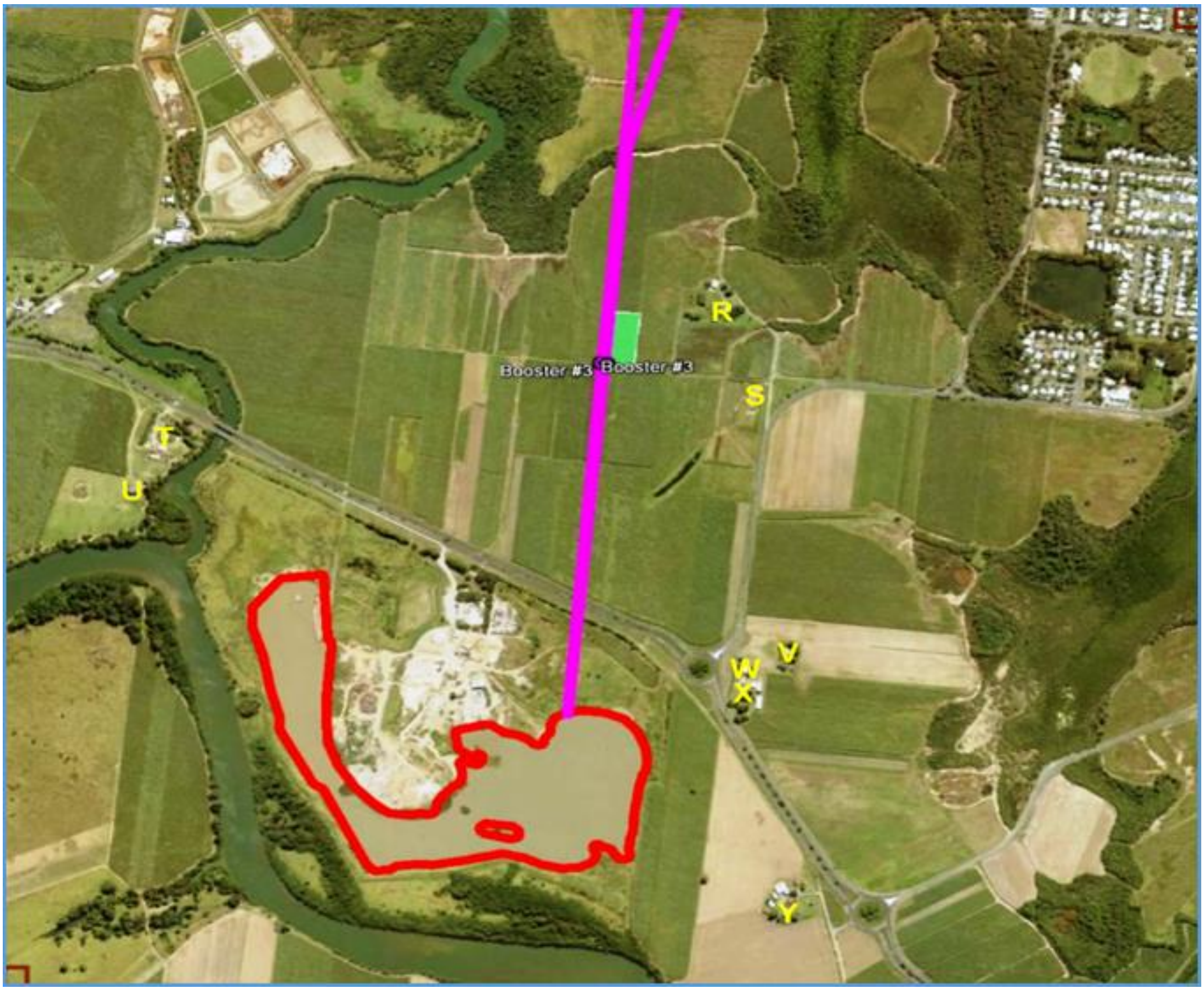
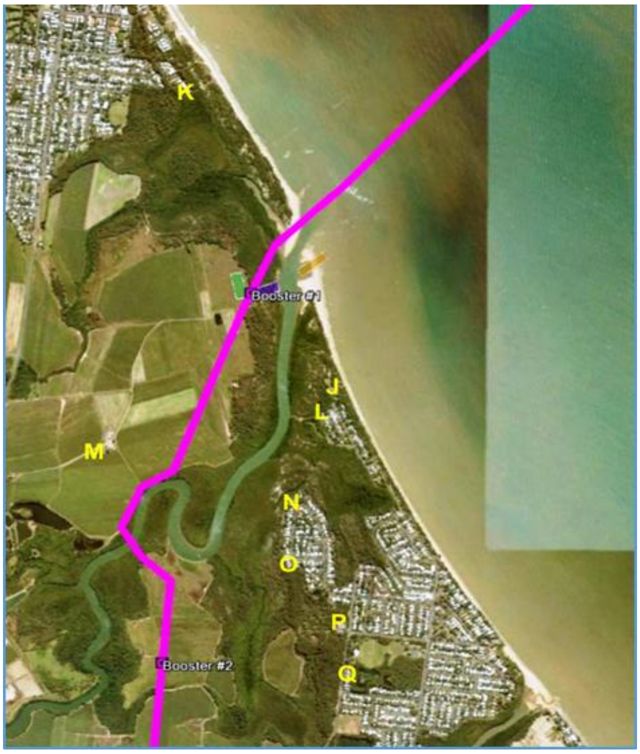


Figure A2-17 Location of sensitive noise and air quality receptors in Barron Delta DMPA area.

	
Figure A2-18 Location of sensitive noise receptors in Yorkeys and Pappalardo's pipeline (marine booster) options.	**Figure A2-19** Location of sensitive noise receptors in Yorkeys and Pappalardo's pipeline (no marine booster) options.

Key findings of baseline Noise and Vibration assessments of the Barron Delta DMPA, dredge material delivery pipeline and pump out facility locations are:

- The noise environment at sensitive receptors on the Barron Delta includes low background noise levels due to the rural nature of some of the monitoring areas.

Findings of the preliminary noise constraints and opportunities assessment include:

- The project aspects with the highest potential to generate noise impacts are anticipated to be the operation of dredging pipeline booster pumps, and off-shore TSHD pump out to the dredging pipeline.
- Booster pump stations are located near (within 200 to 500 metres) receptors.
- Noise mitigation will be required for all landside booster pumps located along all pipeline route options. The preferred dredging pipeline option would be the Pappalardo (No Marine) option, which does not require a marine booster and locates on-shore booster pumps in areas with larger separation distances than the other pipeline routes.
- Noise from the marine booster pump and TSHD pump-out is likely to be audible and exceed noise limits at coastal receptors under adverse conditions and would require mitigation measures.

Air Quality

ASK as part of preparation of a Baseline Air Quality Assessment (refer **Appendix S**) identified Sensitive Air Quality receptors in the vicinity of the Barron Delta DMPA as shown on **Figure A2-17**.

Key findings of baseline Air Quality assessments of the Barron Delta DMPA, dredge material delivery pipeline and pump out facility locations are:

- It is understood cane firing is no longer widely practised in the Barron Delta area, so air pollution issues generated by existing activities would include dust from vehicle traffic, cane field preparation and harvesting, and wind erosion, with occasional smoke from cane firing during harvesting season.

- There is currently an existing sand extraction and waste disposal operation (Northern Sands) with associated traffic. It is anticipated that these activities would generate particulates mostly of larger particle size. This would elevate dust deposition levels in the vicinity of the site.
- Placement of material would be into a deep, wet pit, and so particulate emissions are of no concern from placement of the material itself. However there is some potential for dust during construction of the associated pipeline, and vehicle/plant movements along the pipeline route, laydown yards, and trucks using unsealed roadways.
- The nearest sensitive receptor is 200 m downwind of the edge of the existing pit and there are residences within 400 m of the south-eastern end near the pipeline, however deep under water placement will minimise any odour emissions.
- Emissions from the pipeline construction and operation are considered minor and should not influence the choice of pipeline route.

Landscape and Visual

Cardno prepared a Landscape and Visual assessment of the existing environment (refer **Appendix T**) which identified landscape and visual constraints and opportunities summarised below:

<u>Barron Delta DMPA</u>

- The Barron Delta site is an existing area of disturbance (extraction and landfill), and has been for some time, so expectations for aesthetic improvement are low.
- The site forms a part of an overall mosaic of disturbance or cultivation (i.e. the Delta is not pristine).
- There are views from urban residential estates and sites, however, there will not be any noticeable difference between the existing situation and the proposed dredge material placement activity and infrastructure, particularly when seen as a panorama over the Delta.
- There are ample opportunities to successfully screen views into the site by supplementary or infill planting around the site given that most receptors are either glimpses from the Highway, or distant viewpoints.

<u>Pipeline</u>

- The Pappalardo and Yorkeys pipeline alignment heads north from the site crossing the Barron River before heading to the coast. The land component passes predominately through rural land and coastal landscapes. The Machans option proposes a more easterly alignment which bring it closer to the urban development at Machans Beach.
- Visibility of the land-based component of the Pappalardo and Yorkeys pipeline routes are limited with the crossing of the Captain Cook Highway being key point where it will be viewed by people travelling along the highway.
- The Barron Delta pipeline routes will be visible from the air, however they sit within a mosaic of disturbance or cultivation and will not be a significant feature given the location and temporary nature.
- The ocean component of the pipeline and the associated booster pump will be visible both from the waters of the GBRWHA and the mainland.
- A land based option for the booster pump is preferable in terms of its potential to be able to be screened by foreshore or intervening vegetation (existing or proposed), and reducing the perception of marine impacts when people from offshore or looking out to the GBR.
- The Pappalardo Route is the preferred option with respect to visual amenity and landscape character.

Cultural Heritage

A Cultural Heritage assessment prepared by Alice Buhrich (refer **Appendix U**) identified Cultural Heritage values associated with the Cairns Shipping Development Project include Aboriginal heritage values, both tangible and non-tangible heritage and places of non-Indigenous significance.

The identified Cultural Heritage values summarised below:

- There are two Aboriginal parties relevant to the Barron Delta DMPA precinct, with some overlapping interests as shown in **Figure A2-20**:
  - Yirrganydji Gurabana Aboriginal Corporation YAC (QC2015/004) have a registered native claim from Trinity Inlet to Port Douglas that incorporates the Barron Delta site extending eastwards to the beach and Trinity Inlet. YAC are the Aboriginal party for the Barron Delta site (although see below for future registration of Cairns Regional Claim) and have an overlapping claim with GWY over the shipping channel.
  - Gimuy Walubara Yidinji People (GWY) (QC2012/017) have registered native claims over Cairns and Trinity Inlet that extends south near Gordonvale. GWY have an overlapping claim with YAC over the shipping channel.
- In addition to the Aboriginal parties identified above there are a number of other current and future interests by Aboriginal groups.
  - Dawul Wuru Aboriginal Corporation, representing Yirrganydji interests, have entered into a Traditional Use of Marine Resources Agreement (TUMRA) from north of Barron River to Port Douglas, extending to Green Island.
  - North Queensland Land Council have advised a Cairns Regional native claim for this area is in the process of being finalised (email to A. Buhrich from G. Bell 29 July 2016). The Cairns Regional claim brings together five Aboriginal groups (Bulway, Djabugya, Yirrganydji, Nyakali and Guluy) under a single claim and will extend north of the Barron River to Port Douglas and west to Mareeba. Jeannette Singleton is an applicant to the Cairns Regional claim and advice from NQLC confirms Yirrganydji are the correct people to speak for the Barron Delta site.
  - Jeanette Singleton has advised Yirrganydji intend to lodge a sea claim that will extend south of the existing TUMRA and potentially intersect the shipping channel.
- Yirrganydji oral history records a camp on the southern banks of the intersection of the Barron River and Thomatis Creek. The existing 80 m buffer from waterways, as per existing quarry conditions, should be retained to ensure an adequate buffer around the Yirrganydji camp.
- The Barron Delta site is extensively disturbed and there is little concern about impacts to Aboriginal heritage in the areas currently used by the sand quarry. A CHMP with YAC is required if the Barron Delta DMPA is chosen as the preferred placement option.

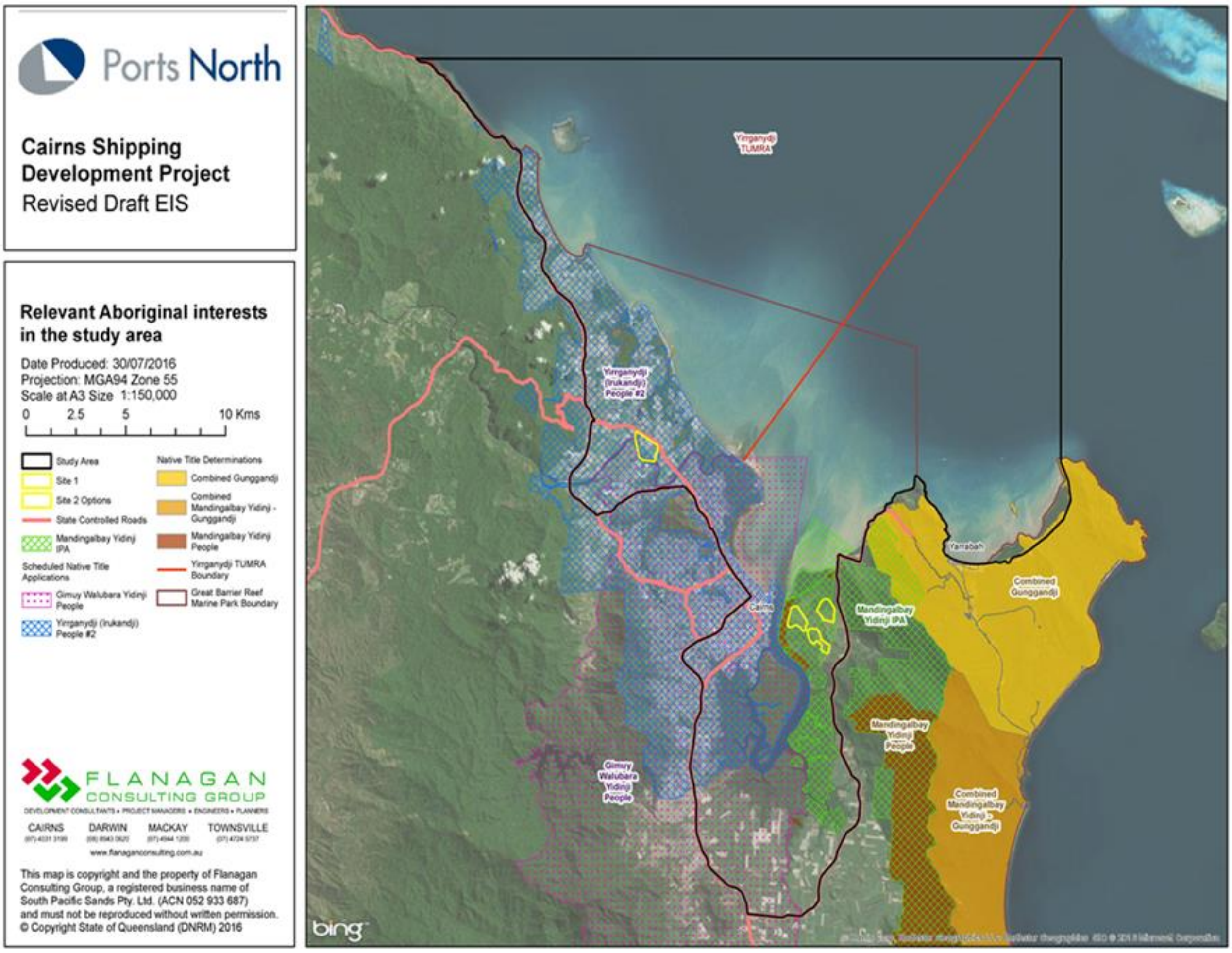


Figure A2-20 Relevant Aboriginal Interests in the Study Area.

A2.6.2.e Summary of Constraints and Opportunities

An analysis of the Constraints and Opportunities identified by the values assessment is provided in **Table A2-11.** This has been used to guide development of design concepts for of the Barron Delta precinct.

TABLE A2-11 CONSTRAINTS AND OPPORTUNITIES ANALYSIS BARRON DELTA PRECINCT

TITLE	STRENGTHS	WEAKNESSES	OPPORTUNITIES	CONSTRAINTS
Land Use (Geology & Soils)	Additional resources present void expansion potential	Extent and manageability of PASS unknown	Void expansion potential for up to 100% of material	Void expansion commercial exposure requiring MOU
Land Use (other)	Compatible with Rural zoning	Nil	Void expansion possible within existing ERA	CRC Operational works required for void expansion
Nature Conservation Areas	Nil	Thomatis Creek is Fish Habitat Area (B)	Nil	Fisheries Act Approval

(Continued over)

TITLE	STRENGTHS	WEAKNESSES	OPPORTUNITIES	CONSTRAINTS
Coastal Processes	Existing immunity to storm tide ~ 1%.	No opportunity to increase storm immunity Pipeline beach crossing at Richters Creek mouth in Erosion Prone Zone	Tailwater Discharge at Highway Bridge to mitigate impacts	Potential Impact on tidal regime.
Marine Water Quality	Nil	Near upper tidal limits High void nutrient levels	Tailwater Discharge at Highway Bridge to mitigate impacts	Discharge impacts on upstream salinities and turbidity
Water Resources (excluding surface water quality)	Lowest groundwater level at 0.00 m AHD Low seepage rate from void to Barron River	Void expansion required to store all PASS and SNP	Sufficient capacity to store 100%PASS below -0.1 m AHD	Void expansion commercial exposure requiring MOU
Marine Ecology	EVNT species not recorded at Northern Sands Species present able to tolerate range of salinities No seagrass in Richters Creek or along offshore pipeline route	Richters Creek is GBR Estuarine Conservation Zone at mouth; Fish Habitat Area (B) offsets for pipeline works required	Tailwater Discharge at Highway Bridge to mitigate impacts	Fisheries Act mangrove clearing permit required
Terrestrial Ecology	Site highly degraded; poor potential habitat for EPBC/NCA Listed species	EPBC/NCA Listed species likely to use Northern Sands Groundwater dependent ecosystems mapped adjacent to Barron River	Potential impacts can be avoided/managed Potential impacts on GDEs unlikely	Nil
Noise and Vibration	Nil	Sensitive receptors present adjacent pipeline and near DMPA Potential impacts from booster pumps and offshore pump out operations	Potential impacts are manageable (acoustic bunding and cladding)	Potential noise nuisance complaints
Air Quality	Adequate buffers to sensitive receptors present	Potential GHG impacts from booster pumps and offshore pump out operations	Nil	Nil
Landscape and Visual	Northern Sands well screened from highway; pipeline not highly visible to highway users	Pipeline shore crossing will be temporarily visible to beach users	Screening of placement area readily achieved	Tailwater pond (if required) at adjacent site would be temporarily visible to highway users

(Continued over)

TITLE	STRENGTHS	WEAKNESSES	OPPORTUNITIES	CONSTRAINTS
Cultural Heritage	Placement area has low cultural significance	Culturally significant historic indigenous camp adjacent to Thomatis Creek	Nil	Nil
Stormtide, Flooding, and Terrestrial Water Quality	Bunding to 3.5m AHD scenarios present minimal flooding afflux impact	Bunding to 5.5m AHD creates significant afflux impacts	Flooding afflux can be managed with crop loss compensation	Nil
Dredge Design and Logistics	Minimal bunding may be necessary to accommodate 100% of material	8km pipeline required to deliver dredge material Offsite tailwater treatment facility may be required	Nil	Pipeline blocking risk

A2.6.2.f Design Optimization

On the basis of known dredge material volumes and properties at the time and outputs of the baseline and preliminary impact assessments, design considerations for the Barron Delta Precinct included:

- There was insufficient room in the existing NS void for all soft clay material
- All PASS could be accommodated (780 000 m^3 bulked up) in the existing NS void with a minimum 1 m water cover (top at RL-1.0 m AHD)
- Balance Self Neutralising PASS (SNP) 1.2 M m^3 (bulked up) would have to be stored elsewhere or alternately the NS void would require expansion through expedited sand extraction activity and/or the provision of bunding to temporarily increase capacity for water management and post placement settlement
- 3.8 m water cover would be required during flood events to minimise or avoid resuspension risk.
- Option to treat SNP in bunded (for flood immunity) longitudinal ponds off. This would require additional NS tailwater treatment area.
- Shape of offsite ponds would be subject to flood modelling and include compensating channels with shape trade-offs (depth v area of disturbance; drying of material)
- Groundwater plume to be modelled at NS and SNP ponds

A2.6.3 Trinity East Placement Precinct Option Development

A2.6.3.a Precinct and Site Overview

The Options Study found that the Trinity Inlet East Placement Precinct contains land east of Trinity Inlet and bounded by Pine Creek Road. This area is locally known as East Trinity and provides opportunities for a number of possible terrestrial placement options on different types of land. In developing the concept designs for three nominal sites (Sites 10, 11, and 12) it was recognised that the overall Trinity East Placement Precinct is very large and a multitude of different designs could be produced.

Overall, the three East Trinity sites featured both strengths and weaknesses at each selected site. Each was found to have different characteristics and as expected, the Site Evaluation process identified strengths and weaknesses for each.

The Options Study concluded that the interplay of beneficial and adverse features and other issues are a complex matter and recommended that during the early stages of the EIS a planning exercise be undertaken to create the 'best' East Trinity site, based on impact avoidance and minimisation and a detailed understanding of opportunities and constraints of the precinct.

A2.6.3.b History of the Site

According to the Draft EIS, the site known as 'East Trinity' was bought by CSR Pty Ltd in the 1970s to grow sugar cane. A bund wall (rock levee) was constructed through foreshore mangroves to prevent salt water entering the site and floodgates were installed to allow water to leave the site (but not enter) and the enclosed area was drained. Draining of the area exposed ASS leading to acidification of onsite soils and discharges of sulphuric acid and heavy metals to Trinity Inlet following rainfall. Sugar cane production was not successful (as a result of the soil becoming acidic) and the remaining natural vegetation onsite was seriously degraded. Fish kills in and near the site were reportedly common (Lord 2006).

Various unsuccessful plans for development were proposed during the 1980s and 1990s, whilst the site was left largely unmanaged (Smith *et al.* 2003). In the early 1990s a proposal to develop a satellite city on the site attracted community attention, but failed to gain approval.

In 2000, the Queensland Government purchased the site with the intent of preserving the scenic rim of Cairns and for remediating the acid sulfate problems. It was designated an Environmental Reserve (the East Trinity Reserve) and rehabilitation measures to reduce acidic discharges to Trinity Inlet and improve its environmental values have been ongoing. In order to maintain pH levels at East Trinity and prevent the release of acidic waters, a large portion of the site is tidally inundated daily, via flood gates (Lord 2006). Ninety per cent of East Trinity Reserve lies below two metres above mean sea level, with significant areas at even lower levels.

The site is owned by the Department of National Parks, Recreation, Sport and Racing (NPRSR). DSITIA is the resident manager of the site and undertakes pest and weed management as well as acid sulfate remediation and site rehabilitation program.

Site investigations undertaken by Fisheries Queensland and the Department of Employment, Economic Development and Innovation (DEEDI) (now the Department of Agriculture and Fisheries (DAF)) indicate that remediation works have substantially improved the water, soil, vegetation and the diversity and quantity of native fauna (NPRSR 2014). The site has also attracted some international scientific interest as a successful case study for the remediation of acidic soils.

A2.6.3.c Gap Analysis and Preliminary Design Concepts

DSITI Discussions

In late June 2016 discussions were held with the Department of Science, Information Technology and Innovation (DSITI) to determine the status of the remediation project and identify those parts of the site where dredge material placement would be best sited.

In terms of the remediation project:

- the Hills Creek catchment is effectively stable, in that the regular (moderated) tidal inundation is sufficient to buffer the acidity and therefore allow passive treatment to continue
- the Firewood Creek catchment is expected to reach this condition within 10 years.

DSITI provided initial recommendations for possible placement sites as shown on **Figure A2-21** below. These were selected on the basis that:

- the sites were not being actively managed by DSITI
- soil pH were neutral with minor areas of Actual Acid Sulfate Soils (pH 4.5)
- some areas of self-neutralising soils.

DSITI also provided details of extensive testing and assessment of the site, including:

- flora studies by the Queensland Herbarium
- bird and fish studies by the Queensland Museum
- soils testing
- surface water and groundwater testing
- water quality in the receiving environment of Trinity Inlet.

Figure A2-21 DSITI suggestions for East Trinity placement sites.

Source: P Lawrence (pers. comm. 23 June 2016).

Literature Research and Desktop Analysis

In addition to review of the Draft EIS a range of online database searches and spatial dataset interrogations were performed (**Table A2-12**) prior to ground survey to inform the survey focus for the East Trinity study area. To meet the desktop research requirements in the Guidelines for Flora Survey & Assessment (Wannan 2012), EPBC Protected Matters Search and Wildlife Online, searches were undertaken with a buffer of 10 km (central co-ordinates: -16.932, 145.7989. However due to the small size of the site and to obtain a more accurate determination of the species most likely to be found in the close vicinity of the site, a further set of searches were undertaken with a buffer of 3 km. The same co-ordinates were used for this second set of searches.

TABLE A2-12 DATABASES/DATA SETS UTILISED FOR DESKTOP ASSESSMENT OF EAST TRINITY

Database/set	Relevant Legislation / Purpose of Dataset Review
Queensland NCA Wildlife Online	Nature Conservation Act 1992 / Nature Conservation (Wildlife) Regulation 2006
EPBC Protected Matters Search Tool (PMST)	Environment Protection and Biodiversity Conservation Act 1999
Regional ecosystem and remnant map – Version 8.0 (RE)	Vegetation Management Act 1999
Matters of State Environmental Significance –Version 4.1 (MSES)	State Planning Policy / Sustainable Planning Act 2009
Protected plants flora survey trigger map - Version 4	Nature Conservation Act 1992
Regulated vegetation management map – Version 1.32	Vegetation Management Act 1999
Directory of Nationally Important Wetlands	Non-statutory
Queensland waterways for waterway barrier works	Fisheries Act 1994 and Sustainable Planning Act 2009
Queensland DCDB 2016 (Tenure)	Land Act 1994
Great Barrier Reef Coast State Marine Park Zoning Map	Queensland Marine Parks Act 2004
Wetland Protection Area wetlands and trigger zones	Environment Protection Regulation 2008
Cairns Plan 2016	Sustainable Planning Act 2009
Atlas of Groundwater Dependent Ecosystems (BOM)	Non-statutory Databases/

DSITI also provided access to a number of East Trinity baseline data and remediation project reports.

A2.6.3.d Values and Baseline Assessments

Overview

The following is a brief summary of that material as it is relevant to the concept design process. It applies to both the East Trinity site itself and the delivery and return water pipelines. **Figure A2-22** shows the preliminary concept design on which Values and Baseline Assessments were based; this design was developed from available information at the time including the Draft EIS, 2016 Options Report (**Appendix I**) and available desktop information.

Assessment of constraints and opportunities were based on a broad concept of placement of dredge material within earthen bunds (approximately 60 ha at depth of 3 m) created from insitu materials or imported materials, if in-situ materials were found to be unsuitable. The preliminary placement area is shown in **Figure A2-22**.

Figure A2-22 Preliminary East Trinity Placement Area Concept Design.

Soils and Geology

Golders Associates investigations of the Soils and Geology at East Trinity (refer **Appendix V**) identified that the East Trinity site is underlain by young (Holocene age) alluvial deposits to depths of about 2 m to 4 m below the ground surface at the eastern end of the site, progressively increasing in depth towards the west. At the western margins of the site the thickness of Holocene deposits typically ranged between about 6.5 m and 12 m, increasing to a depth of about 22 m between Hills Creek and Magazine Creek.

The younger alluvial deposits are underlain by older (Pleistocene age), consolidated alluvial deposits and then Permian age Granite bedrock at depths of at least 90 m near Trinity Inlet.

The Holocene age alluvium is typically soft and highly compressible. Design of ponds will need to consider total and differential settlements induced by the embankments and by the dredged materials.

The materials within the upper 1 m of the soil profile are expected to be generally clayey in nature, however their permeability and suitability for construction of embankments is not known at this time. Use of synthetic liners may need to be considered.

Acid sulfate soil conditions at the site have been extensively studied and partially remediated over the past 15 years. PASS and AASS materials underlie the entire site. It is recommended that areas underlain by AASS plus areas where past remediation works have been carried out should be avoided to prevent disturbance and possible remobilisation of acid. A buffer distance of at least 10 m between such areas and dredged spoil ponds is also recommended.

Figure A2-23 shows areas where siting of the ponds should not result in disturbance of PASS. These areas typically occur above 1 m AHD and can support excavations generally to depths of less than 1 m below ground level. There is greater than 120 ha of land above 1m AHD.

Some areas with site levels between 0.5 m and 1 m AHD should also be suitable for siting of ponds (providing excavation depths are less than 0.5m below ground level). When these areas are included the area potentially available for dredged spoil ponds is greater than 230 ha.

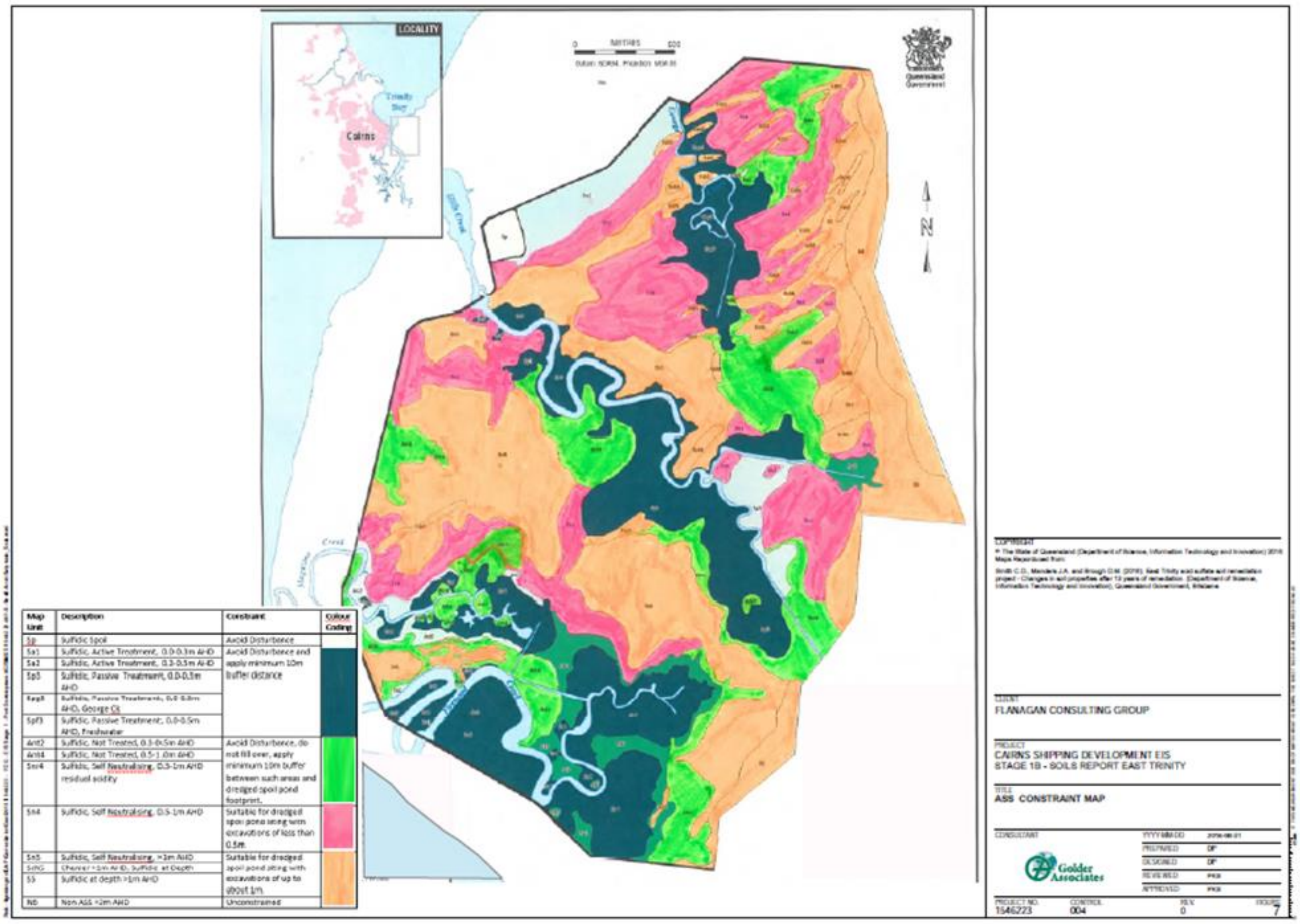


Figure A2-23 East Trinity ASS Constraints.

Groundwater

Golder Associates groundwater investigations (refer **Appendix W**) identified groundwater constraints and opportunities as described below.

<u>Description of Aquifers</u>

Discontinuous shallow aquifers overlying and within the lower permeability Holocene sediments, comprising groundwater systems associated with relic dune systems and/or paleochannels related to recent stream meanderings. Water levels between 2001 and 2002 ranged between approximately -2.2 m AHD to 0.5 m AHD, and were generally below 0 m AHD. In general, groundwater quality within the shallow groundwater system is variable and considered of low quality. Electrical conductivity ranges from 1500 microSiemens per centimetre (µS/cm)) to 120 000 µS/cm (i.e. fresh to hypersaline) while pH ranges 2.1 to 8.

Deeper aquifers (up to 5 distinct sandy aquifers) in the Pleistocene sediments down to around 80 m, isolated from surface waters and shallow aquifers and discharging well out in Trinity Bay. Water levels between 2001 and 2002 ranged between approximately -2.2 to 3.3 in the Pleistocene sediment which was generally less acidic and less saline than the shallow aquifer.

Constraints and Opportunities

Seepage from the bunded areas is likely to occur at relatively low rates, but nevertheless has the potential to increase water levels around the bunded area. Water quality on the site is generally quite poor, with high levels of salinity in the low permeability soils. Increased water levels surrounding the bund may impact on terrestrial vegetation with low salt tolerance. This is more of an issue in less saline areas towards the eastern margins of the site.

Seepage from the bunded area also has the potential to increase hydraulic gradients and increase rates of movement of any acidic groundwater, if such conditions are present in close proximity to the bunded area.

The rate of saline (seawater) seepage through the base of bunded areas during placement of dredged spoil is generally expected to be low, given the low permeability soils (soil permeability will need to be confirmed at the design stage). Where Chenier ridges occur within the bund footprint, a liner may be required to prevent preferential flow through these sandy areas.

Coastal Processes

The BMT WBM Coastal Processes Report (refer **Appendix M**) substantially upgraded the TUFOW FV hydrodynamic and receiving water quality model developed for the Draft EIS in order to enable it to assess the impact of land based placement tailwater discharges on the receiving environments within Trinity Inlet, based on a 12 month baseline data acquisition program. Tailwater discharge locations assessed during the values assessments are shown on **Figure A2-24**.

East Trinity is a relatively well flushed tidal estuary, with a small fluvial influence. Preliminary indications indicate that tailwater discharge within bunds or creeks is likely to have a significant influence on water quality (salinity and turbidity) within these confined waterways.

Despite Trinity Inlet being relatively close to marine conditions, there is still a potential for saline water to advect upstream within this estuarine system. From a hydrodynamic and water quality perspective, discharge of tailwater directly into Trinity Inlet would allow improved mixing compared to discharge into the smaller Firewood Creek and/or Hills Creek. This is confirmed by preliminary tailwater discharge modelling.

Key findings of the preliminary Coastal Processes assessment are:

- Tailwater discharge into Firewood Creek upstream of the bund (Location 1) results in a median tailwater concentration inside the bund of approximately 50%. Associated salinity increases are relatively modest (~1 PSU) due to the ambient salinity being close to marine levels. Median turbidity increases are predicted to exceed 35 NTU above background within the bund.
- Tailwater discharge into Firewood Creek downstream of the bund (Location 2) results in a median tailwater concentration within the restricted creek waterway of approximately 40%. Associated salinity increases are relatively modest (<1 PSU) due to the ambient salinity being close to marine levels. Median turbidity increases are predicted to exceed 12 NTU above background within the creek.
- Tailwater discharge into Hills Creek upstream of the bund (Location 4) results in a median tailwater concentration within the restricted creek waterway exceeding 95%. Associated median salinity increases exceed 8 PSU. Median turbidity increases are predicted to exceed 50 NTU above background within the creek.
- All of the Trinity Inlet discharge locations, including the direct discharge (Location 3) benefit from the good tidal flushing once mixing occurs within the main estuary channel. Median tailwater concentrations are less than 8% within the main estuary. Associated median salinities are only marginally increased and median turbidity increases are predicted to be less than 3 NTU above background.
- A minimum bund level in the order of 2.3m AHD (i.e. 100 year ARI storm tide inundation risk) or preferably higher at RL 4.0m AHD (i.e. 10 000 year ARI storm tide) will be required to provide appropriate storm tide and local flood protection.

Figure A2-24 Tailwater discharge modelling locations – East Trinity.

Flooding, Stormtide and Hydrology

A qualitative and quantitative hydrological, hydraulic and preliminary water quality assessment of the proposed dredge material placement was undertaken by WBM BMT (refer **Appendix N**) to assist in determining the preferred facility location whilst ensuring no adverse off-site flooding and water quality impacts.

Key findings are:

- Placement within the East Trinity area will require the dredge material to be located within a bunded area to prevent the loss of material and protect the material from being released during flooding and storm surge, with the level commensurate with the appropriate risk.
- East Trinity will require a bund to contain the dredge material and prevent inundation by storm surge and local catchment flooding.
- The bund will require a minimum freeboard in the order of 400mm to contain direct rainfall based on a 10 year ARI 24 storm event. If environmental assessments indicate a sensitive environment to overflows, then additional freeboard would be required to be commensurate with the acceptable risk criteria.
- A minimum bund level in the order of 2.3 m AHD (i.e. 100 year ARI storm tide inundation risk) or preferably higher at RL 4.0 m AHD (i.e. 10 000 year ARI storm tide) will be required to provide appropriate storm tide and local flood protection. The final level of the bunded area or final land form (i.e. wet and bunded or capped and revegetated) will need to commensurate with the period of exposure and the sensitivity of a potential impact upon the receiving environment. With each Site A, B or C a large open perimeter channel and increased conveyance through the outer East Trinity bund wall would be necessary to reduce the flood impacts.

Marine Water Quality

As with coastal processes assessments, a 12 month baseline water quality data acquisition program conducted by BMT WBM (refer **Appendix O**) commenced at the outset of Values and Baseline Assessment phase, therefore the following findings are considered preliminary. The 12-month Water Quality Assessment program included deployed instruments, grab sampling, depth profiling and 10 year historic satellite based turbidity assessments.

Key preliminary findings included:

- Trinity Inlet typically has lower median turbidity (~10 NTU) compared to nearshore coastal waters in Cairns Harbour (~30 NTU) and along the Northern Beaches (~20 NTU), with water clarity improving with distance upstream in Trinity Inlet.
- From data collected on 26-28 July 2016, water quality at East Trinity is characterised by:
  - Electrical conductivity (EC) measurements of a similar magnitude to marine waters inside and outside the bund.
  - Relatively neutral pH levels inside and outside the bund in both creeks (pH 7.5 - 8.5).
  - Turbidity between 7 and 30 NTU.
  - Low levels of dissolved metals/metalloids and slightly elevated nutrients.
  - Generally, water quality in Hills Creek was better than Firewood Creek during the survey, with lower turbidity in Hills Creek inside the bund, and lower metals/metalloids in Hills Creek compared to Firewood Creek.
- Tailwater discharge into Firewood Creek and/or Hills Creek inside the bund may change water quality within these creeks. Salinity is likely not much of an issue (as waters are saline), but turbidity of tailwater (around 100 NTU) is much greater than receiving waters (<30 NTU) and mixing/dilution would be limited.
- Tailwater discharge into Firewood Creek outside of bund would be similar to above, except would not impact the upper reaches of Firewood Creek (i.e. less disturbance area), and would likely provide better mixing/dilution.

- Tailwater discharge into Trinity Inlet would result in a larger differential between tailwater turbidity (100 NTU) and receiving water turbidity (~10 NTU), however there would be greater mixing and dilution in Trinity Inlet so likely to be less of an issue compared to the above two options.
- Footprint of placement site may alter flow regime and water quality. Further information on this is contained in the Flooding report.
- From a water quality perspective, discharge of tailwater directly into Trinity Inlet would likely allow better mixing compared to discharge into the smaller Firewood Creek and/or Hills Creek. However, preliminary tailwater modelling (provided separately) will provide a better assessment of this, and noting that existing water quality (turbidity) in Trinity Inlet is good.

Marine Ecology

As part of the values assessment, BMT WBM prepared a Marine Ecology Report (refer **Appendix P**). Potential threats to estuarine and marine biodiversity values associated with land placement are as follows:

- Tailwater discharge into Firewood Creek and/or Hills Creek inside the bund may alter surface and groundwater levels. Mangroves (and the burrowing fauna that control mangrove health) and Melaleuca are sensitive to long-term changes in water levels, and changes to hydrology that disrupt wetting and drying cycles could lead to plant stress and possibly mortality.
- Increases in turbidity within the bund may reduce light availability to seagrass communities inside the bund. Seagrass meadow extent within the bund has not been mapped to date and would require further assessment if this option is to be further considered.
- Melaleuca and mangrove species at the tidal limit are sensitive to extended periods of high salinity. Discharges of saline waters could therefore lead to stress and mortality of salt sensitive species, depending on management of the location, intensity, frequency and duration of tailwater discharges.
- Tailwater discharge into Firewood Creek downstream of the bund would be less likely to cause hydrology impacts (level and salinity) due to a lack of containment. The bund creates a very large tidal impediment (and lag) and acts to pond water.
- It is expected that most fish and invertebrate species would be tolerant of seawater salinities. The higher salinity in tailwater may provide more suitable habitat conditions for marine species, which could result in temporary changes to fauna community structure within the mixing zone of tailwater discharges.
- Seagrass meadows at the mouth of Magazine Creek were very sparse and comprised of pioneer species. The extent and resilience of these meadows (i.e. seed banks, seed sources) has not been examined to date. It is expected that any seagrass in the Magazine Creek dredger pump-out footprint would be temporarily lost, but would recolonise here if habitat conditions are re-instated i.e. depth, sediments, turbidity. No seagrass was observed at the potential pump out site at the entrance to Hills Creek.
- Preliminary mitigation measures to be included within concept design considerations include:
  - Discharge of tailwater downstream of the bunded areas, or in Trinity Inlet directly, would likely provide for better mixing and would be less likely to cause water level changes than discharge into the bunded area. This would also likely result in fewer salinity impacts to several salt-sensitive species that live in the bunded area. On this basis, a discharge point located downstream of the bunded area is preferred from an aquatic biodiversity perspective.
  - Management actions (e.g. flap gates, ebb-tide discharges etc.) may be required to ensure that the dispersion of saline tailwater waters during flood-tides does not result in long term increases in salinity within upstream environments. This will need to be balanced against the need to maintain appropriate hydrological and water quality regimes, as well as fish passage, within upstream environments.

Terrestrial Ecology

A Terrestrial Ecology values assessments undertaken by Biotropica (refer **Appendix Q**) included desktop assessments and a range of dry season fauna and flora studies. The extent of dry season field surveys by Biotropica is shown on **Figure A2-25**.

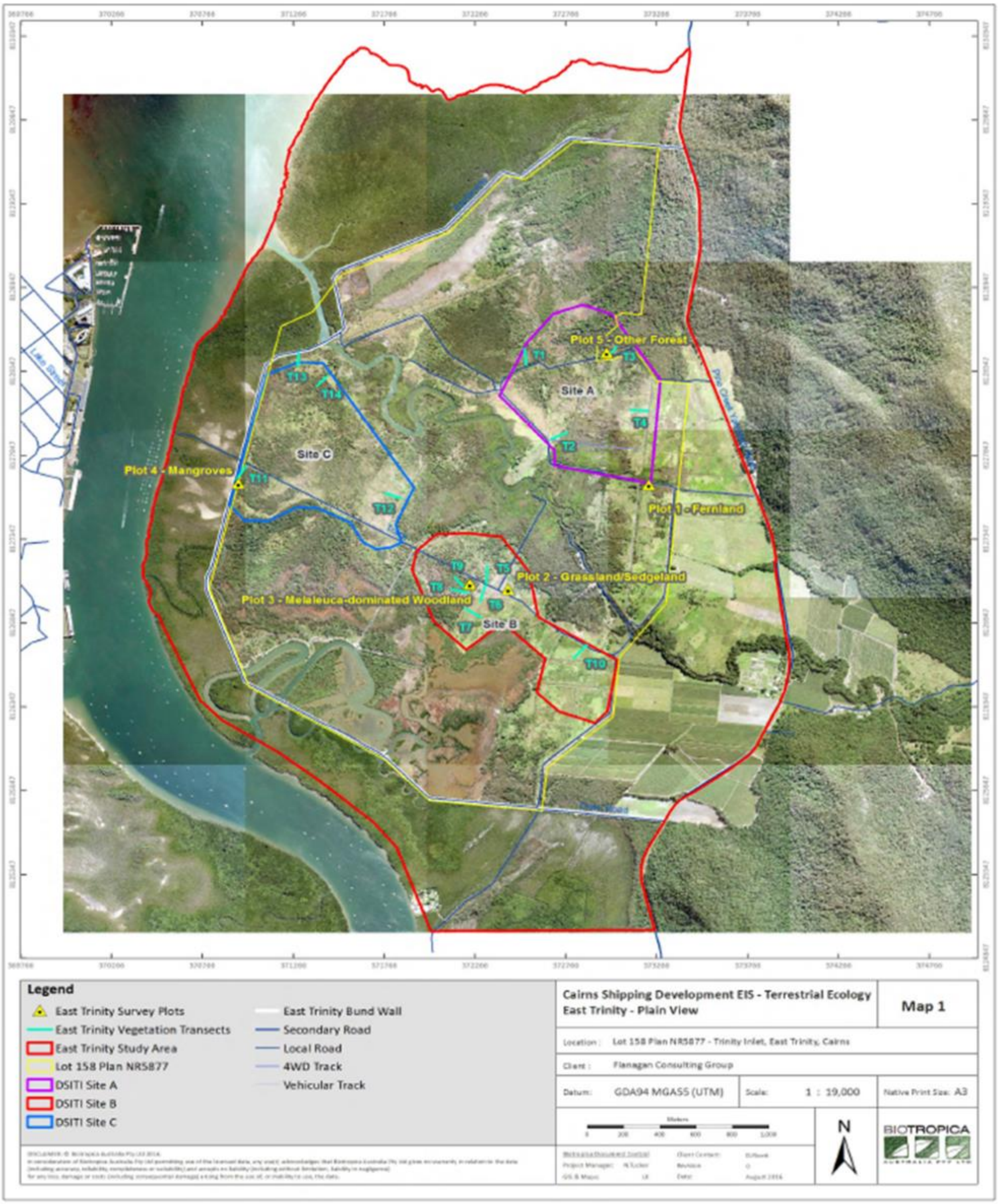


Figure A2-25 Terrestrial ecology assessment areas – East Trinity.

Key findings of the Terrestrial Ecology assessment are:

- The majority of potential impacts at East Trinity could be ameliorated by placement area selection. Site B contains large areas of anthropogenic grassland with minimal natural values, and utilisation of this area would negate many of the constraints identified above. Anthropogenic grasslands are generally devoid of woody vegetation that provides habitat for ant plants (Myrmecodia beccarii) and they provide minimal value to the EVNT species.

- Site B also presents a shorter route for pipelines when compared to either Site A or Site C. Whilst the discharge options for Site B are likely to result in the clearing of marine plants, any Myrmecodia beccarii present could be translocated. This would potentially entail an offset (i.e., establishing extra individuals of the species) and this is a relatively straightforward and established conservation mechanism. Clearing of marine plants would also entail provision of an offset. It is possible that this offset may be achievable on the site through direct establishment of marine plants in an area where that assemblage is naturally regenerating, and where its long term development is assured.

Site B was recommended as the placement area. This site has the lowest biodiversity values and represents the largest extent of anthropogenic grasslands present within the East trinity study area. The options for disposal of tail water also present the lowest risk to biodiversity values within Site B. Sites A and C display much higher biodiversity values, and the pipeline inbound/tail water options for these sites are also more likely to impinge on biodiversity values.

Noise and Vibration

Baseline noise monitoring was undertaken by ASK (refer **Appendix R**) to inform an assessment of the existing noise environment in the East Trinity area and a preliminary assessment of noise impacts at the East Trinity DMPA. Locations of sensitive receptors are shown on **Figure A2-26**.

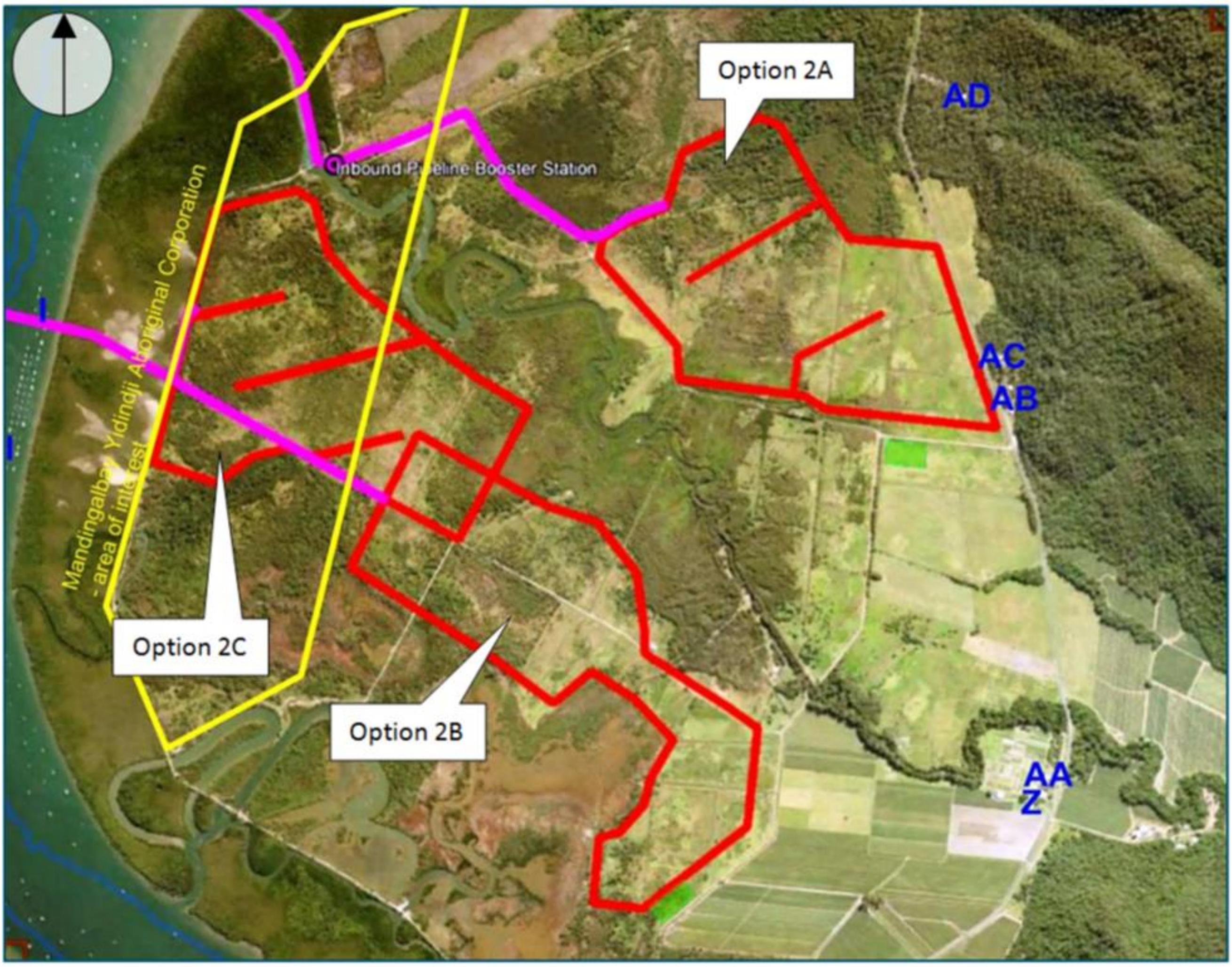


Figure A2-26 Location of DMPAs and sensitive receptors in the East Trinity Area.

Key findings of the baseline noise constraints assessment are:

- Based on the predicted noise levels, construction noise limits are anticipated to be exceeded for establishment activity within the Site 2A location close to receptors (within 400 m), but should be achievable for Sites 2B and 2C which have larger separation distances to receptors.
- Due to the high sound power levels associated with large mobile equipment, it may not be possible for earthmoving and site establishment works to comply with a background plus type criteria. Therefore, it may be considered sufficient to manage site establishment works such that heavy earthmoving work is conducted during daytime hours.
- It is noted that the highly affected construction noise level of 75 dBA Leq (15 minutes) is not exceeded, even at 100 m from large earthmoving equipment, and therefore depending on the duration of works required, noise impacts from site establishment may result in acceptable impact to sensitive receptors.
- Based on the calculated noise levels for earthmoving equipment for site establishment, is recommended that consideration is given to selecting quieter (smaller) equipment if East Trinity Site 2A is the DMPA option selected.
- The East Trinity Site 2A placement area is located within 100 m of sensitive receptors. East Trinity Sites 2C and 2B are preferable due to increased separation distance, with Site 2C having the largest buffer.
- As a general control, it is recommended that use of mobile earthmoving equipment during outside-standard hours is limited or avoided (if feasible) to reduce the potential for noise impacts.
- Boat moorings are located in proximity to this area and may need to be considered as sensitive receptors.
- Further detailed modelling will be required once the preferred solution and concept design is identified.

Air Quality

A baseline assessment of air quality constraints was conducted by ASK (refer **Appendix S**) for the East Trinity DMPA. Sensitive air quality receptors in the vicinity of the East Trinity DMPA are shown on **Figure A2-27**.

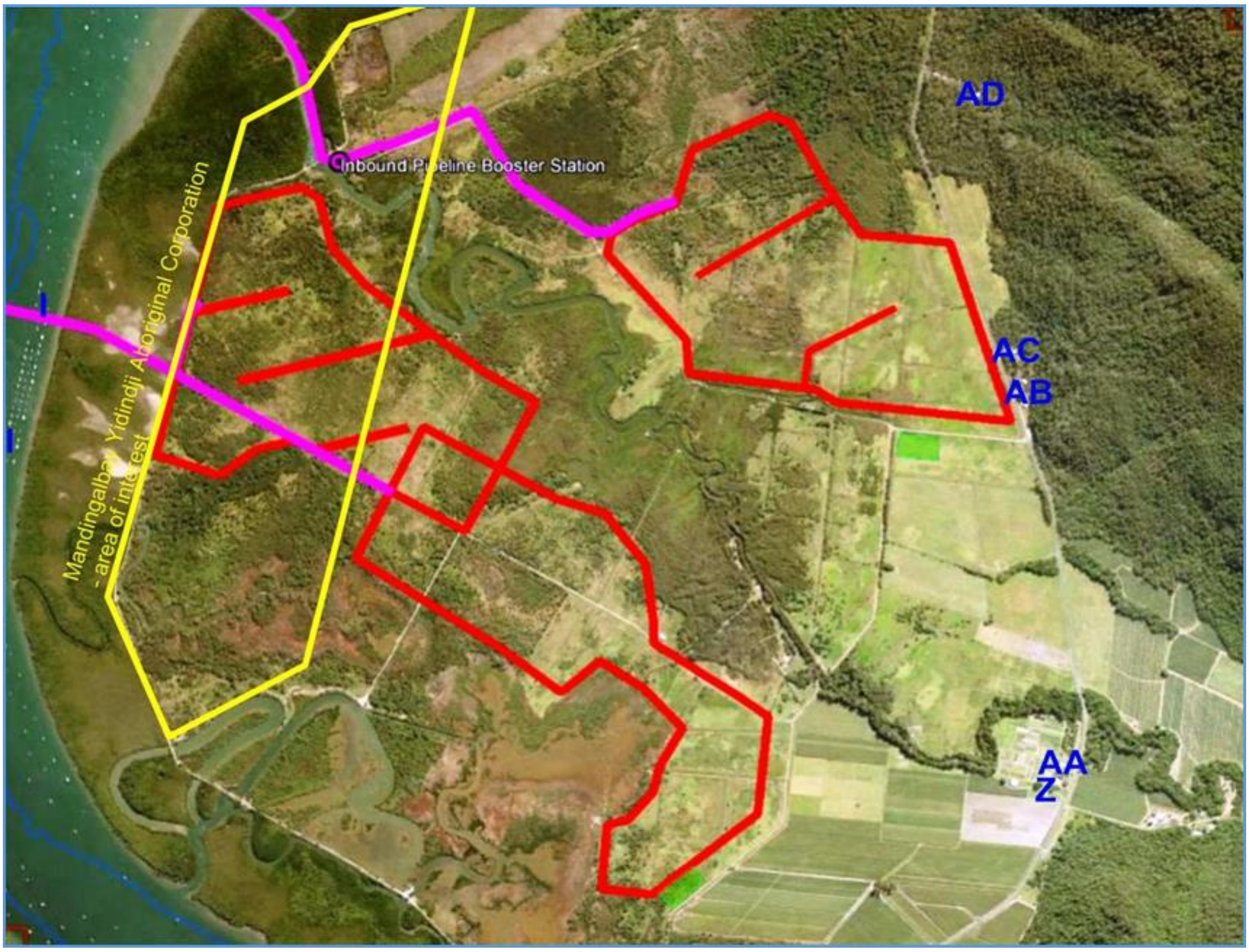


Figure A2-27 Location of sensitive air quality receptors in the East Trinity area.

Key findings of baseline Air Quality assessments of the East Trinity DMPA dredge material delivery pipeline and pump out facility locations are:

- The East Trinity option includes large quantities of material to be distributed over a wide area. Impacts from pipeline construction and operation (use of pumping stations and machinery to move material) will include diesel emissions but are considered minor.
- East Trinity Site A is not recommended due to the small, and potentially inadequate, separation distance to sensitive receptors.
- East Trinity Sites B and C are the preferred options since the separation distances to sensitive receptors are large and there are a reduced number of permanent sensitive receptors. Dust and odour impacts are likely to be addressed by normal control measures and these sites are recommended from an air quality perspective. Odour from material containing acid sulphate properties and decomposing biological material can be managed by proper treatment with lime.
- Buffers to boat moorings on the eastern side of Trinity Inlet may be too small to address with control measures.

Landscape and Visual

Cardno prepared a Landscape and Visual assessment of the existing environment (refer **Appendix T).** The study area for the visual and landscape values assessment includes the township of Cairns, surrounding lands, farms and residences, and extends offshore into Trinity Inlet, Trinity Bay and the nearshore and offshore waters of the Great Barrier Reef Marine Park and World Heritage Area. Assessment of visual and landscape values of the East Trinity DMPA precinct from numerous visibility points utilised ground truthed Zone of Visual Influence modelling (ZVI). Outputs of the modelling are shown on **Figure A2-28**.

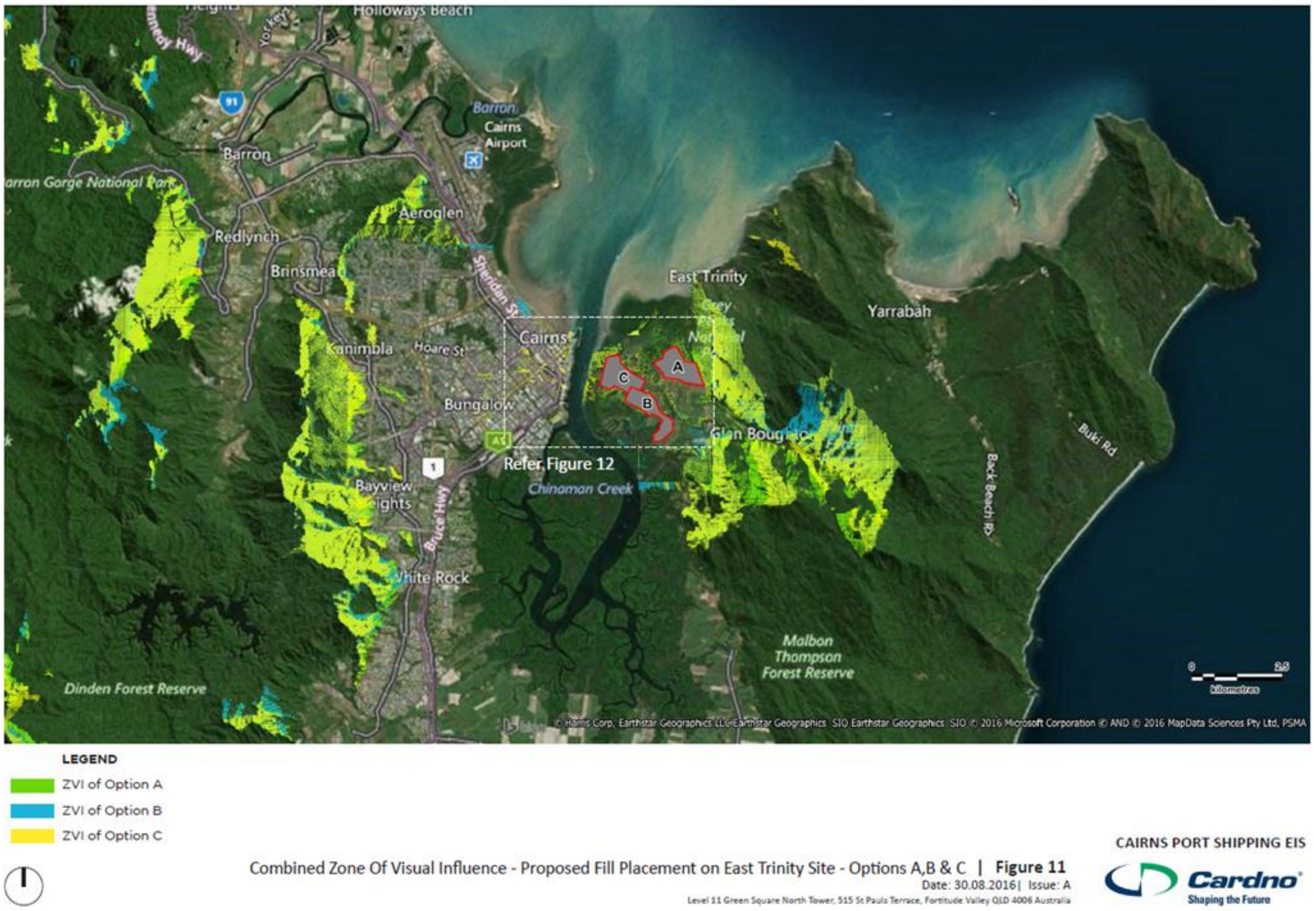


Figure A2-28 Combined Zone of Visual Influence assessment – East Trinity.

Key findings of the visual and landscape values assessment at the East Trinity DMPA precinct are:

- Parts of the East Trinity sites (A, B and C) will be visible from CBD buildings and residences located at higher elevations (at least 30 m AHD in height). Viewshed analysis indicates the East Trinity (site A) is less visible than sites B and C from city views from the west, and is the furthest site from these receptors, such as the Convention Centre.
- The location of East Trinity (A) abutting the Pine Creek-Yarrabah Road is shown to be partially visible from the road frontage, and potentially from the residence across the road. However the views are concentrated to an area in the southwest of the site, and the view arcs indicate that most of these views are from the north of the site. This area will likely be seen from southbound vehicles, at speed.
- The proposed location at which the pipeline will enter Trinity Inlet (all options) will be visible to moored vessels and other vessels using the inlet.
- There will be limited viewing opportunities from close proximity due to the existing vegetation and lack of road access.

Cultural Heritage

A Cultural Heritage assessment prepared by Alice Buhrich (refer **Appendix U**) identified Cultural Heritage values associated with the Cairns Shipping Development Project include Aboriginal heritage values, both tangible and non-tangible heritage and places of non-Indigenous significance.

As shown on **Figure A2-20**, Mundingalbay Yidinji (MY) has a determined claim over claimable land at East Trinity (QCD2006/004). MY have a Cultural Heritage Body that includes East Trinity and are the Aboriginal party for East Trinity with interests in the shipping channel.

MY currently manage part of the East Trinity site as an Indigenous Protected Area (IPA) and aspirations for future use of the site include tourism and conservation. The MY IPA extends across half of the shipping channel.

Key findings of the Cultural Heritage Assessment are:

- Cairns harbour and adjacent areas are part of a living Aboriginal cultural landscape. Story places, archaeological sites, contact sites and places of contemporary Aboriginal significance are documented in the broad study area. Non-Indigenous heritage values include shipwrecks, Trinity Wharf complex and local heritage places associated with the development of Cairns.
- A CHMP with MY is required if East Trinity is chosen as the preferred placement option.
- Concerns were raised about the compatibility of the CSDP and MY aspirations for future use of the East Trinity site however, MY have identified one area of possible use for placement of dredge material, a highly degraded area of 90 ha south of Hill's Creek. This area should be surveyed for cultural heritage sites prior to site disturbance.
- There are two possible locally significant non-Indigenous heritage places within East Trinity that could be impacted by the proposed pipeline.
- Only minimal impact is expected on the bund wall, this impact is reversible and will not significantly impact the heritage values.
- The Chinese tramway route is possibly of local significance, and this route is the preferred pipeline location. The tramway is very poorly preserved, physical remains consist of a remnant embankment and small amounts material within the tidal zone to the north of the bund wall. The tramway could hold significant values to the Wah Day family, and it is recommended that detailed recording of the tramway should be conducted including documenting material remains and Wah Day family oral history.

A2.6.3.e Summary of Constraints and Opportunities

An analysis of the Constraints and Opportunities identified by the values assessment is provided in **Table A2-13** This has been used to guide development of design concepts for of the East Trinity.

TABLE A2-13 CONSTRAINTS AND OPPORTUNITIES ANALYSIS EAST TRINITY PRECINCT

TITLE	STRENGTHS	WEAKNESSES	OPPORTUNITIES	CONSTRAINTS
Land Use (Geology & Soils)	Nil	ASS present at shallow depth adding to construction risks High potential geotechnical constraints (settlement potential under treatment areas)	Sufficient low constraints land available for 100% of dredge material Limed PASS dredge material may be suitable for beneficial reuse for residential, commercial or industrial development	Import of bund material if insitu materials prove unsuitable
Land Use (other)	Nil	Potentially incompatible zoning MYAC Cultural Heritage restrictions	Cultural Heritage restrictions are negotiable with MYAC	Zoning incompatibility approvability risk
Nature Conservation Areas	Site B has lowest biodiversity values	Hills Creek, Magazine creek and Trinity Inlet are FHA(A)	Sufficient available area for adequate riparian buffers	Fisheries Act approvals including offsets requirement
Coastal Processes	Existing storm tide immunity approximately 1%.	Flood conveyance required around bunded area	Likely treatment bund at RL 3.5 will increase immunity to > 1%	Nil
Marine Water Quality	Salinity at Trinity Inlet discharge point will be relatively unimpacted by tailwater	Discharge point turbidity will be observable to public and high rises Discharge upstream of bund will create moderate water quality impacts	Discharge at Magazine Creek bund	Fisheries Act approvals
Groundwater	Any impact to groundwater will be localized. No connection to deeper aquifers	Some potential for increase of shallow groundwater levels and export of acidic water to estuarine areas	Installation of liner to eliminate (minimise) seepage to shallow groundwater	Liner costs Ongoing potential legacy issues
Marine Ecology	Tailwater impacts likely to be limited	Potential for impact to Seagrass area north of Hills Creek mouth	Modelling likely to show tailwater discharge downstream of existing bund will create minimal impacts on marine ecology	Nil
Terrestrial Ecology	Site B has lowest biodiversity values	Sites A and C have moderate biodiversity values and highest marine plant clearing potential for pipeline options	Ant plant translocation feasible for pipeline clearing	EPBC Act / NC Act approvals for listed plant clearing
Noise and Vibration	Impacts to sensitive receptors unlikely	Site A closest to sensitive receptor	May be necessary to temporarily move moored boats during construction period	Nil

TITLE	STRENGTHS	WEAKNESSES	OPPORTUNITIES	CONSTRAINTS
Air Quality	Sites B and C preferred because of greater separation distances	Potential odour impacts from PASS and biological decay; dust impacts are manageable	Odour issues able to be managed by lime treatment	Nil
Landscape and Visual	Visibility from Cairns west area and Wet Tropics area is minimal; minimal impacts from local passing traffic	Highly visible from elevated areas (cruise ships, high rises); difficulty of site rehabilitation	Site A provides least potential impact	Any rehabilitation failure will increase visual impacts
Cultural Heritage	High level of disturbance has created minimal potential CH issues	Two areas of CH potential within East Trinity; MYAC area restricts availability of Site A west; may not be compatible with MYAC development plans	Maintenance of European CH egg Chinese tramway, CSR bund	CHMP negotiations with MY group; MY native title claim
EPBC Act Issues	Minimal potential impacts on EPBC Act species	Clearing of Ant plants and other marine plants for inlet and outlet pipelines	Suitable areas for offsets on site	EPBC Act/NC Act permits for clearing of Ant plants
Flooding, and Terrestrial Water Quality	Proposed bund height of 3.5 is above Storm surge ARI 1% of 2.3 m	Risk of Afflux to upstream farms	Provide flood conveyance around DMPA	Nil
Dredge Design and Logistics	Short delivery pipeline required; higher levels of salinity at potential discharge locations; shorter steaming time for TSHD	Significant soil treatment (PASS lime treatment) works required; ongoing legacy issues (soil and water monitoring, rehabilitation maintenance); significant DMPA construction costs	Adequate area available for tailwater treatment	Costs of lime treatment Cost of DMPA construction Cost of ongoing maintenance

A2.6.3.f Design Optimisation

Based on known dredge material volumes and properties at the time and outputs of the baseline and preliminary impact assessments, design considerations for the East Trinity Precinct included:

- 2 M m^3 (bulked up volume) capacity including PASS and self-neutralising PASS
- Maximum bund Height 3.5 m AHD (3.0 + 0.5 m freeboard)
- Bunded area (100 ha) to consist of 5 x 20 ha cells to allow for PASS treatment rotation and tailwater treatment
- located at:
  - Eastern end Site A
  - Eastern End Site B
  - Middle Site B
  - Western end Site B (adjacent MYAC)
  - Southern end MYAC

A2.7 Review of DMPA Constraints and Opportunities

Following completion of the values and baseline assessments and preliminary design concept development, a workshop was convened with key CSDP technical advisors to consider and compare the characteristics of the DMPA options.

At this time, prior to the completion Dredge Material Placement Assessment Study (JFA 2017) Bulking Factor and material volume calculation assumptions were necessary in order to progress design considerations (refer **Table A2-14)**.

TABLE A2-14 REVIEW OF CONSTRAINTS AND OPPORTUNITIES – DREDGE MATERIAL PROPERTIES

MATERIAL	PROPORTION	VOLUME (M3)	PLACEMENT VOLUME (m3) @BF	CONSOLIDATED VOLUME (m3) @BF
Stiff Clay	6	50 000	75 000 (1.5)	55 000 (1.1)
PASS	30	250 000	665 000 (2.6)	500 000 (2.0)
Self-neutralising PASS (SNP)	64	52 000	1 362 000 (2.6)	1 040 000 (2.0)
Total	**100**	**830 000**		

A2.7.1 Review of DMPA Options

On the basis of the identified constraints and opportunities for the Barron Delta and East Trinity precincts, the following placement options were identified (**Table A2-15**),

TABLE A2-15 REVIEW OF DMPA OPTIONS

OPTION	NORTHERN SANDS	PNQ VOID	STIFF CLAY DMPA	EAST TRINITY	COMMENTS
1	830 000				All materials dredged and pumped to Northern Sands
2	780 000		50,000		Soft Clays pumped to NS/ stiff clays barged to disposal site at Terrestrial site (e.g. Tingira Street)
3	500 000	280 000	50 000		Part soft clays pumped to NS/ balance to another Barron Delta Void/ stiff clays barged to disposal at Terrestrial site (e.g. Tingira Street)
4	500 000		50 000	280 000	Part soft clays pumped to NS/ balance to East Trinity/ stiff clays barged to disposal at Terrestrial site (e.g. Tingira Street)
5	250 000		50 000	530 000	PASS only pumped to NS/ SNP pumped to East Trinity/stiff clays barged to disposal at Terrestrial site (e.g. Tingira Street)
6			50 000	780 000	Soft clays pumped to East Trinity/ stiff clays barged to disposal at Terrestrial site (e.g. Tingira Street)
7				830 000	All material pumped to East Trinity

The placement options include hybrid solutions of placement at both precincts (options 3, 4 and 5). The feasibility of the existing NS void to contain the bulked-up materials (Option 2) after pumping was not known and hybrid solution options were necessary. Discussions with dredging contractors at this stage indicated that pumping the stiff clay materials could increase the risk of pipeline blockage. As the pumpability of stiff clays was not confirmed at this stage, placement of all dredge materials including stiff clays at either precinct (Options 1 and 7) remained unresolved.

Subsequent dredging industry advice following the Options Study indicated that it may not be feasible to pump stiff clays without increasing the risk of pipe blockage; it was therefore necessary to identify a separate DMPA for these materials. Preliminary assessment of the dredge materials indicated that stiff clay material volumes could be in the order of 50 000 m^3; dredging methodology would entail dredging with a backhoe dredger and transfer to shore DMPA by barge and unloading to heavy haulage vehicles to a nearby placement site.

Prospective sites needed to have the following characteristics:

- as close as possible to Trinity Inlet to minimise cartage costs
- established unloading facility at or near site
- preferably be in an industrial or disturbed area
- beneficial reuse of material possible
- low environmental values
- appropriate tenure and site access arrangements.

A2.7.2 Comparison of DMPA Constraints and Opportunities

The relative environmental merits and preliminary impacts of the Barron Delta and East Trinity precincts were assessed and compared (refer **Table A2-16**).

Two potential major approval / acceptability issues (assessed as high permanent impacts) would occur with adoption of East Trinity compared the Barron Delta DMPA.

- dredge material placement on East Trinity is not compatible with Land Use (Reserve for Environmental Purposes)
- high landscape and visual amenity impact with high exposure to elevated residential areas, hotels, offices, cruise ships and flight path.

The use of East Trinity has long term (decades) legacy issues including the management of acid sulfate, rain water runoff and associated water quality and impact of bunds on localised flooding. No beneficial reuse opportunities feasible.

In comparison the Barron Delta DMPA has no long term legacy issues nor management / monitoring requirements beyond one wet season and 1-2 years ground water monitoring. The Barron site is compatible with land use and current sand extraction permit requirement to fill the void created by extraction. The Barron Delta DMPA requires no import of construction material whereas East Trinity soils are largely unsuitable for bunds and the reliance on liner is a risk.

The site comparison shows that East Trinity has five issues where medium level impacts arose compared to low to negligible for Barron (Soil/Geology, Marine Ecology, Terrestrial Ecology, Air Quality, and Cultural Heritage) compared to just one area (Dredge Logistics) where it had a slightly superior outcome.

Consideration of the relative merits, constraints, and potential impacts resulted in the Barron Delta option as the preferred site for the placement of soft clay materials and to be subject more detailed environmental impact assessment.

TABLE A2-16 CSDP DMPA VALUES AND CONSTRAINTS SUMMARY- EAST TRINITY AND BARRON DELTA

STUDY	BARRON DELTA	EAST TRINITY – REFINED*
Land Use (Geology & Soils)	Suitable construction soil present. Disturbance to PASS unlikely but manageable.	Acid Sulfate Soil management required. Above ground ponds present a legacy issue.
Land Use (other)	Compatible with rural zoning.	Potentially not compatible with Reserve for Environmental Purposes. Legacy issue
Nature Conservation Areas	Offshore Pump Out in World Heritage Area	Offshore Pump Out In World Heritage Area. Tailwater receiving environment in FHA (A) zone.
Coastal Processes	Existing immunity to storm tide~ 1%.	Existing immunity to storm tide~ 1%. Required containment bunding to 4.0m AHD will provide 10 000 year ARI immunity.
Marine Water Quality (includes Barron and sub-catchments)	Moderate salinity at Barron River Highway Bridge – may be suitable for tailwater discharge depending on outcome of baseline water quality – offshore piped discharge contingency to be confirmed.	Moderate salinity in Firewood Creek – may be suitable for bund wall tailwater discharge.
Water Resources / Groundwater	May be some impacts	Likely to be some impacts but these could be mitigated by lining.
Marine Ecology	Absence of high value ecosystems on site; adjacent marine vegetation able to be managed; in stream impacts likely acceptable depending on outcome of baseline water quality at Barron River Highway Bridge.	Likely water quality impacts on biodiversity from discharge upstream of bund; minor impact with discharge downstream of bund.
Terrestrial Ecology	Nil to limited biodiversity on site; subject to wet season survey.	Moderate biodiversity; subject to wet season survey.
Noise and Vibration	<100 m Sensitive Receptor (pipeline).	Generally acceptable buffer to sensitive receptors.
Air Quality	Acceptable buffer to sensitive receptor.	Generally acceptable buffer to sensitive receptors.
Landscape and Visual	Nil to limited impacts, however offsite tailwater pond at Smarts Farm (tbc) may cause short term high amenity impacts.	High visibility to elevated sites (hotels, cruise ships) – legacy issue.
Cultural Heritage	Buffer to Yirrganydji camp on Thomatis Creek, otherwise minimal potential impacts.	Likely impact on MYAC access to western areas.
EPBC Act Issues	Minimal potential impact on EPBC species	Minimal potential impact on EPBC species.

STUDY	BARRON DELTA	EAST TRINITY – REFINED*
Flooding Stormtide and Hydrology	Risk of sediment remobilisation – risk of afflux if mitigated by bund (tbc).	Risk of afflux to Wah Day Farm.
Dredge Design and Logistics	Extended steaming time, 8 km pumping distance.	Short steaming time, <2 km pumping distance.

*Based on refined least impact configuration – total 90 ha (Site A and truncated Site

A2.7.3 Stiff Clay DMPA

Dredging industry advice following the Options Study indicated that it may not be feasible to pump stiff clays without increasing the risk of pipe blockage; it was therefore necessary to identify a separate DMPA for these materials. Preliminary assessment of the dredge materials indicated that stiff clay material volumes could be in the order of 50 000 m^3; dredging methodology would entail dredging with a backhoe dredger and transfer to shore DMPA by barge and unloading to heavy haulage vehicles to a nearby placement site. Prospective sites needed to have the following characteristics:

- as close as possible to Trinity Inlet to minimise cartage costs
- established unloading facility at or near site
- preferably be in an industrial or disturbed area
- beneficial reuse of material possible
- low environmental values
- appropriate tenure and site access arrangements.

Ports North identified vacant port land at Tingira St Portsmith which met these criteria as shown on **Figure A2-29**.

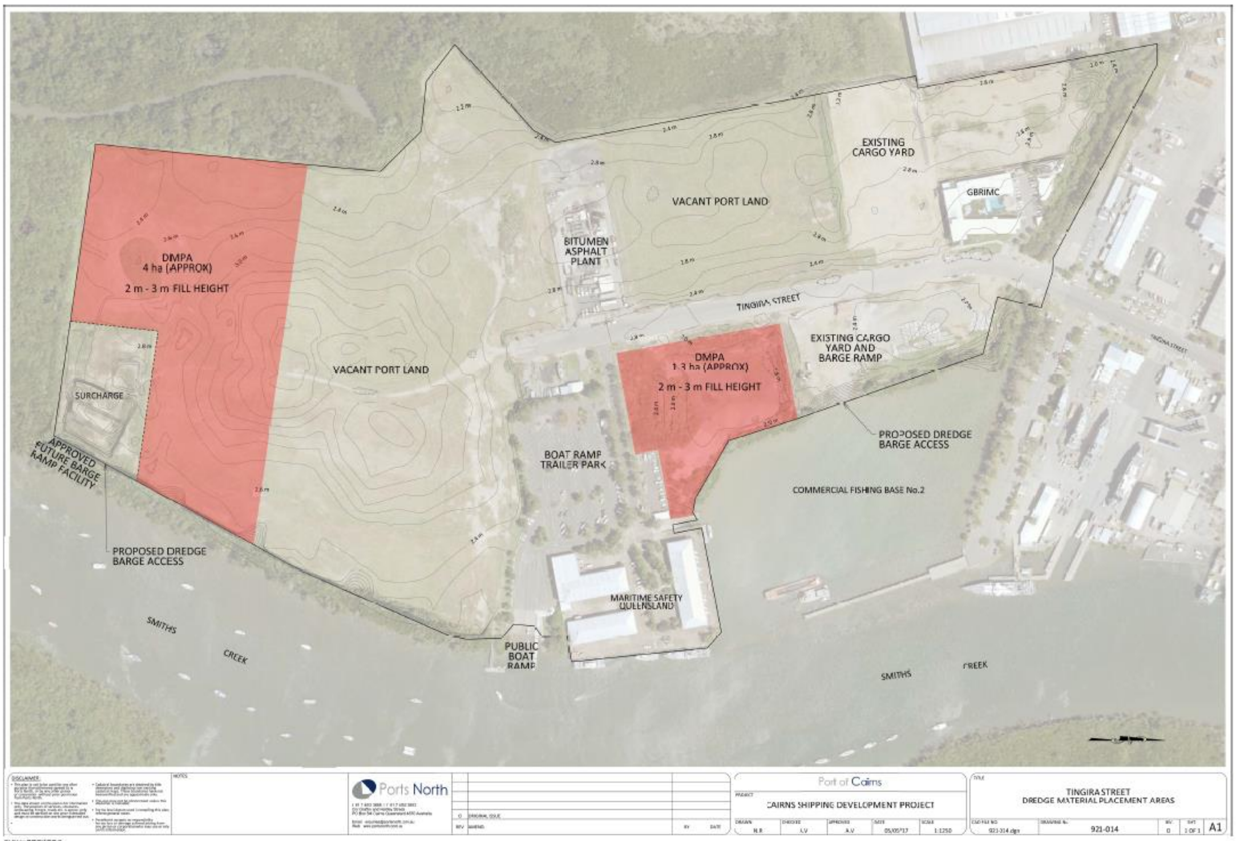


Figure A2-29 Tingira Street Stiff Clay DMPA layout.

The Tingira Street site includes two land parcels located within ‘Strategic Port Land’ on previously reclaimed Ports North lands. The land is designated under Ports Norths approved Land Use Plan for industrial uses. The land requires ground improvement via placement of temporary raised filling (surcharging) to consolidate the poor underlying soil conditions. This process has been undertaken by Ports North for developments on adjacent parcels of the land with imported fill. Further permanent cover fill will reduce the required thickness of industrial pavements as well as provide the benefit of enhanced stormtide immunity).

The placement of the stiff clay material on this site presents a beneficial re-use and low impact land improvement option. The site is bounded by Trinity Inlet to the east, commercial activities to the north and a mangrove community to the west. An existing barge ramp is located on the northern parcel and approvals are in place for a barge ramp on the southern parcel. No vegetation clearing would be necessary apart form that approved for the southern barge access ramp.

A2.8 2017 Revised Draft EIS Project

Following consideration of the shipping simulations, channel recalibration, the updated Cruise Ship Demand Analysis and Dredge Material Placement Options and a detailed review of the values assessments of the alternate placement precincts the CSDP project was revised to include the following elements to be subject to detailed investigation and impact assessment as part of the revised Draft EIS:

- Widening and deepening of the shipping channel and Crystal Swing Basin, and establishment of a new shipping swing basin (Smith Creek Swing Basin) upstream of the existing Main Swing Basin to enable future expansion of the HMAS Cairns Navy base including:
  - 8.8 m Declared Channel depth
  - Deepening of the existing Crystal Swing Basin
  - Smiths Creek Swing Basin to 310 m
  - Outer Channel width 90 -100 m
  - Inner Channel width generally to 110 m (outer bend to 180 m)
  - up to 1 000 000 m^3 total dredge material*.
- Establishment of dredge material placement areas on the Barron Delta for soft clays and Tingira St Portsmith for stiff clays to accommodate capital dredge material.
- Ancillary infrastructure upgrades including:
  - fender system upgrade to the existing cruise shipping wharves 1-5 to accommodate larger and heavier cruise ships. Decommissioning of wharf 6 including retention and upgrading of key bollards and retention of representative historic elements
  - upgrade of ship services to the cruise shipping wharves, including Intermediate Fuel Oil (IFO), potable water and fire-fighting services
  - relocation of existing and installation of new navigational aids.

*Dredge Volume increased to 1 000 0000m^3 consisting of 900 000 m^3 of soft clays and 100 000 m^3 of stiff clays to allow for dredging tolerance, survey accuracy as a worse case for dredging volumes for DMPA concept design and impact assessment. These allowances were introduced at this stage, once the channel design, dredge material types and quantities, dredging and placement methodologies were finalised sufficiently, to allow the most appropriate estimation of the required contingencies and were based on detailed assessment of channel cross sections at 250 m intervals. The soft clay contingency also includes an allowance for additional siltation that may occur in the areas of channel widening (not currently covered by annual channel maintenance dredging) in the intervening years between the time of the surveys undertaken and the time of the project dredging commencement.

The CSD Project has been recalibrated taking into account recent plans and initiatives associated with;

- The Reef 2050 Long-Term Sustainability Plan (Reef 2050 Plan). The Plan was developed in response to concerns about the management of the Great Barrier Reef (GBR) by the World Heritage Committee in 2011. It is aimed at strengthening Australia's management of the GBR and providing a blueprint for the continuing efforts to preserve it.
- The Queensland Government Maintenance Dredging Strategy (MDS) for Great Barrier Reef World Heritage Area (GBRWHA) Ports released on 30 November 2016. This addresses requirements of Reef 2050 Plan (Action WQA16) and aims to provide certainty to the ports industry and to the wider community that the economic and social contribution of ports is maintained, while ensuring the continued protection of Queensland's environmental assets.

Both initiatives were not current when the Terms of Reference for the Project were developed but are important guiding documents for planning, assessing and managing dredging in the GBRWHA. The recalibrated Project is based on ensuring consistency with associated management objectives and that future maintenance dredging at the Port of Cairns adopts long term management actions that are aligned with the MDS. Ports North is presently working with the Queensland Government to ensure future maintenance dredging is based upon a Long-term Maintenance Dredging Management Plan that address operational needs, environmental risks, monitoring and adaptive actions.

A2.9 References

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