FLANAGAN CONSULTING GROUP

DEVELOPMENT CONSULTANTS • MANAGERS • ENGINEERS • PLANNERS

PROJECT NO: 5002/02

Townsville Ocean Terminal

&

Breakwater Cove

5002/02
R-PF3946-Rev 5
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Review of Construction Issues

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1.0 INTRODUCTION

City Pacific lodged an EIS for the development of the Townsville Ocean Terminal and associated residential/commercial development in September 2007.

Responding submissions to the EIS were received from a number of government agencies, commercial organisations, clubs and private individuals.

This report documents a review of construction issues in response to submissions received relating to construction issues.

Included in the review is a consideration of the following:

- construction methods proposed (particularly for the excavation of the TOT berth pocket and extension to the swing basin)
- soil and water management within the Future Development Area (FDA),
- construction sequence,
- temporary access to the existing breakwater marina
- External Impacts including requirements for the import of material and services requirements during construction

2.0 EIS CONSTRUCTION SEQUENCE

The construction of the Townsville Ocean Terminal and Breakwater Cove Residential areas is proposed to be completed over a period of just over 3 years. The EIS identified a sequence of construction comprising 25 steps from the construction of access bunds; to the construction of a bridge to the Strand Breakwater. The steps are not necessarily sequential and many are carried out in parallel.

For the purposes of the review of construction issues, the construction sequence has been clarified and simplified to identify four (4) distinct construction stages, each involving separate and distinct construction activities to achieve construction of key elements of the project.

An indicative construction programme showing the relationship and sequence between each of the stages as identified in the EIS has been prepared. For the purposes of this review it has been assumed that construction will commence in early 2009. Construction of the residential building and built form with the Breakwater Cove precinct will continue for a number of years after completion of the Breakwater Cove land forms, roads and services. The EIS Construction programme showing the sequence of construction activities is attached in **Appendix A.**

2.1 Stage 1 – Bunding and Dewatering

This stage involves the tasks to enclose the development site with breakwaters and bunds, and to dewater the site. This stage includes the sequence steps 1 to 6 inclusive as detailed in the Hyder Construction Methodology Report section 2.2. This stage is anticipated to take 12 months.

2.2 Stage 2 Reclamation, Land Form and Services

This stage includes all tasks necessary to create the reclaimed land forms within the Breakwater Cove development and the construction of the berthing pocket and swing basin for the Ocean Terminal. This stage includes steps 7 to 24 inclusive as detailed in the Hyder Construction Methodology Report section 2.2. This will include the following key activities which will commence progressively and be carried out in parallel:

- Excavation of TOT berth, swing basin extension, marina basin, canals and access channels

- filling to create land forms
- Precast works, Engineering fill and rip rap
- Roads and services
- Landscaping
- Removal of temporary works

This stage is anticipated to commence 10 months after project construction commences and with be completed within 28 months.

At the completion of Stage 2 of the project all the reclaimed land forms will be completed including the revetment walls fronting the canals. The northern, northern outer and southern temporary bunds will have been removed and sea water introduced into the canals and marina basin. Roads and services will be installed to access and service the residential precincts of Breakwater Cove.

2.3 Stage 3 Ocean Terminal

This stage involves the construction of the Ocean Terminal Buildings, wharf and facilities, including installation of the roadwork, drainage and services infrastructure to service the Terminal. This stage is anticipated to commence 8 months after project construction commences and will be carried out in parallel with Stage 2 works and will be completed within 16 months.

The Ocean Terminal is anticipated to completed ready to commence operations within 24 months of project construction commencing.

2.4 Stage 4 Residential Dwellings and Built Form

This stage involves the construction of the residential buildings and built forms within Breakwater Cove. It is expected that this stage will commence 29 months after project construction commences will continue for a number of years after the civil engineering works to create , protect and service the Breakwater Cove precincts are completed.

3.0 REVIEW OF CONSTRUCTION METHODS

3.1 Enclosure of FDA (Placement of Rock for Outer Walls)

Given the nature of marine works and in order to achieve the desirable outcome of isolation of the construction site from the external environment and to contain the impacts of construction activity to within the site it is essential that an impermeable barrier be placed between the disturbed site and the external environment. The outer walls are required for protection of the works however can also function to isolate and contain the construction site.

The EIS identified the use of a HDPE liner to the constructed rock walls. This will be subject to review during detailed design of the operational works to consider alternate barrier or interception techniques including sheet piling, bentonite curtains etc. The existing breakwater walls are permeable and consideration will be given to providing barriers internally to the FDA together with cut off trenches or other interception techniques to avoid sea water penetration to the site or alternate uncontrolled release of site water and soil.

Once the TOT berth and the FDA are dewatered it will be necessary to prevent the entry of sea water into the disturbed site. Similarly the management of on site water and soil will require the containment of the site and the partition of the site into management areas separated by impermeable bunds.

The placement of rock for the outer rock wall is essential to protect the project and cannot be avoided. Mitigation measures to control and manage the elevated turbidity were not adequately defined in the EIS.

It is recognised that turbidity will be created when the base layer of rock is placed and the required management strategy will be to contain the elevated turbidity to the immediate work environment to ensure the process does not cause irreversible environmental harm to the surrounding environment. The use of silt curtains during material placement will be required together with appropriate monitoring and control of construction activities.

3.2 Construction of TOT berth and Swing Basin

3.2.1 Base Methodology

Construction of the TOT Berth Pocket is proposed using dry excavation techniques for the area west of the existing Port Western Breakwater. The permeability of the existing breakwater and the stability of the existing wall under hyrdo-static pressure are two issues of concern which may mitigate against successfully applying dry excavation techniques. Inability to dewater this area and / or instability of the wall may require excavation using a cutter /section dredge.

Increasing the size of the swing basin by deepening Ross Creek east of the existing Port Western Breakwater adjacent to the berth pocket is proposed via cutter suction dredge.

The feasibility of construction of the TOT berth and swing basin via cutter suction dredge needs to take the following into account:

1. Cutter suction dredging produces dredge spoil at a volume of approximately 13 times the insitu volume of material to be removed.
2. The dredge spoil will have a water content of approximately 95%.
3. Construction of the TOT berth and swing basin requires dredging of 260,000 m^3 of sediment.
4. Using cutter suction dredging will produce 3,380,000 m^3 of dredge spoil.
5. Dewatering and Disposal/reuse options for dredge spoil will require significant areas of the FDA to be available for treatment, dewatering and stockpiling.
6. Dredging between the existing Breakwater wall and the internal wall of the TOT berth pocket in the staged approach suggested in the EIS may lead to instability in the existing breakwater wall.

3.2.2 Dredge Spoil Disposal/Reuse Options

There are two options available for the disposal of dredged spoil from the TOT berth and Swing Basin:

1. Off shore disposal
2. On-site dewatering/drying and reuse on-site or disposal to approved landfill reclamation facility

The implications of each of these options are discussed below:

1. <u>Off shore disposal</u>.

Disposal adjacent to the Great Barrier Reef Marine Park is no longer viewed favourably by legislative authorities and the Commonwealth Government.

Obtaining an off shore disposal permit for disposal of dredged material for disposal of 260,000 m^3 (3,380,000 m^3 at 95% water content) sourced from the initial construction of the swing basin and/or TOT berth can not be relied on given the time required for the approval process and the complexities.

In order to obtain a permit for off-shore disposal the consideration would need to be given to the following:

- The potential to adversely impact the Great Barrier Reef Marine Park
- Public opinion
- The complexities required in obtaining permit for approval of offshore disposal of dredged material from Department of Water, Heritage and Arts(DWHA) and existing legislative climate.

To obtain a permit the following would be required:

- Undertake sediment characterisation to meet National Ocean disposal guidelines (0.5 m interval sampling and broad analysis and leaching criteria including heavy metals, nutrients and organics);
- Detailed environmental assessment of options and basis for need
- Establish Technical advisory committee of all stakeholders (DWHA, EPA, DPIF, TPA, GBRMPA)
- Undertake hydrodynamic and benthic modelling of proposed disposal site

The requirement of modelling, baseline data collection for one year and the approval process is likely to take an extended period and approval can not be guaranteed. This method of disposal cannot be relied on.

It is therefore necessary for the facility to ensure that it has the capacity to treat (if necessary) and dispose of the material generated from dredging of the Ocean Terminal and swing basin.

2. On-site dewatering/drying and reuse on-site or disposal to approved landfill reclamation facility
   Dewatering of bulk cutter suction dredge material from the Port of Townsville takes approximately 2 years to produce competent geotechnical material, without mixing. Dewatering of the considerable dredge spoil volumes that would be generated by the proposed cutter / suction dredging with impose a significant demand on the area of the FDA to be used for dredge spoil management, dewatering and stockpiling. The alienation of a significant proportion of the site will cause substantial delays to the project programme.

3.2.3 Revised Construction Methodologies

It is considered that on-site dewatering and re-use for the 3,380,000 m^3 of dredge spoil sourced from the dredging of the TOT berth and swing basin is not feasible if cutter suction or similar dredge is utilised to excavate these materials due to the limitations of space within the FDA area.

There is a need to reduce the volumes and water content to achieve project outcomes. The sediment will need to be excavated by more traditional “dry” excavation techniques to avoid the mixing of water with excavated material which is a feature of cutter suction dredge operations.

Possible options include use of a clam shell bucket or dragline or alternately installation of a barrier around the TOT berth and Swing basin to provide an isolated, dry environment where dry excavation methods can be utilised.

Use of clam shell or dragline, although feasible, would still require a larger materials handling and dewatering capacity compared to a dry excavation technique. It would also have higher environmental impacts relative to an isolate and dry excavation technique.

The utilisation of a barrier (such as sheet piles) to isolate the TOT berth area and the bulk of the extension to the swing basin has the added benefit of reducing the potential for instability in the exiting Western Breakwater wall as it will no longer be required to function as a barrier between the berth excavation and Ross Creek. If the barrier can be constructed along the alignment of the existing channel markers such that the whole of the swing basin extension can be achieved using dry excavation techniques there will be no requirement for cutter /suction dredging techniques to be utilised.

Enclosing the entire TOT berth and swing basin may impose unacceptable restrictions to Ross Creek maritime traffic. To reduce the impact to maritime traffic, the outer wall of sheet pile may be emplaced inside the outer perimeter to be excavated. If so, a small volume of cutter suction dredging will be required to complete the extension to the swing basin. Dredging of 20,000 m^3 of material from the swing basin can be completed in a relative short period (estimated 4 weeks). The dredge spoil generated (260,00m^3) can be managed (isolated and contained) within bunded areas within the FDA.

3.3 Removal of Outer Temporary Works (Bund/Rock Walls)

At completion of the construction of the marina basin and the Breakwater Cove precinct approximately 42,000 m^3 of temporary breakwater wall is to be removed. It is proposed that this material be recovered via excavator, loaded into trucks and transferred to the north of the northern breakwater. In this location it will be formed into an area suitable for storage and dewatering of dredge spoil from Operational maintenance dredging if required. In the interim it can function as an isolated bird sanctuary and fish habitat.

Detailed design of the fish habitat area and the bird sanctuary will be undertaken in consultation with DPIF and EPA.

3.4 Dredging of outer entry for new marina access

The entrance and access for the new marina requires initial dredging to allow sufficient draught for large vessels. The EIS indicted that 15,000 m^3 of material from the outer entry dredge area would be dredged using cutter suction dredge. This would produce approximately 195,000 m^3 of dredge spoil (approx 95% water content).

Two possible options are viable for the excavation of this material:

1. Sheet piling, dewatering and dry excavation.
2. Dredging

As the location is open water, sheet piling will induce increased potential for adverse noise impacts to marine environment. It will also be logistically difficult to pump and dry excavated materials as the site is separated from the enclosed FDA.

Dredging provides the preferred solution as the potential turbidity impacts can be more easily managed relative to the potential noise impacts from piling.

The material is predominantly sandy silt and can be readily dewatered and reused on-site. There is sufficient available area to dewater and dry the 195,000 m^3 of dredge spoil using a cutter suction dredge methodology. However, it is suggested that use of a clam shell bucket or drag line will provide a more practical solution with dredge spoil volumes of no more than 20,000 m^3. This would significantly reduce drying times and the volume of water requiring management and disposal within the contained FDA.

4.0 SOIL AND WATER MANAGEMENT WITHIN THE FDA

Given that off site disposal of unsuitable materials may not be available it is necessary to consider soil and water management during the construction of the project based on a philosophy of the site being self sufficient and self contained.

Management of unsuitable materials (soft clays from FDA and TOT and possibly dredge spoil from the swing basin) will involve transfer of the materials to temporary storage areas (bunded for isolation and containment) for dewatering and treatment prior to being placed at the base of the completed marina basin and canal excavations. Management of unsuitable soils involves temporary works (bunds) within the FDA for isolation and containment prior to transfer to their final placement within the completed excavated areas.

Material recovered from the dredge spoil treatment that is suitable for reuse will be placed in fill areas / land forms.

Water collected on site including the last 400mm of turbid water following dewatering of the bulk of the FDA and TOT, rainwater and ground water collected during the works together with water recovered from management of soils, dredge spoil dewatering will be required to be stored and treated through a treatment train to ensure acceptable water quality standards are achieved prior to release to receiving waters. Details of construction water quality management are set out is Flanagan Consulting Group's Report *"Water Quality Management during Construction"* (Ref R-KO0131 - Rev. 2) 7_ July 2008.

In the instance that fill or dredge spoil cannot be utilized on-site, it can be disposed to Stuart Landfill which is operated by Townsville City Council. The acceptance criteria for Vantassel Street, Stuart Landfill is presented in **Appendix C**.

Dredge Spoil or fill will need to be dried so that separation and liquefaction does not occur during transport. As a guide, this is likely to correlate to less than 20% moisture content for sand and less than 30% moisture content for clay.

Laboratory results indicate that acceptance criteria for maximum concentrations are unlikely to be exceeded. Should leaching criteria be exceeded the material will be treated with lime or an alternative fixative material within the bunded areas on-site. All material transported to landfill will be analyzed in accordance with Stuart Landfill license requirements.

5.0 CONSTRUCTION SEQUENCE

The construction sequence is proposed to be modified to reflect an isolation and containment philosophy which is designed to ensure that all material disturbed on site is managed and replaced within the FDA. The EIS did not adequately deal with management of water during construction and did not show sufficient areas for use as material storage or for a water treatment train. The original sequence was based on construction "up gradient" from north to south and generally did not demonstrate use of the site for construction water management. The sequence could also lead to potential drainage difficulties and does not facilitate staged construction of Breakwater Cove.

A revised construction sequence is shown on **Figures 1-6**. The revised sequence is generally described below:

Stage 1 Isolation and Containment (Figure 1)

FDA

- Construction of Sea Walls and Bunds
- Dewater FDA to 400mm depth
- Establish water treatment and soil storage bunds

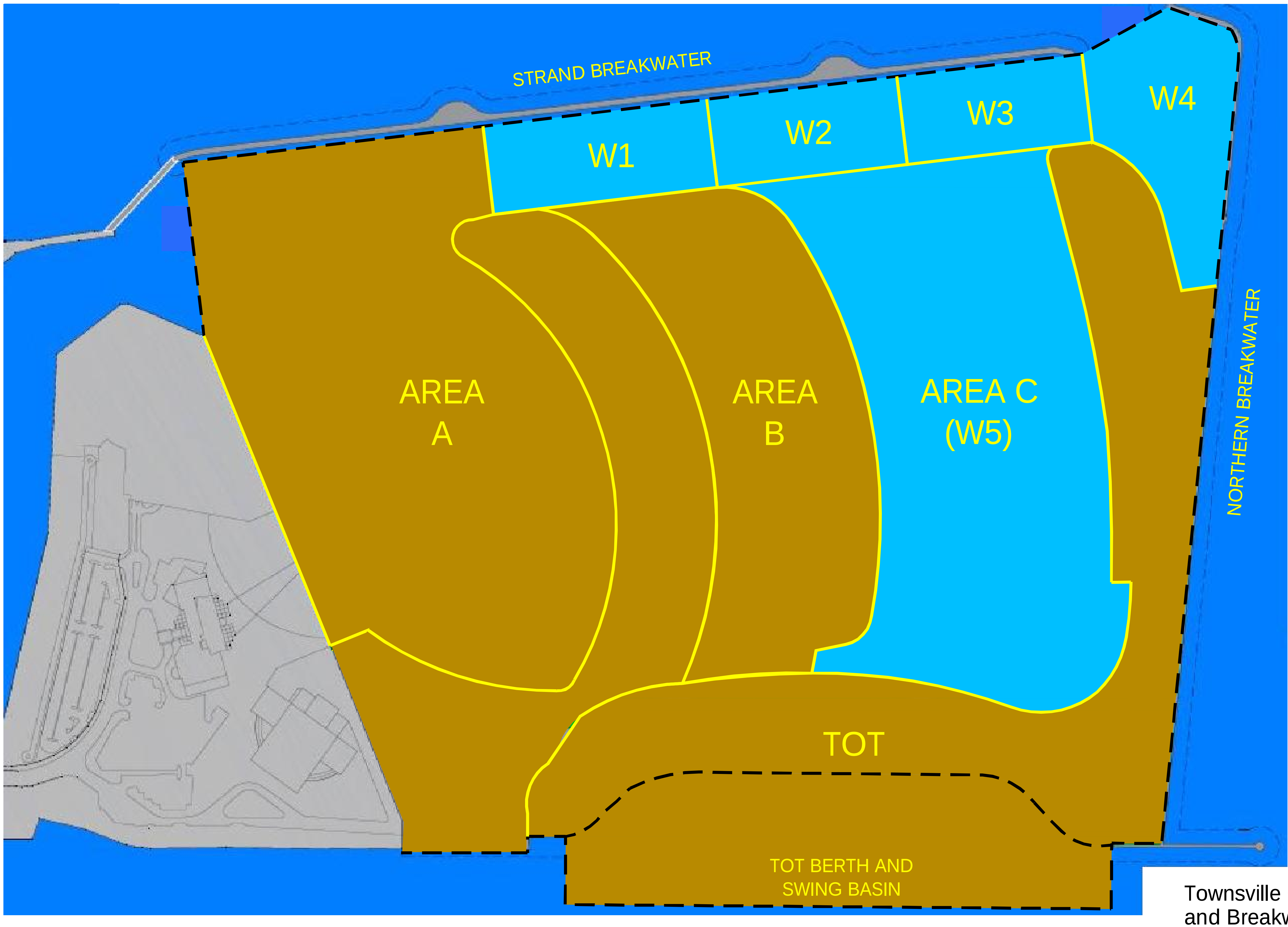
TOT

- TOT Berth/Swing basin Sheet piling
- Dewater TOT Berth/swing basin to 400mm depth

Stage 2 Land Forms

TOT (Figure 2)

- Dewater Balance water to FDA
- Transfer Soft Clay from TOT to Area B
- Excavate TOT Berth and Swing Basin
- Fill TOT Area
- Dredge to Swing Basin if required (spoil to area C)



BUND WALL

IMPERMEABLE WALL

DEWATERED AREA

WATER STORAGE/PONDS

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Townsville Ocean Terminal and Breakwater Cove

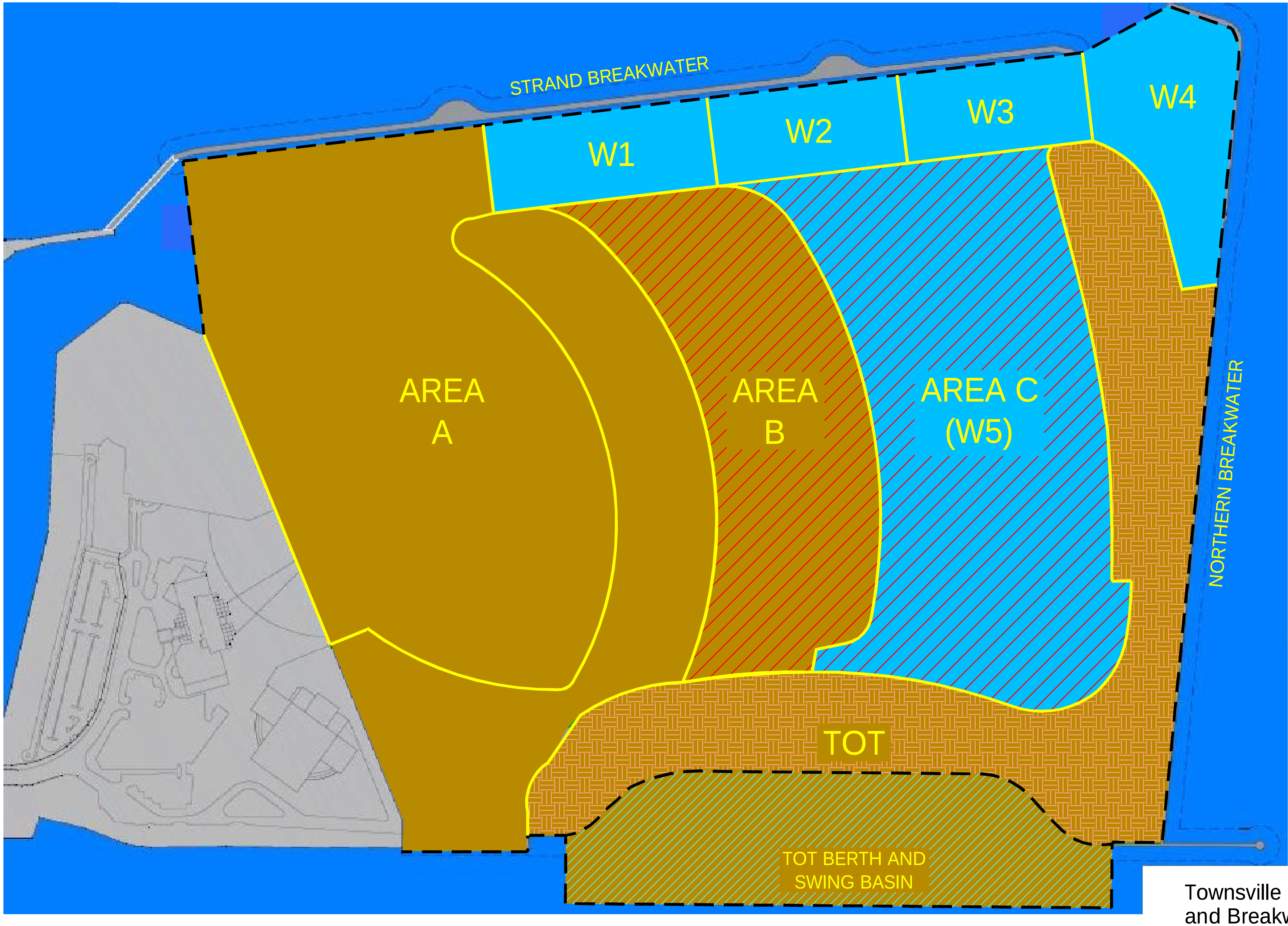
REVIEW OF CONSTRUCTION ISSUES

FIGURE 1

NOT TO SCALE

Acad No. 5002AM

30 June 2008



BUND WALL
IMPERMEABLE WALL
DEWATERED AREA
WATER STORAGE/PONDS
CUT
FILL
STORAGE

Townsville Ocean Terminal and Breakwater Cove
REVIEW OF CONSTRUCTION ISSUES
FIGURE 2
NOT TO SCALE

Acad No. 5002AN
30 June 2008

Stage 2 A (Figure 3)

- Dewater Balance water from Area A & B to W1,W2, W3 & Area C
- Transfer Soft Clay Area A to Area B
- Excavate Marina Basin and Access Channel in Area A
- Filling to Area A Land Forms and Balance of TOT Area
- Pre-cast Engineering fill and riprap
- Roads and Services
- Landscaping

Stage 2 B (Figure 4)

- Transfer Soft Clay from Area B to bottom of Marina Basin
- Excavate Area B Canal and Access Channel
- Filling to Area B Land Forms
- Precast Engineering fill and riprap
- Roads and Services
- Landscaping

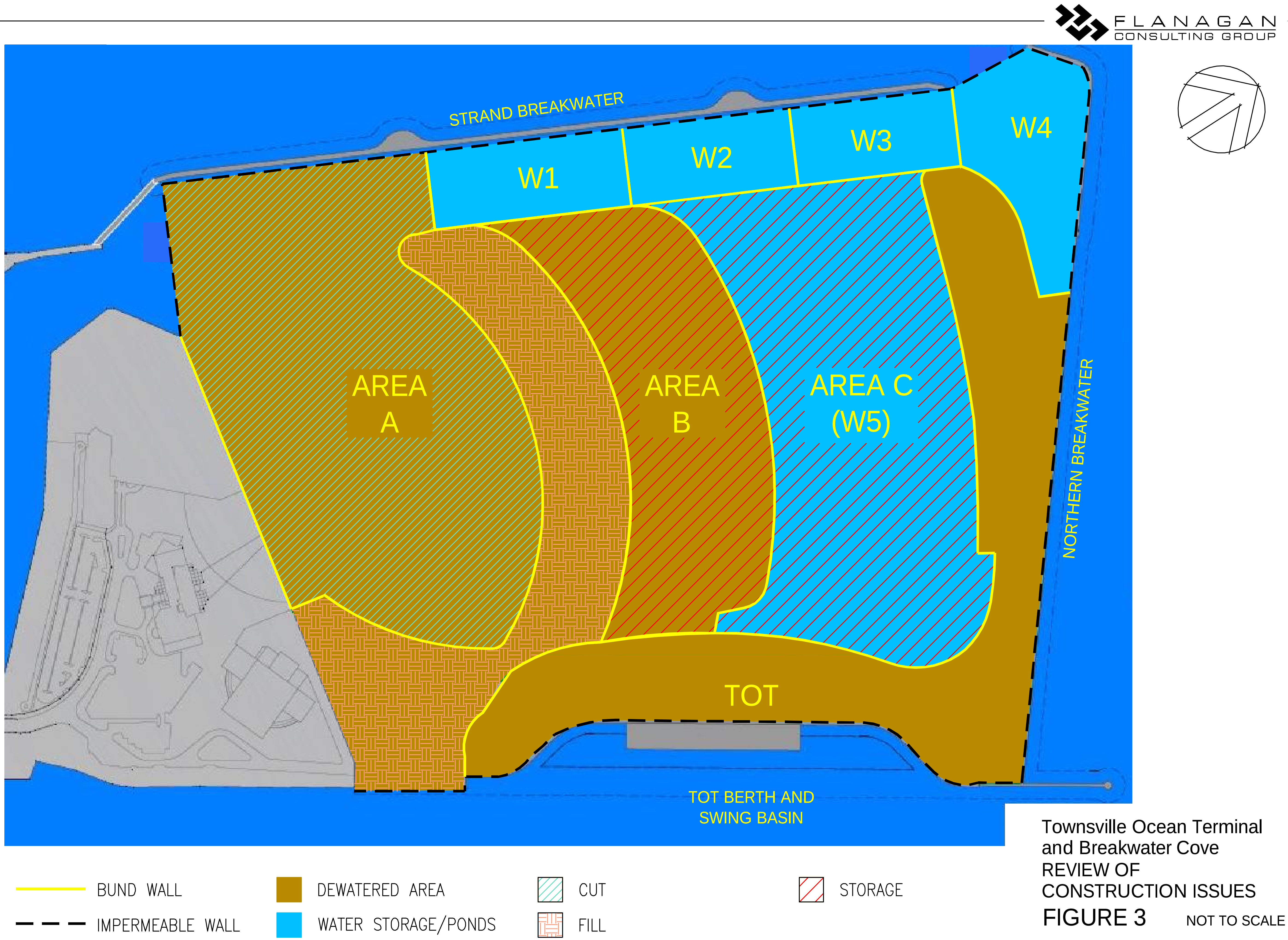
Stage 2C (Figure 5 & 6)

- Transfer Soft Clay or Dredge Spoil from Area C to bottom of Marina Basin and Area B Canal
- Excavation Area C Canals and Access Channel
- Filling to Area C Land Forms
- Precast Engineering fill and riprap
- Roads and Services
- Landscaping

Dredge Outer entrance channel

Remove Temporary Bunds Breakwaters

Construct Operational Dredge Spoil Facility



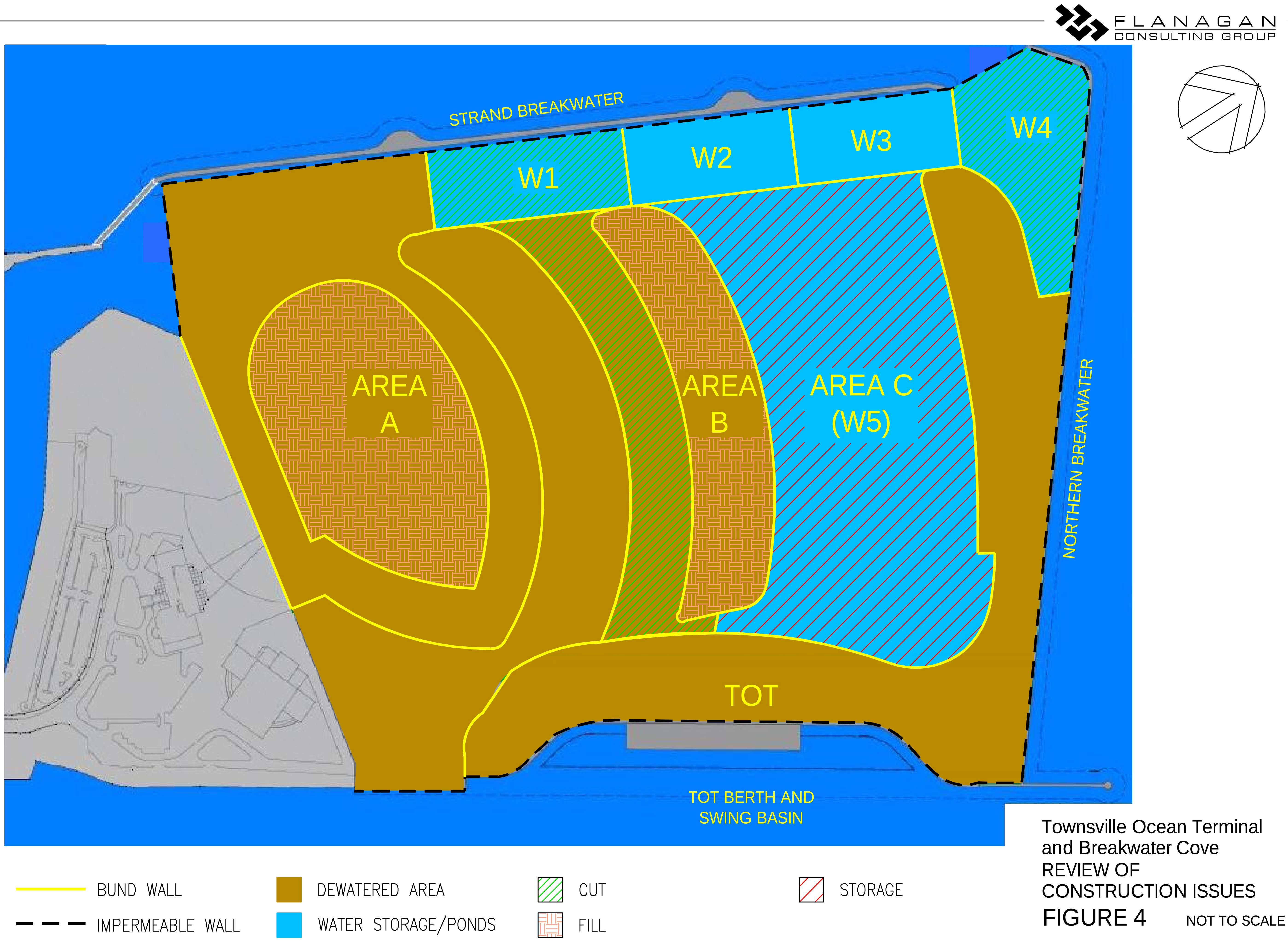
Townsville Ocean Terminal and Breakwater Cove
REVIEW OF CONSTRUCTION ISSUES

FIGURE 3

NOT TO SCALE

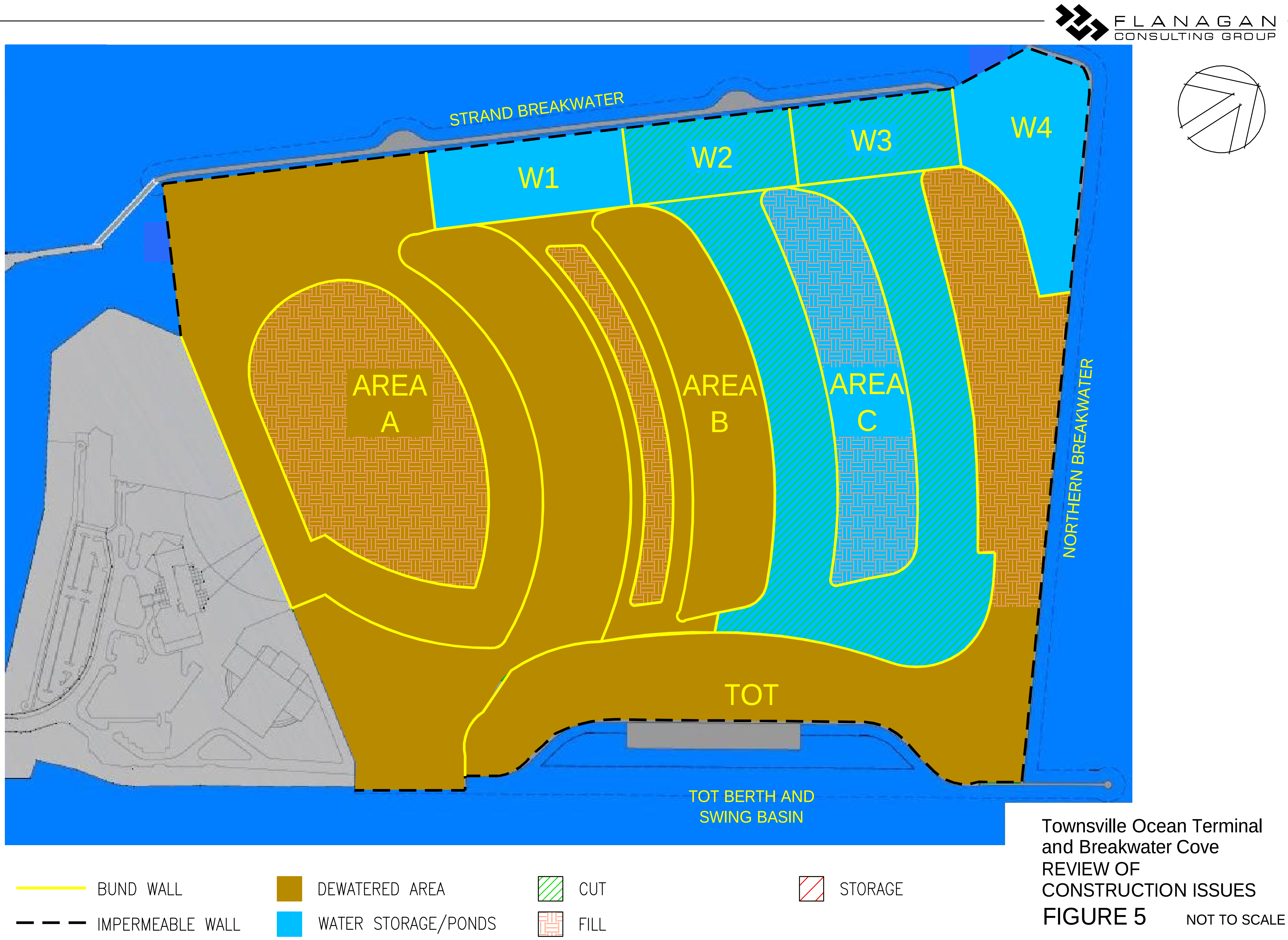
Acad No. 5002AO

30 June 2008



Townsville Ocean Terminal and Breakwater Cove
REVIEW OF CONSTRUCTION ISSUES
FIGURE 4
NOT TO SCALE

Acad No. 5002AP
30 June 2008



Townsville Ocean Terminal and Breakwater Cove
REVIEW OF CONSTRUCTION ISSUES

FIGURE 5 NOT TO SCALE

Acad No. 5002AQ 30 June 2008

Townsville Ocean Terminal and Breakwater Cove
REVIEW OF CONSTRUCTION ISSUES

FIGURE 6

NOT TO SCALE

Acad No. 5002AR

30 June 2008

Stage 3 TOT Terminal)

Stage 4 - Breakwater Cove Built Form

The revised sequence proposes construction “down gradient” from south to north such that the water treatment train is maintained “down stream” of the disturbed areas of the construction site. The water treatment train is progressively reduced as the site is developed. It allows for the balance area of the site to be used for water treatment and soil storage and treatment and subsequently progressively developed. The revised sequence can allow for Breakwater Cove to be progressively developed and for the marina precinct to be completed and operational with the balance areas progressively developed in later stages if necessary.

The revised sequence demonstrates that there are adequate areas of the site being used for water treatment prior to discharge and for the site to be isolated from the external environment and for all construction activities to be contained and controlled.

The Revised Construction programme showing the sequence of construction activities is attached in **Appendix B.** The programme for the revised sequence is consistent with the completion dates included in the original EIS programme. The dewatering, excavation and possibly storage of dredge spoil from the swing basin rely on water treatment and storage within the FDA. This will follow full enclosure and dewatering of the FDA. In order to achieve the completion of the TOT within two years, high production rates for excavation in the confined space of the TOT berth pocket and swing basin will be required.

6.0 TEMPORARY ACCESS TO EXISTING BREAKWATER MARINA

The enclosure of the Future Development Area (FDA) will involve the diversion of exiting maritime traffic accessing/exiting the Breakwater Marina to the west of the existing access channel.

The maritime traffic from the Breakwater Marina will be required to enter Cleveland Bay by sailing to the west of the Strand breakwater. The Strand breakwater is to be constructed during Stage 1 of the project construction. The effect of construction on the maritime traffic from the marina is addressed in the report *Townsville Ocean Terminal & Breakwater Cove – Impacts on Maritime Traffic (R-KO0115) – Flanagan Consulting Group May 2008.*

Depth soundings on the existing channel and the alternate temporary access show that the proposed temporary access route has a slightly deeper minimum depth compared to the existing access to the marina. As such, there is no reduced level of service to/from the current marina as a result of the proposed temporary access route.

Consequently there is no requirement for dredging of a temporary access channel to maintain the level of service to the existing marina during construction of the FDA.

7.0 IMPORTED MATERIALS

7.1 Material Requirements

The construction of the TOT and Breakwater Cove will require the importation of significant quantities of a range of materials for the exclusion of seawater from the site; reclamation of the land forms; the construction of the Townsville Ocean Terminal; and the completion of structures on the reclaimed land forms within Breakwater Cove.

Material requirements have been detailed in Hyder Consulting Report *Townsville Ocean Terminal Construction Methodology Report – September 2007 (reference F001-QL00704-QLR-05)* which was included as Appendix 5 of the EIS.

The categories of materials required for the completion of the project are:

- Armour rock for the construction of breakwaters and bunds exposed to Cleveland Bay.
- Other rock products for the core of the breakwaters and bunds; filter rock; and crushed rock.
- Sand for the installation of wick drains for dewatering of saturated material excavated from the canals within the reclamation area.
- Engineered fill for the completion of land forms.
- Building materials for the construction of the Ocean Terminal facilities and wharf.
- Building materials for the construction of dwelling/structures on the reclaimed land forms within Breakwater Cove.

The quantity of imported materials required for the construction of Stages 1 & 2 of the Townsville Ocean Terminal and Breakwater Cove has been estimated by Hyder Consulting in their *Townsville Ocean Terminal Construction Methodology Report – September 2007 (reference F001-QL00704-QLR-05)*.

An estimate of the materials required for the construction of Stages 3 & 4 has been made based on the concept plans for the Ocean Terminal included in the *Townsville Ocean Terminal Construction Methodology Report – September 2007 (reference F001-QL00704-QLR-05)*; and assumptions made on the built form of the residential and commercial buildings for Breakwater Cove. The built form has been assumed to be similar to other coastal developments in tropical Australia. The actual built form will be influenced by the entities commissioning the design and construction of the individual properties, hence the estimates of materials requirements for Stage 4 should be considered as conservative estimates only.

The external materials requirements for the Townsville Ocean Terminal and Breakwater Cove are summarised below.

Table 7.1 Construction Materials Requirements

	Armour Rock	Crushed Rock	Engineered Fill	Sand	Building Materials	Totals
Stage 1	160,300m^3	529,300m^3				689,600m^3
	256,500 t	945,500t				1,202,000t
Stage 2	120m^3	29,600m^3	292,100m^3	8,400m^3		330,220m^3
	200t	53,300t	585,100t	15,200t		653,800t
Stage 3		30,000t			12,600t	42,600t
Stage 4					52,000t	52,000t

7.2 Source of materials

7.2.1 Bulk Rock, Quarry Products and Fill Materials

Material required for establishment of the reclaimed landed forms will be sourced from within the project site. Materials required for the protection of the project site from coastal effects and construction of the civil structures required for the final land forms (Stages 1 & 2) are to be sourced external to the site from local licensed quarries.

The final choice of source for each material will be determined on logistic and economic factors, and may involve a combination of sources to service the large demand for materials by the project.

Alternate sources are as follows:

Rosneath Quarry

- Source of high quality armour rock for breakwater construction and bund facing; crushed rock for core fill and engineering structures; and filter rock.
- Owned by Cemex Australia Pty Ltd (formerly Readymix), a major quarry operator both locally and nationally.
- Rosneath Quarry is located on the Flinders Highway approximately 16km south of the Townsville CBD.
- The quarry is currently being reactivated after a cessation in operation.
- Development approval for the quarry has been issued by Townsville City Council.
- An Application to the Environment Protection Agency for an ERA to operate the quarry is currently being assessed.

Pinnacles Quarry

- Source of hard rock for armour of breakwaters and bunds; crushed rock products for non armour purposes; core fill; filter rock; and engineered fill.
- Owned and operated by CEC, a major materials supplier and contractor both regionally and locally.
- Pinnacles Quarry is located south of Hervey Range Road, approximately 30km west of the Townsville CBD.
- The quarry is fully licensed to operate for the production of quarry materials.

Marathon Quarry

- The quarry is a hard rock quarry and will supply armour rock for breakwater and bund construction; core fill; and filter rock.
- Owned by Marathon Quarries. Currently the quarry is dormant, and will be activated for the project.
- Marathon Quarries hold current development approvals and environmental approvals for the quarry.
- Marathon Quarry is located on the Flinders Highway approximately 42km from the Townsville CBD.

7.2.2 Sand Supplies

Sand input quantities required for the project are moderate and will be procured from existing licensed sand extraction leases. The identified quantity of sand required in Stages 1 & 2 is 8,400m^3.

7.2.3 Building Materials

Building materials including, concrete, reinforcement pre-cast products (including manholes and drainage structures), pipes, conduits, asphalt, paving materials, masonry blocks, bricks, timber, sheeting, fabricated timber products, steelwork, metalwork, cabling, electrical and communications facilities, finishes and fittings will be sourced from local and regional suppliers and fabricators.

7.3 Imported Materials Delivery

The delivery of significant volumes of materials for the construction of the Project presents a challenge due to the location of the project site on the seaward side of the Breakwater Peninsula east of the Townsville CBD. Current vehicular access to the existing Breakwater Marina, Casino and Entertainment Centre is limited to existing routes via the Strand or through the entertainment/recreational precinct in Flinders Street east. The location of existing bridge crossings in the centre of the CBD (Denham Street) and upstream Stanley Street and Charters Towers Road necessitates traffic accessing the Breakwater precinct to travel through the CBD.

Planning for the land reclamation components of the project considered options for importing of sand fill material via barge from sand sources remote from the site as well as reclamation of materials from within the Future Development Area. The latter option was selected following consideration of cost, logistical and environmental issues.

Notwithstanding the source of reclamation materials either option still involves the importation of the following bulk materials for Stage 1 & 2 of the Project

- Armour rock for the construction of breakwaters and bunds exposed to Cleveland Bay.
- Other rock products for the core of the breakwaters and bunds; filter rock; and crushed rock.
- Sand for the installation of wick drains for dewatering of saturated material excavated from the canals within the reclamation area.
- Engineered fill for the completion of land forms.

The EIS indicated that the preferred route for the haulage of materials from the bulk material sources generally involves the use of the existing road network designated for heavy vehicles through to the site via a temporary bridge crossing of Ross Creek to avoid heavy vehicle traffic traversing the local road network through the CBD and the developed areas of the city. Some of the submissions to the EIS have queried the route selection and suggested alternate options be considered. As part of this review a Multi-criteria analysis of the feasible haul route options has been undertaken to determine if the adopted route in optimal taking into account cost, environmental and social impacts.

8.0 HAUL ROUTE OPTIONS

Six materials delivery options have been considered as part of this review. The options are a combination of route options previously considered in the EIS, with the addition of two alternative road haul/barge options.

8.1 Road Only Delivery Options

Route 1

Route 1 to the construction site is by way of the most direct route on designated heavy vehicle haul routes on state controlled roads, culminating in Boundary Street, Benwell Road, Archer Street, Ross Street, a proposed temporary bascule bridge crossing of Ross Creek, The Strand; Sir Leslie Thiess Drive, and Entertainment Road. Refer to **Figure 7.**

Benwell Road is operated by the Port of Townsville as the primary heavy vehicle entry to the port. Archer Street, Ross St, The Strand; Sir Leslie Thiess Drive, and Entertainment Road are controlled by the Townsville City Council.

Route 1 is the preferred route identified in the EIS.

The road haulage distance from the source quarries for this option is:

- Rosneath Quarry to site by option 1 19km
- Pinnacles Quarry to site by option 1 31km
- Marathon Quarry to site by option 1 44km

Route 2

Road haul of materials from source quarries to site utilizing existing road network.

Route 2 is proposed to be by way of the most direct route on designated heavy vehicle haul routes on state controlled roads, then by Dean Street, Denham Street, Flinders Street, Wickham Street, The Strand; Sir Leslie Thiess Drive, and Entertainment Road. Refer to **Figure 7.**

Dean Street and Denham Street are State controlled roads.

Flinders Street Wickham Street, The Strand; Sir Leslie Thiess Drive, and Entertainment Road are controlled by the Townsville City Council.

The road haulage distance from the source quarries for this option is:

- Rosneath Quarry to site by option 2 18km
- Pinnacles Quarry to site by option 2 30km
- Marathon Quarry to site by option 2 43km

Route 3

Road haul of materials from source quarries to site utilizing existing road network

Route 3 is proposed to be by way of the most direct route on designated heavy vehicle haul routes on state controlled roads, then by Hugh Street, Percy Street, Bundock Street, Warburton Street, Eyre Street, Oxley Street, The Strand; Sir Leslie Thiess Drive, and Entertainment Road. Refer to **Figure 8.**

Hugh Street, Percy Street, Bundock Street, Warburton Street, and Eyre Street are part of North Ward Road, a State Controlled Road.

Oxley Street, The Strand; Sir Leslie Thiess Drive, and Entertainment Road are controlled by the Townsville City Council.

The road haulage distance from the source quarries for this option is:

- Rosneath Quarry to site by option 3 23km
- Pinnacles Quarry to site by option 3 31km
- Marathon Quarry to site by option 3 48km

The current upgrading of North Ward Road including the construction of the Eyre Street, Oxley Street intersection may coincide with the commencement of construction of Stage 1 of the project and this route to the Strand may not be available. The Strand between Oxley St and Wickham St is not geometrically suitable for large articulated vehicles.

Significant reconstruction and modification of this section of the Strand would be required which may impact on existing recreational amenity of the area which is highly valued by the community. Such modifications and loss of recreational amenity may not be acceptable to the community.

Consequentially Route 3 as originally proposed is not considered feasible for the reasons of incompatibility of the proposed use with the existing street environment. It is noted that the Department of Main Roads indicated that it would not permit the use of North Ward road for heavy haulage of bulk materials. Notwithstanding the Departments advice Option 3 has been included in the MCA analysis for completeness.

The majority of the route 3 utilises existing transportation routes, and the route is not feasible only for the proposed road links of Oxley Street and The Strand.

The modified route 3 proposed is the substitution of Denham St, Flinders St East, and Wickham Street, for Oxley St and The Strand (between Oxley and Wickham Streets). It is considered that the proposed delivery vehicles will be able to negotiate this route. The route is described on **Figure 8**.

The road haulage distance from the source quarries for this option is:

- Rosneath Quarry to site by option 3A 23km
- Pinnacles Quarry to site by option 3A 31km
- Marathon Quarry to site by option 3A 48km

8.2 Road and Barge Options

Route 4

Delivery of the project construction materials by existing road network and barge. The proposed barge loading site is adjacent to the junction of Boundary Street and Benwell Road. Materials will be stockpiled for transfer to barges operating out the Ross River mouth travelling west to the project site.

The road route from each of the source quarries is proposed to be by way of the most direct route on designated heavy vehicle haul routes on state controlled roads, including Boundary Street. Refer to **Figure 7.**

Materials delivered to the barge loading site will be stockpiled at the barge loading site.

Barges will be loaded at the facility located on the northern bank of Ross River, at the junction of Boundary St and Benwell Road. Loading and unloading of barges will be completed by the use of two front end loaders (FEL) at each of the loading and unloading sites. Duration of loading of the barges will depend on size of the barge, but will be typically 15 to 30 minutes.

The road haulage distance from the source quarries for this option is:

- Rosneath Quarry to site by option 4 16km
- Pinnacles Quarry to site by option 4 28km
- Marathon Quarry to site by option 4 41km

The barges will transfer materials to the site by a 6-7km route around the Port of Townsville entrance to the site. The final approaches to the site will require dredging to permit safe operation of loaded barges at all tides. The dredging can be minimised by the utilisation of front loading ramp barges similar to those used for servicing of inshore islands off the Queensland coast. The typical draught of these vessels is 2 metres.

Route 5

Delivery of project construction materials by combination of road and barge. The proposed barge loading facility proposed would be constructed on the southern bank of the Ross River within the road reserve for the Townsville Port Access Road, Eastern Access Corridor. Refer to **Figure 9.**

The road route considered is by way of the most direct route on designated heavy vehicle haul routes on state controlled roads to the Eastern Access Corridor. The entry to the corridor is from the Bruce Highway approximately 1km south of Cluden.

The Eastern Access Corridor is the proposed link to the Port of Townsville between the Bruce Highway and Ross River. The EAC is not yet constructed. The EAC is currently under design and is expected to commence construction in 2009 for completion by late 2011.

A temporary barge loading ramp would to be constructed on the south bank of the Ross River to load materials for delivery to the project site.

The barges will transfer materials to the site by a 6-7km route around the Port of Townsville entrance to the site. The final approaches to the site will require dredging to permit safe operation of loaded barges at all tides. The dredging can be minimised by the utilisation of front loading ramp barges similar to those used for servicing of inshore islands off the Queensland coast. The typical draught of these vessels is 2 metres

Subject to approval of the project, the transport of heavy materials for Stages 1 & 2 will commence in 2009. Stages 1 & 2 bulk earthworks operations are scheduled take 28 months from commencement. Utilisation of the EAC for delivery for this period will coincide with the EAC construction period. The Townsville Port Access Project has stringent environmental conditions to satisfy which will impinge on the availability of a haul route along the EAC. The use of the corridor in parallel with the construction of a high class road facility will introduce environmental and construction conflicts which are likely to impact on the costs of both projects. The issue of heavy haulage of materials trough a construction site for the Access road will also introduce Work Place health and Safety issues as the construction of the Port Access Road will effectively be carried out under operating traffic conditions. In order to reduce conflict it may be necessary to introduce side tracks with consequential increases in the road “footprint”, disturbance, cost and environmental impacts.

Route 5 could be viable if the construction of the Port Access road was delayed till after completion of heavy haulage for the Breakwater Cove project. Such a delay will have consequential impacts of the cost of the Port Access road and will defer the considerable economic benefits to the region which it is proposed to provide.

Based on the incompatibility of the proposed use for the EAC as a haulage route during construction of the Port Access Road; Route 5 is not considered feasible and not been further considered in the MCA of feasible options

Route 6

Delivery of project construction materials by combination of road and barge.

The road route considered is by way of the most direct route on designated heavy vehicle haul routes on state controlled roads and then onto Racecourse Road, Cleveland Bay Sewerage Treatment Plant access road, and new haul road to Cleveland Bay adjacent to Sandfly Creek. Refer to **Figure 9.**

Construction materials will be transferred to self propelled barges at a new temporary barge landing and materials transfer site adjacent to Cleveland Bay at Sandfly Creek.

Cleveland Bay is shallow in this area and a dredged channel for 2.5km will be required to ensure access for barges to the transfer site. The eastern part of Cleveland Bay is characterised by high quality sea grass beds and the impacts of dredging will be significant.

Route 6 is an additional option to those considered in the EIS and has been proposed as an alternative to the use of the EAC corridor. The potentially significant environmental impacts of establishing the barge facility and a navigable channel for transfer to the reclamation site render this Option unfeasible when there are prudent and feasible alternatives involving existing transport networks. Route 6 has not been further considered in the MCA of feasible options.

8.3 Multi Criteria Analysis of Feasible Materials Delivery Options

The comparison of divergent characteristics of Haulage options is possible by the application of Multi Criteria Analysis. Haulage options can be compared using the criteria of Cost; Transport Efficiency; Social Impact; and Environmental Impact.

Transport Efficiency for a short term materials delivery process is equivalent to the cost of delivery and consequently this criterion has been excluded from the analysis.

The construction materials delivery options for the project have been compared using the following criteria, and attributes:

- Transport Cost: including the capital cost of temporary works.
- Environmental Impacts
  - Uncontrolled activation of marine sediments
  - Greenhouse gas emission.
  - Marine mammal collision.
- Social Impacts
  - Traffic congestion
  - Traffic impact on residences and businesses.

The relative value for each attribute has been determined and ranked on a scale of 1-3 with the greatest impact option ranked 3 for the attribute. Criteria with multiple attributes have been reduced to a single ranking by summing the values ascribed for each attribute and ranking the criteria based on the summed values for their attributes.

8.3.1 Cost

The cost of construction materials delivery is comprised of the following elements:

- Road haul – cycle times for the loading, transport and unloading of materials; the operating cost of the haulage plant;
- Barge route component cost – loading; transport to the development area; unloading; cost of establishment of landing facilities.
- Fixed plant cost to facilitate haul route, including demobilisation.

Assumptions that have been utilised for the cost analysis of the options are

- Average heavy vehicle speed from Rosneath to the site 45kph
- Average heavy vehicle speed from Pinnacles to the site 45kph
- Average heavy vehicle speed from Marathon to Rosneath 80kph.
- B double side tipper wet hire rate $160.00/hr
- Semi trailer tipper wet hire rate $140.00/hr
- FEL loading times: Semi 7 minutes; B double 14 minutes
- Unloading times: Semi 3 minutes; B double
- Influence on cycle time of bascule bridge queuing 5 minutes
- Influence on cycle time of traversing Flinders St East 10 minutes
- Barge FLV with 200t capacity; $8000 per day charter cost
- Barge loading with 2xCAT966 FEL (or equivalent) 15minutes; Unloading 15 minutes
- Barge steaming time from Ross River to development area 40 minutes each way
- Total construction materials to be delivered in Stages 1 & 2; 1,856,000 tonnes.

Transportation costs for Route 1 include the estimated cost of the provision of the temporary bascule bridge, $4,500,000.

Transportation costs for Route 4 include the estimated cost of the provision of the barge landing facilities at Boundary St and at the development area. It is estimated that these facilities will cost in the order of $50,000 each. This equates to an additional cost per tonne of $0.054/t.

Barge transfer:

Loading 15 minutes + travel time (80m return) + unloading 15 minutes = 110 min.
1440 minutes per 24 hours; hence maximum trips per day = 13
FEL @ 800/day (assume crew drive loaders) x 4 = $3,200/d
13 loads @ 200t each = 2600t
Daily cost = $8,000+ $3,200 = $11,200

Therefore Barge transfer equates to $4.31/t.

Materials Source

The source of materials has not been finalised but one of the following licensed quarries will be the source of the materials for the project.

- Rosneath
- Marathon
- Pinnacles

The analysis has considered the delivery to the site from each of the proposed materials sources and by means of each of the Routes 1, 2, 3, & 4. The cost of the bascule bridge has been included in the costs for Route 1.

Option		Roseneath				
		km	road time (min)	cycle time (min)	$/t	c/t/km
1	semi	19	25.3	65.7	$8.55	$0.45
	Bdouble	19	25.3	74.7	$7.81	$0.41
2	semi	18	24	68	$6.35	$0.35
	Bdouble	18	24	77	$5.55	$0.31
3A	semi	23	30.7	81.3	$7.59	$0.33
	Bdouble	23	30.7	90.3	$6.51	$0.28
4	semi	16	21.3	52.7	$9.23	$0.58
	Bdouble	16	21.3	61.7	$8.75	$0.55

Option		Pinnacles				
		km	road time (min)	cycle time (min)	$/t	c/t/km
1	semi	31	41.3	97.7	$11.54	$0.37
	Bdouble	31	41.3	106.7	$10.11	$0.33
2	semi	30	40	100	$9.33	$0.31
	Bdouble	30	40	109	$7.86	$0.26
3A	semi	31	41.3	102.7	$9.58	$0.31
	Bdouble	31	41.3	111.7	$8.05	$0.26
4	semi	28	37.3	84.7	$12.21	$0.44
	Bdouble	28	37.3	93.7	$11.06	$0.40

Option		Marathon				
		km	road time (min)	cycle time (min)	$/t	c/t/km
1	semi	44	44.1	103.2	$12.05	$0.27
	Bdouble	44	44.1	112.2	$10.51	$0.24
2	semi	43	42.8	105.5	$9.85	$0.23
	Bdouble	43	42.8	114.5	$8.25	$0.19
3A	semi	48	49.4	118.8	$11.09	$0.23
	Bdouble	48	49.4	127.8	$9.21	$0.19
4	semi	41	40.1	90.2	$12.73	$0.31
	Bdouble	41	40.1	99.2	$11.46	$0.28

Based on the analysis of the cost to deliver materials from each of the materials sources the ranking of the feasible routes under the cost criteria is set out below:

Cost Criteria Ranking

Route	Rank
1	**3**
2	**1**
3	**2**
4	**4**

Route 2 is the optimal route to achieve the lowest cost of delivery of imported materials to the project.

8.3.2 Environmental

The environmental impact of each of the four feasible routes under consideration has been estimated by consideration of relative impacts on 3 attributes of environmental impact.

- Uncontrolled release of marine sediments; by dredging; operating craft with minimal clearances to the sea floor; Routes 1, 2, & 3 do not have a marine component and are therefore ranked equally.
- Greenhouse gas emissions; which for this comparison has been taken as proportional to the fuel consumed in the transportation of the materials by each of the 4 routes. The fuel consumption of each option has been estimated.

- Marine mammal strike; Cleveland Bay is recognised for the sea grass beds which attract dugongs; and is also recognised an important habitat for the snub finned dolphin. Mammal strike is proportional to the distance travelled in the waters of Cleveland Bay. Routes 1, 2, & 3 do not have a marine component and are therefore ranked equally.

Fuel Consumption has been estimated using the following assumptions.

- Loaded articulated vehicle average fuel economy; 1.5km/L loaded; 4 km/L unloaded.
- Barge fuel consumption 45L/hr. Steaming time 40 minutes each way.
- Front end loaders for loading/unloading barges 20L/hr each

Application of the assumptions to the known haul tasks for each of the routes leads to the following estimates of fuel used for each of the source quarries.

Route	***Estimated Total Fuel Consumption (L)***			
	Rosneath	**Pinnacles**	**Marathon**	**Average**
1	923,600	1,506,900	2,138,800	1,523,100
2	875,000	1,458,300	2,090,200	1,474,500
3	1,118,000	1,506,900	2,333,300	1,652,700
4	1,706,000	2,289,100	2,921,000	2,305,300

Based on the analysis of the potential environmental impacts resulting from delivery of materials from each of the materials sources the ranking of the feasible routes under the environmental criteria is set out below:

Route	Sediment	Emissions	Mammal	Sum	**Rank**
1	1	2	1	4	**2**
2	1	1	1	3	**1**
3	1	3	1	5	**3**
4	4	4	4	12	**4**

Route 2 is the optimal route to achieve the lowest environmental impacts however the relative difference in emissions between options 1, 2 & 3 is marginal and all three could be ranked equally.

8.3.3 Social

The attributes of the social impacts criterion of the materials haulage for the Townsville Ocean Terminal project are considered to be impacts on the amenity of road users through increased congestion on the haulage routes; and the impacts on the residents and businesses that are adjacent to the haul routes.

All of the materials delivery routes involve transport by road through parts of the Townsville City. The relative effect on congestion to other road users has been ranked by considering the number of intersections the haul vehicles have to traverse and impact on marine traffic in Ross Creek. The least number has the least effect on traffic congestion.

The relative traffic nuisance on neighbouring properties to the haul routes has been gauged by ranking the routes in accordance with the number of residences and businesses along the routes. The greater the number the higher the relative social nuisance attributed to the route.

The relative positions of the routes for the social impacts attributes are summarised below.

Route	Congestion	Nuisance	Sum	**Rank**
1	2	3	5	**2**
2	4	2	6	**3**
3	3	4	7	**4**
4	1	1	3	**1**

Route 4 is the optimal route to achieve the lowest social impacts.

8.4 Comparison of Feasible Options

The selection of a preferred option for the delivery of materials to the construction site will be the result of an assessment of which of the Criteria is more important. This assessment is not appropriate at this time.

In the event that minimisation of the project cost is the primary selection criterion, then **Route 2** can be considered the optimal route however its adoption would come with a social impact premium over Routes 1 and 4.

In the event that minimisation of environmental impacts is the primary selection criterion, then **Route 2** ranks as the route with the least impact however it is only marginally better than routes 1 and 3.

In the event that minimisation of social impacts is the primary selection criterion, then **Option 4** ranks as the route with the least social impact however its adoption would come with an environmental and cost premium over other options.

An unweighted comparison of the feasible haul route options is shown below;

Route	Cost	Environmental	Social	Sum	**Rank**
1	3	2	2	7	**2**
2	1	1	3	5	**1**
3	2	3	4	9	**3**
4	4	4	1	9	**3**

The unweighted comparison reveals that the optimum route is Route 2. The EIS identified Route 1 as the proponents preferred haul route. It is ranked 2 in the unweighted comparison. It is noted that selection of Route 1 results in a cost premium and marginally increased environmental impacts however with significantly reduced social impacts in terms of congestion and nuisance.

The Multi-Criteria analysis conducted as part of this review indicates that the preferred route adopted by the proponent represents a reasonable trade off of cost and environmental impacts against the benefit of reduced social impact.

8.5 Further consideration of Route Option 1

In response to a significant number of submissions received on the EIS regarding the potential impacts of the temporary bridge crossing on Marine Traffic in Ross Creek and on residential properties in close proximity to the temporary bridge the proponent has investigated alternate locations and methods of crossing Ross Creek.

Option 1A was discussed with the management of the Port, Port engineering and Captain John Preston the Regional Harbour Master (RHM). Both the Port and the RHM were comfortable with Option 1A in principle. Both alternatives will require formal approval of both the TPA and the RHM. Option 1A will be designed in detail and a submission made to the TPA and the assessment manager on Port land after the EIS is approved.

Figure 7 shows Route Option 1A Route which is a possible modification to Route Option 1. The modification could involve relocating the crossing of Ross Creek downstream towards the mouth and replacing the temporary bridge crossing of Ross Creek with a barge crossing. The alternate Route Option 1a will remove the requirement for road haul along the southern end of The Strand, Sir Leslie Thiess Drive and Entertainment Road. The haul route will extend on the eastern side of Ross Creek along Ross Street and Lennon Drive to a temporary barge loading facility on the eastern bank of Ross Creek. Materials can be delivered to the site by crossing Ross Creek by barge to an unloading facility adjacent to the materials handling area to be constructed at the end of Entertainment Road in the SE Corner of the FDA site.

Two alternate locations for a downstream barge crossing have been identified including a barge loading facility at the corner of Lennon Drive east of the Harbour Masters office. This will involve the construction of a ramp to facilitate the loading and unloading of a barge or barges. The barge will then sail down the Ross Creek to the site where a ramp will be constructed within the site. That means that the ramp design will be such that the barge while loading/unloading will be well outside the Ross Creek channel.

An alternative location for this ramp has been identified with the Port and the Regional Harbour Master at the end of Berth 10. This location will allow a non motorised, chain driven barge to cross Ross Creek to the site, or alternatively a motorised barge. This alternative has still to be finally approved by the Port, but, has the advantage of being the shorter trip across Ross Creek. This option will involve minimum crossing time and will cause minimal disruption to Ross Creek maritime traffic.

The possible locations of the temporary barge facilities and details of the proposed ramps are included in **Appendix D**.

Route Option 1 A will involve a slightly shorter haul route however the barge loading, crossing and unloading may result in a slightly longer haul cycle time compared to the temporary bridge crossing. The capital costs savings that could result from avoiding the construction of the temporary bridge will be offset by the costs of construction of loading ramps and barge loading and unloading facilities as well as barge acquisition. The cost /tonne of material delivered is likely to be similar to the costs involved if the temporary bridge (Route Option1) is used.

Route Option 1A may involve slightly higher environmental risks that Route Option1. The use of a barge will involve some risks of disturbance of sediments in Ross Creek however as the barge will be operation at the deeper reaches of Ross Creek or within the Port the potential for sediment disturbance will be very low.

Similarly the use of a barge will have increased risk of marine mammal strike compared to a bridge crossing. Given existing maritime traffic at the mouth of Ross Creek the potential for marine mammals to be present at the location of the barge is very low.

The use of the barge will involve potentially increased emission due to the operation of the barge and the stopping and starting of the haul trucks as part of the loading and unloading. The potential for increased emissions will be somewhat offset by the shorter haul route involved.

In terms of social impact Route Option 1A will have significantly reduced impact on residences and business in proximity to the temporary bridge and significantly reduced potential of congestion and nuisance on traffic in the Breakwater Precinct. Route Option 1A would utilize Ross Street and Lennon Street which are relatively lightly trafficked compared to the Strand, Sir Leslie Thiess Drive and Entertainment Drive.

Based on the above if Route Option 1A is included in the Multi-criteria analysis of route options it would rank slightly below Route Option 1 in terms of cost and environmental risks however would rank considerably better on social impact criteria.

If significant weight is placed on the social impact criteria it is likely that Route Option 1 A would rank above Route Option 1 & 2 and would therefore be the preferred option.

9.0 CONSTRUCTION IMPACTS

9.1 Haul Route Pavements

The haul route identified is utilises a combination of state controlled roads and local streets.

The state controlled roads that would comprise the preferred haul route is dependent on which quarry is used for the source of the materials for the project. All the possibilities are:

- Flinders Highway
- Hervey Range Road
- Ross River Road
- Nathan St
- Dalrymple Rd
- Woolcock St
- Boundary Road
- Bruce Highway
- Abbott St, Railway Esplanade

The local roads included in the preferred route are

- Benwell Road
- Archer St
- Ross St
- The Strand
- Sir Leslie Thiess Drive
- Entertainment Rd

The approximate number of equivalent standard axles to be applied to the road pavements is 450,000 ESA. The estimate is based on the following assumptions;

- Stage 1 and Stage 2 materials – total 1,850,000 tonnes
- 50:50 split between B triple and semi trailer trucks.
- 8.9 ESA/B train and 6.5 ESA/ semi trailer
- Maximum legal loads for all trucks.

The major segments of the proposed haul routes are state controlled roads. Consultation with the Department of Main Roads has provided the pavement design traffic for some of the road elements proposed for the preferred haul route. The pavement design traffic estimates are summarised in **Table 9.1**

The impact of the materials haul task on the road network elements utilised for the transport of the materials is the potential accelerated consumption of pavement design life. The typical design life for a highway flexible pavement is 20 to 25 years. For the purpose of this analysis it is assumed the design life for all the road elements is 20 years (240 months).

In the case of Townsville City streets, Archer Street and Sir Leslie Thiess Drive, in the absence of the actual design traffic assumptions for the street pavements, an estimate of design pavement traffic has been made based on recent traffic counts (Archer Street at railway crossing 1000vpd with 6.6%CV – 2006; Sir Leslie Thiess Drive 7114vpd with 4.4%CV – 2005).

Table 9.1 Pavement Design Load for Haul Road Links

Road Link	Design ESA
Hervey Range Road 83A	$4x10^6$
Ross River Road 612	$5x10^6$
Nathan St 10L	N/A
Woolcock St 832	$1x10^7$
Flinders Highway 14A	$6.1x10^6$
Boundary St 832	$1x10^7$
Archer St	$2x10^{6}$ *
Sir Leslie Thiess Drive	$4x10^{6}$ *

The impact of the proposed haulage of construction materials can be expressed as consumption of an equivalent period of the design life of the road link. It should be recognised, however, that the haulage of the construction materials for Stage 1 and Stage 2 will be spread over at least 27 months.

The vehicles to be utilised for the transport of the project construction materials will be legally registered for use in Queensland. The registration fees for heavy vehicles are structured to reflect the relative impact each vehicle has on the national and state flexible pavement road network.

The estimated proportion of the pavement design life for each of the road links 'consumed' by the delivery of construction materials is summarised in **Table 9.2**. Not all of the road links will be utilised, the final selection of material source will determine which haul route to Boundary St will be adopted.

Table 9.2 Estimated Equivalent Design Life of Construction Materials Haul

Road Link	Design ESA	Proportion of Design Capacity Consumed
Hervey Range Road 83A	$4x10^6$	11%
Ross River Road 612	$5x10^6$	9%
Nathan St 10L	N/A	
Woolcock St 832	$1x10^7$	4.5%
Flinders Highway 14A	$6.1x10^6$	7.4%
Boundary St 832	$1x10^7$	4.5%
Archer St	$2x10^6$	23%
Sir Leslie Thiess Drive	$4x10^6$	11%

With the exception of Archer Street the haulage of construction materials to the project site will consume a relatively small proportion of the pavement design capacity.

If Route Option 1A is implemented it is likely that the proportion of pavement design capacity consumed in Lennon Street will be similar to Archer Street.

Mitigation of the impact of construction materials haul traffic on road network pavements may be achieved by:

- Installation of additional capacity in the pavements prior to commencement of the construction materials transport.
- Restoration of pavement structural capacity at the completion of the materials transport.
- Negotiation of Infrastructure Agreements under the Integrated Planning Act with the agencies that operate the road network elements for mitigation of the impact by installation of capacity; restoration of capacity; or payment for consumed capacity.

9.2 Services

Construction of the Townsville Ocean Terminal and Breakwater Cove will require the support of infrastructure services as an input during the initial construction period (Stages 1 & 2 until such time a permanent connection to the services networks are implemented.
It is conservatively estimated that interim services during the initial construction will be required for up to 3 years.

Services required include:

- Water
- Waste water.
- Electricity

Water

Water will be required for the construction labour facilities and for construction purposes including dust suppression and compaction during Stages 1 & 2.

The construction labour force for the first 3 years is estimated in the EIS as follows.

Table 9.3 Estimated Construction Personnel Numbers

	Average	Peak
Year 1	50	50
Year 2	188	225
Year 3	200	300

The estimated water demand for the period of the project construction to service the construction personnel is:

Table 9.4 Estimated Water Demand for Construction Personnel

	Water Demand kL/day
Year 1	1.5
Year 2	14.4
Year 3	19.2

Construction process will require water for compaction of materials. Materials won from the floor of the project site will be sufficiently moist to achieve design compaction. Imported materials will require the addition of water to achieve optimum compaction. Rock materials will not require additional water; however, engineered fill and pavement materials will require an estimated 10% and 5% additional moisture respectively.

The infrastructure services for the project will mostly be buried in the engineered fill on the reclaimed land forms. The water used for the compaction of the engineered fill will be sweet water to minimise the long term deterioration of buried services.

The water required for construction is approximately 400L/m^3 including dust suppression and ancillary activities. The estimated quantity of water required for civil construction is 117,000kL (average 390kL/day peak 600kL/day) during year 2 and 5,500kL in year 3.

Construction water can be provided via a connection to the existing water supply network in the locale. Provision of on site storage of construction water will permit the draw off from the existing network during off peak periods (i.e. overnight) to avoid impacts on periods of peak instantaneous demand on the existing network. These details can be considered during operation works design.

Sewerage

The construction workforce will generate sewage at the construction facilities which will be located near the end of Entertainment Road. The number of equivalent persons (EP) represented by the construction workforce has been estimated from the workforce estimates; and the standard allocation of ablution facilities for construction workforces.

The estimated wastewater flows from the construction facilities during the construction of the Townsville Ocean Terminal are estimated from the nominal wastewater flow per EP in Townsville City (230L/EP/day DWF) and summarised in **Table 9.5**.

Table 9.5 Estimated Waste Water Generation (DWF)

	Waste Water kL/day
Year 1	0.35
Year 2	5.5
Year 3	7.4

The sewerage pump station (PS1A1) at the intersection of Sir Leslie Thiess Drive Entertainment Road currently has capacity to receive the waste water flows from the construction stages of the Townsville Ocean Terminal Project. Townsville City is planning an upgrade of capacity of PS1A1 to cater for waste water from proposed development of the Breakwater Peninsula and the Townsville Ocean Terminal.

Electricity

Electricity demand by the construction of the Townsville Ocean Terminal and Breakwater Cove will be primarily the energy necessary to service the construction personnel facilities and project offices.

Ergon Energy is in the process of installing increased capacity to the Breakwater Peninsula area, and electricity supply for construction facilities will be available.

9.3 Environmental Impacts

The impact to the environment during construction has been considered in detail in the report *Townsville Ocean Terminal & Breakwater Cove – Review of Environmental Management Plan (R-KO0116) – Flanagan Consulting Group May 2008.*

Particular construction generated impacts are addressed as follows:

Environmental Impact	EMP Element
Noise	CEMP Element 1
Air Quality (Dust & Greenhouse Gases)	CEMP Element 2
Water and Sediment Quality	CEMP Element 5
Stormwater & Erosion and Sediment Control	CEMP Element 6
Flora and Fauna	CEMP Element 7
Weed Control	CEMP Element 8
Acid Sulphate Soils (ASS)	CEMP Element 9
Waste Minimisation	CEMP Element 13
Dangerous and Hazardous Substances	CEMP Element 14
Site Rehabilitation and Decommissioning	CEMP Element 15
Safety and Hazard Management	CEMP Element 16

The impact of construction on water quality of surrounding waters is potentially significant. An in depth review of the water quality aspects of the construction of the Townsville Ocean Terminal and Breakwater Cove is addressed in the report *Townsville Ocean Terminal & Breakwater Cove - Water Quality Management during Construction* (*R-KO0130)* – Flanagan Consulting Group June 2008.

The construction contractor appointed for the project will be required to prepare contractor construction and environmental management plans to address each of the elements and to achieve each nominated performance criterion.

9.4 Social Impact

The social impact of the Townsville Ocean Terminal and Breakwater Cove construction has been considered in *Townsville Ocean Terminal & Breakwater Cove – Review of Environmental Management Plan (R-KO0116) – Flanagan Consulting Group May 2008.*

Construction management plan outlines have been developed to address the impacts and mitigation strategies.

Social Impact	EMP Element
Noise	CEMP Element 1
Residential Amenity	CEMP Element 3
Cultural Heritage	CEMP Element 10
Visual Amenity	CEMP Element 11
Landscaping and Open Space	CEMP Element 12

The construction contractor appointed for the project will be required to prepare contractor construction and environmental management plans to address each of the elements and to achieve each nominated performance criterion.

9.5 Maritime Traffic

Construction of the Townsville Ocean Terminal and Breakwater Cove will affect maritime traffic entering and exiting the Breakwater Marina; and maritime traffic within Ross Creek.

The preferred materials haul route for the reclamation of the site includes the construction and operation of a bascule bridge over Ross Creek during construction Stages 1 & 2.

The impact on the maritime traffic in Ross Creek of construction of the project has been identified, and mitigation measures identified, in the report *Townsville Ocean Terminal & Breakwater Cove – Impacts on Maritime Traffic (R-KO0115) – Flanagan Consulting Group June 2008.*

The maritime traffic from the Breakwater Marina will be required to enter Cleveland Bay by sailing to the west of the Strand breakwater. The Strand breakwater is to be constructed during Stage 1 of the project construction. The effect of construction on the maritime traffic from the marina is addressed in the report *Townsville Ocean Terminal & Breakwater Cove – Impacts on Maritime Traffic (R-KO0115) – Flanagan Consulting Group June 2008.*

9.6 Traffic

Traffic accessing the Townsville Ocean Terminal and Breakwater Cove construction site are categorised into 3 categories

1. Mobilisation of major construction plant to the site.
2. Commuting of construction personnel to the site.
3. Materials delivery from the designated sources to the site.

Construction plant to be utilised for reclamation and construction of the land forms range in size up to 100 tonne hydraulic excavators. Mobilisation of the large plant items will necessitate the use of over-dimensional loads. Such loads are regulated by Queensland Transport and will be delivered in accordance with permits granted, at times to minimise the effect on traffic in the Townsville city.

The proposed plant for the construction task is listed in section 2.3 of the *Townsville Ocean Terminal Construction Methodology Report – September 2007 Hyder Consulting (reference F001-QL00704-QLR-05)*, included in the EIS submission.

The proposed construction personnel numbers for the project are summarised in **Table 9.3**. It is expected that many of the construction workers will commute to the site daily in personal vehicles. Working hours for the project will be in accordance with Townsville City Council development conditions. Working shifts will be configured within the approved working hours to ensure construction personnel commuter traffic movements are not coincident with traffic peaks experienced in the Townsville CBD.

Materials delivery to the project site is proposed by means of registered road vehicles using designated transportation routes from the designated licensed source quarries. The frequency of delivery vehicles accessing the site has been estimated at 5.8 vehicles per hour (1 vehicle per 10.4 minutes) in Stage 1, and 6.9 vehicles per hour (1 vehicle per 8.7 minutes) in Stage 2. (Section 5.2.1, Table 10 of *Townsville Ocean Terminal Construction Methodology Report – September 2007 Hyder Consulting*). The proposed traffic volumes of materials delivery vehicles can be absorbed on the designated routes.

The major intersections on the designated routes are signal controlled with complete signal cycle times in the order of two (2) minutes. The proposed frequency of deliveries of the construction materials will mean that only one project materials delivery vehicle will be queued at any individual controlled intersection along the designated route at any one time. The proposed frequency of delivery vehicles is not expected to have adverse impact on congestion of intersections along the designated haul routes.

10.0 CONSTRUCTION MANAGEMENT

The construction contractor engaged for the construction of the Townsville Ocean Terminal and Breakwater Cove project will be required to prepare detailed construction management plans.

The management plans will include as a minimum:

- Environmental MP
- Construction MP
- Water Quality MP
- Traffic MP
- Emergency MP

One of the emergency scenarios that will be considered will be the effects of a major tropical storm during the construction phase. The outer breakwater for the development area is designed to withstand a 100 year average recurrence interval event. The probability of an event of this size occurring in any one year is approximately 0.01. The period of the construction phase of the project where the interior of the development site is drained of water is approximately 2.5 years. The probability of the design event occurring during the drained phase of construction is approximately 0.025. It follows that the probability of an event that will top the walls is less than 0.025, an unlikely occurrence.

Early warning of major storm systems is such that a period of at least some days warning will occur. It is expected that the Emergency MP will include the removal of personnel, plant and equipment and securing the development area until an official all clear is given. This is no different to the procedures that currently apply to all construction sites in the region and is standard practice in Northern Australia

The possible effects of the development area being flooded during construction are

- Inundation of partially completed works; requiring drainage and treatment of a similar quantity of water as at the completion of Stage 1.

- Potential breakwater damage from a localised breach of the wall. The Emergency MP may consider the deliberate flooding of the site to protect against breaches in the breakwater walls. The Emergency MP will address the predicted storm magnitude that will trigger such protective measures.

In its submission on the EIS the Townsville City Council references advices on Coastal Issues from Bruce Harper – Managing Director of Systems Engineering Australia. In the advice relating to construction risk it is suggested that an appropriate risk treatment for all tropical cyclone related risks during construction would be to “avoid the tropical cyclone season”. Such a risk management strategy would be grossly conservative and would represent an avoidance of risk rather than management of the risks and adoption of appropriate responses. If such a strategy was to apply throughout the region the construction industry would be required to shut down for the period November – May to avoid cyclone risks. This would effectively consider an extreme cyclone as a certainty. Adoption of such a strategy would require Councils and agencies in the region to also enact their emergency management plans over the period. It is unlikely that Council and agencies would implement evacuation of at risk areas for the entire cyclone season simply to avoid the risk.

The suggested risk management strategy is impractical and does not reflect established construction industry or indeed civic practices in the management of extreme weather risks.

11.0 CONCLUSIONS

Following a review of the construction issues the following conclusions can be drawn:

1. Due to limitations on the availability of off site disposal sites alternate construction methodologies are required to reduce the potential for large volumes of dredge spoil to be managed, dewatered and stored on site.
2. Management of soil and water on site should be based on an isolate and contain construction philosophy
3. A revised sequence demonstrates that there are adequate areas of the site being used for water treatment prior to discharge and for the site to be isolated from the external environment and for all construction activities to be contained and controlled.
4. The analysis of the haul route options by the multi criteria analysis has shown that the preferred route, Route 1, is a reasonable compromise between increased cost to the project (when compared to Routes 2 and 3); reduced environmental impacts (when compared to Route 4); and reduced social impacts (when compared to Routes 2 and 3).
5. Route Option 1 may be able to be modified by the relocation of the crossing of Ross Creek further downstream and the use of a barge in lieu of a temporary Bridge
6. Route Option 1A will have significantly reduced impact on residences and business in proximity to the temporary bridge and significantly reduced potential of congestion and nuisance on traffic in the Breakwater Precinct.
7. The construction of the Townsville Ocean Terminal and Breakwater Cove is feasible utilising equipment, labour and materials readily available in the local market.
8. The environmental impacts, social impacts, and responses to extreme events can be adequately managed by current construction management practices, which include specific construction management plans to address the processes to be instigated to mitigate adverse impacts of construction.

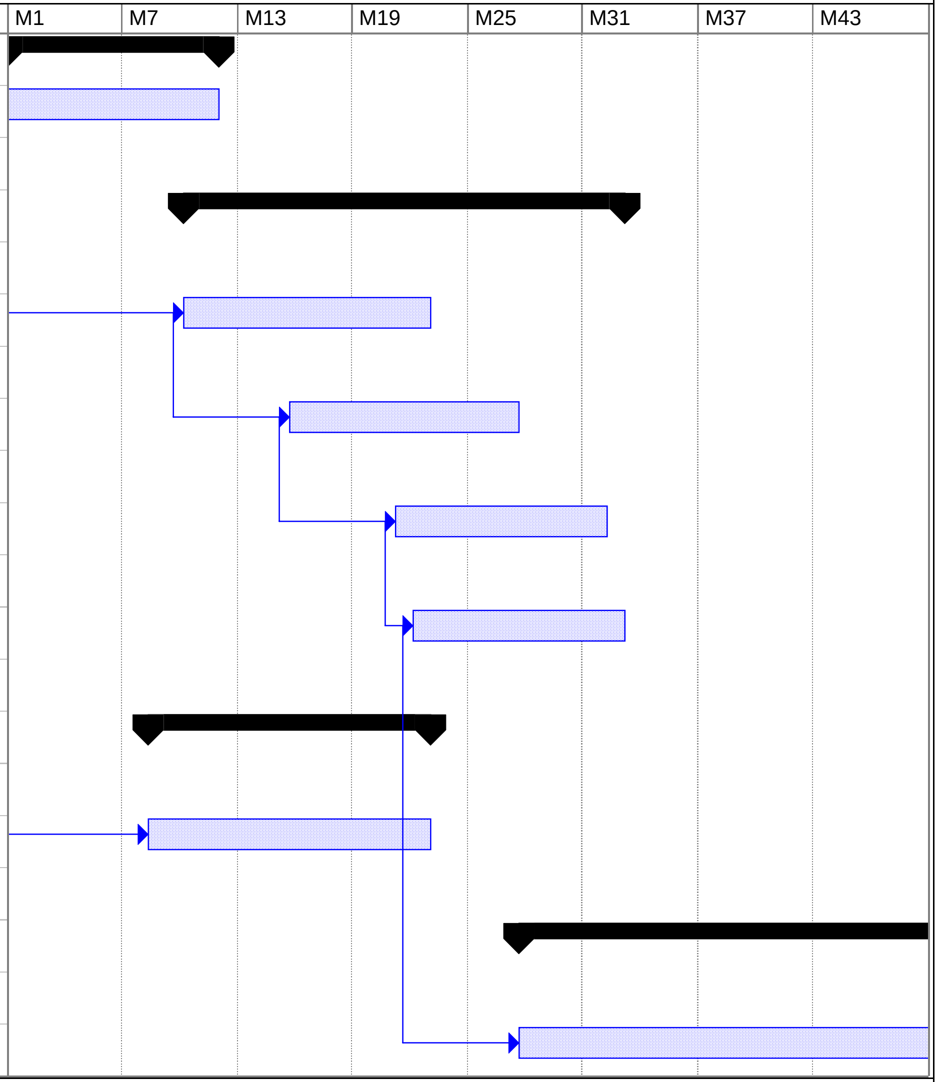
APPENDIX A

EIS CONTRUCTION PROGRAMME

Townsville Ocean Terminal & Breakwater Cove
EIS Construction Programme

FLANAGAN CONSULTING GROUP

ID		Task Name	Duration	Start	Finish
1		**Stage 1**	**240 days**	**Thu 1/01/09**	**Wed 2/12/09**
2		Construction of Sea Walls and Bunds	12 mons	Thu 1/01/09	Wed 2/12/09
3					
4		**Stage 2**	**500 days**	**Thu 8/10/09**	**Wed 7/09/11**
5					
6		Excavation and filling	14 mons	Thu 8/10/09	Wed 3/11/10
7					
8		Precast Engineering fill and riprap	13 mons	Thu 25/03/10	Wed 23/03/11
9					
10		Roads and Services	12 mons	Thu 9/09/10	Wed 10/08/11
11					
12		Landscaping	12 mons	Thu 7/10/10	Wed 7/09/11
13					
14		**Stage 3**	**320 days**	**Thu 13/08/09**	**Wed 3/11/10**
15					
16		Terminal Building and Wharf	16 mons	Thu 13/08/09	Wed 3/11/10
17					
18		**Stage 4**	**1200 days**	**Thu 24/03/11**	**Wed 28/10/15**
19					
20		Breakwater Cove Built Form	60 mons	Thu 24/03/11	Wed 28/10/15



Project: TOT - Breakwater Cove Prog
Date: Sun 22/06/08

Task	Milestone	External Tasks
Split	Summary	External Milestone
Progress	Project Summary	Deadline

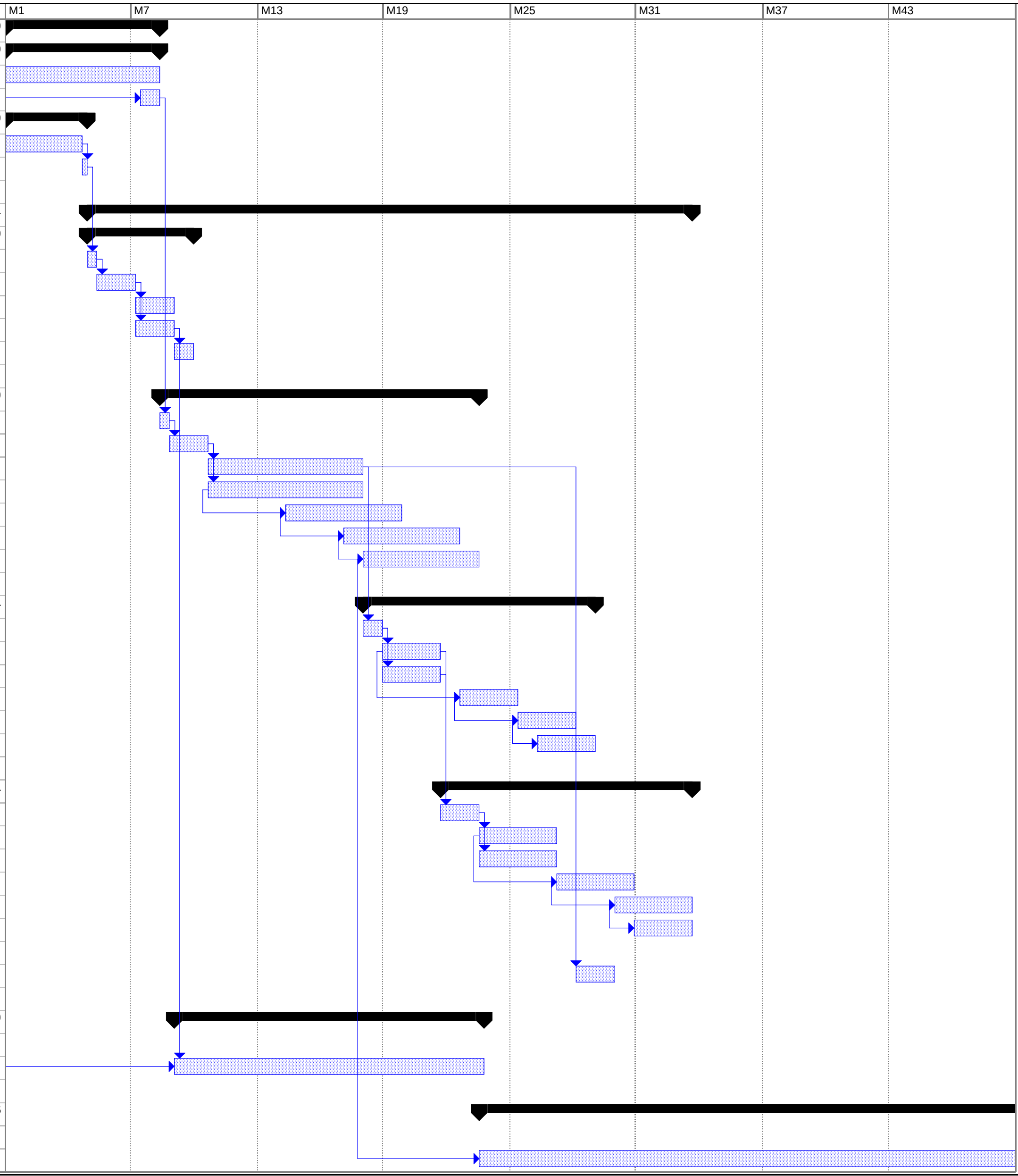
APPENDIX B

REVISED CONTRUCTION PROGRAMME

Townsville Ocean Terminal & Breakwater Cove
Revised Construction Programme

FLANAGAN CONSULTING GROUP

ID	Task Name	Duration	Start	Finish
1	**Stage 1 Isolation and Containment**	**160 days**	**Thu 1/01/09**	**Wed 12/08/09**
2	**FDA**	**160 days**	**Thu 1/01/09**	**Wed 12/08/09**
3	Construction of Sea Walls and Bunds	8 mons	Thu 1/01/09	Wed 12/08/09
4	Dewater FDA to 400mm depth	1 mon	Thu 16/07/09	Wed 12/08/09
5	**TOT**	**85 days**	**Thu 1/01/09**	**Wed 29/04/09**
6	TOT Berth/Swing basin Sheet piling	4 mons	Thu 1/01/09	Wed 22/04/09
7	Dewater TOT Berth/swing basin to 400mm depth	1 wk	Thu 23/04/09	Wed 29/04/09
8				
9	**Stage 2 Land Forms**	**625 days**	**Thu 30/04/09**	**Wed 21/09/11**
10	**TOT**	**110 days**	**Thu 30/04/09**	**Wed 30/09/09**
11	Dewater Balance water to FDA	2 wks	Thu 30/04/09	Wed 13/05/09
12	Transfer Soft Clay from TOT to Area B	2 mons	Thu 14/05/09	Wed 8/07/09
13	Excavate TOT Berth and Swing Basin	2 mons	Thu 9/07/09	Wed 2/09/09
14	Fill TOT Area	2 mons	Thu 9/07/09	Wed 2/09/09
15	Dredge to Swing Basin (spoil to area C)	1 mon	Thu 3/09/09	Wed 30/09/09
16				
17	**Stage 2 A**	**330 days**	**Thu 13/08/09**	**Wed 17/11/10**
18	Dewater Balance water from Area A & B to W1,W2, W3 & Area C	2 wks	Thu 13/08/09	Wed 26/08/09
19	Transfer Soft Clay Area A to Area B	2 mons	Thu 27/08/09	Wed 21/10/09
20	Excavate Marina Basin	8 mons	Thu 22/10/09	Wed 2/06/10
21	Filling to Area A Land Forms and Balance of TOT Area	8 mons	Thu 22/10/09	Wed 2/06/10
22	Precast Engineering fill and riprap	6 mons	Thu 11/02/10	Wed 28/07/10
23	Roads and Services	6 mons	Thu 6/05/10	Wed 20/10/10
24	Landscaping	6 mons	Thu 3/06/10	Wed 17/11/10
25				
26	**Stage 2 B**	**240 days**	**Thu 3/06/10**	**Wed 4/05/11**
27	Transfer Soft Clay from Area B to bottom of Marina Basin	1 mon	Thu 3/06/10	Wed 30/06/10
28	Excavate Area B Canal	3 mons	Thu 1/07/10	Wed 22/09/10
29	Filling to Area B Land Forms	3 mons	Thu 1/07/10	Wed 22/09/10
30	Precast Engineering fill and riprap	3 mons	Thu 21/10/10	Wed 12/01/11
31	Roads and Services	3 mons	Thu 13/01/11	Wed 6/04/11
32	Landscaping	3 mons	Thu 10/02/11	Wed 4/05/11
33				
34	**Stage 2C**	**260 days**	**Thu 23/09/10**	**Wed 21/09/11**
35	Transfer Soft Clay or Dredge Spoil from Area C to bottom of Marina Basin and Area B Canal	2 mons	Thu 23/09/10	Wed 17/11/10
36	Excavation Area C Canals	4 mons	Thu 18/11/10	Wed 9/03/11
37	Filling to Area C Land Forms	4 mons	Thu 18/11/10	Wed 9/03/11
38	Precast Engineering fill and riprap	4 mons	Thu 10/03/11	Wed 29/06/11
39	Roads and Services	4 mons	Thu 2/06/11	Wed 21/09/11
40	Landscaping	3 mons	Thu 30/06/11	Wed 21/09/11
41				
42	Dredge Outer entrance channel	2 mons	Thu 7/04/11	Wed 1/06/11
43				
44	**Stage 3 TOT Terminal**	**320 days**	**Thu 3/09/09**	**Wed 24/11/10**
45				
46	Terminal Building and Wharf	16 mons	Thu 3/09/09	Wed 24/11/10
47				
48	**Stage 4 - Breakwater Coave Built Form**	**1200 days**	**Thu 18/11/10**	**Wed 24/06/15**
49				
50	Breakwater Cove Built Form	60 mons	Thu 18/11/10	Wed 24/06/15



Project: TOT - Breakwater Cove Revis
Date: Tue 24/06/08

Task		Progress		Summary		External Tasks	
Split		Milestone		Project Summary		External Milestone	

Deadline

APPENDIX C
Acceptance Criteria for Stuart Landfill

TOWNSVILLE CITY COUNCIL
VANTASSEL STREET SANITARY LANDFILL, STUART
LANDFILL ACCEPTANCE CRITERIA

BACKGROUND INFORMATION

Selected solid industrial wastes which are known to contain hazardous constituents are presently accepted for special burial provided these wastes comply with strict acceptance criteria defined by the Townsville City Council.

This criteria is for solid waste only. It refers to the regulated waste permitted to be disposed of at Townsville City Council Landfill at Vantassel Street Stuart in accordance with Environmental Licence Number NR150 dated 16th July 1998.

Four characteristics are used to identify the hazardous nature of wastes and their suitability for disposal to landfill:

- ignitability
- corrosivity
- reactivity
- toxicity.

1. **Ignitability**
   Solid industrial wastes that are capable of causing a fire when ignited through friction, absorption of moisture, or spontaneous chemical changes under standard temperature and pressure are hazardous.

2. **Corrosivity**
   Solid industrial wastes which on dissolution exhibit a pH of 2 or less or 12.5 or greater are hazardous.

3. **Reactivity**
   Solid industrial wastes are hazardous if they have any of the following reactive properties:
   - react violently with water;
   - form potentially explosive mixtures with water;
   - generate toxic gases, vapours, or fumes dangerous to human health or the environment when mixed with water;
   - contain substances which generate toxic gases, vapours, or fumes when exposed to pH conditions between 2 and 12.5;
   - are capable of detonation or explosive reaction when subjected to a strong initiating source or if heated under confinement;
   - are readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.

4. **Toxicity**

Solid industrial wastes will be classified as hazardous and require special management if:

- leaching contaminant levels in the solid waste when measured in accordance with the USEPA Toxicity Characteristic Leaching Procedure (TCLP Test) exceed the allowable concentrations for approved municipal landfills as specified in the attached table.

Other regulated wastes approved for disposal are:

- asbestos waste (for special burial);
- tyres;
- abattoir effluent (dewatered solids only);
- bacterial sludges (septic tank and sewage) (dewatered solids only);
- Fish processing wastes (liquid waste streams to be prohibited);
- Food processing wastes (liquid waste streams to be prohibited);
- Grease interceptor trap effluent and residues (dewatered solids only);
- Potentially Infectious clinical and related wastes which have been effectively treated to render them non-infectious;
- Poultry processing wastes (liquid waste streams to be prohibited); and
- Solid pharmaceutical products rendered unrecognisable (other than any substances listed under Schedule 8 of the Poisons Regulations 1978 and cytotoxic wastes).

Prohibited Wastes

The following wastes are not accepted at the landfill:

- Liquescent waste streams or any waste capable of yielding free liquids;
- Untreated infectious and chemical wastes and liquid pharmaceuticals from clinical and related waste stream;
- Cytotoxic waste;
- Untreated sharps;
- S8 pharmaceuticals;
- All radioactive wastes, unless otherwise approved under the Radioactive Substances Act 1958;
- Pyrophoric wastes (where co-disposed with other potentially combustible);
- Explosives, ammunition, pyrotechnics or propellants; and
- Any substances which fall into the categories of ignitability, corrosivity, reactivity and radioactivity.

Special Handling

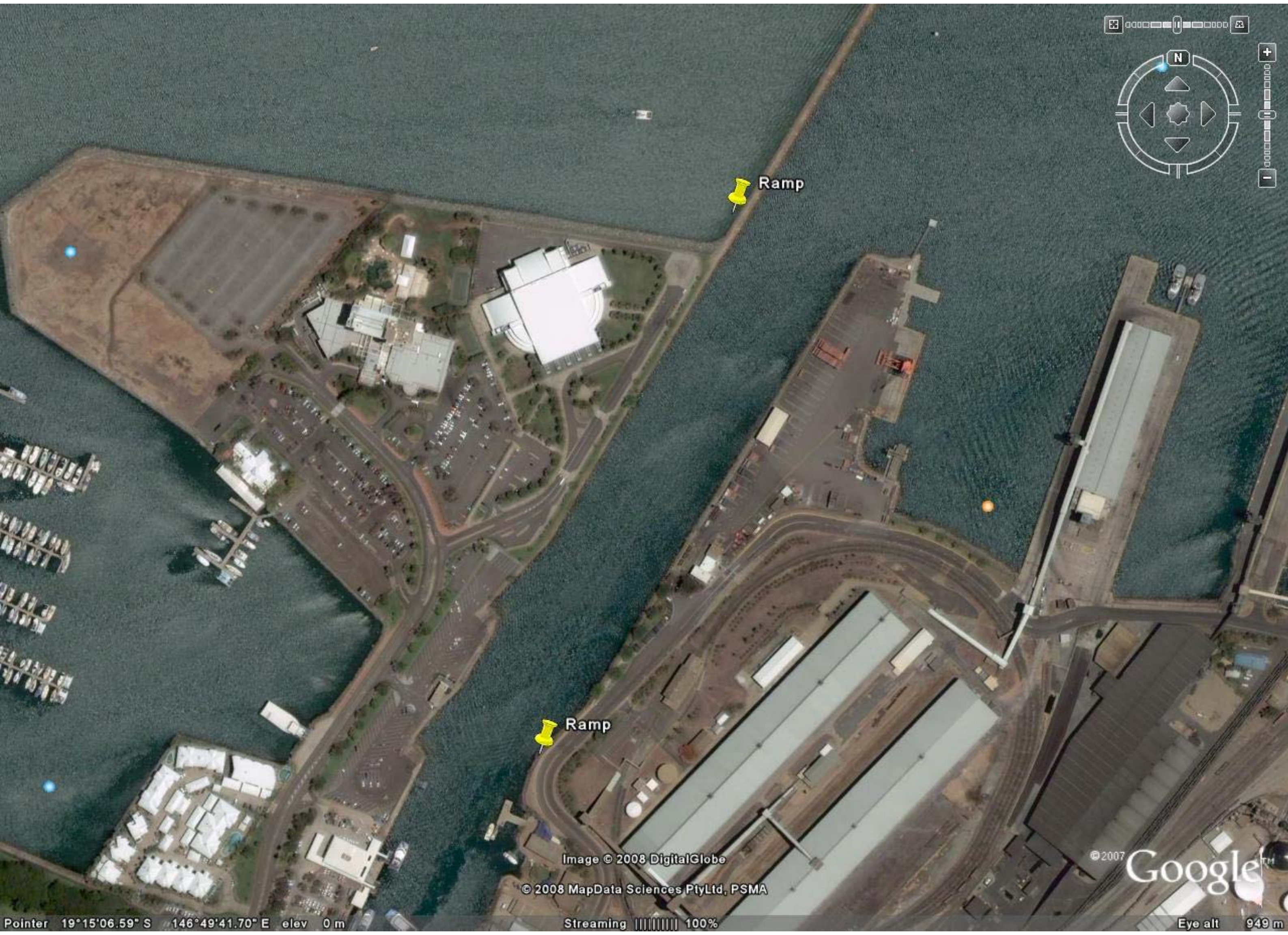
Some waste because of its chemical/physical properties will require special handling. Apart from special wastes (asbestos, sharps, large non compactable objects, etc) some material may comply with leachate tests but have an overall contamination which exceeds safe practice. These levels are shown in brackets in the Total Contamination scale; a handling fee may apply.

CONTAMINANT ANALYSIS	MAXIMUM CONTAMINANT CONCENTRATION IN SOLID WASTE (mg/kg)	ALLOWABLE LEACHING CONTAMINANT LEVELS (mg/L)
Non Specific Contaminants		
BOD		20,000
TOC		10,000
Petroleum Hydrocarbons		50
Metals/Non-Metals		
Antimony		5.0
Arsenic	(100)	5.0
Barium		100.0
Cadmium	(20)	0.5
Chromium	(25)	5.0
Cobalt		5.0
Copper	(100)	100.0
Lead	(300)	5.0
Mercury	(2)	0.1
Molybdenum		1.0
Nickel		5.0
Selenium		1.0
Silver		5.0
Thallium		1.0
Tin		3.0
Vanadium		5.0
Zinc		500.0
Inorganic Anions		
Bromide		50.0
Chloride		6,000
Cyanide (total)	(250)	5.0
Fluoride		150.0
Sulphate		4,000
Nitrate		1,000
Monocyclic Aromatic Hydrocarbons		
Benzene	20	1.0
Ethyl Benzene	1000	50.0
Toluene	600	30.0
Xylene	500	20.0
Total MAH	1000	50.0
Polycyclic Aromatic Hydrocarbons		
Anthracene		0.7
Benzo (a) anthracene		0.05
Benzo (a) phenanthrene		0.05
Benzo (a) pyrene	(1)	0.02
Chrysene		0.1
Dibenz (a,h) anthracene		0.02
Dibenz (a,h) pyrene		0.1
Dimethylbenz (a) anthracene		0.05
Fluoranthene		0.2
Indeno (1,2,3-Cd) pyrene		0.1
Napthalene		0.7
Phenanthrene		0.1
Pyrene		0.7
Total PAH	1000 (20)	1.0
Phenolic Contaminants		

Non halogenated compounds		
Phenol	250 (5)	10.0
m-Cresol	500	20.0
o-Cresol	500	20.0
p-Cresol	500	20.0
Total non-halogenated phenol	500	
Halogenated phenols		
Chlorophenol	5	0.1
Trichlorophenol	20	1.0
Pentachlorophenol	20	1.0
Total halogenated phenol	20	
Chlorinated Hydrocarbons		
Chlorinated Aliphatic Compounds		
Carbon Tetrachloride	10	0.3
1,2 Dichloroethane	20	1.0
1,1 Dictloroethene	1	0.03
Tetrachloroethene	20	1.0
Trichloroethene	25	3.0
Total chlorinated aliphatic	50	
Chlorinated Aromatic Compounds		
Chlorobenzene (total)	200	10.0
Hexachlorobenzene	1	0.02
Total chlorinated aromatic	200	
Pesticides		
Organochlorine		
Aldrin		0.01
Chlordane		0.06
Dieldrin		0.01
DDT		0.03
Endrin		0.01
Heptachlor		0.03
Lindane		1.0
Methoxychlor		1.0
Toxaphene		0.05
Total organochlorine pesticides	10	
Herbicides		
2,4-D		1.0
2,4-DB		2.0
MCPA		2.0
2,4,5-T		0.02
Total herbicides	50	
Carbamates		
Carbaryl		0.6
Carbofuran		0.3
Total carbamate pesticides	50	
Organophosphorus		
Diazinon		0.1
Parathion		0.3
Methyl Parathion		0.06
Total Organophosphorus	10	

CONTAMINANT ANALYSIS	**MAX. CONTAMINANT LEVELS IN SOLID INDUSTRIAL REFUSE (mg/kg)**
Petroleum Hydrocarbons	
Total Petroleum Hydrocarbons C_6-C_9)	1,000
Total Petroleum Hydrocarbons (C_9-C_{18})	10,000
Total Petroleum Hydrocarbons (>C_{18})	50,000

APPENDIX D
ROSS CREEK BARGE CROSSING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Ramp
Image © 2008 DigitalGlobe
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Streaming ||||||||| 100%
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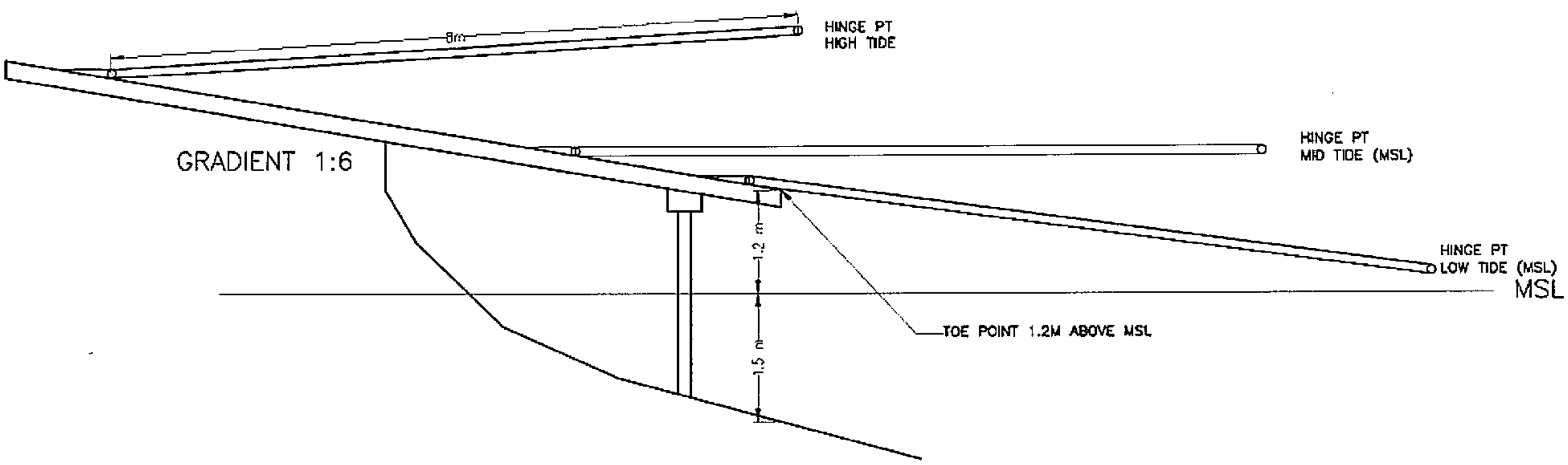

PROPOSED RAMP

A			
REV.	MODIFICATION		DATE
TITLE	RAMP DRAWING - TOWNSVILLE		
VESSEL	40M FERRY		
SCALE 1:50	CHECKED	APPR'D	
DATE 07/07/08	DRAWN C.W.	DWG 2 of 2	

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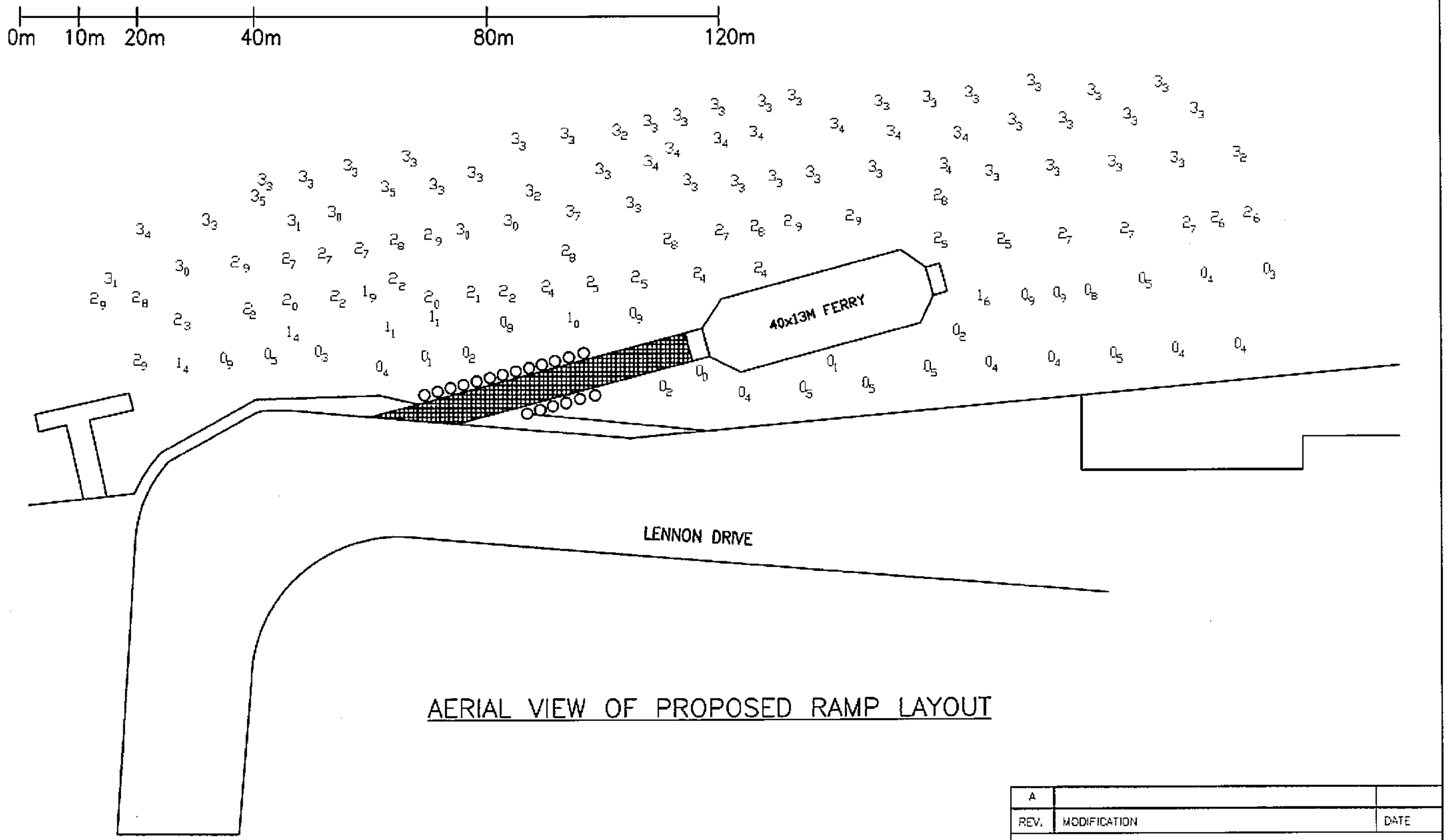
Phone(07) 55295 777 Fax(07) 55295 177
Email: admin@seatransport.com



AERIAL VIEW OF PROPOSED RAMP LAYOUT

A				
REV.	MODIFICATION			DATE
TITLE	**RAMP DRAWING - TOWNSVILLE**			
VESSEL	**40M FERRY**			
SCALE	**NTS**	CHECKED	APPR'D	
DATE	**07/07/08**	DRAWN **C.W.**	DWG **1 of 2**	

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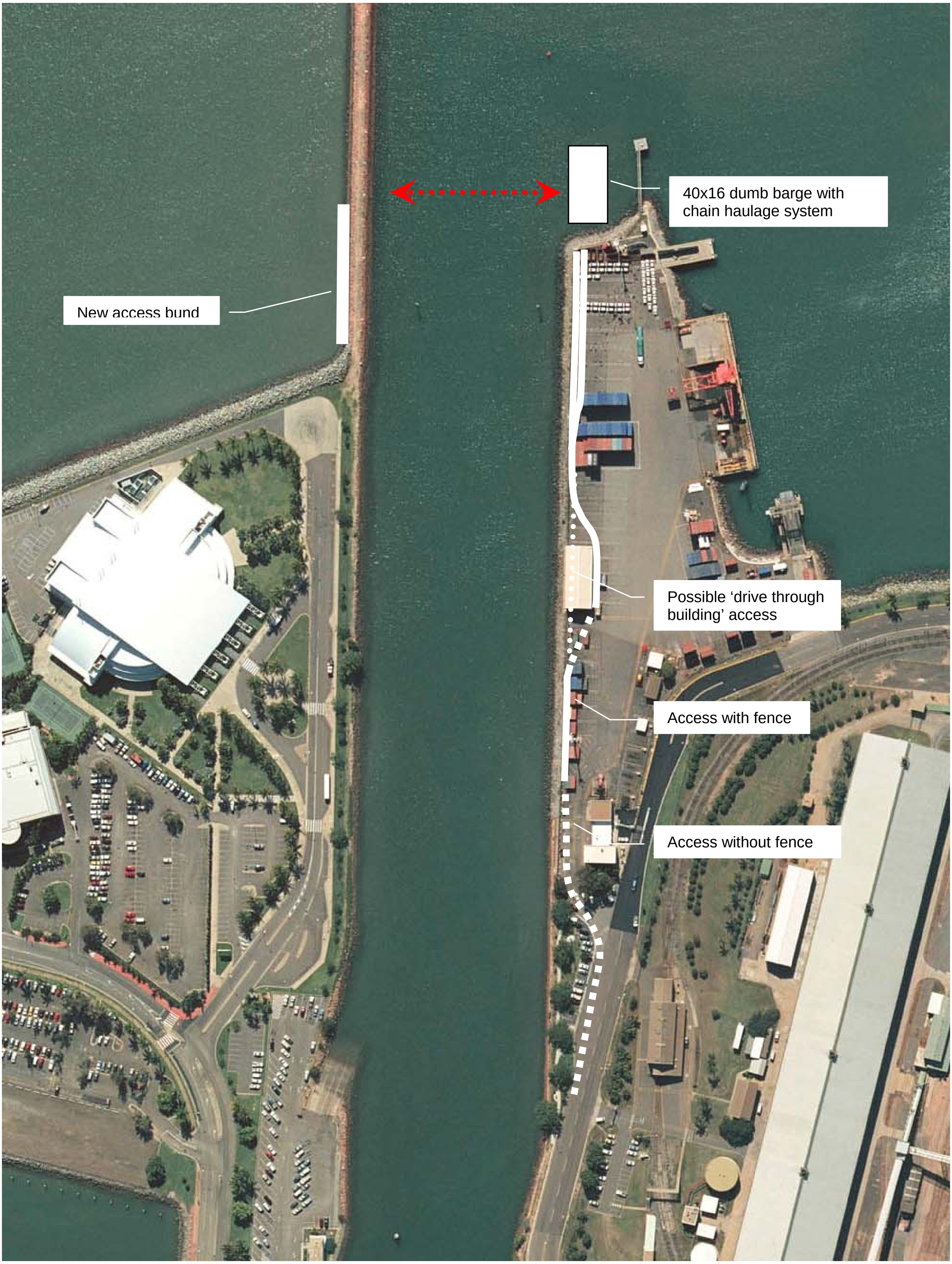
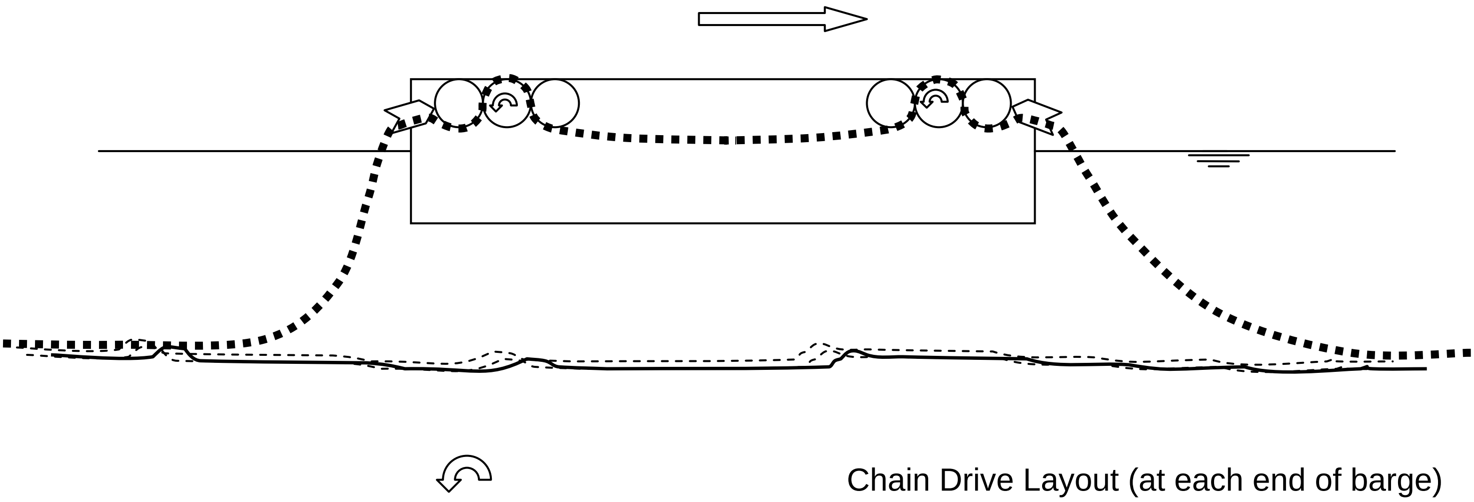
TOT – POSSIBLE HAULAGE ROUTE
Port of Townsville 7/08



TOT – POSSIBLE HAULAGE ROUTE
Port of Townsville 7/08

*Optimisation of barge size in relation to truck size, frequency, navigational restraint & cost may allow direct ramp onto western breakwater



Chain Drive Layout (at each end of barge)