City Pacific Limited

Townsville Ocean Terminal Infrastructure Report

Tuesday, 11 September 2007

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Contents

Executive Summary

This report addresses the non-transport infrastructure of the TOT project including energy and telecommunications, water supply, sewerage reticulation, stormwater drainage, lighting and other infrastructureas required by Section 4.4 of the Terms of Reference.

The owners/custodians of all existing services and infrastructure are identified and the location of existing infrastructure is indicated on engineering drawings.

This report provides an assessment of the requirements for constructing, upgrading or relocating all non-transport infrastructure in the vicinity of the project area.

Construction of the TOT project and installation of required infrastructure and services will be undertaken in accordance with all normal Townville City Council planning requirements, engineering standards and safety.

Energy

The existing energy supply to the project site is a combination of underground and overhead services which falls under the ownership, operation and maintenance of Ergon Energy. The energy requirements of the project have been assessed by Hasthill Consultants and confirmation received that supply for the requirements of the TOT Project can be provided.

An assessment of the capacity of existing electrical networks to service the project and required upgrades are provided in Section 2.1. An Energy Reticulation Master Plan has been developed by Hasthill Consultants detailing the proposed Ergon Energy infrastructure to service the TOT project.

Energy efficiency measures will be implemented within each residential dwelling within the Breakwater Cove Precinct to ensure compliance with the current energy provisions of the Building Code of Australia. It is also proposed to encourage builders, residents and developers of the future development area to be aware of the “Sustainable Housing for the Tropics” initiative by Townsville City Council.

Water Supply and Storage

Water supply is provided by existing underground services in Sir Leslie Thiess Drive and Entertainment Road. The water supply is provided, operated and maintained by Citiwater Townsville. Existing infrastructure is illustrated on drawings provided in Appendix A.

An assessment of the potable water demand for the construction and operational phases of the project has been undertaken by Steve Paul and Partners. The results of this assessment identify that with reasonable upgrades, water supply to the TOT project is able to be provided. It is proposed that the required water supply upgrades will be facilitated by agreement with the Council and, for subsequent development application upon completion of the land Platforms, by payment under Council's headworks contributions policy or the Priority Infrastructure Plans Charges whichever is applicable at the time of the future relevant development applications associated with the TOT project.

Water usage by all project elements are described in Section 2.2 and water conservation and management measures are described in Section 2.2.7. There is no proposal for recycling of water within the project site. All water will be sourced from the Council potable water supply.

Stormwater Drainage

The project site will not connect into the existing stormwater drainage system currently owned and maintained by the Townsville City Council. The conceptual stormwater drainage system is indicated on drawings contained in Appendix A and is described in Section 2.3.2. Environmental best management practices are proposed for treatment of stormwater flowing through the site. Various stormwater quality improvement devices will be implemented to reduce pollutants leaving the site. These devices include gross pollutant traps, leaf/litter baskets, and oil and grit separators.

A Stormwater Management Plan has been prepared addressing stormwater quantity and quality and the principles of water sensitive urban design. Water quality objectives have been determined for the site by C&R Consulting following detailed investigation of existing water quality. These are provided in the Water and Sediment Quality Report.

The project site is not included in any coastal management district. Stormwater drainage outlets will be constructed with an outlet to the receiving waters in the new waterway areas situated below highest astronomical tide and mean high water spring tide levels. The detailed design of these structures will be the subject of further operational works development applications.

Sewerage

The sewerage reticulation system within the City is owned, operated and maintained by Citiwater.. There are no existing Citiwater sewerage facilities within the project site. Existing sewerage facilities owned and operated by Citiwater are located in Sir Leslie Thiess Drive and Entertainment Road. The existing sewerage pump stations situated near the intersection of Entertainment Road and Sir Leslie Thiess Drive will be the point of discharge of sewer from the project site. The location of existing infrastructure is illustrated on drawings provided in Appendix A.

The proposed sewage from the project site is to be collected internally via a series of gravity sewer mains, vacuum mains and pump station with discharge rising mains to connect to the existing sewer pump station situated at the corner of Sir Leslie Thiess Drive and Entertainment Road.

Marine pump-out facilities are described in Section 2.4.2. In accordance with the TOT project brief, a single or multiple storage tank with a combined capacity of 90,000 litres to provide interim storage for approx 10 hours will be provided on site. No provision is made for the pre-treatment of the wastewater before it is discharged into the City wastewater drainage system.

Contingency measures are described in Section 2.4.4 and will include emergency pumping arrangements within the vacuum pump station for bypass pumping and/or a pump out facility. Arrangements will also be made for a temporary standby generator in case of electrical power failure to the vacuum pump station.

Telecommunications

Telecommunications within proximity of the TOT site are provided by Telstra. Due to the number of dwellings and provision of telephone lines to the TOT as well as broadband Internet facilities, negotiations are taking place with Telstra to provide a Remote Integrated Multiplexor (RIM) Unit to be centrally located within the proposed development. A Communications Reticulation Master Plan has been prepared by Hasthill Consultants detailing infrastructure required to provide telecommunications services to the project site. This plan is provided in Appendix B.

Fibre Optic cable will be reticulated by Telstra from the nearest existing node via underground conduits in the road reserve of the existing and proposed road infrastructure. Multipair copper cables would then be reticulated via underground conduit and pit network to each dwelling within the Breakwater Cove precinct and the TOT.

Other Infrastructure

An assessment of options for fuel supply to vessels in the TOT Precinct has been undertaken. Three options were considered including: Road Tanker; Bunkering pipe line facility, and Fuel barge.

A number of temporary structures used in construction of the TOT and Breakwater Cove Precincts will be established within the project site during the construction phase of development. Temporary buildings and structures and temporary stockpile areas are described in Section 2.8.2

1 Description of Environmental Values

1.1 Location of Existing Infrastructure

The Townsville Ocean Terminal (TOT) project site is positioned to take advantage of and complement the Townsville Central City area and Port of Townsville precinct. The TOT project site through its proximity and relationship to the existing built form of the City and Port provides the site with the ability to connect to existing infrastructure and infrastructure corridors.

Preliminary surveys have been undertaken to establish the location of underground services within adjacent road reserves and open space areas. Surveys and data searches have been undertaken in consultation with the various service providers to establish the relative spatial position and capacity of existing services such as electrical energy, water supply, sewerage, telecommunications and street lighting. Detailed survey of existing service facilities will be undertaken as part of the detailed design process associated with the TOT project. The location of proposed and existing infrastructure services are indicated on Drawing K038-QL00704-01 in Appendix A.

The analysis of the existing survey and infrastructure details has been undertaken to enable an assessment of the various infrastructure that will be required for the TOT project including existing infrastructure position, its capacity and potential future connection point requirements.

Energy

The existing energy supply to the project site is a combination of underground and overhead services which falls under the ownership, operation and maintenance of Ergon Energy. Reference to the position of existing services is indicated on Hasthill Consulting's Drawing No. 6582-TOT:E:01 contained in Appendix B.

It is noted that there is a main feeder line that connects the Townsville Central City area with Magnetic Island close to the project site. This feeder line is generally located as shown on Drawing 010/946C. The present exact location of this line will be specifically identified in close coordination and cooperation with the energy suppliers at the detailed design phase of the project and prior to construction commencing on site. Where necessary, the trunk feeder cable connecting Townsville City Precinct with Magnetic Island will be realigned to a position to ensure it is clear of any proposed construction works. Such works will be undertaken by Ergon in accordance with normal procedures to ensure consistency of supply to Magnetic Island.

Water Supply

Water supply is provided by existing underground services in Sir Leslie Thiess Drive and Entertainment Road. The water supply is provided, operated and maintained by Citiwater Townsville, a business unit of Townsville City Council.

One of the key objectives of Citiwater is to "provide strategic planning to ensure Council's water and sewerage infrastructure is expanded to meet future requirements of the City".

Part of the provision of water supply infrastructure is planned and programmed with contributions levied against the development industry through adopted headworks contributions that are generally applied to applications made pursuant to the *Integrated Planning Act 1997* for a Material Change of Use or Reconfiguring a Lot which would include a standard format lot or reconfiguring a lot under a body corporate and the Community Management Act.

In addition to the adoption of headworks contributions, Council is completing an assessment of Priority Infrastructure Provisions for the City in accordance with all Council's obligations under IPA. As these developer contributions will be levied by Council at the future development stage of the TOT project, for Council trunk infrastructure requirements the assessment of infrastructure for water supply, sewerage and stormwater drainage for the project is an assessment for the proposed infrastructure works internal to the site and for those works external to the site that extend from the property boundary to the existing facilities associated with the Townsville Central City area.

The existing water supply facilities in proximity to the TOT site are shown on Drawing K038-QL00704-01 in Appendix A.

Sewerage Reticulation

The sewerage reticulation system within the City is owned, operated and maintained by Citiwater. In a similar manner to the water supply infrastructure, headworks contributions are levied with respect to sewerage connection by developments for Material Change of Use or Reconfiguration of a Lot where there is an increase in equivalent persons (equivalent person being the basic consumer unit which is equivalent in terms of service demand to an average occupant of an average occupied dwelling unit) for all development.

The exiting sewerage network in proximity of the TOT site is indicated on Drawing K038-QL00704-01 in Appendix A.

This infrastructure assessment will review the infrastructure requirements internal to the project site and the works external to the project site required to connect to the nearest sewerage connection point or pump station. Any augmentation or upgrading downstream of the connection point is to be

managed by Citiwater through the developer contributions or Priority Infrastructure Provisions in accordance with normal development approval requirements.

Telecommunications

Telecommunications within proximity of the TOT site are provided by Telstra. The primary telecommunications infrastructure and facilities are indicated on Hasthill's Drawing 6582-TOT:E:02 contained in Appendix B.

Street Lighting

Existing street lighting is contained within the road reserves adjacent to the project site. Street lighting within the development will connect with the energy supply lines that are situated external to the site and within the exiting road reserve areas.

Roadways

Existing roads including Sir Leslie Thiess Drive and Entertainment Drive will provide vehicular access to the site.

1.2 Environmental Values affected by Proposed Project Infrastructure

The Townsville City Plan - Part 3 describes the Desired Environmental Outcomes (DEOs) for the City. In particular Part 3.1 identifies the following:

1. The DEOs are based on ecological sustainability established by the *Integrated Planning Act 1997* (IPA) and are the basis for the measures of the City Plan.

2. Each DEO is sought to be achieved to the extent practicable having regard to each of the other desired environmental outcomes.

One of the DEOs for the Townsville City area relates to infrastructure and services. The relevant outcomes as described in the Townsville City Plan, relating to infrastructure listed below offer an insight into the environmental values that may be influenced by the proposed TOT project.

Infrastructure and Services DEO

"A community with an appropriate level of access to services, where infrastructure is provided efficiently and effectively, contributing to a high standard of living for residents and meeting ESD responsibilities.

Strategies for achieving the infrastructure and services DEO include –

- *Implement strategic planning based on available data to provide for infrastructure needs analysis for future development.*
- *Define minimum service levels for infrastructure required for new developments.*
- *Protect the community's investment in existing infrastructure by ensuring new development does not adversely affect its function or efficiency.*
- *Prepare plan(s) to obtain fair/equitable contributions during the development process towards the provision of infrastructure.*
- *Recognise that infrastructure includes provision of community facilities and infrastructure in accordance with the definitions of the IPA.*
- *Ensure urban residential areas contain the highest levels of infrastructure services as well as conveniently accessible local community services, as these areas are where the greatest concentration of population will reside."*

Location and Owner/Custodians of Land Tenure

The TOT project is to be formed by the reclamation of land from State waters pursuant to the terms of development leases between the State and the proponent. A further and more detailed description of the existing land details and future tenure arrangements is identified in Section 3.7 of the EIS.

In relation to infrastructure services such as water supply, sewerage rising mains, energy supply mains, gas mains and telecommunication mains the extension of these services to adequately service the project site are proposed to be contained within the existing dedicated road reserve areas. These road areas are currently under the ownership of the State and roadworks and other facilities are maintained by Townsville City Council and other utility supply agencies (for their respective utility service).

2 Potential Impacts and Mitigation Measures

2.1 Energy

2.1.1 Energy Requirements of the Project

An Energy Reticulation Master Plan has been developed by Hasthill Consultants detailing the proposed Ergon Energy infrastructure to enable low voltage power reticulation to each dwelling within the Breakwater Cove precinct and to service the Townsville Ocean Terminal (TOT).

The following Ergon standard After Diversity Maximum Demands (ADMD) have been used for the project.

- Typical single residence 5.0kVA (ADMD) per dwelling
- Typical multi unit residence 3.5 kVA (ADMD) per dwelling
- Allowance for the use of the TOT

A network of 11,000 Volt cables in a ring main is proposed to supply a number of pad mounted transformers strategically located around the site. Transformers will generally be located in open space areas, within landscaped areas to provide a more aesthetically pleasing solution.

Four 415 Volt 50 HZ 50 Amp 3-phase power points will be provided and located at regular spacing on the wharf adjacent to a bollard.

2.1.2 Existing Network Capacity

Due to the increase in power demand to the area for the proposed development, discussions are continuing with Ergon Energy who are establishing a new zone sub station near the Townsville Strand with new underground high voltage lines to be reticulated from this location to the TOT site.

2.1.3 Potential Impacts on Existing Infrastructure and Required Upgrades

Electricity supply to the project site will require new 11kV cables to be reticulated along the edge of the existing Sir Leslie Thiess Drive and Entertainment roadway and within the proposed new private roads from the new zone sub station to each of the proposed pad mounted transformers.

The High and Low voltage network would be owned and maintained by Ergon Energy. The Energy Reticulation Master Plan prepared by Hasthill Consulting (Drawing No. 6582-TOT:E:01 in Appendix B) provides details of the electrical infrastructure required to supply energy requirements for the proposed development.

As other significant development is occurring within the locality, which will also require connection through Sir Leslie Thiess Drive, the proponent is in discussion with other developers to ensure coordinated infrastructure upgrades along this route.

There is a significant supply system that provides electrical energy to Magnetic Island from the mainland supply situated adjacent to Strand, in the Townsville City Central Precinct.

The proposed works within the TOT project site will require the relocation of part of this existing electricity supply cable to Magnetic Island. The construction sequencing of the TOT project will be dependent upon the relocation of this supply. This will be necessary to ensure that the new relocated main can be positioned clear of the proposed future works associated with the TOT project site. The proposed future works that may impact on this existing electricity supply cable include dredging activities and construction of the Strand breakwater.

It is proposed that the final position of the relocated electricity main to Magnetic Island will be positioned accurately by survey. In addition this information will be retained as a document indicating a lease area or other equivalent notification suitable to the Department of Natural Resources and Water and other relevant State agencies. The survey will also be provided to the Harbour Master of the Townsville Port and the operators of the marinas in the vicinity to ensure that any maps that are produced in relation to navigation devices clearly indicate the position of this cable to ensure there is no accidental damage from future mooring or anchoring of vessels or maintenance dredging operations that maybe undertaken from time to time in the future.

Discussions are continuing with Ergon Energy in relation to this regional trunk supply relocation to ensure there are no delays caused to the TOT project at the time of proposed construction commencement.

2.1.4 Energy Conservation Measures

Energy efficiency measures must be implemented within each residential dwelling within the Breakwater Cove precinct to ensure compliance with the current energy provisions of the Building Code of Australia (BCA). The energy efficiency provisions contained in BCA 2005 Part J require consideration of:

- Thermal efficiency of the building fabric (roofs, walls and floors) and the ability to resist heat transfer to reduce the need for air conditioning;
- Minimisation of external glazing to control the amount of energy flow in and out of the house;
- Sealing of building elements (external windows, doors and other openings) to control air flow and prevent loss of heated/cooled air;
- Provision of cross-flow air movement to maximise natural ventilation and provide cooling of internal rooms; and
- Provision of insulation and sealing of building services pipework (air conditioning and hot water services) to prevent loss of energy.

(ABCB 2007)

In addition to these provisions, the BCA requires that new houses achieve a minimum 4-Star energy rating. These requirements as well as sustainable housing principles have been incorporated into the EMP to be provided to future land owners within the Breakwater Cove precinct.

It is also proposed to encourage builders, residents and developers of the future development area to be aware of the initiative by the Townsville City Council in relation to energy efficiency development particularly through its "Sustainable Housing for the Tropics" programme. Particular emphasis will be placed on the various fact sheets and guidelines, for example, the technical manual for homes to design for "Lifestyle and the Future".

2.2 Water Supply and Storage

2.2.1 Existing Water Supply Network

The existing Townsville Citiwater reticulation mains are contained within the road reserve areas of the Strand, Sir Leslie Thiess Drive and Entertainment Road. The water supply trunk main network in the vicinity of the proposed TOT site is generally as follows:

- 250mm diameter Citiwater water supply main in Sir Leslie Thiess Drive on the northern and western side of this roadway.
- There is an existing 150mm water supply main in Sir Leslie Thiess Drive generally on the eastern and Southern road verge area.

The location of the existing water supply mains are shown on Drawing K038-QL00704-01 in Appendix A.

2.2.2 Project Potable Water and Fire Service Demand

The objectives to be adopted for the TOT are based on the Townsville City Plan Policy – City Plan Policy 2 Development Standard E. – D11 Water Reticulation.

"The objective of a water supply system is to provide to the consumer a reticulated (either potable or dual potable/raw) water supply to meet the demands imposed upon it by consumers and meet fire fighting requirements. Consumer requirements shall be met by providing a water main and allowing an appropriate point of connection for each individual property."

The TOT project water supply design criteria shall be in accordance with the;

- "Water Reticulation Code of Australia",
- Townsville City Council Specifications C401 - Development Construction Specification Water Reticulation.
- Institute of Public Works Engineering Australia (IPWEA) - Streets Opening Conference Information Bulletin on Codes and Practices (Sections 3 and 4 detailing locations and depths of other services and preferred location for water reticulation pipes)
- Water Resources Guidelines for Planning and Design of Urban Water Supply Department of Natural Resources TB No. :3/1997
- Guidelines for Planning and Design of Urban Water Supply Schemes Update of Chapter 3 -Quality of Water Chapter 21A -Fire Fighting
- Water Act 2000, and
- Sewerage and Water Supply Act 1949 incorporating amendments and subordinate legislation including Standard Water Supply Law Water Services Association of Australia (WSAA) WSA 03 - Water Reticulation Code of Australia

Construction shall be in accordance with the "Development Construction Specification - Water Reticulation". The construction shall also be in accordance with Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments and the Australian Standards referenced in the Townsville City Council Policies.

The key water supply design criteria will comply with the Townsville City Council requirements as follows;

- Townsville City Council's residential maximum hour demand of 0.048 L/s/EP. The design shall also refer to Council's "Water Supply Distribution Planning Report" of March 1995.

- Townsville City Council does not permit dead ends. A "tube" main must be laid back around a cul-de-sac and connected back into the feeder main.

- Minimum service pressure provision shall be 22 metres of pressure at the customer's meter with a minimum flow rate of 30L/minute.

- Property services and water meters shall only be installed by Council upon application.

- Reticulation systems shall be designed to supply peak instantaneous demand by gravity while maintaining a minimum static head of 220kPa.

- Water mains required for fire-fighting purposes in the development shall be designed in accordance with the Fire Services requirements. For the external reticulation system firefighting provisions are detailed in the Guidelines for Planning and Design of Urban Water Supply Schemes Chapter 21A -Fire Fighting

- Each dwelling shall have an individual service tapped from the main and extending 300mm inside the lot boundary unless otherwise permitted by the Water Authority.

Further ongoing discussions are to be held with Townsville City Council in relation to water metering of the community management scheme area.

2.2.3 Adopted Design Parameters Provisions – for Water Supply

Design Codes

The following design standards and codes have been used to determine the utility demand requirements to date and these standards and codes will be used in the detailed design phase of the TOT project.

1. The Building Code of Australia Requirements and in particular E1.3 and E1.4.

2. Australian Standards

    - AS3500 Parts 1-4 Sanitary Drainage & Water Supply

    - AS2419 Fire Hydrants

- AS2441 Fire Hose reels
- AS2118 Fire Sprinklers
- AS3962 Guidelines for Marinas

3. Townsville City Council Local Authority Regulations and Guidelines
4. The Department of Natural Resources and Mines Planning Guidelines for Water Supply and Seweage.
5. The Queensland Development Design Specification D11 Water Reticulation.

Fire Service

The design parameters for the provisions for Fire Hydrant, Fire Hose and Fire Sprinkler services as required under BCA and Australian Standard 2419, 2118 and 3962 requirements have been made dependent on the individual site requirements.

It is noted that relevant BCA and Australian Standards refer to fire protection services within the property and therefore do not necessarily apply to hydrants located on the reticulation system. The absolute minimum flow requirements shall be provided under Townsville City Council Guidelines of 151/s at 12 metres.

Minimum preferred design flows to suit specific developments have been nominated in the attached schedule. The maximum residual pressure provided for under fire fighting flows should be 65-70 metres head.

Possible design flows for future fire sprinkler requirements have been adopted for reasonable design possibilities. Any site specific flows above this would generally be provided on site by the provision of water storage and fixed in-situ pumps.

2.2.4 Temporary Construction Demands and Proposed Facilities

It is anticipated that the contractor for the project site may require several construction compounds within the site. These temporary compounds will provide for safe and secure provision of demountable site offices, ablutions, buildings, parking and storage of materials and equipment for servicing and minor repair facilities for the construction activities. This compound may relocate within the site as construction sequencing for the various elements proceeds.

Water supply is generally required for the demountable offices and ablution facilities. A water supply connection will be made from the existing water supply main in Sir Leslie Thiess Drive to service this requirement.

The proposed connection of the project site to the existing Townsville Citiwater water supply main is proposed to occur generally at the intersection of Sir Leslie Thiess Drive and Entertainment Drive. There are two water supply mains existing at this position being a 250 diameter water main and a 150 diameter water main. The proposed connection point is indicated on Drawing K038-QL00704 in Appendix A.

With regard to upgrading of water supply mains within the City, Townsville City Council has existing headworks contributions that are levied on developments that require a Material Change of Use or Reconfiguration of a Lot development application. The project site has been considered in relation to water supply augmentation and it is proposed that the required water supply augmentation will be facilitated by payment of the required headworks contributions to Townsville City Council. This will enable Townsville City Council, through its water supply business unit Citiwater, to provide for any upgrading of the water supply networks within the City area.

Council has also formulated Priority Infrastructure Plans which will replace the City infrastructure headworks policies in due course and will form part of the Townsville City Plan. The priority infrastructure planning will identify plans for existing and proposed truck infrastructure including cost estimates and timing. The priority infrastructure plan will also provide for infrastructure charge schedules and the mechanism and schedule of funding for the supply and charging of the planned and existing infrastructure.

The Integrated Planning Act requires the preparation of Priority Infrastructure Plans (PIP) including an Infrastructure Charges Schedule (ICS). The primary benefits of this system are:

- Forward planning of growth and infrastructure by Council in a more sustainable manner;
- Provision of certainty and transparency to the development industry in terms of the infrastructure Council plans to supply to meet future growth; and
- Ensuring new development and redevelopment pays its “fair share” towards the cost of providing infrastructure and the infrastructure charges schedule.

Contributions for water supply and sewerage will be levied by Townsville City Council under either its headworks contribution policy or the Priority Infrastructure Plan Charges whichever is applicable at the time of the future relevant development applications associated with the TOT projects.

2.2.5 Cruise Vessel Demands and Proposed Facilities

Potable water will be provided through a pipeline connection from the Citiwater reticulation system capable of delivering 200t/hour with 4 discharge points on the wharf equally spaced. Industry standard connections will be provided. Backflow prevention devices will also be included. A fire service will be run from the same water main allowing for 5 hydrants equally spaced along the wharf.

2.2.6 Project Potable Water Demand

The potable water requirements for operation of the project site have been calculated by Steve Paul and Partners and are presented in Table 1. The proposed water reticulation layout is illustrated on Drawing K031-QL00704-02 in Appendix A.

Table 1: Water supply demands and supply rates

Water Supply	Daily Demand (average)	Rate of Supply (peak)
Breakwater Cove Multiple Dwellings (500)	425,000L	57.6L/s
Breakwater Cove Detached Dwellings (200)	750L/lot	0.6L/s
Breakwater Cove Retail (1500m^2)	7,500L	2.96L/s
Breakwater Cove Marina:		
Commercial berths (360)	25,000L	8L/s
Superyachts (10)	5,000L	0.75L/s
Ocean Terminal	280,000L	55.0L/s

2.2.7 Water Supply Conservation Measures

The water supply conservation measures proposed to be adopted by the Townsville Ocean Terminal project include the following:

- Provision for individual rainwater tanks for detached dwellings within the project.
- Provision of rainwater tanks to service irrigation needs of landscaping adjoining the ocean terminal building and surrounds.
- Encourage the final developers, builders and residents to follow the principles contained in the Townsville City Council “Sustainable Housing for the Tropics” initiative

2.3 Stormwater Drainage

2.3.1 Existing Stormwater Drainage

The project site is situated externally to any stormwater drainage catchment that may impact on the existing stormwater drainage in Entertainment Road or Sir Leslie Theiss Drive. The existing stormwater drainage facilities in Entertainment Road are the closest stormwater drainage facilities to the project site.

Stormwater drainage in this area generally provides for a localised catchment of the car park areas and roadway adjacent to Entertainment Road. The project site will not connect into the existing stormwater drainage system currently owned and maintained by the Townsville City Council. Existing stormwater drainage in the vicinity of the site is indicated on Drawing K038-QL00704-01 in Appendix A.

2.3.2 Concept Stormwater Drainage and Disposal System

The concept stormwater drainage and disposal system for the TOT project comprises individual catchments of each of the residential peninsulas and the catchment for the open space road reserves and terminal building area. The conceptual stormwater drainage layout is indicated on Drawing K023-QL00704-03 in Appendix A.

The key elements of the stormwater drainage system generally provide for the following;

- Individual detached dwellings to discharge stormwater to a rainwater tank contained within the single allotments. The overflow from the rainwater tank will discharge into a treatment device prior to discharge to the receiving waters.
- Roadway and car park treatment areas stormwater drainage will be collected in kerb and channel gully pits and pipe drainage systems with diversion flows proposed to be provided to water quality treatment areas prior to discharge to the receiving waters.
- Stormwater drainage from the access road and car park of the terminal building and facilities is proposed to be collected and treated in a treatment device prior to discharge to receiving waters.

2.3.3 Stormwater Management Plan

A Site-Based Stormwater Management Plan– Water Quality and Quantity Study (SWMP) has been prepared by Hyder Consulting and is contained in

Appendix C. The SWMP provides strategies to prevent impacts to the existing water quality in receiving waterways during the operational phase of the development.

Stormwater discharge has been quantified for all standard design Average Recurrence Intervals for the preliminary layout. A full hydraulic analysis will be prepared at the detailed design stage. This analysis will be in accordance with Townsville City Council requirements.

There is no existing surface topography within the project site apart from the existing breakwater wall and the project will be constructed on reclaimed land over a tidal area. There are no existing drainage paths or patterns for the site in its current state due to water coverage.

Stormwater Layout Options

Two options were assessed for the Breakwater Cove Precinct to mitigate the effects of stormwater runoff from the site and protect the water quality of receiving environments. These options are described below:

Option A

All residential lots are to be graded to the road where stormwater discharge from minor storm events is collected in the road drainage. The runoff from the lots and roads for the major storm events will be conveyed within the road reserve. The preliminary stormwater layout for Option A is provided in the SWMP (Drawing K023-QL00704-02 in Appendix A).

Option B

Option B has the same sub-catchments as per Option A however the lots grade towards the rear of the properties and rear-of-allotment drainage is provided. The preliminary stormwater layout for Option B is provided in Appendix A (Drawing K024-QL00704-01).

Stormwater Quantity Analysis

Preliminary stormwater analysis has been conducted for the two stormwater layout options to predict the discharge rates at each outlet for the subdivision.

Stormwater layout for Option A has fewer outlets as a result of no rear-of-allotment drainage. All runoff from the lots for Option A will drain towards the road drainage. The size of the road drainage system and end of line treatment devices will be larger for Option A due to the increase of flows contributing to the system from the lot runoff.

The introduction of rear-of-allotment drainage in Option B will reduce the size of road drainage as the lots and road sub-catchments are separated. Option B has additional outlets to cater for discharge from rear-of-allotment drainage assisting in the mixing fresh water into the proposed canals and reducing discharge volumes at outlet locations.

Although both options have the same areas the discharge rates for Option B are greater than Option A due to smaller time of concentrations from splitting the lots into separate catchments discharging to the rear-of-allotment drainage. Retention from rainwater tanks for Option B has not been taken into account for the quantity analysis.

A detailed hydraulic assessment will be undertaken at the detailed design stage of the development. This analysis will comply with the Townsville City Council requirements for a conventional operational works application pursuant to the Integrated Planning Act.

Water Quality Objectives

A number of water quality guidelines currently exist for Australian, Queensland and North Queensland receiving waters upon which water quality objectives for receiving environments can be based and existing site and catchment water quality monitoring results can be compared. The water quality guidelines used in reference to this study include:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (Australian and New Zealand Environment and Conservation Council); and
- Queensland Water Quality Guidelines 2006 (Environmental Protection Agency).

Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)

The Australian and New Zealand Environment and Conservation Council (ANZECC) has prepared the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines). Guideline values are to be used in determining water quality objectives for protection of environmental values.

Where guideline values are exceeded, it is not expected that significant impacts will occur however, there is the potential for impacts on environmental values and exceedences should trigger further investigation. Trigger values for physical and chemical indicators of water quality are

specified by the ANZECC Guidelines for a range of ecosystem types. The values for inshore marine ecosystems in tropical northern Queensland are provided in the SWMP.

The ANZECC Guidelines identify the need to develop locally relevant guideline values tailored to particular regions and water types in order to refine the conservative values contained in the national guidelines according to local conditions.

Queensland Water Quality Guidelines (2006)

The Environmental Protection Agency (EPA) has prepared guidelines for water quality in Queensland to be considered in conjunction with the ANZECC Guidelines. The guideline values are based on water quality data collected from waterways throughout Queensland since 1992. It is intended that these values be applied to water quality management for establishing water quality objectives and assessment of development in Queensland.

Where the Queensland Guidelines provide localised guideline values for water quality indicators, these values have been adopted for the setting of water quality objectives for the project. Where information on particular indicators is not provided by the Queensland Guidelines, ANZECC guideline values have been adopted.

The Ross River basin is included in the drainage division of Central Coast Queensland region in the Qld Guidelines. The physico-chemical guideline values for enclosed coastal waters in this region are given the SWMP.

The Guidelines acknowledge the need to consider site-specific conditions in determining appropriate guidelines and alternative levels of protection, particularly in disturbed environments.

Existing Water Quality

Site-specific investigations of water quality have been undertaken by C&R Consulting Pty Ltd (C&R). This study has also reviewed existing information on the water quality of Cleveland Bay in the vicinity of the project site. The results are summarised as follows:

- The Cleveland Bay area has been assessed as being slightly to moderately disturbed.
- Levels of Phosphorous at sampling locations surrounding the project site range from <50µg/L to 19,800µg/L and levels of up to 1,140µg/L were detected at the project site. The highest level of Phosphorous was detected at sample location S6, near Kissing Point, where high levels were also found in sediment samples.

- High Nitrogen levels were also detected in sediments near Kissing Point. However, Nitrogen levels in surface waters sampled within the project site and surrounding areas were below guideline values ranging from <500µg/L to 700µg/L between all sites sampled.
- Site-specific guideline investigation and intervention levels for the project have been recommended based on existing levels of contaminants in surface waters.

Treatment Devices

The site has a total catchment area of 29.14 hectares (land form only). The site has been divided into stages based on the proposed future use (ocean terminal, residential sites, open space etc.) and each stage has been further divided into sub-catchments for the purposes of stormwater treatment. Each sub-catchment will drain by overland flow to a series of treatment devices then to a central discharge location for release.

Rainwater Tanks

Individual rainwater tanks may be used within residential lots for storage and reuse of roof water.

The Queensland State Government requires that all new Class 1 homes built after 1 January 2007 will install a minimum 5000L tank to collect rainfall for connection to non-potable water uses including garden irrigation, toilet flushing and washing machine cold water.

Townsville City Council have applied to the Queensland Government for an exemption from QDC Part 25 Water Savings Targets therefore rainwater tanks may not be required for the project due to Townsville's rainfall and temporal patterns.

Stormwater Quality Improvement Devices

Environmental best management practices are proposed for treatment of stormwater flowing through the site. Various stormwater quality improvement devices (SQIDs) will be implemented to reduce pollutants leaving the site. There are a number of individual devices that can be placed together to form an overall 'stormwater treatment train'. By using a series of devices, the sediment, pollutants and nutrients in the stormwater run-off can be treated so that the final discharge from the site will meet environmental guidelines. The typical types of devices used are as follows:

Gross Pollutant Trap

Gross pollutant traps (GPTs) remove solids of greater than 5mm in size that are conveyed in stormwater to prevent entry of pollutants to receiving waterways. Gross pollutant loads include rubbish and coarse sediment mostly organic material such as leaves and twigs and also plastic and paper items such as food and drink containers.

Leaf/Litter Basket

Metal or plastic litter baskets can be installed in gully pits within individual drainage lines to intercept gross pollutants from up to 1 hectare catchments. Litter and organic material is trapped within the basket and some coarse sediment may be removed by filtration through trapped material.

Oil and Grit Separator

Oil and grit separators are structures consisting of one or more chambers that remove sediment, screen debris, and separate oil from stormwater. These structures are also known as oil and water separators or water quality inlets.

Stormwater Modelling

A quantitative assessment of stormwater runoff quality was undertaken to assess pollutant export loads from the development site using the Cooperative Research Centre for Catchment Hydrology's (CRCCH) MUSIC (Model for Urban Stormwater Improvement Conceptualisation) model.

Base case models (unmitigated developed) have been prepared to estimate the quantities (annual loads) of suspended solids, total nitrogen and total phosphorous exported from those areas of the proposed site to be developed. Details of the MUSIC modelling are contained in the SWMP.

Modelling Results and Conclusions

Comparisons of modelling results have shown that Option B produces a higher pollutant reduction efficiency rate than Option A. This is due to the implementation of leaf/litter baskets within the rear-of-allotment drainage system.

Option B would achieve a greater dispersion of fresh water into the receiving waters due to the greater number of outlets as a result from rear-of-allotment drainage. The introduction of rainwater tanks shows an

increase in the pollutant removal efficiency due to retention and reuse of runoff within the system.

Either Option B without rainwater tanks or with rainwater tanks would be the preferred option with pollutant load reductions of up to 92% of Gross Pollutants, 51% of total suspended solids, 22% of Total Phosphorous and 25% of Total Nitrogen achieved on an annual basis.

2.3.4 Operational Works in the Coastal Management District

The physical project site is not included in any coastal management district. However, in recognition of the State Coastal Policy, the following measures are proposed.

The stormwater drainage outlets will be constructed with an outlet to the receiving waters in the new waterway areas situated below highest astronomical tide and mean high water spring tide levels. As a result these structures will be constructed in tidal waters. The structures will take the form of conventional stormwater drainage pipe outlets and associated concrete headwalls.

The detailed design of these structures will be the subject of further operational works development applications to be lodged with various agencies in association with the on-going detailed design and construction of civil engineering works associated with the proposed development.

2.4 Sewerage

2.4.1 Existing Sewerage Network Capacity

The existing sewerage infrastructure in the Townsville Central Business District is typical of that existing throughout the City. It comprises sewer gravity mains collecting from individual properties, being then collected to pump stations and lift stations to be transported from these facilities via rising mains to major pump stations within the city.

There are no existing Citiwater sewerage facilities within the project site. Existing sewerage facilities owned and operated by Citiwater are located in Sir Leslie Thiess Drive and Entertainment Road. The existing sewerage pump stations situated near the intersection of Entertainment Road and Sir Leslie Thiess Drive will be the point of discharge of the sewer from the project site.

2.4.2 Project Sewerage Requirements

Sewerage

The objective and key design criteria to be adopted for the TOT project include the following, based on the Townsville City Plan Policy – City Plan Policy 2 Development Standard E.- D 12 Sewerage System.

"The objective of the sewerage system is to transport sewage or effluent from domestic properties to the treatment plant in accordance with all current relevant legislation. Consumer requirements shall be met by providing a sewer main and allowing an appropriate point of connection for each individual property."

The design of gravity sewer systems and pump station components shall comply with the Water Services Association of Australia's publication "Sewerage Code of Australia" unless specified otherwise by Townsville City Council. The sewerage works are to be constructed in accordance with the "Development Construction Specification - Sewerage System (C402)".

The above design criteria apply to the following:

The sewerage system:

a) Gravity sewers including junctions and property connection sewers.

b) Common effluent sewers both gravity and pressurised.

c) Vacuum sewer system.

d) Maintenance holes and other structures.

e) Rising mains.

f) Pump stations.

The design will also comply with the following;

- Institute of Public Works Engineering Australia (IPWEA) - Streets Opening Conference Information Bulletin on Codes and Practices (Sections 3 and 4 detailing locations and depths of other services).
- Water Resources Guidelines for Planning and Design of Sewerage Schemes Volumes 1 and 2
- Water Act 2000 and Sewerage and Water Supply Act 1949 incorporating amendments and subordinate legislation including Standard Sewerage Law
- Water Services Association of Australia (WSAA)
- WSA 02 - Sewerage Code of Australia
- European Standard BS EN 1091 - Vacuum Sewerage Systems.

The following Townsville Citiwater design and construction criteria will apply to the TOT project for sewerage construction;

- Townsville City Council requirement is ADWF of 230 L/EP/day.
- Townsville City Council Alternative Method – Design Flow is 1313 L/EP/day (consists of 5 x 230 = 1150 plus I/I of 163 L/EP/day for a total of 1313) NB: Townsville City Council may stipulate I/I of 326 L/EP/day in high risk area. This is to be finalised with the representatives of Citiwater.
- Easements over sewers (gravity and pressure) are not required.
- Property connections (i.e. combine house drains) are not lawful in Queensland.
- Wet weather storage is not required as it is impractical in tropical conditions. Reference is made to the Townsville City Council policy.
- Combined house drains are not allowed under Townsville City Plan policy.
- Townsville City Council prefers sewers to be located at rear of properties to serve as many houses as possible per length of sewer.
- In general, Townsville City Council has a strong preference for the conveyance of sewage by gravity only and therefore Townsville City Council's approval in writing is required for a pumping station proposal and its particular requirements including current electrical and telemetry standards, overflow and emergency arrangements and Citiwater's current licence conditions.
- The design shall be in accordance with the flow used for the design of sewers serving industrial areas and developments not specifically listed in the SEWERAGE CODE OF AUSTRALIA or Department of Natural Resources Guidelines. (WSA 02 Part 1, section 2.3).
- The design shall take account of AS 2200, AS/NZS 2566.1, AS 3500, AS 3735, the SEWERAGE CODE OF AUSTRALIA and, the Department of Natural Resource Guidelines.
- Where the pump station site is exposed to possible flooding, the design shall provide for the top of pump well to be one (1) metre above the 1 in 100 year flood level or to such other level as provided by Council's planning instruments, whichever is the higher. The TOT pump stations will be positioned to a level 1 metre above the 1 in 100 year flood level.
- The design shall provide for the design of pump wells against flotation both during the construction/installation stage and whilst operating under flood conditions designed as above.

- The design shall size pipes and pump station capacity to avoid surcharges
  under design flow conditions. The design shall provide for overflows in strict accordance with the conditions of the licence, if any, permitting sewage overflow.

The design shall provide for alarms and signals systems for overflows

The design for the TOT project sewerage system shall conform to Townsville City Council design criteria and will include a combination of vacuum sewer systems, gravity pipeline distribution system with pump stations and rising mains, which will transport fresh sewage, or common effluent for treatment.

A pressurised common effluent or vacuum systems is proposed to be utilized in the TOT project site.

The design shall not provide for common effluent or vacuum discharges to gravity sewers or conventional wastewater treatment plants without the concurrence of Townsville Citiwater.

The sewer catchment area to be served is the area of the TOT project site. There is no requirement to provide for upstream sewer flows. .

Design Codes

The following design standards and codes have been used to determine the utility demand requirements to date and these standards and codes will be used in the detailed design phase of the TOT project.

1. The Building Code of Australia Requirements and in particular E1.3 and E1.4.
2. Australian Standards
   - AS3500 Parts 1-4 Sanitary Drainage & Water Supply
   - AS2419 Fire Hydrants
   - AS2441 Fire Hose reels
   - AS2118 Fire Sprinklers
   - AS3962 Guidelines for Marinas
3. Townsville City Council Local Authority Regulations and Guidelines
4. The Department of Natural Resources and Mines Planning Guidelines for Water Supply and Sewerage.

5. The Queensland Development Design Specification D12 Sewerage Systems.

Breakwater Cove Internal Infrastructure Requirements

The project site will provide residential lots for future construction of 200 detached houses and 500 medium density dwellings.

The design parameters in this section comprise the provisions for sanitary plumbing and house drainage flows sized in accordance with AS 3500 requirements and Townsville City Council Guidelines.

The sanitary flows have been reviewed on a two system basis of estimated fixture unit ratings as nominated in AS 3500 Part 2 and/or flows per Equivalent Population (EP) basis as nominated in Townsville City Council Development Guidelines, which ever is the greater.

The Vacuum Code of Australia WSA06 identifies the vacuum system philosophy generally as follows: “vacuum sewerage systems are used for individual and domestic waste water collection and disposal. The vacuum sewer system uses principles of slug flow under vacuum conditions to collect and transport sewerage, rather than using a gravity system. Depending upon the terrain and the subdivision layout, the system is economical and practical, and can be used over long distances and varying elevations. It is particularly suited to flat terrain, involving very long strip developments, long waterways, bad ground and environmentally sensitive areas. Because of the limited depth required much less damage to the environment will occur during the construction phase”.

In a vacuum sewer system, a vacuum is induced and maintained in the pipe system by means of a central vacuum generator and vacuum vessel. Wastewater gravitates to a collection chamber connected to the vacuum system. When the wastewater volume reaches a predetermined level in the collection sump, the pneumatically operated vacuum interface valve opens. Atmospheric pressure pushes the wastewater plus some air from the collection chamber into the sewerage collection lines that are laid in a saw tooth profile. The configuration of the proposed vacuum sewer reticulation system is indicated on Drawing K030-QL00704-02.

Ocean Terminal Sewage Discharge

In accordance with the TOT project brief design guidelines, a single or multiple storage tank with a combined capacity of 90,000 litres to provide interim storage for approx 10 hours will be provided on site. Off peak discharge is to be at 2.5-3 l/s. No provision is made for the pre-treatment of the waste water before it is discharged into the City waste water drainage system.

Sewage and Grey Water

Sewage and grey water will be disposed of in an environmentally acceptable manner. Sewage/grey water will be discharged directly into the town sewerage system through a storage tank, pump station and piping system. The minimum pump capacity of the pump station will be 4.5 litres.

A typical discharge form the Benchmark ship is 230 litre/capita/day and design discharge is 2.5 litre/s. This is consistent with the arrangement that is undertaken currently at the TPA facility for vessels.

The Wharf will not cater for ballast water receival and/or treatment.

Marina Discharge

Discharge from commercial and private marina berths is currently and most likely will remain as a centralised collection point via a land based vacuum sewerage and storage facility or similar. This type of system is considered under Townsville City Council discharge guidelines as trade waste and should be collected in an on site holding well of suitable capacity for either transportation off site by a licensed contractor or to be discharged to sewer at a preset discharge rate.

Site sewerage management would most likely be at a relatively low flow rate to allow a reasonably cost effective system. (Approximately 1-1.5 l/s).

2.4.3 Potential Impacts on Existing and Planned Infrastructure

The proposed sewerage from the project site is to be collected internally via a series of gravity sewer mains, vacuum mains and pump station with discharge rising mains to connect to the existing sewer pump station situated at the corner of Sir Leslie Thiess Drive and Entertainment Road.

It is proposed that the sewer reticulation and vacuum pump station system within the project site will be privately owned, operated and maintained by the body corporate. The sewer facilities external to the project site will become assets of Townsville Citiwater. These facilities will ultimately be operated and maintained by Citiwater.

2.4.4 Contingency Measures

The proposed sewerage facilities to be contained within the project site are conventional gravity sewer mains and sewer rising mains. There will be a variation to the conventional aspect of the sewer facilities to be constructed within the project site; this will be the vacuum sewer components of the proposed network system. The vacuum sewerage facility will be generally

constructed to be compliant with the Vacuum Sewer Code of Australia WSA06-2004 and relevant amendments.

The Vacuum Sewer Code identifies the planning, design and construction of sewerage reticulation up to and including a nominal diameter of 300mm, vacuum service connections and property connection sewers.

The project site infrastructure configuration will have regard to the requirements to accommodate the vacuum stations. Generally, these vacuum stations will be situated in the lowest portion of the residential peninsular elements. Vacuum sewerage systems can cope with uphill flows. It is not necessary for the vacuum stations to be situated at the lowest point in the system. The vacuum stations in the project site are generally to provide for the following:

- Vehicle access and parking;
- Emergency pumping arrangement;
- Maintenance clearances;
- Onsite or mobile generator facility; and
- Buffer between the station and adjoining properties.

The vacuum station is divided into two primary areas, an above ground plant room and a below ground dry well. The vacuum station provides generally for the following elements:

- The full level of the dry well is designed to suit the invert levels of the incoming sewers, the vacuum vessel diameter and dimensions of the selected sewer pumps.
- Vacuum vessel, sewerage pumps, valves and pipe work to collect the wash down water are generally located in the dry well.
- The plant ramp contains a vacuum generator, control cubicles, vacuum pump, and where required a moisture removal vessel.
- Vacuum stations will have an odour control system installed to minimise potential impacts from odour emissions from the site.

It is proposed emergency pumping arrangements will be made in the vacuum pump station for bypass pumping and/or a pump out facility. Arrangements will also be made for a temporary standby generator in case of electrical power failure to the vacuum pump station.

An odour control filter (or bio filter) will be used to remove odours from the vacuum generator exhaust gases containing odourous compounds which will include biodegradable organic compounds bypassing gases to a natural biological active filter membrane.

The on-site generator configured to provide for an auto-start on loss of power and will be properly secured with required safety signage. Noise from the generator will comply with the relevant Townsville City Council and EPA noise guidelines and requirements.

The vacuum sewer will generally be located on the opposite side of the road reserve to the water main construction. The sewer depths in the vacuum sewers will be located at depths to mitigate risk of third party intrusion and shall have a minimum depth of 600mm.

2.4.5 Required Infrastructure Upgrades

There are no further required infrastructure upgrades to be undertaken as part of the TOT programme of works as referred to in item 2.4.3. Any sewerage works external to the site required to be upgraded will be undertaken by Citiwater in accordance with the provisions and forward planning projections allowed for in the headworks contributions or priority infrastructure charges which ever the case maybe.

2.5 Telecommunications

2.5.1 Existing Network Capacity

Due to the number of dwellings and provision of telephone lines to the TOT as well as broadband Internet facilities, negotiations are taking place with Telstra to provide a Remote Integrated Multiplexor (RIM) Unit to be centrally located within the proposed development.

2.5.2 Project Infrastructure Requirements

A Communications Reticulation Master Plan has been prepared by Hasthill Consultants detailing infrastructure required to provide telecommunications services to the project site. The proposed telecommunications reticulation for the site is presented on Hasthill's Drawing No. 6582-TOT:E:02 contained in Appendix B.

2.5.3 Potential Impacts on Existing Telecommunications Infrastructure and Required Upgrades

Fibre Optic cable will be reticulated by Telstra from the nearest existing node via underground conduits in the road reserve of the existing and proposed road infrastructure. Multipair copper cables would then be reticulated via underground conduit and pit network to each dwelling within the Breakwater Cove precinct and the TOT.

2.6 Street Lighting and Wharf Lighting

2.6.1 Proposed Street Lighting

Hasthill Consultants have carried out an initial design for proposed lighting around the wharf and car park area to determine the approximate number and height of floodlights. Reference is made to the Hasthill Consulting report in Appendix B.

The design standards utilised are:

- AS1158.3.1 Category P11A (disabled car park bays will be category P12, but are not currently designated).
- AS3827 parts 1 & 2 (1998 – calculated values)
- AS4282 (intensity control limits)

From the proposed scheme, the above standards can be met and the calculated spill plane average luminance of maximum 1.37 lux is achieved. (in most cases is less than 1 lux).

This compares well to typical local council accepted light spill levels and would be similar to the value of lux for general street lighting.

The general heights of poles to enable compliance to AS1158 are as follows:

- Car parking areas – 12m.
- Wharf – 20m

2.6.2 Proposed Wharf Lighting

Wharf lighting will be provided to ensure a minimum of 50 lux per AS1158.3 over the full extent of the wharf area by means of flood lights mounted on 10x6m masts equally spaced on the land side of the wharf. Flood lights are to be appropriately shielded to prevent interference with navigation beacons.

Lighting to the wharf area would be controlled and switched such that two modes of operation would be present as security mode or normal mode. This would dramatically reduce the lighting level at required times and be dependent upon any curfew hours imposed.

Due to the type of luminaires proposed and the control of spill light, it is not anticipated that the navigation lighting and signage will be adversely affected.

2.6.3 Construction Lighting

Any lighting associated with construction would be in the form of local flood lights utilised for security only.

There may from time to time be adhoc work, either within the site or external to the site, associated with utility services connections to existing live services that may require working into the evening to ensure continuity of supply and the safe connection to utility services. These works would be undertaken by Citiwater and or the contractor for the Townsville Ocean Terminal project. The works would be undertaken in accordance with the requirements of Townsville City Council and will ensure traffic management programmes are in place where work may be undertaken in existing road reserves.

2.6.4 Lighting (Energy) Conservation and Safety Measures

Energy conservation would be incorporated as part of the Building Code of Australia requirements including energy efficiency audits and use of compact fluorescent and fluorescent lighting to each dwelling.

It is proposed to incorporate photocell and time clock control of all external street, car park and wharf lighting to ensure illumination is only active when required.

General safety lighting (as required by AS1158) would be located around the project including street lighting, car park lighting and wharf lighting.

Select, low glare, high photometric control luminaries, lanterns and floodlights would be used to minimise any effect on residences and to the surrounding area.

2.7 Roads

The proposed internal road network is illustrated on Drawing K032-QL00704-03. Road cross sections are provided on Drawings K033-QL00704-02, K034-QL00704-02 and K035-QL00704-02.

2.8 Other Infrastructure

2.8.1 Fuel Supply

An assessment of options for fuel supply to vessels in the TOT Precinct has been undertaken.Three options were considered including:

- Road Tanker;

- Bunkering pipe line facility, and
- Fuel barge

Diesel fuel is currently delivered to vessels in the Port of Townsville by road tanker. The road tanker will be required to park on the discharge apron along the wharf that is designed to capture and prevent any spillage from entering the waterway or land.

The fuel tanker discharge aprons at the TOT will be designed to capture one compartment or 9,000 litres in case of a major leak during the bunkering operation. A typical containment apron is detailed on Drawing 07080-A-0010 (contained in Appendix D) which includes a 10,000 litre underground tank that will hold any unwanted spill. The underground tank will only be in operation during bunkering, this will make sure that the capture tank does not fill up with rainwater.

A further option for delivery of fuel to vessels would involve bunkering by barge. A double hulled 1500 DWT bunker barge would be used for this purpose. The barge would berth alongside the vessel during bunkering and would be located within the berth pocket outside the Port navigational channel.

This fuel bunkering service would be provided by a separate commercial entity and any barge berthing facilities and fuel storage would be provided by an independent contractor.

2.8.2 Temporary Structures and Materials

A number of temporary structures used in construction of the TOT and Breakwater Cove Precincts will be established within the project site during the construction phase of development. These are outlined below.

Temporary Buildings and Structures

Temporary buildings will be installed on the project site within a designated construction compound to provide office, lunch room, first aid area and toilet facilities for construction staff. This compound will also provide a location for stockpiles and storage of construction materials and equipment. A storage area will be provided within the construction compound for secure storage of civil infrastructure facilities including water supply and sewerage pipeworks, valves and associated fittings.

An equipment maintenance area will be provided within the construction compound for routine maintenance of construction vehicles, plant and equipment. This area will be fully bunded and runoff contained to prevent

dispersal of oils and hydrocarbons to receiving environments. Extensive equipment maintenance and/or repairs will be conducted at an off-site facility.

The site will be fully bunded by construction of permanent breakwaters and temporary bunding material to isolate the site from adjacent waterways. Temporary bunds will be constructed of rock material and will be removed at the completion of site reclamation works to allow water to flow into canal and marina areas.

Temporary Stockpile Site – Riverside Marine

Negotiations have been undertaken with the owner of the Riverside Marine site for temporary stockpiling of rock and sand fill material for the period of construction. Materials delivered by overland truck via Boundary Road will be stored temporarily within this site and removed to the project site by barge. The barge landing facility at this site will require upgrade for delivery of construction materials to the project site which will be left in place for future use by Riverside Marine.

Removal and Disposal of Temporary Structures

The Construction Project Manager will supervise decommissioning and removal of all temporary structures and materials which will be undertaken within 2 weeks of completion of construction works.

It is expected that the majority of structures and materials will be either demobilised and returned to suppliers or manufacturers or reused within the site. Any structures or materials that cannot be reused will be removed to an approved recycling facility or landfill site for disposal as described in the Waste Management report.

Temporary Accommodation

It is not proposed to construct temporary accommodation for housing of construction employees. Construction personnel will be sourced predominantly from the local construction workforce. It is expected that specialist personnel required to be sourced from other areas can be housed within existing accommodation facilities in Townsville. This matter is discussed in the Social Impact Report.

Where a construction caretaker is required to remain on site from time to time for site security purposes, temporary accommodation will be provided within the proposed temporary office and facilities buildings. This is not expected to be a regular use and a separate structure is therefore not required for accommodation purposes.

APPENDIX A

ENGINEERING DRAWINGS

NOTATION

SUB-CATCHMENT NOTATION

- STAGE NUMBER
- STAGE SUB-CATCHMENT
- DEVELOPMENT CATEGORY SUB-CATCHMENT
- DEVELOPMENT CATEGORY (REFER TO DEVELOPMENT CATEGORY ABBREVIATIONS)

OUTLET NOTATION

- STAGE NUMBER
- STAGE SUB-CATCHMENT

DEVELOPMENT CATEGORIES

A - APARTMENTS (INCLUDING SOME RETAIL COMPONENTS)
U - URBAN RESIDENTIAL SITES
P - PUBLIC PARK
R - ROADWAY
C - CARPARK / HARDSTAND AREAS

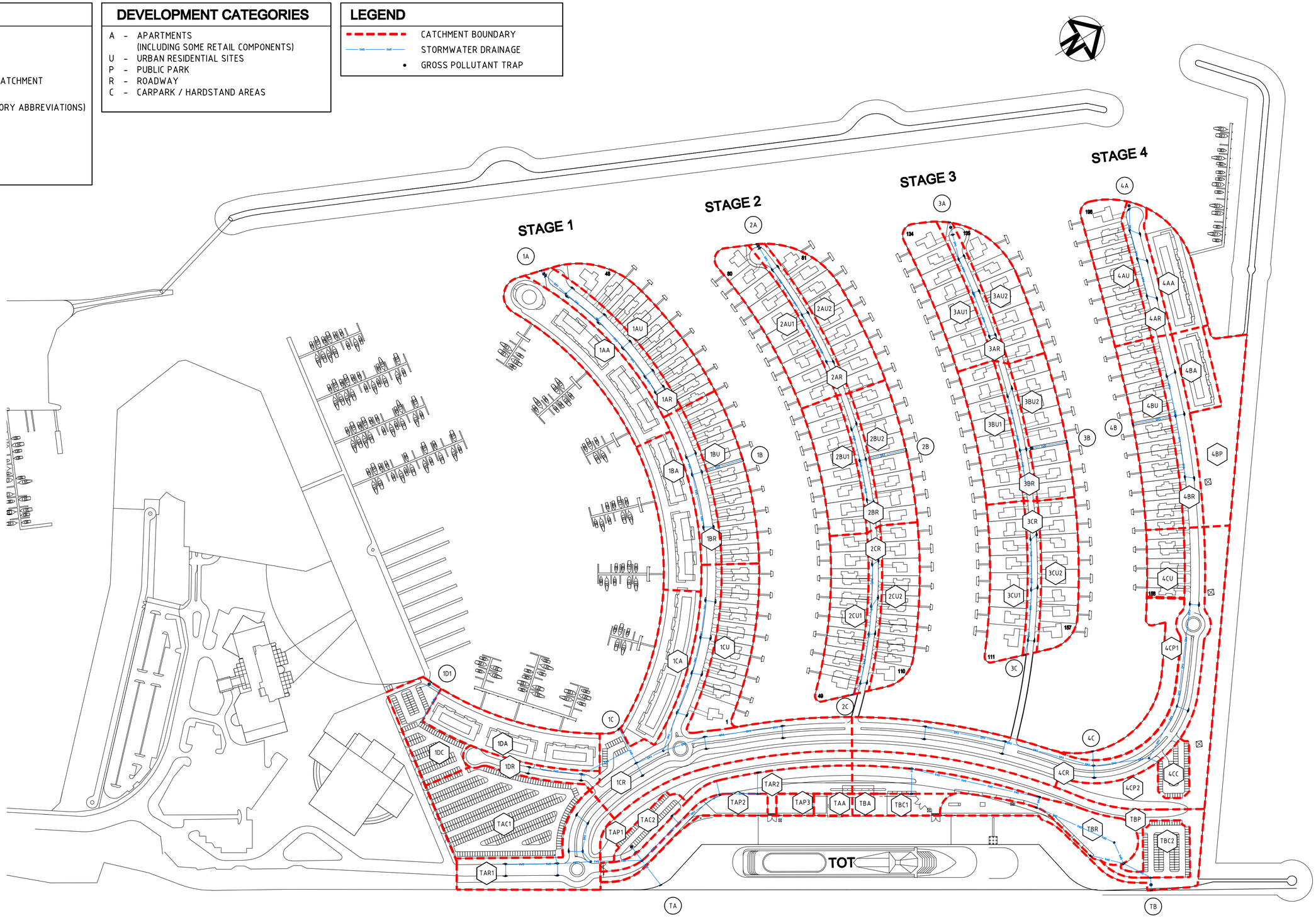
LEGEND

- CATCHMENT BOUNDARY
- STORMWATER DRAINAGE
- GROSS POLLUTANT TRAP

CATCHMENT TABLE

CATCHMENT	AREA (Ha)	TOTAL AREAS (Ha)
1AA	0.8581	
1AU	0.7202	
1AR	0.4302	2.0085
1BA	0.6292	
1BU	0.6923	
1BR	0.3443	1.6658
1CA	0.6297	
1CU	0.6975	
1CR	1.5648	2.8953
1DA	0.7113	
1DC	0.4520	
1DR	0.2143	1.3776
2AU1	0.7211	
2AU2	0.6256	
2AR	0.2530	1.5997
2BU1	0.5503	
2BU2	0.5715	
2BR	0.2016	1.3234
2CU1	0.6680	
2CU2	0.6493	
2CR	0.2384	1.5557
3AU1	0.6186	
3AU2	0.5347	
3AR	0.2200	1.3733
3BU1	0.5665	
3BU2	0.5817	
3BR	0.2027	1.3509
3CU1	0.6345	
3CU2	0.5890	
3CR	0.2223	1.4458
4AA	0.4468	
4AU	0.5855	
4AR	0.3012	1.3335
4BA	0.2814	
4BU	0.7663	
4BR	0.4259	
4BP	0.7026	2.1762
4CC	0.1620	
4CU	0.2778	
4CR	1.5949	
4CP1	0.3968	
4CP2	0.8810	3.3125
TAA	0.0905	
TAR1	0.7351	
TAR2	0.5112	
TAP1	0.4903	
TAP2	0.2566	
TAP3	0.0875	
TAC1	1.1778	
TAC2	0.1915	3.5405
TBA	0.1130	
TBR	0.7622	
TBP	0.9488	
TBC1	0.1003	
TBC2	0.3031	2.2274

TOTAL SITE AREA = 29.1861 Ha



Issue	Description	Date
03	REVISED LAYOUT	31.07.2007
02	REVISED LAYOUT	30.05.2007
01	ORIGINAL ISSUE	08.01.2007

100mm on Original

Scale (Plan): 0 50 100 150 200m — 1 : 2000

Scale (Sections)

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename: K023-24-QL00704-01- SWD OPTION A & B PRELIM.DWG

Client: Townsville Ocean Terminal

Status: **PRELIMINARY** NOT TO BE USED FOR CONSTRUCTION

Approved

R.E.P.Q No :

Scales: AS SHOWN

Original Size: A1

Height Datum: A.H.D

Grid: LOCAL

Current Issue Signatures: Author B.W; Designer B.W; Reviewer J.S

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: INDICATIVE STORMWATER LAYOUT OPTION A, LOT DISCHARGE TO ROADWAYS

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Drawing No. K023 — Project No. QL00704 — Issue 03

14/Sep/2007 11:00 AM F:\QL00704\E-CAD\C-Civil\B-Sketches\K023-24-QL00704-01- SWD OPTION A & B PRELIM.dwg V1

NOTATION

SUB-CATCHMENT NOTATION

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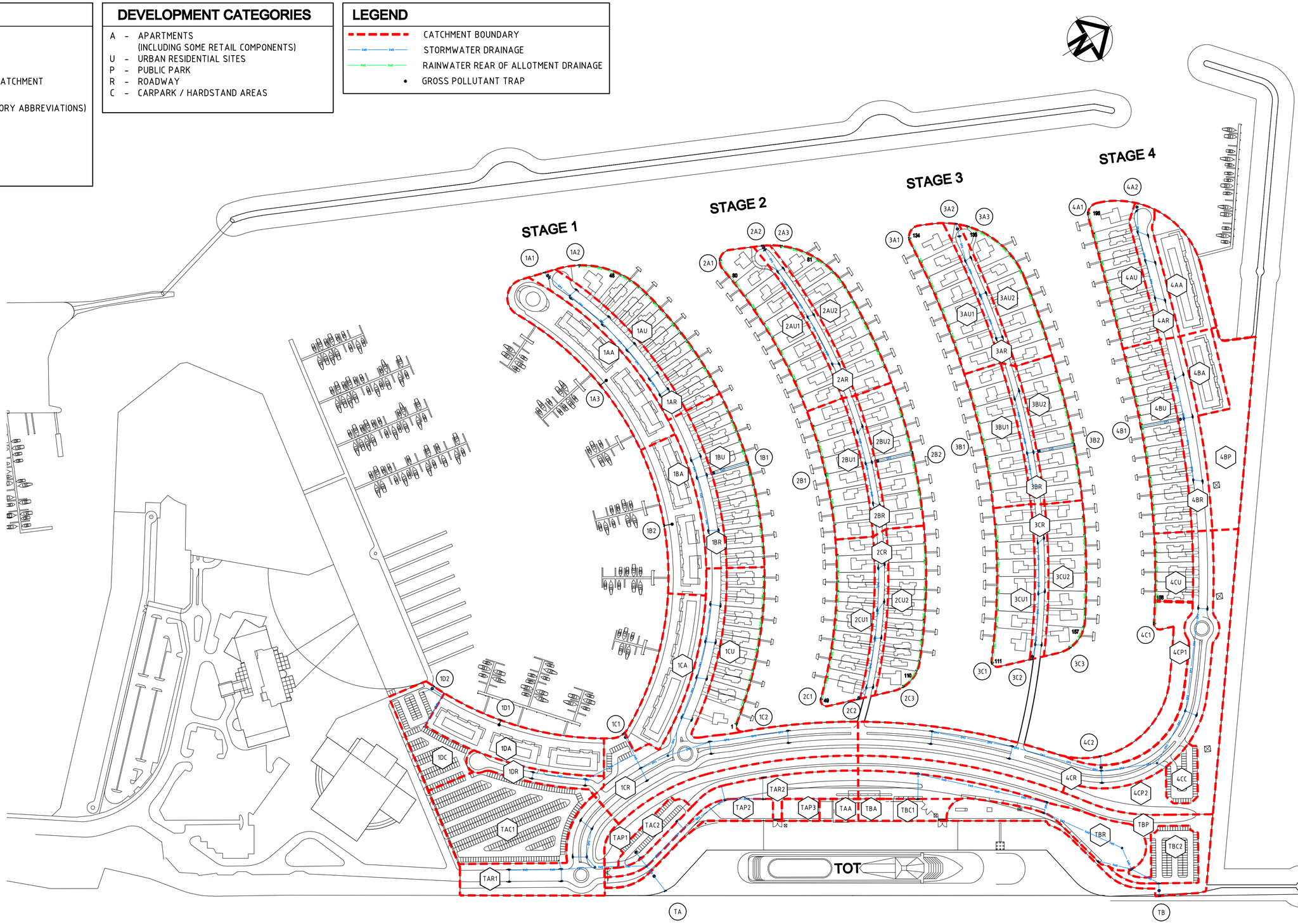
LEGEND

- CATCHMENT BOUNDARY
- STORMWATER DRAINAGE
- RAINWATER REAR OF ALLOTMENT DRAINAGE
- GROSS POLLUTANT TRAP

CATCHMENT TABLE

CATCHMENT	AREA (Ha)	TOTAL AREAS (Ha)
1AA	0.8581	
1AU	0.7202	
1AR	0.4302	2.0085
1BA	0.6292	
1BU	0.6923	
1BR	0.3443	1.6658
1CA	0.6297	
1CU	0.6975	
1CR	1.5648	2.8953
1DA	0.7113	
1DC	0.4520	
1DR	0.2143	1.3776
2AU1	0.7211	
2AU2	0.6256	
2AR	0.2530	1.5997
2BU1	0.5503	
2BU2	0.5715	
2BR	0.2016	1.3234
2CU1	0.6680	
2CU2	0.6493	
2CR	0.2384	1.5557
3AU1	0.6186	
3AU2	0.5347	
3AR	0.2200	1.3733
3BU1	0.5665	
3BU2	0.5817	
3BR	0.2027	1.3509
3CU1	0.6345	
3CU2	0.5890	
3CR	0.2223	1.4458
4AA	0.4468	
4AU	0.5855	
4AR	0.3012	1.3335
4BA	0.2814	
4BU	0.7663	
4BR	0.4259	
4BP	0.7026	2.1762
4CC	0.1620	
4CU	0.2778	
4CR	1.5949	
4CP1	0.3968	
4CP2	0.8810	3.3125
TAA	0.0905	
TAR1	0.7351	
TAR2	0.5112	
TAP1	0.4903	
TAP2	0.2566	
TAP3	0.0875	
TAC1	1.1778	
TAC2	0.1915	3.5405
TBA	0.1130	
TBR	0.7622	
TBP	0.9488	
TBC1	0.1003	
TBC2	0.3031	2.2274
TOTAL SITE AREA = 29.1861 Ha		



Issue	Description	Date
03	REVISED LAYOUT	31.07.2007
02	REVISED LAYOUT	30.05.2007
01	ORIGINAL ISSUE	08.01.2007

100mm on Original

Scale (Plan): 0 50 100 150 200m — 1 : 2000

Scale (Sections)

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename: K023-24-QL00704-01- SWD OPTION A & B PRELIM.DWG

Client: Townsville Ocean Terminal

Status: **PRELIMINARY** NOT TO BE USED FOR CONSTRUCTION

Approved

R.E.P.Q No :

Scales: AS SHOWN

Original Size: A1

Height Datum: A.H.D

Grid: LOCAL

Current Issue Signatures

Author B.W

Designer B.W

Reviewer J.S

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: INDICATIVE STORMWATER LAYOUT OPTION B, REAR LOT DISCHARGE TO WATERWAY

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Drawing No. K024 — Project No. QL00704 — Issue 03

14/Sep/2007 11:00 AM F:\QL00704\E-CAD\C-Civil\B-Sketches\K023-24-QL00704-01- SWD OPTION A & B PRELIM.dwg V1

LEGEND

SEWERAGE MAINS

STRAND BREAKWATER

TOWNSVILLE BREAKWATER PRECINCT

MARINERS PENINSULA

MARINERS PENINSULA MARINA

JUPITERS CASINO

TOWNSVILLE ENTERTAINMENT CENTRE

SIR LESLIE THIESS DRIVE

ENTERTAINMENT DRIVE

CLEVELAND BAY

SEWERAGE PUMP STATION

TOWNSVILLE OCEAN TERMINAL PRECINCT

SEWER RISING MAIN TO CONNECT TO WORKS EXTERNAL

NOTES

1. GRAVITY HOUSE CONNECTION SEWER
2. VACUM SEWER MAIN TO SEWERAGE PUMP STATION
3. RISING MAIN FROM PUMP STATION TO WORKS EXTERNAL

Issue	Description	Date
02	NEW LAYOUT	12.06.2007
01	ORIGINAL ISSUE	15.05.2007

100mm on Original

Scale (Plan): 0 50 100 150 200m — 1 : 2000

Scale (Sections)

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename: K030-K031-QL00704-02- SEW + WAT PRELIM.DWG

Client: Townsville Ocean Terminal

Status: PRELIMINARY — NOT TO BE USED FOR CONSTRUCTION

Approved

R.E.P.Q No :

		Current Issue Signatures	
Scales	AS SHOWN	Author P.S.M	
Original Size	A1	Designer P.S.M	
Height Datum	A.H.D	Reviewer J.S	
Grid	LOCAL	© Copyright reserved	

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: INDICATIVE SEWER RETICULATION LAYOUT INTERNAL TO T.O.T. PROJECT SITE

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Drawing No.	Project No.	Issue
K030	QL00704	02

14/Sep/2007 11:00 AM F:\QL00704\E-CAD\C-Civil\B-Sketches\K030-K031-QL00704-02- SEW + WAT PRELIM.dwg V1

LEGEND

WATER MAIN

STRAND BREAKWATER

TOWNSVILLE BREAKWATER PRECINCT

CLEVELAND BAY

MARINERS PENINSULA

MARINERS PENINSULA MARINA

JUPITERS CASINO

TOWNSVILLE ENTERTAINMENT CENTRE

SIR LESLIE THIESS DRIVE

ENTERTAINMENT DRIVE

TOWNSVILLE OCEAN TERMINAL PRECINCT

Issue	Description	Date
02	NEW LAYOUT	12.06.2007
01	ORIGINAL ISSUE	15.05.2007

100mm on Original

Scale (Plan): 0 50 100 150 200m — 1 : 2000

Scale (Sections)

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename: K030-K031-QL00704-02- SEW + WAT PRELIM.DWG

Client: Townsville Ocean Terminal

Status: PRELIMINARY — NOT TO BE USED FOR CONSTRUCTION

Approved

R.E.P.Q No :

Scales	AS SHOWN	Current Issue Signatures	
		Author P.S.M	
Original Size	A1	Designer P.S.M	
Height Datum	A.H.D	Reviewer J.S	
Grid	LOCAL	© Copyright reserved	

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: INDICATIVE WATER RETICULATION LAYOUT INTERNAL TO T.O.T. PROJECT SITE

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Drawing No.	Project No.	Issue
K031	— QL00704	— 02

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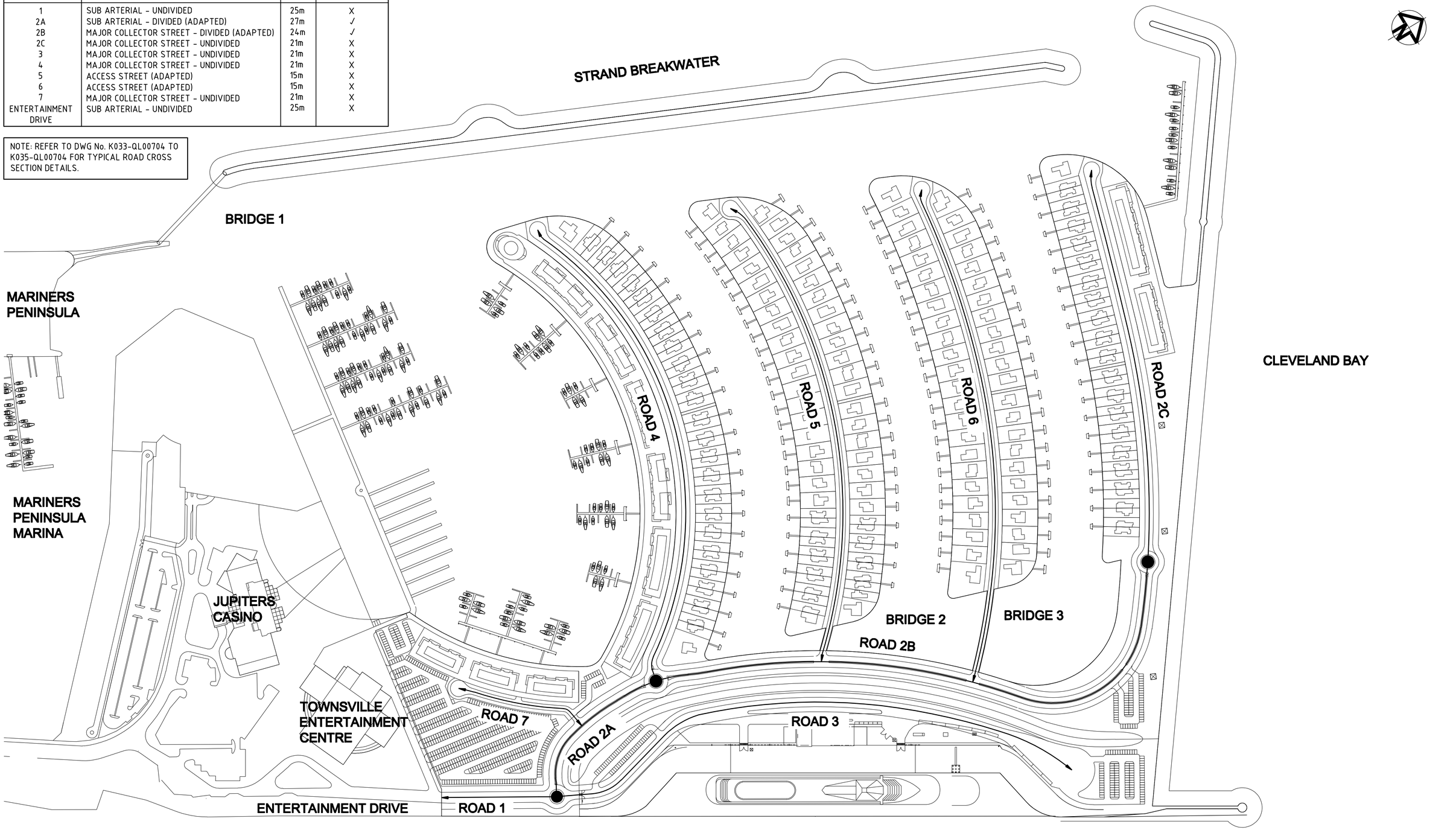
ROAD	CLASSIFICATION	WIDTH	CENTRE MEDIAN
1	SUB ARTERIAL - UNDIVIDED	25m	X
2A	SUB ARTERIAL - DIVIDED (ADAPTED)	27m	✓
2B	MAJOR COLLECTOR STREET - DIVIDED (ADAPTED)	24m	✓
2C	MAJOR COLLECTOR STREET - UNDIVIDED	21m	X
3	MAJOR COLLECTOR STREET - UNDIVIDED	21m	X
4	MAJOR COLLECTOR STREET - UNDIVIDED	21m	X
5	ACCESS STREET (ADAPTED)	15m	X
6	ACCESS STREET (ADAPTED)	15m	X
7	MAJOR COLLECTOR STREET - UNDIVIDED	21m	X
ENTERTAINMENT DRIVE	SUB ARTERIAL - UNDIVIDED	25m	X

NOTE: REFER TO DWG No. K033-QL00704 TO K035-QL00704 FOR TYPICAL ROAD CROSS SECTION DETAILS.



Issue	Description	Date
03	AMMENDED LAYOUT	27.07.2007
02	NEW LAYOUT	12.06.2007
01	ORIGINAL ISSUE	04.06.2007

100mm on Original

Scale (Plan): 0 50 100 150 200m — 1 : 2000

Scale (Sections)

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename: K032-QL00704-01- ROAD LAYOUT.DWG

Client: Townsville Ocean Terminal

Status: PRELIMINARY — NOT TO BE USED FOR CONSTRUCTION

Approved — R.E.P.Q No :

Scales: AS SHOWN

Original Size: A1

Height Datum: A.H.D

Grid: LOCAL

Current Issue Signatures: Author P.S.M; Designer R.M; Reviewer J.S

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: INDICATIVE ROAD CLASSIFICATION LAYOUT INTERNAL TO TOT PROJECT SITE

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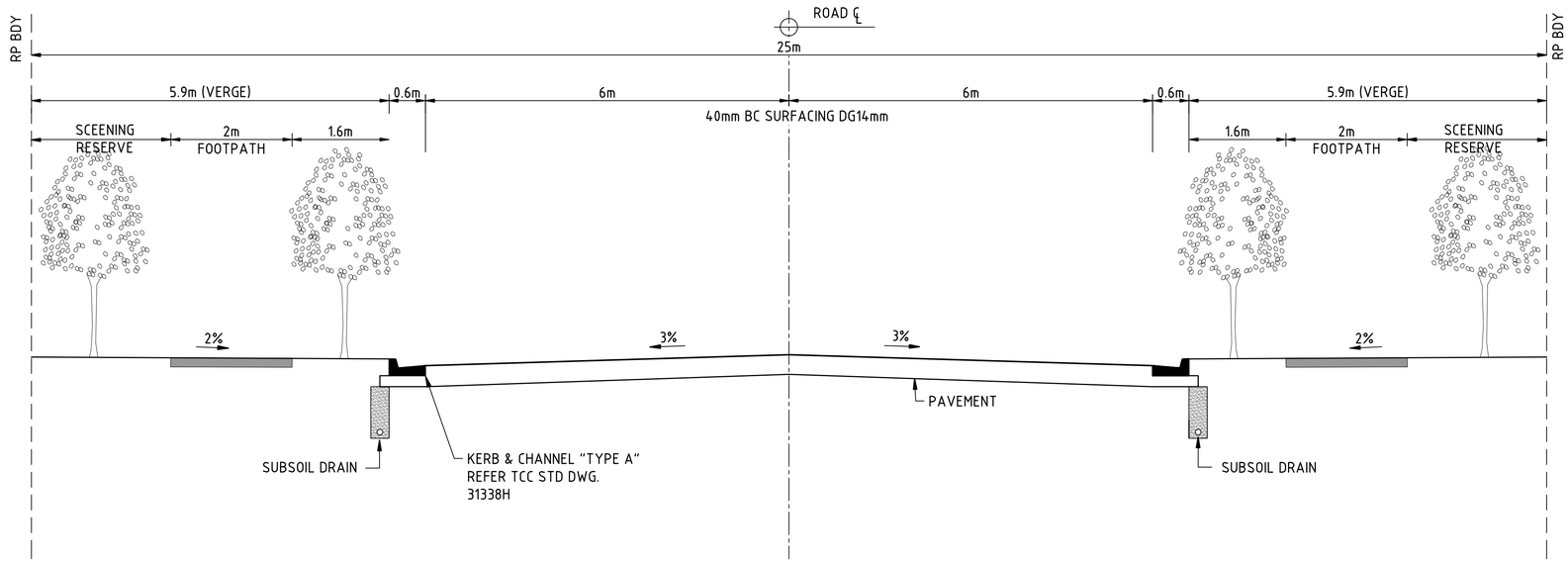
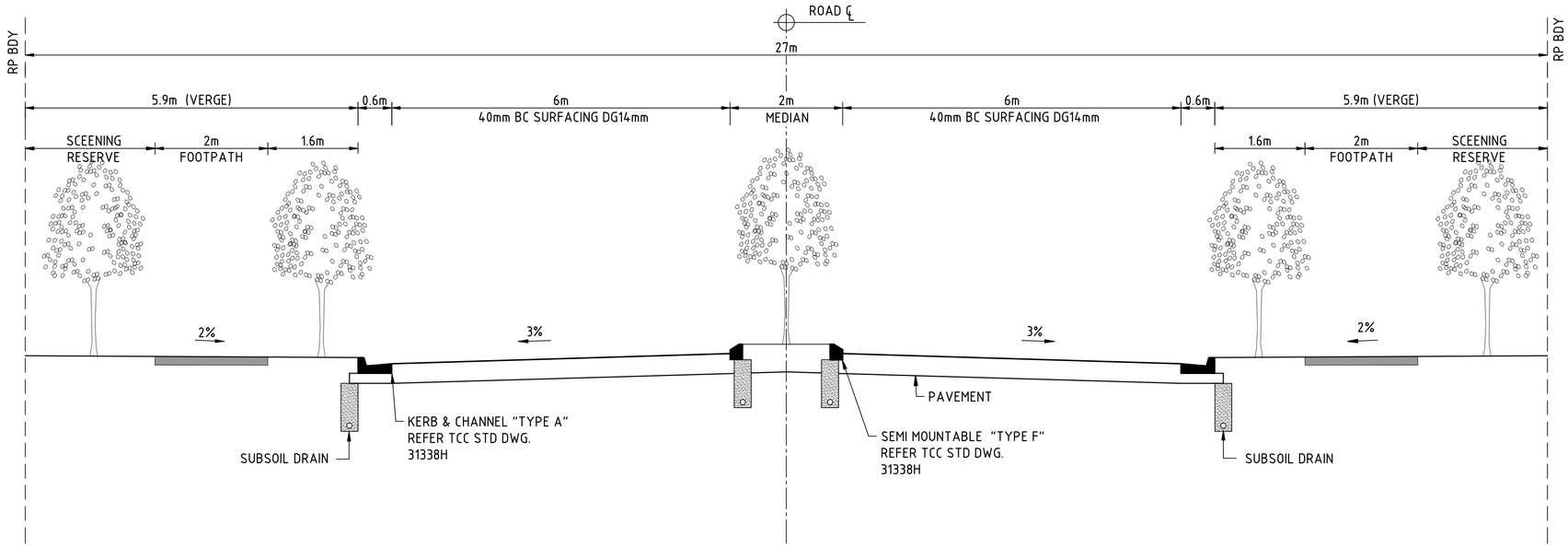
Drawing No. K032 — Project No. QL00704 — Issue 03

14/Sep/2007 10:59 AM F:\QL00704\E-CAD\C-Civil\B-Sketches\K032-QL00704-01- ROAD LAYOUT.dwg V1

NOTE: REFER TO DWG No. K032-QL00704 FOR ROAD LAYOUT.



EXTERNAL ROAD & ROAD 1
SUBARTERIAL ROAD - UNDIVIDED



ROAD 2A
SUBARTERIAL ROAD - DIVIDED (ADAPTED)

Issue	Description	Date
02	AMMENDED LAYOUT	27.07.2007
01	ORIGINAL ISSUE	04.06.2007

100mm on Original

Scale (Plan)

Scale (Sections)
0 0.5 1 2 3 4 5m
1 : 50

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename K033-K035 - QL00704-01- ROAD SECTION + DETAILS.DWG

Client: Townsville Ocean Terminal

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

Approved

R.E.P.Q No :

Scales: AS SHOWN

Current Issue Signatures

Original Size: A1

Height Datum: A.H.D

Grid: LOCAL

Author P.S.M

Designer R.M

Reviewer J.S

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: ROAD CROSS SECTIONS SHEET 1 OF 3

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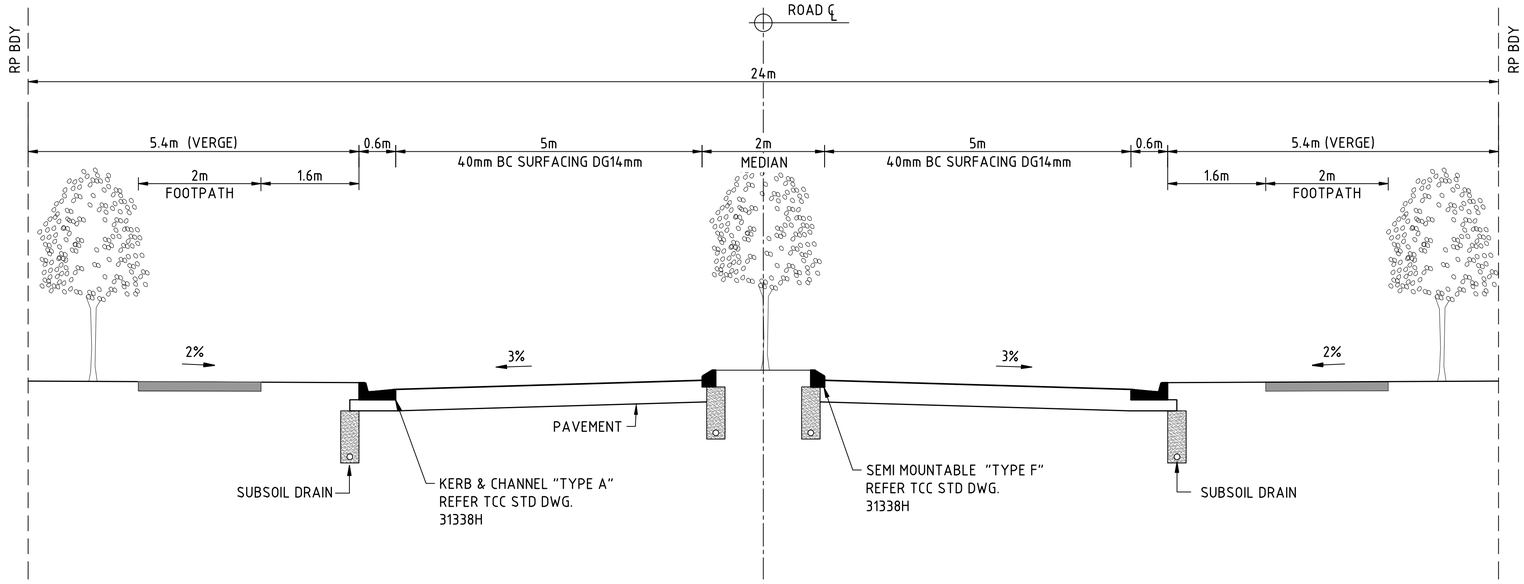
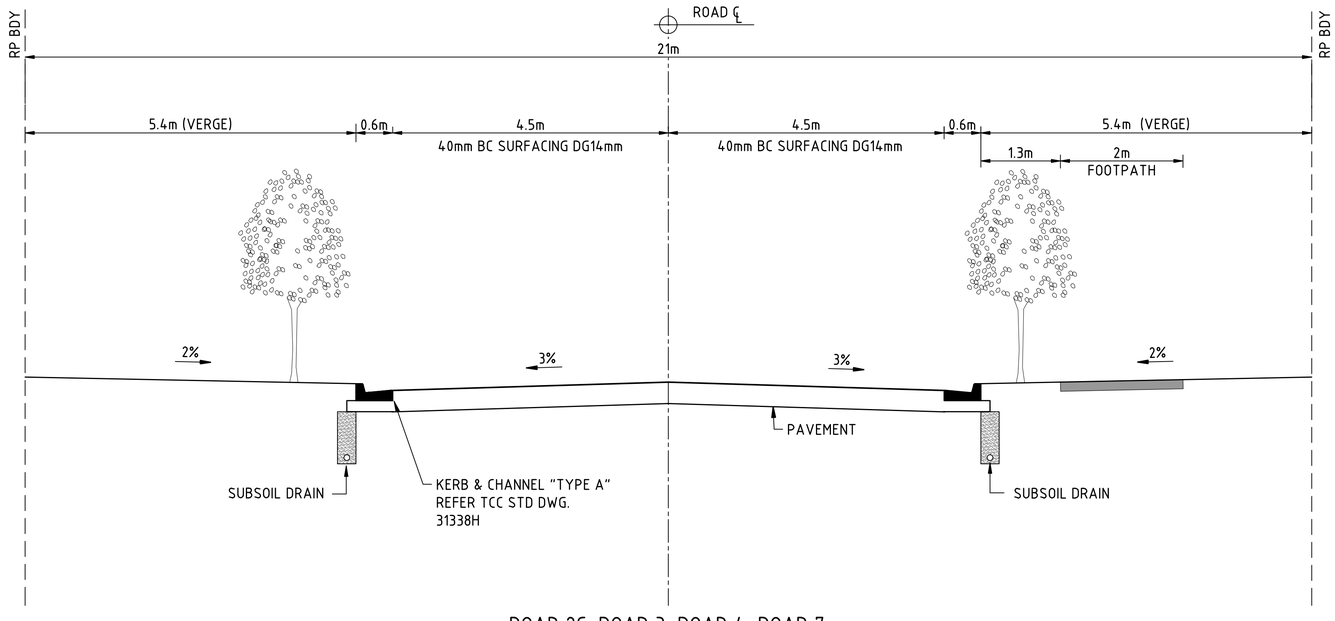
Drawing No. K033 — Project No. QL00704 — Issue 02

14/Sep/2007 10:59 AM F:\QL00704\E-CAD\C-Civil\B-Sketches\K033-K035 - QL00704-01- ROAD SECTION + DETAILS.dwg V1

NOTE: REFER TO DWG No. K032-QL00704 FOR ROAD LAYOUT.



ROAD 2B
MAJOR COLLECTOR STREET - STREET DIVIDED (ADAPTED)



ROAD 2C, ROAD 3, ROAD 4, ROAD 7
MAJOR COLLECTOR STREET - UNDIVIDED

Issue	Description	Date
02	AMMENDED LAYOUT	27.07.2007
01	ORIGINAL ISSUE	04.06.2007

100mm on Original

Scale (Plan)

Scale (Sections)

0 0.5 1 2 3 4 5m

1 : 50

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename K033-K035 - QL00704-01- ROAD SECTION + DETAILS.DWG

Client: Townsville Ocean Terminal

Status: **PRELIMINARY**
NOT TO BE USED FOR CONSTRUCTION

Approved

R.E.P.Q No :

Scales	AS SHOWN	Current Issue Signatures	
		Author P.S.M	
Original Size	A1	Designer R.M	
Height Datum	A.H.D	Reviewer J.S	
Grid	LOCAL	© Copyright reserved	

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: ROAD CROSS SECTIONS SHEET 2 OF 3

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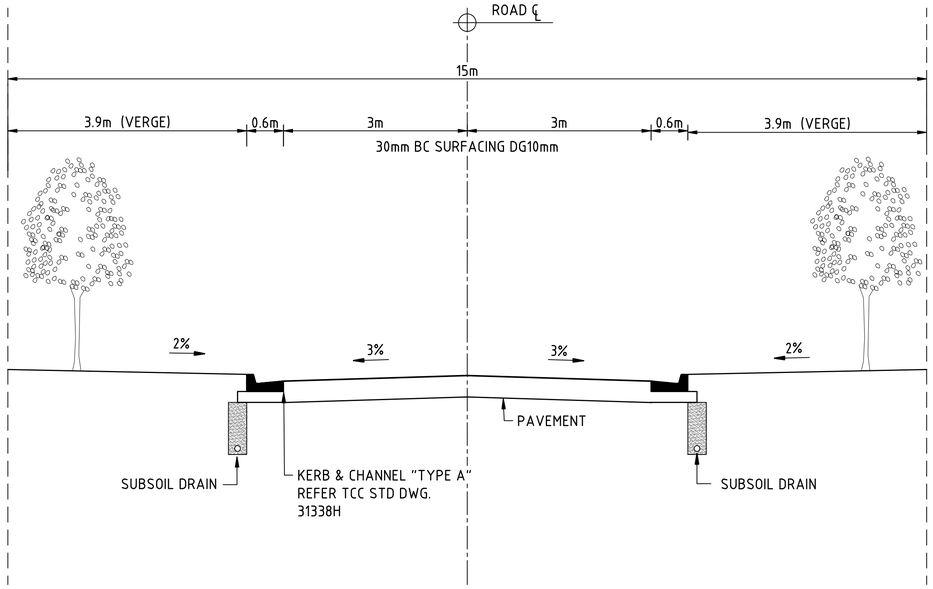
Drawing No.	Project No.	Issue
K034	QL00704	02

14/Sep/2007 10:59 AM F:\QL00704\E-CAD\C-Civil\B-Sketches\K033-K035 - QL00704-01- ROAD SECTION + DETAILS.dwg V1

NOTE: REFER TO DWG No. K032-QL00704 FOR ROAD LAYOUT.



ROAD 5 & ROAD 6
ACCESS STREET (ADAPTED)

Issue	Description	Date
02	AMMENDED LAYOUT	27.07.2007
01	ORIGINAL ISSUE	04.06.2007

Scale (Plan)

Scale (Sections)

0 0.5 1 2 3 4 5m

1 : 50

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename K033-K035 - QL00704-01- ROAD SECTION + DETAILS.DWG

Client: Townsville Ocean Terminal

Status: **PRELIMINARY**
NOT TO BE USED FOR CONSTRUCTION

Approved

R.E.P.Q No :

Scales	AS SHOWN	Current Issue Signatures	
		Author P.S.M	
Original Size	A1	Designer R.M	
Height Datum	A.H.D	Reviewer J.S	
Grid	LOCAL	© Copyright reserved	

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: ROAD CROSS SECTIONS SHEET 3 OF 3

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Drawing No.	Project No.	Issue
K035	QL00704	02

100mm on Original

14/Sep/2007 10:59 AM F:\QL00704\E-CAD\C-Civil\B-Sketches\K033-K035 - QL00704-01- ROAD SECTION + DETAILS.dwg V1

INFRASTRUCTURE INTERNAL TO TOWNSVILLE OCEAN TERMINAL PROJECT SITE

INFRASTRUCTURE EXTERNAL TO TOWNSVILLE OCEAN TERMINAL PROJECT SITE

TOWNSVILLE OCEAN PERMINAL PROJECT SITE BOUNDARY

PROPOSED RISING MAIN

DISCHARGE MANHOLE

PROPOSED GRAVITY SEWER

ENTERTAINMENT ROAD

EXTENSION TO EXISTING MAIN

FOR CONTINUATION REFER BELOW

PROPOSED GRAVITY SEWER

CONNECTION POINT FOR T.O.T SEWER TO EXISTING SEWER PUMP STATION BY (LIVE CONNECTION CITIWATER)

ENTERTAINMENT ROAD

PROPOSED WATER MAIN

SIR LESLIE THIESS DRIVE

SIR LESLIE THIESS DRIVE

CONNECTION POINT FOR T.O.T PROJECT WATER SUPPLY. CITIWATER TO CONNECT INTO EXISTING Ø250mm WATERMAIN (LIVE WATERMAIN).

FOR CONTINUATION REFER ABOVE

KELLEHE

KING ST

THE STRAND

FLINDERS STREET

ABANDONED SEWER MAIN

LEGEND

- EXISTING WATER MAIN
- EXISTING SEWER
- EXISTING STORMWATER DRAINAGE
- PROPOSED WATER MAIN
- PROPOSED SEWER
- PROPOSED SEWER RISING MAIN
- SITE BOUNDARY

Issue	Description	Date
01	ORIGINAL ISSUE	13.06.07

100mm on Original

Scale (Plan): 0 10 20 40 60 80 100m — 1 : 1000

Scale (Sections)

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename: K038-QL00704-01- EXISTING SERVICES PLAN.DWG

Client: Townsville Ocean Terminal

Status: **PRELIMINARY** NOT TO BE USED FOR CONSTRUCTION

Approved

R.E.P.Q. No :

Scales	1:1000 @ A1	Current Issue Signatures	
		Author P.S.M	
Original Size	A1	Designer R.M.	
Height Datum	A.H.D	Reviewer J.S	
Grid	LOCAL	© Copyright reserved	

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: PROPOSED AND EXISTING INFRASTRUCTURE SERVICES LAYOUT

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Drawing No.	Project No.	Issue
K038	— QL00704	— 01

14/Sep/2007 11:00 AM F:\QL00704\E-CAD\C-Civil\B-Sketches\K038-QL00704-01- EXISTING SERVICES PLAN.dwg V1

APPENDIX B

HASTHILL CONSULTING REPORT AND DRAWINGS

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hasthill consultants

electrical mechanical fire lift engineers

LO:pp c11697

June 26th 2007

Hyder Consulting
PO Box 1653
SOUTHPORT QLD 4215

For the attention of Elizabeth Clough

Dear Elizabeth,

Re: Townsville Ocean Terminal- Final EIS Report

Further to our recent discussions and meetings regarding the Environmental Impact Statement Report for the Townsville Ocean Terminal and having reviewed the latest Queensland Government "Draft Terms of reference for an Environmental Impact Statement", we can report as follows: -

Issues to be addressed in this report: -

We have reviewed the draft terms of reference detailed above and have concluded that the following items will need to be addressed by Hasthill Consultants as follows: -

- Impact on infrastructure in the area for the associated Telecommunications and Electricity Networks.
- Illustrative plans showing proposed infrastructure arrangements for electricity and telecommunications services
- Illustrative plans showing proposed lighting around the project area
- Comment on potential impacts and mitigation measures
- Detail all energy requirements/capacity/upgrades/energy conservation
- Comment on Telecommunications capacity
- Detail lighting for safety and security/ environmental impact/ mitigation etc

ISO 9001

Specific Review Report

1. Infrastructure – Electricity:

A master plan has been developed by Hasthill Consultants detailing the proposed Ergon Energy infrastructure to enable low voltage power reticulation to each dwelling and to the Townsville Ocean Terminal. Ergon standard After Diversity Maximum Demands have been used as follows: -

- Typical single residence 5kVA (ADMD) per dwelling
- Typical multi unit residence 3.5 kVA (ADMD) per dwelling
- Allowance for TOT and Car parks etc

A network of 11,000 volt cables in a ring main is proposed to a number of pad mounted transformers strategically located around the site, generally located in common/park areas, within landscaped areas to provide a more aesthetically pleasing solution.

Due to the increase in power demand to the area for the proposed development, discussion continues with Ergon Energy to establish a new zone sub station near the Townsville Esplanade with new underground high voltage lines to be reticulated to this location.

New 11kV cables would be reticulated along the edge of the existing road and within the proposed new road reserves from the proposed zone sub station to each of the proposed pad mounted transformers.

The High and Low voltage network would be owned and maintained by Ergon Energy.

Refer to proposed Ergon Energy master plan (drawing No. 6582-TOT:E:01) for details.

Energy efficiency measures would be undertaken to ensure compliance with the current Building Code of Australia (BCA) whereby areas such as the following would be addressed: -

- Building Fabric
- External Glazing
- Building Sealing
- Air Movement
- Air Conditioning and Ventilation Systems
- Artificial Lighting and Power
- Hot Water Supply
- Access for Maintenance

This would ensure compliance with BCA Section J.

2. Infrastructure – Telecommunications

Due to the number of dwellings and provision of telephone lines to the TOT plus broadband Internet facilities, negotiations are taking place with Telstra to provide a RIM Unit (Remote Integrated Multiplexor) centrally located within the proposed development.

Fibre Optic cable would be reticulated by Telstra from the nearest existing node via underground conduits in the road reserve of the existing and proposed road infrastructure.

Multipair copper cables would then be reticulated via underground conduit and pit network to each dwelling and the TOT development.

3. Proposed lighting around the project area

We have carried out an initial design for proposed lighting around the wharf and car park area to determine the approximate number and height of floodlights.

The design standards utilized are: -

- AS1158.3.1. Category P11A (disabled car park bays will be category P12, but are not currently designated).
- AS3827 parts 1 & 2 (1998) -calculated values)
- AS4282 (intensity control limits)

From the proposed scheme, the above standards can be met and the calculated spill plane average luminance of maximum 1.37 lux is achieved. (In most cases is less than 1 lux).

TABLE 1. SPILL ILLUMINACE ON PROPERTY BOUNDARY

LABEL	UNITS	AVG	MAX	MIN
Spill Plane # 1	Lux	1.08	2	0
Spill Plane # 2	Lux	0.00	0	0
Spill Plane # 3	Lux	1.37	2	1
Spill Plane # 4	Lux	0.90	1	0
Spill Plane # 5	Lux	1.00	1	1
Spill Plane # 6	Lux	1.00	1	1
Spill Plane # 7	Lux	1.00	1	1
Spill Plane # 8	Lux	1.00	1	1
Spill Plane # 9	Lux	0.41	1	0

This compares well to typical local council accepted light spill levels and would be similar to the value of lux for general street lighting. Refer also to notes below: -

1. The values tabulated and identified in the layout were calculated in accordance with AS 4282, specifically figure 2.1 and table 2.1. For pre-curfew conditions not post curfew conditions. It does not include for any additional road of amenity lighting that may be included by others.

2. The critical values are the maximum values. For compliance with AS 4282 the maximum should not exceed:
    - 10 lux pre-curfew (typically until 11.00pm). Calculated on the plane of the property boundary.
    - 2 lux post-curfew (typically between 11.00pm and sunrise) for light surrounds, calculated in the plane of the affected windows.
    - 1 lux post-curfew for dark surrounds, calculated in the plane of the affected window.

3. The levels achieved were in all but two cases sufficient to claim compliance with post curfew conditions for "dark surrounds", even when calculated at the site boundary and not on the windows. This compliance condition is the most onerous and stringent within AS 4282.
   Planes 1 & 3 showed maximum values of 2 lux at the site boundary making them compliant with dark surrounds if applied at the windows. Note that only the lease/property lines were shown on the supplied drawing.

4. Note that although plane 2 shows all O's it did receive some light but this was less than 0.5 lux and the analysis software rounded this down to 0.

Refer to Hasthill Consultants drawings 6582 TOT: E: 10, E: 11 and E: 12 for details.

The general heights of poles to enable compliance to AS1158 are as follows: -

- Car parking areas – 12m
- Wharf – 20m

Lighting to the wharf area would be controlled and switched such that two modes of operation would be present as security mode or normal mode. This would dramatically reduce the lighting level at required times and be dependent upon any curfew hours imposed.

Due to the type of luminaires proposed and the control of spill light, we do not anticipate that the navigation lighting and signage will be adversely affected.

Any lighting associated with construction would be in the form of local flood lights utilised for security only.

4. General comments

Energy conservation would be incorporated as part of the Building Code of Australia requirements including energy efficiency audits and use of compact fluorescent and fluorescent lighting to each dwelling, (Refer to section 1 above)

Also incorporated would be photocell and time clock control of all external street, car park and wharf lighting to ensure illumination is only active when required.

General safety lighting (as required by AS1158) would be located around the project including street lighting, car park lighting and wharf lighting.

Select, low glare, high photometric control luminaries, lanterns and floodlights would be used to minimise any effect on residences and to the surrounding area.

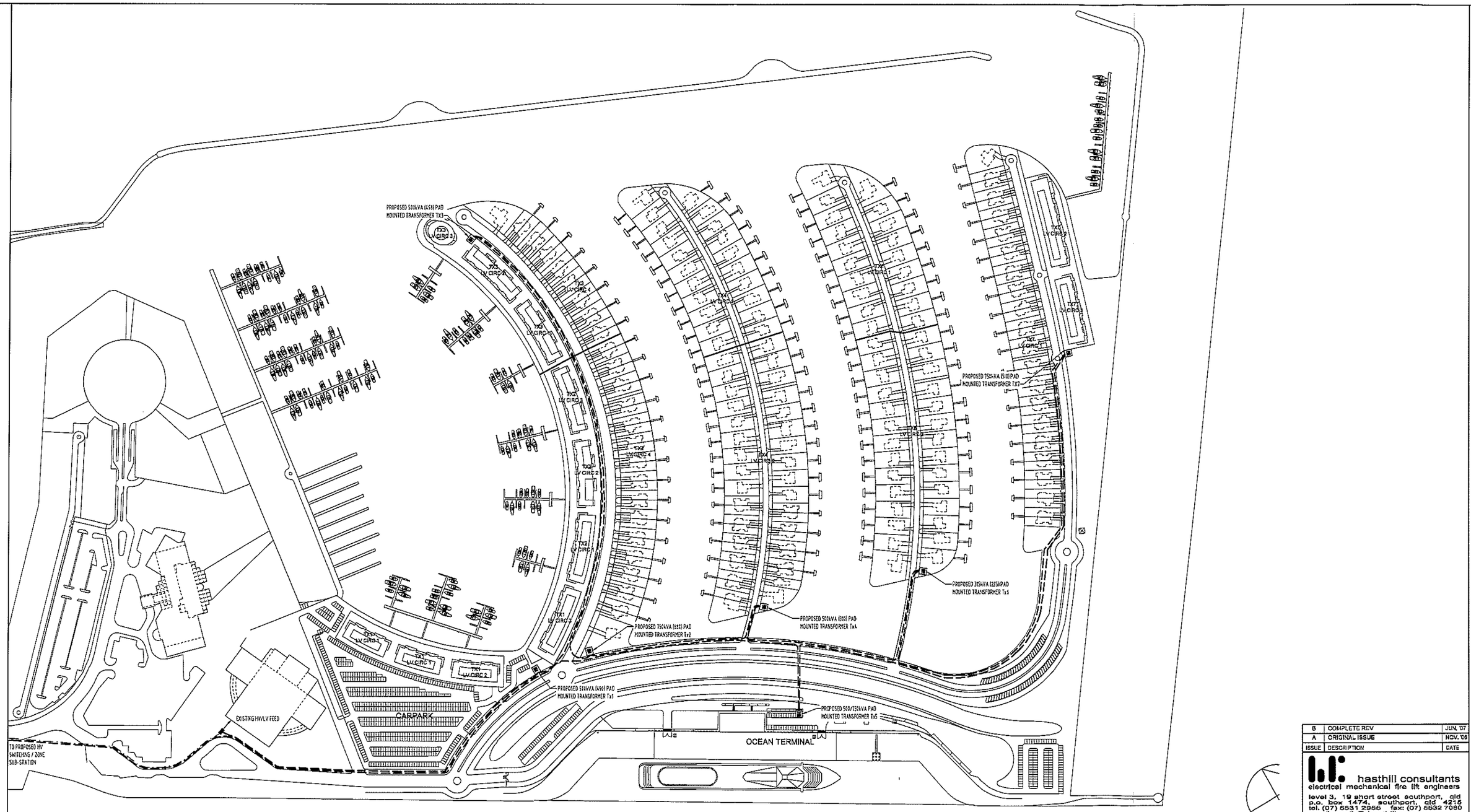
Summary

Elizabeth, I trust that this final EIS report on the electrical services is of assistance, should you need further details or clarification, please contact me on (07) 5531 2955.

Yours faithfully

LEN OLDFIELD
DIRECTOR
RPEQ 7662

Attached Drawing No. 6582-TOT:E01, E:02, E:10, E:11 & E:12



LEGEND

- HV CONDUIT / CABLE
- EXISTING FEED

NOTES

1. CALCULATED VOLTAGE DROPS CARRIED OUT ASSUMING ERGON HAVE RETICULATED LV CABLES & PILLARS WITHIN PRIVATE ROADS.
2. MAXIMUM DEMANDS USED:-
   UNITS 3.5kVA ADMD
   SINGLE LOTS 5kVA ADMD

ISSUE	DESCRIPTION	DATE
B	COMPLETE REV	JUN. '07
A	ORIGINAL ISSUE	NOV. '06

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PROJECT

TOWNSVILLE OCEAN TERMINAL AND BREAKWATER COVE

DRAWING

PROPOSED ERGON ENERGY HV/LV RETICULATION MASTER PLAN

SCALE	1 : 2000		
DRAWN	MH	DATE NOV. '06	CHECKED LCO
PROJECT No.	6582-TOT	DRAWING No.	E : 01
ISSUE	B		
NO. IN SET	1		

POSSIBLE PROPOSED TELSTRA CONNECTION PILLAR

PROPOSED TELSTRA CONNECTION PILLAR

PROPOSED TELSTRA CONNECTION PILLAR

PROPOSED TELSTRA CONNECTION PILLAR

PROPOSED TELSTRA CONNECTION PILLAR

CARPARK

POSSIBLE TELSTRA RM UNIT

OCEAN TERMINAL

TO EXISTING TELSTRA P.O. NODE

LEGEND

FIBRE OPTIC COMS CABLE

MULTI PAIR COMMUNICATIONS CABLE

ISSUE	DESCRIPTION	DATE
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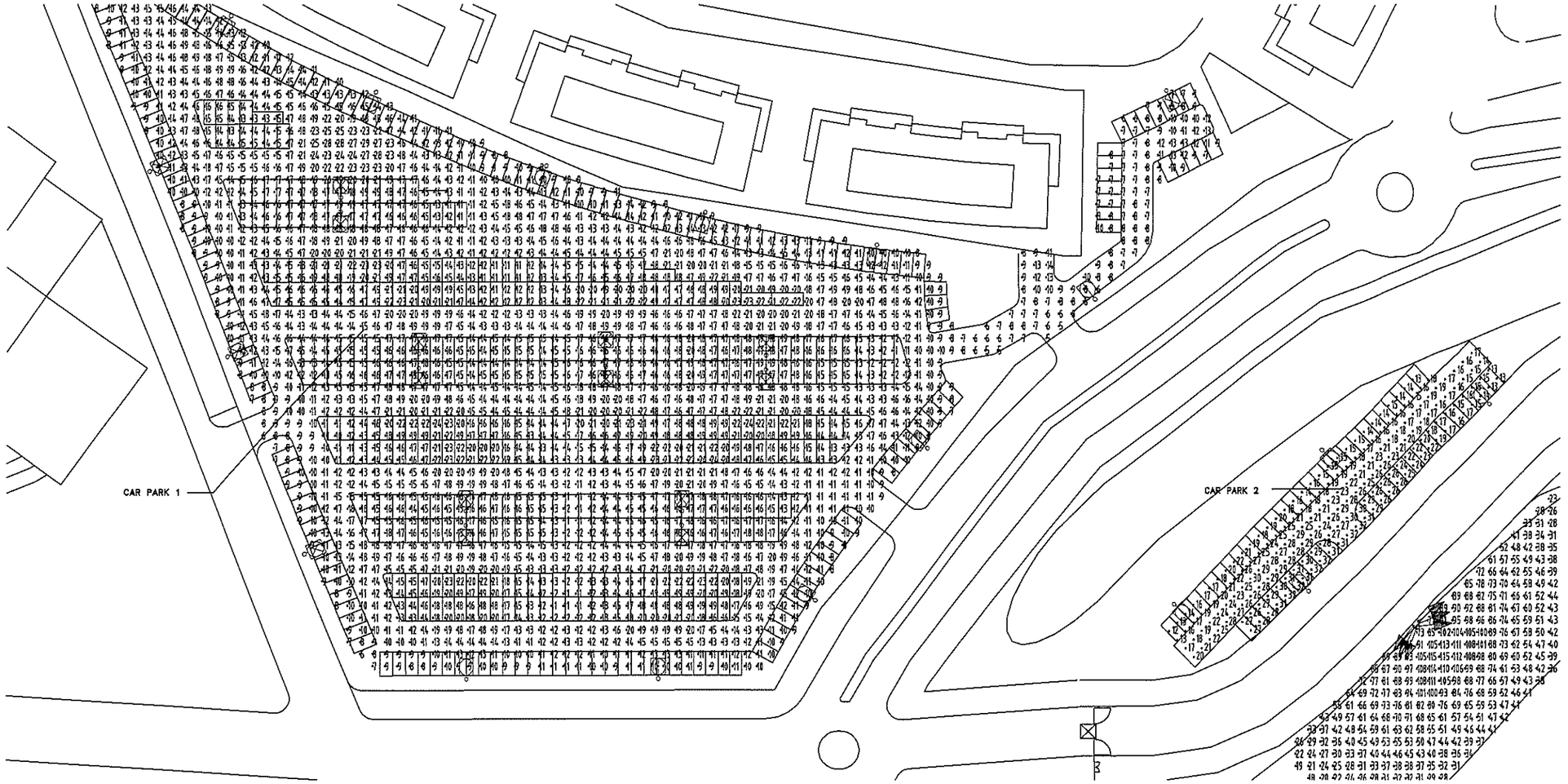
PROJECT

TOWNSVILLE OCEAN TERMINAL AND BREAKWATER COVE

DRAWING

PROPOSED TELSTRA COMMUNICATIONS RETICULATION MASTER PLAN

SCALE	1 : 2000		
DRAWN MH	DATE NOV. '06	CHECKED LCO	
PROJECT NO. 6582-TOT	DRAWING NO. E : 02	ISSUE B	
	SHEET NO. 2		



Numeric Summary					
Label	Units	Avg	Max	Min	UE2
Terminal Forecourt	Lux	23.77	97	6	NA
Wharf	Lux	53.17	138	10	NA
CAR PARK 1 HORIZONTAL	Lux	14.33	29	4	2.0
CAR PARK 1 VERTICAL 2	Lux	9.11	20	3	NA
CAR PARK 1 VERTICAL 1	Lux	9.31	21	3	NA
CAR PARK 2 HORIZONTAL	Lux	21.59	32	12	1.5
CAR PARK 2 VERTICAL 1	Lux	12.00	20	3	NA
CAR PARK 2 VERTICAL 2	Lux	11.20	22	3	NA
CAR PARK 3 HORIZONTAL	Lux	38.85	88	16	2.2
CAR PARK 4 HORIZONTAL	Lux	15.35	24	7	1.6
CAR PARK 4 VERTICAL 1	Lux	11.66	19	8	NA
CAR PARK 4 VERTICAL 2	Lux	8.84	14	5	NA
CAR PARK 3 VERTICAL 2	Lux	23.96	28	19	NA
CAR PARK 3 VERTICAL 1	Lux	8.63	16	4	NA

NOTE THAT ALL LUMINAIRES USED ARE OF THE CUT-OFF STYLE AND HAVE BEEN APPLIED HERE WITH THE FRONT GLASS PARALLEL TO THE GROUND IN ALL CASES.
THE ORIENTATION OF SINGLE OR BACK TO BACK LUMINAIRES CAN BE DETERMINED FROM THEIR ORIENTATION ON THE LAYOUTS SHOWN.

Luminaire Schedule							
Symbol	Qty	Label	Description	Filename	Height	Lumens	LLF
	36	CHV-FP-1000-PSMV-F	LSI-HAMILTON LIGHTING 1kW MH CHALLENGER CHV-FP-1000-PSMV-F FORWARD THROW	LSI00694.ies	20m	110000	0.7
	8	CH2VM-FP-320-PSMV-F	LSI-HAMILTON LIGHTING 320W MH CHALLENGER II CH2VM-FP-320-PSMV-F FORWARD THROW ON 12m POLE	LSI00833.ies	12m	32000	0.7
	17	CH2VM-FP-320-PSMV-F-HSS	LSI-HAMILTON LIGHTING 320W MH CHALLENGER II CH2VM-FP-320-PSMV-F-HSS FORWARD THROW WITH HOUSE SIDE SHIELD	LSI00834.ies	12m	32000	0.7
	6	CH2VM-3-320-PSMV-F	LSI-HAMILTON LIGHTING 320W MH CHALLENGER II CH2VM-3-320-PSMV-F TYPE III DISTRIBUTION	LSI00958.ies	12m	34000	0.7
	8	TWIN CH2VM-FP-320-PSMV-F	LSI-HAMILTON LIGHTING 2 x 320W MH CHALLENGER II CH2VM-FP-320-PSMV-F FORWARD THROW ON	LSI00833.ies	12m	32000	0.7
	4	TWIN CH2VM-3-320-PSMV-F	LSI-HAMILTON LIGHTING 2 x 320W MH CHALLENGER II CH2VM-3-320-PSMV-F TYPE III DISTRIBUTION	LSI00958.ies	12m	34000	0.7

NOTES:

1. THIS SCHEME WAS DESIGNED TO MEET THE LIGHT TECHNICAL PARAMETERS OF AS 1158.3.1 CATEGORIES P11A. LIGHTING TO P12 COULD NOT BE UNDERTAKEN AS NO CLEARLY IDENTIFIABLE DISABLED BAYS COULD BE FOUND ON THE DRAWING SUPPLIED.
2. THE LIGHT LOSS FACTOR OF 0.7 APPLIED TO THIS SCHEME IS CONSISTENT WITH THE USE OF AN IP 5X RATED LUMINAIRE USED WITHIN A "NORMAL" POLLUTION CATEGORY ENVIRONMENT. IN ORDER TO MAINTAIN THE ILLUMINATION LEVELS ACHIEVED BY THIS SCHEME IT IS NECESSARY TO REGULARLY MAINTAIN AND CLEAN THE LUMINAIRES AND REPLACE ALL LAMPS ON A REGULAR BASIS, EVEN IF THEY APPEAR TO BE FUNCTIONING NORMALLY.
3. CALCULATIONS ARE SUBJECT TO THE ACCURACIES AND TOLERANCES NOMINATED WITHIN AS 3817 PARTS 1 & 2 (1998).
4. FOR CLARITY ONLY THE HORIZONTAL VALUES HAVE BEEN SHOWN, VERTICAL ILLUMINANCE VALUES CAN BE VIEWED ON THEIR OWN AUTO CAD LAYER.

STATEMENT OF COMPLIANCE

THIS SCHEME, AS PRESENTED HERE, WILL MEET THE LIGHT TECHNICAL PARAMETERS OF AS 1158.3.1 FOR CATEGORY P11A.

ISSUE	DESCRIPTION	DATE
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PROJECT
TOWNSVILLE OCEAN TERMINAL AND BREAKWATER COVE

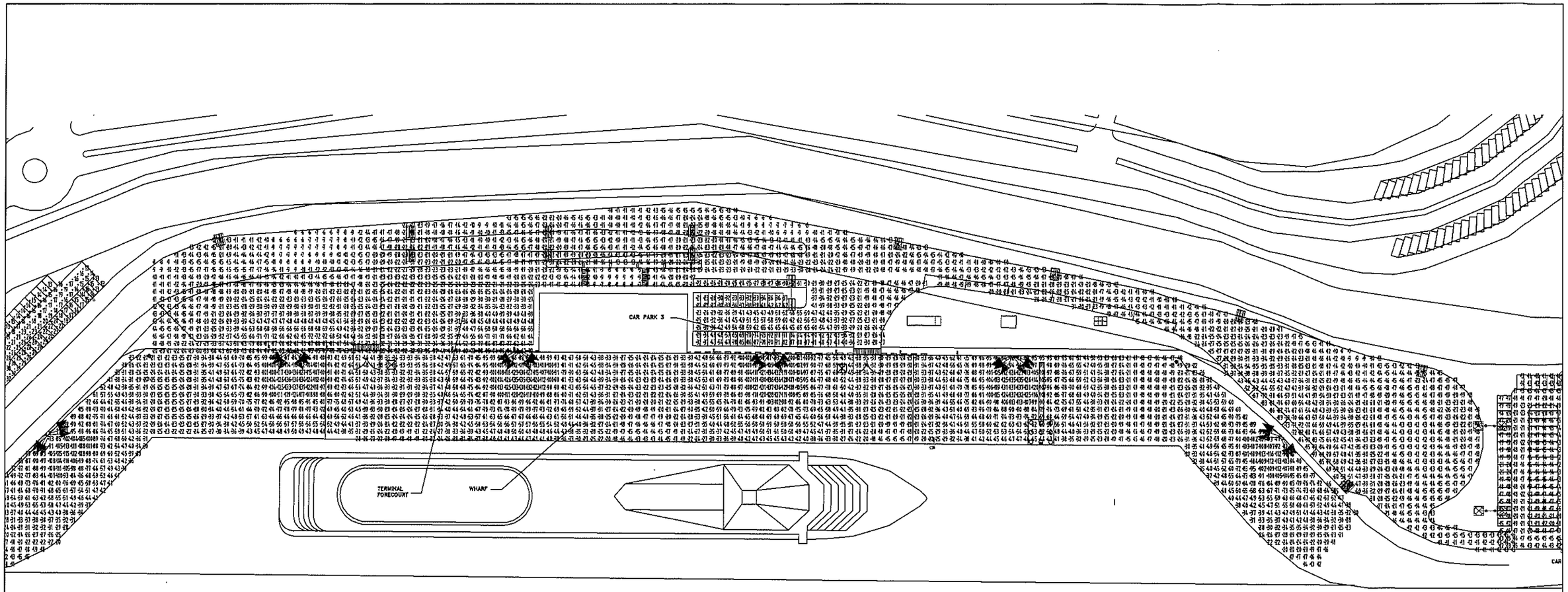
DRAWING
PROPOSED TELSTRA CARPARK, TERMINAL & WHARF LUX LEVEL 5 PART A

SCALE N.T.S.

DRAWN MH | DATE JUL. '07 | CHECKED LCO

PROJECT No. 6582-TOT | DRAWING No. E : 10 | ISSUE B

No. IN SET 3



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Wharf	Lux	53.17	138	10	NA
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CAR PARK 2 HORIZONTAL	Lux	21.59	32	12	1.5
CAR PARK 2 VERTICAL 1	Lux	12.00	20	3	NA
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CAR PARK 3 HORIZONTAL	Lux	38.85	88	16	2.2
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CAR PARK 3 VERTICAL 2	Lux	23.96	28	19	NA
CAR PARK 3 VERTICAL 1	Lux	8.63	16	4	NA

NOTE THAT ALL LUMINAIRES USED ARE OF THE CUT-OFF STYLE AND HAVE BEEN APPLIED HERE WITH THE FRONT GLASS PARALLEL TO THE GROUND IN ALL CASES.
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Luminaire Schedule							
Symbol	Qty	Label	Description	Filename	Height	Lumens	LLF
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	17	CH2VM-FP-320-PSMV-F-HSS	LSI-HAMILTON LIGHTING 320W MH CHALLENGER II CH2VM-FP-320-PSMV-F-HSS FORWARD THROW WITH HOUSE SIDE SHIELD	LSI00834.ies	12m	32000	0.7
	6	CH2VM-3-320-PSMV-F	LSI-HAMILTON LIGHTING 320W MH CHALLENGER II CH2VM-3-320-PSMV-F TYPE III DISTRIBUTION	LSI00958.ies	12m	34000	0.7
	8	TWIN CH2VM-FP-320-PSMV-F	LSI-HAMILTON LIGHTING 2 x 320W MH CHALLENGER II CH2VM-FP-320-PSMV-F FORWARD THROW ON	LSI00833.ies	12m	32000	0.7
	4	TWIN CH2VM-3-320-PSMV-F	LSI-HAMILTON LIGHTING 2 x 320W MH CHALLENGER II CH2VM-3-320-PSMV-F TYPE III DISTRIBUTION	LSI00958.ies	12m	34000	0.7

NOTES:

1. REFER TO NOTES 1 TO 6, LUMINAIRE DESCRIPTIONS AND ILLUMINATION VALUES TABLE ON SHEET 1 OF 3 OF THIS DRAWING SET.
2. THE WHARF AREA DESIGNED TO MEET THE RECOMMENDATIONS FOR WHARVES NOMINATED IN THE QBSE CODE OF PRACTICE "LIGHTING FOR THE INDUSTRIAL ENVIRONMENT".
3. SECURITY LIGHTING CAN EASILY BE ACCOMMODATED WITHIN THIS SCHEME BY STRATEGIC SELECTION OF SOME OF THE LUMINAIRES USED. HOWEVER, IN ORDER FOR THE SECURITY LIGHTING TO BE MOST EFFECTIVE IT NEEDS TO TARGET AREAS OF RISK AND VULNERABILITY. THESE AREAS WERE NOT KNOWN AT THE TIME OF DESIGN.

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PROJECT
TOWNSVILLE OCEAN TERMINAL AND BREAKWATER COVE

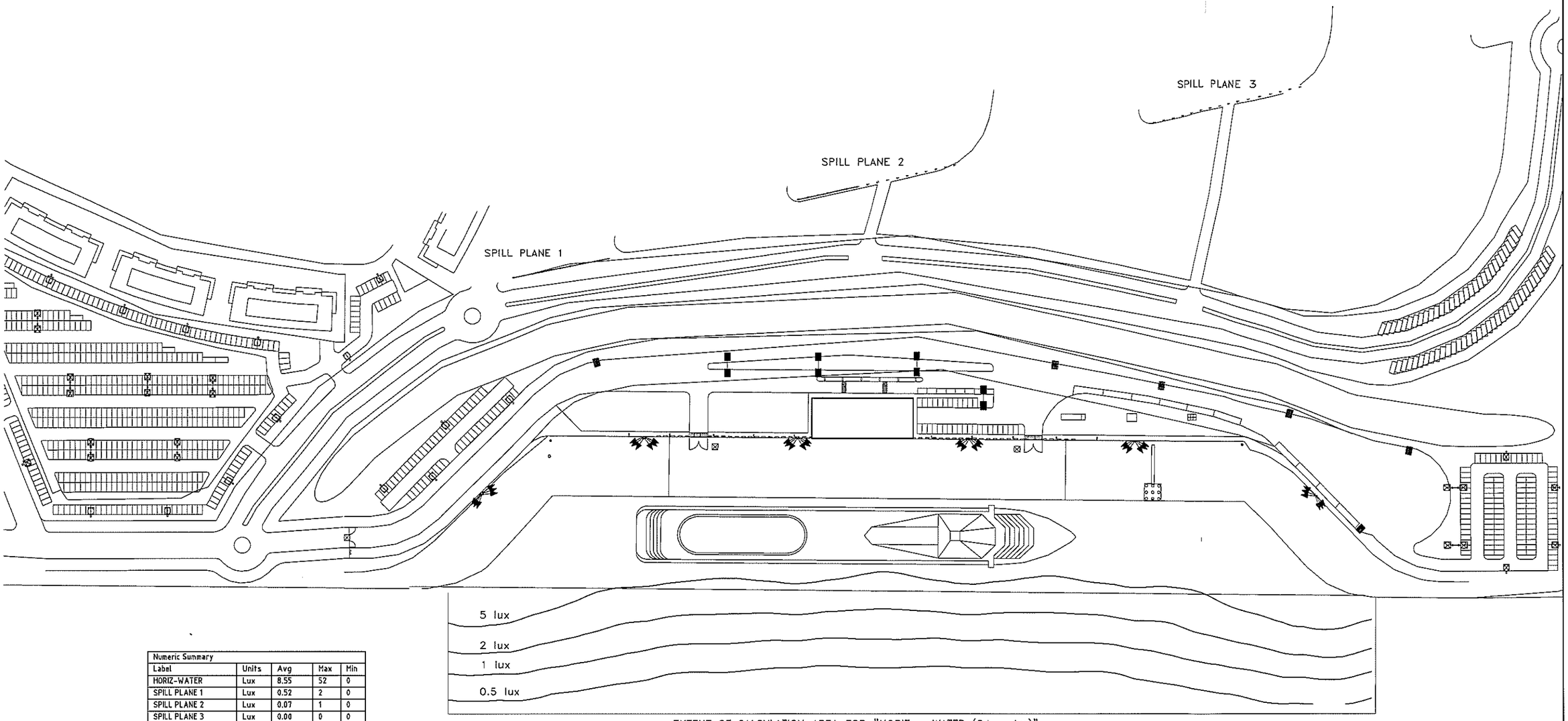
DRAWING
PROPOSED CARPARK, TERMINAL & WHARF LIGHTING PART B

SCALE N.T.S.

DRAWN MH | DATE JUL. '07 | CHECKED LCO

PROJECT No. 6582-TOT | DRAWING No. E : 11 | ISSUE B

No. IN SET 3



EXTENT OF CALCULATION AREA FOR "HORIZ – WATER (G.L. –4m)"

Numeric Summary				
Label	Units	Avg	Max	Min
HORIZ-WATER	Lux	8.55	52	0
SPILL PLANE 1	Lux	0.52	2	0
SPILL PLANE 2	Lux	0.07	1	0
SPILL PLANE 3	Lux	0.00	0	0

NOTES:

1. THE VALUES TABULATED AND IDENTIFIED IN THE LAYOUT ABOVE WERE CALCULATED IN ACCORDANCE WITH AS 4282, SPECIFICALLY FIGURE 2.1 AND TABLE 2.1. FOR PRE-CURFEW CONDITIONS NOT POST CURFEW CONDITIONS. IT ALSO APPLIES ONLY TO THE LUMINAIRES SHOWN. IT DOES NOT INCLUDE ANY ADDITIONAL ROAD OR AMENITY LIGHTING THAT MAY BE INCLUDED BY OTHERS.

2. THE CRITICAL VALUES ARE THE MAXIMUM VALUES. FOR COMPLIANCE WITH AS 4282 THE MAXIMUM SHOULD NOT EXCEED:
   - 10 LUX PRE-CURFEW (TYPICALLY UNTIL 11:00PM). CALCULATED ON THE PLANE OF THE PROPERTY BOUNDARY.
   - 2 LUX POST-CURFEW (TYPICALLY BETWEEN 11:00PM AND SUNRISE) FOR LIGHT SURROUNDS, CALCULATED IN THE PLANE OF THE AFFECTED WINDOWS.
   - 1 LUX POST-CURFEW FOR DARK SURROUNDS, CALCULATED IN THE PLANE OF THE AFFECTED WINDOW

3. THE LEVELS ACHIEVED WERE IN ALL CASES SUFFICIENT TO CLAIM COMPLIANCE WITH POST CURFEW CONDITIONS FOR "DARK SURROUNDS", EVEN WHEN CALCULATED AT THE SITE BOUNDARY AND NOT ON THE WINDOWS. THIS COMPLIANCE CONDITION IS THE MOST ONEROUS AND STRINGENT WITHIN AS 4282. PLANE 1 SHOWED MAXIMUM VALUES OF 2 LUX AT THE SITE BOUNDARY MAKING THIS BOUNDARY COMPLIANT WITH LIGHT SURROUNDS, BUT, MAY BE COMPLIANT WITH DARK SURROUNDS IF APPLIED AT THE WINDOWS.

4. NOTE THAT ALTHOUGH PLANE 3 SHOWS ALL 0'S IT DID RECEIVE SOME LIGHT BUT THIS WAS LESS THAN 0.5 LUX AND THE ANALYSIS SOFTWARE ROUNDED THIS DOWN TO 0.

TABLE 2. LUMINAIRE INTENSITY CONTROL LIMITS			
LUMINAIRE	ACTUAL INTENSITY	AS 4282 MAX INTENSITY	Min
CHV-FP-1000-PSMV-F	<1483 Cd	7500 Cd	0
CH2VM-FP-320-PSMV-F	<2632 Cd	7500 Cd	0
CH2VM-3-320-PSMV-F	<799 Cd	7500 Cd	1

NOTES:

1. THE INTENSITY CONTROL LIMITS OF AS 4282 APPLY TO INDIVIDUAL LUMINAIRES NOT GROUPS OF LUMINAIRES ON A HEAD FRAME.

2. ALL THE LUMINAIRES USED IN THIS SCHEME WERE ORIENTATED AS SHOWN ON THE LAYOUT DRAWINGS WITH THE FRONT GLASS PARALLEL TO THE GROUND IN ALL INSTANCES.

3. THE DEGREE OF INTENSITY CONTROL EXERCISED BY THE LUMINAIRES USED IS SUFFICIENT TO EASILY COMPLY WITH THE MAXIMUM PERMISSIBLE LUMINOUS INTENSITY OF 7500 Cd APPLIED WITHIN "LEVEL 1" CATEGORY OF CONTROL OF AS 4282.
   LEVEL 1 CONTROL IS THE MOST ONEROUS INTENSITY CONTROL CONDITION APPLIED BY AS 4282, AND IS ENTIRELY APPROPRIATE FOR A DEVELOPMENT OF THIS NATURE.

4. THE EVALUATION OF THE INDIVIDUAL LUMINAIRE INTENSITY VALUES WAS CONDUCTED IN ACCORDANCE WITH CLAUSE 5.3.2.2, AND ITS ASSOCIATED CALCULATION METHODS AND DIAGRAMS, OF AS 4282.

NOTES:

1. THIS SCHEME SHOWS THE VERTICAL PLANE SPILL LIGHT GENERATED BY ALL THE LUMINAIRES REQUIRED FOR THE CAR PARKS, WHARF AND TERMINAL FORECOURT. ALL THE VALUES CALCULATED WERE DONE SO USING INITIAL LAMP LUMEN VALUES AND WERE CALCULATED IN THE VERTICAL PLANE OF THE NEAREST SITE BOUNDARY OF HABITABLE PROPERTIES. THESE CONDITIONS ARE NOMINATED WITHIN AS 4282 "THE CONTROL OF THE OBTRUSIVE EFFECTS OF OUTDOOR LIGHTING". REFER TABLE 1 BELOW FOR RESULTS OF ANALYSIS AND COMMENTS.

2. THE INTENSITY CONTROL LIMITS NOMINATED WITHIN AS 4282 ARE NOT EXCEEDED BY ANY OF THE LUMINAIRES USED IN THIS SCHEME. REFER TABLE 2 LEFT FOR ACTUAL VALUES GENERATED BY THE INDIVIDUAL LUMINAIRES AND THE MAXIMUM PERMISSIBLE VALUE FOR COMPLIANCE NOMINATED BY AS 4282.

3. CALCULATIONS ARE SUBJECT TO THE ACCURACIES AND TOLERANCES NOMINATED WITHIN AS 3827 PARTS 1 & 2 (1998).

4. THE HORIZONTAL ILLUMINANCE PLANE "HORIZ-WATER(GL.-4m)" CONSISTS OF INITIAL VALUES CALCULATED AT 4m BELOW GROUND LEVEL.

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B	REVISED LAYOUT	JUL. '07
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PROJECT

TOWNSVILLE OCEAN TERMINAL AND BREAKWATER COVE

DRAWING

PROPOSED CARPARK, TERMINAL & WHARF SPILL PLANES LIGHTING

SCALE	N.T.S.		
DRAWN	MH	DATE JUL. '07	CHECKED LCO

PROJECT No.	DRAWING No.	ISSUE
6582-TOT	E : 12	B

No. IN SET 3

APPENDIX C

STORMWATER MANAGEMENT PLAN

CITY PACIFIC LIMITED

CITY PACIFIC LIMITED TOWNSVILLE OCEAN TERMINAL PROJECT

STORMWATER MANAGEMENT PLAN - WATER QUALITY AND QUANTITY STUDY

Monday, 19 February 2007

Report no: QL00704 / R001

Hyder Consulting

CITY PACIFIC LIMITED

CITY PACIFIC LIMITED TOWNSVILLE OCEAN TERMINAL PROJECT

STORMWATER MANAGEMENT PLAN - WATER QUALITY AND QUANTITY STUDY

Author: Rob Maskey / Liz Clough

Checker: Jon Saggers

Approver: Rangi Campbell

Report no: QL00704 / R001 Date: Monday, 19 February 2007

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Hyder Consulting

Contents

1 Introduction

This Site-Based Stormwater Management Plan– Water Quality and Quantity Study (SWMP) has been prepared for City Pacific Limited and will be used as supporting information for the Environmental Impact Statement.

The aim of this SWMP – Water Quality and Quantity Study is to provide a conceptual plan for stormwater quality control for the proposed mixed use development at the Townsville Ocean Terminal. The plan provides strategies along with supporting documentation which aim to prevent impacts to the existing water quality in the receiving water body, during the operational phase of the proposed development.

Stormwater discharge has been quantified for all standard design Average Recurrence Intervals for the preliminary layout. A full hydraulic analysis will be prepared at the detailed design stage.

Due to the nature of the proposed reclaimed development the project will not adversely impact on the external infrastructure upstream or downstream of the site, ensuring a no net increase in flow rates discharging from the site between pre-development and post-development conditions. The proposed development will also reduce stormwater pollutant loads in compliance with Townsville City Council requirements.

2 Site Description

The proposed Townsville Ocean Terminal Project will be developed adjacent to the existing Port of Townsville and to the north of the existing Townsville Entertainment Centre. A site locality plan (Drawing No. K043-QL00704-SK-01) is provided in Appendix A.

2.1 Description

The project consists of the following key components:

- A cruise ship terminal, berthing pocket and associated facilities (the TOT precinct); and
- An integrated residential waterfront development (Breakwater Cove Precinct) and associated facilities.

The TOT Precinct will be constructed within the Western Breakwater of the Port of Townsville and will provide dedicated berthing facilities for the cruise shipping industry and visiting navy ships. The Breakwater Cove Precinct will be constructed on reclaimed land to the west of the TOT Precinct and will provide waterfront residential lots for construction of attached and detached dwellings and apartment buildings.

2.2 Topography and Drainage

There is no existing surface topography within the site area as the proposed project will be constructed on reclaimed land over a tidal area.

There are no existing drainage paths or patterns for the site in its current state due to water coverage.

2.3 On Site Vegetation

There are no terrestrial vegetation communities within the site due to the tidal nature and depth of water within the proposed site boundary.

Patchy low density seagrass beds have been found within the proposed site area. The top layer of the seabed consists of a mixture of organic extremely to very soft silty clay (ooze) with a varying thickness across the site of 1.3m to 3.1m.

3 Drainage Layout Options

Various options were assessed for the Breakwater Cove Precinct to determine effects of stormwater runoff and water quality. The two options are described below:

3.1 Option A

All residential lots are graded to the road where stormwater discharge from minor storm events is collected in the road drainage. The runoff from the lots and roads for the major storm events will be conveyed within the road reserve. The preliminary stormwater layout for Option A is provided in Appendix B (Drawing K023-QL00704-02).

3.2 Option B

Option B has the same sub-catchments as per Option A however the lots grade towards the rear of the properties and rear-of-allotment drainage is provided. The preliminary stormwater layout for Option B is provided in Appendix B (Drawing K024-QL00704-02).

The TOT precinct for both options are assumed to have the same sub-catchments for simplicity.

4 Stormwater Quantity Analysis

4.1 Design Rainfall Data

Design Intensity-Frequency-Duration (IFD) data for Townsville has been used for the analysis as per Section 2 of Townsville City Council's Handbook for Drainage Design Criteria and Stormwater Drainage Design Specification D5, Section D5.04.

4.2 Catchment Areas

Catchment areas for the proposed site have been defined and are included in drawings K023-QL00704-02 and K024-QL00704-02 in Appendix B. Catchments are labelled with respect to the following:

- Stage number;
- Stage sub-catchment; and
- Development category.

Where the following development categories have been identified:

- A – Apartment blocks;
- U – Urban residential sites (including attached and detached dwellings);
- P – Public park;
- R – Roadway and
- C – Car park and hardstand areas.

4.3 Rational Method

Rational Method calculations to determine peak flow rates have been carried out in accordance with Volume 1, Chapter 14, AR&R and the requirements of Queensland Design Specification D5 Stormwater Drainage Design.

4.3.1 Runoff Coefficients

The coefficients of runoff for each sub-catchment have been determined by visual inspection and reflect the percentage of each development category within each contributing catchment as per Section 5.04 of QUDM and Book 8 of AR&R. The coefficients of runoff have been included in the Rational Method Calculations sheets in Appendix C. C10 values used for the Rational Method range from 0.81 to 0.84 dependant on the mix of development category and fraction impervious within the catchment area.

4.3.2 Times of Concentration

The time of concentration of a catchment is defined as the time required for storm runoff to flow from the most remote point on the catchment to the outlet of the catchment. The time of concentration for each catchment was evaluated from the following combination of flow components as outlined in QUDM Section 5.05.2:

- Roof to Main System Connection – For the roof, downpipes and pipe connection system from the building to the kerb and channel or a rear-of-allotment drainage system as per Section 5.05.6 of QUDM.
- Kerb and Channel Flow Time - Using Manning's Equation as per Section 5.05.8 of QUDM
- Underground pipe flow time – Using length and fall of the pipe determined from Figure 5.05.6 of QUDM.

Each component of flow time and the total time of concentration are included in the Rational Method Calculations sheets in Appendix C.

The minimum time of concentration is taken as 5 minutes.

4.4 Discharge Rates

Discharge rates at each outlet for all standard Design Average Recurrence Intervals (ARI) including Q_1, Q_2, Q_5, Q_{10}, Q_{20}, Q_{50} and Q_{100} have been calculated and are included in the Stormwater Quantity Results in Appendix C.A summary of the stormwater quantity results (cumulative catchments) for each option for the entire site is shown below:

Table 4.1: Stormwater discharge rates for total site for Options A and B

Option	Area m3/sec	Q1 m3/sec	Q2 m3/sec	Q5 m3/sec	Q10 m3/sec	Q20 m3/sec	Q50 m3/sec	Q100 m3/sec
A	29.14	4.75	6.53	9.57	11.50	14.04	18.24	21.34
B	29.14	5.30	7.31	10.70	12.85	15.69	20.36	23.83

4.5 Quantity Comparison of Options

Preliminary stormwater analysis has been conducted for the two stormwater layout options to predict the discharge rates at each outlet for the subdivision.

Stormwater layout for Option A has fewer outlets as a result of no rear-of-allotment drainage. All runoff from the lots for option A will drain towards the road drainage. The size of the road drainage system and end of line treatment devices will be larger for Option A due to the increase of flows contributing to the system from the lot runoff.

The introduction of rear-of-allotment drainage in Option B will reduce the size of road drainage as the lots and road sub-catchments are separated. Option B has additional outlets to cater for discharge from rear-of-allotment drainage assisting in the mixing fresh water into the proposed canals and reducing discharge volumes at outlet locations.

Although both options have the same areas the discharge rates for Option B are greater than Option A due to smaller time of concentrations from splitting the lots into separate catchments discharging to the rear-of-allotment drainage. Retention from rainwater tanks for Option B has not been taken into account for the quantity analysis.

A detailed hydraulic assessment will be undertaken at the detailed design stage of the development.

5 Water Quality

5.1 Water Quality Objectives

5.1.1 Water Quality Guidelines

A number of water quality guidelines currently exist for Australian, Queensland and North Queensland receiving waters upon which water quality objectives for receiving environments can be based and existing site and catchment water quality monitoring results can be compared. The water quality guidelines used in reference to this study include:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (Australian and New Zealand Environment and Conservation Council); and
- Queensland Water Quality Guidelines 2006 (Environmental Protection Agency).

5.1.2 Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)

The Australian and New Zealand Environment and Conservation Council (ANZECC) has prepared the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines). Guideline values are to be used in determining water quality objectives for protection of environmental values.

Where guideline values are exceeded, it is not expected that significant impacts will occur however, there is the potential for impacts on environmental values and exceedences should trigger further investigation. Trigger values for physical and chemical indicators of water quality are specified by the ANZECC Guidelines for a range of ecosystem types. The values for inshore marine ecosystems in tropical northern Queensland are given in Table 5.1.

Table 5.1: Trigger values for indicators of the water quality of inshore marine environments in tropical northern Queensland

Water Quality Indicator	Trigger Value
Total Phosphorous (µg/L)	15
Total Nitrogen (µg/L)	100
Dissolved Oxygen (% saturation – lower limit)	90
pH (range)	8.0 – 8.4
Turbidity (NTU – range)	1 - 20
Suspended Solids (mg/L)	15

The ANZECC Guidelines identify the need to develop locally relevant guideline values tailored to particular regions and water types in order to refine the conservative values contained in the national guidelines according to local conditions.

5.1.3 Queensland Water Quality Guidelines (2006)

The Environmental Protection Agency (EPA) has prepared guidelines for water quality in Queensland to be considered in conjunction with the ANZECC Guidelines. The guideline values are based on water quality data collected from waterways throughout Queensland since 1992. It is intended that these values be applied to water quality management for establishing water quality objectives and assessment of development in Queensland.

Where the Queensland Guidelines provide localised guideline values for water quality indicators, these values have been adopted for the setting of water quality objectives for the project. Where information on particular indicators is not provided by the Queensland Guidelines, ANZECC guideline values have been adopted.

The Ross River basin is included in the drainage division of Central Coast Queensland region in the Qld Guidelines. The physico-chemical guideline values for enclosed coastal waters in this region are given in Table 5.2.

Table 5.2: Guideline values for indicators of the water quality of enclosed coastal waters in the Central Coast Queensland region

Water Quality Indicator	Trigger Value
Total Phosphorous (µg/L)	20
Total Nitrogen (µg/L)	200
Dissolved Oxygen (% saturation – range)	90 - 100
pH (range)	8.0 – 8.4
Turbidity (NTU)	6

The Guidelines acknowledge the need to consider site-specific conditions in determining appropriate guidelines and alternative levels of protection, particularly in disturbed environments.

5.2 Existing Water Quality

Site-specific investigations of water quality have been undertaken by C&R Consulting Pty Ltd (C&R). This study has also reviewed existing information on the water quality of Cleveland Bay in the vicinity of the project site. The C&R water quality report is contained as an Appendix to the EIS and is summarised in this section.

The Cleveland Bay area has been assessed as being slightly to moderately disturbed. Surface water samples collected during this study indicate very high levels of total Phosphorous which is often associated with elevated levels of metals in water (C&R 2007).

Levels of Phosphorous at sampling locations surrounding the project site range from <50µg/L to 19,800µg/L and levels of up to 1,140µg/L were detected at the project site. The highest level of Phosphorous was detected at sample location S6, near Kissing Point, where high levels were also found in sediment samples. Phosphorous appears to be released from sediments at this site and disperses downstream towards the Strand (sampling locations S2 to S4). The level of Phosphorous at the project site was within the range detected at control sites within Cleveland Bay (C&R 2007).

High Nitrogen levels were also detected in sediments near Kissing Point. However, Nitrogen levels in surface waters sampled within the project site and surrounding areas were below guideline values ranging from <500µg/L to 700µg/L between all sites sampled (C&R 2007).

Site-specific guideline investigation and intervention levels for the project have been recommended based on existing levels of contaminants in

surface waters. Exceedence of the 'investigation level' will require further testing be undertaken at the project site, while exceedence of the intervention level will require works to cease until the cause of exceedence can be determined and actions taken to prevent further release of contaminants from the site (C&R 2007). The levels recommended by C&R are provided in the Water and Sediment Quality report and summarised in Section 4.6 of the EIS.

5.3 The Site Catchment Area

The proposed development site will be located within the Ross River Catchment and water released from the site will discharge to Cleveland Bay.

The site has a total catchment area of 29.14 hectares (land form only). The site has been divided into stages based on the proposed future use (ocean terminal, residential sites, open space etc.) and each stage has been further divided into sub-catchments for the purposes of stormwater treatment. Each sub-catchment will drain by overland flow to a series of treatment devices then to a central discharge location for release.

5.4 Proposed Stormwater Treatment Measures

Two treatment train options have been considered for stormwater management within the site. These include:

Option A: Breakwater Cove Precinct –overland flow will drain from residential lots and open space areas to roadways and will be directed to a GPT prior to discharge; TOT Precinct – hardstand areas will drain to an oil/grit separator for capture of potential contaminants prior to discharge from the site. An additional alternative where roof water may be collected in rainwater tanks is also assessed.

Option B: Breakwater Cove Precinct –overland flow will drain to the rear of residential lots and will be directed to leaf/litter baskets within lots prior to discharge, stormwater from roadways will be directed to a GPT prior to discharge; TOT Precinct – hardstand areas will drain to an oil/grit separator for capture of potential contaminants prior to discharge from the site. An additional alternative is also assessed for Option B where roof water is to may be collected in rainwater tanks.

5.5 Rainwater Tanks

Individual rainwater tanks may be used within residential lots for storage and reuse of roof water. These devices may assist in mitigating stormwater flows during the wet season and significant reductions in total water demand on municipal supplies may be achieved.

5.5.1 Rainwater Collection System Design

The Queensland State Government requires that all new Class 1 homes built after 1 January 2007 will install a minimum 5000L tank (detached dwellings) to collect rainfall from at least half of the total roof area or 100m^2 (whichever is the lesser) for connection to non-potable water uses including garden irrigation, toilet flushing and washing machine cold water.

Townsville City Council have applied to the Queensland Government for an exemption from QDC Part 25 Water Savings Targets therefore rainwater tanks may not be required for the project due to Townsville's rainfall and temporal patterns.

On the provision that rainwater tanks may be implemented within the proposed site at least two downpipes may be required to discharge from the roof gutter to the tank with roof drainage designed to fall towards the tank location. Downpipes should be screened to prevent entry of leaves and debris and tank lids and covers should be close-fitting to exclude mosquitoes. First flush devices should be fitted to divert first rains containing accumulated dust, bird droppings and other debris on rooftops.

5.5.2 Installation and Maintenance

If the tanks are required they will need to be sited within each lot to enable access for maintenance of the tank and of the dwelling and for monitoring of water quality. The site for installation of the tank should ensure that views, natural light and ventilation for habitable rooms is not reduced in dwellings or on adjacent sites and should not restrict spaces potentially used for parking or landscaping.

The installation and maintenance of the tanks should be undertaken so as to prevent impacts on human health and to avoid creation of breeding areas for mosquitoes. Rainwater tanks will be supplied with a continuous water supply by connection to the town water main. Pipes outlets, taps and fittings supplied by the rainwater tank will be clearly identified as 'non-drinking water'.

5.6 Stormwater Quality Improvement Devices

Environmental best management practices are proposed for treatment of stormwater flowing through the site. Various stormwater quality improvement devices (SQIDs) will be implemented to reduce pollutants leaving the site. There are a number of individual devices that can be placed together to form an overall 'stormwater treatment train'. By using a series of devices, the sediment, pollutants and nutrients in the stormwater run-off can be treated so that the final discharge from the site will meet environmental guidelines. The typical types of devices used are as follows:

5.6.1 Gross Pollutant Trap

Gross pollutant traps (GPTs) remove solids of greater than 5mm in size that are conveyed in stormwater to prevent entry of pollutants to receiving waterways. Gross pollutant loads include rubbish and coarse sediment mostly organic material such as leaves and twigs and also plastic and paper items such as food and drink containers.

Gross pollutants are trapped in a trash rack and sediments accumulate at the base of the trap. GPTs require regular (monthly) removal of material by hand or by vacuum truck to prevent upstream flooding and decomposition of trapped organic material.

Minor GPTs collecting from a catchment of less than 10 hectares are constructed in a gully pit below the natural ground level and are therefore visually unobtrusive. These devices are generally designed to accommodate mid-range rainfall events and will remove pollutants from the majority of total runoff in a catchment.

5.6.2 Leaf/Litter Basket

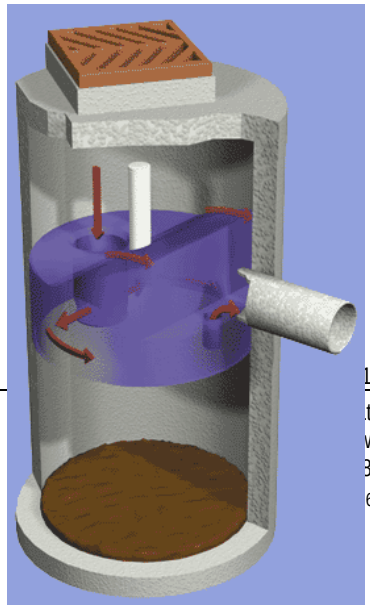
Metal or plastic litter baskets can be installed in gully pits within individual drainage lines to intercept gross pollutants from up to 1 hectare catchments. Litter and organic material is trapped within the basket and some coarse sediment may be removed by filtration through trapped material.

These devices are inexpensive to install and are visually unobtrusive. Maintenance for removal of trapped material by hand is required every 4 to 6 weeks to prevent odours from decomposition of organic material and re-suspension of trapped material.

Leaf/litter baskets are only suggested for Option B only within the rear-of-allotment drainage.

5.6.3 Oil and Grit Separator

Oil and grit separators are structures consisting of one or more chambers that remove sediment, screen debris, and separate oil from stormwater. These structures are also known as oil and water separators or water quality inlets. Their major environmental benefit comes in the form of improved downstream water quality as part of a treatment train.



Oil and grit separators are particularly well suited to capture particulates and hydrocarbons from small, highly impervious areas such as residential townhouse/apartment parking lots,

loading/parking areas at commercial facilities, and gas stations.

An oil and grit separator is to be installed at two locations within the ocean terminal hardstand area to trap and contain sediments and oil conveyed from the impervious area within the terminal.

The treatment device is to be sized to treat a Q3month flow and capture sediment/suspended solids to meet best practice discharge guidelines as follows:

- 80% of course sediment 5mm diameter or less, and 50% of fine sediment 0.1mm diameter or less, capture;
- Capture of litter; and
- No visible discharges of hydrocarbons e.g.; oils, greases.

6 Stormwater Quality Modelling (MUSIC)

A quantitative assessment of stormwater runoff quality was considered for the developed unmitigated cases and the developed mitigated cases of the development.

The pollutant export loads from the development site was assessed using the Cooperative Research Centre for Catchment Hydrology's (CRCCH) MUSIC (Model for Urban Stormwater Improvement Conceptualisation) model.

Base case models (unmitigated developed) have been prepared to estimate the quantities (annual loads) of suspended solids, total nitrogen and total phosphorous exported from those areas of the proposed site to be developed. The loads generated from the base cases can be compared to the results of the developed situation (incorporating water quality treatment structures) to determine if the objectives within the attached stormwater quality management plan are achieved.

6.1 Water Quality Cases

In order to affectively compare the treatment efficiency of the stormwater options identified in Section 2 the following cases have been assessed:

- Case 1 - Option A unmitigated case (no treatment)
- Case 2 - Option A without rainwater tanks;
- Case 3 - Option A with rainwater tanks;
- Case 4 - Option B unmitigated case (no treatment)
- Case 5 - Option B without rainwater tanks;
- Case 6 - Option B with rainwater tanks.

It should be noted that for all mitigated cases above the ocean terminal stormwater treatment will be the same. The ocean terminal catchments do not have rainwater tanks for treatment and rely upon oil/grit separators at the end of the stormwater line for pollutant removal.

6.1.1 Case 1 - Option A unmitigated case (no treatment)

Stormwater runoff from the roads, car parks, parks and lots are combined and discharge directly to the canal areas without treatment. No treatment trains exist for Case 1.

6.1.2 Case 2 – Option A without rainwater tanks

Runoff from the roads, car parks, parks and lots are discharged to the road drainage system. The runoff is then routed to a GPT where suspended solids and other pollutants are treated prior to release to the canal areas. Refer to Appendix D for the MUSIC model layout for Option A without rainwater tanks (drawing No. K039-QL00704-01).

6.1.3 Case 3 – Option A - with rainwater tanks

Stormwater from half the roof catchment or 100m^2 (whichever is the lesser) within lots and apartment blocks are received and stored by a rainwater tank. Overflow from the rainwater tanks and runoff from the other portion of the roof (not attached to the tank) is diverted to the road drainage system. The road drainage and allotment runoff is then routed to a GPT where suspended solids and other pollutants are treated prior to release to the canal areas. Refer to Appendix D for the MUSIC model layout for Option A with rainwater tanks (drawing No. K040-QL00704-01).

6.1.4 Case 4 – Option B unmitigated case (no treatment)

All lots in option B grade away from the road and towards the rear of the property. Runoff from the road, park and car park catchments are conveyed via the road drainage system and discharged directly to the canal areas. Runoff from the roof and ground areas is conveyed to the rear-of-allotment drainage system prior to being discharged directly to the canal areas without treatment. No treatment trains exist for Case 4.

6.1.5 Case 5 – Option B without rainwater tanks

Runoff from the road, park and car park catchments are conveyed via the road drainage system and routed into a GPT for treatment prior to being discharged directly to the canal areas. Runoff from the roof and ground area of lots and apartment blocks are diverted to the rear-of-allotment drainage system where a leaf/litter basket (refer to section 5.5.2) removes pollutants from the runoff. The discharge is then released into the canal system. Refer to Appendix D for the MUSIC model layout for Option B without rainwater tanks (drawing No. K041-QL00704-01).

6.1.6 Case 6 - Option B with rainwater tanks

Stormwater from half the roof catchment or 100m^2 (whichever is the lesser) within lots and apartment blocks is received and stored by a rainwater tank. Overflow from the rainwater tanks, runoff from the other portion of the roof (not attached to the tank) as well as any overland flow within lots is diverted to the rear-of-allotment drainage system where a leaf/litter basket (refer to section 5.5.2) removes pollutants from the runoff. The discharge is then

released into the canal system. The road drainage is then routed to a GPT where suspended solids and other pollutants are treated prior to release to

the canal areas. Refer to Appendix D for the MUSIC model layout for Option B with rainwater tanks (drawing No. K042-QL00704-01).

6.2 Meteorological Data

The meteorological data utilized by MUSIC to simulate catchment processes was obtained for Townsville Aero Station Number 32040 (19°3' S, 146°6' E) from the Townsville Meteorology Office. Six-minute time step rainfall data was obtained from 1995 to 2006. The mean annual rainfall for the above mentioned period is 1175mm

The daily values for average area potential evapo-transpiration for the site were derived from monthly values obtained from the Townsville airport from 1995 to 2006. The mean annual evapo-transpiration is 1539mm.

6.3 Land Uses

The portions of the site for which load estimations have been calculated have been divided into the following land uses based on the proposed development:

- Apartment Blocks;
- Carpark / Hardstand Areas;
- Park / Open Space;
- Roads;
- Attached Dwellings and
- Detached Dwellings.

Stormwater catchments for water quality modelling for Option A and Option B are provided in Appendix E showing the development categories.

6.3.1 Land Type Split and Impervious Areas

Splitting of the land use types (above) is recommended when attempting to model rainwater tanks and when different land uses are being drained to separate treatment systems (i.e. road runoff to gross pollutant trap with allotment runoff to rainwater tanks and inter-allotment drainage).

In order to appropriately model the treatment efficiency of the rainwater tank cases the urban and apartment nodes have been divided into the following sub-nodes:

- Ground;
- Roof to drain;
- Roof to rainwater tank.

For each development category the roof and ground areas were split by visual inspection and the total impervious areas were assessed.

Table 6.1: Roof and ground area splits for development categories.

Development Category	Roof Area (%)	Ground Area (%)
Detached Dwellings	60	40
Attached Dwellings	75	25
Apartment Blocks	90	10

All catchments were analysed where a combination of different development categories existed with the same catchment. Source nodes were then factored to produce a realistic split of roof and ground imperviousness for that catchment.

For water quality options with rainwater tanks the roof areas were split into two separate nodes being roof to drain and roof to tanks for each catchment. Roof water to rainwater tank areas were assessed on the requirement that rainwater tanks must receive rainfall from at least one half of the roof catchment area or 100m2, whichever is the lesser (QDC Part 25).

The split source nodes for each catchment were then individually assessed and effective impervious areas were allocated to each node as shown below.

Table 6.2: land use areas represented by a source node within the MUSIC model and the respective impervious areas

Development Category	Source node Abbreviation	Total Impervious (%)	Effective Impervious (%)*
Carpark / Hardstand Areas	C	Varies	Varies
Park / Open Space	P	0	0
Roads (including footpath verge)	R	80	65
Ground	U Ground	Varies	Varies
Roof to drain	U roof to drain	100	100
Roof to rainwater tank	U roof	100	100

* Refer to MUSIC User Guide and Brisbane City Council Guidelines for Pollutant Export Modelling V7. for effective impervious area.

6.4 Generation of Pollutant Loads

As outlined in the MUSIC User Manual, a comprehensive review of stormwater quality in urban catchments was undertaken by Duncan (1999) and this review forms the basis for the default values of event mean concentrations in MUSIC for TSS, TP and TN. Further investigation by the CRC for Catchment Hydrology has further refined these event mean concentrations for both stormwater runoff (i.e. surface flows) and base flow conditions. More recently Fletcher et al (2004, 2005) has updated the values provided in Duncan (1999) and specifically provides guidance on appropriate land type breakdown.

Table 6.3 Stormwater Water Quality Parameters for MUSIC Source Nodes

Land-Use	Parameter	Log10 TSS (mg/L)		Log10 TP (mg/L)		Log10 TN (mg/L)	
		Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow
Forest	Mean	0.51	1.90	-1.79	-1.10	-0.59	-0.075
	Std Dev	0.28	0.20	0.28	0.22	0.22	0.24
Car parks	Mean	0.78	1.92	-1.11	-0.59	0.14	0.25
	Std Dev	0.45	0.44	0.48	0.36	0.20	0.32
Roads	Mean	0.78	2.43	-1.11	-0.30	0.14	0.26
	Std Dev	0.45	0.44	0.48	0.36	0.20	0.32
Roofs	Mean	0.78	1.30	-0.60	-0.89	0.32	0.26
	Std Dev	0.39	0.38	0.50	0.34	0.30	0.34
Ground	Mean	0.78	2.18	-0.60	-0.47	0.32	0.37
	Std Dev	0.39	0.38	0.50	0.34	0.3	0.34

6.5 MUSIC Model Case Studies

Unmitigated case models have been developed to estimate the pollutant annual loads of suspended solids, total nitrogen and total phosphorus exported from the site (no treatment). The loads of the unmitigated developed cases can then be compared to the results of the mitigated developed cases (incorporating water quality treatment structures) to determine the effectiveness of the treatment train by comparing the reduction efficiency of pollutants (percentage).

6.5.1 Option A With Versus Without Treatment

The following cases have been compared for Option A to determine reduction efficiencies:

- Case 1 - Option A unmitigated case (no treatment)
- Case 2 - Option A without rainwater tanks; and
- Case 3 - Option A with rainwater tanks

Results of the MUSIC models for Case 1 and Case 2 at all outlets is attached in Appendix F (Table G.1). The results show a reduction in pollutant loading for all pollutants due to the addition of gross pollutant traps at the end of the drainage system.

Results of the MUSIC models for Case 1 and Case 3 at all outlets is attached in Appendix F (Table G.2). Significant reductions in pollutants and flow are achieved by the implementation of rainwater tanks along with gross pollutant traps at the end of the drainage system.

A stage comparison of the MUSIC models for Case 2 and Case 3 is attached in Appendix F (Table G.3). The results show a further reduction in pollutant removal efficiency with the implementation of rainwater tanks.

Table 6.4: A summary comparison of all cases for option A for the entire site:

Pollutant	Case 1	Case 2	Case 3	% Reduction	
				Case 2	Case 3
Flow (ML/yr)	220.4	220.4	192.9	0.0	12.5
Total Suspended Solids (kg/yr)	38110.0	24200.0	22560.0	36.5	40.8
Total Phosphorus (kg/yr)	77.7	74.5	68.3	4.1	12.1
Total Nitrogen (kg/yr)	486.2	430.0	374.6	11.6	23.0
Gross Pollutants (kg/yr)	4773.0	671.3	527.6	85.9	88.9

6.5.2 Option B With Versus Without Treatment

The following cases have been compared for Option A to determine pollutant reduction efficiencies:

- Case 4 - Option B unmitigated case (no treatment)
- Case 5 - Option B without rainwater tanks; and
- Case 6 - Option B with rainwater tanks

Results of the MUSIC models for Case 1 and Case 2 at all outlets is attached in Appendix F (Table G4). The results show a reduction in pollutant loading for all pollutants due to the addition of gross pollutant traps at the end of the drainage system and leaf/litter traps at the rear of each lot and apartment block.

Results of the MUSIC models for Case 1 and Case 3 at all outlets is attached in Appendix F (TableG.5). Significant reductions in pollutants and flow are achieved by the implementation of rainwater tanks along with gross pollutant traps at the end of the drainage system and leaf/litter traps at the rear of each lot and apartment block.

A stage comparison of the MUSIC models for Case 5 and Case 6 is attached in Appendix F (Table G.6). The results show a further reduction in pollutant removal efficiency with the implementation of rainwater tanks.

Table 6.5: A summary comparison of all cases for option B for the entire site (including the ocean terminal).

Pollutant	Case 4	Case 5	Case 6	% Reduction	
				Case 5	Case 6
Flow (ML/yr)	220.4	220.4	192.7	0.0	12.6
Total Suspended Solids (kg/yr)	36740.0	18820.0	17880.0	48.8	51.3
Total Phosphorus (kg/yr)	76.0	64.4	59.6	15.4	21.6
Total Nitrogen (kg/yr)	488.9	418.3	365.8	14.4	25.2
Gross Pollutants (kg/yr)	4773.0	451.8	375.7	90.5	92.1

6.5.3 Option A versus Option B without Rainwater Tanks

The two options A and B have been compared without rainwater tanks to determine which strategy should be adopted if no rainwater tanks were to be implemented. The following cases have been compared:

- Case 2 - Option A without rainwater tanks; and
- Case 5 - Option B without rainwater tanks

Comparison of the MUSIC model results for Case 2 and Case 5 summarised for each stage is attached in Appendix F (Table G.7). The results show a reduction efficiency improvement by the addition of the rear of allotment drainage in Option B.

Table 6.6: A summary comparison for option A and Option B at each stage (including the ocean terminal).

Pollutant	Case 1	Case 5	% Reduction
Flow (ML/yr)	220.4	220.4	0.0
Total Suspended Solids (kg/yr)	24200.0	18820.0	14.6
Total Phosphorus (kg/yr)	74.5	64.4	13.4
Total Nitrogen (kg/yr)	430.0	418.3	2.4
Gross Pollutants (kg/yr)	671.3	451.8	4.6

6.5.4 Option A versus Option B with Rainwater Tanks

The two options A and B have been compared with rainwater tanks to determine which strategy should be adopted if rainwater tanks were to be implemented. The following cases have been compared:

- Case 3 - Option A with rainwater tanks; and
- Case 6 - Option B with rainwater tanks

Comparison of the MUSIC model results for Case 3 and Case 6 summarised for each stage is attached in Appendix F (Table G.8). The results show a reduction efficiency improvement by the addition of the rear of allotment drainage in Option B and the addition of rainwater tanks

Table 6.7: A summary comparison for option A and Option B at each stage (including the ocean terminal).

Pollutant	Case 3	Case 6	% Reduction
Flow (ML/yr)	192.9	192.7	0.1
Total Suspended Solids (kg/yr)	22560.0	17880.0	12.7
Total Phosphorus (kg/yr)	68.3	59.6	11.4
Total Nitrogen (kg/yr)	374.6	365.8	1.8
Gross Pollutants (kg/yr)	527.6	375.7	3.2

6.6 Modelling Results & Conclusions

Comparisons of modelling results have shown that Option B produces a higher pollutant reduction efficiency rate than option A. This is due to the implementation of leaf/litter baskets within the rear-of-allotment drainage system.

Option B would achieve a greater dispersion of fresh water into the receiving waters due to the greater number of outlets as a result from rear-of-allotment drainage.

The introduction of rainwater tanks shows an increase in the pollutant removal efficiency due to retention and reuse of runoff within the system.

Therefore Option B with rainwater tanks may be the preferred option however it should be noted that due to Townsville's rainfall and temporal patterns it may be unlikely that this option would be selected.

Townsville City Council have applied to the Queensland Government for an exemption from QDC Part 25 Water Savings Targets therefore rainwater tanks may not be required.

In conclusion either Option B without rainwater tanks (Case 5) or with rainwater tanks (Case 6) would be the preferred option with pollutant load reductions of up to 92% of Gross Pollutants, 51% of total suspended solids, 22% of Total Phosphorous and 25% of Total Nitrogen achieved on an annual basis.

Appendix A

Site Locality Plan

Issue	Description	Date
01	ORIGINAL ISSUE	03 08 2007

100mm on Original

Scale (Plan)

Scale (Sections)

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename: K200-QL00704-01-SITE LOCALITY PLAN.DWG

Client: Townsville Ocean Terminal

Status: **PRELIMINARY**
NOT TO BE USED FOR CONSTRUCTION

Approved

R.E.P.Q No :

Scales	NTS	Current Issue Signatures	
		Author P.S.M	
Original Size	A1	Designer R.M	
Height Datum	A.H.D	Reviewer J.S	
Grid	LOCAL	© Copyright reserved	

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: SITE LOCALITY PLAN

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Drawing No.	Project No.	Issue
K200	QL00704	01

14/Sep/2007 10:29 AM F:\QL00704\E-CAD\C-Civil\B-Sketches\K200-QL00704-01-SITE LOCALITY PLAN.dwg V1

Appendix B

Preliminary Stormwater Layouts

NOTATION

SUB-CATCHMENT NOTATION

- STAGE NUMBER
- STAGE SUB-CATCHMENT
- DEVELOPMENT CATEGORY SUB-CATCHMENT
- DEVELOPMENT CATEGORY (REFER TO DEVELOPMENT CATEGORY ABBREVIATIONS)

OUTLET NOTATION

- STAGE NUMBER
- STAGE SUB-CATCHMENT

DEVELOPMENT CATEGORIES

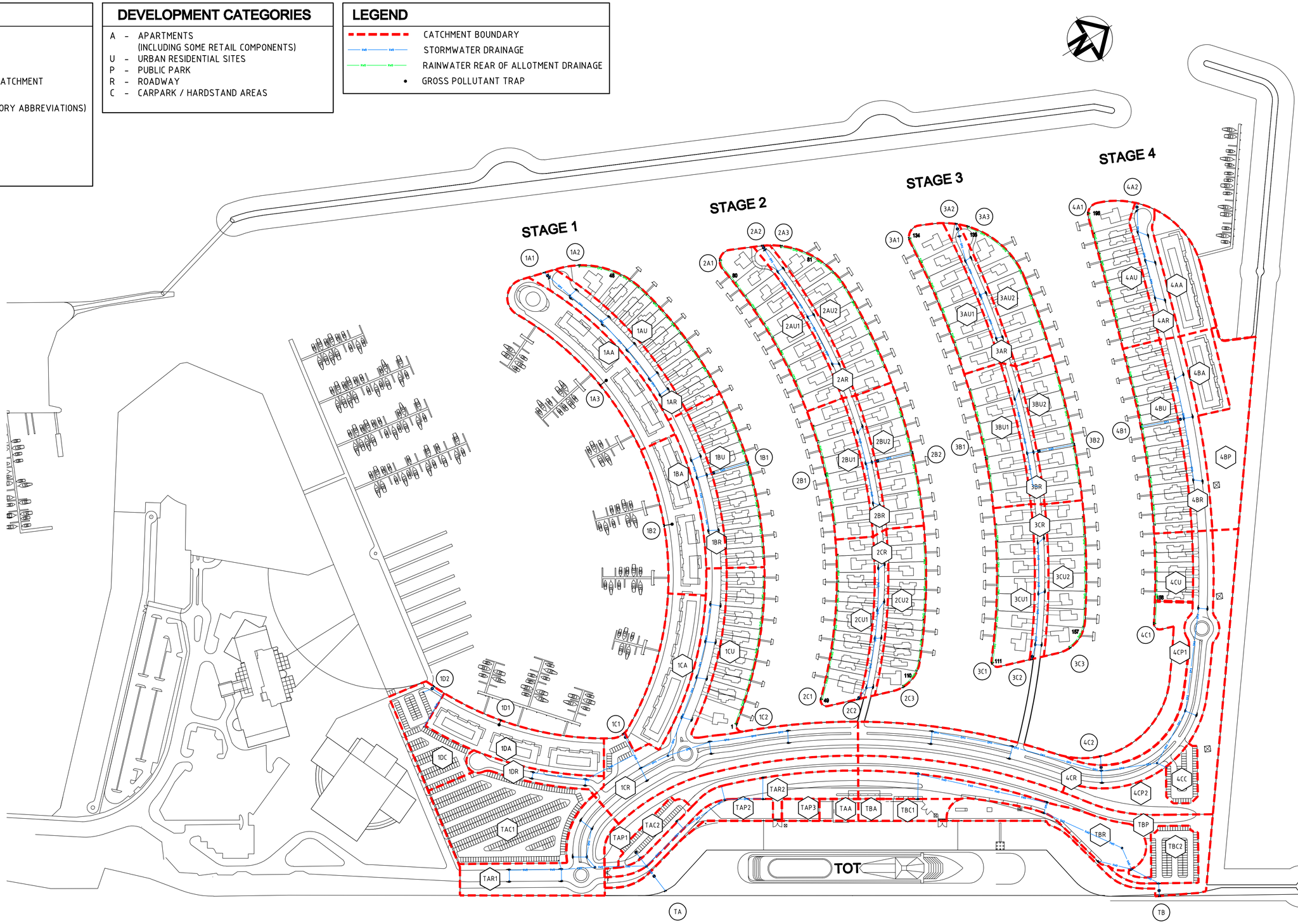
A - APARTMENTS (INCLUDING SOME RETAIL COMPONENTS)
U - URBAN RESIDENTIAL SITES
P - PUBLIC PARK
R - ROADWAY
C - CARPARK / HARDSTAND AREAS

LEGEND

- CATCHMENT BOUNDARY
- STORMWATER DRAINAGE
- RAINWATER REAR OF ALLOTMENT DRAINAGE
- GROSS POLLUTANT TRAP

CATCHMENT TABLE

CATCHMENT	AREA (Ha)	TOTAL AREAS (Ha)
1AA	0.8581	
1AU	0.7202	
1AR	0.4302	2.0085
1BA	0.6292	
1BU	0.6923	
1BR	0.3443	1.6658
1CA	0.6297	
1CU	0.6975	
1CR	1.5648	2.8953
1DA	0.7113	
1DC	0.4520	
1DR	0.2143	1.3776
2AU1	0.7211	
2AU2	0.6256	
2AR	0.2530	1.5997
2BU1	0.5503	
2BU2	0.5715	
2BR	0.2016	1.3234
2CU1	0.6680	
2CU2	0.6493	
2CR	0.2384	1.5557
3AU1	0.6186	
3AU2	0.5347	
3AR	0.2200	1.3733
3BU1	0.5665	
3BU2	0.5817	
3BR	0.2027	1.3509
3CU1	0.6345	
3CU2	0.5890	
3CR	0.2223	1.4458
4AA	0.4468	
4AU	0.5855	
4AR	0.3012	1.3335
4BA	0.2814	
4BU	0.7663	
4BR	0.4259	
4BP	0.7026	2.1762
4CC	0.1620	
4CU	0.2778	
4CR	1.5949	
4CP1	0.3968	
4CP2	0.8810	3.3125
TAA	0.0905	
TAR1	0.7351	
TAR2	0.5112	
TAP1	0.4903	
TAP2	0.2566	
TAP3	0.0875	
TAC1	1.1778	
TAC2	0.1915	3.5405
TBA	0.1130	
TBR	0.7622	
TBP	0.9488	
TBC1	0.1003	
TBC2	0.3031	2.2274
TOTAL SITE AREA = 29.1861 Ha		



Issue	Description	Date
03	REVISED LAYOUT	31.07.2007
02	REVISED LAYOUT	30.05.2007
01	ORIGINAL ISSUE	08.01.2007

100mm on Original

Scale (Plan): 0 50 100 150 200m — 1 : 2000

Scale (Sections)

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename: K023-24-QL00704-01- SWD OPTION A & B PRELIM.DWG

Client: Townsville Ocean Terminal

Status: **PRELIMINARY** NOT TO BE USED FOR CONSTRUCTION

Approved

R.E.P.Q No :

Scales	AS SHOWN	Current Issue Signatures	
		Author B.W	
Original Size	A1	Designer B.W	
Height Datum	A.H.D	Reviewer J.S	
Grid	LOCAL	© Copyright reserved	

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: INDICATIVE STORMWATER LAYOUT OPTION B, REAR LOT DISCHARGE TO WATERWAY

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Drawing No. K024 — Project No. QL00704 — Issue 03

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NOTATION

SUB-CATCHMENT NOTATION

- STAGE NUMBER
- STAGE SUB-CATCHMENT
- DEVELOPMENT CATEGORY SUB-CATCHMENT
- DEVELOPMENT CATEGORY (REFER TO DEVELOPMENT CATEGORY ABBREVIATIONS)

OUTLET NOTATION

- STAGE NUMBER
- STAGE SUB-CATCHMENT

DEVELOPMENT CATEGORIES

A - APARTMENTS (INCLUDING SOME RETAIL COMPONENTS)
U - URBAN RESIDENTIAL SITES
P - PUBLIC PARK
R - ROADWAY
C - CARPARK / HARDSTAND AREAS

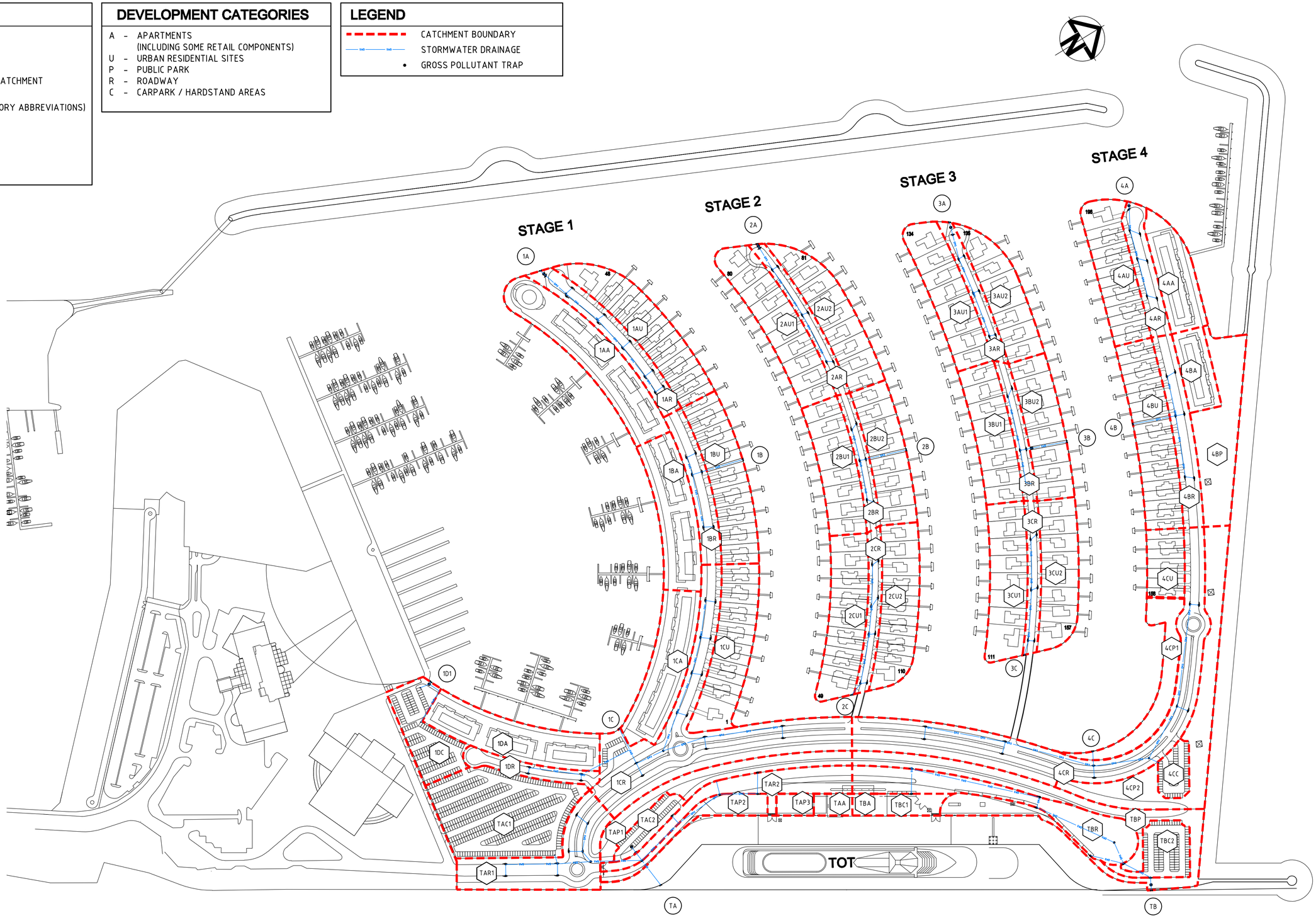
LEGEND

- CATCHMENT BOUNDARY
- STORMWATER DRAINAGE
- GROSS POLLUTANT TRAP

CATCHMENT TABLE

CATCHMENT	AREA (Ha)	TOTAL AREAS (Ha)
1AA	0.8581	
1AU	0.7202	
1AR	0.4302	2.0085
1BA	0.6292	
1BU	0.6923	
1BR	0.3443	1.6658
1CA	0.6297	
1CU	0.6975	
1CR	1.5648	2.8953
1DA	0.7113	
1DC	0.4520	
1DR	0.2143	1.3776
2AU1	0.7211	
2AU2	0.6256	
2AR	0.2530	1.5997
2BU1	0.5503	
2BU2	0.5715	
2BR	0.2016	1.3234
2CU1	0.6680	
2CU2	0.6493	
2CR	0.2384	1.5557
3AU1	0.6186	
3AU2	0.5347	
3AR	0.2200	1.3733
3BU1	0.5665	
3BU2	0.5817	
3BR	0.2027	1.3509
3CU1	0.6345	
3CU2	0.5890	
3CR	0.2223	1.4458
4AA	0.4468	
4AU	0.5855	
4AR	0.3012	1.3335
4BA	0.2814	
4BU	0.7663	
4BR	0.4259	
4BP	0.7026	2.1762
4CC	0.1620	
4CU	0.2778	
4CR	1.5949	
4CP1	0.3968	
4CP2	0.8810	3.3125
TAA	0.0905	
TAR1	0.7351	
TAR2	0.5112	
TAP1	0.4903	
TAP2	0.2566	
TAP3	0.0875	
TAC1	1.1778	
TAC2	0.1915	3.5405
TBA	0.1130	
TBR	0.7622	
TBP	0.9488	
TBC1	0.1003	
TBC2	0.3031	2.2274

TOTAL SITE AREA = 29.1861 Ha



Issue	Description	Date
03	REVISED LAYOUT	31.07.2007
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100mm on Original

Scale (Plan): 0 50 100 150 200m — 1 : 2000

Scale (Sections)

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename: K023-24-QL00704-01- SWD OPTION A & B PRELIM.DWG

Client: Townsville Ocean Terminal

Status: **PRELIMINARY** NOT TO BE USED FOR CONSTRUCTION

Approved

R.E.P.Q No :

Scales	AS SHOWN	Current Issue Signatures	
		Author B.W	
Original Size	A1	Designer B.W	
Height Datum	A.H.D	Reviewer J.S	
Grid	LOCAL	© Copyright reserved	

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: INDICATIVE STORMWATER LAYOUT OPTION A, LOT DISCHARGE TO ROADWAYS

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Drawing No. K023 — Project No. QL00704 — Issue 03

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Appendix C

Rational Method Calculations

Hyder Consulting	RATIONAL METHOD CALCULATIONS	DOCUMENT No QL00704
OFFICE GOLD COAST	PROJECT TITLE TOWNSVILLE OCEAN TERMINAL	
SUBJECT SUMMARY OF METHOD FOR POST DEVELOPED DESIGN FLOW QUANTITIES, OPTIONS A&B		SHEET No 1 of 5

The Rational Method has been used to calculate the design flows for each of the outlets within in the Townsville Cruise Ship Terminal and future development area catchments. The following is a summary of Rational Method Calculations and results.

General
Flows for each storm event have been derived following the Rational Method as per TCC Guidelines and QDUM.

Catchments
The catchments within each stage were broken down into sub-catchments of varying size and outlet position. Each outlet was analysed to determine contributing catchments and thus flow path.

Time of Concentration
The time of concentration was calculated from a combination of flow components, including:

Pipe Flow
Using length and fall of pipe, time of concentration, t_c (mins) was determined from Figure 5.05.6 (QUDM)

Sheet Flow - Friend's Equation
Overland sheet flow was determined from length, surface type and slope using Figure 5.05.2 (QUDM)
The recommended roof drainage system travel times were used from Table 5.05.5 (QUDM)

Gutter Flow - Manning's Equation
Uniform kerb and channel flow time using slope and length was calculated from Figure 5.05.7 (QUDM)

Coefficient of Runoff
The coefficients used were derived from QUDM, Table 5.04.1 and reflect the percentage of development category in each contributing catchment. These values combined with the one hour rainfall intensity for a 10 year A.R.I. (Handbook for Drainage Design Handbook, TCC 2004) were used in Table 5.04.2 to obtain the corresponding C_{10} values.
The values vary between 0.5 and 0.8 depending on the percentage of development category.

Design Rainfall
The Intesnsity - Frequency - Duration (IFD) charts have been supplied by Townsville City Council in Appendix 1 Handbook for Drainage Design Criteria, issue date; September 2004

Design Flow
Design folws were derived using the Rational Method:

$$Q_y = \frac{C_y \cdot {}^{t}I_y \cdot A}{360} \quad m^3/s$$

The design flows were calculated and are displayed in Tables A1-A7 and B1-B7 for options A and B respectively.

Table C - A1: 1 Year ARI Design Flows

Outlet	Contributing Catchments	Area (Ha)	Time of Concentration, t_c (mins)				I_1 mm/hr	C_1	Q_1 m^3/sec
			Sheet	Gutter	Pipe	Total			
1A	1AU+1AR+1AA	2.0085	5	1	3.2	9.2	94.50	0.67	0.354
1B	1BU+1BR+1BA	1.6658	5	1	2	8	99.24	0.66	0.305
1C	1CA+1CU+1CR	2.8953	5	1	4.5	10.5	90.05	0.67	0.487
1D	1DA+1DC	1.4882	8.5	0	1.6	10.1	91.33	0.69	0.260
2A	2AU1+2AU2+2AR	1.5997	5	1	3	9	95.21	0.65	0.274
2B	2BU1+2BU2+2BR	1.3234	5	1	1.9	7.9	99.70	0.65	0.237
2C	2CU1+2CU2+2CR	1.5557	5	1	2.7	8.7	96.42	0.65	0.270
3A	3AU1+3AU2+3AR	1.3733	5	1	2.6	8.6	96.82	0.65	0.239
3B	3BU1+3BU2+3BR	1.3509	5	1	2	8	99.24	0.65	0.241
3C	3CU1+3CU2+3CR	1.4458	5	1	2.5	8.5	97.23	0.65	0.253
4A	4AA+4AU+4AR	1.3014	5	1	2.1	8.1	98.84	0.66	0.237
4B	4BA+4BU+4BP+4BR	2.1715	21	0	2	23	69.44	0.65	0.271
4C	4CU+4CP1+4CP2+4CR	3.3143	19	0	4.6	23.6	68.66	0.66	0.415
TA	TAA+TAC1-2+TAR1-2+TAP1-2-3	3.4179	5	2.5	3.6	11.1	88.16	0.66	0.549
TB	TBA+TBC1-2+TBR+TBP	2.2272	5	1.4	5	11.4	87.30	0.66	0.354
	TOTAL SITE AREA	29.14					TOTAL DISCHARGE		4.75

Table C - A2: 2 Year ARI Design Flows

Outlet	Contributing Catchments	Area (Ha)	Time of Concentration, t_c (mins)				I_2 mm/hr	C_2	Q_2 m^3/sec
			Sheet	Gutter	Pipe	Total			
1A	1AU+1AR+1AA	2.0085	5	1	3.2	9.2	122.62	0.71	0.488
1B	1BU+1BR+1BA	1.6658	5	1	2	8	127.75	0.71	0.417
1C	1CA+1CU+1CR	2.8953	5	1	4.5	10.5	116.86	0.71	0.671
1D	1DA+1DC	1.4882	8.5	0	1.6	10.1	118.51	0.73	0.358
2A	2AU1+2AU2+2AR	1.5997	5	1	3	9	123.54	0.69	0.378
2B	2BU1+2BU2+2BR	1.3234	5	1	1.9	7.9	128.45	0.69	0.325
2C	2CU1+2CU2+2CR	1.5557	5	1	2.7	8.7	124.80	0.69	0.371
3A	3AU1+3AU2+3AR	1.3733	5	1	2.6	8.6	125.22	0.69	0.329
3B	3BU1+3BU2+3BR	1.3509	5	1	2	8	127.75	0.69	0.330
3C	3CU1+3CU2+3CR	1.4458	5	1	2.5	8.5	125.65	0.69	0.347
4A	4AA+4AU+4AR	1.3014	5	1	2.1	8.1	127.33	0.71	0.325
4B	4BA+4BU+4BP+4BR	2.1715	21	0	2	23	90.15	0.69	0.374
4C	4CU+4CP1+4CP2+4CR	3.3143	19	0	4.6	23.6	89.14	0.70	0.572
TA	TAA+TAC1-2+TAR1-2+TAP1-2-3	3.4179	5	2.5	3.6	11.1	114.42	0.70	0.757
TB	TBA+TBC1-2+TBR+TBP	2.2272	5	1.4	5	11.4	113.29	0.70	0.489
	TOTAL SITE AREA	29.14					TOTAL DISCHARGE		6.53

Table C - A3: 5 Year ARI Design Flows

Outlet	Contributing Catchments	Area (Ha)	Time of Concentration, t_c (mins)				I_5 mm/hr	C_5	Q_5 m^3/sec
			Sheet	Gutter	Pipe	Total			
1A	1AU+1AR+1AA	2.0085	5	1	3.2	9.2	160.41	0.80	0.714
1B	1BU+1BR+1BA	1.6658	5	1	2	8	168.39	0.79	0.614
1C	1CA+1CU+1CR	2.8953	5	1	4.5	10.5	152.91	0.80	0.981
1D	1DA+1DC	1.4882	8.5	0	1.6	10.1	155.06	0.82	0.524
2A	2AU1+2AU2+2AR	1.5997	5	1	3	9	161.61	0.77	0.553
2B	2BU1+2BU2+2BR	1.3234	5	1	1.9	7.9	169.17	0.77	0.479
2C	2CU1+2CU2+2CR	1.5557	5	1	2.7	8.7	163.64	0.77	0.544
3A	3AU1+3AU2+3AR	1.3733	5	1	2.6	8.6	164.32	0.77	0.482
3B	3BU1+3BU2+3BR	1.3509	5	1	2	8	168.39	0.77	0.486
3C	3CU1+3CU2+3CR	1.4458	5	1	2.5	8.5	165.00	0.77	0.510
4A	4AA+4AU+4AR	1.3014	5	1	2.1	8.1	167.71	0.79	0.478
4B	4BA+4BU+4BP+4BR	2.1715	21	0	2	23	118.11	0.77	0.548
4C	4CU+4CP1+4CP2+4CR	3.3143	19	0	4.6	23.6	116.79	0.78	0.838
TA	TAA+TAC1-2+TAR1-2+TAP1-2-3	3.4179	5	2.5	3.6	11.1	149.72	0.78	1.107
TB	TBA+TBC1-2+TBR+TBP	2.2272	5	1.4	5	11.4	148.27	0.78	0.715
	TOTAL SITE AREA	29.14					TOTAL DISCHARGE		9.57

Table C - A4: 10 Year ARI Design Flows

Outlet	Contributing Catchments	Area (Ha)	Time of Concentration, t_c (mins)				I_{10} mm/hr	C_{10}	Q_{10} m^3/sec
			Sheet	Gutter	Pipe	Total			
1A	1AU+1AR+1AA	2.0085	5	1	3.2	9.2	183.07	0.84	0.858
1B	1BU+1BR+1BA	1.6658	5	1	2	8	192.16	0.83	0.738
1C	1CA+1CU+1CR	2.8953	5	1	4.5	10.5	174.54	0.84	1.179
1D	1DA+1DC	1.4882	8.5	0	1.6	10.1	176.99	0.86	0.629
2A	2AU1+2AU2+2AR	1.5997	5	1	3	9	184.44	0.81	0.664
2B	2BU1+2BU2+2BR	1.3234	5	1	1.9	7.9	193.05	0.81	0.575
2C	2CU1+2CU2+2CR	1.5557	5	1	2.7	8.7	186.76	0.81	0.654
3A	3AU1+3AU2+3AR	1.3733	5	1	2.6	8.6	187.53	0.81	0.579
3B	3BU1+3BU2+3BR	1.3509	5	1	2	8	192.16	0.81	0.584
3C	3CU1+3CU2+3CR	1.4458	5	1	2.5	8.5	188.30	0.81	0.613
4A	4AA+4AU+4AR	1.3014	5	1	2.1	8.1	191.39	0.83	0.574
4B	4BA+4BU+4BP+4BR	2.1715	21	0	2	23	134.90	0.81	0.659
4C	4CU+4CP1+4CP2+4CR	3.3143	19	0	4.6	23.6	133.40	0.82	1.007
TA	TAA+TAC1-2+TAR1-2+TAP1-2-3	3.4179	5	2.5	3.6	11.1	170.92	0.82	1.331
TB	TBA+TBC1-2+TBR+TBP	2.2272	5	1.4	5	11.4	169.25	0.82	0.859
	TOTAL SITE AREA	29.14					TOTAL DISCHARGE		11.50

Table C - A5: 20 Year ARI Design Flows

Outlet	Contributing Catchments	Area (Ha)	Time of Concentration, t_c (mins)				I_{20} mm/hr	C_{20}	Q_{20} m^3/sec
			Sheet	Gutter	Pipe	Total			
1A	1AU+1AR+1AA	2.0085	5	1	3.2	9.2	212.80	0.88	1.047
1B	1BU+1BR+1BA	1.6658	5	1	2	8	223.35	0.87	0.901
1C	1CA+1CU+1CR	2.8953	5	1	4.5	10.5	202.90	0.88	1.439
1D	1DA+1DC	1.4882	8.5	0	1.6	10.1	205.74	0.90	0.768
2A	2AU1+2AU2+2AR	1.5997	5	1	3	9	214.39	0.85	0.810
2B	2BU1+2BU2+2BR	1.3234	5	1	1.9	7.9	224.38	0.85	0.702
2C	2CU1+2CU2+2CR	1.5557	5	1	2.7	8.7	217.08	0.85	0.798
3A	3AU1+3AU2+3AR	1.3733	5	1	2.6	8.6	217.97	0.85	0.707
3B	3BU1+3BU2+3BR	1.3509	5	1	2	8	223.35	0.85	0.713
3C	3CU1+3CU2+3CR	1.4458	5	1	2.5	8.5	218.87	0.85	0.748
4A	4AA+4AU+4AR	1.3014	5	1	2.1	8.1	222.45	0.87	0.701
4B	4BA+4BU+4BP+4BR	2.1715	21	0	2	23	156.92	0.85	0.805
4C	4CU+4CP1+4CP2+4CR	3.3143	19	0	4.6	23.6	155.18	0.86	1.230
TA	TAA+TAC1-2+TAR1-2+TAP1-2-3	3.4179	5	2.5	3.6	11.1	198.70	0.86	1.624
TB	TBA+TBC1-2+TBR+TBP	2.2272	5	1.4	5	11.4	196.77	0.86	1.048
	TOTAL SITE AREA	29.14					TOTAL DISCHARGE		14.04

Table C - A6: 50 Year ARI Design Flows

Outlet	Contributing Catchments	Area (Ha)	Time of Concentration, t_c (mins)				I_{50} mm/hr	C_{50}	Q_{50} m^3/sec
			Sheet	Gutter	Pipe	Total			
1A	1AU+1AR+1AA	2.0085	5	1	3.2	9.2	252.37	0.97	1.360
1B	1BU+1BR+1BA	1.6658	5	1	2	8	264.84	0.95	1.170
1C	1CA+1CU+1CR	2.8953	5	1	4.5	10.5	240.65	0.97	1.870
1D	1DA+1DC	1.4882	8.5	0	1.6	10.1	244.02	0.99	0.998
2A	2AU1+2AU2+2AR	1.5997	5	1	3	9	254.25	0.93	1.052
2B	2BU1+2BU2+2BR	1.3234	5	1	1.9	7.9	266.05	0.93	0.911
2C	2CU1+2CU2+2CR	1.5557	5	1	2.7	8.7	257.43	0.93	1.036
3A	3AU1+3AU2+3AR	1.3733	5	1	2.6	8.6	258.49	0.93	0.919
3B	3BU1+3BU2+3BR	1.3509	5	1	2	8	264.84	0.93	0.926
3C	3CU1+3CU2+3CR	1.4458	5	1	2.5	8.5	259.55	0.93	0.971
4A	4AA+4AU+4AR	1.3014	5	1	2.1	8.1	263.78	0.95	0.910
4B	4BA+4BU+4BP+4BR	2.1715	21	0	2	23	186.23	0.93	1.046
4C	4CU+4CP1+4CP2+4CR	3.3143	19	0	4.6	23.6	184.16	0.94	1.599
TA	TAA+TAC1-2+TAR1-2+TAP1-2-3	3.4179	5	2.5	3.6	11.1	235.68	0.94	2.110
TB	TBA+TBC1-2+TBR+TBP	2.2272	5	1.4	5	11.4	233.40	0.94	1.362
	TOTAL SITE AREA	29.14					TOTAL DISCHARGE		18.24

Hyder Consulting	STORMWATER QUANTITY RESULTS	DOCUMENT No QL00704
OFFICE GOLD COAST	PROJECT TITLE TOWNSVILLE OCEAN TERMINAL	
SUBJECT OPTION A - SUMMARY OF POST DEVELOPED DISCHARGE RATES		SHEET No 5 of 5

Table C - A7: 100 Year ARI Design Flows

Outlet	Contributing Catchments	Area (Ha)	Time of Concentration, t_c (mins)				I_{100} mm/hr	C_{100}	Q_{100} m^3/sec
			Sheet	Gutter	Pipe	Total			
1A	1AU+1AR+1AA	2.0085	5	1	3.2	9.2	282.97	1.01	1.591
1B	1BU+1BR+1BA	1.6658	5	1	2	8	296.93	1.00	1.368
1C	1CA+1CU+1CR	2.8953	5	1	4.5	10.5	269.85	1.01	2.188
1D	1DA+1DC	1.4882	8.5	0	1.6	10.1	273.61	1.03	1.167
2A	2AU1+2AU2+2AR	1.5997	5	1	3	9	285.07	0.97	1.231
2B	2BU1+2BU2+2BR	1.3234	5	1	1.9	7.9	298.29	0.97	1.066
2C	2CU1+2CU2+2CR	1.5557	5	1	2.7	8.7	288.63	0.97	1.212
3A	3AU1+3AU2+3AR	1.3733	5	1	2.6	8.6	289.81	0.97	1.075
3B	3BU1+3BU2+3BR	1.3509	5	1	2	8	296.93	0.97	1.083
3C	3CU1+3CU2+3CR	1.4458	5	1	2.5	8.5	291.00	0.97	1.136
4A	4AA+4AU+4AR	1.3014	5	1	2.1	8.1	295.74	1.00	1.065
4B	4BA+4BU+4BP+4BR	2.1715	21	0	2	23	208.91	0.97	1.225
4C	4CU+4CP1+4CP2+4CR	3.3143	19	0	4.6	23.6	206.60	0.98	1.872
TA	TAA+TAC1-2+TAR1-2+TAP1-2-3	3.4179	5	2.5	3.6	11.1	264.29	0.98	2.469
TB	TBA+TBC1-2+TBR+TBP	2.2272	5	1.4	5	11.4	261.73	0.98	1.593
	TOTAL SITE AREA	29.14					TOTAL DISCHARGE		21.34

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Table C- B1: 1 Year ARI Design Flows

Outlet	Catchment	Area (Ha)	Time of Concentration, t_c (mins)				I_1 mm/hr	C_1	Q_1 m^3/sec
			Sheet	Gutter	Pipe	Total			
1A1	1AR	0.4302	0	1	3.2	4.2	98.434	0.688	0.081
1A2	1AA	0.8581	5	0	1	6	109.24	0.688	0.179
1A3	1AU	0.7202	5	0	3.6	8.6	96.822	0.64	0.124
1B1	1BU+1BR	1.0366	5	1	1.9	7.9	104.389	0.656	0.197
1B2	1BA	0.6292	5	0	1	6	109.24	0.688	0.131
1C1	1CR+1CA	2.1812	0	1	3.8	4.8	96.016	0.688	0.4
1C2	1CU	0.7141	5	0	3.1	8.1	98.837	0.64	0.125
1D1	1DA	0.7113	8.5	0	1.6	10.1	108.701	0.688	0.148
1D2	1DC	0.7769	5	0	1	6	109.24	0.688	0.162
2A1	2AU1	0.7211	5	0	3	8	99.24	0.64	0.127
2A2	2AR	0.253	0	1	3	4	99.24	0.688	0.048
2A3	2AU2	0.6256	5	0	3.1	8.1	115.75	0.64	0.129
2B1	2BU1	0.5503	5	0	1.4	6.4	107.084	0.64	0.105
2B2	2BU2+2BR	0.7731	5	0	1.4	6.4	107.084	0.648	0.149
2C1	2CU1	0.668	5	0	2.8	7.8	115.75	0.64	0.137
2C2	2CR	0.2384	0	1	2.8	3.8	100.162	0.688	0.046
2C3	2CU2	0.6493	5	0	3	8	99.24	0.64	0.115
3A1	3AU1	0.6186	5	0	2.7	7.7	100.623	0.64	0.111
3A2	3AR	0.22	0	1	2.7	3.7	100.623	0.688	0.042
3A3	3AU2	0.5347	5	0	2.8	7.8	100.162	0.64	0.095
3B1	3BU1	0.5665	5	0	2.7	7.7	115.75	0.64	0.117
3B2	3BU2+3BR	0.7844	5	0	1.8	6.8	104.928	0.648	0.148
3C1	3CU1	0.6345	5	0	2.8	7.8	100.162	0.64	0.113
3C2	3CR	0.2223	0	1	2.6	3.6	101.084	0.688	0.043
3C3	3CU2	0.589	5	0	2.8	7.8	100.162	0.64	0.105
4A1	4AU	0.5855	5	0	2.8	7.8	115.75	0.64	0.12
4A2	4AR+4AA	0.7159	5	1	2.1	8.1	103.389	0.688	0.141
4B	4BU+4BA+4BP+4BR	2.1715	21	0	2.1	23.1	115.75	0.648	0.452
4C1	4CU	0.3704	5	0	1.9	6.9	104.389	0.64	0.069
4C2	4CR+4CP1-2	2.9439	19	0	4.1	23.1	94.854	0.672	0.521
TA	TAA+TAC1-2+TAR1-2+TAP1-2-3	3.4179	5	2.5	3.6	11.1	70.826	0.672	0.452
TB	TBA+TBC1-2+TBR+TBP	2.2272	5	1.4	5	11.4	90.37	0.664	0.371
	TOTAL SITE AREA	29.14					TOTAL DISCHARGE		5.30

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Table C - B2: 2 Year ARI Design Flows

Outlet	Catchment	Area (Ha)	Time of Concentration, t_c (mins)				I_2 mm/hr	C_2	Q_2 m^3/sec
			Sheet	Gutter	Pipe	Total			
1A1	1AR	0.4302	0	1	3.2	4.2	126.908	0.731	0.111
1A2	1AA	0.8581	5	0	1	6	141.71	0.731	0.247
1A3	1AU	0.7202	5	0	3.6	8.6	125.224	0.68	0.17
1B1	1BU+1BR	1.0366	5	1	1.9	7.9	135.419	0.697	0.272
1B2	1BA	0.6292	5	0	1	6	141.71	0.731	0.181
1C1	1CR+1CA	2.1812	0	1	3.8	4.8	124.382	0.731	0.551
1C2	1CU	0.7141	5	0	3.1	8.1	127.329	0.68	0.172
1D1	1DA	0.7113	8.5	0	1.6	10.1	141.011	0.731	0.204
1D2	1DC	0.7769	5	0	1	6	141.71	0.731	0.224
2A1	2AU1	0.7211	5	0	3	8	127.75	0.68	0.174
2A2	2AR	0.253	0	1	3	4	127.75	0.731	0.066
2A3	2AU2	0.6256	5	0	3.1	8.1	150.14	0.68	0.177
2B1	2BU1	0.5503	5	0	1.4	6.4	141.71	0.68	0.147
2B2	2BU2+2BR	0.7731	5	0	1.4	6.4	141.71	0.6885	0.21
2C1	2CU1	0.668	5	0	2.8	7.8	150.14	0.68	0.189
2C2	2CR	0.2384	0	1	2.8	3.8	129.144	0.731	0.063
2C3	2CU2	0.6493	5	0	3	8	127.75	0.68	0.157
3A1	3AU1	0.6186	5	0	2.7	7.7	129.841	0.68	0.152
3A2	3AR	0.22	0	1	2.7	3.7	129.841	0.731	0.058
3A3	3AU2	0.5347	5	0	2.8	7.8	129.144	0.68	0.13
3B1	3BU1	0.5665	5	0	2.7	7.7	150.14	0.68	0.161
3B2	3BU2+3BR	0.7844	5	0	1.8	6.8	136.118	0.6885	0.204
3C1	3CU1	0.6345	5	0	2.8	7.8	129.144	0.68	0.155
3C2	3CR	0.2223	0	1	2.6	3.6	130.538	0.731	0.059
3C3	3CU2	0.589	5	0	2.8	7.8	129.144	0.68	0.144
4A1	4AU	0.5855	5	0	2.8	7.8	150.14	0.68	0.166
4A2	4AR+4AA	0.7159	5	1	2.1	8.1	134.023	0.731	0.195
4B	4BU+4BA+4BP+4BR	2.1715	21	0	2.1	23.1	150.14	0.6885	0.624
4C1	4CU	0.3704	5	0	1.9	6.9	135.419	0.68	0.095
4C2	4CR+4CP1-2	2.9439	19	0	4.1	23.1	123.078	0.714	0.719
TA	TAA+TAC1-2+TAR1-2+TAP1-2-3	3.4179	5	2.5	3.6	11.1	91.95	0.714	0.623
TB	TBA+TBC1-2+TBR+TBP	2.2272	5	1.4	5	11.4	117.268	0.7055	0.512
	TOTAL SITE AREA	29.14					TOTAL DISCHARGE		7.31

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Table C - B3: 5 Year ARI Design Flows

Outlet	Catchment	Area (Ha)	Time of Concentration, t_c (mins)				I_5 mm/hr	C_5	Q_5 m^3/sec
			Sheet	Gutter	Pipe	Total			
1A1	1AR	0.4302	0	1	3.2	4.2	167.034	0.817	0.163
1A2	1AA	0.8581	5	0	1	6	185.25	0.817	0.361
1A3	1AU	0.7202	5	0	3.6	8.6	164.322	0.76	0.25
1B1	1BU+1BR	1.0366	5	1	1.9	7.9	177.069	0.779	0.397
1B2	1BA	0.6292	5	0	1	6	185.25	0.817	0.265
1C1	1CR+1CA	2.1812	0	1	3.8	4.8	162.966	0.817	0.807
1C2	1CU	0.7141	5	0	3.1	8.1	167.712	0.76	0.253
1D1	1DA	0.7113	8.5	0	1.6	10.1	184.341	0.817	0.298
1D2	1DC	0.7769	5	0	1	6	185.25	0.817	0.327
2A1	2AU1	0.7211	5	0	3	8	168.39	0.76	0.256
2A2	2AR	0.253	0	1	3	4	168.39	0.817	0.097
2A3	2AU2	0.6256	5	0	3.1	8.1	196.21	0.76	0.259
2B1	2BU1	0.5503	5	0	1.4	6.4	185.25	0.76	0.215
2B2	2BU2+2BR	0.7731	5	0	1.4	6.4	185.25	0.7695	0.306
2C1	2CU1	0.668	5	0	2.8	7.8	196.21	0.76	0.277
2C2	2CR	0.2384	0	1	2.8	3.8	169.944	0.817	0.092
2C3	2CU2	0.6493	5	0	3	8	168.39	0.76	0.231
3A1	3AU1	0.6186	5	0	2.7	7.7	170.721	0.76	0.223
3A2	3AR	0.22	0	1	2.7	3.7	170.721	0.817	0.085
3A3	3AU2	0.5347	5	0	2.8	7.8	169.944	0.76	0.192
3B1	3BU1	0.5665	5	0	2.7	7.7	196.21	0.76	0.235
3B2	3BU2+3BR	0.7844	5	0	1.8	6.8	177.978	0.7695	0.298
3C1	3CU1	0.6345	5	0	2.8	7.8	169.944	0.76	0.228
3C2	3CR	0.2223	0	1	2.6	3.6	171.498	0.817	0.087
3C3	3CU2	0.589	5	0	2.8	7.8	169.944	0.76	0.211
4A1	4AU	0.5855	5	0	2.8	7.8	196.21	0.76	0.243
4A2	4AR+4AA	0.7159	5	1	2.1	8.1	175.383	0.817	0.285
4B	4BU+4BA+4BP+4BR	2.1715	21	0	2.1	23.1	196.21	0.7695	0.911
4C1	4CU	0.3704	5	0	1.9	6.9	177.069	0.76	0.138
4C2	4CR+4CP1-2	2.9439	19	0	4.1	23.1	161.009	0.798	1.051
TA	TAA+TAC1-2+TAR1-2+TAP1-2-3	3.4179	5	2.5	3.6	11.1	120.459	0.798	0.913
TB	TBA+TBC1-2+TBR+TBP	2.2272	5	1.4	5	11.4	153.444	0.7885	0.749
	TOTAL SITE AREA	29.14					TOTAL DISCHARGE		10.70

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Table C - B4: 10 Year ARI Design Flows

Outlet	Catchment	Area (Ha)	Time of Concentration, t_c (mins)				I_{10} mm/hr	C_{10}	Q_{10} m^3/sec
			Sheet	Gutter	Pipe	Total			
1A1	1AR	0.4302	0	1	3.2	4.2	190.616	0.86	0.196
1A2	1AA	0.8581	5	0	1	6	211.35	0.86	0.433
1A3	1AU	0.7202	5	0	3.6	8.6	187.528	0.8	0.3
1B1	1BU+1BR	1.0366	5	1	1.9	7.9	202.044	0.82	0.477
1B2	1BA	0.6292	5	0	1	6	211.35	0.86	0.318
1C1	1CR+1CA	2.1812	0	1	3.8	4.8	185.984	0.86	0.969
1C2	1CU	0.7141	5	0	3.1	8.1	191.388	0.8	0.304
1D1	1DA	0.7113	8.5	0	1.6	10.1	210.316	0.86	0.357
1D2	1DC	0.7769	5	0	1	6	211.35	0.86	0.392
2A1	2AU1	0.7211	5	0	3	8	192.16	0.8	0.308
2A2	2AR	0.253	0	1	3	4	192.16	0.86	0.116
2A3	2AU2	0.6256	5	0	3.1	8.1	223.82	0.8	0.311
2B1	2BU1	0.5503	5	0	1.4	6.4	211.35	0.8	0.258
2B2	2BU2+2BR	0.7731	5	0	1.4	6.4	211.35	0.81	0.368
2C1	2CU1	0.668	5	0	2.8	7.8	223.82	0.8	0.332
2C2	2CR	0.2384	0	1	2.8	3.8	193.93	0.86	0.11
2C3	2CU2	0.6493	5	0	3	8	192.16	0.8	0.277
3A1	3AU1	0.6186	5	0	2.7	7.7	194.815	0.8	0.268
3A2	3AR	0.22	0	1	2.7	3.7	194.815	0.86	0.102
3A3	3AU2	0.5347	5	0	2.8	7.8	193.93	0.8	0.23
3B1	3BU1	0.5665	5	0	2.7	7.7	223.82	0.8	0.282
3B2	3BU2+3BR	0.7844	5	0	1.8	6.8	203.078	0.81	0.358
3C1	3CU1	0.6345	5	0	2.8	7.8	193.93	0.8	0.273
3C2	3CR	0.2223	0	1	2.6	3.6	195.7	0.86	0.104
3C3	3CU2	0.589	5	0	2.8	7.8	193.93	0.8	0.254
4A1	4AU	0.5855	5	0	2.8	7.8	223.82	0.8	0.291
4A2	4AR+4AA	0.7159	5	1	2.1	8.1	200.125	0.86	0.342
4B	4BU+4BA+4BP+4BR	2.1715	21	0	2.1	23.1	223.82	0.81	1.094
4C1	4CU	0.3704	5	0	1.9	6.9	202.044	0.8	0.166
4C2	4CR+4CP1-2	2.9439	19	0	4.1	23.1	183.756	0.84	1.262
TA	TAA+TAC1-2+TAR1-2+TAP1-2-3	3.4179	5	2.5	3.6	11.1	137.582	0.84	1.097
TB	TBA+TBC1-2+TBR+TBP	2.2272	5	1.4	5	11.4	175.148	0.83	0.899
	TOTAL SITE AREA	29.14					TOTAL DISCHARGE		12.85

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Table C - B5: 20 Year ARI Design Flows

Outlet	Catchment	Area (Ha)	Time of Concentration, t_c (mins)				I_{20} mm/hr	C_{20}	Q_{20} m^3/sec
			Sheet	Gutter	Pipe	Total			
1A1	1AR	0.4302	0	1	3.2	4.2	221.558	0.903	0.239
1A2	1AA	0.8581	5	0	1	6	245.6	0.903	0.529
1A3	1AU	0.7202	5	0	3.6	8.6	217.974	0.84	0.366
1B1	1BU+1BR	1.0366	5	1	1.9	7.9	234.809	0.861	0.582
1B2	1BA	0.6292	5	0	1	6	245.6	0.903	0.388
1C1	1CR+1CA	2.1812	0	1	3.8	4.8	216.182	0.903	1.183
1C2	1CU	0.7141	5	0	3.1	8.1	222.454	0.84	0.371
1D1	1DA	0.7113	8.5	0	1.6	10.1	244.401	0.903	0.436
1D2	1DC	0.7769	5	0	1	6	245.6	0.903	0.479
2A1	2AU1	0.7211	5	0	3	8	223.35	0.84	0.376
2A2	2AR	0.253	0	1	3	4	223.35	0.903	0.142
2A3	2AU2	0.6256	5	0	3.1	8.1	260.06	0.84	0.38
2B1	2BU1	0.5503	5	0	1.4	6.4	245.6	0.84	0.315
2B2	2BU2+2BR	0.7731	5	0	1.4	6.4	245.6	0.8505	0.449
2C1	2CU1	0.668	5	0	2.8	7.8	260.06	0.84	0.405
2C2	2CR	0.2384	0	1	2.8	3.8	225.402	0.903	0.135
2C3	2CU2	0.6493	5	0	3	8	223.35	0.84	0.338
3A1	3AU1	0.6186	5	0	2.7	7.7	226.428	0.84	0.327
3A2	3AR	0.22	0	1	2.7	3.7	226.428	0.903	0.125
3A3	3AU2	0.5347	5	0	2.8	7.8	225.402	0.84	0.281
3B1	3BU1	0.5665	5	0	2.7	7.7	260.06	0.84	0.344
3B2	3BU2+3BR	0.7844	5	0	1.8	6.8	236.008	0.8505	0.437
3C1	3CU1	0.6345	5	0	2.8	7.8	225.402	0.84	0.334
3C2	3CR	0.2223	0	1	2.6	3.6	227.454	0.903	0.127
3C3	3CU2	0.589	5	0	2.8	7.8	225.402	0.84	0.31
4A1	4AU	0.5855	5	0	2.8	7.8	260.06	0.84	0.355
4A2	4AR+4AA	0.7159	5	1	2.1	8.1	232.584	0.903	0.418
4B	4BU+4BA+4BP+4BR	2.1715	21	0	2.1	23.1	260.06	0.8505	1.334
4C1	4CU	0.3704	5	0	1.9	6.9	234.809	0.84	0.203
4C2	4CR+4CP1-2	2.9439	19	0	4.1	23.1	213.596	0.882	1.541
TA	TAA+TAC1-2+TAR1-2+TAP1-2-3	3.4179	5	2.5	3.6	11.1	160.025	0.882	1.34
TB	TBA+TBC1-2+TBR+TBP	2.2272	5	1.4	5	11.4	203.606	0.8715	1.098
	TOTAL SITE AREA	29.14					TOTAL DISCHARGE		15.69

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Table C - B6: 50 Year ARI Design Flows

Outlet	Catchment	Area (Ha)	Time of Concentration, t_c (mins)				I_{50} mm/hr	C_{50}	Q_{50} m^3/sec
			Sheet	Gutter	Pipe	Total			
1A1	1AR	0.4302	0	1	3.2	4.2	262.722	0.989	0.31
1A2	1AA	0.8581	5	0	1	6	291.15	0.989	0.686
1A3	1AU	0.7202	5	0	3.6	8.6	258.486	0.92	0.476
1B1	1BU+1BR	1.0366	5	1	1.9	7.9	278.397	0.943	0.756
1B2	1BA	0.6292	5	0	1	6	291.15	0.989	0.503
1C1	1CR+1CA	2.1812	0	1	3.8	4.8	256.368	0.989	1.536
1C2	1CU	0.7141	5	0	3.1	8.1	263.781	0.92	0.481
1D1	1DA	0.7113	8.5	0	1.6	10.1	289.733	0.989	0.566
1D2	1DC	0.7769	5	0	1	6	291.15	0.989	0.621
2A1	2AU1	0.7211	5	0	3	8	264.84	0.92	0.488
2A2	2AR	0.253	0	1	3	4	264.84	0.989	0.184
2A3	2AU2	0.6256	5	0	3.1	8.1	308.24	0.92	0.493
2B1	2BU1	0.5503	5	0	1.4	6.4	291.15	0.92	0.409
2B2	2BU2+2BR	0.7731	5	0	1.4	6.4	291.15	0.9315	0.582
2C1	2CU1	0.668	5	0	2.8	7.8	308.24	0.92	0.526
2C2	2CR	0.2384	0	1	2.8	3.8	267.268	0.989	0.175
2C3	2CU2	0.6493	5	0	3	8	264.84	0.92	0.439
3A1	3AU1	0.6186	5	0	2.7	7.7	268.482	0.92	0.424
3A2	3AR	0.22	0	1	2.7	3.7	268.482	0.989	0.162
3A3	3AU2	0.5347	5	0	2.8	7.8	267.268	0.92	0.365
3B1	3BU1	0.5665	5	0	2.7	7.7	308.24	0.92	0.446
3B2	3BU2+3BR	0.7844	5	0	1.8	6.8	279.814	0.9315	0.568
3C1	3CU1	0.6345	5	0	2.8	7.8	267.268	0.92	0.433
3C2	3CR	0.2223	0	1	2.6	3.6	269.696	0.989	0.165
3C3	3CU2	0.589	5	0	2.8	7.8	267.268	0.92	0.402
4A1	4AU	0.5855	5	0	2.8	7.8	308.24	0.92	0.461
4A2	4AR+4AA	0.7159	5	1	2.1	8.1	275.766	0.989	0.542
4B	4BU+4BA+4BP+4BR	2.1715	21	0	2.1	23.1	308.24	0.9315	1.732
4C1	4CU	0.3704	5	0	1.9	6.9	278.397	0.92	0.264
4C2	4CR+4CP1-2	2.9439	19	0	4.1	23.1	253.311	0.966	2.001
TA	TAA+TAC1-2+TAR1-2+TAP1-2-3	3.4179	5	2.5	3.6	11.1	189.911	0.966	1.742
TB	TBA+TBC1-2+TBR+TBP	2.2272	5	1.4	5	11.4	241.492	0.9545	1.426
	TOTAL SITE AREA	29.14					TOTAL DISCHARGE		20.36

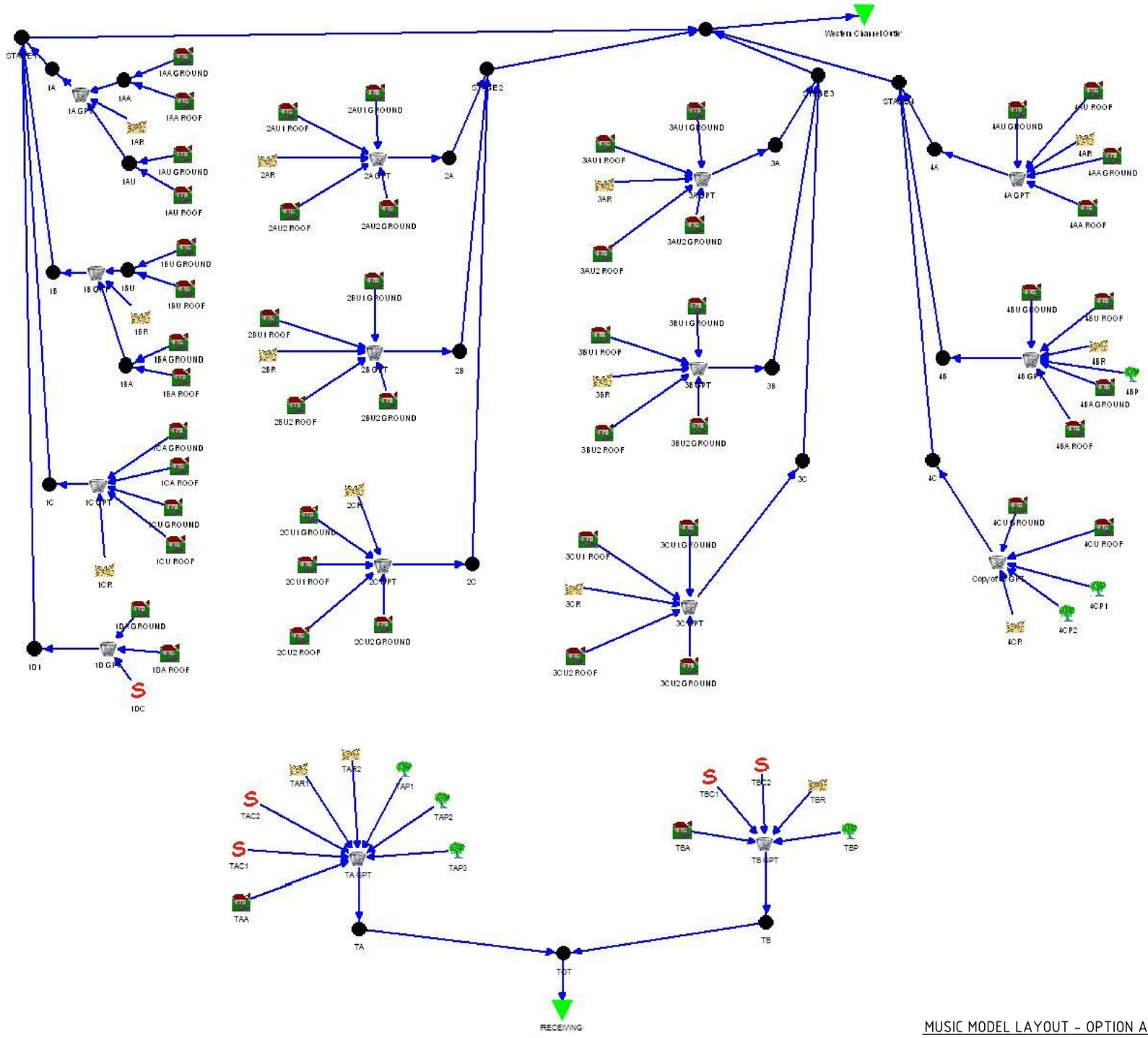
Hyder	STORMWATER QUANTITY RESULTS	DOCUMENT No QL00704
OFFICE GOLD COAST	PROJECT TITLE TOWNSVILLE OCEAN TERMINAL	
SUBJECT OPTION B - SUMMARY OF POST DEVELOPED DISCHARGE RATES		SHEET No 7 of 7

Table C - B7: 100 Year ARI Design Flows

Outlet	Catchment	Area (Ha)	Time of Concentration, t_c (mins)				I_{100} mm/hr	C_{100}	Q_{100} m^3/sec
			Sheet	Gutter	Pipe	Total			
1A1	1AR	0.4302	0	1	3.2	4.2	294.558	1.032	0.363
1A2	1AA	0.8581	5	0	1	6	326.39	1.032	0.803
1A3	1AU	0.7202	5	0	3.6	8.6	289.814	0.96	0.557
1B1	1BU+1BR	1.0366	5	1	1.9	7.9	312.098	0.984	0.884
1B2	1BA	0.6292	5	0	1	6	326.39	1.032	0.589
1C1	1CR+1CA	2.1812	0	1	3.8	4.8	287.442	1.032	1.797
1C2	1CU	0.7141	5	0	3.1	8.1	295.744	0.96	0.563
1D1	1DA	0.7113	8.5	0	1.6	10.1	324.802	1.032	0.662
1D2	1DC	0.7769	5	0	1	6	326.39	1.032	0.727
2A1	2AU1	0.7211	5	0	3	8	296.93	0.96	0.571
2A2	2AR	0.253	0	1	3	4	296.93	1.032	0.215
2A3	2AU2	0.6256	5	0	3.1	8.1	345.52	0.96	0.576
2B1	2BU1	0.5503	5	0	1.4	6.4	326.39	0.96	0.479
2B2	2BU2+2BR	0.7731	5	0	1.4	6.4	326.39	0.972	0.681
2C1	2CU1	0.668	5	0	2.8	7.8	345.52	0.96	0.615
2C2	2CR	0.2384	0	1	2.8	3.8	299.646	1.032	0.205
2C3	2CU2	0.6493	5	0	3	8	296.93	0.96	0.514
3A1	3AU1	0.6186	5	0	2.7	7.7	301.004	0.96	0.497
3A2	3AR	0.22	0	1	2.7	3.7	301.004	1.032	0.19
3A3	3AU2	0.5347	5	0	2.8	7.8	299.646	0.96	0.427
3B1	3BU1	0.5665	5	0	2.7	7.7	345.52	0.96	0.522
3B2	3BU2+3BR	0.7844	5	0	1.8	6.8	313.686	0.972	0.664
3C1	3CU1	0.6345	5	0	2.8	7.8	299.646	0.96	0.507
3C2	3CR	0.2223	0	1	2.6	3.6	302.362	1.032	0.193
3C3	3CU2	0.589	5	0	2.8	7.8	299.646	0.96	0.471
4A1	4AU	0.5855	5	0	2.8	7.8	345.52	0.96	0.539
4A2	4AR+4AA	0.7159	5	1	2.1	8.1	309.152	1.032	0.634
4B	4BU+4BA+4BP+4BR	2.1715	21	0	2.1	23.1	345.52	0.972	2.026
4C1	4CU	0.3704	5	0	1.9	6.9	312.098	0.96	0.308
4C2	4CR+4CP1-2	2.9439	19	0	4.1	23.1	284.018	1.008	2.341
TA	TAA+TAC1-2+TAR1-2+TAP1-2-3	3.4179	5	2.5	3.6	11.1	213.032	1.008	2.039
TB	TBA+TBC1-2+TBR+TBP	2.2272	5	1.4	5	11.4	270.786	0.996	1.669
	TOTAL SITE AREA	29.14					TOTAL DISCHARGE		23.83

Appendix D

Music Model Layouts



MUSIC MODEL LAYOUT - OPTION A WITHOUT RAINWATER TANKS

Issue	Description	Date
01	ORIGINAL ISSUE	21.06.2007

100mm on Original

Scale (Plan)

Scale (Sections)

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename: K039-QL00704-01- MUSIC LAYOUT A WO RWT.DWG

Client: Townsville Ocean Terminal

Status: **PRELIMINARY** NOT TO BE USED FOR CONSTRUCTION

Approved

R.E.P.Q No :

Scales: AS SHOWN

Original Size: A1

Height Datum: AHD

Grid: LOCAL

Current Issue Signatures

Author I.G

Designer R.J.M

Reviewer J.S

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: MUSIC MODEL LAYOUT OPTION A WITHOUT RAINWATER TANKS

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Drawing No. K039 — Project No. QL00704 — Issue 01

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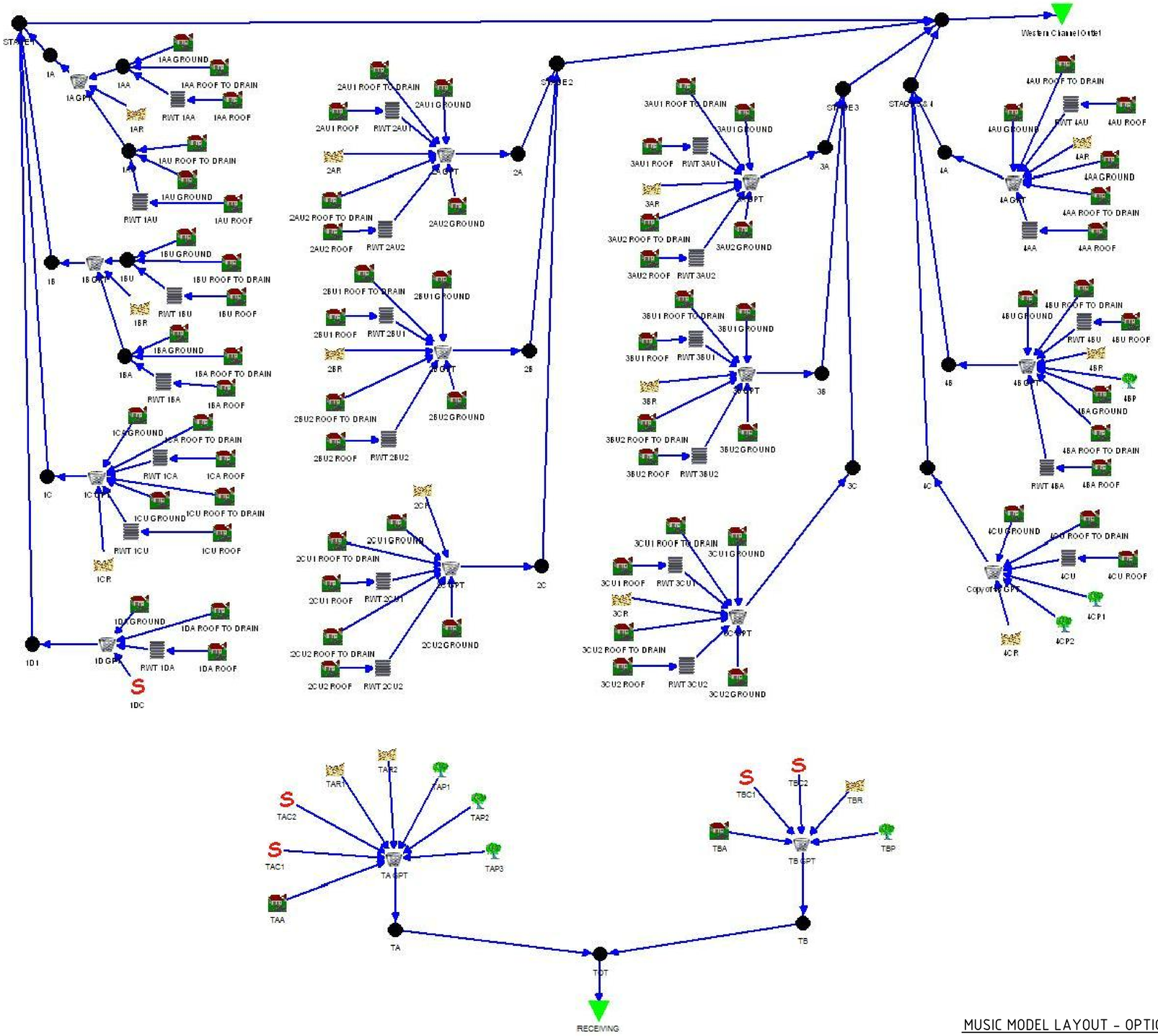

MUSIC MODEL LAYOUT - OPTION A WITH RAINWATER TANKS

Issue	Description	Date
01	ORIGINAL ISSUE	21.06.2007

100mm on Original

Scale (Plan)

Scale (Sections)

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename: K040-QL00704-01- MUSIC LAYOUT A W RWT.DWG

Client: Townsville Ocean Terminal

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Original Size	A1	Author I.G	
Height Datum	AHD	Designer R.J.M	
Grid	LOCAL	Reviewer J.S	

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: MUSIC MODEL LAYOUT OPTION A WITH RAINWATER TANKS

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Drawing No.	Project No.	Issue
K040	QL00704	01

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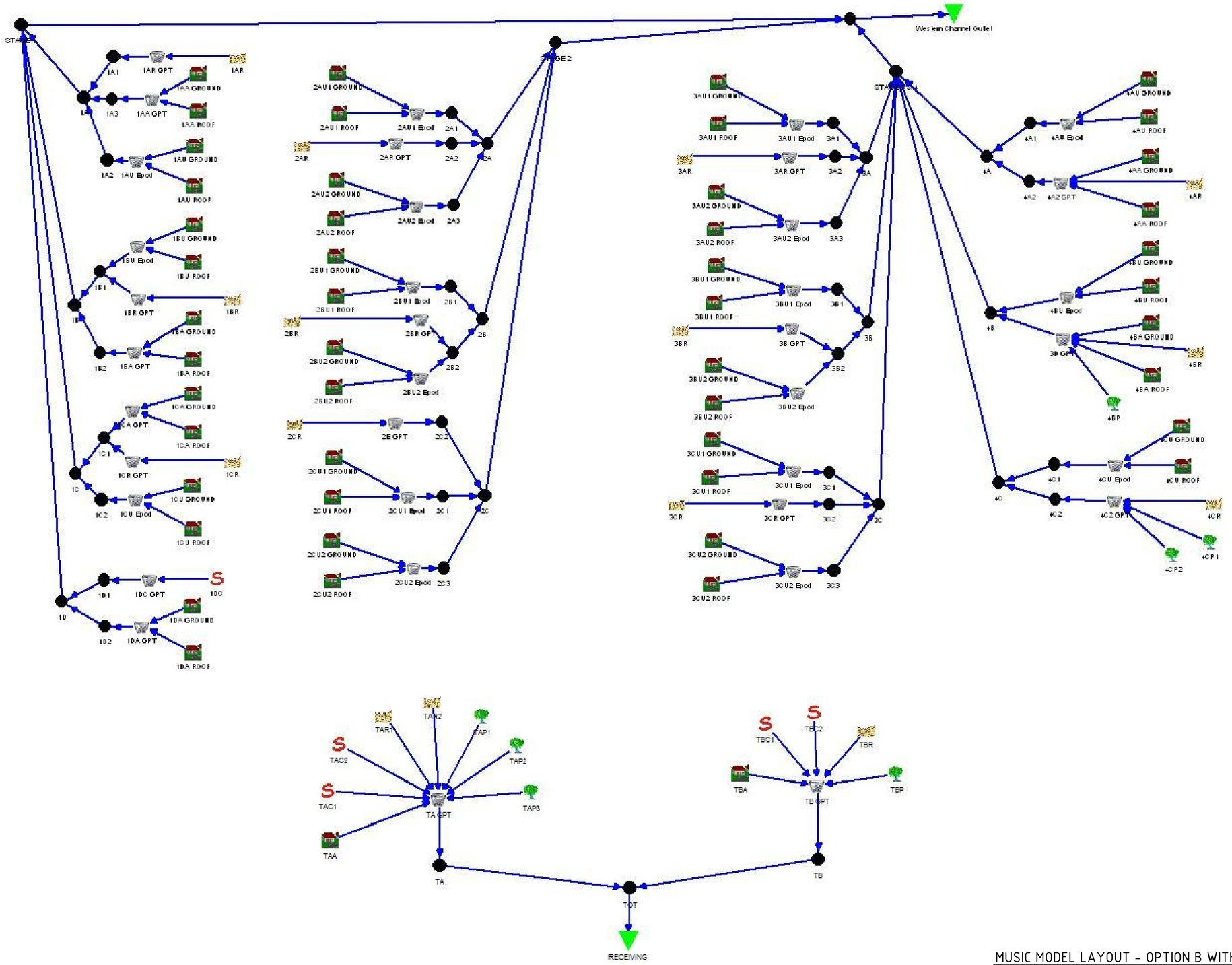

MUSIC MODEL LAYOUT - OPTION B WITHOUT RAINWATER TANKS

Issue	Description	Date
01	ORIGINAL ISSUE	21.06.2007

100mm on Original

Scale (Plan)

Scale (Sections)

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename: K041-QL00704-01- MUSIC LAYOUT B WO RWT.DWG

Client: Townsville Ocean Terminal

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		Author I.G	
Original Size	A1	Designer R.J.M	
Height Datum	AHD	Reviewer J.S	
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Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: MUSIC MODEL LAYOUT OPTION B WITHOUT RAINWATER TANKS

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Drawing No.	Project No.	Issue
K041	QL00704	01

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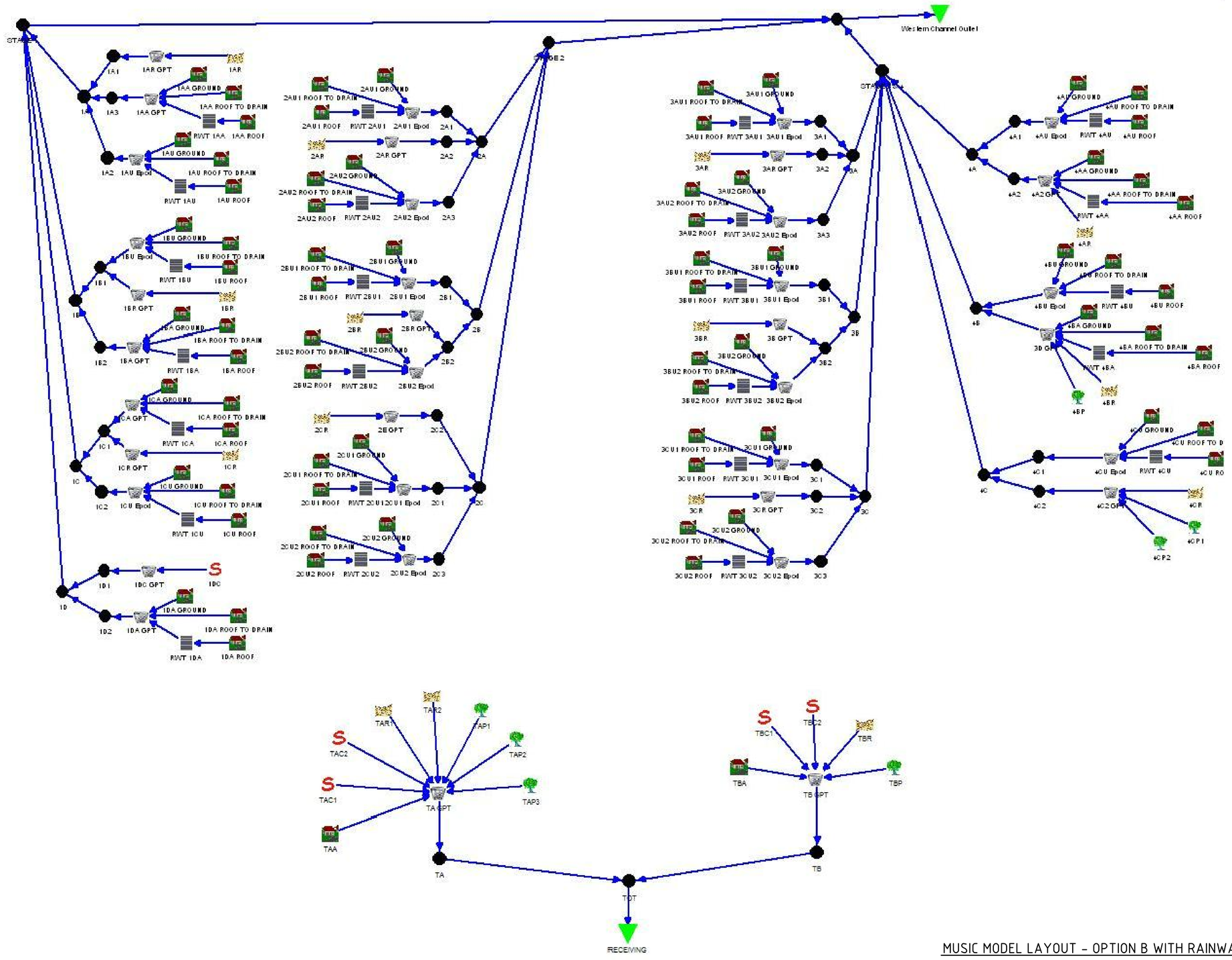

MUSIC MODEL LAYOUT - OPTION B WITH RAINWATER TANKS

Issue	Description	Date
01	ORIGINAL ISSUE	21.06.2007

100mm on Original

Scale (Plan)

Scale (Sections)

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Architect: BUCHAN GROUP

Filename: K042-QL00704-01- MUSIC LAYOUT B W RWT.DWG

Client: Townsville Ocean Terminal

Status: **PRELIMINARY** NOT TO BE USED FOR CONSTRUCTION

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R.E.P.Q No :

Scales: AS SHOWN

Original Size: A1

Height Datum: AHD

Grid: LOCAL

Current Issue Signatures

Author I.G

Designer R.J.M

Reviewer J.S

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: MUSIC MODEL LAYOUT OPTION B WITH RAINWATER TANKS

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Drawing No. K042 — Project No. QL00704 — Issue 01

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Appendix E

Stormwater Catchment Plans for Water Quality Modelling

LEGEND

- APARTMENT BLOCKS (INCLUDING SOME RETAIL)
- CARPARK / HARDSTAND AREAS
- PARK / OPEN SPACE
- ROADS
- ATTACHED DWELLINGS
- DETATCHED DWELLINGS
- CATCHMENT BOUNDARY

NOTATION

SUB-CATCHMENT NOTATION

2CL1
- STAGE NUMBER
- STAGE SUB-CATCHMENT
- DEVELOPMENT CATEGORY SUB-CATCHMENT
- DEVELOPMENT CATEGORY (REFER TO DEVELOPMENT CATEGORY ABBREVIATIONS)

OUTLET NOTATION

1A2
- STAGE NUMBER
- STAGE SUB-CATCHMENT OUTLET NUMBER
- STAGE SUB-CATCHMENT

DEVELOPMENT CATEGORIES

A - APARTMENT BLOCKS (INCLUDING SOME RETAIL COMPONENTS)
U - URBAN RESIDENTIAL SITES
P - PUBLIC PARK
R - ROADWAY
C - CARPARK / HARDSTAND AREAS

CATCHMENT TABLE

CATCHMENT	AREA (Ha)	TOTAL AREAS (Ha)
1AA	0.8581	
1AU	0.7202	
1AR	0.4302	2.0085
1BA	0.6292	
1BU	0.6923	
1BR	0.3443	1.6658
1CA	0.6297	
1CU	0.7141	
1CR	1.5515	2.8953
1DA	0.7113	
1DC	0.7769	1.4882
2AU1	0.7211	
2AU2	0.6256	
2AR	0.253	1.5997
2BU1	0.5503	
2BU2	0.5715	
2BR	0.2016	1.3234
2CU1	0.668	
2CU2	0.6493	
2CR	0.2384	1.5557
3AU1	0.6186	
3AU2	0.5347	
3AR	0.22	1.3733
3BU1	0.5665	
3BU2	0.5817	
3BR	0.2027	1.3509
3CU1	0.6345	
3CU2	0.589	
3CR	0.2223	1.4458
4AA	0.4576	
4AU	0.5855	
4AR	0.2583	1.3014
4BA	0.2802	
4BU	0.7663	
4BR	0.3627	
4BP	0.7623	2.1715
4CU	0.2778	
4CR	1.773	
4CP1	0.2880	
4CP2	0.9754	3.3143
TAA	0.0622	
TAR1	0.6122	
TAR2	0.5785	
TAP1	0.598	
TAP2	0.342	
TAP3	0.1158	
TAC1	0.976	
TAC2	0.1332	3.4179
TBA	0.061	
TBR	0.7622	
TBP	0.9488	
TBC1	0.1521	
TBC2	0.3031	2.2272
TOTAL SITE AREA = 29.1389 Ha		

Issue	Description	Date
03	AMENDED LAYOUT	14.06.2007
02	AMENDED LAYOUT	16.05.2007
01	ORIGINAL ISSUE	08.01.2007

Scale (Plan): 0 50 100 150 200m — 1 : 2000

Scale (Sections)

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename: 000-QL00704-02-SWD QUALITY CATCHMENT PLANS.DWG

Client: Townsville Ocean Terminal

Status: **PRELIMINARY** NOT TO BE USED FOR CONSTRUCTION

Approved

R.E.P.Q No :

Scales	AS SHOWN	Current Issue Signatures	
		Author P.S.M	
Original Size	A1	Designer R.M	
Height Datum	A.H.D	Reviewer L.J.O	
Grid	LOCAL	© Copyright reserved	

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: STORMWATER CATCHMENTS FOR WATER QUALITY MODELING OPTION A

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Drawing No. K019 — Project No. QL00704 — Issue 03

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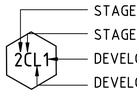
LEGEND

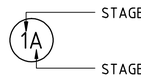
- APARTMENT BLOCKS (INCLUDING SOME RETAIL)
- CARPARK / HARDSTAND AREAS
- PARK / OPEN SPACE
- ROADS
- ATTACHED DWELLINGS
- DETATCHED DWELLINGS
- CATCHMENT BOUNDARY

NOTATION

SUB-CATCHMENT NOTATION



OUTLET NOTATION



DEVELOPMENT CATEGORIES

A – APARTMENT BLOCKS (INCLUDING SOME RETAIL COMPONENTS)
U – URBAN RESIDENTIAL SITES
P – PUBLIC PARK
R – ROADWAY
C – CARPARK / HARDSTAND AREAS

CATCHMENT TABLE

CATCHMENT	AREA (Ha)	TOTAL AREAS (Ha)
1AA	0.8581	
1AU	0.7202	
1AR	0.4302	2.0085
1BA	0.6292	
1BU	0.6923	
1BR	0.3443	1.6658
1CA	0.6297	
1CU	0.7141	
1CR	1.5515	2.8953
1DA	0.7113	
1DC	0.7769	1.4882
2AU1	0.7211	
2AU2	0.6256	
2AR	0.253	1.5997
2BU1	0.5503	
2BU2	0.5715	
2BR	0.2016	1.3234
2CU1	0.668	
2CU2	0.6493	
2CR	0.2384	1.5557
3AU1	0.6186	
3AU2	0.5347	
3AR	0.22	1.3733
3BU1	0.5665	
3BU2	0.5817	
3BR	0.2027	1.3509
3CU1	0.6345	
3CU2	0.589	
3CR	0.2223	1.4458
4AA	0.4576	
4AU	0.5855	
4AR	0.2583	1.3014
4BA	0.2802	
4BU	0.7663	
4BR	0.3627	
4BP	0.7623	2.1715
4CU	0.2778	
4CR	1.773	
4CP1	0.2880	
4CP2	0.9754	3.3143
TAA	0.0622	
TAR1	0.6122	
TAR2	0.5785	
TAP1	0.598	
TAP2	0.342	
TAP3	0.1158	
TAC1	0.976	
TAC2	0.1332	3.4179
TBA	0.061	
TBR	0.7622	
TBP	0.9488	
TBC1	0.1521	
TBC2	0.3031	2.2272
TOTAL SITE AREA = 29.1389 Ha		

Issue	Description	Date
03	AMENDED LAYOUT	14.06.2007
02	AMENDED LAYOUT	16.05.2007
01	ORIGINAL ISSUE	08.01.2007

100mm on Original

Scale (Plan): 0 50 100 150 200m — 1 : 2000

Scale (Sections):

Surveyor: BRAZIER MOTTI

Architect: BUCHAN GROUP

Filename: 000-QL00704-02-SWD QUALITY CATCHMENT PLANS.DWG

Client: Townsville Ocean Terminal

Status: **PRELIMINARY** NOT TO BE USED FOR CONSTRUCTION

Approved

Scales: AS SHOWN

Original Size: A1

Height Datum: A.H.D

Grid: LOCAL

R.E.P.Q No :

Current Issue Signatures

Author P.S.M

Designer R.M

Reviewer L.J.O

Project: TOWNSVILLE OCEAN TERMINAL PROJECT

Title: STORMWATER CATCHMENTS FOR WATER QUALITY MODELING OPTION B

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Drawing No. K020 — Project No. QL00704 — Issue 03

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Appendix F

Music Modelling Results

Hyder Consulting

MUSIC MODELING RESULTS

DOCUMENT No: QL00704

OFFICE: GOLD COAST

PROJECT TITLE: TOWNSVILLE OCEAN TERMINAL

SUBJECT

TABLE G.1 OPTION A - WITHOUT RAINWATER TANKS

SUMMARY OF TREATMENT TRAIN EFFECTIVENESS AT OUTLETS

OUTLET	POLLUTANT	SOURCE	RESIDUAL	% REDUCTION
1A	Flow (ML/yr)	18.10	18.10	0.00
	Total Suspended Solids (kg/yr)	1980.00	1420.00	28.40
	Total Phosphorus (kg/yr)	5.03	4.96	1.50
	Total Nitrogen (kg/yr)	42.30	36.80	13.10
	Gross Pollutants (kg/yr)	408.00	54.00	86.80
1B	Flow (ML/yr)	15.00	15.00	0.00
	Total Suspended Solids (kg/yr)	2680.00	1620.00	39.50
	Total Phosphorus (kg/yr)	5.59	5.43	2.90
	Total Nitrogen (kg/yr)	34.20	29.70	13.20
	Gross Pollutants (kg/yr)	339.00	44.00	87.00
1C	Flow (ML/yr)	24.60	24.60	0.00
	Total Suspended Solids (kg/yr)	6900.00	3550.00	48.60
	Total Phosphorus (kg/yr)	12.30	11.30	7.40
	Total Nitrogen (kg/yr)	54.90	47.70	13.10
	Gross Pollutants (kg/yr)	582.00	76.40	86.90
1D	Flow (ML/yr)	13.90	13.90	0.00
	Total Suspended Solids (kg/yr)	1150.00	883.00	23.20
	Total Phosphorus (kg/yr)	3.77	3.68	2.50
	Total Nitrogen (kg/yr)	33.10	28.80	13.10
	Gross Pollutants (kg/yr)	329.00	44.50	86.50
2A	Flow (ML/yr)	12.10	12.10	0.00
	Total Suspended Solids (kg/yr)	1390.00	995.00	28.50
	Total Phosphorus (kg/yr)	3.34	3.31	1.10
	Total Nitrogen (kg/yr)	26.00	22.60	13.10
	Gross Pollutants (kg/yr)	252.00	31.20	87.60
2B	Flow (ML/yr)	10.00	10.00	0.00
	Total Suspended Solids (kg/yr)	1110.00	800.00	27.70
	Total Phosphorus (kg/yr)	2.73	2.70	1.00
	Total Nitrogen (kg/yr)	21.30	18.50	13.20
	Gross Pollutants (kg/yr)	208.00	25.30	87.90
2C	Flow (ML/yr)	12.90	12.90	0.00
	Total Suspended Solids (kg/yr)	1310.00	976.00	25.20
	Total Phosphorus (kg/yr)	3.37	3.34	1.00
	Total Nitrogen (kg/yr)	27.50	23.90	13.10
	Gross Pollutants (kg/yr)	277.00	35.60	87.20
3A	Flow (ML/yr)	10.40	10.40	0.00
	Total Suspended Solids (kg/yr)	1200.00	849.00	29.10
	Total Phosphorus (kg/yr)	2.91	2.87	1.10
	Total Nitrogen (kg/yr)	22.20	19.30	13.10
	Gross Pollutants (kg/yr)	216.00	26.60	87.70
3B	Flow (ML/yr)	10.20	10.20	0.00
	Total Suspended Solids (kg/yr)	1110.00	807.00	27.50
	Total Phosphorus (kg/yr)	2.76	2.73	1.00
	Total Nitrogen (kg/yr)	21.60	18.80	13.20
	Gross Pollutants (kg/yr)	212.00	25.80	87.80
3C	Flow (ML/yr)	11.00	11.00	0.00
	Total Suspended Solids (kg/yr)	1230.00	880.00	28.40
	Total Phosphorus (kg/yr)	2.99	2.96	1.00
	Total Nitrogen (kg/yr)	23.40	20.30	13.10
	Gross Pollutants (kg/yr)	227.00	27.90	87.70
4A	Flow (ML/yr)	11.60	11.60	0.00
	Total Suspended Solids (kg/yr)	1240.00	896.00	27.90
	Total Phosphorus (kg/yr)	3.12	3.08	1.20
	Total Nitrogen (kg/yr)	26.50	23.00	13.20
	Gross Pollutants (kg/yr)	260.00	33.60	87.10
4B	Flow (ML/yr)	14.50	14.50	0.00
	Total Suspended Solids (kg/yr)	1710.00	1180.00	30.80
	Total Phosphorus (kg/yr)	3.78	3.72	1.50
	Total Nitrogen (kg/yr)	28.20	24.50	12.90
	Gross Pollutants (kg/yr)	279.00	35.90	87.10

Hyder Consulting

MUSIC MODELING RESULTS

DOCUMENT No.
QL00704

OFFICE
GOLD COAST

PROJECT TITLE
TOWNSVILLE OCEAN TERMINAL

SUBJECT
OPTION A - WITHOUT RAINWATER TANKS

SUMMARY OF TREATMENT TRAIN EFFECTIVENESS AT OUTLETS

SHEET No
2 of 2

OUTLET	POLLUTANT	SOURCE	RESIDUAL	% REDUCTION
4C	Flow (ML/yr)	20.00	20.00	0.00
	Total Suspended Solids (kg/yr)	6210.00	2930.00	52.80
	Total Phosphorus (kg/yr)	10.10	9.00	10.90
	Total Nitrogen (kg/yr)	40.30	35.00	13.10
	Gross Pollutants (kg/yr)	412.00	49.80	87.90
TA	Flow (ML/yr)	22.80	22.80	0.00
	Total Suspended Solids (kg/yr)	5480.00	4040.00	26.30
	Total Phosphorus (kg/yr)	10.10	9.77	3.30
	Total Nitrogen (kg/yr)	53.30	51.40	3.50
	Gross Pollutants (kg/yr)	500.00	123.00	75.30
TB	Flow (ML/yr)	13.40	13.40	0.00
	Total Suspended Solids (kg/yr)	3410.00	2380.00	30.20
	Total Phosphorus (kg/yr)	5.88	5.66	3.80
	Total Nitrogen (kg/yr)	31.20	30.00	4.10
	Gross Pollutants (kg/yr)	269.00	38.00	85.90

Hyder Consulting

MUSIC MODELING RESULTS

DOCUMENT No: QL00704

OFFICE: GOLD COAST

PROJECT TITLE: TOWNSVILLE OCEAN TERMINAL

SUBJECT

TABLE G.2 OPTION A - WITH RAINWATER TANKS

SUMMARY OF TREATMENT TRAIN EFFECTIVENESS AT OUTLETS

OUTLET	POLLUTANT	SOURCE	RESIDUAL	% REDUCTION
1A	Flow (ML/yr)	18.10	13.50	25.50
	Total Suspended Solids (kg/yr)	2050.00	1220.00	40.40
	Total Phosphorus (kg/yr)	5.11	4.19	18.00
	Total Nitrogen (kg/yr)	41.40	26.40	36.20
	Gross Pollutants (kg/yr)	408.00	31.30	92.30
1B	Flow (ML/yr)	15.00	11.20	25.10
	Total Suspended Solids (kg/yr)	2700.00	1320.00	51.10
	Total Phosphorus (kg/yr)	5.61	4.44	20.70
	Total Nitrogen (kg/yr)	34.30	22.00	35.90
	Gross Pollutants (kg/yr)	339.00	25.80	92.40
1C	Flow (ML/yr)	24.60	20.90	14.90
	Total Suspended Solids (kg/yr)	6960.00	3070.00	55.90
	Total Phosphorus (kg/yr)	12.20	9.84	19.20
	Total Nitrogen (kg/yr)	54.50	40.60	25.60
	Gross Pollutants (kg/yr)	582.00	57.30	90.20
1D	Flow (ML/yr)	13.90	10.90	21.50
	Total Suspended Solids (kg/yr)	1130.00	745.00	34.20
	Total Phosphorus (kg/yr)	3.71	3.06	17.40
	Total Nitrogen (kg/yr)	33.40	22.60	32.50
	Gross Pollutants (kg/yr)	329.00	29.80	91.00
2A	Flow (ML/yr)	12.10	10.80	10.70
	Total Suspended Solids (kg/yr)	1420.00	947.00	33.30
	Total Phosphorus (kg/yr)	3.35	3.08	7.90
	Total Nitrogen (kg/yr)	25.70	20.00	22.40
	Gross Pollutants (kg/yr)	252.00	24.10	90.40
2B	Flow (ML/yr)	10.00	8.95	10.90
	Total Suspended Solids (kg/yr)	1120.00	749.00	33.40
	Total Phosphorus (kg/yr)	2.74	2.52	8.10
	Total Nitrogen (kg/yr)	21.30	16.50	22.70
	Gross Pollutants (kg/yr)	208.00	19.50	90.60
2C	Flow (ML/yr)	12.90	11.20	12.80
	Total Suspended Solids (kg/yr)	1300.00	891.00	31.40
	Total Phosphorus (kg/yr)	3.33	3.01	9.60
	Total Nitrogen (kg/yr)	27.40	20.70	24.40
	Gross Pollutants (kg/yr)	277.00	25.00	91.00
3A	Flow (ML/yr)	10.40	9.40	9.80
	Total Suspended Solids (kg/yr)	1210.00	802.00	33.60
	Total Phosphorus (kg/yr)	2.90	2.68	7.50
	Total Nitrogen (kg/yr)	22.20	17.30	21.80
	Gross Pollutants (kg/yr)	216.00	21.00	90.30
3B	Flow (ML/yr)	10.20	9.16	10.60
	Total Suspended Solids (kg/yr)	1130.00	763.00	32.40
	Total Phosphorus (kg/yr)	2.77	2.55	7.90
	Total Nitrogen (kg/yr)	21.80	16.90	22.40
	Gross Pollutants (kg/yr)	212.00	20.00	90.60
3C	Flow (ML/yr)	11.00	9.87	9.90
	Total Suspended Solids (kg/yr)	1230.00	829.00	32.50
	Total Phosphorus (kg/yr)	2.99	2.77	7.50
	Total Nitrogen (kg/yr)	23.30	18.20	21.80
	Gross Pollutants (kg/yr)	227.00	21.90	90.30
4A	Flow (ML/yr)	11.60	9.07	21.70
	Total Suspended Solids (kg/yr)	1230.00	770.00	37.60
	Total Phosphorus (kg/yr)	3.14	2.64	15.80
	Total Nitrogen (kg/yr)	26.50	17.70	33.00
	Gross Pollutants (kg/yr)	260.00	20.30	92.20
4B	Flow (ML/yr)	14.50	12.10	16.20
	Total Suspended Solids (kg/yr)	1680.00	1050.00	37.60
	Total Phosphorus (kg/yr)	3.73	3.25	12.70
	Total Nitrogen (kg/yr)	27.90	19.90	28.50
	Gross Pollutants (kg/yr)	279.00	23.50	91.60

Hyder Consulting

MUSIC MODELING RESULTS

DOCUMENT No: QL00704

OFFICE: GOLD COAST

PROJECT TITLE: TOWNSVILLE OCEAN TERMINAL

SUBJECT: OPTION A - WITH RAINWATER TANKS

SHEET No: 2 of 2

SUMMARY OF TREATMENT TRAIN EFFECTIVENESS AT OUTLETS

OUTLET	POLLUTANT	SOURCE	RESIDUAL	% REDUCTION
4C	Flow (ML/yr)	20.00	19.60	2.00
	Total Suspended Solids (kg/yr)	6330.00	2990.00	52.70
	Total Phosphorus (kg/yr)	10.10	8.95	11.80
	Total Nitrogen (kg/yr)	40.20	34.10	15.10
	Gross Pollutants (kg/yr)	412.00	47.20	88.50
TA	Flow (ML/yr)	22.80	22.80	0.00
	Total Suspended Solids (kg/yr)	5480.00	4040.00	26.30
	Total Phosphorus (kg/yr)	10.10	9.77	3.30
	Total Nitrogen (kg/yr)	53.30	51.40	3.50
	Gross Pollutants (kg/yr)	500.00	123.00	75.30
TB	Flow (ML/yr)	13.40	13.40	0.00
	Total Suspended Solids (kg/yr)	3410.00	2380.00	30.20
	Total Phosphorus (kg/yr)	5.88	5.66	3.80
	Total Nitrogen (kg/yr)	31.20	30.00	4.10
	Gross Pollutants (kg/yr)	269.00	38.00	85.90

TABLE G.4 OPTION B - WITHOUT RAINWATER TANKS

SUMMARY OF TREATMENT TRAIN EFFECTIVENESS AT OUTLETS

OUTLET	POLLUTANT	SOURCE	RESIDUAL	% REDUCTION
1A	Flow (ML/yr)	18.10	18.10	0.00
	Total Suspended Solids (kg/yr)	1990.00	957.00	51.90
	Total Phosphorus (kg/yr)	5.01	4.23	15.70
	Total Nitrogen (kg/yr)	41.40	35.10	15.20
	Gross Pollutants (kg/yr)	408.00	41.50	89.80
1B	Flow (ML/yr)	15.00	15.00	0.00
	Total Suspended Solids (kg/yr)	2770.00	1290.00	53.40
	Total Phosphorus (kg/yr)	5.80	4.86	16.20
	Total Nitrogen (kg/yr)	34.60	28.90	16.50
	Gross Pollutants (kg/yr)	339.00	26.30	92.30
1C	Flow (ML/yr)	24.60	24.60	0.00
	Total Suspended Solids (kg/yr)	5620.00	2470.00	56.00
	Total Phosphorus (kg/yr)	10.50	8.91	15.50
	Total Nitrogen (kg/yr)	57.30	48.50	15.40
	Gross Pollutants (kg/yr)	583.00	52.10	91.10
1D	Flow (ML/yr)	13.90	13.90	0.00
	Total Suspended Solids (kg/yr)	1140.00	780.00	31.60
	Total Phosphorus (kg/yr)	3.68	3.50	5.00
	Total Nitrogen (kg/yr)	33.20	28.80	13.30
	Gross Pollutants (kg/yr)	329.00	41.00	87.50
2A	Flow (ML/yr)	12.10	12.10	0.00
	Total Suspended Solids (kg/yr)	1400.00	525.00	62.40
	Total Phosphorus (kg/yr)	3.38	2.44	27.60
	Total Nitrogen (kg/yr)	25.70	20.90	18.70
	Gross Pollutants (kg/yr)	252.00	10.30	95.90
2B	Flow (ML/yr)	10.00	10.00	0.00
	Total Suspended Solids (kg/yr)	1090.00	382.00	64.80
	Total Phosphorus (kg/yr)	2.71	1.94	28.50
	Total Nitrogen (kg/yr)	21.40	17.40	19.00
	Gross Pollutants (kg/yr)	208.00	6.62	96.80
2C	Flow (ML/yr)	12.90	12.90	0.00
	Total Suspended Solids (kg/yr)	1290.00	486.00	62.40
	Total Phosphorus (kg/yr)	3.33	2.39	28.40
	Total Nitrogen (kg/yr)	27.30	22.20	18.70
	Gross Pollutants (kg/yr)	277.00	11.60	95.80
3A	Flow (ML/yr)	10.40	10.40	0.00
	Total Suspended Solids (kg/yr)	1170.00	438.00	62.50
	Total Phosphorus (kg/yr)	2.88	2.09	27.50
	Total Nitrogen (kg/yr)	22.20	18.10	18.50
	Gross Pollutants (kg/yr)	216.00	9.34	95.70
3B	Flow (ML/yr)	10.20	10.20	0.00
	Total Suspended Solids (kg/yr)	1120.00	388.00	65.40
	Total Phosphorus (kg/yr)	2.79	1.99	28.80
	Total Nitrogen (kg/yr)	21.70	17.60	19.10
	Gross Pollutants (kg/yr)	212.00	6.51	96.90
3C	Flow (ML/yr)	11.00	11.00	0.00
	Total Suspended Solids (kg/yr)	1180.00	437.00	63.00
	Total Phosphorus (kg/yr)	2.93	2.11	28.00
	Total Nitrogen (kg/yr)	23.30	19.00	18.60
	Gross Pollutants (kg/yr)	227.00	9.58	95.80
4A	Flow (ML/yr)	11.60	11.60	0.00
	Total Suspended Solids (kg/yr)	1210.00	667.00	44.70
	Total Phosphorus (kg/yr)	3.09	2.66	13.70
	Total Nitrogen (kg/yr)	26.50	22.30	15.90
	Gross Pollutants (kg/yr)	260.00	22.00	91.50
4B	Flow (ML/yr)	14.50	14.50	0.00
	Total Suspended Solids (kg/yr)	1710.00	835.00	51.20
	Total Phosphorus (kg/yr)	3.84	3.20	16.60
	Total Nitrogen (kg/yr)	28.80	23.90	17.30
	Gross Pollutants (kg/yr)	279.00	14.00	95.00

Hyder Consulting

MUSIC MODELING RESULTS

DOCUMENT No: QL00704

OFFICE: GOLD COAST

PROJECT TITLE: TOWNSVILLE OCEAN TERMINAL

SUBJECT: OPTION B - WITHOUT RAINWATER TANKS

SUMMARY OF TREATMENT TRAIN EFFECTIVENESS AT OUTLETS

SHEET No: 2 of 2

OUTLET	POLLUTANT	SOURCE	RESIDUAL	% REDUCTION
4C	Flow (ML/yr)	20.00	20.00	0.00
	Total Suspended Solids (kg/yr)	6180.00	2740.00	55.60
	Total Phosphorus (kg/yr)	10.10	8.66	13.80
	Total Nitrogen (kg/yr)	40.30	34.50	14.40
	Gross Pollutants (kg/yr)	412.00	39.80	90.30
TA	Flow (ML/yr)	22.80	22.80	0.00
	Total Suspended Solids (kg/yr)	5480.00	4040.00	26.30
	Total Phosphorus (kg/yr)	10.10	9.77	3.30
	Total Nitrogen (kg/yr)	53.30	51.40	3.50
	Gross Pollutants (kg/yr)	500.00	123.00	75.30
TB	Flow (ML/yr)	13.40	13.40	0.00
	Total Suspended Solids (kg/yr)	3410.00	2380.00	30.20
	Total Phosphorus (kg/yr)	5.88	5.66	3.80
	Total Nitrogen (kg/yr)	31.20	30.00	4.10
	Gross Pollutants (kg/yr)	269.00	38.00	85.90

Hyder Consulting

MUSIC MODELING RESULTS

DOCUMENT No: QL00704

OFFICE: GOLD COAST

PROJECT TITLE: TOWNSVILLE OCEAN TERMINAL

SUBJECT

SHEET No: 1 of 2

TABLE G.5 OPTION B - WITH RAINWATER TANKS

SUMMARY OF TREATMENT TRAIN EFFECTIVENESS AT OUTLETS

OUTLET	POLLUTANT	SOURCE	RESIDUAL	% REDUCTION
1A	Flow (ML/yr)	18.10	13.50	25.50
	Total Suspended Solids (kg/yr)	2020.00	870.00	57.00
	Total Phosphorus (kg/yr)	5.01	3.48	30.40
	Total Nitrogen (kg/yr)	41.90	25.90	38.00
	Gross Pollutants (kg/yr)	408.00	22.20	94.60
1B	Flow (ML/yr)	15.00	11.20	25.10
	Total Suspended Solids (kg/yr)	2800.00	930.00	66.70
	Total Phosphorus (kg/yr)	5.81	3.61	38.00
	Total Nitrogen (kg/yr)	34.60	21.70	37.10
	Gross Pollutants (kg/yr)	339.00	14.90	95.60
1C	Flow (ML/yr)	24.60	20.70	15.90
	Total Suspended Solids (kg/yr)	5710.00	2420.00	57.70
	Total Phosphorus (kg/yr)	10.70	8.44	21.20
	Total Nitrogen (kg/yr)	56.90	40.90	28.10
	Gross Pollutants (kg/yr)	583.00	42.00	92.80
1D	Flow (ML/yr)	13.90	10.90	21.50
	Total Suspended Solids (kg/yr)	1160.00	702.00	39.70
	Total Phosphorus (kg/yr)	3.74	3.02	19.30
	Total Nitrogen (kg/yr)	33.40	22.60	32.50
	Gross Pollutants (kg/yr)	329.00	29.70	91.00
2A	Flow (ML/yr)	12.10	10.80	10.70
	Total Suspended Solids (kg/yr)	1360.00	492.00	63.80
	Total Phosphorus (kg/yr)	3.34	2.27	32.00
	Total Nitrogen (kg/yr)	25.80	18.80	27.30
	Gross Pollutants (kg/yr)	252.00	8.45	96.60
2B	Flow (ML/yr)	10.00	8.95	10.90
	Total Suspended Solids (kg/yr)	1120.00	382.00	66.00
	Total Phosphorus (kg/yr)	2.74	1.84	32.90
	Total Nitrogen (kg/yr)	21.20	15.30	27.90
	Gross Pollutants (kg/yr)	208.00	5.49	97.40
2C	Flow (ML/yr)	12.90	11.20	12.80
	Total Suspended Solids (kg/yr)	1290.00	467.00	63.70
	Total Phosphorus (kg/yr)	3.32	2.20	33.80
	Total Nitrogen (kg/yr)	27.30	19.30	29.20
	Gross Pollutants (kg/yr)	277.00	8.40	97.00
3A	Flow (ML/yr)	10.40	9.40	9.80
	Total Suspended Solids (kg/yr)	1180.00	428.00	63.70
	Total Phosphorus (kg/yr)	2.88	1.97	31.50
	Total Nitrogen (kg/yr)	22.20	16.30	26.50
	Gross Pollutants (kg/yr)	216.00	7.62	96.50
3B	Flow (ML/yr)	10.20	9.16	10.60
	Total Suspended Solids (kg/yr)	1140.00	382.00	66.60
	Total Phosphorus (kg/yr)	2.81	1.88	33.10
	Total Nitrogen (kg/yr)	21.70	15.70	27.70
	Gross Pollutants (kg/yr)	212.00	5.47	97.40
3C	Flow (ML/yr)	11.00	9.87	9.90
	Total Suspended Solids (kg/yr)	1220.00	437.00	64.10
	Total Phosphorus (kg/yr)	3.00	2.04	31.90
	Total Nitrogen (kg/yr)	23.20	17.00	26.70
	Gross Pollutants (kg/yr)	227.00	7.73	96.60
4A	Flow (ML/yr)	11.60	9.07	21.70
	Total Suspended Solids (kg/yr)	1230.00	575.00	53.20
	Total Phosphorus (kg/yr)	3.13	2.28	27.10
	Total Nitrogen (kg/yr)	26.60	17.30	35.10
	Gross Pollutants (kg/yr)	260.00	12.50	95.20
4B	Flow (ML/yr)	14.50	12.10	16.20
	Total Suspended Solids (kg/yr)	1720.00	756.00	56.10
	Total Phosphorus (kg/yr)	3.83	2.82	26.30
	Total Nitrogen (kg/yr)	28.90	19.50	32.60
	Gross Pollutants (kg/yr)	279.00	10.70	96.20

Hyder Consulting

MUSIC MODELING RESULTS

DOCUMENT No: QL00704

OFFICE: GOLD COAST

PROJECT TITLE: TOWNSVILLE OCEAN TERMINAL

SUBJECT: OPTION B - WITH RAINWATER TANKS

SUMMARY OF TREATMENT TRAIN EFFECTIVENESS AT OUTLETS

SHEET No: 2 of 2

OUTLET	POLLUTANT	SOURCE	RESIDUAL	% REDUCTION
4C	Flow (ML/yr)	20.00	19.60	2.00
	Total Suspended Solids (kg/yr)	6180.00	2720.00	56.00
	Total Phosphorus (kg/yr)	10.10	8.61	14.40
	Total Nitrogen (kg/yr)	40.80	34.20	16.10
	Gross Pollutants (kg/yr)	412.00	39.40	90.40
TA	Flow (ML/yr)	22.80	22.80	0.00
	Total Suspended Solids (kg/yr)	5480.00	4040.00	26.30
	Total Phosphorus (kg/yr)	10.10	9.77	3.30
	Total Nitrogen (kg/yr)	53.30	51.40	3.50
	Gross Pollutants (kg/yr)	500.00	123.00	75.30
TB	Flow (ML/yr)	13.40	13.40	0.00
	Total Suspended Solids (kg/yr)	3410.00	2380.00	30.20
	Total Phosphorus (kg/yr)	5.88	5.66	3.80
	Total Nitrogen (kg/yr)	31.20	30.00	4.10
	Gross Pollutants (kg/yr)	269.00	38.00	85.90

Hyder Consulting

MUSIC MODELING RESULTS

DOCUMENT No: QL00704

OFFICE: GOLD COAST

PROJECT TITLE: TOWNSVILLE OCEAN TERMINAL

SUBJECT: OUTLET COMPARISON OF TREATMENT TRAIN EFFECTIVENESS FOR OPTIONS A AND B WITHOUT RAINWATER TANKS

SHEET No: 1 of 1

OUTLET	POLLUTANT	SOURCE	OPTION A		OPTION B		OPTION A V's OPTION B
			RESIDUAL	% REDUCTION	RESIDUAL	% REDUCTION	% REDUCTION EFFICIENCY
1A	Flow (ML/yr)	18.10	18.10	0.00	18.10	0.00	0.00
	Total Suspended Solids (kg/yr)	1980.00	1420.00	28.40	957.00	51.90	23.50
	Total Phosphorus (kg/yr)	5.03	4.96	1.50	4.23	15.70	14.20
	Total Nitrogen (kg/yr)	42.30	36.80	13.10	35.10	15.20	2.10
	Gross Pollutants (kg/yr)	408.00	54.00	86.80	41.50	89.80	3.00
1B	Flow (ML/yr)	15.00	15.00	0.00	15.00	0.00	0.00
	Total Suspended Solids (kg/yr)	2680.00	1620.00	39.50	1290.00	53.40	13.90
	Total Phosphorus (kg/yr)	5.59	5.43	2.90	4.86	16.20	13.30
	Total Nitrogen (kg/yr)	34.20	29.70	13.20	28.90	16.50	3.30
	Gross Pollutants (kg/yr)	339.00	44.00	87.00	26.30	92.30	5.30
1C	Flow (ML/yr)	24.60	24.60	0.00	24.60	0.00	0.00
	Total Suspended Solids (kg/yr)	6900.00	3550.00	48.60	2470.00	56.00	7.40
	Total Phosphorus (kg/yr)	12.30	11.30	7.40	8.91	15.50	8.10
	Total Nitrogen (kg/yr)	54.90	47.70	13.10	48.50	15.40	2.30
	Gross Pollutants (kg/yr)	582.00	76.40	86.90	52.10	91.10	4.20
1D	Flow (ML/yr)	13.90	13.90	0.00	13.90	0.00	0.00
	Total Suspended Solids (kg/yr)	1150.00	883.00	23.20	780.00	31.60	8.40
	Total Phosphorus (kg/yr)	3.77	3.68	2.50	3.50	5.00	2.50
	Total Nitrogen (kg/yr)	33.10	28.80	13.10	28.80	13.30	0.20
	Gross Pollutants (kg/yr)	329.00	44.50	86.50	41.00	87.50	1.00
2A	Flow (ML/yr)	12.10	12.10	0.00	12.10	0.00	0.00
	Total Suspended Solids (kg/yr)	1390.00	995.00	28.50	525.00	62.40	33.90
	Total Phosphorus (kg/yr)	3.34	3.31	1.10	2.44	27.60	26.50
	Total Nitrogen (kg/yr)	26.00	22.60	13.10	20.90	18.70	5.60
	Gross Pollutants (kg/yr)	252.00	31.20	87.60	10.30	95.90	8.30
2B	Flow (ML/yr)	10.00	10.00	0.00	10.00	0.00	0.00
	Total Suspended Solids (kg/yr)	1110.00	800.00	27.70	382.00	64.80	37.10
	Total Phosphorus (kg/yr)	2.73	2.70	1.00	1.94	28.50	27.50
	Total Nitrogen (kg/yr)	21.30	18.50	13.20	17.40	19.00	5.80
	Gross Pollutants (kg/yr)	208.00	25.30	87.90	6.62	96.80	8.90
2C	Flow (ML/yr)	12.90	12.90	0.00	12.90	0.00	0.00
	Total Suspended Solids (kg/yr)	1310.00	976.00	25.20	486.00	62.40	37.20
	Total Phosphorus (kg/yr)	3.37	3.34	1.00	2.39	28.40	27.40
	Total Nitrogen (kg/yr)	27.50	23.90	13.10	22.20	18.70	5.60
	Gross Pollutants (kg/yr)	277.00	35.60	87.20	11.60	95.80	8.60
3A	Flow (ML/yr)	10.40	10.40	0.00	10.40	0.00	0.00
	Total Suspended Solids (kg/yr)	1200.00	849.00	29.10	438.00	62.50	33.40
	Total Phosphorus (kg/yr)	2.91	2.87	1.10	2.09	27.50	26.40
	Total Nitrogen (kg/yr)	22.20	19.30	13.10	18.10	18.50	5.40
	Gross Pollutants (kg/yr)	216.00	26.60	87.70	9.34	95.70	8.00
3B	Flow (ML/yr)	10.20	10.20	0.00	10.20	0.00	0.00
	Total Suspended Solids (kg/yr)	1110.00	807.00	27.50	388.00	65.40	37.90
	Total Phosphorus (kg/yr)	2.76	2.73	1.00	1.99	28.80	27.80
	Total Nitrogen (kg/yr)	21.60	18.80	13.20	17.60	19.10	5.90
	Gross Pollutants (kg/yr)	212.00	25.80	87.80	6.51	96.90	9.10
3C	Flow (ML/yr)	11.00	11.00	0.00	11.00	0.00	0.00
	Total Suspended Solids (kg/yr)	1230.00	880.00	28.40	437.00	63.00	34.60
	Total Phosphorus (kg/yr)	2.99	2.96	1.00	2.11	28.00	27.00
	Total Nitrogen (kg/yr)	23.40	20.30	13.10	19.00	18.60	5.50
	Gross Pollutants (kg/yr)	227.00	27.90	87.70	9.58	95.80	8.10
4A	Flow (ML/yr)	11.60	11.60	0.00	11.60	0.00	0.00
	Total Suspended Solids (kg/yr)	1240.00	896.00	27.90	667.00	44.70	16.80
	Total Phosphorus (kg/yr)	3.12	3.08	1.20	2.66	13.70	12.50
	Total Nitrogen (kg/yr)	26.50	23.00	13.20	22.30	15.90	2.70
	Gross Pollutants (kg/yr)	260.00	33.60	87.10	22.00	91.50	4.40
4B	Flow (ML/yr)	14.50	14.50	0.00	14.50	0.00	0.00
	Total Suspended Solids (kg/yr)	1710.00	1180.00	30.80	835.00	51.20	20.40
	Total Phosphorus (kg/yr)	3.78	3.72	1.50	3.20	16.60	15.10
	Total Nitrogen (kg/yr)	28.20	24.50	12.90	23.90	17.30	4.40
	Gross Pollutants (kg/yr)	279.00	35.90	87.10	14.00	95.00	7.90
4C	Flow (ML/yr)	20.00	20.00	0.00	20.00	0.00	0.00
	Total Suspended Solids (kg/yr)	6210.00	2930.00	52.80	2740.00	55.60	2.80
	Total Phosphorus (kg/yr)	10.10	9.00	10.90	8.66	13.80	2.90
	Total Nitrogen (kg/yr)	40.30	35.00	13.10	34.50	14.40	1.30
	Gross Pollutants (kg/yr)	412.00	49.80	87.90	39.80	90.30	2.40
TA	Flow (ML/yr)	22.80	22.80	0.00	*NOT APPLICABLE*		
	Total Suspended Solids (kg/yr)	5480.00	4040.00	26.30			
	Total Phosphorus (kg/yr)	10.10	9.77	3.30			
	Total Nitrogen (kg/yr)	53.30	51.40	3.50			
	Gross Pollutants (kg/yr)	500.00	123.00	75.30			
TB	Flow (ML/yr)	13.40	13.40	0.00	*NOT APPLICABLE*		
	Total Suspended Solids (kg/yr)	3410.00	2380.00	30.20			
	Total Phosphorus (kg/yr)	5.88	5.66	3.80			
	Total Nitrogen (kg/yr)	31.20	30.00	4.10			
	Gross Pollutants (kg/yr)	269.00	38.00	85.90			

Hyder Consulting

MUSIC MODELING RESULTS

DOCUMENT No: QL00704

OFFICE: GOLD COAST

PROJECT TITLE: TOWNSVILLE OCEAN TERMINAL

SUBJECT: OUTLET COMPARISON OF TREATMENT TRAIN EFFECTIVENESS FOR OPTIONS A AND B WITH RAINWATER TANKS

SHEET No: 1 of 1

OUTLET	POLLUTANT	SOURCE	OPTION A		OPTION B		OPTION A V's OPTION B
			RESIDUAL	% REDUCTION	RESIDUAL	% REDUCTION	% REDUCTION EFFICIENCY
1A	Flow (ML/yr)	18.10	13.50	25.50	13.50	25.50	0.00
	Total Suspended Solids (kg/yr)	1980.00	1220.00	40.40	870.00	57.00	16.60
	Total Phosphorus (kg/yr)	5.03	4.19	18.00	3.48	30.40	12.40
	Total Nitrogen (kg/yr)	42.30	26.40	36.20	25.90	38.00	1.80
	Gross Pollutants (kg/yr)	408.00	31.30	92.30	22.20	94.60	2.30
1B	Flow (ML/yr)	15.00	11.20	25.10	11.20	25.10	0.00
	Total Suspended Solids (kg/yr)	2680.00	1320.00	51.10	930.00	66.70	15.60
	Total Phosphorus (kg/yr)	5.59	4.44	20.70	3.61	38.00	17.30
	Total Nitrogen (kg/yr)	34.20	22.00	35.90	21.70	37.10	1.20
	Gross Pollutants (kg/yr)	339.00	25.80	92.40	14.90	95.60	3.20
1C	Flow (ML/yr)	24.60	20.90	14.90	20.70	15.90	1.00
	Total Suspended Solids (kg/yr)	6900.00	3070.00	55.90	2420.00	57.70	1.80
	Total Phosphorus (kg/yr)	12.30	9.84	19.20	8.44	21.20	2.00
	Total Nitrogen (kg/yr)	54.90	40.60	25.60	40.90	28.10	2.50
	Gross Pollutants (kg/yr)	582.00	57.30	90.20	42.00	92.80	2.60
1D	Flow (ML/yr)	13.90	10.90	21.50	10.90	21.50	0.00
	Total Suspended Solids (kg/yr)	1150.00	745.00	34.20	702.00	39.70	5.50
	Total Phosphorus (kg/yr)	3.77	3.06	17.40	3.02	19.30	1.90
	Total Nitrogen (kg/yr)	33.10	22.60	32.50	22.60	32.50	0.00
	Gross Pollutants (kg/yr)	329.00	29.80	91.00	29.70	91.00	0.00
2A	Flow (ML/yr)	12.10	10.80	10.70	10.80	10.70	0.00
	Total Suspended Solids (kg/yr)	1390.00	947.00	33.30	492.00	63.80	30.50
	Total Phosphorus (kg/yr)	3.34	3.08	7.90	2.27	32.00	24.10
	Total Nitrogen (kg/yr)	26.00	20.00	22.40	18.80	27.30	4.90
	Gross Pollutants (kg/yr)	252.00	24.10	90.40	8.45	96.60	6.20
2B	Flow (ML/yr)	10.00	8.95	10.90	8.95	10.90	0.00
	Total Suspended Solids (kg/yr)	1120.00	749.00	33.40	382.00	66.00	32.60
	Total Phosphorus (kg/yr)	2.74	2.52	8.10	1.84	32.90	24.80
	Total Nitrogen (kg/yr)	21.30	16.50	22.70	15.30	27.90	5.20
	Gross Pollutants (kg/yr)	208.00	19.50	90.60	5.49	97.40	6.80
2C	Flow (ML/yr)	12.90	11.20	12.80	11.20	12.80	0.00
	Total Suspended Solids (kg/yr)	1310.00	891.00	31.40	467.00	63.70	32.30
	Total Phosphorus (kg/yr)	3.37	3.01	9.60	2.20	33.80	24.20
	Total Nitrogen (kg/yr)	27.50	20.70	24.40	19.30	29.20	4.80
	Gross Pollutants (kg/yr)	277.00	25.00	91.00	8.40	97.00	6.00
3A	Flow (ML/yr)	10.40	9.40	9.80	9.40	9.80	0.00
	Total Suspended Solids (kg/yr)	1200.00	802.00	33.60	428.00	63.70	30.10
	Total Phosphorus (kg/yr)	2.91	2.68	7.50	1.97	31.50	24.00
	Total Nitrogen (kg/yr)	22.20	17.30	21.80	16.30	26.50	4.70
	Gross Pollutants (kg/yr)	216.00	21.00	90.30	7.62	96.50	6.20
3B	Flow (ML/yr)	10.20	9.16	10.60	9.16	10.60	0.00
	Total Suspended Solids (kg/yr)	1110.00	763.00	32.40	382.00	66.60	34.20
	Total Phosphorus (kg/yr)	2.76	2.55	7.90	1.88	33.10	25.20
	Total Nitrogen (kg/yr)	21.60	16.90	22.40	15.70	27.70	5.30
	Gross Pollutants (kg/yr)	212.00	20.00	90.60	5.47	97.40	6.80
3C	Flow (ML/yr)	11.00	9.87	9.90	9.87	9.90	0.00
	Total Suspended Solids (kg/yr)	1230.00	829.00	32.50	437.00	64.10	31.60
	Total Phosphorus (kg/yr)	2.99	2.77	7.50	2.04	31.90	24.40
	Total Nitrogen (kg/yr)	23.40	18.20	21.80	17.00	26.70	4.90
	Gross Pollutants (kg/yr)	227.00	21.90	90.30	7.73	96.60	6.30
4A	Flow (ML/yr)	11.60	9.07	21.70	9.07	21.70	0.00
	Total Suspended Solids (kg/yr)	1240.00	770.00	37.60	575.00	53.20	15.60
	Total Phosphorus (kg/yr)	3.12	2.64	15.80	2.28	27.10	11.30
	Total Nitrogen (kg/yr)	26.50	17.70	33.00	17.30	35.10	2.10
	Gross Pollutants (kg/yr)	260.00	20.30	92.20	12.50	95.20	3.00
4B	Flow (ML/yr)	14.50	12.10	16.20	12.10	16.20	0.00
	Total Suspended Solids (kg/yr)	1710.00	1050.00	37.60	756.00	56.10	18.50
	Total Phosphorus (kg/yr)	3.78	3.25	12.70	2.82	26.30	13.60
	Total Nitrogen (kg/yr)	28.20	19.90	28.50	19.50	32.60	4.10
	Gross Pollutants (kg/yr)	279.00	23.50	91.60	10.70	96.20	4.60
4C	Flow (ML/yr)	20.00	19.60	2.00	19.60	2.00	0.00
	Total Suspended Solids (kg/yr)	6210.00	2990.00	52.70	2720.00	56.00	3.30
	Total Phosphorus (kg/yr)	10.10	8.95	11.80	8.61	14.40	2.60
	Total Nitrogen (kg/yr)	40.30	34.10	15.10	34.20	16.10	1.00
	Gross Pollutants (kg/yr)	412.00	47.20	88.50	39.40	90.40	1.90
TA	Flow (ML/yr)	22.80	22.80	0.00	*NOT APPLICABLE*		
	Total Suspended Solids (kg/yr)	5480.00	4040.00	26.30			
	Total Phosphorus (kg/yr)	10.10	9.77	3.30			
	Total Nitrogen (kg/yr)	53.30	51.40	3.50			
	Gross Pollutants (kg/yr)	500.00	123.00	75.30			
TB	Flow (ML/yr)	13.40	13.40	0.00	*NOT APPLICABLE*		
	Total Suspended Solids (kg/yr)	3410.00	2380.00	30.20			
	Total Phosphorus (kg/yr)	5.88	5.66	3.80			
	Total Nitrogen (kg/yr)	31.20	30.00	4.10			
	Gross Pollutants (kg/yr)	269.00	38.00	85.90			

Hyder Consulting

MUSIC MODELING RESULTS

DOCUMENT No: QL00704

OFFICE: GOLD COAST

PROJECT TITLE: TOWNSVILLE OCEAN TERMINAL

SUBJECT

TABLE G.7 STAGE COMPARISON OF TREATMENT TRAIN EFFECTIVENESS FOR OPTIONS A AND B WITHOUT RAINWATER TANKS

SHEET No: 1 of 1

STAGE	POLLUTANT	SOURCE	OPTION A		OPTION B		OPTION A V's OPTION B
			RESIDUAL	% REDUCTION	RESIDUAL	% REDUCTION	% REDUCTION EFFICIENCY
STAGE 1	Flow (ML/yr)	71.60	71.60	0.00	71.60	0.00	0.00
	Total Suspended Solids (kg/yr)	11500.00	7470.00	41.20	5500.00	52.20	11.00
	Total Phosphorus (kg/yr)	25.00	25.40	4.60	21.50	14.10	9.50
	Total Nitrogen (kg/yr)	167.00	143.00	13.10	141.00	15.20	2.10
	Gross Pollutants (kg/yr)	1660.00	219.00	86.80	161.00	90.30	3.50
STAGE 2	Flow (ML/yr)	35.00	35.00	0.00	35.00	0.00	0.00
	Total Suspended Solids (kg/yr)	3780.00	2770.00	27.40	1390.00	63.10	35.70
	Total Phosphorus (kg/yr)	9.42	9.36	1.00	6.77	28.10	27.10
	Total Nitrogen (kg/yr)	74.40	64.80	13.10	60.50	18.80	5.70
	Gross Pollutants (kg/yr)	737.00	92.00	87.50	28.60	96.10	8.60
STAGE 3	Flow (ML/yr)	31.60	31.60	0.00	31.60	0.00	0.00
	Total Suspended Solids (kg/yr)	3470.00	2530.00	28.40	1260.00	63.60	35.20
	Total Phosphorus (kg/yr)	8.60	8.56	1.00	6.18	28.10	27.10
	Total Nitrogen (kg/yr)	67.30	58.30	13.20	54.70	18.70	5.50
	Gross Pollutants (kg/yr)	656.00	80.30	87.80	25.40	96.10	8.30
STAGE 4	Flow (ML/yr)	46.00	46.00	0.00	46.00	0.00	0.00
	Total Suspended Solids (kg/yr)	9100.00	5010.00	45.30	4250.00	53.40	8.10
	Total Phosphorus (kg/yr)	17.00	15.80	7.10	14.50	14.40	7.30
	Total Nitrogen (kg/yr)	95.70	82.50	13.10	80.70	15.70	2.60
	Gross Pollutants (kg/yr)	950.00	119.00	87.40	75.80	92.00	4.60
TOT	Flow (ML/yr)	36.20	36.20	0.00	*NOT APPLICABLE*		
	Total Suspended Solids (kg/yr)	8890.00	6420.00	27.80			
	Total Phosphorus (kg/yr)	16.00	15.40	3.50			
	Total Nitrogen (kg/yr)	84.50	81.40	3.70			
	Gross Pollutants (kg/yr)	770.00	161.00	79.00			

Hyder Consulting

MUSIC MODELING RESULTS

DOCUMENT No: QL00704

OFFICE: GOLD COAST

PROJECT TITLE: TOWNSVILLE OCEAN TERMINAL

SUBJECT

TABLE G.8 STAGE COMPARISON OF TREATMENT TRAIN EFFECTIVENESS FOR OPTIONS A AND B WITH RAINWATER TANKS

SHEET No: 1 of 1

STAGE	POLLUTANT	SOURCE	OPTION A		OPTION B		OPTION A V's OPTION B
			RESIDUAL	% REDUCTION	RESIDUAL	% REDUCTION	% REDUCTION EFFICIENCY
STAGE 1	Flow (ML/yr)	71.60	56.50	21.00	56.30	21.30	0.30
	Total Suspended Solids (kg/yr)	11500.00	6350.00	50.50	4820.00	58.00	7.50
	Total Phosphorus (kg/yr)	25.00	21.50	19.00	18.30	26.60	7.60
	Total Nitrogen (kg/yr)	167.00	112.00	31.80	111.00	33.40	1.60
	Gross Pollutants (kg/yr)	1660.00	144.00	91.30	109.00	93.40	2.10
STAGE 2	Flow (ML/yr)	35.00	31.00	11.50	31.00	11.50	0.00
	Total Suspended Solids (kg/yr)	3780.00	2590.00	32.60	1340.00	64.50	31.90
	Total Phosphorus (kg/yr)	9.41	8.63	8.50	6.32	32.90	24.40
	Total Nitrogen (kg/yr)	74.20	57.00	23.30	53.40	28.10	4.80
	Gross Pollutants (kg/yr)	737.00	68.60	90.70	22.30	97.00	6.30
STAGE 3	Flow (ML/yr)	31.60	28.40	10.10	28.40	10.10	0.00
	Total Suspended Solids (kg/yr)	3540.00	2390.00	32.80	1250.00	64.80	32.00
	Total Phosphorus (kg/yr)	8.69	8.00	7.60	5.90	32.20	24.60
	Total Nitrogen (kg/yr)	67.10	52.40	22.00	49.00	27.00	5.00
	Gross Pollutants (kg/yr)	656.00	63.00	90.40	20.80	96.80	6.40
STAGE 4	Flow (ML/yr)	46.00	40.80	11.40	40.80	11.40	0.00
	Total Suspended Solids (kg/yr)	9130.00	4810.00	47.90	4050.00	55.60	7.70
	Total Phosphorus (kg/yr)	17.00	14.80	12.70	13.70	19.40	6.70
	Total Nitrogen (kg/yr)	96.30	71.80	24.10	71.00	26.30	2.20
	Gross Pollutants (kg/yr)	950.00	91.00	90.40	62.60	93.40	3.00
TOT	Flow (ML/yr)	36.20	36.20	0.00	*NOT APPLICABLE*		
	Total Suspended Solids (kg/yr)	8890.00	6420.00	27.80			
	Total Phosphorus (kg/yr)	16.00	15.40	3.50			
	Total Nitrogen (kg/yr)	84.50	81.40	3.70			
	Gross Pollutants (kg/yr)	770.00	161.00	79.00			

Hyder Consulting

MUSIC MODELING RESULTS

DOCUMENT No: QL00704

OFFICE: GOLD COAST

PROJECT TITLE: TOWNSVILLE OCEAN TERMINAL

SUBJECT

TABLE G.3 STAGE COMPARISON OF TREATMENT TRAIN EFFECTIVENESS FOR OPTION A WITHOUT RAINWATER TANKS V's WITH RAINWATER TANKS

SHEET No: 1 of 1

STAGE	POLLUTANT	SOURCE	WITHOUT RAINWATER TANKS		WITH RAINWATER TANKS		OPTION A V's OPTION B
			RESIDUAL	% REDUCTION	RESIDUAL	% REDUCTION	% REDUCTION EFFICIENCY
STAGE 1	Flow (ML/yr)	71.6	71.6	0.0	56.5	21.0	21.0
	Total Suspended Solids (kg/yr)	12700.0	7470.0	41.2	6350.0	50.5	9.3
	Total Phosphorus (kg/yr)	26.6	25.4	4.6	21.5	19.0	14.4
	Total Nitrogen (kg/yr)	165.0	143.0	13.1	112.0	31.8	18.7
	Gross Pollutants (kg/yr)	1660.0	219.0	86.8	144.0	91.3	4.5
STAGE 2	Flow (ML/yr)	35.0	35.0	0.0	31.0	11.5	11.5
	Total Suspended Solids (kg/yr)	3820.0	2770.0	27.4	2590.0	32.6	5.2
	Total Phosphorus (kg/yr)	9.5	9.4	1.0	8.6	8.5	7.5
	Total Nitrogen (kg/yr)	74.6	64.8	13.1	57.0	23.3	10.2
	Gross Pollutants (kg/yr)	737.0	92.0	87.5	68.6	90.7	3.2
STAGE 3	Flow (ML/yr)	31.6	31.6	0.0	28.4	10.1	10.1
	Total Suspended Solids (kg/yr)	3540.0	2530.0	28.4	2390.0	32.8	4.4
	Total Phosphorus (kg/yr)	8.7	8.6	1.0	8.0	7.6	6.6
	Total Nitrogen (kg/yr)	67.1	58.3	13.2	52.4	22.0	8.8
	Gross Pollutants (kg/yr)	656.0	80.3	87.8	63.0	90.4	2.6
STAGE 4	Flow (ML/yr)	46.0	46.0	0.0	40.8	11.4	11.4
	Total Suspended Solids (kg/yr)	9160.0	5010.0	45.3	4810.0	47.9	2.6
	Total Phosphorus (kg/yr)	17.0	15.8	7.1	14.8	12.7	5.6
	Total Nitrogen (kg/yr)	95.0	82.5	13.1	71.8	24.1	11.0
	Gross Pollutants (kg/yr)	950.0	119.0	87.4	91.0	90.4	3.0
TOT	Flow (ML/yr)	36.2	36.2	0.0			
	Total Suspended Solids (kg/yr)	8890.0	6420.0	27.8			
	Total Phosphorus (kg/yr)	16.0	15.4	3.5	*NOT APPLICABLE*		
	Total Nitrogen (kg/yr)	84.5	81.4	3.7			
	Gross Pollutants (kg/yr)	770.0	161.0	79.0			