Cardno LawsonTreloar

Shaping the Future

SHUTE HARBOUR MARINA PROJECT

Stormwater Management Strategy to Support EIS

January 2008
Job No. LJ8779/R2

Prepared for Shute Harbour Marina

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Document Control

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LJ8779/D2	20/11/07	L. Allan		D. Niven		N. Collins	
LJ8779/R2	09/01/08	L. Allan		D. Niven		C. Catalano	
LJ8779/R2	11/01/08	L. Allan		D. Niven		C. Catalano	

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EXECUTIVE SUMMARY

This Stormwater Management Strategy (SWMS) has been prepared by Cardno Lawson Treloar Pty Ltd (CLT), specialist hydrologic, hydraulic and water quality consultants, for Shute Harbour Marina Development Pty Ltd. This report has been completed to support the Environmental Impact Study (EIS) and provides details for the stormwater quality and quantity management of the proposed Shute Harbour Marina prior to discharge entering Shute Bay.

The Proposed Shute Harbour Marina development is located on Lot 2 on SP117389 within the Whitsunday Shire Council (WSC). The site is located to the South of Mt Rooper and Conway National Park with access obtained from Proserpine Shute Harbour Road as shown of Figure 1 and the proposed layout is shown on Cardno (QLD) Drawing Number 7900/48/01-001 Rev. I included in the reference drawings.

This report specifies the recommended Environmental Values (EVs) and Water Quality Objectives (WQOs) for the site and details conceptual stormwater quality treatment measures to ensure appropriate pollutant levels are achieved from the site runoff. Details of the maintenance and monitoring requirements are also included

A Stormwater Management Plan (SWMP) for the background, construction, establishment and operational phases is included in Appendix A. These plans detail the water quality management requirements for the SWMS and sets out a checklist to achieve the stated WQOs.

Detailed pollutant export analysis was carried out using eWater's water quality predictive tool MUSIC. The pollutant export analysis demonstrated that the proposed development has achieved the industry standard load reductions of 80% total suspended solids, 60% total phosphorus, 45% total nitrogen. The pollutant export modelling has also demonstrated that the proposed development achieves the WQOs prior to discharge into Shute Bay and ultimately the Coral Sea.

Detailed hydrologic modelling was undertaken using the Watershed Bounded Network Model. Detailed hydraulic modelling was carried out using SOBEK, a hydrodynamic software package developed by Delft Hydraulics in the Netherlands. This analysis of the local flood management ensures that the proposed Marina and associated tourist and residential allotments are not adversely impacted by flood waters.

The proposed development has demonstrated the improvement of Proserpine Shute Harbour Road to 100 year ARI local flood immunity. The diversion culverts and channel will provide local flood free allotments.

1. INTRODUCTION

This Stormwater Management Strategy (SWMS) has been prepared by Cardno Lawson Treloar Pty Ltd (CLT), specialist hydrologic, hydraulic and water quality consultants, for Shute Harbour Marina Development Pty Ltd. This report has been completed to support the Environmental Impact Study (EIS) and provides details for the stormwater quality and quantity management of the proposed Shute Harbour Marina prior to discharge entering Shute Bay.

This report specifies the recommended Environmental Values (EVs) and Water Quality Objectives (WQOs) for the site and details conceptual stormwater quality treatment measures to ensure appropriate pollutant levels are achieved from the site runoff.

A Stormwater Management Plan (SWMP) for the background, construction, establishment and operational phases is included in Appendix A. These plans detail the water quality management requirements for the SWMS and sets out a checklist to achieve the stated WQOs.

The SWMS presents the details of the local flood management to ensure that the proposed Marina and associated tourist and residential allotments are not adversely impacted by flood waters.

The proposed Shute Harbour Marina layout is shown on Cardno (QLD) Drawing Number 7900/48/01-001 Rev. I included in the reference drawings.

2. SITE CHARACTERISTICS & PROPOSED DEVELOPMENT

The Proposed Shute Harbour Marina development is located on Lot 2 on SP117389 within the Whitsunday Shire Council (WSC). The site is located to the South of Mt Rooper and Conway National Park with access obtained from Proserpine Shute Harbour Road as shown of Figure 1.

The site covers an area of approximately 42ha and is bounded to the north by Proserpine Shute Harbour Road and Shute Bay to the South, East and West. Approximately 13ha of the total site is to be residential development while the remainder of the site is to be used as a Marina including associated infrastructure.

With the exception of a small parcel of land south of Proserpine Shute Harbour Road the site is currently tidal water and flats within Shute Bay.

The proposed Shute Harbour Marina development will reclaim land within the site bounds to create 117 residential lots, and a marina development consisting of 733 berths. As part of the development it is proposed to dredge the marina area within the Shute Bay. The residential allotments and parklands are proposed to surround the marina area to the north and west with fill levels above appropriate storm surge levels. Details of the proposed layout are shown on Cardno (QLD) Drawing Number 7900/48/01-001 Rev. I included in the reference drawings.

The proposed Shute Harbour development will use a number of Water Sensitive Urban Design (WSUD) techniques to ensure that the development does not adversely impact on the quality of the adjacent Shute Bay and ultimately the Coral Sea. The proposed stormwater treatment train has been designed to fully treat the stormwater prior to discharging from the site. The marina will not form part of the stormwater treatment train.

3. DATA

The SWMS assessments have been based on:

- Recent aerial photos provided by Cardno (Qld);
- 1 metre contours supplied by Cardno (Qld);
- Detailed ground survey provided by Kevin Holt Consulting;
- Proposed layout supplied by Cardno (Qld);
- Developed Design TIN supplied by Cardno (Qld);
- Water quality samples collected by Cardno Ullman and Nolan (Mackay); and
- Rainfall data for the Hamilton Island Airport was sourced from the Bureau of Meteorology and evapo-transpiration data was taken from the Climatic Atlas of Australia.

4. OPPORTUNITIES AND CONSTRAINTS

The stormwater quality management of the proposed Shute Harbour development is constrained by the following:

- The requirement for stormwater discharge from the site to be at an acceptable discharge standard, in terms of quality (i.e. pollutants are to be contained and/or controlled on-site);
- All reasonable and practicable measures must be taken to minimise or prevent environmental harm;
- EPA's requirements for water quality control relevant to the site are detailed in the EPP for Water;
- Management of flood waters to ensure appropriate flood immunity.
- The proximity of the site to the marine vegetation.

Based on these constraints the opportunity of the proposed Shute Harbour development SWMS is to provide a design, management and ongoing maintenance set of guidelines for the project, which will ensure:

- Appropriate standards are maintained on stormwater discharging from the site, particularly in regard to quality and quantity;
- Effective and economical drainage of the site, to appropriate government and client standards.

This plan is intended to provide:

- The project designers with water quality guidelines which are to be incorporated in the final design;
- Assessment agencies with a clear and concise report which defines the plan for stormwater quality water management for the project, including guidelines for stormwater quality management operations and maintenance.
- Assessment agencies with a clear and concise report which defines the flood management for the project.

5. ENVIRONMENTAL VALUES & WATER QUALITY OBJECTIVES

The Shute Harbour Marina drains to Shute Bay and ultimately to the Coral Sea (refer to Figure 1). From a review of all available literature specific Environmental Values (EVs) have not been formally established for the site's receiving waters. Following a review of the EVs for similar water bodies the following EVs are proposed for the site's receiving waters and are presented below in Table 5.1.

Table 5.1 Environmental Values and Goals

Environmental Value	Rating	Description
Aquatic Ecosystems	High	The intrinsic value of aquatic ecosystems – for example, plants, animals and their ecological interactions.
Wildlife Habitat	High	Riparian wildlife and their habitat, food and drinking water – for example, key species such as turtles, platypus, seagrass and dugongs.
Human Consumers of Aquatic Foods	High	Health of humans consuming aquatic foods (such as fish, crustaceans and shellfish, other than oysters) from natural waterways.
Primary Recreation	High	Health of humans during recreation which involves direct contact and a high probability of water being swallowed – for example, swimming, surfing, windsurfing, diving and water-skiing.
Secondary Recreation	High	Health of humans during recreation which involves indirect contact and a low probability of water being swallowed – for example, wading, boating, rowing and fishing.
Visual Recreation	High	Amenity of waterways for recreation which does not involve any contact with water – for example, walking and picnicking adjacent to a waterway.
Cultural Heritage	High	Indigenous and non-indigenous cultural heritage – for example: • Custodial, spiritual, cultural and traditional heritage, hunting, gathering and ritual responsibilities; • Symbols, landmarks and icons (such as waterways, turtles and frogs); and • Lifestyles (such as agriculture and fishing).
Aquaculture	High	Health of aquaculture species and humans consuming aquatic foods (such as fish, molluscs and crustaceans) from commercial ventures.
Oystering	High	Health of humans consuming oysters from natural waterways and commercial ventures.
Seagrass	High	Maintenance and rehabilitation of seagrass habitat.

With these objectives in mind, long term WQOs for the proposed Shute Harbour Marina development were derived from *'Australian and New Zealand Guidelines for Fresh and Marine Water Quality'* (ANZECC, 2000) and *'Queensland Water Quality Guidelines'* (QWQG, 2006), as shown below in Table 5.2.

Table 5.2 Long-Term Median Water Quality Objectives

Water Quality Parameter	Water Quality Objective
pH	8.0 to 8.4
Dissolved Oxygen	90-100%
Turbidity	< 6 NTU
Total Phosphorus	< 0.02 mg/L
Total Nitrogen	< 0.2 mg/L
Suspended Solids	< 15 mg/L
Chlorophyll 'a'	< 0.002 mg/L
Ammonia	< 0.008 mg/L
Oxidised Nitrogen	< 0.003 mg/L
Reactive Phosphorus	< 0.006 mg/L
Diuron	< 0.001 mg/L
Secchi Disk Depth	> 1.5 m
Faecal Coliforms	< 150 orgs/100mL for Primary Contact
Total Aluminium	< 0.2 mg/L
Total Iron	< 0.02mg/L
Total Organic Carbon	-*
Dissolved Organic Carbon	-*
Dissolved Inorganic Nitrogen	-*
Dissolved Aluminium	-*
Dissolved Iron	-*

*To be specified following background water quality monitoring.

Following a detailed background water quality monitoring program these WQOs may be further refined based on site specific conditions.

During the short construction period a set of water quality objectives has been nominated to be immediately achievable for the release criteria to ensure the environmental values are maintained.

Table 5.3 Construction Phase – Water Quality Objectives

Water Quality Parameter	Water Quality Indicator
pH	8.0 to 8.4
Suspended Solids	<50 mg/L
Turbidity	• < 10% increase from background levels; and • During dredging no visible plume beyond 20 metres from the lease extents
Litter/gross pollutants	No anthropogenic (man-made) material greater than 50mm in any dimension

6. EXISTING WATER QUALITY DATA

Preliminary background water quality monitoring has been carried out by Cardno Ullman & Nolan Geotechnic (CU&NG) as part of the preparation of the SWMS.

Water quality data has been collected by CU&NG in various locations around the Shute Harbour development site. Surface water quality monitoring locations are detailed in Figure 4.

Prior to the completion of this report two water quality monitoring campaigns have been completed. The first was completed on the 8 June 2007 and the second on the 5 September 2007. Monitoring was undertaken at several salt water locations within the Coral Sea (SW1, SW2, SW3, SW4, SW5, SW6, SW7 and SW8) and at one fresh water location (FW3).

The collected water quality data is included in Appendix E. Table 6.1 below presents the median water quality levels for the data collected, for the water quality parameters dissolved oxygen as a percent of saturation, pH, turbidity, total nitrogen, total phosphorous and suspended solids.

Table 6.1 Median Water Quality Levels (Based on Two Monitoring Campaigns)

Site ID	Dissolved Oxygen (%)	pH	Turbidity (NTU)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Suspended Solids (mg/L)
SW1	100.3	8.04	4.49	0.1	*0.04**	*37**
SW2	97.9	8.10	4.09	0.1	*0.03**	*26**
SW3	93.7	8.12	4.02	0.1	0.02	*70**
SW4	95.7	8.08	3.74	0.1	0.02	*27**
SW5	94.9	8.08	4.11	0.1	0.02	*30**
SW6	95.8	8.10	2.29	0.1	0.02	*28**
SW7	99.5	8.07	5.83	0.1	0.02	*64**
SW8	94.8	8.12	3.02	0.1	0.02	*34**
FW3	*130.1**	-	*41.7**	*1.1**	*0.09**	*78**
Median	95.8	8.09	4.09	0.1	0.02	*34**
WQO	**90-110**	**8.0-8.4**	**<6**	**<0.2**	**<0.02**	**<15**

* Exceeds the WQO.

Table 6.1 above indicates that prior to the development of the Shute Harbour Marina site; Dissolved oxygen as a percent of saturation, pH, turbidity, total nitrogen and total phosphorus generally meet the proposed WQO for all saltwater monitoring locations. Total suspended solids do not meet the WQO at the saltwater locations. The single freshwater sample currently indicates levels above the proposed WQO.

Based on the above results it appears as though the WQOs will be required to be revised. This revision will be undertaken following sufficient sampling to determine the background water quality conditions.

Heavy metals, oil and grease and total petroleum hydrocarbons were analysed in the same monitoring periods with results presented in Appendices E1 and E2. Metals were generally recorded at low levels with oils below the detectable limit in most samples, with the exception at monitoring locations SW8 in the September monitoring period where oil and grease levels were recorded at 20mg/L. This result is probably due to increased number of boat users in the September school holidays.

7. STORMWATER MANAGEMENT OPTIONS

The construction of the Shute Harbour Marina development will be undertaken over a number of weeks in accordance with the following table.

Table 7.1 Construction Timing

Week	Construction Works
1 - 8	Preliminary site works including clearing and disposal of mangroves
9 - 41	Construction of sheet pile revetment walls around the edge of the marina basin
16 - 41	Construction of breakwater
42 – 43	Enclosure of marina basin prior to dredging (temporary sheet piling and silt curtains)
44 - 90	Dredging of marina basin and treatment and placement as fill behind revetment walls.
91 - 108	Construction of final earthworks, road works and services
	Completion of civil works to reclamation areas 1 and 2
91 -	Fit out of marina

There a 2 different zones within the site that will require different management techniques. These are:

- Construction Zone 1: This zone includes the dredging of the marina area, reclaiming the land that the urban development will be situated on and the construction of the marina berths and pontoons.

- Construction Zone 2: This zone includes the construction of the urban development on the reclaimed land.

7.1 Construction Zone 1 Management

Construction Zone 1 includes the dredging of the marina area, reclaiming the land that the urban development will be situated on and the construction of the marina berths and pontoons.

The construction of the proposed Shute Harbour development is expected to include significant movement of earth during the construction phase. The management of stormwater during this process is critical to ensure no detrimental effects to the water quality of the adjacent environment.

Plate 7.1.1 – Floating Silt Curtain

The proposed Construction Phase 1 management will be based on preventing the dispersal of sediment and contamination of water outside the construction site. This will be achieved by implementing floating silt curtains, earth bunds and sheet pile walls.

Floating Silt Curtains – Generally consist of:

- UV Resistant PVC Coated Floatation devices;
- Geotextile fabric screens with double sewn seams; and
- Chain ballast and connectors to temporarily anchor the silt curtain to the bed surface during construction.

Floating Silt curtains will improve the water quality by:

- Confining sediment;
- Prevent the dispersal and contamination of water outside the curtain; and
- During this phase following the construction of the marina wall, the future marina will act as a sediment detention basin.

Earth Bunds – will improve the water quality by:

- Confining sediment;
- Prevent the dispersal and contamination of water outside the bund; and
- During this phase following the construction of the marina wall, the future marina will act as a sediment detention basin.

Plate 7.1.2 – Earth Bund Wall

Sheet Pile Walls – will improve water quality by:

- Confining sediment;
- Prevent the dispersal and contamination of water outside the wall; and
- During this phase following the construction of the marina wall, the future marina will act as a sediment detention basin.

Plate 7.1.3 – Sheet Pile Wall

7.2 Construction Zone 2 Management

Construction zone 2 includes the construction of the urban development on the reclaimed land.

The proposed Construction Phase 2 management of the stormwater will be based on containment diversion and retention and treatment of runoff from disturbed surfaces.

- Sediment fences surrounding stripped earth and stockpiles of soil and debris.
- Construction of perimeter bunding at the toe and/or top of the earthworks batters.
- Catch drains, including check dams, through the site to catch and direct site runoff.
- Temporary bunding and sediment basins.

Plate 7.2.1 – Typical Sediment Fences

Plate 7.2.2 – Typical Catch Drains

Plate 7.2.3 – Typical Sediment Basin

All catch drains and sediment basins will be constructed above the groundwater table and avoid acid sulfate soils.

It will be the responsibility of the contractor to prepare an approved Erosion and Sediment control plan to Council specifications prior to any construction activity taking place.

7.3 Operational Phase Management

7.3.1 Proposed Treatment Trains

The stormwater runoff will be treated on site through a treatment train approach prior to discharging to the marina and ultimately the Coral Sea. The conceptual details are presented on Figure 3. Treatment trains details are as follows:

- The stormwater runoff from the urban residential lots will pass through grassed swales with underlying bio-retention systems. Runoff will then flow through bio-retention basins before flowing offsite.
- All runoff from roofs will pass through rainwater tanks and into grassed swales with underlying bio-retention systems before passing through one of several bio-retention basins.

- Runoff from the car parking facility will be directed through an oil and grease separator and into a bio-retention swale and into one of several bio-retention basins.

- Road runoff will be directed through one of several bio-retention basins.

7.3.2 Treatment Train Devices

As detailed above WSUD is proposed to ensure that the pollutant concentrations comply with current industry standards. The following describes each of the treatment train devices in more detail, discussing what the systems are and how the device treats stormwater.

Flush Kerbs – Are proposed at opportunistic locations, particularly along the western stretch of road that traverses the parkland area. This will reduce any hydrologic and water quality impacts of the roadways/paths by:

- Encouraging water to infiltrate/soak into adjacent soil layers;

- Slowing flows from the site by encouraging them to pass through vegetated areas; and

- Removing much of the dissolved/particulate pollutant load from the roadways by passing it through the grassed/vegetated areas.

Plate 7.3.1 – Typical Flush Kerb

Oil / Grease Separator – All stormwater collected in the stormwater pipes from the car parking facility of the development will be directed through an oil and grease separator. The oil and grease separator will:

- Trap trash and litter; and

- Remove oils and greases.

Rainwater Tanks – On-site water re-use on residential buildings. Water re-use would take the form of a number of tanks, to collect roof runoff. The storage capacity of each tank will be used to supply water to the house/building for re-use purposes. The quality of water in the rainwater tanks will be suitable for all non-potable (or non-drinking) purposes. As such, the water will be used for some or all of the following:

- Toilet water supply flushing;

- Landscape irrigation; and

Plate 7.3.2 – Rainwater Tank

- Lawn watering.

In order to supply pressure for these uses, water could be pumped to a suitable 'header' tank in the ceiling of each separate building. In the event of the rainwater tank level falling below a critical level (say 5% of capacity), automatic top-up by town water will occur.

Extended Detention and Bio-Retention Basin – This basin will generally be dry and only fill during rainfall events. This will improve water quality by slowing velocities and allowing sedimentation and adsorption of soluble nutrients.

Underlying the basin will be a bio-retention system. This will allow the stormwater to pass through a sand/gravel filter and a bio-film medium. This should improve the water quality by removing:

- Suspended solids;
- Nutrients; and
- Metals.

Plate 7.3.3 – Extended Detention and Bio-Retention Basin

Vegetated Swales with underlying bio-retention system – The swales, which comprise broad, shallow, grassed and vegetated channels are effective in:

- reducing flow volumes (by infiltration);
- slowing flow rates (due to the retarding effect of vegetation on flows); and
- improving water quality (by filtering and settling particulate pollutants and trapping dissolved pollutants).

Plate 7.3.4 - Vegetated Swale with underlying Bio-Retention System

Underlying the swale will be a bio-retention system. This will allow the stormwater to pass through a sand/gravel filter and a bio-film medium. This should improve the water quality by removing:

- suspended solids;
- nutrients; and
- metals.

Rock Protection – Rock protection will be provided at all locations where stormwater is discharged from the site in order to prevent erosion.

Plate 7.3.5 – Rock Outlet Protection

On-Site Landscaping Practices – The site will be landscaped and re-vegetated using species and techniques that do not require excessive fertilisation and watering. This will significantly reduce the potential for the export of nutrients from the site. The herbicides and pesticides will be limited on site to limit risk of excess nutrients in the runoff.

8. POLLUTANT EXPORT MODELLING

8.1 Approach

CLT has carried out detailed pollutant export analysis using the eWater's, water quality predictive tool, MUSIC Version 3.1 to assess the possible pollutant loads and concentrations discharged from the site. MUSIC, as with all modelling packages, has degrees of uncertainty and error. The algorithms are based on the latest and most up to date scientific research undertaken both in Australia and worldwide.

The pollutant generation engine adopts a stochastic approach in generating the pollutant levels which best reflects the behaviour of the research data. This will also generally provide a range of answers that will reduce the influence of the uncertainty and error in the model. The stormwater quality management methods are based on the current best-practise approaches and do not consider methods that have been previously demonstrated to not meet removal efficiencies.

It is recognised that Whitsunday Shire Council have not completed a set of guidelines for the use of MUSIC, whereas some of the South East Queensland (SEQ) Council's have published MUSIC guidelines. In the absence of local guidelines SEQ parameters have been adopted. Overall the pollutant assessment was carried out in accordance with:

- Gold Coast City Council, 2006, '*MUSIC Modelling Guidelines*'
- Brisbane City Council, 2000, '*Subdivision and Development Guidelines*'
- Brisbane City Council, 2003, '*Guidelines for Pollutant Export Modelling in Brisbane*', Version 7; and
- Brisbane City Council (BCC), 1999, '*Design Guidelines for Stormwater Quality Improvement Devices*'.
- CRC for Catchment Hydrology, 2005, '*Model for Urban Stormwater Improvement Conceptualisation Version 3.01 User Manual*'; and
- Healthy Waterways, 2006, '*Water Sensitive Urban Design Technical Design Guidelines for South East Queensland*.'

To assist Council in their assessment of the proposed residential development, all assumptions and modelling techniques are clearly stated.

CLT has considered the following modelled catchment conditions:

- **Post-Development Case –** Post-development catchment conditions without treatment; and
- **Mitigated Case –** Post-development catchment conditions with treatment.

Table 8.1 below indicates the catchment areas and land uses the post-development and mitigated catchment conditions, as shown on Figure 2.

Table 8.1 Post-Development and Mitigated Catchment Areas and Land Uses

Catchment Label	Land Use		Sub- Area (ha)	Total Catchment Area (ha)
	Actual	Modeled		
C1	Urban Res	Urban Res	1.078	3.095
	Roads	Urban Roads	0.265	
	Park	Rural Res	1.752	
C2	Urban Res	Urban Res	1.490	2.813
	Roads	Urban Roads	0.309	
	Park	Rural Res	0.427	
	Open Space	Urban Ground	0.587	
C3	Urban	Urban	1.800	3.204
	Roads	Urban	0.373	
	Open Space	Urban Ground	1.031	
C4	Urban	Urban	0.416	2.160
	Roads	Urban Roads	0.318	
	Carpark	Urban Roads	0.406	
	Urban High Density	Commercial	0.198	
	Open Space	Urban Ground	0.822	
C5	Roads	Urban Roads	0.113	0.933
	Urban High Density	Commercial	0.219	
	Ground	Urban Ground	0.601	
C6	Urban	Urban	1.080	1.080
			Total (ha)	13.285

Rainfall data was obtained from the Bureau of Meteorology from two rainfall stations at the Hamilton Island Airport. Data from June 1996 to March 2002 was obtained from Hamilton Island Airport (Station Number 33255) and March 2002 to June 2006 from Hamilton Island Airport (Station Number 33106).

The MUSIC Modelling assumed the following:

- A 6 minute time step was adopted to ensure accurate assessment of the proposed treatment devices.
- The pollutant generation parameters are adopted from Gold Coast City Council's (GCCC's) 'MUSIC Modelling Guidelines' (2006), with a break down into macro scale parameters.
- No flow routing was assumed, which provides a conservative estimate of treatment device efficiency.

- Total Impervious Area (TIA) was converted to Effective Impervious Area (EIA) by calibrating the post development model to the expected Annual Volumetric Runoff Coefficients (AVRC) based on GCCC (2006) recommendations for different land uses. Table 8.2 below details the expected AVRC for the Shute Harbour Marina Development.

Table 8.2 Expected AVRC

Land Use	AVRC	Area (ha)	AVRC x Area	Expected AVRC
Urban Residential	0.39	2.365	0.92	$\frac{\Sigma \text{ (ARVC x Area)}}{\text{Total Area}}$
Urban Roof	0.39	3.548	1.38	
Urban Ground	0.39	3.252	1.27	
High Density Urban	0.57	0.416	0.24	
Roads & Car Park	0.57	1.720	0.98	
Total		11.301	4.79	0.424

- GCCC MUSIC Modelling Guidelines were used for the removal rates and parameters of all treatment devices as this document defines the latest published information on the performance of the devices.

- Rainwater tanks were modelled on each urban lot with a capacity of 5000L. A daily usage of 0.326 kL/day was adopted for each lot, as specified in the GCCC MUSIC Modelling Guidelines, 2006.

- The surface area of the bio-retention basins was assumed to be 2% of the total area draining to each basin and to have an extended detention depth of 0.3m. The bio-retention filter media depth was assumed to be 1.0m and to have a hydraulic conductivity of 180mm/hr.

- To remove the bias in the median values resulting from zero flows, flow based sub samples of 0.1L/s were used for reporting all pollutant concentrations.

8.2 Results

A comparison of the flow from the post development case to the expected Annual Volumetric Runoff Coefficient (AVRC) for the site is provided in Table 8.3. This demonstrates the adopted rainfall runoff parameters for each land use is appropriate and provides a good calibration to the AVRCs.

Table 8.3 Runoff and AVRC Calibration

AVRC	Post Development
MUSIC Annual Flow (ML/year)	47.40
Modelled Area (ha)	11.30
Average Rainfall (mm/year)	1040
AVRC	**0.403**
Expected AVRC	**0.424**

The annual average pollutant loads discharged from the Shute Harbour Marina Development are shown in Table 8.4 for the post-development and mitigated cases.

Table 8.4 10 Year Predicted Annual Pollutant Loads

Pollutant	Annual Load (kg/yr)		Reduction - Mitigated to Unmitigated	Recommended Industry Standard Reduction	Requirement Met?
	Post-Development	Mitigated			
SS	9430	1840	81%	80%	Yes
TP	19	6	71%	60%	Yes
TN	107	45	58%	45%	Yes

Table 8.4 shows that the proposed mitigation measures lead to a reduction in loads from the Shute Harbour Marina site in accordance with current industry standards. With suitable operation and maintenance of the treatment devices it is expected that the treatment devices will meet the performance shown above.

Table 8.5 summarises the predicted pollutant concentrations that discharge from the Shute Harbour Marina Development. This indicates that with the implementation of the proposed treatment devices the proposed Shute Harbour Marina Development will meet the required WQOs.

Table 8.5 Predicted Median Pollutant Concentrations

Pollutant	Post-Development	Mitigated	WQO
SS	157.00 mg/L	1.040 mg/L	15 mg/L
TP	0.34 mg/L	0.012 mg/L	0.02 mg/L
TN	2.09 mg/L	0.164 mg/L	0.2 mg/L

8.3 Preliminary Treatment Device Design

Preliminary design of the treatment devices has been carried out. The bio-retention basins have been sized based on consideration of the infiltration rate and the filter area necessary to provide treatment of urban runoff based on Central Queensland rainfall conditions. The required filter and storage areas for each of the bio-retention basins are listed in Table 8.6. Figure 3 shows the location of the bio-retention devices, which conceptually demonstrates that there is sufficient area available at each location to achieve the treatment requirements.

Table 8.6 Design Parameters – Bio-Retention Basins

Treatment Device	Filter and Storage Area (m^2)
Bio-Basin 1	616
Bio-Basin 2	387
Bio-Basin 3	179
Bio-Basin 4	735
Bio-Basin 5	521

The other design parameters for each of the basins are the same, and are listed below:

- Filter Media Depth – 1.2 m

- Extended Detention Depth – 0.3m
- Median Particle Size – 0.45 mm
- Saturated Hydraulic Conductivity – 180 mm/hr

The above saturated hydraulic conductivity of the bio-retention basins and bio-retention swales is to be in accordance with Facility for Advancing Water Biofiltration's (FAWB) guideline '*Guideline Specifications for Soil Media in Bioretention Systems'* (updated March 2007) and Health Waterways' guidelines '*Water Sensitive Urban Design Technical Design Guidelines for South East Queensland'* (Version 1 dated 2006).

The locations of each bio-retention swale are shown on Figure 3. These grass swales with underlying bio-retention system were modelled as follows:

Table 8.7 Design Parameters – Bio-Retention Swales

Bio Swale ID	Length (m)	Slope (%)	Filter Area (m^2)	Swale Surface Area (m^2)
1A	140	0.64	210	490
1B	155	0.58	233	543
2A	170	0.59	255	595
2B	80	0.88	120	280
3A	70	1.14	105	245
3B	80	1.13	120	280
4A	90	0.89	135	315
4B	190	0.63	285	665
4C	220	0.45	330	770
4D	95	0.74	143	333
5A	160	1.06	240	560

Other design parameters common to all bio-retention swales are listed below:

- Vegetation Height – 75mm
- Seepage Loss – 0mm/hr
- Swale Base Width – 1.5m
- Swale Depth – 0.25m
- Swale Top Width – 3.5m
- Swale Batters – 1 in 4
- Filter Media Depth – 1.2m
- Median Particle Size – 0.45mm
- Saturated Hydraulic Conductivity – 180mm/hr

An oil and grease separator is proposed at the stormwater outlet of the car parking facility located in the north-east of the development. The pollutant reduction efficiencies of the modelled oil and grease separator have been adopted from GCCC MUSIC Modelling Guidelines (2006) specifications for a gross-pollutant trap; as follows:

- Total suspended solids (TSS) = 50%

- Total Phosphorous (TP) = 20%
- Total Nitrogen (TN) = 0%

8.4 Conclusion

From the analysis, the pollutant removal efficiencies of the stormwater treatment train are effective. With the incorporation of the proposed bio-retention systems, vegetated buffer strips and GPTs, annual pollutant loads are predicted to be reduced and median pollutant concentrations successfully meet WQOs, and the environmental values which they protect.

9. MAINTENANCE PLANS

As detailed earlier in this report a number of treatment devices have been proposed as part of the stormwater treatment. The devices that will require maintenance include:

- Gross pollutant traps;
- Bio-retention systems; and
- Vegetated Buffer.

Maintenance for the each component will vary depending on its operation requirements and type of device. Further details are provided below with concise details provided in Appendix B.

9.1 Marina Management

Maintenance of the Marina consists of:

- Regular inspections to determine when marina maintenance is required; and
- Collection of litter, removal of floating and rooted exotic weed and any other pests.

9.2 Oil and Grease Separator

Maintenance of the oil and grease separator consists of:

- Regular inspections to determine when clean out is required; and
- Clean out of sediment and gross pollutants.

9.3 Bio-Retention Basins

Maintenance of bio-retention systems should include:

- Regular inspection of the basin profile for any increase in sediment deposition, scouring from storm flows, rill erosion of the batters, clogging and vehicle damage;
- Regular inspection of inflow systems, overflow pits and under-drains to identify and clean any areas of scour, litter build up and blockages;
- Removal of accumulated sediment from sediment forebay and where sediment is smothering basin vegetation;
- Repairing any damage to the basin profile from scour, rill erosion or vehicle damage by replacement of appropriate fill, to match onsite soils, and revegetation;
- Tilling of the bio-retentions basin surface, or removal of the surface layer, if there is evidence of clogging;
- Regular watering/irrigation of vegetation until plants are established and actively growing; and
- Removal of invasive weeds and dead plants and replacing with plants of equivalent size and species.

9.4 Vegetated Swale with Underlying Bio-Retention System

Maintenance of vegetated swales with underlying should include:

- Regular inspection of the swale profile for increased sediment deposition, scouring of the swale invert from storm flows, rill erosion of the swale batters and damage from vehicles;
- Regular inspections to determine when mowing is required;
- Regular inspection of inlet points, surcharge pits and field inlet pits for scour, litter build up and blockages;
- Removal of sediment that is impeding the conveyance of the swale and smothering the swale vegetation;
- Repairing any damage to the swale profile from scour, rill erosion or vehicle damage;
- Tilling of the bio-retention trench surface if there is evidence of clogging;
- Clearing any blockages of the inlets and outlets;
- Regular watering/irrigation of vegetation until plants are established and actively growing;
- Mow turf or slash vegetation to preserve the optimal design height for the vegetation;
- Removal of invasive weeds and plants that have died and replace with plants of equivalent size and species; and
- Removal of litter and debris.

9.5 Rainwater Tanks

Maintenance of bio-retention systems should include:

- Regular inspections of the roof, gutters and the tank inlet for leaves and blockages;
- Removal of leaves and other debris from the roof, gutters and tank inlet;
- Regular inspection fro mosquito breeding sites;
- Inspection of the tank for the accumulation of sludge; and
- Removal of any sludge by siphon or by completely emptying the tank.

10. WATER QUALITY MONITORING PROGRAM

In developing the water quality monitoring program a number of discussions were undertaken with the EPZ and GBRMPA to ensure that the most appropriate program adopted.

The surface water quality monitoring program will consist of 3 components:

- Background Phase;
- Construction Phase; and
- Operational Phase.

The details of the aim of each component and requirements for each component are detailed below.

Concise surface water quality monitoring details are contained within the SWMP in Appendix A.

The surface water quality monitoring locations are shown on Figure 4, and a brief description of each is provided in Table 10.1 below.

Table 10.1 Water Quality Monitoring Locations

Label	Description
SH1	Shute Bay, west of the proposed development.
SH2	Shute Bay, to the north of the proposed marina entrance.
SH3	Shute Bay, west of the proposed marina entrance.
SH4	Shute Bay, south west of the end of the western wing of the proposed development.
SH5	Shute Bay, south of the proposed marina.
SH6*	Inside the Shute Harbour Marina at the discharge location.
SH7	Within the unnamed tributary north of the western end of the Proserpine Shute Harbour Road upgrade.
SH8	Within the unnamed tributary north of Proserpine Shute Harbour Road between SH7 and SH9.
SH9	Within the unnamed tributary north of the eastern end of the Proserpine Shute Harbour Road upgrade.
SH10	Within the unnamed tributary north of Proserpine Shute Harbour Road east of the site extent.

* Construction Phase only – to be located on-site

Table 10.2 details the water quality parameters to be monitored during each component.

Table 10.2 Water Quality Parameters

In-situ Parameters	Laboratory Parameters
Temperature	Total Nitrogen
Dissolved Oxygen	Total Phosphorous
pH	Suspended Solids
Specific Conductance	Heavy Metals: Cu, Pb
Salinity	Faecal Coliforms
Turbidity	Chlorophyll 'a'

10.1 Background Phase Monitoring

The aim of background water quality data monitoring is to establish the water quality of the receiving waters of Shute Bay prior to any construction being undertaken. Background monitoring is to be completed under a range of sea state conditions (wind, wave, current and tide). This will allow the WQOs to be revised to better match site specific conditions and provide a bench mark for all future development.

The background phase monitoring involves monthly monitoring of the site and surrounding waterways for at least 1 year prior to the commencement of construction.

Background water quality monitoring will be conducted monthly at each monitoring location in Table 10.1 for the parameters in Table 10.2 above and also include Heavy Metals (As, Ba, Be, Cd, Cr, Co, Mn, Ni, V, Zn, Hg), Acidity, Total Organic Carbon, Dissolved Inorganic Nitrogen, Dissolved Inorganic Phosphorus as requested in the ToR.

The background phase water quality monitoring is also to include continuous turbidity monitoring at location SH3, achieved through the placement on an automatic data. The purpose of the automatic data logger will be to obtain a continuous and accurate measurement of the existing variance in the turbidity for the various sea state conditions.

10.2 Construction Phase Monitoring

The aim of Construction phase monitoring is to ensure on-site stormwater management practices are being maintained during the construction.

Construction water quality monitoring will be conducted monthly at each monitoring location in Table 10.1 for the parameters in Table 10.2 above. Additional parameters in the ToR are not included in the construction phase as these are not considered relevant for a marina development of the scale and intensity that is proposed. In the event of an incident the background data can be utilised as the relevant point of reference.

The construction phase monitoring includes an extra monitoring location within the marina for testing prior to controlled discharges. In addition spot checks of turbidity in visual plumes will also be monitored.

10.3 Operational Phase Monitoring

The operational phase commences when all construction works are complete and all SQIDs are installed and working.

Operational phase water quality monitoring will consist on monthly monitoring for up to 2 years following the completion of construction. This monitoring will be conducted on a 3-

monthly basis at each monitoring location in Table 10.1 for the parameters in Table 10.2 above. The additional parameters in the ToR are not included in the construction phase as these are not considered relevant for a marina development of the scale and intensity that is proposed. In the event of an incident the background data can be utilised as the relevant point of reference.

11. HYDROLOGIC ASSESSMENT

11.1 Approach

Cardno Lawson Treloar has undertaken a hydrologic assessment of the catchment using the Watershed Bounded Network Model (WBNM) Version 1.03. Modelling has been carried out in accordance with the Queensland Urban Drainage Manual (QUDM).

The WBNM model layout is shown in Figure 5. Specific details used for setting up the WBNM model are described below.

11.1.1 Catchment Areas and Land Use Parameters

The total catchment area draining to the Proserpine Shute Harbour Road catchment is estimated to be 48.2 ha. The areas of the sub-catchments are tabled below, based on the contours detailed on topographic mops sourced from Sunmap.

Table 11.1 WBNM Catchment Areas

Catchment	Total Area (ha.)	Sub Area Land Use (ha)		Fraction Impervious	
		Urban	Open Space	Impervious	Pervious
C1	25.2	-	25.2	0%	100%
C2	7.9	-	7.9	0%	100%
C3	1.6	-	1.6	0%	100%
C4	4.3	-	4.3	0%	100%
C5	1.0	-	1.0	0%	100%
C6	2.2	1.7	0.5	63%	37%
C7	1.2	1.2	-	80%	20%
C8	4.8	4.8	-	80%	20%

The adopted land use within the catchment has been based on 1:25,000 Topographic Maps and aerial photography. The catchment is situated in the area of Whitsunday Shire Council. A fraction impervious of 0% is adopted for open space and parks and 80% for urban areas, based on Table 5.04.1 of QUDM.

11.1.2 Rainfall Losses

The rainfall losses adopted for the hydrologic analysis are shown in Table 11.2. A global value of 1.7 has been adopted for the WBNM Catchment Lag Parameter.

The hydrologic model was assessed for the design average recurrence interval (ARI) events of 2 to 100 years. Each ARI was run for the following storm durations: 15, 30, 45, 60, 90 and 120 minutes.

Table 11.2 WBNM Rainfall Losses

Rainfall Loss Type	ARI (years)		
	2 and 5	10 and 20	50 and 100
Pervious Initial Loss (mm)	15	10	5
Pervious Continuing Loss (mm/hr)	2.5	2.5	2.5
Impervious Initial Loss (mm)	1.5	1	0.5
Impervious Continuing Loss (mm/hr)	0	0	0

11.2 Calibration

Calibration of peak flows from WBNM has been carried out using a Rational Method Approach. Rational Method parameters summarised in Table 11.3, with the calculations included in Appendix C.

Table 11.3 Rational Method Parameters

Area	48.33 ha
C_{10}	0.726
t_c	25 min.

Results of the calibration are shown in Table 11.4.

Table 11.4 Calibration Results WBNM Entire Catchment

ARI (Years)	Predicted Peak Flow		
	Entire Catchment		
	Rational Method	WBNM	Difference
	(m^3/s)	(m^3/s)	(%)
2	7.16	7.42	3.6%
5	10.32	10.63	3.0%
10	12.34	13.30	7.7%
20	15.03	16.11	7.2%
50	19.50	19.73	1.2%
100	22.81	22.61	-0.9%

In general, a good agreement was achieved between the Rational Method Calculations and the WBNM model estimates, hence the reported WBNM parameters were adopted.

11.3 Results

The predicted peak flows for each catchment is presented in Table 11.5 below. The hydrographs generated from each of the catchments were utilized as boundary conditions for the hydraulic analysis.

Table 11.5 WBNM Predicted Peak Flows

ARI (years)	Peak Flow (m^3/s)							
	C1	C2	C3	C4	C5	C6	C7	C8
2	2.79	1.22	0.34	0.76	0.23	0.74	0.46	1.64
5	4.22	1.79	0.49	1.09	0.34	0.99	0.61	2.17
10	5.46	2.23	0.63	1.33	0.44	1.16	0.71	2.54
20	6.66	2.68	0.76	1.61	0.52	1.36	0.83	2.97
50	8.00	3.18	0.91	1.99	0.62	1.54	0.92	3.30
100	9.22	3.66	1.04	2.29	0.70	1.73	1.03	3.71

12. HYDRAULIC ASSESSMENT

12.1 General

Currently the flows from the catchments upstream of the proposed marina flow across and under Proserpine - Shute Harbour Road straight into Shute Bay. Due to the simplicity of the current flow regime this situation was not modelled as part of the hydraulic assessment.

It is proposed to raise Proserpine - Shute Harbour Road to achieve 100 year ARI local flood immunity and to divert the local upstream catchments around the proposed marina.

The upstream diversion will utilize a drainage culvert to divert the eastern catchment to the east side of the marina and an open channel to divert the remaining catchments to the west side of the marina. Concept details are presented in Figure 6.

The hydraulic analysis of the proposed road raising and channel diversion was performed in SOBEK version 2.10.003 SOBEK is a hydrodynamic software package developed by Delft Hydraulics in the Netherlands, which takes into account storage as well as conveyance.

12.2 Hydraulic Approach

The hydraulic analysis considered the proposed road and channel as detailed on Cardno (Qld) drawing 7900/48/01-001 Rev. I. The SOBEK model layout is shown on Figure 7. To ensure the flood immunity of the road the culverts modelled are detailed in Table 12.1

Table 12.1 Proposed Road Crossing Details

SOBEK	Road	Culvert			
Upstr ID	Immunity (yr ARI)	Type	Invert Level		Length (m)
			Upstr (mAHD)	Downstr (mAHD)	
Culvert 10	100	RCP ∅ 900mm	4.64	4.24	23.9
Culvert 11	100	RCP ∅ 1200mm	2.42	1.98	16.0
Culvert 12	100	RCP ∅ 1500mm	3.60	3.50	13.6
Culvert 13	100	RCP ∅ 1500mm	3.60	3.50	13.6
Culvert 14	100	RCP ∅ 1200mm	5.39	1.8	138.6

The open channel was based on a typical profile of 3m in base with 1 in 3 side batters. The upstream channel invert was RL 3.6m AHD draining 450m to RL 1.8m AHD.

A manning's roughness of 0.07 was assumed as it is expected the channel will be landscaped for aesthetic purposes.

The inflow hydrographs were extracted from the WBNM model and input into the model as shown on Figure 7. The tailwater condition was assumed to be the Highest Astronomical Tide (HAT) of RL 2.353m AHD.

12.3 Hydraulic Results

Table 12.2 summarises the predicted peak 100 year ARI flood levels and discharges. Cross-section locations are shown on Figure 7.

Table 12.2 Developed Case Predicted Peak 100 Year ARI Flood Levels and Discharge

Sobek ID	Description	Flood Level (mAHD)	Discharge (m^3/s)
12 & 13	2 x Culvert 1500mm		3.80
CRS_23		4.88	0.79
CRS_22		4.88	7.54
CRS_21		4.81	7.53
CRS_20		4.74	7.53
CRS_19		4.67	7.53
CRS_18		4.60	7.53
CRS_17		4.55	7.54
11	Culvert 1200mm		1.26
CRS_16		4.49	8.75
CRS_15		4.42	8.76
CRS_14		4.35	8.76
CRS_13		4.28	9.70
CRS_12		4.20	9.70
CRS_11		4.11	9.70
CRS_10		4.03	9.70
CRS_09		3.95	9.94
CRS_08		3.86	9.94
10	Culvert 900mm		3.80
CRS_07		3.77	10.29
CRS_06		3.67	10.29
CRS_05		3.56	10.73
CRS_04		3.43	10.73
CRS_03		3.28	10.73
CRS_02		3.10	10.73
CRS_01		2.82	10.73
14	Culvert 1200mm		2.21
CRS_35		3.13	2.21
CRS_36		3.06	2.21
CRS_37		2.98	2.21
CRS_38		2.93	2.21
CRS_39		2.89	2.21
12	2 x Culvert 1500mm		
CRS2_20		5.17	1.22
CRS2_19		5.17	1.11
CRS2_18		5.17	1.04

Sobek ID	Description	Flood Level (mAHD)	Discharge (m^3/s)
CRS2_17		5.17	0.93
CRS2_16		5.17	0.73
CRS2_15		5.17	0.64
CRS2_14		5.17	1.26
CRS2_13		5.34	0.00
CRS2_12		5.88	0.00
CRS2_11		6.01	0.00
CRS2_10		5.99	0.00
CRS2_09		6.31	0.00
CRS2_08		6.48	0.00
CRS2_07		6.79	0.00
CRS2_06		7.25	0.00
CRS2_04		5.24	0.00
CRS2_05		6.47	0.00
CRS2_03		8.68	0.00
CRS2_02		9.63	0.00
CRS2_21		5.17	1.16
CRS2_22		5.17	0.52
CRS2_23		5.17	0.39
CRS2_24		5.17	0.08
CRS2_25		5.55	0.00
CRS2_26		6.01	0.00
CRS2_27		6.29	0.00
CRS2_28		6.60	0.00
CRS2_29		6.71	0.00
CRS2_30		6.71	0.00
CRS2_31		6.62	0.00
CRS2_32		6.37	0.00
CRS2_33		6.32	0.00
CRS2_34		6.32	0.02
CRS2_35		6.32	2.23
CRS2_36		6.25	0.01
CRS2_37		6.25	0.00
CRS2_38		7.19	0.00
CRS2_39		7.06	0.00

The flood analysis indicates the proposed channel and culvert diversion will contain the flows. Appropriate freeboard is recommended for any adjacent allotments.

13. CONCLUSION

This SWMS has been prepared by CLT to provide Shute Harbour Marina Development Pty Ltd appropriate details for the stormwater quantity and quality management of the proposed Shute Harbour Marina development.

The proposed development has been demonstrated in this report to achieve the industry standard load reductions of 80% total suspended solids, 60% total phosphorus, 45% total nitrogen. The proposed development has also demonstrated to achieve the water quality objectives prior to discharge into Shute Bay and ultimately the Coral Sea.

In addition, to help ensure the developments success, the following guidelines have been provided:

- Background, construction, establishment and operational stormwater management plans; and

- On-going maintenance plans for the proposed treatment devices.

The proposed development has demonstrated the improvement of Proserpine Shute Harbour Road to 100 year ARI local flood immunity. The diversion culverts and channel will provide local flood free allotments.

14. REFERENCES

ANZECC/ ARMCANZ, 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Brisbane City Council, 1999, 'Design Guidelines for Stormwater Quality Improvement Devices'

Brisbane City Council, 2000, 'Subdivision and Development Guidelines'

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Co-operative Research Centre for Catchment Hydrology, 2005, 'MUISC Version 3.0 User Guide'

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Gold Coast City Council, 2006, 'MUSIC Modelling Guidelines'

Healthy Waterways, 2001, 'South East Queensland Regional Water Quality Management Strategy'

Healthy Waterways, 2006, 'Water Sensitive Urban Design Technical Design Guidelines for South East Queensland'

Queensland Environmental Protection Agency, 2006, 'Queensland Water Quality Guidelines 2006'

University of Wollongong, 2005, 'WBNM User Guide'

WL / Delft Hydraulics, 2007, 'SOBEK User Guide'

15. QUALIFICATIONS AND CERTIFICATION

15.1 The Report

This report has been prepared by Cardno Lawson Treloar Pty Ltd (CLT) specifically for Shute Harbour Marina Development Pty Ltd and specifically to provide advice on possible water quality management options for the proposed residential development on Lot 2 SP117389.

Our analysis and overall approach has been specifically catered for the particular requirements Shute Harbour Marina Development Pty Ltd, and may not be applicable beyond this scope. For this reason any other third parties are not authorised to utilise this report without further input and advice from CLT.

15.2 Limitations, Qualifications and Reservations

The report is based on the following studies and information prepared by others:

- Recent aerial photos provided by Cardno (Qld);
- 1 metre contours provided by Cardno (Qld);
- Detailed ground survey provided by Kevin Holt Consulting;
- Proposed layout supplied by Cardno (Qld);
- Water quality samples collected by Cardno Ullman and Nolan (Mackay); and
- Rainfall data for the Hamilton Island Airport was sourced from the Bureau of Meteorology and evapo-transpiration data was taken from the Climatic Atlas of Australia.

Cardno Lawson Treloar's report accurately assesses catchment runoff quality, using industry standard techniques.

Cardno Lawson Treloar's report accurately assesses water quality management, using industry standard techniques; however baseline water quality monitoring has consisted of limited sampling to date. Hence, future observed quality may vary from predicted. It is for this reason that the SWMP contained in this report should remain a living document throughout the construction and operational phases of this development.

While CLT's report accurately assesses flooding from design storms, it is an ungauged catchment, hence future observed flood levels may vary from that predicted, depending on the accuracy of stream flow estimates. It is for this reason that freeboard to habitable floors is adopted.

Our assessments are based on standard engineering practices.

15.3 Reliance

Cardno Lawson Treloar Pty Ltd acknowledges that Council will rely on this certification in its assessment of the proposal.

FIGURES

Cardno Lawson Treloar

0.4 0 0.4 0.8 1.2 1.6 2km
1:40000

Scale 1:40000 (A3)

FIGURE 1
SITE LOCATION

Rev: Orig. Date: November 2007

Project No.: LJ8779

Shute Harbour Marina Development Pty Ltd

CAD FILE: O:\Work\AT\J8779\Figures\R2\Figures_1_2_3_4_5_6_7.dwg
XREF's: X-SURV-road; X-BASE; J8779 Cadastre; X-DESIGN; New Layout Rec 20071024; 1m Contours

PRINT DATE: 20 November, 2007 - 4:41pm

Cardno Lawson Treloar

30 0 30 60 90 120 150m
1:3000

Scale 1:3000 (A3)

FIGURE 2
MUSIC MODEL CATCHMENT LAYOUT

Rev: Orig. Date: November 2007

Project No.: LJ8779

Shute Harbour Marina Development Pty Ltd

CAD FILE: O:\WorkLAT\J8779\Figures\R2\Figures_1_2_3_4_5_6_7.dwg
XREF's: X-SURV-road; X-BASE; J8779 Cadastre; X-DESIGN; New Layout Rec 20071024; 1m Contours

PRINT DATE: 20 November, 2007 - 4:35pm

Cardno Lawson Treloar

BIO-BASIN 4

BIO-BASIN 3

BIO-BASIN 2

BIO-BASIN 5

BIO-BASIN 1

SHUTE BAY

SHUTE BAY

H

N

LEGEND:

- Site Boundary
- Urban Areas
- High Density Urban
- Park
- Road and Carpark
- Open Space
- Marina
- Bio-Retention Basin
- Bio-Retention Swale
- GPT
- Stormwater Low Flow Path
- H Local Highpoint

30 0 30 60 90 120 150m
1:3000

Scale 1:3000 (A3)

FIGURE 3
CONCEPTUAL STORMWATER MANAGEMENT STRATEGY

Rev: Orig. Date: November 2007

Project No.: LJ8779

Shute Harbour Marina Development Pty Ltd

CAD FILE: O:\WorkLAT\J8779\Figures\R2\Figures_1_2_3_4_5_6_7.dwg
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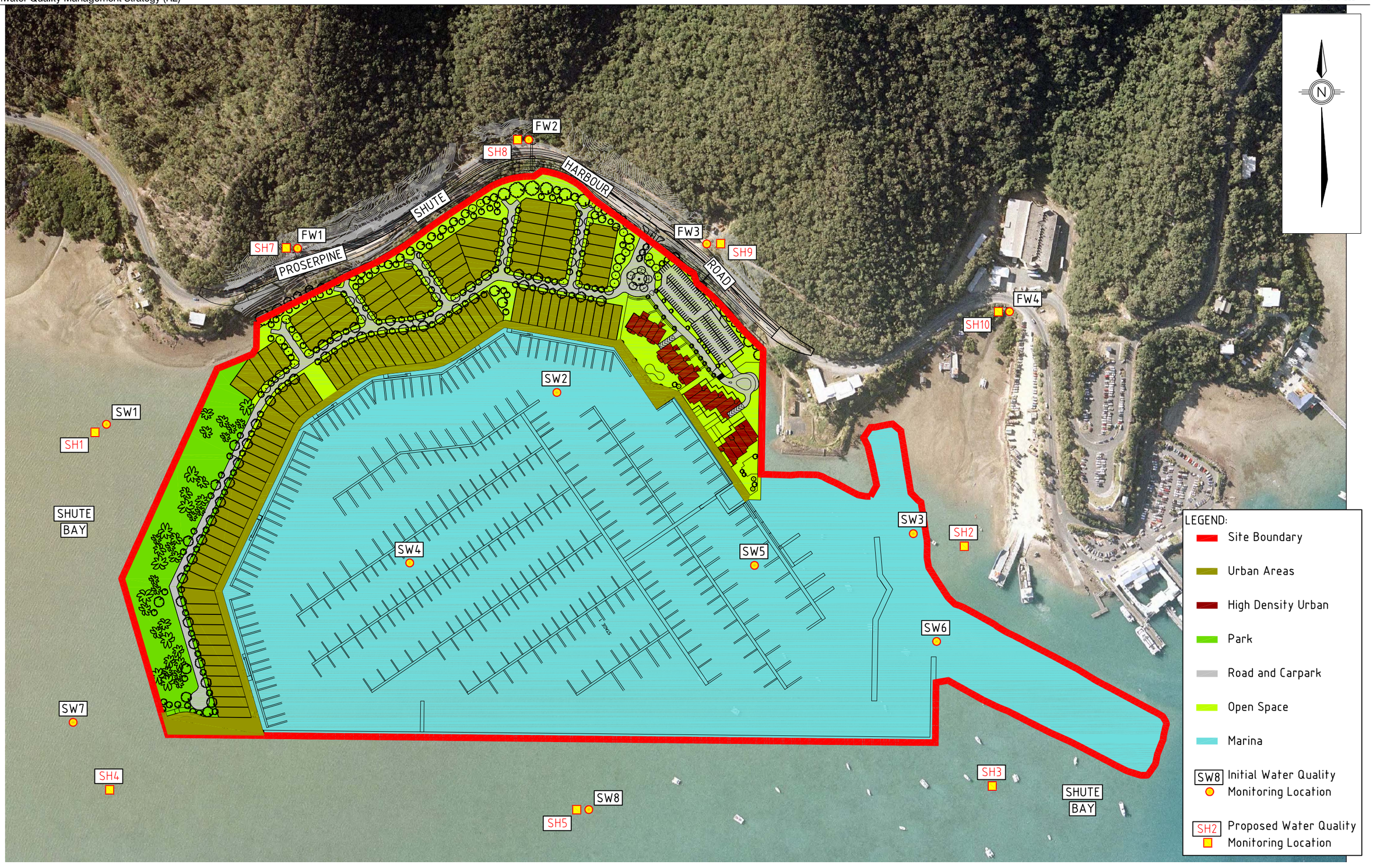
PRINT DATE: 20 November, 2007 - 4:36pm

Cardno Lawson Treloar



40 0 40 80 120 160 200m
1:4000

Scale 1:4000 (A3)

FIGURE 4
SURFACE WATER QUALITY MONITORING LOCATIONS

Rev: Orig. Date: November 2007

Project No.: LJ8779

Shute Harbour Marina Development Pty Ltd

CAD FILE: O:\WorkLAT\J8779\Figures\D2V2\Figures_1_2_3_4_5_6_7.dwg
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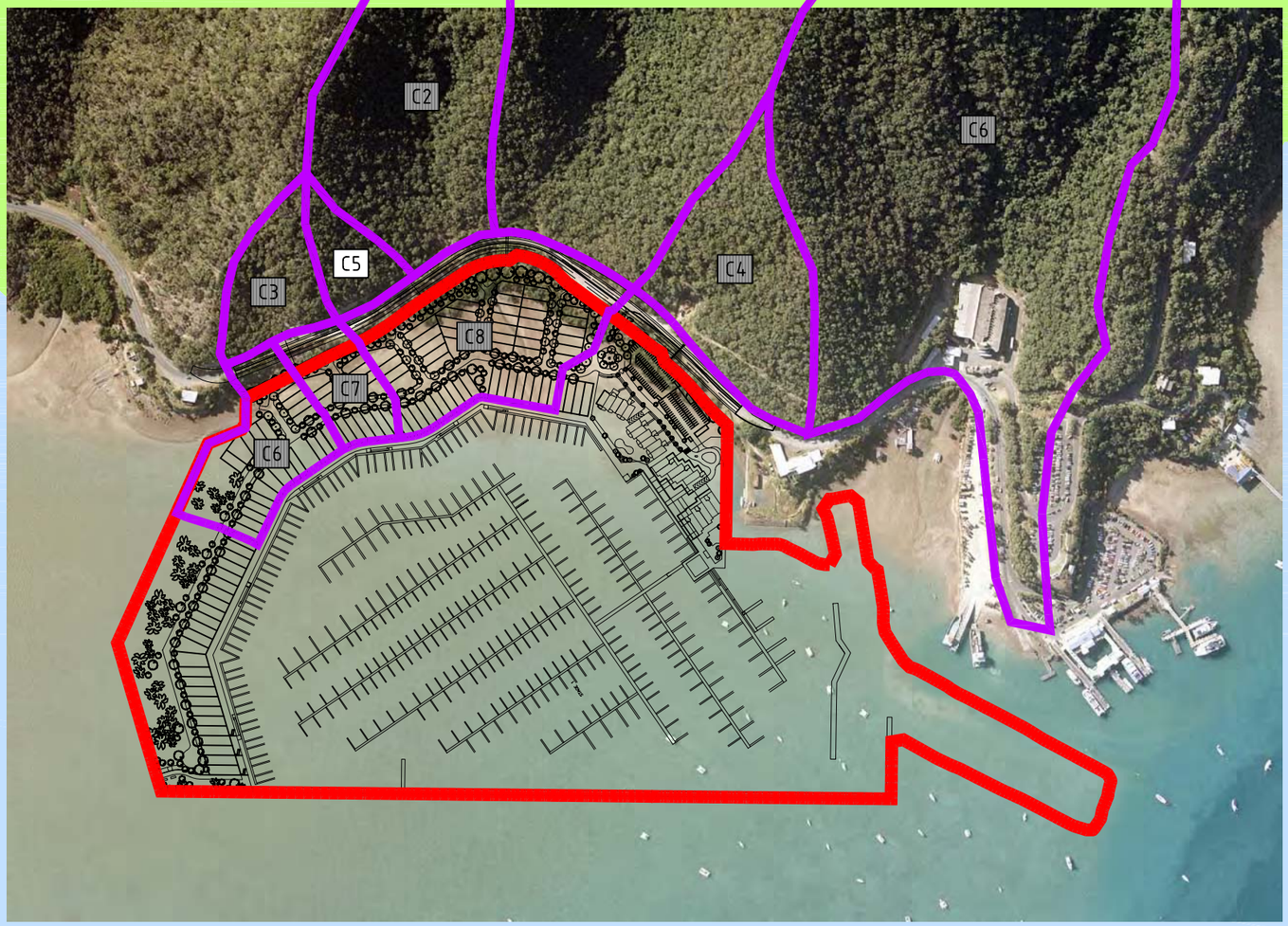
PRINT DATE: 09 January, 2008 - 4:10pm

Cardno Lawson Treloar



LEGEND:
- Site Extents
- WBNM Catchment Boundary
- C5 WBNM Catchment Label

100 0 100 200 300 400 500m
1:10,000

Scale 1:10000 (A3)

FIGURE 5
WBNM MODEL LAYOUT

Rev: Orig. Date: November 2007

Project No.: LJ8779

Shute Harbour Marina Development Pty Ltd

CAD FILE: O:\WorkLAT\J8779\Figures\R2\Figures_1_2_3_4_5_6_7.dwg
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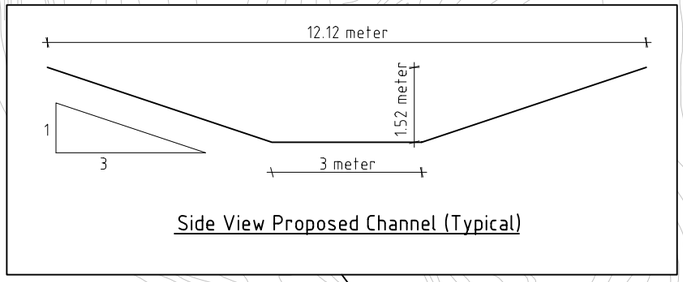
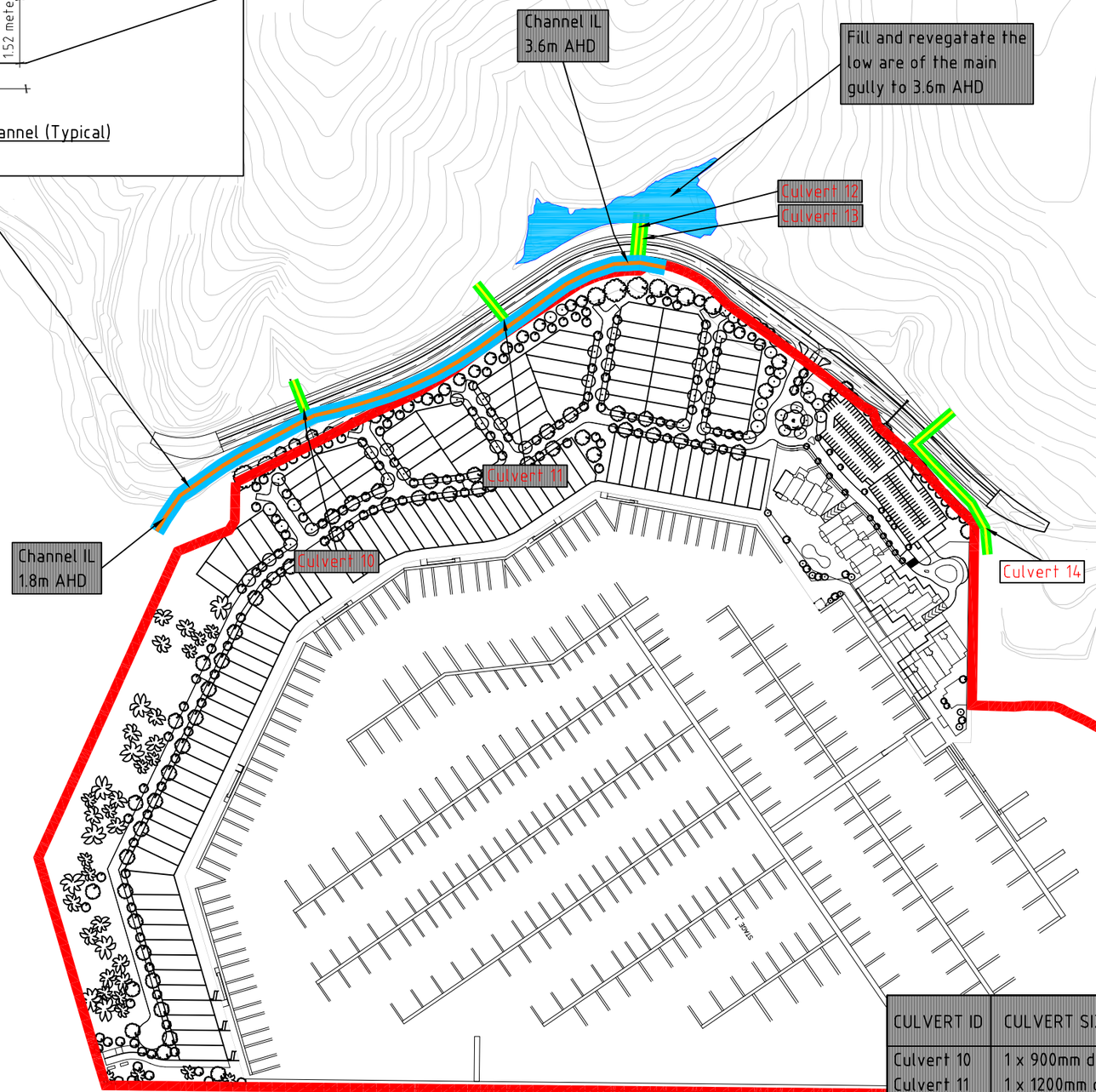
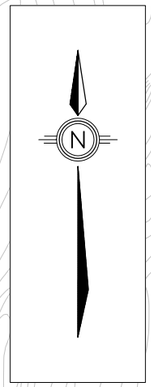
PRINT DATE: 20 November, 2007 - 4:37pm

Cardno Lawson Treloar

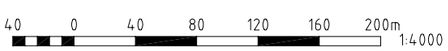






CULVERT ID	CULVERT SIZE	UPSTREAM INVERT LEVEL	DOWNSTREAM INVERT LEVEL
Culvert 10	1 x 900mm dia RCP	4.64m AHD	4.24m AHD
Culvert 11	1 x 1200mm dia RCP	2.42m AHD	1.98m AHD
Culvert 12	1 x 1500mm dia RCP	3.60m AHD	3.50m AHD
Culvert 13	1 x 1500mm dia RCP	3.60m AHD	3.50m AHD
Culvert 14	1 x 1200mm dia RCP	5.39m AHD	1.80m AHD

LEGEND:
- Site Boundary
- Proposed Filling
- Proposed Channel
- Proposed Culvert
- CRIS_38 SOBEK Cross Section Label



Scale 1:4000 (A3)

FIGURE 6
PROPOSED STORMWATER DRAINAGE MANAGEMENT

Rev: Orig. Date: November 2007

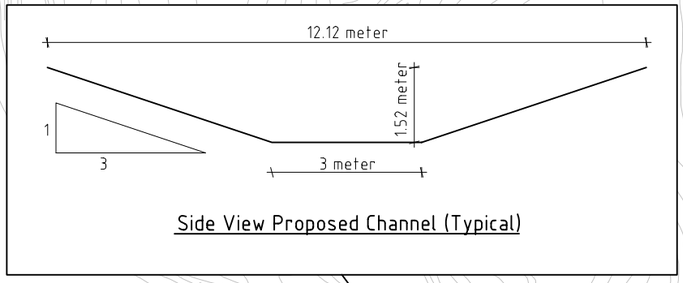
Shute Harbour Marina Development Pty Ltd

CAD FILE: O:\WorkLAT\J8779\Figures\R2\Figures_1_2_3_4_5_6_7.dwg
XREF's: X-SURV-road; X-BASE; J8779 Cadastre; X-DESIGN; New Layout Rec 20071024; 1m Contours

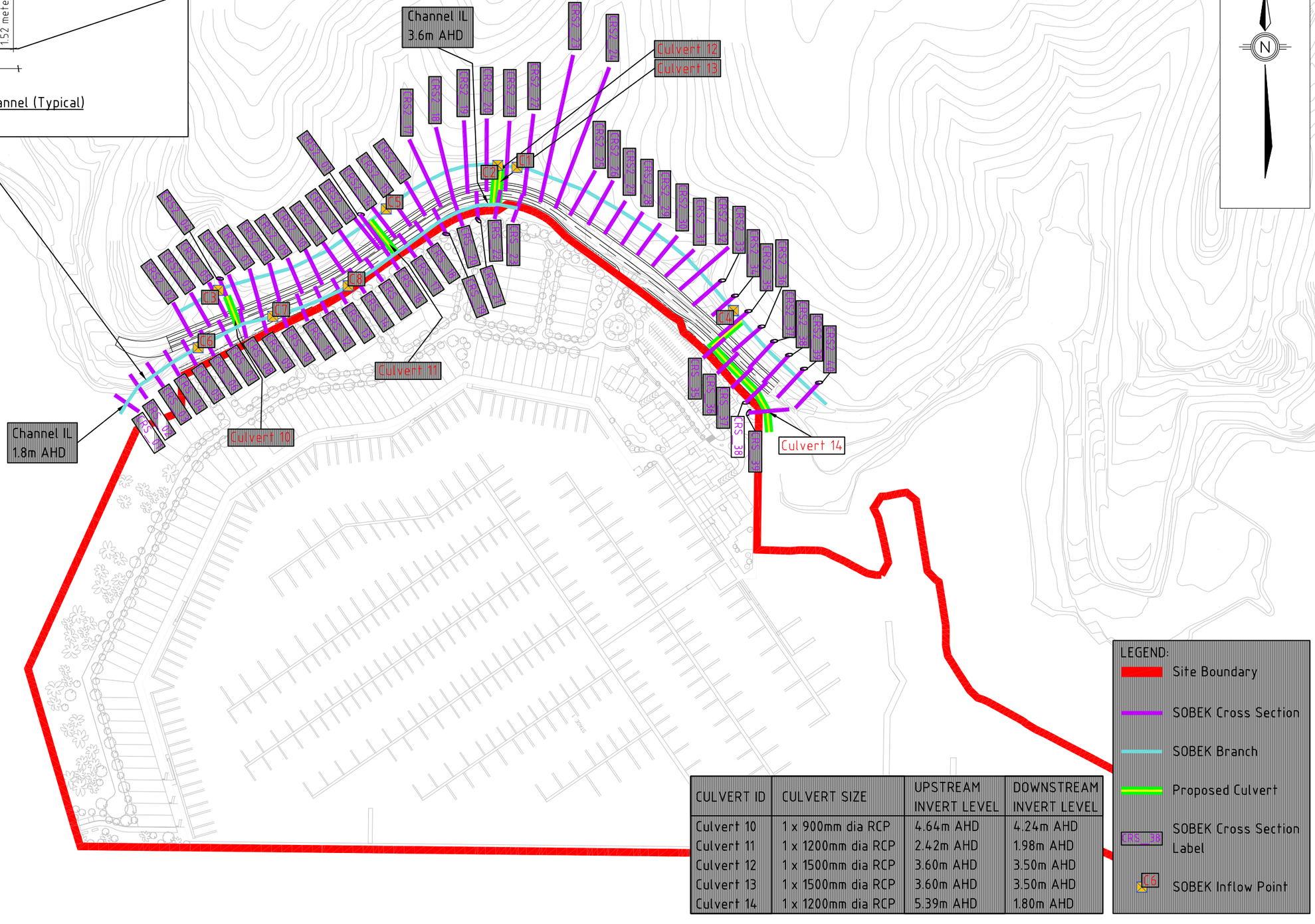
Project No.: LJ8779

PRINT DATE: 20 November, 2007 - 4:38pm

Cardno Lawson Treloar



Side View Proposed Channel (Typical)



CULVERT ID	CULVERT SIZE	UPSTREAM INVERT LEVEL	DOWNSTREAM INVERT LEVEL
Culvert 10	1 x 900mm dia RCP	4.64m AHD	4.24m AHD
Culvert 11	1 x 1200mm dia RCP	2.42m AHD	1.98m AHD
Culvert 12	1 x 1500mm dia RCP	3.60m AHD	3.50m AHD
Culvert 13	1 x 1500mm dia RCP	3.60m AHD	3.50m AHD
Culvert 14	1 x 1200mm dia RCP	5.39m AHD	1.80m AHD

LEGEND:
- Site Boundary
- SOBEK Cross Section
- SOBEK Branch
- Proposed Culvert
- SOBEK Cross Section Label (CRS_38)
- SOBEK Inflow Point (C6)

40 0 40 80 120 160 200m
1:4000

Scale 1:4000 (A3)

FIGURE 7
SOBEK MODEL LAYOUT

Rev: Orig. Date: November 2007

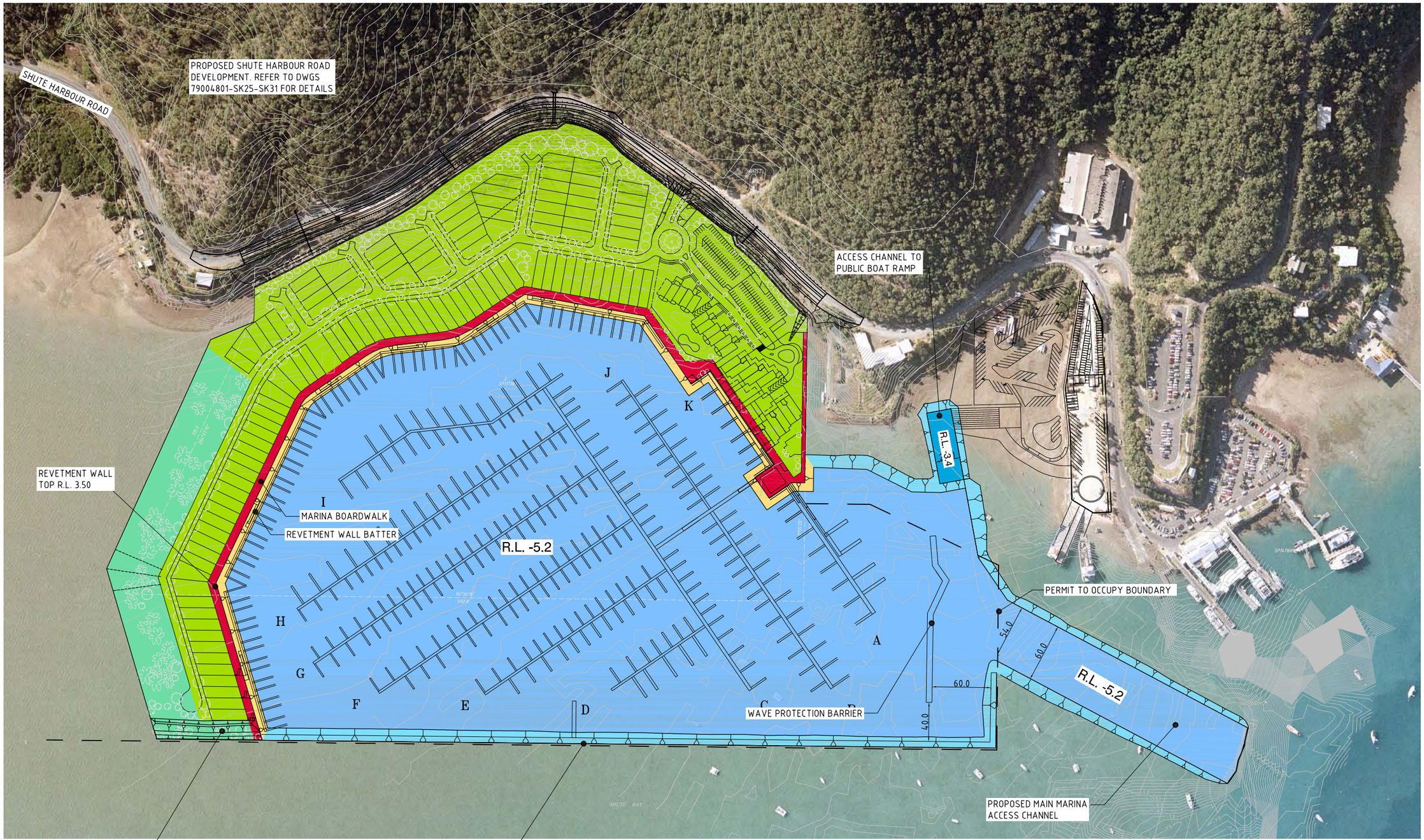
Shute Harbour Marina Development Pty Ltd

CAD FILE: O:\WorkLAT\J8779\Figures\R2\Figures_1_2_3_4_5_6_7.dwg
XREF's: X-SURV-road; X-BASE; J8779 Cadastre; X-DESIGN; New Layout Rec 20071024; 1m Contours

Project No.: LJ8779

PRINT DATE: 20 November, 2007 - 4:39pm

REFERENCE DRAWINGS



LAYOUT PLAN
1:2000

EARTHWORKS LEGEND:

- MARINA DREDGING R.L. -5.2
- MARINA DEVELOPMENT AREA
- MARINA VEGETATION AREA
- MARINA BOARDWALK
- REVETMENT WALL BATTER (1 ON 5 MAX)
- DREDGE CHANNEL BATTER (1 ON 5 MAX)
- MARINA DREDGING R.L.-3.4 BOAT RAMP CHANNEL

20 0 20 40 60 80 100m 1:2000
SCALE BEFORE REDUCTION

PRELIMINARY
Date 06 November, 2007

DATE PLOTTED: 06 November, 2007 - 4:43pm

Rv.	DATE	REVISIONS	REC.	APPR.
G	02-11-2007	BOAT RAMP CHANNEL DEPTH AMENDED	SR	
F	31-10-2007	DREDGING EDGE AMENDED TO SUIT PERMIT TO OCCUPY BOUNDARY	SR	
E	31-10-2007	REVISED LAYOUT AMENDMENTS	SR	
D	30-08-2007	EARTHWORKS RE-DESIGN	SR	
C	07-06-2007	ENTIRE SITE UPDATED	SR	
I	06-11-2007	WAVE BARRIER AMENDED TO SUIT PERMIT TO OCCUPY BOUNDARY	SR	
H	05-11-2007	BOAT RAMP CHANNEL & WAVE PROTECTION BATTER AMMENDED	RR	

DESIGNED:
DRAWN:
CHECKED:
RECOMMENDED: PROJ. MAN.
A1 DATUM: A.H.D.
APPROVED: PROJ. DIR.

CAD FILE: L:\7900-48\01\Acad\79004801-001.dwg
XREF's: XR-A1-BO-SHT; X-SU; X-DESIGN; X-EX CONTS -combined survey; X-BASE

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Gold Coast	(07) 5539 9333	(07) 5538 4647
Sunshine Coast	(07) 5443 2555	(07) 5443 5642
Townsville	(07) 4772 1166	(07) 4721 2508
Hervey Bay	(07) 4124 5455	(07) 4124 5155
Central Coast	(02) 4323 2558	(02) 4324 3251
Melbourne	(03) 9818 7755	(03) 9818 7033
Rockhampton	(07) 4924 7500	(07) 4926 4375
Toowoomba	(07) 4637 8122	(07) 4637 8155

SHUTE HARBOUR MARINA DEVELOPMENT

SHUTE HARBOUR MARINA DEVELOPMENT
BULK EARTHWORKS
LAYOUT PLAN

DATE:
DRAWING No: 7900/48/01-001
Rv. I

APPENDIX A

Stormwater Management Plan for Water Quality

APPENDIX A.1

SHUTE HARBOUR MARINA
STORMWATER MANAGEMENT PLAN
BACKGROUND PHASE

1. Water Quality Management – Background Phase

Issue:	Water Quality Management – Background Phase
Operational Policy:	The aim of background water quality monitoring is to establish the water quality of the receiving waters of Shute Bay prior to any construction being undertaken. Backgrond monitoring is to be completed under a range of sea state conditions including: • Wind; • Wave; • Current; and • Tidal.
Responsibility:	The developer should be responsible for water quality issues for the duration of the defects liability period, nominally 12 months from completion of construction.
Monitoring:	Background phase water quality monitoring will involve monthly monitoring for at least 1 year prior to construction. Monitoring locations will include: • **SH1** – Shute Bay, west of the proposed development. • **SH2** – Shute Bay, to the north of the proposed marina entrance. • **SH3** – Shute Bay, west of the proposed marina entrance. • **SH4** – Shute Bay, south west of the end of the western wing of the proposed development. • **SH5** – Shute Bay, south of the proposed marina entrance. • **SH7** – Within the unnamed tributary north of the western end of the Proserpine Shute Harbour Road upgrade. • **SH8** – Within the unnamed tributary north of Proserpine Shute Harbour Road between FW1 and FW3. • **SH9** – Within the unnamed tributary north of the eastern end of the Proserpine Shute Harbour Road upgrade. • **SH10** – Within the unnamed tributary north of Proserpine Shute Harbour Road east of the site extent. Along with monthly monitoring, the background phase will also include continous turbidity monitoring at location SH3.

Issue:	Water Quality Management – Background Phase
Monitoring (Cont.):	Key water quality parameters to be monitored are: • pH; • Temperature; • Salinity; • Turbidity; • Dissolved Oxygen; • Suspended Solids; • Total Nitrogen; • Total Phosphorous; • Heavy Metals; • Faecal Coliforms; • Total Organic Carbon; • Dissolved Organic Carbon; • Chlorophyll 'a'; • Ammonia; • Oxidised Nitrogen; • Reactive Phosphorus; • Secchi Disk Depth; • Dissolved Inorganic Nitrogen; • Total Aluminium; • Dissolved Aluminium; • Total Iron; • Dissolved Iron; and • Gross pollutants.
Reporting:	A Water Quality Report for all water quality monitoring results and assessments shall be submitted to Council, following the 12 months of background monitoring.

APPENDIX A.2

SHUTE HARBOUR MARINA
STORMWATER MANAGEMENT PLAN
CONSTRUCTION PHASE

2. Water Quality Management – Construction Phase

Issue:	Water Quality Management – Construction Phase
Operational Policy:	The aim of construction phase is to ensure on-site stormwater management practices are being maintained during the construction and to provide a framework for detailed design to ensure that the water quality in the waterways remains at an acceptable level as specified in the water quality objectives (WQO's) for the site at all times and to ensure that any waters discharged from the site are of an acceptable quality.
Performance Criteria:	Water discharges off the site should be of a quality, which ensures there is no detriment to the downstream environment. The quality of discharge from the site should achieve the following long term WQO's: Release Criteria • pH – 8.0-8.4; • Suspended Solids – < 50 mg/L; • Turbidity – < 10% increase from background levels and during dredging no visible plume beyond 20 metres from the lease extents; and • No anthropogenic (man-made) material greater than 50mm in any dimension. WQOs are upper limits for median values or ranges in which medians should lie, unless otherwise stated. In addition to the monthly monitoirng, the construction phase monitoring will also include spot checks of turbidity within visual plumes in the marina area.
Responsibility:	The developer should be responsible for water quality issues for the duration of the defects liability period, nominally 12 months from completion of construction. It is noted that the project will be completed in a number of stages; the developer will remain responsible until all stages are complete. Thereafter the Council shall be responsible for water quality issues.

Issue:	Water Quality Management – Construction Phase
Implementation Strategy:	A comprehensive stormwater runoff management system is proposed for the development. Consisting of two primary control phases: 1. Dredging. 2. Construction. Water quality can be maintained during dreging by implementing the following devices: • Floating Silt Curtains; • Earth Bund; and • Sheet Pile Walls. Water quality can be maintained during construction by implementing the following devices: • Sediment Fences; • Catch Drains; and • Sediment Basins. These controls will: • Trap trash; • Trap coarse sediment and attached metals; and • Trap oils and grease.
Monitoring:	Construction phase water quality monitoring will involve monthly monitoring for the duration of the construction works. Monitoring locations will include: • **SH1** – Shute Bay, west of the proposed development. • **SH2** – Shute Bay, to the north of the proposed marina entrance. • **SH3** – Shute Bay, west of the proposed marina entrance. • **SH4** – Shute Bay, south west of the end of the western wing of the proposed development. • **SH5** – Shute Bay, south of the proposed marina entrance. • **SH6** – Inside the Shute Harbour Marina, at the discharge location • **SH7** – Within the unnamed tributary north of the western end of the Proserpine Shute Harbour Road upgrade. • **SH8** – Within the unnamed tributary north of Proserpine Shute Harbour Road between FW1 and FW3. • **SH9** – Within the unnamed tributary north of the eastern end of the Proserpine Shute Harbour Road upgrade. • **SH10** – Within the unnamed tributary north of Proserpine Shute Harbour Road east of the site extent. Along with monthly monitoring, the construction phase will also include spot checks of visual plumes within the marina for turbidity.

Issue:	Water Quality Management – Construction Phase
Monitoring (Cont):	Key water quality parameters to be monitored are: • pH; • Temperature; • Salinity; • Turbidity; • Dissolved Oxygen; • Suspended Solids; • Total Nitrogen; • Total Phosphorous; • Heavy Metals*; • Faecal Coliforms*; • Total Organic Carbon*; • Dissolved Organic Carbon*; • Chlorophyll 'a'; • Ammonia*; • Oxidised Nitrogen*; • Reactive Phosphorus*; • Secchi Disk Depth; • Dissolved Inorganic Nitrogen*; • Total Aluminium; • Dissolved Aluminium; • Total Iron; • Dissolved Iron; and • Gross pollutants. * - Quaterly monitoring Note that additional water quality monitoring may be required if compliance with the water quality objectives for the site are not being met.
Trigger Levels	**TURBIDITY:** **Turbidity levels exceed 10% increase from Background levels** • Commence corrective action: - Change the dredge location; - Reducing dredging rate; - Deploy silt curtains where appropriate; and - Cease dredging activites until conditions change.
Auditing:	Reviews are to be carried out on a monthly basis to assess the implementation strategy. A checklist is to be completed which assesses the strategy against each of the monitoring points above.
Identification of Incident or Failure:	• Water discharged from the site falls below the long term WQOs. • Visual inspection identifying build up of sediment on and off the site. • Trigger levels exceeded. • Poorly maintained or damaged control devices.
Reporting:	A Water Quality Report for all water quality monitoring results and assessments shall be submitted to Council, following a monitoring campaign.

Issue:	**Water Quality Management – Construction Phase**
Corrective Action:	The source of contaminate is to be located immediately and the following measures implemented: • Isolation of contaminant, if possible, until remedial measures are fully implemented. • Increase rate of inspections, maintenance and clean-outs as appropriate. • Remove any floating debris in the waterbody. • Review of implementation strategy to ensure sufficiency and prevention of recurrence.

APPENDIX A.3

SHUTE HARBOUR MARINA
STORMWATER MANAGEMENT PLAN
OPERATIONAL PHASE

3. Water Quality Management – Operational Phase

Issue:	Water Quality Management – Operational Phase
Operational Policy:	To provide a framework for detailed design to ensure that the water quality in the waterways remain at an acceptable level as specified in the water quality objectives (WQO's) for the site at all times and to ensure that any waters discharged from the site are of an acceptable quality.
Performance Criteria:	Water discharges off the site should be of a quality, which ensures there is no detriment to the downstream environment. The expected long term Water Quality Objectives (WQOs) for the establishment phase monitoring are detailed below: • pH – 8.0-8.4; • Dissolved Oxygen – 90-100%; • Turbidity – < 6 NTU • Total Phosphorus – < 0.02 mg/L; • Total Nitrogen – < 0.2 mg/L; • Suspended Solids – < 15 mg/L; • Chlorophyl 'a' – < 0.002 mg/L; • Ammonia – < 0.008 mg/L; • Oxidised Nitrogen – < 0.003 mg/L; • Reactive Phosphorus – < 0.006 mg/L; • Diuron – < 0.001 mg/L; • Secchi Disk Depth – > 1.5 m; • Faecal Coliforms – < 150 orgs/100mL; • Total Aluminium – < 0.2 mg/L; • Total Iron – 0.02 mg/L; • Total Organic Carbon*; • Dissolved Organic Carbon*; • Dissolved Inorganic Nitrogen*; • Dissolved Aluminium*; and • Dissolved Iron*. * To be specified following background water quality monitoring. WQOs are upper limits for median values or ranges in which medians should lie, unless otherwise stated.
Responsibility:	The developer should be responsible for water quality issues for the duration of the defects liability period, nominally 12 months from completion of construction. It is noted that the project will be completed in a number of stages; the developer will remain responsible until all stages are complete. Thereafter the Council shall be responsible for water quality issues.

Issue:	Water Quality Management – Operational Phase
Implementation Strategy:	A comprehensive stormwater runoff management system is proposed for the development, comprising local runoff water quality control. Local catchment runoff water quality control can be achieved by the following: • Flush kerbs; • Oil and grease separators; • Rainwater Tanks; • Bio-Retention Basins; • Vegetated Swales with underlying bio-retention system; and • On site landscaping. These controls will: • Trap trash; • Remove Nutrients and Metals; • Trap coarse sediment and attached metals; and • Trap oils and grease.
Monitoring:	Monitoring of all treatment devices for maintenance requirement in accordance with the maintenance plans. Operational phase water quality monitoring will involve monthly monitoring of the following locations: • **SH1** – Shute Bay, west of the proposed development. • **SH2** – Shute Bay, to the north of the proposed marina entrance. • **SH3** – Shute Bay, west of the proposed marina entrance. • **SH4** – Shute Bay, south west of the end of the western wing of the proposed development. • **SH5** – Shute Bay, south of the proposed marina entrance. • **SH7** – Within the unnamed tributary north of the western end of the Proserpine Shute Harbour Road upgrade. • **SH8** – Within the unnamed tributary north of Proserpine Shute Harbour Road between FW1 and FW3. • **SH9** – Within the unnamed tributary north of the eastern end of the Proserpine Shute Harbour Road upgrade. • **SH10** – Within the unnamed tributary north of Proserpine Shute Harbour Road east of the site extent.

Issue:	Water Quality Management – Operational Phase
Monitoring (Cont):	Key water quality parameters to be monitored are: • pH; • Temperature; • Salinity; • Turbidity; • Dissolved Oxygen; • Suspended Solids; • Total Nitrogen; • Total Phosphorous; • Heavy Metals*; • Faecal Coliforms; • Total Organic Carbon*; • Dissolved Organic Carbon*; • Chlorophyll 'a'; • Ammonia*; • Oxidised Nitrogen*; • Reactive Phosphorus*; • Secchi Disk Depth; • Dissolved Inorganic Nitrogen*; • Total Aluminium; • Dissolved Aluminium; • Total Iron; • Dissolved Iron; and • Gross pollutants. * -To be monitored quarterly Note that additional water quality monitoring may be required if compliance with the water quality objectives for the site are not being met.
Auditing:	Reviews are to be carried out on a monthly basis to assess the implementation strategy. A checklist is to be completed which assesses the strategy against each of the monitoring points above.
Identification of Incident or Failure:	• Water discharged from the site falls below the long term WQOs. • Visual inspection identifying build up of sediment on and off the site. • Trigger levels exceeded. • Poorly maintained or damaged control devices.
Reporting:	A Water Quality Report for all water quality monitoring results and assessments shall be submitted to Council, following a monitoring campaign.

Issue:	**Water Quality Management – Operational Phase**
Corrective Action:	The source of contaminate is to be located immediately and the following measures implemented: • Isolation of contaminant, if possible, until remedial measures are fully implemented. • Increase rate of inspections, maintenance and clean-outs as appropriate. • Remove any floating debris in the waterbody. • Review of implementation strategy to ensure sufficiency and prevention of recurrence.

APPENDIX B

Maintenance Plan Details

APPENDIX B.1

MAINTENANCE CHECKLIST AND PLAN DETAILS

VEGETATED SWALE WITH UNDERLYING BIO-RETENTION SYSTEM

SWALE BIO-RETENTION MAINTENANCE CHECKLIST

Asset I.D.		
Inspection Frequency:	1 to 6 monthly	Date of Visit:
Location:		
Description:		
Site Visit by:		

INSPECTION ITEMS	Y	N	ACTION REQUIRED (DETAILS)
Sediment accumulation at inflow points?			
Litter within swale?			
Erosion at inlet or other key structures (eg crossovers)?			
Traffic damage present?			
Evidence of dumping (eg building waste)?			
Vegetation condition satisfactory (density, weeds etc)?			
Replanting required?			
Mowing required?			
Clogging of drainage points (sediment or debris)?			
Evidence of ponding?			
Set down from kerb still present?			
Damage/vandalism to structures present?			
Surface clogging visible?			
Drainage system inspected?			
Remulching of trees and shrubs required?			
Soil additives or amendments required?			
Pruning and/ or removal of dead or diseased vegetation required?			
Resetting of system required?			
COMMENTS			

Source: WSUD Technical Design Guidelines for South East Queensland – Version 1 June 2006 (Moreton Bay Waterways and Catchments Partnership)

MAINTENANCE PLAN DETAILS

BIO-RETENTION SYSTEM

SCHEDULE OF SITE VISITS													
Purpose of Visit	**Frequency**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Routine inspection	12/year	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Annual inspection	1/year				✓								
Routine maintenance	2/year				✓						✓		
Routine clean out of sediment	1 / 2 years				✓								

The above schedule is a guideline only. Routine clean out and maintenance should be scheduled based on the outcome of routine inspection.

INSPECTION	
1.	**Routine Inspection**
1.1	Routine inspection should be carried out on a regular monthly basis. The purpose of the inspection is to indicate when maintenance of the Bio retention system is required.
1.2	Inspections should consider erosion at the inlet or other key structures, clogging of the sand filter (may be seen due to evidence of ponding), accumulation of sediments at inflow points, litter within the basin, the existence of traffic damage and the condition of vegetation.
1.3	Complete appropriate Maintenance Form. Maintenance is required if clogging of the sand filter is excessive, if litter has accumulated within the basin, if any damage or vandalism to the structure is present or if the vegetation has grown too dense or has weeds.
2.	**Annual Inspection**
2.1	Once a year, the condition of the bio retention system should be closely inspected. Any damage or problems should be noted on the Maintenance Form for action.

ROUTINE MAINTENANCE	
1.	**Purpose**
1.1	Routine maintenance of the bio retention system involves weed control and the collection of any litter, removal of dead or diseased vegetation, and mulch replacement.
2.	**Weed Management**
2.1	If weeds have been observed during routine inspection, these weeds should be removed from the bio retention system. Weeding generally involves manual removal of perennial species.
2.2	The aim is to remove the weed including the roots when the weeds are less than 3 months old, otherwise weeds infestation rapidly occurs and is difficult to control.
2.3	Herbicides should not be used as they would contaminate the water in the creek.
2.4	The weeds should be disposed offsite at an appropriate waste management facility.
2.5	Replant appropriate plant species, where necessary, in areas that have been extensively weeded.

3.	**Litter Management**
3.1	Remove and dispose of litter that may be visible within and around the bio retention system.

4.	**Dead or Diseased Vegetation**
4.1	Remove or dispose of any dead or diseased vegetation within system
5.	**Mulch Replacement**
5.1	Mulch replacement is recommended when erosion is evident or the system looks unattractive.

CLEANOUT OF SEDIMENT	
1.	**Setup and Prepare Site for Cleanout**
1.1	Notify adjacent residents of cleanout at least three days prior to date of cleanout.
1.2	Setup equipment onsite.
2.	**Cleanout of Sediment**
2.1	The preferred method of cleanout of the bio retention system is replacing the clogged medium.
2.2	Position the equipment on the side of the system to allow easy access into the bio retention system and transfer of material into adjacent tipper truck. The truck should be positioned so that water from the truck body drains into the bio retention system.
2.3	Drain waste in the truck thoroughly before proceeding to the disposal point.

MAINTENANCE PLAN DETAILS

VEGETATED SWALE

SCHEDULE OF SITE VISITS													
Purpose of Visit	**Frequency**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Routine inspection	12/year	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Annual inspection	1/year				✓								
Routine maintenance	12/year	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

The above schedule is a guideline only. Routine maintenance should be scheduled based on the outcome of routine inspection.

INSPECTION	
1.	**Routine Inspection**
1.1	Routine inspection should be carried out on a regular monthly basis. The purpose of the inspection is to indicate when mowing/maintenance of the swale is required, if any erosion or scouring has occurred and to identify any build up of sediments or litter.
1.2	The length of grass in the swale should be assessed.
1.3	Complete appropriate Maintenance Form. Routine mowing/maintenance should be scheduled when the height of vegetation in the swale is excessive.
2.	**Annual Inspection**
2.1	Once a year, the condition of the swale should be closely inspected. Any damage or problems should be noted on the Maintenance Form for action.

ROUTINE MAINTENANCE	
1.	**Purpose**
1.1	Routine maintenance of the swale involves weed control, the collection of any litter, and the mowing of excessive vegetation.
2.	**Weed Management**
2.1	If weeds have been observed during routine inspection, these weeds should be removed from the swale. Weeding generally involves manual removal of perennial species.
2.2	The aim is to remove the weed including the roots when the weeds are less than 3 months old, otherwise weeds infestation rapidly occurs and is difficult to control.
2.3	Herbicides should not be used as they would contaminate the water in the discharging to the Broadwater.
2.4	The weeds should be disposed offsite at an appropriate waste management facility.
2.5	Replant appropriate plant species, where necessary, in areas that have been extensively weeded.
3.	**Litter Management**
3.1	Remove and dispose of litter that may be visible around the swale.
4.	*1.1.1.1.1 Mowing*
4.1	Mow excessive vegetation and dispose of mulch at any appropriate waste management facility.

APPENDIX B.2

MAINTENANCE CHECKLIST AND PLAN DETAILS

BIO-RETENTION BASIN

BIO-RETENTION BASIN MAINTENANCE CHECKLIST

Asset I.D.		
Inspection Frequency:	1 to 6 monthly	Date of Visit:
Location:		
Description:		
Site Visit by:		

INSPECTION ITEMS	Y	N	ACTION REQUIRED (DETAILS)
Sediment accumulation at inflow points?			
Litter within swale?			
Erosion at inlet or other key structures?			
Traffic damage present?			
Evidence of dumping (eg building waste)?			
Vegetation condition satisfactory (density, weeds etc)?			
Watering of vegetation required?			
Replanting required?			
Mowing/slashing required?			
Clogging of drainage points (sediment or debris)?			
Evidence of ponding?			
Damage/vandalism to structures present?			
Surface clogging visible?			
Drainage system inspected?			
Resetting of system required?			
COMMENTS			

Source: WSUD Technical Design Guidelines for South East Queensland – Version 1 June 2006 (Moreton Bay Waterways and Catchments Partnership)

MAINTENANCE PLAN DETAILS

BIO RETENTION BASIN

SCHEDULE OF SITE VISITS													
Purpose of Visit	**Frequency**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Routine inspection	12/year	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Annual inspection	1/year				✓								
Routine maintenance	2/year				✓						✓		
Routine clean out of sediment	1 / 2 years				✓								

The above schedule is a guideline only. Routine clean out and maintenance should be scheduled based on the outcome of routine inspection.

INSPECTION	
1.	**Routine Inspection**
1.1	Routine inspection should be carried out on a regular monthly basis. The purpose of the inspection is to indicate when maintenance of the Bio retention system is required.
1.2	Inspections should consider erosion, condition of vegetation, ponded water.
1.3	Complete appropriate Maintenance Form.
2.	**Annual Inspection**
2.1	Once a year, the condition of the bio retention system should be closely inspected. Any damage or problems should be noted on the Maintenance Form for action.

ROUTINE MAINTENANCE	
1.	**Purpose**
1.1	Routine maintenance of the bio retention system involves weed control and the collection of any litter, removal of dead or diseased vegetation, and mulch replacement.
2.	**Weed Management**
2.1	If weeds have been observed during routine inspection, these weeds should be removed from the bio retention system. Weeding generally involves manual removal of perennial species.
2.2	The aim is to remove the weed including the roots when the weeds are less than 3 months old, otherwise weeds infestation rapidly occurs and is difficult to control.
2.3	Herbicides should not be used as they would contaminate the water in the lake.
2.4	The weeds should be disposed offsite at appropriate waste management facility.
2.5	Replant appropriate plant species, where necessary, in areas that have been extensively weeded.
3.	**Litter Management**
3.1	Remove and dispose of litter that may be visible around the bio retention system.
4.	**Dead or Diseased Vegetation**
4.1	Remove or dispose of any dead or diseased vegetation within system
5.	**Mulch Replacement**
5.1	Mulch replacement is recommended when erosion is evident or system looks unattractive.

CLEANOUT OF SEDIMENT	
1.	**Setup and Prepare Site for Cleanout**
1.1	Notify adjacent residents of cleanout at least three days prior to date of cleanout.
1.2	Setup equipment onsite.
2.	**Cleanout of Sediment**
2.1	The preferred method of cleanout of the bio retention system is replacing the clogged medium.
2.2	Position the equipment on the side of the system to allow easy access into the bio retention system and transfer of material into adjacent tipper truck. The truck should be positioned so that water from the truck body drains into the bio retention system.
2.3	Drain waste in the truck thoroughly before proceeding to the disposal point.

APPENDIX B.3

MAINTENANCE CHECKLIST AND PLAN DETAILS

VEGETATED SWALE

VEGETATED SWALE MAINTENANCE CHECKLIST

Asset I.D.		
Inspection Frequency:	1 to 6 monthly	Date of Visit:
Location:		
Description:		
Site Visit by:		

INSPECTION ITEMS	Y	N	ACTION REQUIRED (DETAILS)
Sediment accumulation at inflow points?			
Litter within swale?			
Erosion at inlet or other key structures (eg crossovers)?			
Traffic damage present?			
Evidence of dumping (eg building waste)?			
Vegetation condition satisfactory (density, weeds etc)?			
Replanting required?			
Mowing required?			
Sediment accumulation at outlets?			
Clogging of drainage points (sediment or debris)?			
Evidence of ponding?			
Soil additives or amendments required?			
Pruning and/ or removal of dead or diseased vegetation required?			
COMMENTS			

Source: WSUD Technical Design Guidelines for South East Queensland – Version 1 June 2006 (Moreton Bay Waterways and Catchments Partnership)

MAINTENANCE PLAN DETAILS

VEGETATED SWALE

SCHEDULE OF SITE VISITS													
Purpose of Visit	**Frequency**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Routine inspection	12/year	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Annual inspection	1/year				✓								
Routine maintenance	12/year	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

The above schedule is a guideline only. Routine maintenance should be scheduled based on the outcome of routine inspection.

INSPECTION	
1.	**Routine Inspection**
1.1	Routine inspection should be carried out on a regular monthly basis. The purpose of the inspection is to indicate when mowing/maintenance of the swale is required.
1.2	The length of grass in the swale should be assessed.
1.3	Complete appropriate Maintenance Form. Routine mowing/maintenance should be scheduled when the height of vegetation in the swale is excessive.
2.	**Annual Inspection**
2.1	Once a year, the condition of the swale should be closely inspected. Any damage or problems should be noted on the Maintenance Form for action.

ROUTINE MAINTENANCE	
1.	**Purpose**
1.1	Routine maintenance of the swale involves weed control the collection of any litter, and mowing of excessive vegetation.
2.	**Weed Management**
2.1	If weeds have been observed during routine inspection, these weeds should be removed from the swale. Weeding generally involves manual removal of perennial species.
2.2	The aim is to remove the weed including the roots when the weeds are less than 3 months old, otherwise weeds infestation rapidly occurs and is difficult to control.
2.3	Herbicides should not be used as they would contaminate the water in the lake.
2.4	The weeds should be disposed offsite at appropriate waste management facility.
2.5	Replant appropriate plant species, where necessary, in areas that have been extensively weeded.
3.	**Litter Management**
3.1	Remove and dispose of litter that may be visible around the swale/buffer.
4.	**Mowing**
4.1	Mow excessive vegetation and dispose of mulch at any appropriate waste management facility.

APPENDIX B.4

MAINTENANCE PLAN DETAILS

OIL AND GREASE SEPERATOR

OIL AND GREASE SEPERATOR

SCHEDULE OF SITE VISITS													
Purpose of Visit	**Frequency**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Routine inspection	12/year	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Annual inspection	1/year				✓								
Routine maintenance	4/year	✓			✓			✓			✓		
Routine clean out of sediment	1 year				✓								

The above schedule is a guideline only. Routine clean out of sediment and gross pollutants should be scheduled based on the outcome of routine inspection and/or manufacturers guidelines.

INSPECTION	
1.	**Routine Inspection**
1.1	Routine inspection should be carried out on a regular monthly basis. The purpose of the inspection is to indicate when cleanout of the oil and grease collector is required.
1.2	The depth of oil and grease/sediment/gross pollutants in the oil and grease collector should be measured according to design specifications.
1.3	Complete an appropriate Maintenance Form. Routine cleanout of sediment/gross pollutants should be scheduled when the depth of sediment/gross pollutants in the oil and grease collector s exceeds design levels.
2.	**Annual Inspection**
2.1	Once a year, the condition of the oil and grease collector should be closely inspected. Any damage or problems should be noted on the Maintenance Form for action.

ROUTINE MAINTENANCE	
1.	**Purpose**
1.1	Routine maintenance of the oil and grease collector involves the collection of any weeds, oil, grease and gross pollutants, if required.
2.	**Weed Management**
2.1	If weeds have been observed during routine inspection, these weeds should be removed from the oil and grease collector. Weeding generally involves manual removal of perennial species.
2.2	The aim is to remove the weed including the roots when the weeds are less than 3 months old, otherwise weeds infestation rapidly occurs and is difficult to control.
2.3	Herbicides should not be used as they would contaminate the water in the creek.
2.4	The weeds should be disposed offsite at appropriate waste management facility.
2.5	Replant appropriate plant species, where necessary, in areas that have been extensively weeded.

3.	**Gross Pollutant Management**
3.1	Remove and dispose of gross pollutants that may be visible around the oil and grease collector perimeter.

CLEANOUT OF SEDIMENT	
1.	**Setup and Prepare Site for Cleanout**
1.1	Notify adjacent residents of cleanout at least three days prior to date of cleanout.
1.2	Setup equipment onsite including pump.
2.	**Cleanout of Sediment**
2.1	The preferred method of cleanout of the oil and grease collector is by using equipment as specified by oil and grease collector designer.
2.2	Position the equipment on the side of the oil and grease collector to allow easy access into the sediment area and transfer of material into adjacent tipper truck. The truck should be positioned so that water from the truck body drains into the oil and grease collector.
2.3	Drain waste in the truck thoroughly before proceeding to the disposal point.

APPENDIX B.5

MAINTENANCE PLAN DETAILS

MARINA MAINTENANCE PLANS

MARINA

SCHEDULE OF SITE VISITS													
Purpose of Visit	**Frequency**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Routine inspection	12/year	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Annual inspection	1/year				✓								

Two possible mechanisms that may trigger a maintenance requirement are, in some cases, interrelated. These are:

- A change in the physical characteristics. (That is significant variance in the water level and change in the area, depth or bed profile of the marina).
- A change in the physiochemical and/or biological characteristics of the marina waters to outside the recommended water quality standards as outlined in the SWMP.

For the marina the maintenance indicators can be split into water quality parameter indicators, measured by monitoring equipment, and observational indicators assessed by site inspections.

The water quality parameter indicators are specifically related to the required water quality for the health of the marina waters and for regulation of the discharge off the site. The SWMP has detailed monitoring requirements with the performance criteria.

INSPECTION	
1.	**Routine Inspection**
1.1	Routine inspection should be carried out on a regular monthly basis. The purpose of the inspection is to indicate when maintenance of the marina is required.
1.2	Inspections will be for the following indicators: • Algae • Weed growth • Nutrient Load • Sediment • Pests • Thermal Layering • Structural Integrity
1.3	Complete appropriate **Maintenance Form**. Routine maintenance should be scheduled when the performance indicators above shown a need for maintenance.
2.	**Annual Inspection**
2.1	Once a year, the condition of the marina should be closely inspected. Any damage or problems should be noted on the Maintenance Form for action.

MAINTENANCE	
1.	**General**
1.1	Maintenance of the marina involves: • Removal of material impacting on inlet/outlet structures • Maintenance of floodways, including sediment and cut grass removal/disposal • Monitoring and removal of floating and rooted exotic weed • Collection of any litter • Removal of any pests
2.	**Weed Management**
2.1	If weeds have been observed, these weeds should be removed from the marina. Weeding generally involves manual removal of perennial species.
2.2	The aim is to remove the weed including the roots when the weeds are less than 3 months old, otherwise weeds infestation rapidly occurs and is difficult to control.
2.3	Herbicides should be avoided as they would contaminate receiving waters of the Coral Sea.
2.4	The weeds should be disposed offsite at appropriate waste management facility.
2.5	Replant appropriate plant species, where necessary, in areas that have been extensively weeded.
3	**Pest Management**
3.1	If pests have been observed during routine inspection, these should be removed from the marina.
3.2	The aim is to ensure a healthy marina area, which does not detriment neighbouring human health and the Coral Sea receiving waters.
3.4	Removal procedures include: • Use of insect and fish predators • Reduce areas of breeding grounds • Increase DO levels • Seek professional advice • Ensure method is acceptable to local health authority
4.	**Litter Management**
4.1	Remove and dispose of litter that may be visible around the lake.
5	**Structure Management**
5.1	Check for signs of metal corrosion, concrete cancer and spalling. Obtain advice from an engineer for maintenance requirements.

Extreme Event Triggered Maintenance

Additional maintenance may be required if the marina area is subject to very extreme conditions outside normal operations or if, based on observational indicators and monitoring, the marina conditions are found to be outside acceptable standards. In summary, these events include:

- Flood events;
- Algae blooms;
- Fish kills; and
- Illegal dumping of waste.

Specific Event Triggered Maintenance issues are discussed below.

(a) Flood Inundation

In the event of flood inundation, the marina area may have received sediment loads, debris and infestation of floating weeds. Debris and floating weeds should be removed manually.

Flooding may also put considerable strain on the banks of the marina, particularly at the inlet structures. Areas that may have been damaged by erosion and scour should be corrected.

(b) Algal Blooms

Algae are an important aquatic plant in the ecological environment. Algae, of course, occur naturally; however several factors can exacerbate their numbers causing harm to other plant and animal life. Algal blooms are unlikely as the marina is not a fully enclosed system as the marina area remains open to the Coral Sea. Normal tidal changes are likely to reduce risk of algal blooms occuring. Possible causes of algal outbreaks include:

- Pollution of waterways with nutrients;
- Prolonged warm, sunny and calm weather; and
- Decomposition of organic matter in the marina.

Algal control methods depend very much on the level of algal growth. Maintenance measures are detailed below.

Trigger Level 1: Potentially Toxic Blue Green Cell Count approaches 2000 cells/mL
• Prevention is far better than treatment after the bloom has occurred. Hence at this level turnover mixing could be increased until numbers are brought back to lower levels. • Fertiliser activity should be limited. • Maintain regular monitoring
Trigger Level 2: Potentially Toxic Blue Green Cell Count exceeds 2000 cells/mL
• Fertiliser activity and sprinkling must be limited where possible in the vicinity of the site of concern. • Monitoring frequency to be increased at the affected site to once a week. • Harvest and land dispose of any dead fish.
Trigger Level 3: Potentially Toxic Blue Green Cell Count exceeds 15000 cells/mL
• All fertiliser activity and sprinkling must be stopped for all areas draining to the marina. • Warning signs to be posted around the marina, warning people to stay clear and to not drink or make contact with the water. • All neighbouring residents to be notified. • Monitoring frequency to be increased to weekly. • Follow the Queensland Governments '*Queensland Harmful Algal Bloom Operational Procedures*'. • Contingency measures are to be considered, including: - vertical mixing, through compressed air or mechanical mixing devices; - harvesting and land disposal of algae and dead fish; and - allowing the bloom to run its course.

(c) Fish Kills

Fish kills should not occur within the marina. Water quality monitoring as well as the observational indicators, should provide warning signs long before fish kills are evident. Also the marina is not a closed system, as such tidal effects from the Coral Sea should flush the marina area regularily.

Possible causes for fish kills are similar to the possible causes for algal outbreaks as detailed above. The requirements as for algae bloom trigger levels 2 & 3 should be enforced, (depending on the severity of water pollution) until the source of water pollution is identified and water quality restored.

In the event of fish kills, an environmental consultant should be contacted and water quality testing commenced immediately to identify the cause. Water samples should be taken carefully to ensure skin does not come in contact with the marina water.

(d) Illegal Dumping of Waste

The current proposed development proposes a treatment train arrangement that will trap the herbicide and pesticide use from a typical urban development.

In the unlikely event that there is a major spill of such chemicals within the development, the treatment train will provide some buffering before any substance will enter the marina.

In the event of an oil spill please refer to the Oil Spill Action Plan.

APPENDIX B.6

DRAFT OIL SPILL EMERGENCY ACTION PLAN FOR SHUTE HARBOUR

APPLICATION OF OIL SPILL EMERGENCY ACTION PLAN

This Oil Spill Emergency Action Plan applies to the Shute Harbour.

In the case of an oil spill involving a vessel which berths at or otherwise uses the Shute Harbour marina facility the responsibility for initial emergency action in the event of an oil spill shall lie with the Marina Manager.

In all other cases responsibility for initial emergency action in the event of an oil spill shall lie with the individual principally involved with the oil spill.

Equipment required for managing oil spills shall be stored at the marina.

Prior to the marina becoming operational Whitsunday Shire Council shall assume the responsibilities ascribed to the marina management by this Draft Oil Spill Emergency Action Plan and equipment required for managing oil spills shall be stored by Whitsunday Shire Council.

DEFINITION OF A SPILL OR SLICK

A small spill is broadly defined as less than 1 litre. A medium spill is 2-5 litres. Anything over 5 litres is serious and must be reported immediately to the Johnstone Shire Council Environmental Protection Department.

Small spills and drips can be dispersed using chemical dispersant, but it is preferable to utilise oil absorbent cloth, where possible.

In the event of a medium or serious oil spill being sighted at the Marina, the following action must be adhered to:

ACTION

- The Marina Manager or after hours Marina Security Manager, or in the event of their non-availability Whitsunday Shire Council Environmental Protection Department or after hours Whitsunday Shire Council Emergency Response System must be informed immediately to organise a response team.
- The spill must be contained by surrounding its perimeter with the **OIL SPILL BOOM**. If spillage occurs from a vessel, surround the entire area with the floating boom and deploy oil absorbent pads onto the slick.
- If spillage is within a berth area, contain the spill with the **OIL SPILL BOOM** and deploy oil absorbent pads onto the slick.
- Ensure **FIRE EXTINGUISHERS** are close at hand.
- Isolate the source of the oil/fuel leak. If a fuel line is leaking at the fuel wharf, shut down the valves on the supply lines and turn off electrical supply to the pumps. If fuel is leaking from a boat bilge, turn off the electrical bilge pump, isolate the batteries, open all hatches for venting off fumes.
- Keep any persons not involved with the containment operation well clear of the area. Under no circumstances allow any person to smoke or start engines of any vessels in the area.
- In the event of an oil spill for which the marina management is responsible for initial emergency action the Marina Manager/After Hours Security Manager will coordinate the operation and deploy all staff as deemed necessary and will keep the marina Managing

Director updated with events. In the event of an oil spill for which the marina management is not responsible for initial emergency action Whitsunday Shire Council Environmental Protection Department will coordinate the operation and deploy all staff as deemed necessary.

- In an event of an oil spill for which the marina management is responsible for initial emergency action the Managing Director or his appointee will make any decisions regarding notification of the appropriate authorities in the event of a large spill, ie Whitsunday Shire Council Environmental Protection Department, Maritime Safety Queensland, EPA. In the event of an oil spill for which the marina management is not responsible for initial emergency action Whitsunday Shire Council Environmental Protection Department will make such decisions.
- In the event of an oil spill for which the marina management is responsible for initial emergency action a full detailed report must be provided to the Managing Director within 24 hours.

FIRST AID PROCEDURES

In the event of a person being affected by the oil or fuel spill, the following first aid procedures can be referred to as a guide.

SYMPTOMS AND SIGNS

- Person may complain of a headache.
- Check may feel tight and person may find it difficult to breath.
- There may be facial swelling and redness (especially around the eyes).
- Pulse will be rapid.
- Person may feel nauseated and may be vomiting.
- In severe cases, person may lose consciousness or go into shock.

TREATMENT

Remove person from the area, restore fresh air and adequate breathing. Call the emergency service immediately. Loosen all tight clothing from around the neck and maintain open airway. If breathing becomes difficult, place the person in the recovery position. If they lose consciousness, employ resuscitation procedures if necessary. Be prepared to treat the person for shock. Arrange urgent removal to hospital.

APPENDIX C

Rational Method Calculations

Lawson and Treloar

Project Title: **Shute Harbor**
Subject: **Rational Method Hydrology Calculations** Job No.: **J8779**
Designer: **KCH** Check: **NIC** Date: **19/11/2007** Page: **of**

Rain Fall Data Used:

Location: **Whitsundays, QLD, Whitsundays**

AR&R Vol 2 1987 Parameters

Skewness	0.13
F2	4.05
F50	17.70

Time (hrs)	i_2 ($^{mm}/_{hr}$)	i_{50} ($^{mm}/_{hr}$)
1	56.70	110.40
12	13.50	30.00
72	5.00	11.60

Column and Variable Definition

Variable	**ARI (years)**						
	1	**2**	**5**	**10**	**20**	**50**	**100**
f_y	0.80	0.85	0.95	1.00	1.05	1.15	1.20

Catchment Data for Existing Catchment Conditions

Variable	**Value**	**Unit**
Area	48.33	ha
f_i	0.129	Fraction
C_{10}	0.726	Fraction

Catchment Discharges for Existing Catchment Conditions

Adopted Time: **25** Minutes (or 0.42 hours)

Variable	**ARI (Years)**						
	1	**2**	**5**	**10**	**20**	**50**	**100**
f_y	0.80	0.85	0.95	1.00	1.05	1.15	1.20
Intensity	66.8	86.4	111.5	126.7	146.9	174.0	195.1
Discharge	5.21	7.16	10.32	12.34	15.03	19.50	22.81

APPENDIX D

SOBEK Results

Existing situation with new channel
D02b - Proposed option 3
Tailwater = HAT

SOBEK Cross-section		Peak Waterlevel (m AHD)					
ID		100 Year ARI	50 Year ARI	20 Year ARI	10 Year ARI	5 Year ARI	2 Year ARI
12 & 13	2 x Culvert 1500mm						
CRS_23		4.88	4.81	4.71	4.61	4.50	4.33
CRS_22		4.88	4.81	4.70	4.60	4.49	4.33
CRS_21		4.81	4.73	4.62	4.52	4.41	4.24
CRS_20		4.74	4.66	4.54	4.44	4.33	4.16
CRS_19		4.67	4.59	4.47	4.37	4.25	4.08
CRS_18		4.60	4.52	4.40	4.29	4.17	4.00
CRS_17		4.55	4.46	4.34	4.23	4.11	3.94
11	Culvert 1200mm						
CRS_16		4.49	4.40	4.26	4.15	4.03	3.86
CRS_15		4.42	4.33	4.19	4.08	3.95	3.79
CRS_14		4.35	4.26	4.12	4.01	3.88	3.72
CRS_13		4.28	4.19	4.05	3.94	3.82	3.65
CRS_12		4.20	4.10	3.97	3.85	3.73	3.57
CRS_11		4.11	4.02	3.89	3.77	3.65	3.49
CRS_10		4.03	3.94	3.80	3.69	3.57	3.41
CRS_09		3.95	3.86	3.72	3.61	3.49	3.33
CRS_08		3.86	3.77	3.64	3.53	3.41	3.25
10	Culvert 900mm						
CRS_07		3.77	3.68	3.55	3.45	3.33	3.17
CRS_06		3.67	3.58	3.46	3.35	3.24	3.09
CRS_05		3.56	3.48	3.36	3.26	3.15	3.00
CRS_04		3.43	3.35	3.24	3.14	3.04	2.90
CRS_03		3.28	3.21	3.10	3.01	2.92	2.79
CRS_02		3.10	3.03	2.93	2.86	2.78	2.67
CRS_01		2.82	2.77	2.70	2.64	2.59	2.51
14	Culvert 1200mm						
CRS_35		3.13	3.03	2.91	2.83	2.75	2.65
CRS_36		3.06	2.95	2.83	2.75	2.67	2.57
CRS_37		2.98	2.88	2.76	2.67	2.59	2.49
CRS_38		2.93	2.84	2.72	2.63	2.54	2.45
CRS_39		2.89	2.81	2.69	2.61	2.52	2.44

Existing situation with new channel
D02b - Proposed option 3
Tailwater = HAT

SOBEK Cross-section		Peak Waterlevel (m AHD)					
Pre- ID		100 Year ARI	50 Year ARI	20 Year ARI	10 Year ARI	5 Year ARI	2 Year ARI
12	Culvert 1500mm						
CRS2_20		5.17	5.06	4.91	4.78	4.64	4.44
CRS2_19		5.17	5.06	4.91	4.78	4.64	4.44
CRS2_18		5.17	5.06	4.91	4.78	4.64	4.44
CRS2_17		5.17	5.06	4.91	4.78	4.64	4.44
CRS2_16		5.17	5.06	4.91	4.78	4.64	4.44
11	Culvert 1200mm						
CRS2_15		5.17	5.06	4.91	4.78	4.64	4.44
CRS2_14		5.17	5.06	4.91	4.78	4.64	4.51
CRS2_13		5.34	5.34	5.34	5.34	5.34	5.34
CRS2_12		5.88	5.88	5.88	5.88	5.88	5.88
CRS2_11		6.01	6.01	6.01	6.01	6.01	6.01
CRS2_10		5.99	5.99	5.99	5.99	5.99	5.99
CRS2_09		6.31	6.31	6.31	6.31	6.31	6.31
CRS2_08		6.48	6.48	6.48	6.48	6.48	6.48
CRS2_07		6.79	6.79	6.79	6.79	6.79	6.79
CRS2_06		7.25	7.25	7.25	7.25	7.25	7.25
CRS2_04		5.24	5.19	5.12	5.06	4.99	4.92
10	Culvert 900mm						
CRS2_05		6.47	6.47	6.47	6.47	6.47	6.47
CRS2_03		8.68	8.68	8.68	8.68	8.68	8.68
CRS2_02		9.63	9.63	9.63	9.63	9.63	9.63
13	Culvert 1500mm						
CRS2_21		5.17	5.06	4.91	4.78	4.64	4.44
CRS2_22		5.17	5.06	4.91	4.78	4.64	4.44
CRS2_23		5.17	5.06	4.91	4.78	4.64	4.44
CRS2_24		5.17	5.06	4.91	4.78	4.64	4.44
CRS2_25		5.55	5.55	5.55	5.55	5.55	5.55
CRS2_26		6.01	6.01	6.01	6.01	6.01	6.01
CRS2_27		6.29	6.29	6.29	6.29	6.29	6.29
CRS2_28		6.60	6.60	6.60	6.60	6.60	6.60
CRS2_29		6.71	6.71	6.71	6.71	6.71	6.71
CRS2_30		6.71	6.71	6.71	6.71	6.71	6.71
CRS2_31		6.62	6.62	6.62	6.62	6.62	6.62
CRS2_32		6.37	6.37	6.37	6.37	6.37	6.37
CRS2_33		6.32	6.26	6.19	6.13	6.08	6.07
CRS2_34		6.32	6.26	6.19	6.13	6.08	5.99
CRS2_35		6.32	6.26	6.19	6.13	6.08	5.99
14	Culvert 1200mm						
CRS2_36		6.25	6.17	6.06	5.98	5.90	5.78
CRS2_37		6.25	6.21	6.21	6.21	6.21	6.21
CRS2_38		7.19	7.19	7.19	7.19	7.19	7.19
CRS2_39		7.06	7.06	7.06	7.06	7.06	7.06

Existing situation with new channel
D02b - Proposed option 3
Tailwater = HAT

SOBEK Cross-section		Peak Water Depths (m)					
ID		100 Year ARI	50 Year ARI	20 Year ARI	10 Year ARI	5 Year ARI	2 Year ARI
12 & 13	2 x Culvert 1500mm						
CRS_23		1.48	1.41	1.31	1.21	1.10	0.93
CRS_22		1.38	1.31	1.20	1.10	0.99	0.83
CRS_21		1.39	1.31	1.20	1.10	0.99	0.83
CRS_20		1.40	1.32	1.21	1.11	0.99	0.83
CRS_19		1.41	1.33	1.21	1.11	0.99	0.83
CRS_18		1.43	1.34	1.22	1.11	0.99	0.83
CRS_17		1.46	1.37	1.24	1.13	1.01	0.84
11	Culvert 1200mm						
CRS_16		1.48	1.38	1.25	1.14	1.01	0.85
CRS_15		1.49	1.39	1.26	1.14	1.02	0.85
CRS_14		1.50	1.40	1.27	1.15	1.03	0.86
CRS_13		1.51	1.42	1.28	1.17	1.04	0.88
CRS_12		1.51	1.41	1.28	1.16	1.04	0.88
CRS_11		1.50	1.41	1.28	1.16	1.04	0.88
CRS_10		1.50	1.41	1.27	1.16	1.04	0.88
CRS_09		1.50	1.41	1.27	1.16	1.05	0.88
CRS_08		1.49	1.40	1.27	1.16	1.04	0.88
10	Culvert 900mm						
CRS_07		1.49	1.40	1.27	1.16	1.05	0.89
CRS_06		1.46	1.38	1.25	1.15	1.04	0.88
CRS_05		1.44	1.36	1.23	1.13	1.03	0.88
CRS_04		1.39	1.31	1.19	1.10	1.00	0.86
CRS_03		1.32	1.25	1.14	1.05	0.96	0.83
CRS_02		1.21	1.15	1.05	0.98	0.90	0.79
CRS_01		1.02	0.97	0.90	0.84	0.79	0.71
14	Culvert 1200mm						
CRS_35		0.93	0.83	0.71	0.63	0.55	0.45
CRS_36		0.96	0.85	0.73	0.65	0.57	0.47
CRS_37		0.98	0.88	0.76	0.67	0.59	0.49
CRS_38		1.03	0.94	0.82	0.73	0.64	0.55
CRS_39		1.09	1.01	0.89	0.81	0.72	0.64

Existing situation with new channel
D02b - Proposed option 3
Tailwater = HAT

SOBEK Cross-section		Peak Water Depths (m)					
Pre- ID		100 Year ARI	50 Year ARI	20 Year ARI	10 Year ARI	5 Year ARI	2 Year ARI
12	Culvert 1500mm						
CRS2_20		1.57	1.46	1.31	1.18	1.04	0.84
CRS2_19		1.57	1.46	1.31	1.18	1.04	0.84
CRS2_18		1.57	1.46	1.31	1.18	1.04	0.84
CRS2_17		1.57	1.46	1.31	1.18	1.04	0.84
CRS2_16		1.57	1.46	1.31	1.18	1.04	0.84
11	Culvert 1200mm						
CRS2_15		1.64	1.52	1.38	1.25	1.11	0.91
CRS2_14		0.66	0.55	0.40	0.28	0.14	0.00
CRS2_13		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_12		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_11		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_10		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_09		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_08		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_07		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_06		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_04		0.40	0.34	0.27	0.21	0.14	0.07
10	Culvert 900mm						
CRS2_05		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_03		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_02		0.00	0.00	0.00	0.00	0.00	0.00
13	Culvert 1500mm						
CRS2_21		1.57	1.46	1.31	1.18	1.04	0.84
CRS2_22		1.57	1.46	1.31	1.18	1.04	0.84
CRS2_23		1.72	1.61	1.46	1.33	1.19	0.99
CRS2_24		1.07	0.96	0.81	0.68	0.54	0.35
CRS2_25		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_26		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_27		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_28		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_29		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_30		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_31		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_32		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_33		0.25	0.19	0.12	0.07	0.02	0.00
CRS2_34		0.56	0.50	0.43	0.38	0.33	0.24
CRS2_35		0.80	0.74	0.66	0.61	0.56	0.47
14	Culvert 1200mm						
CRS2_36		0.57	0.49	0.38	0.30	0.21	0.10
CRS2_37		0.05	0.00	0.00	0.00	0.00	0.00
CRS2_38		0.00	0.00	0.00	0.00	0.00	0.00
CRS2_39		0.00	0.00	0.00	0.00	0.00	0.00

Existing situation with new channel
D02b - Proposed option 3
Tailwater = HAT

SOBEK Cross-section		Peak Flow (m3/s)					
ID		100 Year ARI	50 Year ARI	20 Year ARI	10 Year ARI	5 Year ARI	2 Year ARI
12 & 13	2 x Culvert 1500mm	3.80	3.46	2.95	2.49	2.00	1.39
CRS_23		0.79	0.67	0.55	0.38	0.20	0.05
CRS_22		7.54	6.85	5.84	4.94	3.98	2.77
CRS_21		7.53	6.85	5.83	4.94	3.98	2.76
CRS_20		7.53	6.84	5.83	4.94	3.98	2.76
CRS_19		7.53	6.84	5.83	4.93	3.98	2.76
CRS_18		7.53	6.84	5.82	4.93	3.97	2.76
CRS_17		7.54	6.84	5.82	4.93	3.97	2.76
11	Culvert 1200mm	1.26	0.79	0.34	0.12	0.02	0.00
CRS_16		8.75	7.60	6.15	5.05	3.99	2.76
CRS_15		8.76	7.60	6.15	5.05	3.99	2.76
CRS_14		8.76	7.61	6.15	5.05	3.99	2.77
CRS_13		9.70	8.42	6.77	5.55	4.41	3.08
CRS_12		9.70	8.42	6.77	5.55	4.41	3.07
CRS_11		9.70	8.42	6.77	5.55	4.41	3.07
CRS_10		9.70	8.42	6.77	5.55	4.41	3.07
CRS_09		9.94	8.62	6.92	5.68	4.51	3.15
CRS_08		9.94	8.62	6.92	5.68	4.51	3.15
10	Culvert 900mm	3.80	3.46	2.95	2.49	2.00	1.39
CRS_07		10.29	8.92	7.15	5.87	4.66	3.26
CRS_06		10.29	8.93	7.15	5.87	4.66	3.26
CRS_05		10.73	9.31	7.45	6.12	4.87	3.40
CRS_04		10.73	9.31	7.45	6.12	4.87	3.40
CRS_03		10.73	9.31	7.45	6.12	4.87	3.40
CRS_02		10.73	9.31	7.45	6.12	4.87	3.40
CRS_01		10.73	9.31	7.45	6.12	4.87	3.40
14	Culvert 1200mm	2.21	1.95	1.59	1.33	1.08	0.75
CRS_35		2.21	1.94	1.59	1.33	1.08	0.75
CRS_36		2.21	1.94	1.59	1.33	1.08	0.75
CRS_37		2.21	1.94	1.58	1.32	1.08	0.75
CRS_38		2.21	1.94	1.58	1.32	1.08	0.75
CRS_39		2.21	1.94	1.58	1.32	1.08	0.75

Existing situation with new channel
D02b - Proposed option 3
Tailwater = HAT

SOBEK Cross-section		Peak Velocity (m3/s)					
ID		100 Year ARI	50 Year ARI	20 Year ARI	10 Year ARI	5 Year ARI	2 Year ARI
12 & 13	2 x Culvert 1500mm	2.15	1.98	1.81	1.67	1.54	1.36
CRS_23		0.13	0.11	0.09	0.06	0.06	0.05
CRS_22		0.78	0.77	0.74	0.71	0.67	0.61
CRS_21		0.77	0.76	0.74	0.71	0.67	0.61
CRS_20		0.77	0.76	0.74	0.71	0.67	0.61
CRS_19		0.76	0.75	0.73	0.71	0.67	0.61
CRS_18		0.69	0.68	0.66	0.64	0.61	0.55
CRS_17		0.73	0.73	0.70	0.68	0.65	0.59
11	Culvert 1200mm	1.11	0.69	0.30	0.11	0.02	0.00
CRS_16		0.80	0.77	0.73	0.69	0.65	0.59
CRS_15		0.80	0.77	0.72	0.69	0.64	0.59
CRS_14		0.80	0.77	0.72	0.68	0.64	0.58
CRS_13		0.85	0.82	0.77	0.73	0.69	0.62
CRS_12		0.86	0.82	0.78	0.73	0.69	0.62
CRS_11		0.86	0.82	0.78	0.74	0.69	0.62
CRS_10		0.86	0.83	0.78	0.74	0.69	0.62
CRS_09		0.88	0.85	0.80	0.75	0.70	0.63
CRS_08		0.89	0.86	0.80	0.76	0.71	0.64
10	Culvert 900mm	2.15	1.98	1.81	1.67	1.54	1.36
CRS_07		0.93	0.89	0.83	0.78	0.73	0.65
CRS_06		0.95	0.91	0.85	0.79	0.74	0.66
CRS_05		1.02	0.97	0.90	0.84	0.78	0.69
CRS_04		1.08	1.02	0.95	0.88	0.81	0.71
CRS_03		1.16	1.11	1.02	0.94	0.86	0.75
CRS_02		1.33	1.26	1.15	1.06	0.95	0.81
CRS_01		1.74	1.63	1.46	1.31	1.16	0.93
14	Culvert 1200mm	2.63	2.53	2.41	2.32	2.23	2.10
CRS_35		2.41	2.37	2.31	2.23	2.12	1.91
CRS_36		2.32	2.28	2.22	2.15	2.06	1.83
CRS_37		2.24	2.19	2.12	2.05	1.96	1.72
CRS_38		2.13	2.05	1.94	1.85	1.77	1.48
CRS_39		2.32	2.18	2.01	1.88	1.75	1.34

APPENDIX E

Water Quality Results

APPENDIX E.1

Water Quality Results from 08/06/07 Campaign

Water Quality Results as sampled 8/6/2007 for Shute Harbour

Site	Temperature (^{o}C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	pH	Conductivity (mS/cm)	Salinity (ppt)	Turbidity (NTU)
SW1	22.00	-	101.8	8.04	61.400	-	2.78
SW2	23.00	-	101.8	8.16	61.900	-	3.36
SW3	23.00	-	98.9	8.12	61.600	-	3.81
SW4	21.00	-	101.9	8.15	61.900	-	3.25
SW5	22.00	-	100.8	8.14	61.500	-	3.55
SW6	24.00	-	100.4	8.10	62.400	-	1.35
SW7	21.00	-	98.7	8.07	62.100	-	5.55
SW8	23.00	-	102.1	8.12	62.300	-	1.67

Site	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Suspended Solids (mg/L)	Chlorophyll a (mg/m3)	Faecal Coliforms (orgs/100mL)
SW1	0.1	**0.06**	**36**	<2	<2
SW2	<0.1	**0.04**	**18**	<2	<2
SW3	<0.1	0.03	**18**	<2	6
SW4	<0.1	0.03	**18**	<2	<2
SW5	<0.1	0.02	**16**	<2	<2
SW6	<0.1	0.03	15	<2	<2
SW7	0.0	0.00	0	<2	0
SW8	0.0	0.00	0	<2	0

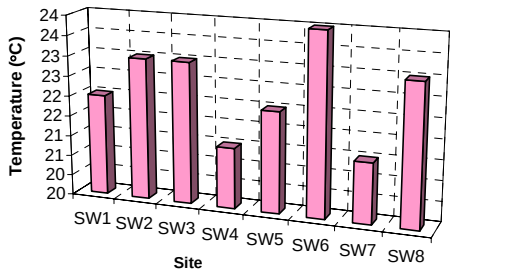
Water Quality Objectives

pH: 8.0 - 8.4
Dissolved Oxygen: 90 - 110%
Total Phosphorous: 0.02 mg/L
Total Nitrogen: 0.2 mg/L
Turbidity: 6 NTU
Suspended Solids: 15 mg/L
Faecal Coliforms: 150 cells / 100 mL Primary Contact

Additional Guidelines for Water Quality

Dissolved Oxygen: >6 mg/L (ANZECC, 1992)
Conductivity: <2.2 mS/cm for Fresh Water (ANZECC, 2000)
Salinity: <1.2 ppt for Fresh Water (ANZECC, 2000)
NO_x: <0.06 (ANZECC, 2000)

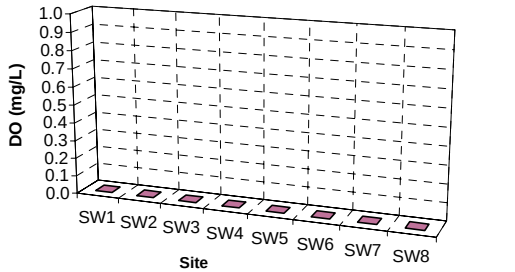
Temperature



	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
8/06/2007	22	23	23	21	22	24	21	23

Dissolved Oxygen

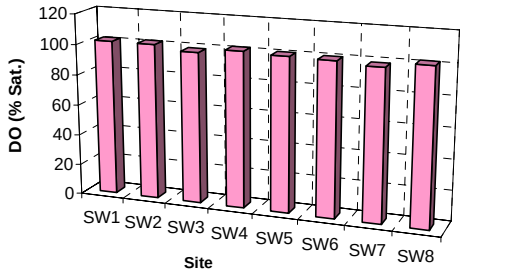
Guideline
>6.0 mg/L



	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
8/06/2007	0	0	0	0	0	0	0	0

Dissolved Oxygen

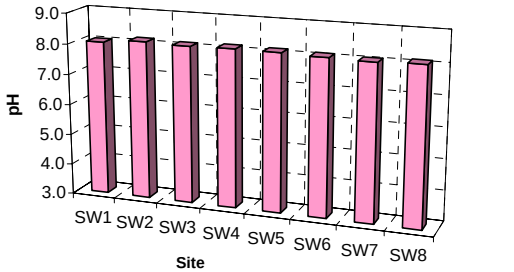
WQO
80 - 110 %



	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
8/06/2007	101.8	101.8	98.9	101.9	100.8	100.4	98.7	102.1

pH

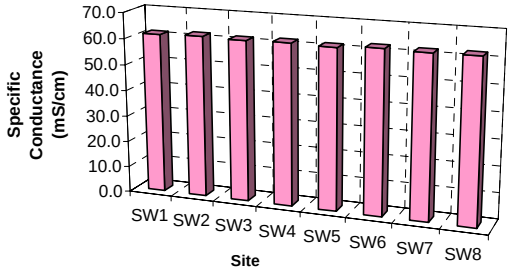
WQO
6.5 - 8.5



	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
8/06/2007	8.04	8.16	8.12	8.15	8.14	8.1	8.07	8.12

Specific Conductance

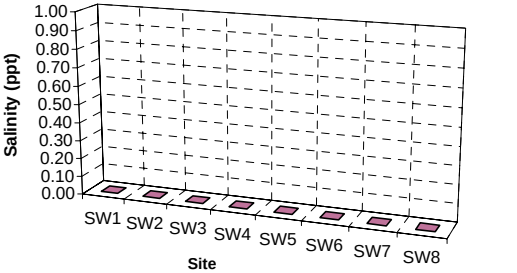
Guideline
2.2 mS/cm



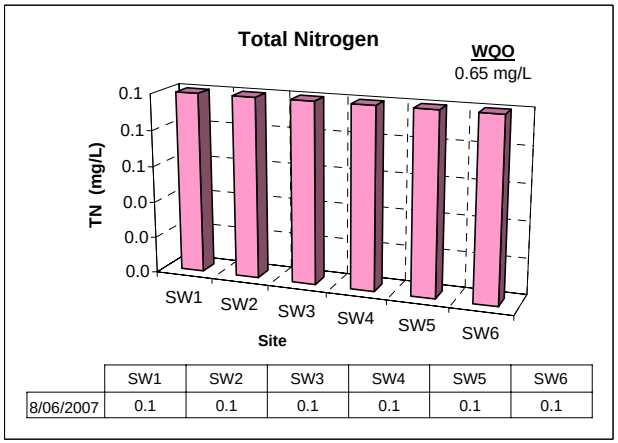
	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
8/06/2007	61.4	61.9	61.6	61.9	61.5	62.4	62.1	62.3

Salinity

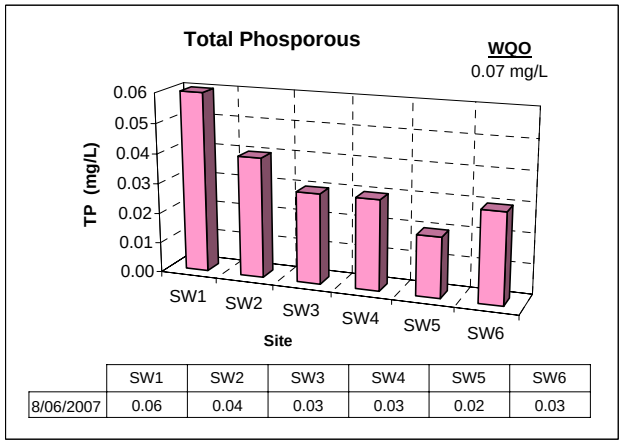
Guideline
1.2 ppt



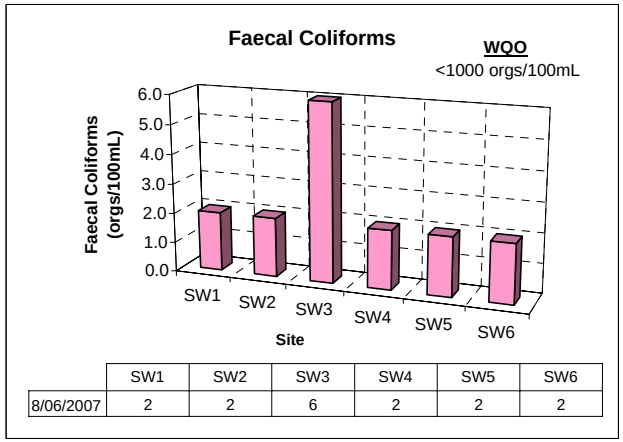
	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
8/06/2007	0	0	0	0	0	0	0	0



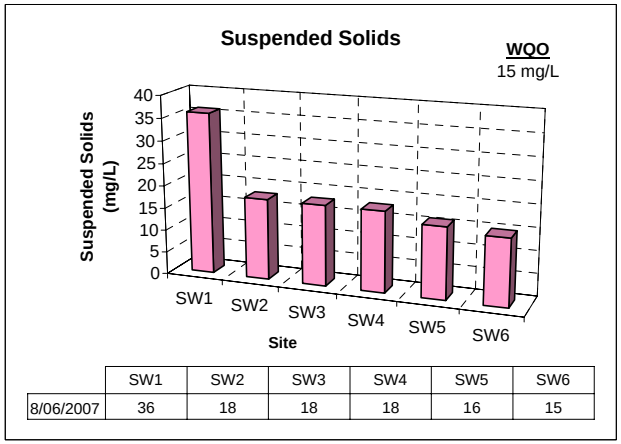
	SW1	SW2	SW3	SW4	SW5	SW6
8/06/2007	0.1	0.1	0.1	0.1	0.1	0.1



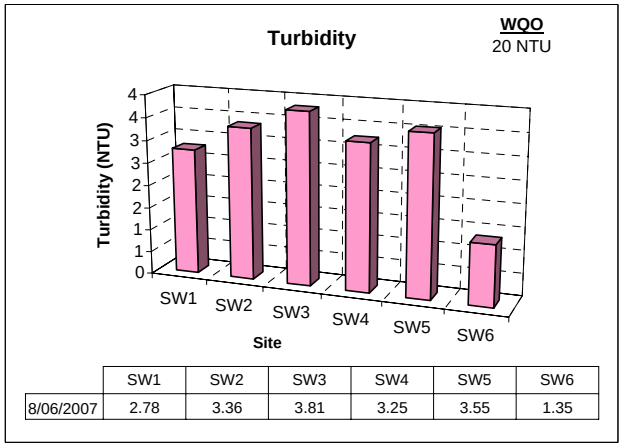
	SW1	SW2	SW3	SW4	SW5	SW6
8/06/2007	0.06	0.04	0.03	0.03	0.02	0.03



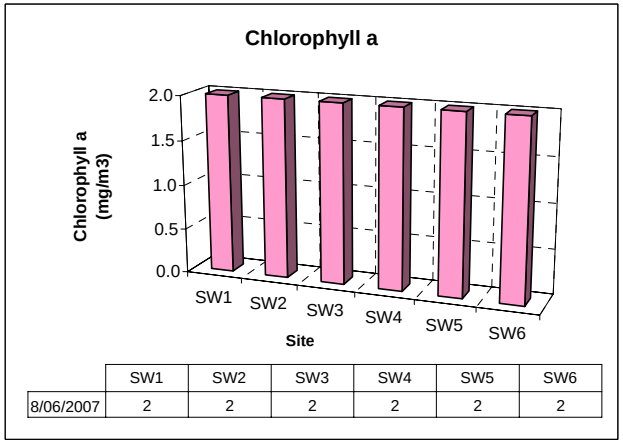
	SW1	SW2	SW3	SW4	SW5	SW6
8/06/2007	2	2	6	2	2	2



	SW1	SW2	SW3	SW4	SW5	SW6
8/06/2007	36	18	18	18	16	15



	SW1	SW2	SW3	SW4	SW5	SW6
8/06/2007	2.78	3.36	3.81	3.25	3.55	1.35



	SW1	SW2	SW3	SW4	SW5	SW6
8/06/2007	2	2	2	2	2	2

APPENDIX E.2

Water Quality Results from 05/09/07 Campaign

Water Quality Results as sampled 5/9/2007 for Shute Harbour

Site	Temperature (^{o}C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	pH	Conductivity (mS/cm)	Salinity (ppt)	Turbidity (NTU)
SW1	22.00	-	98.7	-	57.500	-	**6.19**
SW2	21.00	-	94.0	8.04	58.000	-	4.81
SW3	22.00	-	88.5	-	56.600	-	4.22
SW4	22.00	-	89.5	8.01	58.100	-	4.23
SW5	21.00	-	88.9	8.02	55.400	-	4.67
SW6	22.00	-	91.1	-	55.900	-	3.23
SW7	22.00	-	100.3	-	57.500	-	**6.11**
SW8	21.00	-	**87.5**	-	54.300	-	4.37

Site	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Suspended Solids (mg/L)	Chlorophyll a (mg/m3)	Faecal Coliforms (orgs/100mL)
SW1	<0.1	<0.01	**37**	<2	22
SW2	<0.1	<0.01	**34**	<2	6
SW3	<0.1	<0.01	**122**	<2	<1
SW4	<0.1	<0.01	**55**	<2	4
SW5	<0.1	<0.01	**44**	<2	<1
SW6	<0.1	<0.01	**40**	<2	<1
SW7	0.0	0.00	0	<2	0
SW8	0.0	0.00	0	<2	0

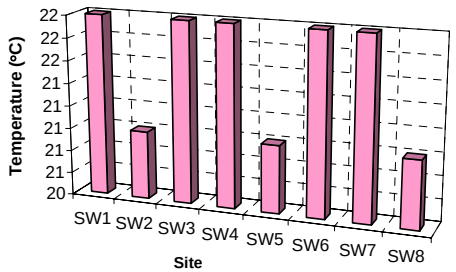
Water Quality Objectives

pH: 8.0 - 8.4
Dissolved Oxygen: 90 - 110%
Total Phosphorous: 0.02 mg/L
Total Nitrogen: 0.2 mg/L
Turbidity: 6 NTU
Suspended Solids: 15 mg/L
Faecal Coliforms: 150 cells / 100 mL Primary Contact

Additional Guidelines for Water Quality

Dissolved Oxygen: >6 mg/L (ANZECC, 1992)
Conductivity: <2.2 mS/cm for Fresh Water (ANZECC, 2000)
Salinity: <1.2 ppt for Fresh Water (ANZECC, 2000)
NO_x: <0.06 (ANZECC, 2000)

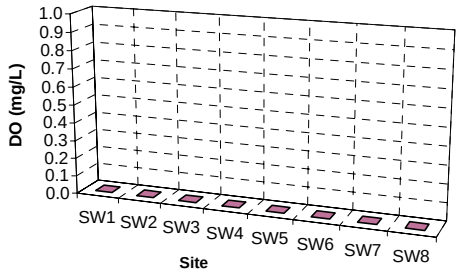
Temperature



	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
5/09/2007	22	21	22	22	21	22	22	21

Dissolved Oxygen

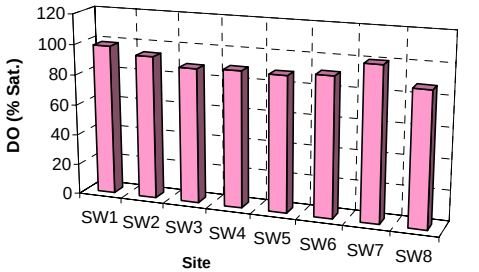
Guideline
>6.0 mg/L



	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
5/09/2007	0	0	0	0	0	0	0	0

Dissolved Oxygen

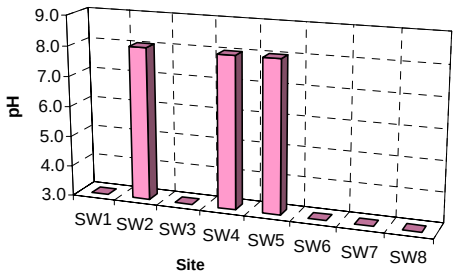
WQO
80 - 110 %



	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
5/09/2007	98.7	94	88.5	89.5	88.9	91.1	100.3	87.5

pH

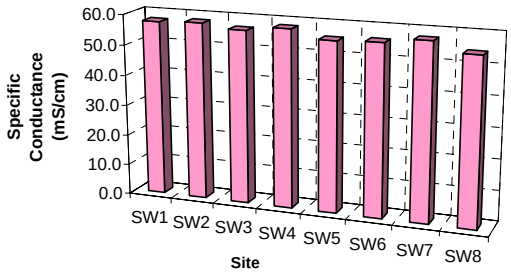
WQO
6.5 - 8.5



	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
5/09/2007	0	8.04	0	8.01	8.02	0	0	0

Specific Conductance

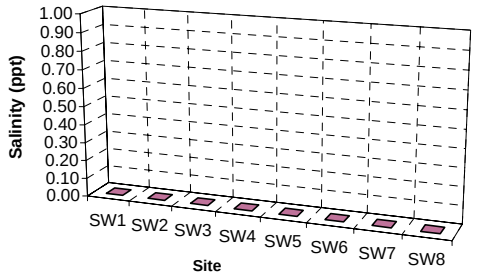
Guideline
2.2 mS/cm



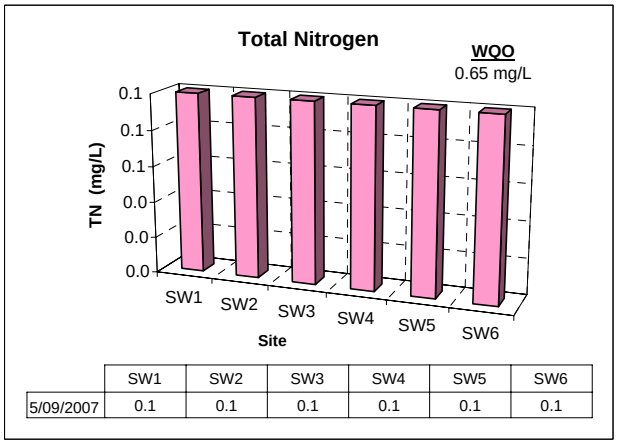
	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
5/09/2007	57.5	58	56.6	58.1	55.4	55.9	57.5	54.3

Salinity

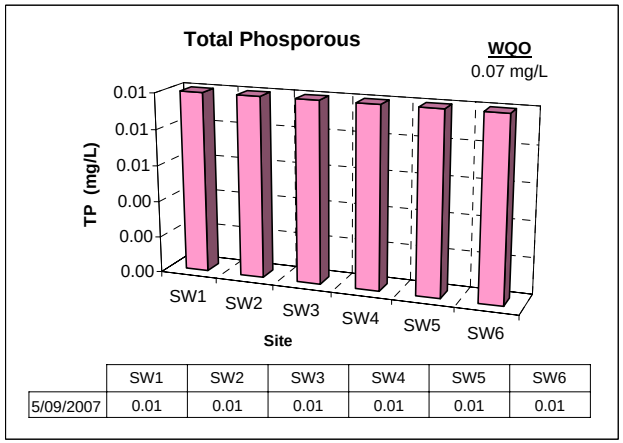
Guideline
1.2 ppt



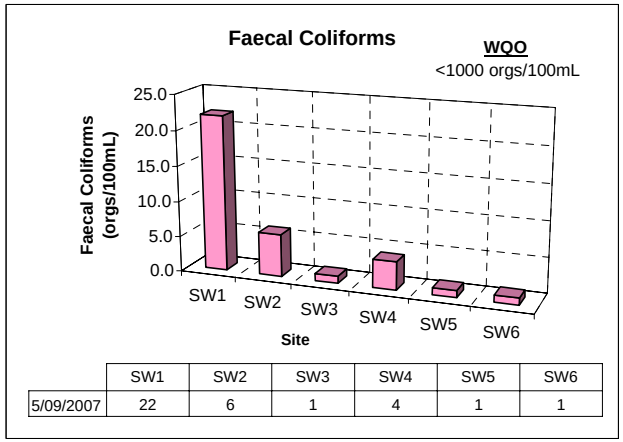
	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
5/09/2007	0	0	0	0	0	0	0	0



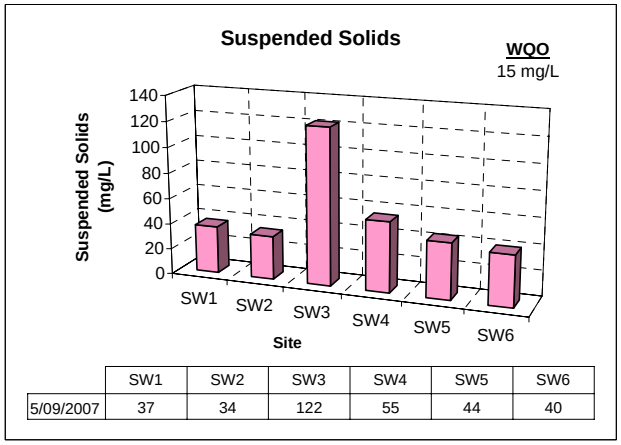
	SW1	SW2	SW3	SW4	SW5	SW6
5/09/2007	0.1	0.1	0.1	0.1	0.1	0.1



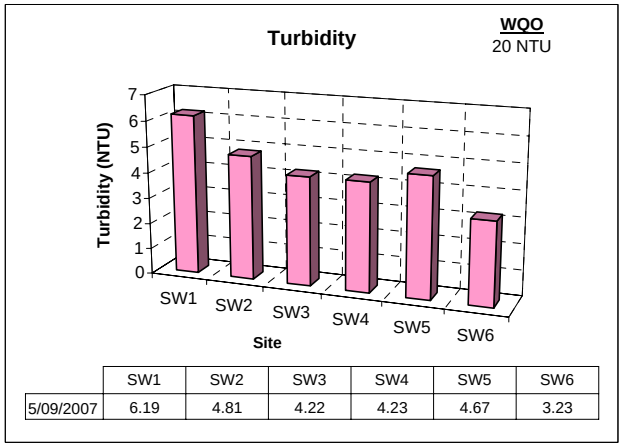
	SW1	SW2	SW3	SW4	SW5	SW6
5/09/2007	0.01	0.01	0.01	0.01	0.01	0.01



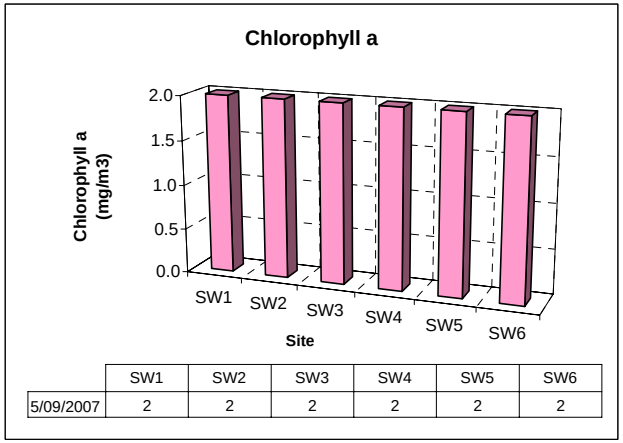
	SW1	SW2	SW3	SW4	SW5	SW6
5/09/2007	22	6	1	4	1	1



	SW1	SW2	SW3	SW4	SW5	SW6
5/09/2007	37	34	122	55	44	40



	SW1	SW2	SW3	SW4	SW5	SW6
5/09/2007	6.19	4.81	4.22	4.23	4.67	3.23



	SW1	SW2	SW3	SW4	SW5	SW6
5/09/2007	2	2	2	2	2	2

APPENDIX E.3

Water Quality Median Results

Water Quality Median Results as sampled from 8/6/2007 to 5/9/2007 for Shute Harbour Marina Development

Site	Temperature (^{o}C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	pH	Conductivity (mS/cm)	Salinity (ppt)	Turbidity (NTU)
SW1	22.00	-	100.3	8.04	59.450	-	4.485
SW2	22.00	-	97.9	8.10	59.950	-	4.085
SW3	22.50	-	93.7	8.12	59.100	-	4.015
SW4	21.50	-	95.7	8.08	60.000	-	3.74
SW5	21.50	-	94.9	8.08	58.450	-	4.11
SW6	23.00	-	95.8	8.10	59.150	-	2.29
SW7	21.50	-	99.5	8.07	59.800	-	5.83
SW8	22.00	-	94.8	8.12	58.300	-	3.02

Site	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Suspended Solids (mg/L)	Chlorophyll a (mg/m3)	Faecal Coliforms (orgs/100mL)
SW1	0.1	**0.04**	**36.5**	2	12
SW2	0.1	**0.03**	**26**	2	4
SW3	0.1	0.02	**70**	2	3.5
SW4	0.1	0.02	**36.5**	2	3
SW5	0.1	0.02	**30**	2	1.5
SW6	0.1	0.02	**27.5**	2	1.5
SW7	0.1	0.02	**64**	2	4
SW8	0.1	0.02	**33.5**	2	6

Water Quality Objectives

pH: 8.0 - 8.4
Dissolved Oxygen: 90 - 110%
Total Phosphorous: 0.02 mg/L
Total Nitrogen: 0.2 mg/L
Turbidity: 6 NTU
Suspended Solids: 15 mg/L
Faecal Coliforms: 150 cells / 100 mL Primary Contact

Additional Guidelines for Water Quality

Dissolved Oxygen: >6 mg/L (ANZECC, 1992)
Conductivity: <2.2 mS/cm for Fresh Water (ANZECC, 2000)
Salinity: <1.2 ppt for Fresh Water (ANZECC, 2000)
NO_x: <0.06 (ANZECC, 2000)

APPENDIX E.4

ALS Laboratory Results

ALS Environmental

CERTIFICATE OF ANALYSIS

Client	: **CARDNO ULLMAN & NOLAN GEOTECHNIC PTY LTD**	*Laboratory*	: **Environmental Division Brisbane**	*Page*	: **1 of 11**
Contact	: **MR ANDREW WILLIAMS**	*Contact*	: **Tim Kilmister**	*Work Order*	: **EB0706556**
Address	: **PO BOX 5630 MMC MACKAY QLD AUSTRALIA 4741**	*Address*	: **32 Shand Street Stafford QLD Australia 4053**		
E-mail	: **soils@cardno.com.au**	*E-mail*	: **Services.Brisbane@alsenviro.com**		
Telephone	: **49525255**	*Telephone*	: **61-7-3243 7222**		
Facsimile	: **49525455**	*Facsimile*	: **61-7-3243 7259**		
Project	: **U22053**	*Quote number*	: **EN/024/07**	*Date received*	: **14 Jun 2007**
Order number	: **UN 1511**			*Date issued*	: **25 Jun 2007**
C-O-C number	: **- Not provided -**			*No. of samples*	- *Received* : **26**
Site	: **Shute Harbour**				*Analysed* : **26**

ALSE - Excellence in Analytical Testing

NATA Accredited Laboratory 825

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Accredited for compliance with ISO/IEC 17025.

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	*Position*	*Department*
Ankit Joshi		**Inorganics - NATA 825 (10911 - Sydney)**
Carsten Emrich	**Senior Organic Chemist**	**Organics - NATA 825 (818 - Brisbane)**
Kim McCabe	**Senior Inorganic Chemist**	**Inorganics - NATA 825 (818 - Brisbane)**
Stephen Hislop	**Senior Inorganic Chemist**	**Inorganics - NATA 825 (818 - Brisbane)**

Comments

This report for the ALSE reference EB0706556 supersedes any previous reports with this reference. Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- **Analytical Results for Samples Submitted**
- **Surrogate Recovery Data**

The analytical procedures used by ALS Environmental have been developed from established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insuffient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting. * Indicates failed Surrogate Recoveries.

Specific comments for Work Order **EB0706556**

It has been noted that DOC is greater than TOC for various samples, however this difference is within the limits of experimental variation.
EK071F for batch EB0706556-001 - 008; LOR raised x5 due to sample matrix interferences

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: SW1	SW2	SW3	SW4	SW5
Sample Matrix Type / Description:				WATER	WATER	WATER	WATER	WATER
Sample Date / Time:				7 Jun 2007 15:00	7 Jun 2007 15:00	7 Jun 2007 11:00	7 Jun 2007 11:00	7 Jun 2007 11:00
Laboratory Sample ID:				EB0706556-001	EB0706556-002	EB0706556-003	EB0706556-004	EB0706556-005
EA025: Suspended Solids								
Suspended Solids (SS)		1	mg/L	36	18	18	18	16
EG005F: Dissolved Metals by ICP-AES								
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG005T: Total Metals by ICP-AES								
Iron	7439-89-6	0.05	mg/L	0.07	0.07	0.06	0.06	0.13
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.01	0.01	0.02	0.03	0.02
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.07	0.08	0.07	0.08	0.10
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.003	0.002	0.001
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	0.006	0.006	0.006	0.006	0.005
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0002	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	0.005	0.006	0.006	0.006	0.006
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.001	0.001	0.001
Copper	7440-50-8	0.001	mg/L	0.003	0.007	0.006	0.006	0.007
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.001
Manganese	7439-96-5	0.001	mg/L	0.002	0.002	0.002	0.002	0.003
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	0.011	0.012	0.010	0.012	0.013
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055: Ammonia as N								
Ammonia as N	7664-41-7	0.010	mg/L	0.040	0.030	0.036	0.032	0.030
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N		0.010	mg/L	<0.010	0.016	0.013	<0.010	0.012
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N		0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
EK062: Total Nitrogen as N (TKN + NOx)								
Total Nitrogen as N		0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
EK063: Inorganic Nitrogen as N (Ammonia + NOx)								
Inorganic Nitrogen as N		0.01	mg/L	0.04	0.04	0.05	0.03	0.04
EK067: Total Phosphorus as P								
Total Phosphorus as P		0.01	mg/L	0.06	0.04	0.03	0.03	0.02

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: SW1	SW2	SW3	SW4	SW5
Sample Matrix Type / Description:				WATER	WATER	WATER	WATER	WATER
Sample Date / Time:				7 Jun 2007 15:00	7 Jun 2007 15:00	7 Jun 2007 11:00	7 Jun 2007 11:00	7 Jun 2007 11:00
Laboratory Sample ID:				EB0706556-001	EB0706556-002	EB0706556-003	EB0706556-004	EB0706556-005
EK071: Reactive Phosphorus as P (Dissolved)								
Reactive Phosphorus - Filtered		0.010	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon		1	mg/L	<1	2	<1	2	<1
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon		1	mg/L	1	1	1	1	1
EP020: Oil and Grease (O&G)								
Oil & Grease		5	mg/L	<5	<5	<5	<5	<5
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction		20	µg/L	<20	<20	<20	<20	<20
C10 - C14 Fraction		50	µg/L	<50	<50	<50	<50	<50
C15 - C28 Fraction		100	µg/L	<100	<100	<100	<100	<100
C29 - C36 Fraction		50	µg/L	<50	<50	<50	<50	<50
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	120	115	108	112	118
Toluene-D8	2037-26-5	0.1	%	107	103	94.5	97.3	102
4-Bromofluorobenzene	460-00-4	0.1	%	108	105	98.4	98.9	105

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: SW6	SW7	SW8	S1	S1b
Sample Matrix Type / Description:				WATER	WATER	WATER	WATER	WATER
Sample Date / Time:				7 Jun 2007 15:00	7 Jun 2007 11:00	7 Jun 2007 15:00	7 Jun 2007 15:00	7 Jun 2007 15:00
Laboratory Sample ID:				EB0706556-006	EB0706556-007	EB0706556-008	EB0706556-009	EB0706556-010
EA025: Suspended Solids								
Suspended Solids (SS)		1	mg/L	15	20	16	18	20
EG005F: Dissolved Metals by ICP-AES								
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	----	----
EG005T: Total Metals by ICP-AES								
Iron	7439-89-6	0.05	mg/L	<0.05	0.13	<0.05	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.01	0.03	0.01	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.05	0.15	0.05	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L	0.006	0.006	0.006	----	----
Cadmium	7440-43-9	0.0001	mg/L	0.0002	0.0005	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	0.006	0.006	0.006	----	----
Cobalt	7440-48-4	0.001	mg/L	0.001	0.001	0.001	----	----
Copper	7440-50-8	0.001	mg/L	0.008	0.009	0.008	----	----
Lead	7439-92-1	0.001	mg/L	0.002	0.006	0.001	----	----
Manganese	7439-96-5	0.001	mg/L	0.001	0.003	0.001	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	0.017	0.038	0.017	----	----
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	0.0001	<0.0001	<0.0001	----	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	0.010	mg/L	0.021	0.032	0.023	----	----
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N		0.010	mg/L	<0.010	<0.010	<0.010	----	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N		0.1	mg/L	<0.1	<0.1	<0.1	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
Total Nitrogen as N		0.1	mg/L	<0.1	<0.1	<0.1	----	----
EK063: Inorganic Nitrogen as N (Ammonia + NOx)								
Inorganic Nitrogen as N		0.01	mg/L	0.02	0.03	0.02	----	----
EK067: Total Phosphorus as P								
Total Phosphorus as P		0.01	mg/L	0.03	0.03	0.02	----	----

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: SW6	SW7	SW8	S1	S1b
Sample Matrix Type / Description:				WATER	WATER	WATER	WATER	WATER
Sample Date / Time:				7 Jun 2007 15:00	7 Jun 2007 11:00	7 Jun 2007 15:00	7 Jun 2007 15:00	7 Jun 2007 15:00
Laboratory Sample ID:				EB0706556-006	EB0706556-007	EB0706556-008	EB0706556-009	EB0706556-010
EK071: Reactive Phosphorus as P (Dissolved)								
Reactive Phosphorus - Filtered		0.010	mg/L	<0.050	<0.050	<0.050	----	----
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon		1	mg/L	<1	<1	<1	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon		1	mg/L	<1	1	1	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease		5	mg/L	<5	<5	<5	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction		20	µg/L	<20	<20	<20	----	----
C10 - C14 Fraction		50	µg/L	<50	<50	<50	----	----
C15 - C28 Fraction		100	µg/L	<100	<100	<100	----	----
C29 - C36 Fraction		50	µg/L	<50	<50	<50	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	110	112	115	----	----
Toluene-D8	2037-26-5	0.1	%	101	101	99.7	----	----
4-Bromofluorobenzene	460-00-4	0.1	%	102	106	104	----	----

ALS Environmental

Analytical Results

				Client Sample ID :	S1c	S2a	S3	S3b	S3c
				Sample Matrix Type / Description :	WATER	WATER	WATER	WATER	WATER
				Sample Date / Time :	7 Jun 2007 15:00	7 Jun 2007 8:00	7 Jun 2007 15:00	7 Jun 2007 15:00	7 Jun 2007 15:00
				Laboratory Sample ID :					
Analyte	*CAS number*	*LOR*	*Units*		EB0706556-011	EB0706556-012	EB0706556-013	EB0706556-014	EB0706556-015
EA025: Suspended Solids									
Suspended Solids (SS)		1	mg/L		34	21	53	22	22

ALS Environmental

Analytical Results

				Client Sample ID :	S4	S4b	S4c	S5a	S6
				Sample Matrix Type / Description :	WATER	WATER	WATER	WATER	WATER
				Sample Date / Time :	7 Jun 2007 15:00	7 Jun 2007 15:00	7 Jun 2007 15:00	7 Jun 2007 8:45	7 Jun 2007 15:00
				Laboratory Sample ID :					
Analyte	*CAS number*	*LOR*	*Units*		EB0706556-016	EB0706556-017	EB0706556-018	EB0706556-019	EB0706556-020
EA025: Suspended Solids									
Suspended Solids (SS)		1	mg/L		19	19	20	22	19

ALS Environmental

Analytical Results

	Client Sample ID :	S6b	S6c	S2b	S2c	S5b
	Sample Matrix Type / Description :	WATER	WATER	WATER	WATER	WATER
	Sample Date / Time :	7 Jun 2007 15:00	7 Jun 2007 15:00	7 Jun 2007 11:00	7 Jun 2007 14:00	7 Jun 2007 11:45
	Laboratory Sample ID :	EB0706556-021	EB0706556-022	EB0706556-023	EB0706556-024	EB0706556-025
Analyte / CAS number / LOR / Units						
EA025: Suspended Solids						
Suspended Solids (SS)	1 mg/L	148	190	17	18	19

ALS Environmental

Analytical Results

			Client Sample ID :	S5c			
			Sample Matrix Type / Description :	WATER			
			Sample Date / Time :	7 Jun 2007 14:45			
			Laboratory Sample ID :	EB0706556-026			
Analyte	*CAS number*	*LOR*	*Units*				
EA025: Suspended Solids							
Suspended Solids (SS)		1	mg/L	19			

ALS Environmental

Surrogate Control Limits

Matrix Type: WATER - Surrogate Control Limits ***Surrogate Control Limits***

Method name	*Analyte name*	*Lower Limit*	*Upper Limit*
EP080: TPH Volatiles/BTEX			
EP080S: TPH(V)/BTEX Surrogates	1,2-Dichloroethane-D4	80	120
	Toluene-D8	88	110
	4-Bromofluorobenzene	86	115

CERTIFICATE OF ANALYSIS

Work Order	: **EB0710162**	Page	: 1 of 7
Client	: **CARDNO ULLMAN & NOLAN GEOTECHNIC PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ANDREW WILLIAMS	Contact	: Tim Kilmister
Address	: PO BOX 5630 MMC MACKAY QLD AUSTRALIA 4741	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: soils@cardno.com.au	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 49525255	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 49525455	Facsimile	: +61-7-3243 7218
Project	: U22053	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: UN1915		
C-O-C number	: ----	Date Samples Received	: 07-SEP-2007
Sampler	: ML AND DW	Issue Date	: 19-SEP-2007
Site	: SHUTE HARBOR		
		No. of samples received	: 9
Quote number	: EN/024/07	No. of samples analysed	: 9

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi		Inorganics
Kim McCabe	Senior Inorganic Chemist	Inorganics
Minh Huynh	Senior Analyst	Organics
Stephen Hislop	Senior Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = Result(s) reported is calculated using analyte detections at or above the LOR. (eg. <5 + 5 + 7 = 12).

- **DOC and TOC conducted by ALS Sydney, NATA accreditation no. 825, site no 10911**
- **EK071F and EK059: Samples 1-9, LOR was raised due to saline matrix interference**
- **EP002: LCS recovery for DOC analyte falls outside the ALS dynamic control limit. However, it is within the acceptance criteria based on ALS DQO . No further action is required.**
- **EP080: Sample SW8 shows poor surrogate recovery due to matrix interference. Confirmed by re-analysis.**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: SW1	SW2	SW3	SW4	SW5
				Client sampling date / time: 05-SEP-2007 15:00	05-SEP-2007 15:00	05-SEP-2007 15:00	05-SEP-2007 15:00	05-SEP-2007 15:00
				EB0710162-001	EB0710162-002	EB0710162-003	EB0710162-004	EB0710162-005
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	1	mg/L	**37**	**34**	**122**	**55**	**44**
EG005F: Dissolved Metals by ICP-AES								
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG005T: Total Metals by ICP-AES								
Iron	7439-89-6	0.05	mg/L	**0.13**	<0.05	<0.05	**0.13**	<0.05
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.11**	**0.07**	**0.14**	**0.25**	**0.19**
Arsenic	7440-38-2	0.001	mg/L	**0.011**	**0.006**	<0.005	**0.007**	<0.005
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.005	<0.005	<0.005
Barium	7440-39-3	0.001	mg/L	**0.005**	**0.005**	**0.007**	**0.007**	**0.006**
Cadmium	7440-43-9	0.0001	mg/L	**0.0001**	**0.0001**	<0.0005	<0.0005	<0.0005
Chromium	7440-47-3	0.001	mg/L	**0.003**	**0.003**	**0.018**	**0.021**	**0.021**
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.005	<0.005	<0.005
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.013**	**0.008**	**0.011**	**0.006**
Lead	7439-92-1	0.001	mg/L	**0.001**	**0.002**	<0.005	<0.005	<0.005
Manganese	7439-96-5	0.001	mg/L	**0.004**	**0.004**	<0.005	**0.007**	<0.005
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.002**	**0.006**	**0.010**	**0.006**
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.05	<0.05	<0.05
Zinc	7440-66-6	0.005	mg/L	**0.015**	**0.016**	**0.026**	**0.036**	**0.023**
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055: Ammonia as N								
Ammonia as N	7664-41-7	0.010	mg/L	**0.021**	**0.026**	**0.024**	**0.024**	**0.030**
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N	----	0.010	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
EK063: Inorganic Nitrogen as N (Ammonia + NOx)								
^ Inorganic Nitrogen as N	----	0.01	mg/L	**0.02**	**0.02**	**0.02**	**0.02**	**0.03**
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID : SW1	SW2	SW3	SW4	SW5
				Client sampling date / time : 05-SEP-2007 15:00	05-SEP-2007 15:00	05-SEP-2007 15:00	05-SEP-2007 15:00	05-SEP-2007 15:00
				EB0710162-001	EB0710162-002	EB0710162-003	EB0710162-004	EB0710162-005
EK071: Reactive Phosphorus as P (Dissolved)								
Reactive Phosphorus - Filtered	----	0.010	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	----	1	mg/L	**2**	**2**	**1**	**2**	**1**
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**2**	**2**	**1**	**2**	**1**
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	**5**	<5	<5	**5**	<5
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
EP080: BTEX								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L	<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	<2
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**131**	**144**	**90.4**	**129**	**134**
Toluene-D8	2037-26-5	0.1	%	**91.2**	**100**	**93.2**	**90.8**	**97.7**
4-Bromofluorobenzene	460-00-4	0.1	%	**94.4**	**105**	**88.3**	**93.5**	**101**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: SW6	SW7	SW8	FW3
				Client sampling date / time: 05-SEP-2007 15:00	05-SEP-2007 15:00	05-SEP-2007 15:00	05-SEP-2007 15:00
				EB0710162-006	EB0710162-007	EB0710162-008	EB0710162-009
EA025: Suspended Solids							
^ Suspended Solids (SS)	----	1	mg/L	**40**	**108**	**51**	**78**
EG005F: Dissolved Metals by ICP-AES							
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	**0.47**
EG005T: Total Metals by ICP-AES							
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	**1.88**
EG020F: Dissolved Metals by ICP-MS							
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	**0.17**
EG020T: Total Metals by ICP-MS							
Aluminium	7429-90-5	0.01	mg/L	**0.17**	**0.19**	**0.09**	**0.73**
Arsenic	7440-38-2	0.001	mg/L	<0.005	<0.005	**0.006**	**0.007**
Beryllium	7440-41-7	0.001	mg/L	<0.005	<0.005	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.007**	**0.007**	**0.004**	**0.040**
Cadmium	7440-43-9	0.0001	mg/L	<0.0005	<0.0005	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	**0.022**	**0.024**	**0.003**	**0.004**
Cobalt	7440-48-4	0.001	mg/L	<0.005	<0.005	<0.001	**0.002**
Copper	7440-50-8	0.001	mg/L	**0.007**	**0.006**	**0.010**	**0.009**
Lead	7439-92-1	0.001	mg/L	<0.005	<0.005	<0.001	**0.004**
Manganese	7439-96-5	0.001	mg/L	<0.005	<0.005	**0.004**	**0.175**
Nickel	7440-02-0	0.001	mg/L	**0.007**	**0.007**	**0.002**	**0.004**
Vanadium	7440-62-2	0.01	mg/L	<0.05	<0.05	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.027**	**0.022**	**0.005**	**0.009**
EG035T: Total Mercury by FIMS							
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
EK055: Ammonia as N							
Ammonia as N	7664-41-7	0.010	mg/L	**0.021**	**0.028**	**0.021**	**0.085**
EK059: Nitrite plus Nitrate as N (NOx)							
Nitrite + Nitrate as N	----	0.010	mg/L	<0.050	<0.050	<0.050	<0.050
EK061: Total Kjeldahl Nitrogen (TKN)							
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	**1.1**
EK062: Total Nitrogen as N (TKN + NOx)							
^ Total Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	**1.1**
EK063: Inorganic Nitrogen as N (Ammonia + NOx)							
^ Inorganic Nitrogen as N	----	0.01	mg/L	**0.02**	**0.03**	**0.02**	**0.08**
EK067: Total Phosphorus as P							
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	**0.09**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: SW6	SW7	SW8	FW3	
				Client sampling date / time: 05-SEP-2007 15:00	05-SEP-2007 15:00	05-SEP-2007 15:00	05-SEP-2007 15:00	
				EB0710162-006	EB0710162-007	EB0710162-008	EB0710162-009	
EK071: Reactive Phosphorus as P (Dissolved)								
Reactive Phosphorus - Filtered	----	0.010	mg/L	<0.050	<0.050	<0.050	<0.050	
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	----	1	mg/L	**1**	**1**	**1**	**7**	
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**1**	**1**	**1**	**7**	
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	**10**	**5**	**20**	**14**	
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	<20	
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	
EP080: BTEX								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	
Toluene	108-88-3	2	µg/L	<2	<2	<2	<2	
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**141**	**151**	**93.5**	**148**	
Toluene-D8	2037-26-5	0.1	%	**95.2**	**99.0**	**82.7**	**93.9**	
4-Bromofluorobenzene	460-00-4	0.1	%	**97.9**	**103**	**79.0**	**98.5**	

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	80	120
Toluene-D8	2037-26-5	88	110
4-Bromofluorobenzene	460-00-4	86	115

LABORATORY REPORT COVERSHEET

Date: 20 September 2007

To: Cardno Ullman & Nolan
71 Connors Rd
PAGET, MACKAY QLD 4740

Attention: Mr Michael Large

Your Reference:	Shute Harbour 422053
Laboratory Report No:	56901
Samples Received:	6/09/2007
Samples / Quantity:	8 Water

The above samples were received intact and analysed according to your written instructions. Unless otherwise stated, solid samples are reported on a dry weight basis and liquid samples as received.

Shey Goddard
Administration Manager
CAIRNS

Jon Dicker
Manager
CAIRNS

SGS Australia Pty Ltd
ABN 44 000 964 278
Environmental Services Unit 2, 58 Comport Street, Portsmith 4870 QLD Australia www.au.sgs.com
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CLIENT: Cardno Ullman & Nolan
PROJECT: Shute Harbour 422053 **Laboratory Report No:** 56901

LABORATORY REPORT

-------- Our Reference Your Reference Date Sampled	Units	56901-1 SW1 5/09/2007	56901-2 SW2 5/09/2007	56901-3 SW3 5/09/2007
Chlorophyll a	µg/L	<2	<2	<2
Faecal Coliforms *	CFU/100 mL	22	6	<1+

-------- Our Reference Your Reference Date Sampled	Units	56901-4 SW4 5/09/2007	56901-5 SW5 5/09/2007	56901-6 SW6 5/09/2007
Chlorophyll a	µg/L	<2	<2	<2
Faecal Coliforms *	CFU/100 mL	4	<1+	<1+

-------- Our Reference Your Reference Date Sampled	Units	56901-7 SW7 5/09/2007	56901-8 SW8 5/09/2007
Chlorophyll a	µg/L	<2	<2
Faecal Coliforms *	CFU/100 mL	6+	10+

CLIENT: Cardno Ullman & Nolan
PROJECT: Shute Harbour 422053 **Laboratory Report No:** 56901

LABORATORY REPORT

TEST PARAMETERS	UNITS	LOR	METHOD
Chlorophyll a	µg/L	2	CEI-040
Faecal Coliforms *	CFU/100 mL	1	CEI-100

CLIENT: Cardno Ullman & Nolan
PROJECT: Shute Harbour 422053 **Laboratory Report No:** 56901

LABORATORY REPORT

NOTES:
LOR - Limit of Reporting.
* This test is not covered by our current NATA accreditation.
+ Other non-interfering bacteria present.

Analysis Date: **Between** 6/09/07 **and** 14/09/07

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