Realty Realizations Pty Ltd

martens consulting engineers

Water Cycle Management Report – Mixed Use Subdivision; West Culburra, NSW

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1 Introduction

1.1 Overview

This report has been prepared to support a project Concept Approval, with NSW Department of Planning (DoP), for a mixed use subdivision located at Lot 61 DP 755971, and parts of Lots 5, 6 and 7 DP 1065111, Culburra Road, West Culburra, NSW.

It provides an assessment of the proposed development with respect to stormwater management, including water quality and quantity.

1.2 Scope

The scope of this assessment has been developed to address the requirements of the Director General's Environmental Assessment Requirements (DGEARs) with respect to stormwater management in consultation with Shoalhaven Council and NSW Office of Environment and Heritage (OEH).

This report provides:

- Documentation of results of a conceptual water quality assessment.
- o Treatment train specification to achieve nominated water quality objectives.
- Assessment of on-site detention (OSD) and stormwater quantity control requirements for the site, including proposed measures to control discharge into adjacent mangrove environment.
- Assess potential impacts of the development on sensitive receiving environments including identified SEPP14 wetlands, seagrass beds and oyster leases.
- Statement of Commitments relating to stormwater management.

Water Quality Monitoring Plan including a Sediment and Erosion Control Plan has been prepared separate to this document (refer to Martens and Associates, October 2013. Ref: P1203365JR03V02).



1.3 Proposed Development

The proposed development includes the following landuses:

- Residential (including Torrens title lots, townhouses and 3-5 storey multiunit development)
- Commercial
- o Industrial
- Tourist accommodation
- o Retirement village
- o Open space

A plan of the proposed development is provided in Attachment A.

1.4 Relevant Planning Controls and Design Principles

The following planning and engineering controls and design principles have been used:

- Shoalhaven City Council (2002) Development Control Plan 100
 Subdivision Code
- Shoalhaven City Council (2012) Draft Sustainable Stormwater Management DCP
- Landcom (2004) Soils and Construction 'Managing Urban Stormwater'
- Neutral or beneficial effect (NorBE) design principle in determining minimum stormwater quality structure requirements



1.5 Agency Consultation

1.5.1 Initial Consultation

The following agencies were contacted as part of consultation completed as part of preparation of this assessment:

- Shoalhaven Council
- NSW Office of Water (NOW)
- NSW Office of Environment and Heritage (NSW OEH)
- DoPI (Fisheries)

Results of initial agency consultation are provided in Attachment H.

1.5.2 EA Submission Consultation

Subsequent to submission of the Environmental Assessment (EA) a number of agencies and stakeholders provided comments relevant to this assessment. These are summarised as:

- All development, including water quality treatment structures, is to be excluded from the 7(a) Environmental Protection zone.
- o The water quality monitoring regime was considered inadequate.

A stakeholder meeting was held on August 13, 2013 and attended by:

- Local oyster farmers
- o Australia's Oyster Coast Inc.
- NSW Food Authority
- Southern Rivers Catchment Management Authority (CMA)
- Shoalhaven Water
- Shoalhaven City Council (SCC)
- NSW Environmental Protection Authority (EPA)
- NSW Fisheries
- o NSW Office of Environment and Heritage (OEH)



 The applicant, Martens and Associates, and Allen Price and Associates representatives.

Outcomes from the stakeholder meeting resulted in a layout redesign and subsequent remodelling of various aspects of the proposed development, particularly water quality modelling. The Water Quality Monitoring Plan and Sediment and Erosion Control Plan are now part of a seperate document (Martens and Associates, 2013 P1203365JR03V02) that provides a detailed outline of monitoring requirement pre, during and post construction.

1.5.3 Ongoing Consultation

During the August stakeholder meeting, the 'Culburra Development-Stakeholder Liaison Group' was formed and it was resolved that subsequent meetings would be held to facilitate additional stakeholder and agency comment and input into various aspects of the proposed development.

During the September meeting of the Group, the draft Water Quality Monitoring Plan was reviewed and discussed. Comments relating to monitoring and water quality treatment requirements were incorporated into project design and documentation.



2 Site Description

2.1 Location and Existing Landuse

The study area is located on the northern side of Culburra Road, West Culburra, within the Shoalhaven City Council local government area (LGA). The study area consists of the following lots:

- Lot 61 DP 755971
- Part Lot 5 DP 1065111
- Part Lot 6 DP 1065111
- o Part Lot 7 DP 1065111

The study area covers an area of approximately 109 ha and consists of undeveloped vegetated land and some agricultural areas in Lot 5 DP 1065111 and Lot 61 DP 755971 (Figure 1).

2.2 Physiography and Hydrology

Majority of the site is elevated >5 mAHD above the Crookhaven River estuary. Immediate foreshore areas are moderately steep and transitional between the subject site and the estuary. Relief across the site is approximately 20 m. The landscape is gently undulating with slopes ranging between 2.5-6.0 %, with some areas of localised over steepening typically associated with drainage lines.

The site of the proposed subdivision lies on a ridgeline and associated northern side slopes discussed above, except for an area of Lot 5 which lies on the southern side of the ridge line.

Site drainage ranges from good to poor across the site, with poor draining areas characteristically associated with lower points of elevation within the landscape. Site drainage likely consists of both infiltration and overland flow (sheet and concentrated).

2.3 Lithology and Soil Landscapes

Reference to the 1:250,000 Wollongong Geological Series Sheet indicates the site lies upon Wandrawandian Siltstone, a member of the Shoalhaven Group. Wandrawandian Siltstone is dominated by siltstone and silty sandstone lithologies, and is pebbly in parts. Immediate foreshore areas of the site, adjacent to Crookhaven River Estuary consist of Quaternary sedimentary units of gravel, sands, silts, and clays



of marine to freshwater environments, and likely overlie Wandrawandian Siltstone in these areas.

Hazelton (1992) indicates that soils within the investigation area belong predominantly to the Greenwell Point Soil Landscape Group. Soils are primarily derived from *in-situ* weathering of the underlying Wandrawandian Siltstone. Soils are characteristically shallow (<50 cm) to moderately deep (50-100 cm) Loams to Yellow Podzolic Soils or Red Solodic Soils.

Soil mapping completed by Hazelton (1992) suggests that the eastern periphery of the site may contain the Seven Mile Soil Landscape group. This soil landscape group is estuarine, and comprises deep (> 1.5 m) Siliceous Sands, Acid Peats, and Humus Podzols. This landscape was not observed during field investigations (November 22, 2010).

2.4 Hydrogeology

Groundwater was observed during intrusive investigations at the site (November 22, 2010). More detailed investigation of groundwater is presented in Section 3.



3 Groundwater Assessment

3.1 Overview

This assessment has been prepared to satisfy issue 7.5 of the Director General Requirements (DGRs) (NSW DoP, 27.05.2010). It documents aquifer characteristics, assesses likely impacts associated with site development, and assesses the requirement for mitigation measures that aim to prevent adverse groundwater impacts.

3.2 Field Investigations

Field investigations for the Groundwater Assessment were undertaken between 22.11.2010 and 26.11.2010 and included the following:

- Site walkover.
- Completion of 26 boreholes with a truck mounted hydraulic auger.
- Completion of 8 of the 24 boreholes as Groundwater Monitoring Bores (GMBs).
- Monitoring of groundwater levels within GMBs.
- Rising/falling head tests to estimate hydraulic conductivity (k) at 7 of the 8 GMBs.
- o Collection of 3 groundwater samples for laboratory analysis.

3.3 Groundwater Conditions

3.3.1 Water Bearing Strata

Aquifer layers are broadly classed as follows:

1. Residual clay:

- Comprised of clay that extends from near natural surface level (typically 0.3 mBGL) to depths generally of the order of 1.3 mBGL.
- Characterised by low hydraulic conductivity (K).
- Generally unconfined.



- Base of layer comprises extremely weathered siltstone.
- Permanent groundwater is likely to only exist in areas with relatively low grades. Other areas may contain ephemeral groundwater (non-permanent) or remain generally unsaturated.
- The majority of boreholes within this stratum were drilled dry. We note that drilling works were undertaken in late November, 2010 and that this month had above average rainfall.
- Flow vectors are expected to generally mimic the surface topography.
- During fieldworks groundwater levels varied from approximately 0.15 mBGL to dry.

2. Siltstone:

- Water bearing zones in the aquifer were observed at weathered siltstone from 3.2 to 4.2 mBGL (BH1), 6.5 to 7.0 mBGL (BH2) and 3.3 to 6.5 mBGL (BH6). We note that shallow GMBs installed immediately adjacent to GMB1 and GMB2 verify that this aquifer layer is confined.
- Characterised by low hydraulic conductivity (K).
- During field works groundwater head levels for this layer varied from 1.41 to 0.62 mBGL.
- Confinement at GMB2 is likely to be associated with geological bedding in the vicinity of the GMB as this GMB was drilled on-top of a knoll and still displayed evidence of confinement.

3.3.2 Hydraulic Conductivity (K)

Site K testing to date (Table 1)indicates that the aquifer(s) are of low permeability. Refer to Figure 2 for GMB locations.



Table 1: Summary of aquifer K testing results.

GMB	Test Medium	Estimated K (m/d)
1	Clay/Extremely Weathered Siltstone	0.057
1a	Clay	0.035
2	Clay/Extremely Weathered Siltstone	0.043
3	Clay/Extremely Weathered Siltstone	0.004
4	Clay/Extremely Weathered Siltstone	0.004
5	Extremely Weathered Siltstone	0.008
6	Clay/Extremely Weathered Siltstone	0.007
Geometric mean		0.013
Median	Clay/Extremely Weathered Siltstone	0.008
Mean		0.023

Notes:

3.3.3 Groundwater Level Measurements

Manual groundwater level measurements taken to date are summarised in Table 2.



^{1.} Results based on Martens and Associates testing completed on 22.11.2010 and 23.10.2010.

^{2.} Test type = rising head for GMB1, GMB1a, GMB2 and GMB6. Falling head for GMB3, GMB4 and GMB5 as these GMBs were dry. All data analysed using the Hvorslev (1981) method.

Table 2: Manual groundwater level measurements.

	Groundwater Levels (mAHD) Recorded by Martens and Associates						
			23.11.2010 2	24.11.2010 ²	25.11.2010 ²	26.11.2010 ²	
GMB ID	Aquifer Layer ¹	GMB Surface Level	mAHD	mAHD	mAHD	mAHD	
1	Siltstone (confined)	6	5.38	5.38	5.34	5.31	
1a	Residual clay (unconfined)	6	-	4.84	4.93	4.97	
2	Siltstone (confined)	22	20.8	20.71	20.63	20.59	
2 a		22	-	Dry	Dry	Dry	
3		15	Dry	Dry	Dry	Dry	
4		8	Dry	Dry	Dry	Dry	
5		8	Dry	Dry	Dry	Dry	
6	Siltstone (confined)	5	-	-	4.87	4.86	

Note:

3.3.4 Groundwater Quality

Groundwater quality samples were taken from GMB1, GMB2 and GMB6. Results for key analytes are summarised (Table 3) with full laboratory report in Attachment G. Results indicate:

- o Groundwater is acidic.
- o Groundwater is fresh at GMB2, brackish at GMB1 and saline at GMB6.
- Nutrient levels are low.



¹ GMB – groundwater monitoring bore.

² Level approximate mAHD based on Allen, Price and Associates survey (Ref: 25405-02)

Table 3: Preliminary groundwater quality results.

GMB ID	Date Sampled	рН	EC	TDS (grav)	Total Nitrogen	Total Phosphorus
		pH Units	μ\$/cm	mg/L	mg/L	mg/L
1	25.11.2010	5.2	4,900	2,900	0.7	<0.5
2	25.11.2010	5.1	250	180	0.4	<0.5
6	26.11.2010	5.6	18,000	13,000	0.3	<0.5

3.3.5 Groundwater/Surface Water Interaction

Interaction of groundwater from the upper unconfined aquifer with surface water is expected to be minimal given the majority of site boreholes and GMBs did not encounter water.

3.3.6 Groundwater Dependent Ecosystems (GDEs)

GDE mapping is outside the scope of this assessment. It is understood that the site's ecological consultant (SLR Consulting) is addressing GDE distribution.

3.4 Groundwater Impact Assessment

3.4.1 Resource Use

Review of the NSW Natural Resource Atlas (Figure 3) indicates that there are no licensed bores in the vicinity (3km) of the site.

3.4.2 Potential Impacts

1. Altered groundwater recharge

The proposed-development has the potential to alter groundwater flow to downslope areas which may contain GDEs. The groundwater flow regime has the potential to be altered as follows:

- o Impervious areas shall increase resulting in reduced groundwater recharge.
- Land currently occupied by forest/woodland vegetation shall be cleared and replaced by a landscape predominantly comprised of grass in pervious areas and no vegetation in impervious areas. Grass vegetation shall exhibit lower evapotranspiration (ET) than the ET



associated with the existing forest/woodland vegetation. This reduction in ET has the potential to increase groundwater recharge rates.

 The balance of the above effects will determine if groundwater recharge is increased or reduced due to the proposed development.

2. Groundwater quality

Groundwater quality is not expected to be adversely impacted by surface water run-off from the proposed development provided discharge waters (derived from site surface water run-off) have undergone an appropriate level of treatment.

3. Potential acid sulfate soils (PASS)

SPOCUS testing indicates that site soils are acidic and that they do not increase in acidity once oxidised. Based on the above, and given that site soils are residual (i.e. not estuarine sediments associated with ASS), risks associated with PASS or ASS soils are low.

3.4.3 CLASS-U3M-1D (Unsaturated Moisture Movement Model)

3.4.3.1 Overview

The CLASS soil moisture model developed by eWater Cooperative Research Centre (CRC) is used to assess site groundwater recharge for existing and developed conditions. The model utilises site rainfall and evaporation data together with soil profile properties to assess the net recharge to groundwater.

In consultation with eWater Cooperative Research Centre it was confirmed that the CLASS model was appropriate for this application as follows:

- Groundwater flow is ephemeral and therefore not suited to modelling with conventional groundwater models such as MODFLOW.
- The conceptual hydrogeological model is suited to CLASS as the soil/rock interface layer has low slope and soil stratigraphy is not overly complex.
- Long-term climate data is considered important for the model simulation and CLASS is run using a long-term daily climate file.



 Catchment and soil science experts of the eWater Cooperative Research Centre previously indicated that the model was suitable for a site with a similar hydrogeological setting (Mundamia Urban Release area).

3.4.3.2 Inputs

Input parameters used in the model are summarised in Table 4.

Table 4: CLASS input parameters.

Element	Input
Soil Layers	2
Soil Layer Depth (mBGL)	Layer 1 – sandy loam (0 – 0.3), Layer 2 – clay (0.3 – 1.3)
Soil Parameters	CLASS default soil catalogue parameters for nominated soil types
Soil K (m/d)	Layer 1 – 1.061, Layer 2 – 0.048
Ksub (m/d) ¹	0.048
Climate file	Daily 50 yr rain and evaporation file derived from NOWRA RAN BOM station
Vegetation	Tree (CLASS default properties) for existing conditions, pasture (CLASS default properties)

Notes:

3.4.3.3 Results

Total seepage flux (Table 5) determined by the CLASS modelling system indicates a groundwater recharge rate of 48 mm/year for existing conditions. When forest is replaced by grass, this increases to 112 mm/year. Considering recharge doesn't occur beneath impervious surfaces and pervious 'grassed' surface shall be 60% of the developed site the overall groundwater recharge for developed conditions is estimated at 67 mm/year (60% x 112 mm/year).

Whilst results indicate a minor increase to groundwater recharge we note that CLASS modelling for developed conditions assumed uniform grass cover. Whist developed pervious areas shall be dominated by grass, a small proportion of trees shall remain or be planted. Consequently, ET in the developed condition is likely to be slightly higher than modelled value and therefore changes to groundwater recharge due to the proposed development are likely to be negligible.



 $^{^{}m l.}$ A Ksub value of 0.048 m/d was assigned so that flux out of the bottom soil layer could be considered as seepage.

Table 5: CLASS results summary.

	Forest CLASS model result	Grassed CLASS model result	Developed conditions CLASS model accounting for impervious surfaces
Average annual groundwater recharge (mm/yr)	48	112	67

3.4.3.4 Impact Assessment

Results indicate that groundwater recharge will not be significantly altered due to the proposed development. Consequently, no mitigation measure is required to address changes to groundwater recharge.

3.5 Conclusions and Recommendations

- The site contains two low permeability aquifers, being an unconfined shallow clay aquifer and a deeper confined aquifer in rock.
- The shallow clay aquifer was observed in 1 of the site's 8 GMBs within approximately 1 m of the land surface in a low lying area of the site. Consequently, it is anticipated that shallow ephemeral aquifers shall exist in local drainage depressions.
- The deeper confined aquifer was observed in 3 of the site's 8 GMBs. This aquifer is confined by siltstone which typically occurs at a depth of approximately 1.3 mBGL. The water bearing zones for this aquifer are thought to comprise extremely weathered siltstone or clay seams. Water bearing zones were considered to be from 3.2 to 4.2 mBGL (BH1), 6.5 to 7 mBGL (BH2) and 3.3 to 6.5 mBGL (BH6).
- o Groundwater was not observed within 4 of the site's 8 GMBs.
- Shallow aquifer(s) beneath the site are likely to be ephemeral (i.e non-permanent) in some areas, non-existent in others and permanent in low lying areas and areas with low grades.
- o If shallow excavations (road pavements, service trenches and shallow footings) are proposed it is likely that works may intersect the shallow unconfined aquifer. This is to be assessed and managed through future construction works.



- The aquifers beneath the site are of low value to stakeholders (ecological and anthropogenic) given their low yield, limited distribution and ephemeral nature.
- Groundwater recharge will not be significantly altered due to the proposed development. Consequently, no mitigation is required to address changes to groundwater recharge which may impact downslope vegetation.
- In principle, groundwater is not expected to constrain site development. However, from a geotechnical perspective it is recommended that the findings in this report are considered for site engineering purposes.



4 Water Quality Assessment

4.1 Overview

This water quality assessment determines treatment measures required to achieve adopted water quality objectives. It allows for a general specification of water quality structures, and will require refinement at detailed design stage.

Given the site's location and the sensitive nature of downstream ecosystems, this assessment shall ensure compliance with water quality objectives at the following receiving environments (Figure 1):

- o SEPP 14 Wetlands between Billy's Island and the site
- Seagrass and oyster leases fringing the foreshore to the north east and north west of the site
- o Curleys Bay
- Crookhaven River
- Lake Wollumboola

4.2 Water Quality Objectives

Element RE12 'Water Quality Management' of Shoalhaven Council's DCP 100 (2002) requires that proposals aim to ensure:

'existing downstream environments are not adversely affected and no net increase in pollution levels discharging from the development'.

During consultation with Shoalhaven Council's subdivision engineer (March 14, 2012), it was noted that a draft 'Sustainable Stormwater Management DCP' was being prepared. If adopted the following pollutant retention (i.e. treated versus untreated) objectives would apply:

- o 90% of gross pollutants
- o 85% of total suspended solids (TSS)
- 65% of total phosphorus (TP)
- 45% of total nitrogen (TN)



o 90% of total hydrocarbons

Based on consultation with Shoalhaven Council and NSW OEH, project water quality objectives are adopted as follows:

- NorBE (neutral or beneficial) pollutant loads in the post development scenario that are equal to or less than those currently generated from the site.
- Treatment train effectiveness will be designed to achieve the draft DCP (2012) requirements for pollutant retention.

Water quality objectives are adopted for all receiving environments (Section 4.1).

4.3 Modelling Methodology

4.3.1 Overview

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC, Version 5.1) developed by the CRC for Catchment Hydrology was utilised to evaluate pre and post development pollutant loads from the site.

Modelling has been undertaken in accordance with *Draft NSW MUSIC Modelling Guidelines* (BMT WBM, 2010).

The following modelling scenarios were considered:

- 1. <u>Pre Development</u> the existing site.
- 2. <u>Post Development (untreated)</u> the developed site without water quality structures.
- 3. <u>Post Development (treated)</u> the developed site with water quality structures included to achieve adopted objectives.

Pre and post development MUSIC model layouts are provided on Sheet 4 and 5 of Attachment A.

4.3.2 Approach

An iterative approach was used for post development modelling to determine appropriate types, sizes and locations of stormwater treatment devices for the site to achieve adopted objectives.



4.3.3 Climate Data

Rainfall data was sourced from Nowra RAN from 1964 – 1970 in accordance with the NSW MUSIC guidelines. Average monthly areal potential evapotranspiration (PET) was sourced from 'Climatic Atlas of Australia – Evapotranspiration' (Bureau of Meteorology, 2001).

4.3.4 Input Parameters

Input parameters for source and treatment nodes are consistent with the *Draft NSW MUSIC Modelling Guidelines* (BMT WBM, 2010). Attachment B summarises input parameters.

4.3.5 Catchment Areas

Pre and post development catchment areas and pervious/impervious areas of each catchment are provided in Attachment D. A ridge forming the catchment boundary between Lake Wollumboula and the Crookhaven River runs along the southern edge of the development area.

The following should be noted with regards to catchment areas:

- o Development north of the ridgeline discharges north to the Crookhaven River as with existing hydrology.
- Where development occurs south of the ridgeline (small portion of the collector road, the industrial subdivision in the site's east and residential development in the site's east), runoff shall be directed to the Crookhaven River by road drainage networks.
- Only the proposed oval (Catchment C4) and the proposed new roundabout intersection along Culburra Road shall discharge south to Lake Wollumboula. They are therefore modelled and assessed separately to ensure water quality objectives are met for each receiving environment.
- o The catchment area draining to the SEPP14 wetlands between Billys Island and the site was determined for the post development based on maintaining wetland hydrology (Section 5.4).
- This wetland outlet was assessed independently and as part of the total Crookhaven River catchment, to assess water quality impacts on the wetlands.



- Outlets into the Crookhaven River, excluding the wetland outlet, were assessed to determine the impacts on fringing seagrass and oyster leases.
- o The Curleys Bay outlet was assessed independently due to its identified significance by NSW DoPI (Fisheries).
- o For both the industrial and the roundabout area, results were compared to an equivalent area of pre-development 'forest' area to ensure that water quality objectives are met by these individual catchments (see Section 4.4.7).
- All residential/accommodation development catchments have been split into 'roof', 'road' and 'remaining' sub-catchments.
 The cumulative areas of each of these sub-catchments are based on the catchment area, the proposed landuse and the proposed site coverage (Attachment A).

4.3.6 Model Parameters

Event Mean Concentration (EMC) inputs were derived from Sydney Metropolitan Catchment Management Authority (SMCMA) (2010) 'Draft NSW MUSIC Modelling Guidelines'



Table 6: Adopted EMCs for source nodes.

		Base Flow (mg/L)		Storm Flow	(mg/L)
Land Use	Parameter	Log (mean)	Log (stdev)	Log (mean)	Log (stdev)
	TN	na	na	0.300	0.190
Roof	TP	na	na	-0.890	0.250
	SS	na	na	1.300	0.320
	TN	0.040	0.130	0.480	0.260
Agricultural	TP	-1.050	0.130	-0.220	0.300
	SS	1.300	0.130	2.150	0.310
	TN	0.110	0.120	0.300	0.190
Residential	TP	-0.850	0.190	0.600	0.250
	SS	1.200	0.170	2.150	0.320
	TN	-0.520	0.130	-0.050	0.240
Forest	TP	-1.520	0.130	-1.100	0.220
	SS	0.780	0.130	1.600	0.200
	TN	0.110	0.120	0.300	0.190
Commercial	TP	-0.850	0.190	-0.600	0.250
	SS	1.200	0.170	2.150	0.320
	TN	0.110	0.120	0.340	0.190
Sealed roads	TP	-0.850	0.190	-0.300	0.250
	SS	1.200	0.170	2.430	0.320
	TN	0.110	0.120	0.300	0.190
Industrial	TP	-0.850	0.190	-0.600	0.250
	SS	1.200	0.170	2.150	0.320

Land use parameters for each catchment node are provided in Attachment D.

4.4 Treatment Train Philosophy

The preferred stormwater treatment strategy for the site utilises stormwater reuse, at source controls, and end of line controls to ensure treatment objectives are satisfied. Individual SQIDs are outlined in the following sub-sections.



4.4.1 Rainwater Tanks

Rainwater tanks shall be utilised across the site to reuse rainwater to satisfy toilet flushing and laundry demands. The following tank sizes were assumed:

- 3 KL per dwelling for freestanding dwellings
- o 3 5KL per dwelling for tourist facilities
- o 3 KL per unit for multi-unit buildings
- 10 KL per industrial 'lot'

Water usage demands were based on figures provided by Shoalhaven Water (16 November, 2012):

- o 1 ET for dwellings and units
- o 15 ET/gross ha/yr for light industrial

where 1 ET = 200KL/yr.

According to NSW Department of Water and Energy (DWE) (2008) 'NSW Guidelines for Greywater Reuse in Sewered, Single Household Residential Premises', toilet flushing and laundry uses account for 44% of total internal water demands. Therefore, total rainwater tank demands have been calculated based on 0.274 KL/day/dwelling (ET).

The total number of dwellings (and hence the cumulative tank volume and cumulative demand) was based on the sub catchment area and the proposed lot sizes within the sub-catchment. A single 'roof' node and 'tank' node was created to model each sub catchment.

4.4.2 SPEL 'Stormceptor' Treatment Device

All road, tank overflow and pervious lot runoff areas shall pass through a 'Stormceptor' (produced by SPEL) unit to remove gross pollutants, suspended solids and nutrients from stormwater runoff. The node (with treatment efficiencies) utilised in modelling was supplied by the manufacturer. Based on additional information from the supplier, high flow bypass for each unit is based on the 90th percentile of daily maxima inflow from the catchment.

Devices to be used onsite shall be confirmed at detailed design stage. If different devices are proposed, treatment removal efficiencies should meet or exceed those used in this assessment.



4.4.3 Bioretention Swales

Road side bioretention swales ('bioswales') are proposed to provide at source treatment of developed areas.

Bioswales provide treatment through media filtration, biological uptake of nutrients, evapotranspiration and detention. Assumed infiltration for modelling of proposed filter media is 50% of the specified design figure to account for reduced infiltration capacity of the swales over their life.

All flow is directed to the bioswales from upslope catchments.

Bioswale input parameters are provided in Attachment B. Typical bioswale design is provided in Attachment F.

4.4.4 Bioretention Basins

Bioretention basins are proposed to treat runoff discharging from 'Catchment 7' (proposed unit block development) and from the industrial zone ('Catchment 8').

Bioretention basins provide treatment through filtration, biological uptake of nutrients, infiltration, evapotranspiration and detention. Overflow outlets of the proposed basins will include baffles to retain floating pollutants such as gross pollutants and hydrocarbons.

Individual basin input parameters are provided in Attachment E with typical basin sections in Attachment F.

4.4.5 Wetlands

Two different wetlands are proposed as part of the proposed development. These are discussed in the following sections. Typical wetland sections are provided in Attachment F with wetland input parameters in Attachment E.

4.4.5.1 Foreshore Wetlands

A number of 'foreshore' wetlands, including a continuous wetland in the vicinity of the inlet between Billys Island and the site, are required to achieve water quality outcomes. Catchment runoff will discharge into the foreshore wetlands which will detain and treat runoff through biological uptake of nutrients, evapotranspiration and detention and discharge immediately upslope of the 7(a) zone boundary. Wetlands shall be designed and vegetated to complement the existing estuarine environment.



Wetlands shall spill either via an energy dissipater to the River or, in the case of the continuous wetland, spill evenly along it's length to promote even dispersal of flow and controlled discharge during major events.

In some areas wetland sections are connected (e.g. Wetland 5) by a 2m wide vegetated swale or similar providing additional treatment and to mimic site hydrology.

4.4.5.2 Parkland Wetland

A wetland is proposed in Catchment C4 (proposed oval and parkland). Inclusion of a wetland here, as opposed to a bioretention basin, allows detained water to be reused for irrigation on the oval. A reuse demand of 6 ML/ha/yr was assumed based on typical irrigation rates for playing fields.

4.4.6 CDS GPT

CDS GPT units (produced by Rocla) are proposed to treat runoff from C16 (proposed electrical substation) to remove gross pollutants and some nutrients. In reality, minimal gross pollutants are expected from this area given staff will only be present periodically.

Devices to be used onsite shall be confirmed at detailed design stage. If different devices are proposed, performance should be adequate to achieve outcomes detailed in this assessment. Unit is to include hydrocarbon removal.

4.4.7 Industrial Zone and Proposed Roundabout Treatment

The industrial zone presents a point source of potentially high pollution generation. As discussed earlier, treatment in this area includes:

- o Rainwater tanks
- A bioretention basin

Additionally it is recommended that approximately 10% of individual industrial lot areas be dedicated to bioretention basin to provide at source treatment of runoff.

The proposed roundabout and intersection with Culburra Road naturally discharges to Lake Wollumboula via Wattle Creek. To achieve acceptable water quality impacts at receiving environments a bioretention swale is proposed to treat road runoff. Final design of the proposed intersection will refine the size of bio-swale area required to achieve a neutral or beneficial water quality outcome.



For both the industrial and roundabout areas, results were compared to an equivalent area of pre-development 'forest' area to ensure that water quality objectives are met by these individual catchments.

4.4.8 7(a) Protection Zone Buffer

An area zoned '7(a) Environmental Protection' lies downslope of the development footprint. No development, excluding a passive recreational walk/cycleway, is proposed in this area in an effort to maintain a vegetated buffer between the development and the receiving estuarine environment.

The design of the MUSIC model ensures runoff is of a suitable water quality prior to entering this protected zone. This area would then naturally provide additional treatment to runoff from the upslope catchment through evapotranspiration, infiltration and filtration. As it has not been included in the water quality model, the beneficial effect of the 7(a) zone is not included therefore, final water quality of runoff discharging to the estuary will be better than that reported within this document.

4.5 MUSIC Results

4.5.1 NORBE Assessment

Assessment of the effect of the development is completed and tabulated in Table 7 to Table 11 for each catchment considered. Catchment description refers to the receiving environment.



Table 7: MUSIC results - NORBE assessment – Crookhaven River

Parameter	Pre-Development	Post-Development	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	13600.0	10800.0	21%	Y
TP (kg/year)	33.9	28.7	15%	Y
TN (kg/year)	252.0	223.0	12%	Y
Gross Pollutants	899.0	899.0	0%	Υ

Table 8: MUSIC results - NORBE assessment – Lake Wollumboula

Parameter	Pre-Development	Post-Development	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	262.0	260.0	1%	Y
TP (kg/year)	0.8	0.7	5%	Y
TN (kg/year)	8.1	7.4	9%	Υ
Gross Pollutants	0.0	0.0	0%	Υ

 Table 9: MUSIC results - NORBE assessment - Billys Island inlet (SEPP 14 Wetlands)

Parameter	Pre-Development	Post-Development	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	1560	787.0	50%	Y
TP (kg/year)	4.69	4.34	7%	Y
TN (kg/year)	50.1	46.9	6%	Y
Gross Pollutants	0.0	0.0	0%	Y



Table 10: MUSIC results - NORBE assessment – Seagrass and Oyster Leases

Parameter	Pre-Development	Post-Development	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	12000	9980	17%	Y
TP (kg/year)	29.2	24.3	17%	Y
TN (kg/year)	202.0	176.0	13%	Υ
Gross Pollutants	899.0	899.0	0%	Y

Table 11: MUSIC results - NORBE assessment - Curleys Bay

Parameter	Pre-Development	Post-Development	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	9170.0	8930.0	3%	Y
TP (kg/year)	18.2	16.40	10%	Y
TN (kg/year)	114.0	105.0	8%	Y
Gross Pollutants	899.0	899	0%	Υ

4.5.2 Treatment Train Effectiveness

Table 12 to Table 16 provide assessment of the treatment train effectiveness (i.e. post development untreated versus post development with treatment) for receiving environments.

Table 12: MUSIC results - treatment train effectiveness - Crookhaven River

Parameter	Sources	Residual	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	46710.0	1224.3	97%	Y
TP (kg/year)	101.2	10.6	90%	Y
TN (kg/year)	750.1	101.9	86%	Y
Gross Pollutants	8415.0	0.0	100%	Y



Table 13: MUSIC results - treatment train effectiveness – Lake Wollumboula

Parameter	Sources	Residual	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	2240.0	260.0	88%	Y
TP (kg/year)	4.8	0.7	85%	Y
TN (kg/year)	28.4	7.4	74%	Y
Gross Pollutants	152.0	0.0	100%	Y

Table 14: MUSIC results - treatment train effectiveness - Billys Island Inlet (SEPP 14 Wetlands)

Parameter	Sources	Residual	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	12400.0	480.0	96%	Y
TP (kg/year)	30.7	3.4	89%	Y
TN (kg/year)	251.0	37.1	85%	Y
Gross Pollutants	2800.0	0.0	100%	Υ

 Table 15:
 MUSIC results - treatment train effectiveness - Seagrass and Oyster Leases

Parameter	Sources	Residual	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	34310.0	744.3	98%	Y
TP (kg/year)	70.5	7.2	90%	Υ
TN (kg/year)	499.1	64.8	87%	Y
Gross Pollutants	5615.0	0.0	100%	Y

Table 16: MUSIC results - treatment train effectiveness - Curleys Bay

Parameter	Sources	Residual	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	3620.0	94.1	97%	Y
TP (kg/year)	7.2	0.4	94%	Y
TN (kg/year)	55.4	6.8	88%	Y
Gross Pollutants	565.0	0.0	100%	Υ



4.5.3 Proposed Industrial Zone and Roundabout

Table 17 and Table 18 provide assessment of water quality results when Catchment 8 (proposed industrial zone) and Catchment C8r (proposed roundabout) were isolated and tested for compliance against NorBe objectives. Results suggest that proposed treatment measures treat water quality from these areas effectively.

Table 17: MUSIC results - NORBE assessment - Industrial Zone

Parameter	Pre-Development	Post-Development	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	333.0	41.2	88%	Y
TP (kg/year)	1.0	0.8	20%	Y
TN (kg/year)	10.3	6.9	33%	Y
Gross Pollutants	0.0	0.0	0%	Υ

 Table 18: MUSIC results - NORBE assessment – Proposed Roundabout Intersection

Parameter	Pre-Development	Post-Development	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	30.0	2.9	90%	Y
TP (kg/year)	0.1	0.1	4%	Y
TN (kg/year)	1.0	0.6	35%	Y
Gross Pollutants	0.0	0.0	0%	Y

4.6 Water Quality Impacts on Sensitive Ecosystems

4.6.1 SEPP 14 Wetlands

MUSIC modelling demonstrates that water quality discharged into the Billys Island inlet will be of better quality than that currently being discharged. The proposed outlet structures shall be designed (at CC stage) to provide for controlled and dispersed flow that does not result in localised scour and disturbance of mangrove species. It is therefore considered that the proposed development shall have a negligible local impact.

4.6.2 Seagrass

MUSIC modelling demonstrates that water quality discharged into areas where seagrass is mapped will be of better quality than that currently being discharged. Although the development will result in an



increased volume of fresh water discharged to these areas, it is anticipated that due to stratification, freshwater 'plumes' will float above saltwater strata (in which seagrass exist) along foreshore areas until mixing occurs within deeper parts of the Crookhaven River and Curleys Bay. Therefore impacts on seagrass resulting from increased freshwater discharge are anticipated to be negligible.

4.6.3 Oyster Leases

MUSIC modelling demonstrates that water quality discharged into areas with oyster leases will be of better quality than that currently being discharged.

The importance of faecal coliform impacts on oyster leases is acknowledged and considered in the design of water quality treatment devices, although not able to be modelled as the MUSIC software package only considers nutrients, suspended sediments and gross pollutants. The outlet structures of proposed treatment wetlands and basins are conceptually designed to provide for approximately 72 hours residence time to allow for the breakdown of faecal coliforms. Wetland and basin planting shall increase the rate of this breakdown.

It is noted that the proposed development shall be sewered and no onsite effluent disposal is proposed which reduces the risk of release of human pathogens to stormwater. A Sewage Management Regime (Allen Price & Associates, 2013) has been prepared to outline design measures and emergency procedures to mitigate the impacts of sewage spills/leaks on the water quality within the estuary.

Therefore impacts on oyster leases resulting from reduced water quality are anticipated to be negligible.

4.6.4 Lake Wollumboula

Excluding the proposed oval and the proposed new round about intersection on Culburra Road, no development area is proposed to drain to Lake Wollumboula.

Through capture, treatment and, where possible, reuse for irrigation, the water quality of runoff discharged from these areas is of a better water quality than existing runoff. The impact on Lake Wollumboula is therefore considered negligible if not beneficial.



4.7 Conclusions

Results indicate that post development water quality objectives will be met by the proposed stormwater treatment train.

It is noted that further refinement of the model at the detailed design stage of the development may alter the sizes of proposed treatment structures, however, performance outcomes of final design are to achieve specification provided in this report.

4.8 Water Quality Monitoring

In response to agency comments (June 21, 2013) (in particular NSW Fisheries, NSW OEH and submissions supplied by representatives of the oyster aquaculture industry) a Water Quality Monitoring Plan for the development has been prepared (Martens and Associates, 2013. Ref: P1203365JR03V02). It has been prepared in consultation with NSW Food Authority, NSW Fisheries, NSW Oyster Coast Inc, local oyster farmers and other stakeholders and with reference to relevant policy such as SEPP 62 and NSW Oyster Industry Sustainable Aquaculture Strategy (OISAS) (2006).

This program has been designed to ensure that the specified water quality objectives are met and treatment train components are operating effectively throughout the construction and operational phase of the proposed development. In turn, this will help to ensure the ongoing health of sensitive ecosystems and maintenance of the local oyster industry.



5 Water Quantity Assessment

5.1 Overview

This water quantity assessment discusses the impact of the proposed development on the flow regime leaving the site, and recommends management measures to control this discharge and mitigate impacts on the receiving wetland ecosystem.

5.2 OSD Requirements

Shoalhaven Council generally require OSD be provided within developments in its local government area. However, Council's Subdivision Engineer (I. Dollery, February 21, 2012) confirms that, given the site discharge is near the outlet of the catchment and in close proximity to the ocean, OSD is not necessary. Where the site discharges to wetland areas measures are proposed to protect the receiving environments from increased localised flows resulting from increased impervious area runoff.

5.3 Objectives

The objective of this assessment is to determine management measures required to, as far as feasible, mimic the hydrological regime in the wetland areas within the Billy Island inlet (Figure 1).

5.4 Hydrological Assessment

5.4.1 Approach

DRAINS hydraulic modelling software was utilised to calculate pre and post development flow rates leaving the site for the 1 in 2, 10, 20 and 100 year ARI storm events. Iterative modelling was utilised to determine the post development catchment area required to achieve flow rates in the wetland that mimic, as nearly as possible, pre development flow rates.

The assessed catchment area of 34.9 ha for the receiving wetlands is identified in Attachment A.

5.4.2 Results

Table 19 provides the pre and post development catchment areas and flow rates for each storm event.



Table 19: Hydrological modelling results.

Saanusia	Catchment Area	Flow Rates (m³/s)			es (m³/s)		
Scenario	(ha)	(%)	(%)	1:2yr	1:10yr	1:20yr	1:100yr
Pre Development	45.5	0%	100%	5.07	9.7	11.8	16.4
Post Development 1	34.9	33%	67%	4.93	8.54	10.3	13.9

Notes:

Results of iterative modelling conclude that the developed catchment area discharging to the wetland needs to be limited to approximately 34.9 ha to mimic the pre-development hydrological regime and minimise the risk of negative impacts from increased flow rates.

5.5 Management Recommendations

The following measures are recommended as part of the proposed development to maintain the hydrological regime in the receiving wetland ecosystem:

- Catchment areas outside the 34.9 ha area that would otherwise discharge into the wetlands (Attachment A) shall be diverted, after treatment, and discharged to open water in the Crookhaven River. MUSIC modelling suggests that water quality objectives are met under these conditions.
- Proposed bioretention basins and wetlands (Sections 4.4.4 and 4.4.5) are to include an outlet structure appropriately designed to achieve dispersed flow into the SEPP14 Wetland and mitigate impacts such as localised scour. Outlet structures are to include rip-rap and vegetation tolerant of freshwater inflows.
- The proposed bioretention basins and wetlands include a maximum of 0.5 and 0.4 m detention depth respectively. This storage will provide a degree of onsite detention of flow during rain events and shall mimic natural baseflow and groundwater flow.



¹ Post development catchment modified to mimic pre development wetland flow regime.

6 Statement of Commitments

With regards to management of stormwater onsite during construction and operation of the proposed development, the following commitments are made by the applicant:

- Water quality treatment devices shall be installed to achieve post development nutrient loads that reflect existing loads at the Crookhaven River, Lake Wollumboola, Curleys Bay and Billys Island inlet.
- The proposed treatment train shall comply with Shoalhaven City Council's Draft Sustainable Stormwater Management DCP (2012) and achieve NorBE at receiving environments.
- To mimic the hydrological regime in the wetland areas, the catchment area discharging into the wetlands shall be reduced to ensure post development flows to these areas are comparable to pre development flow.
- All discharge points shall include outlet structures appropriately designed to achieve dispersed flow into the wetland to mitigate impacts such as localised scour.
- Water quality monitoring shall be undertaken in accordance with the project Water Quality Monitoring Plan (Martens and Associates, 2013), which has been prepared with the input from various stakeholders, to ensure the development continues to comply with site water quality objectives. This plan shall undergo continual review and modification to address project progress and results.
- Impacts on downstream receiving environments during the construction phase shall be mitigated by implementation of the project SECP (Martens and Associates, 2013) which has been prepared in accordance with Landcom (2004) and best management practices.



7 References

- Allen Price & Associates (2013) Proposed Sewage Management Regime for New Development Areas within the Crookhaven River Catchment
- Martens and Associates, (2013) Water Quality Monitoring Plan (P1203365JR03V02)
- Shoalhaven City Council (2002) 'Development Control Plan 100: Subdivision Code'
- Shoalhaven City Council (2012) 'DRAFT: Sustainable Stormwater Management DCP'
- Soil Landscapes of the Kiama 1:100 000 sheet. Soil Conservation Service of NSW, Sydney.
- Sydney Metropolitan Catchment Management Authority (SMCMA) (2010) 'Draft NSW MUSIC Modelling Guidelines'
- Wollongong 1:250,000 Geological Sheet; New South Wales Dept of Mines, 1970.



8 Attachment A – Planset



COVER SHEET

SK200	COVER SHEET
SK201	EXISTING SITE
SK202	PROPOSED SUBDIVISION INDICATIVE LAYOUT AND SITE COVERAGE
SK203	PRE-DEVELOPMENT MUSIC MODEL LAYOUT
SK204	POST-DEVELOPMENT MUSIC MODEL LAYOUT
SK205	HYDROLOGICAL CATCHMENT MANAGEMENT: MANGROVE AREA
SK206	PROPOSED TREATMENT TRAIN
SK207	SEDIMENT AND EROSION CONTROL PLAN
SK208	SEDIMENT AND EROSION CONTROL SPECIFICATIONS
SK209	WATER QUALITY MONITORING PLAN

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PROJECT MANAGER:

ANDREW NORRIS

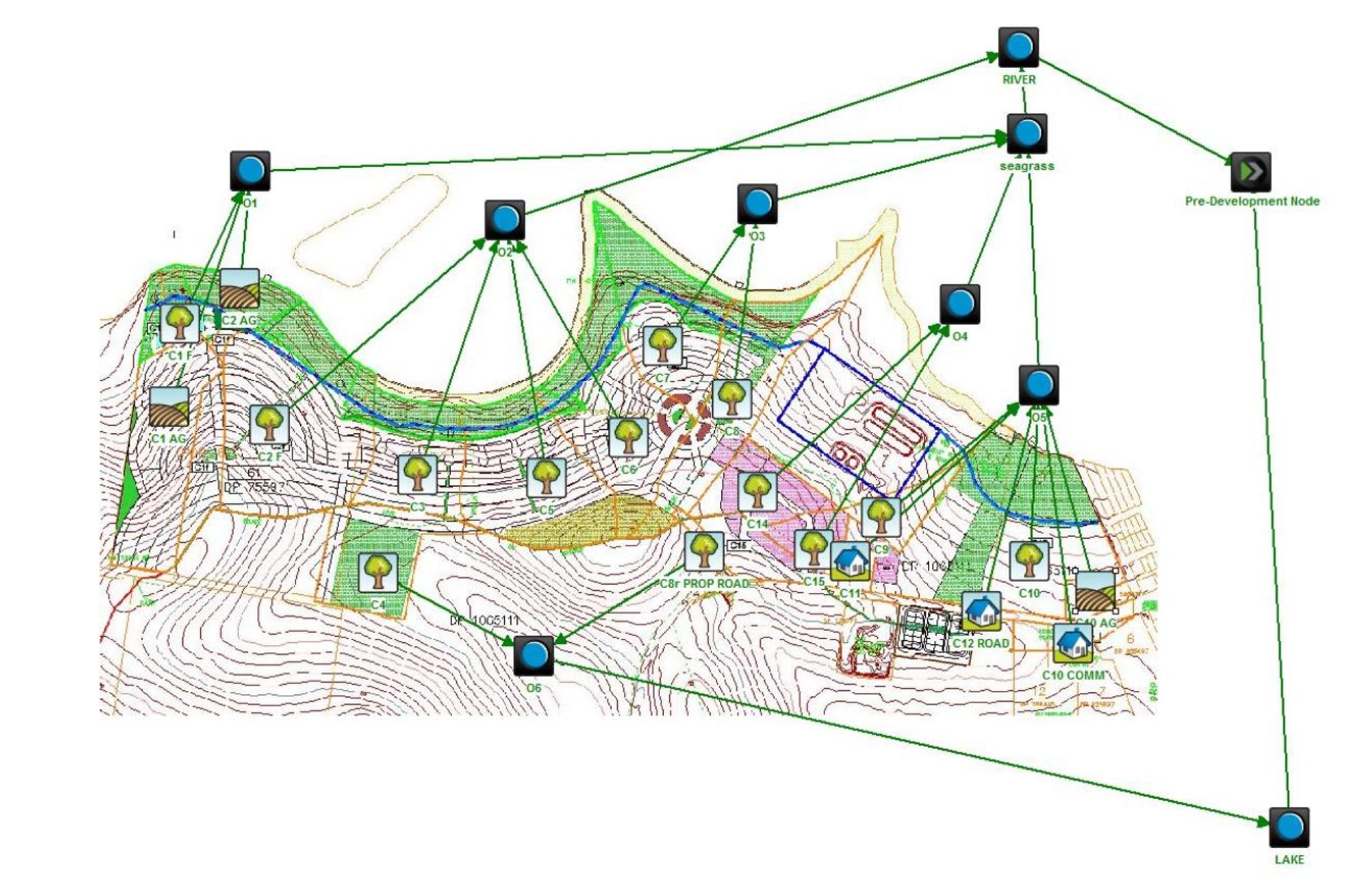
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P1203365JD01V06

DESIGNED: DATUM: mAHD HORIZONTAL RATIO: MLK REVIEWED: VERTICAL RATIO:

SHEET REV. DESCRIPTION DATE 09.10.2013 AN FINAL SK200 PAPER SIZE: A1 / A3



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CLIENT/ PROJECT

PRE-DEVELOPMENT MUSIC MODEL LAYOUT

MIXED USE SUBDIVISION – WEST CULBURRA, NSW

DRAWING NUMBER:

P1203365JD01V06

DESIGNED: DATUM: SHEET

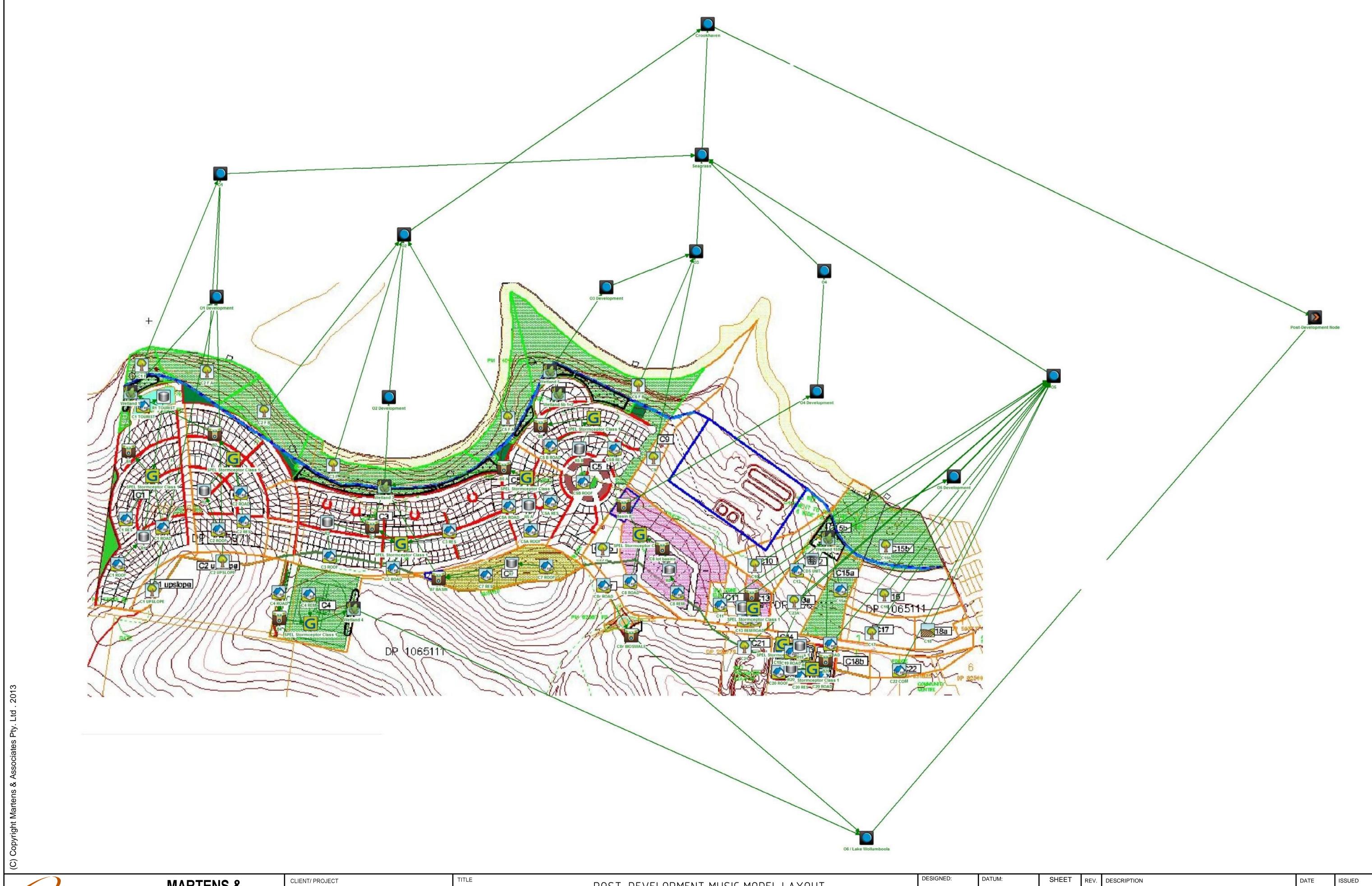
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MLK NTS

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POST-DEVELOPMENT MUSIC MODEL LAYOUT MIXED USE SUBDIVISION - WEST CULBURRA, NSW

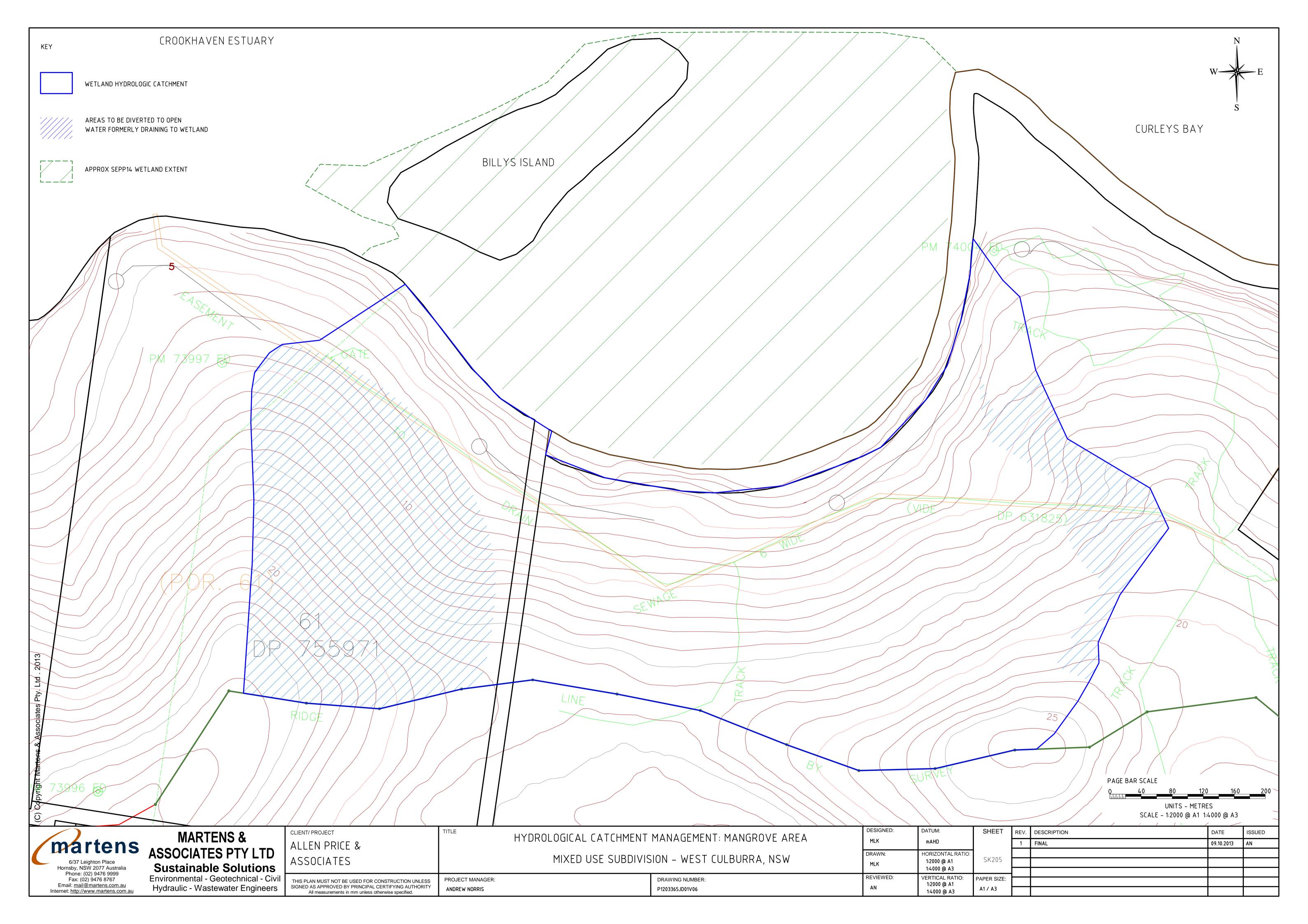
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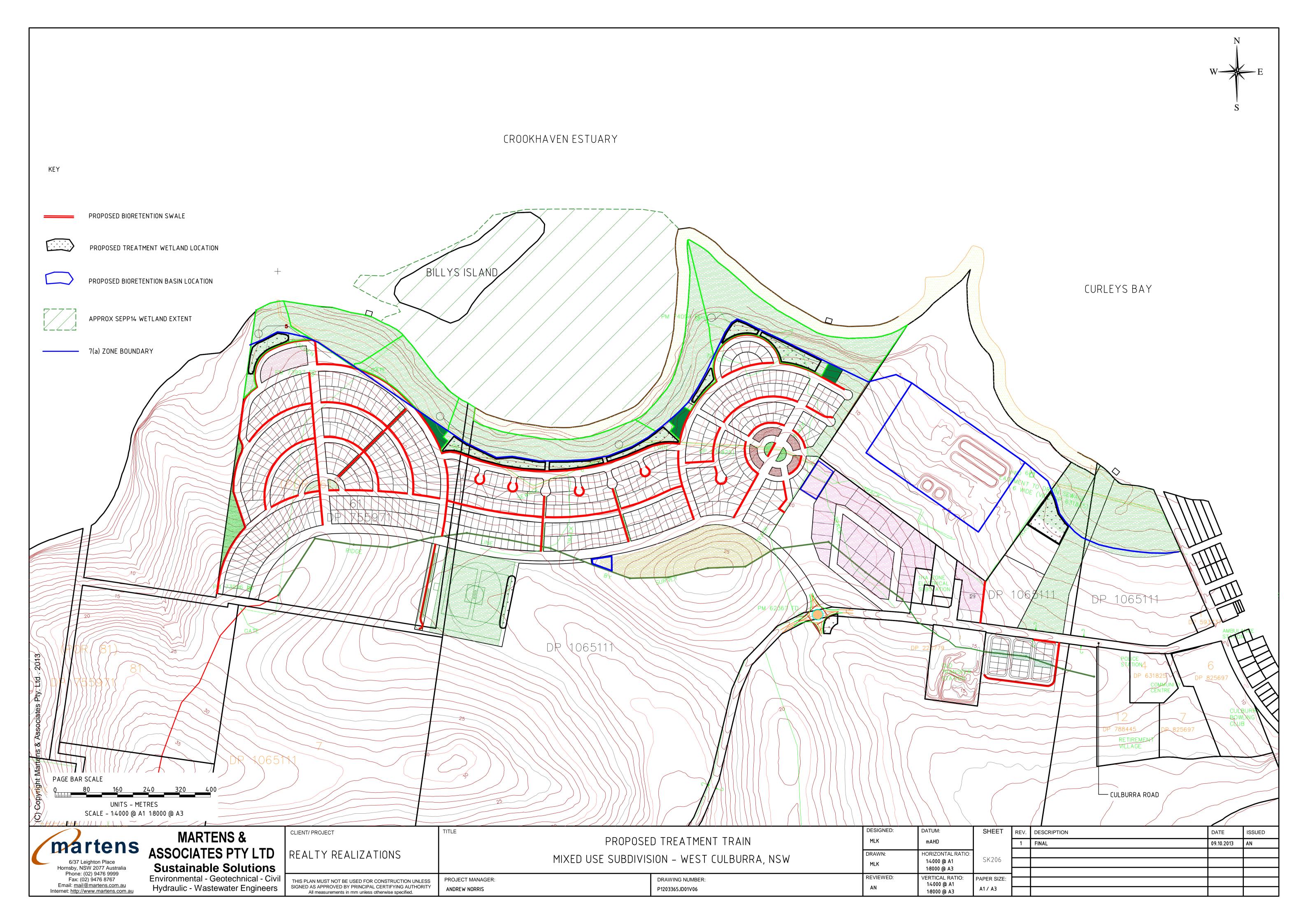
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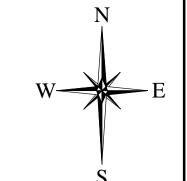
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A1 / A3

09.10.2013 SK204 PAPER SIZE:







CROOKHAVEN ESTUARY

Element	Basin A	Basin B	Basin C	Basin D
Storage Zone Volume (soil) (m³)	1804	1721	384	422
Settling Zone Volume (water) (m³)	6861	6275	2955	4542
Basin Total Volume (m³)	8665	7996	3339	4964

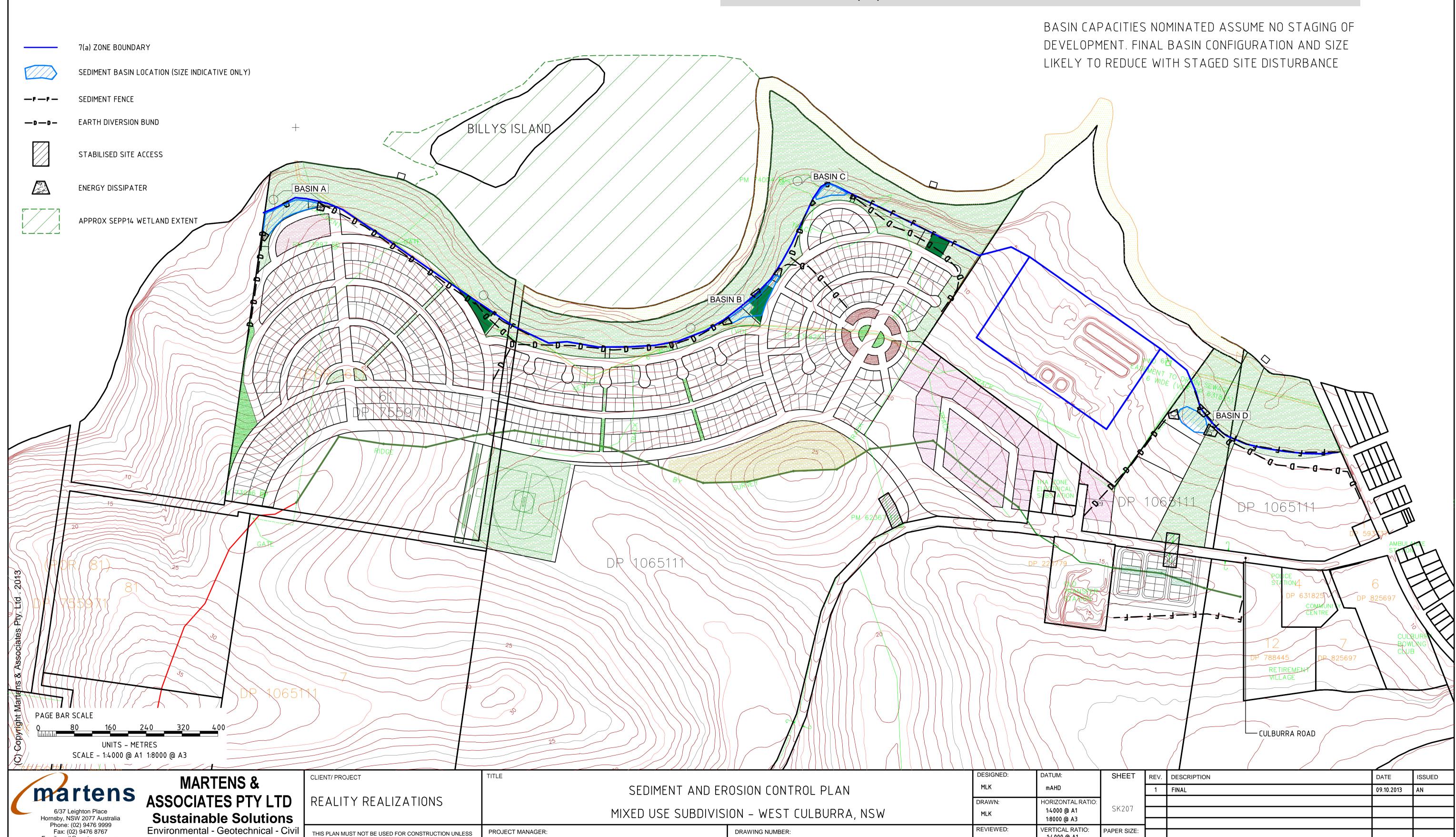
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P1203365JD01V07

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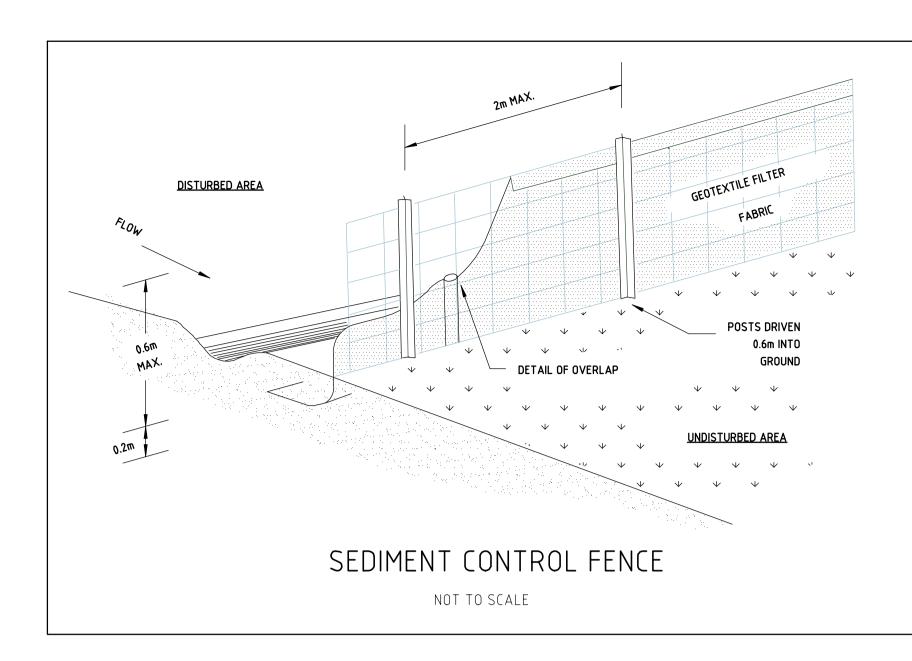
Email: mail@martens.com.au Internet: http://www.martens.com.au

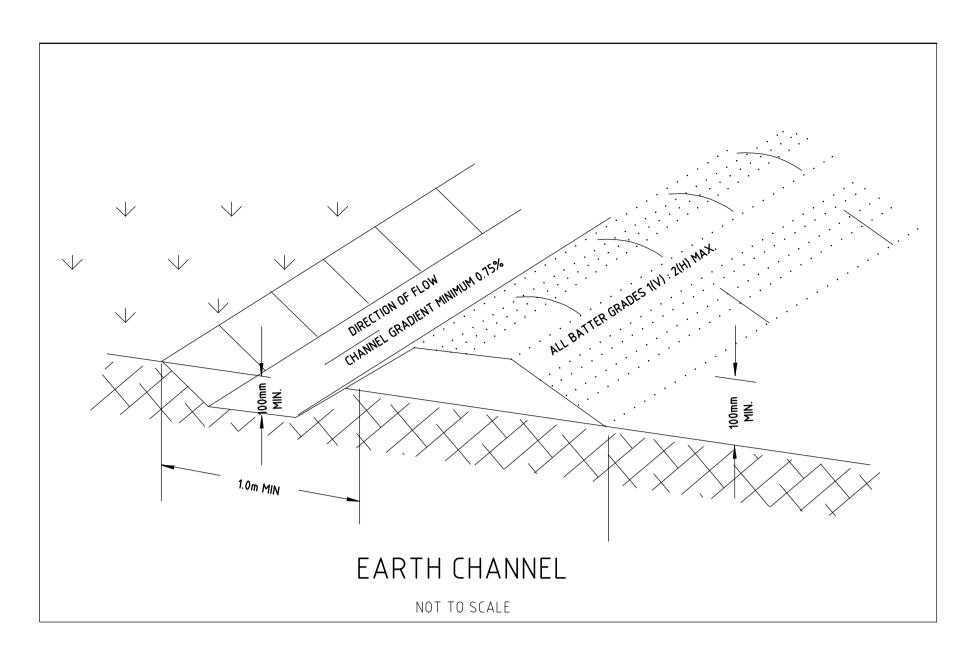
Hydraulic - Wastewater Engineers

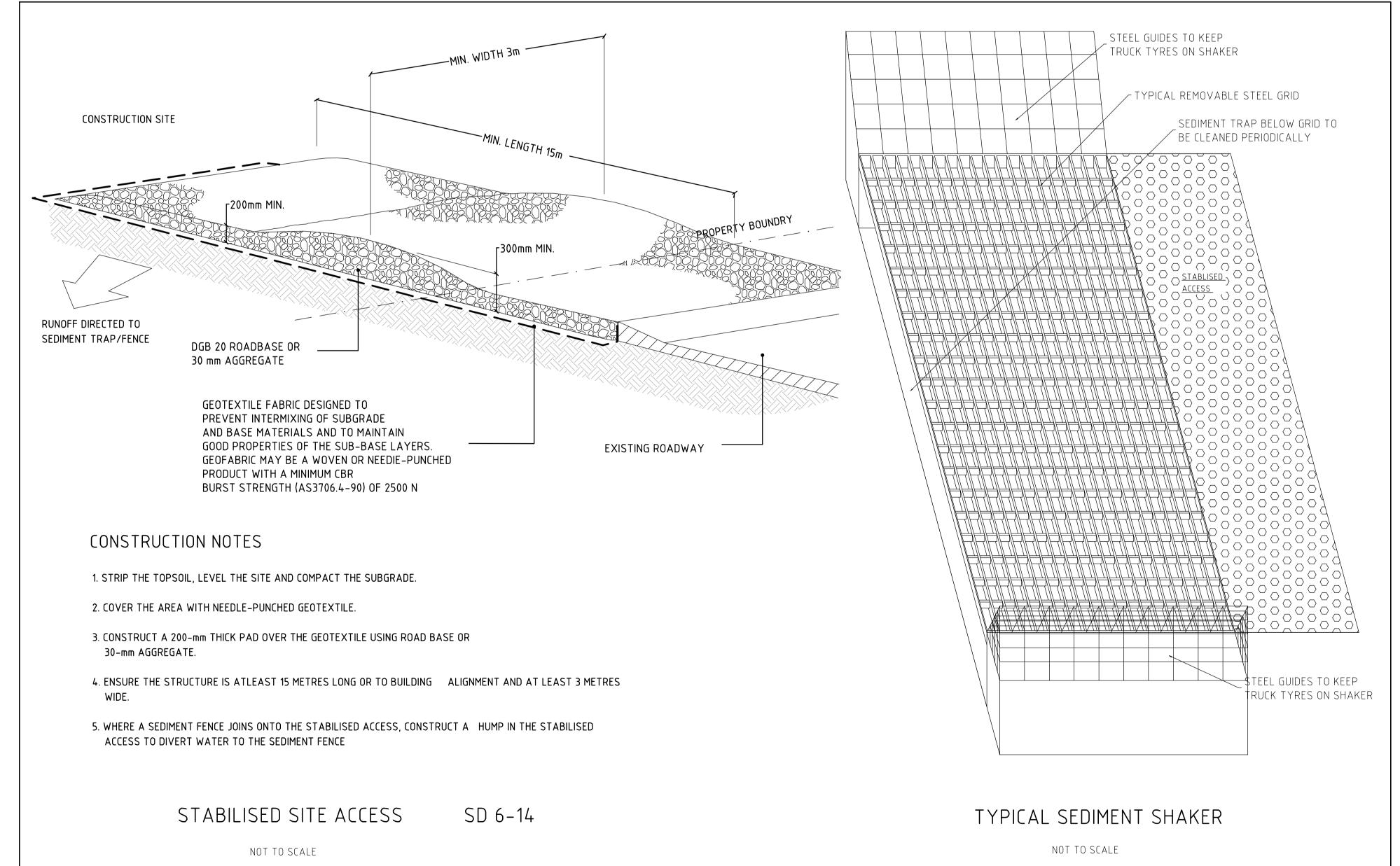
THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY All measurements in mm unless otherwise specified.

PROJECT MANAGER:

ANDREW NORRIS









MARTENS & **ASSOCIATES PTY LTD Sustainable Solutions**

Hydraulic - Wastewater Engineers

CLIENT/ PROJECT

REALITY REALIZATIONS

All measurements in mm unless otherwise specified.

PROJECT MANAGER: THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY ANDREW NORRIS

SEDIMENT AND EROSION CONTROL SPECIFICATIONS MIXED USE SUBDIVISION - WEST CULBURRA, NSW

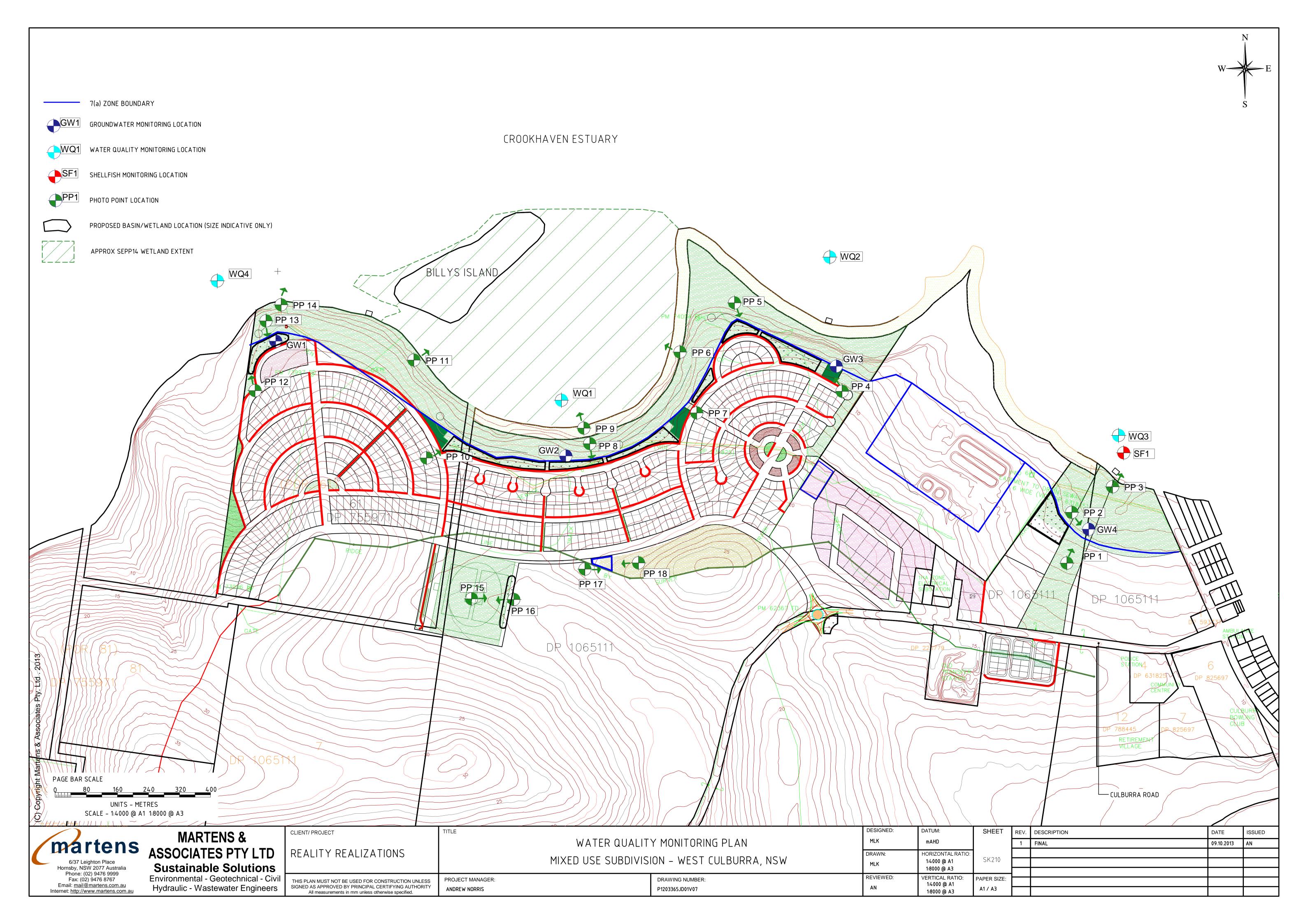
DRAWING NUMBER:

P1203365JD01V06

DESIGNED: DATUM: mAHD HORIZONTAL RATIO SK208 1:4000 @ A1 MLK 1:8000 @ A3 REVIEWED: PAPER SIZE: 1:4000 @ A1 A1 / A3

1:8000 @ A3

DESCRIPTION DATE FINAL 09.10.2013



Attachment B – Summary of MUSIC Input Parameters 9

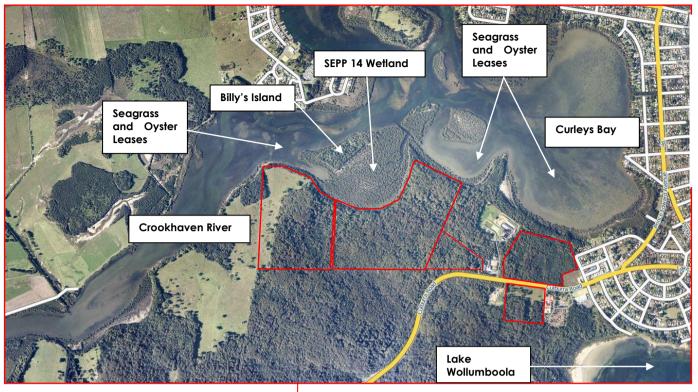


Element	Factor	Input	Source
Setup	Climate File	Climate file (mlh file) from Nowra RAN from 26/11/1992 -	ВОМ
	Node Type	The existing site will be a mixture of agricultual and forested nodes, depending on location across the site. Proposed will be a mixture of roof, road and residential nodes plus forest for undeveloped forest areas.	As per WBM (2010) and development layout
	Roof Area	As per proposed site coverage (ranges from 40% - 60%)	As per development layout
	Road Area	Area per lot layout. Area to be summed for each subcatchment.	As per development layout
Source Nodes	Residential	Remaining lot area (catchment area less road and roof area). Given driveways are not considered 'effective impervious areas' and laybacks are, residential nodes are generally 99% pervious	Assumed based on 'typical' lot layouts
	Rainfall Threshold	Based on land use type or surface type as specified in Table 3.6 of WBM (2010)	WBM (2010) guidelines
	Pervious Area Parameters		Soil properties based on WBM (2010) Table 3-7 and 3-8 and site geotechnical testing by Martens (2010) of 24 boreholes.
	EMC's	As per WBM (2010) for Urban and Forest landuse	WBM (2010) guidelines
	Estimation Method	Stochastically generated	WBM (2010) guidelines
	Low Flow By-Pass	0 m ³ /s	WBM (2010) guidelines
	High Flow Bypass	100 m ³ /s	Online so no bypass (excluding Catchment C15a basin = 50% 1yr ARI)
	Extended Detention depth	Typically 0.5m	By design
	Surface area	Surface area at half the detention depth	WBM (2010) guidelines
	Filter area	By design.	Design of proposed basin
	Unlined filter media	Equal to square root of surface area (actual) multiplied by 4	WBM (2010) guidelines
	Saturated Hydraulic Conductivity	90 mm/hr	MUSIC model help guidelines (ewater) recommend a hydraulic conductibity of 180 mm/hr be used for sands. 50% of this value has been used in modelling as a conservative estimate of realistic long-term hydraulic conductivity of system (ewater).
	Fiter Depth	0.4 - 0.6m	Design of proposed basin
Bioretention Basin	TN content of filter media	IS()() mg/kg	Based on previous discussions with T. Weber (WBM) for other sites (Riverside development September 7, 2012).
	Orthophosphate content of filter media	40 mg/kg	Based on previous discussions with T. Weber (WBM) for other sites (Riverside development September 7, 2012) and product data sheet from RiverSands P/L for typical sand filter media (attached)
	Exfiltration rate	3.6 mm/hr	Based on medium clay subsoils
	Is based lined?	No	Basins shall not be lined
	Vegetation Properties	With effective nutrient removal plants	Landscaping of basins will include deep rooted vegetation.
	Oveflow weir width	varies	Basin design
	Underdrain present	Yes	Basin design
	Submerged zone with carbon	Yes; 0.0 - 0.2m	Basin design
	present		
	Low Flow By-Pass High Flow Bypass	0 m ³ /s 100 m ³ /s	WBM (2010) guidelines No Bypass
	Extended Detention depth	0.25m	By design
	Surface area	Surface area at half the detention depth	WBM (2010) guidelines
	Filter area	By design.	Design of proposed basin
	Unlined filter media		WBM (2010) guidelines
	The state of the s	The state of the s	
	Saturated Hydraulic Conductivity	90 mm/hr	MUSIC model help guidelines (ewater) recommend a hydraulic conductibity of 180 mm/hr be used for sands. 50% of this value has been used in modelling as a conservative estimate of realistic long-term hydraulic conductivity of system (ewater).
	Fiter Depth	0.6m	Design of proposed basin

_{Diameter}			
Bioretention Swales	TN content of filter media	500 mg/kg	Based on previous discussions with T. Weber (WBM) for other sites (Riverside development September 7, 2012).
	Orthophosphate content of filter media	40 mg/kg	Based on previous discussions with T. Weber (WBM) for other sites (Riverside development September 7, 2012) and product data sheet from RiverSands P/L for typical sand filter media (attached)
	Exfiltration rate	3.6 mm/hr	Based on medium clay subsoils
	Is based lined?	No	Swales shall not be lined
	Vegetation Properties	With effective nutrient removal plants	Landscaping of basins will include deep rooted vegetation.
	Oveflow weir width	varies	Basin design
	Underdrain present	Yes	Basin design
	Submerged zone with carbon present	Yes; 0.2m	Basin design
		0 m ³ /s	WBM (2010) guidelines
	High Flow Bypass	100 m ³ /s	Online so no bypass (excluding Catchment C15a basin = 50% 1yr ARI)
	Inlet Pond Volume	Varies	By design
	Surface area	Surface area at half the detention depth	WBM (2010) guidelines
	Extended Detention depth	0.4 - 0.5m	Design of proposed wetlands
Wetlands	Permanent Pool Volume	Varies	Design of proposed wetlands
	Exfiltration rate	3.6 mm/hr	Based on medium clay subsoils
	Equivalent Pipe Diameter	Varies	Adjusted to achieve an approximate detention time of 72 hrs as per 3.8.3.1 of WBM (2010) guidelines
	Weir width	Varies	Design of proposed wetlands
	Reuse	Where used based on 6ML/ha/yr	Typical irrigation rate for golf course grade landscaping
	Low Flow By-Pass	0 m3/s	WBM (2010) guidelines
	High Flow Bypass	Varies - Q (3month)	As per manufactures specification (Rocla) and catchment area
		Input 1075 Ouput 376.7	As per manufactures specification (Rocla)
GPT (CDS GPT)	IIN (mg/I)	Input 50 Ouput 50	As per manufactures specification (Rocla)
	P (mg/)	Input 10 Ouput 7	As per manufactures specification (Rocla)
	GP (kg/ML)	Input 100 Ouput 2	As per manufactures specification (Rocla)
	Low Flow By-Pass	0 m3/s	WBM (2010) guidelines
	High Flow Bypass	Varies	As per manufactures specification (SPEL) 90% of daily maxima inflow
GPT (SPEL Stormceptor)	1155 (mg/1)	Input 1000 Ouput 30	As per manufactures specification (SPEL)
	TN (mg/L)	Input 50 Ouput 35	As per manufactures specification (SPEL)
	P (mg/)	Input 5 Ouput 3.5	As per manufactures specification (SPEL)
	(¬P (KØ/IVII)	Input 15 Ouput 0	As per manufactures specification (SPEL)
	Low Flow By-Pass	0 m3/s	WBM (2010) guidelines
	High Flow Bypass	0.005 m3/s per dwelling (for free standing houses, townhouses, retirement and tourist accomodation). 100mm/hr for unit blocks by assumed roof perimeter	WBM (2010) guidelines
	Volume below overflow	Based on 3KL/dwelling or 3KL/tenement. A volume of 80% of total tank volume is assumed	Development design. As per WBM (2010) MUSIC modelling guidelines
Rainwater Tank		0.2m	By design
	Surface area	Cumulative surface area	By design
	Overflow pipe diameter	100mm	WBM (2010) guidelines
	Reuse	274L/day/ET	Shoalhaven Water

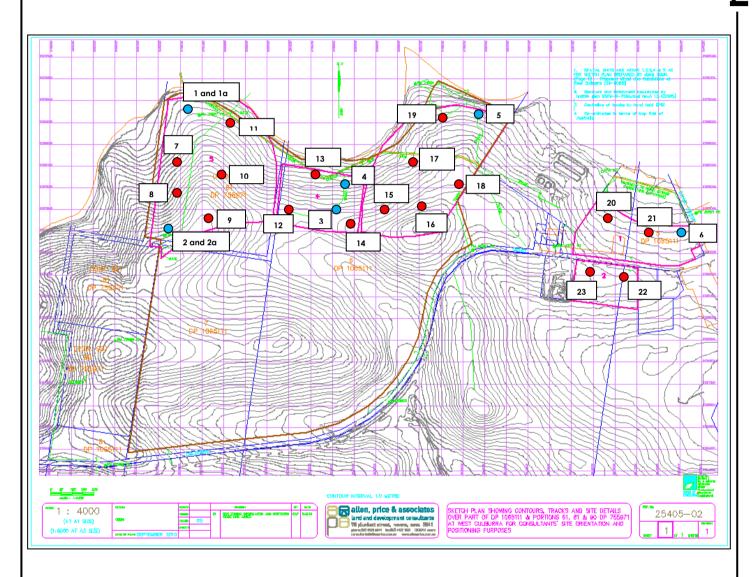
10 Attachment C - Figures







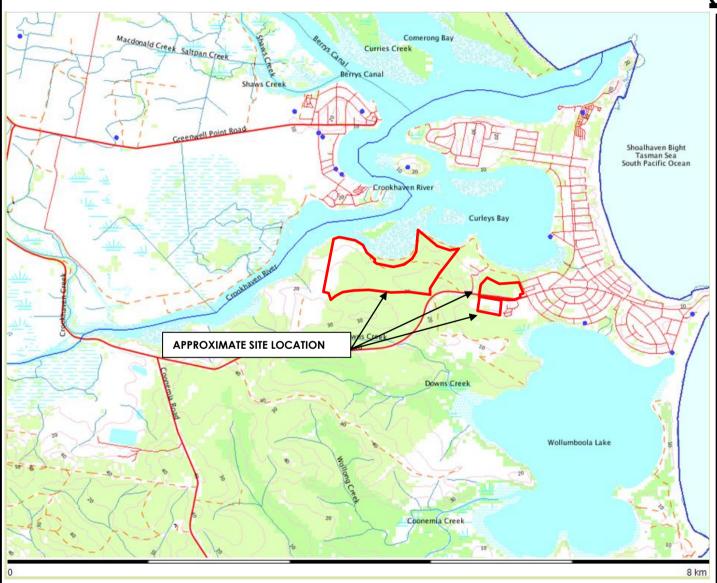
Martens & Associates Pty	Ltd ABN 85 070 240 890	Environment Water Wastewater Geotechnical C	Civil Management
Drawn:	MLK		
Approved:	AN	Site Locality and Regional Context	Figure 1
Date:	01.03.2013		SK301
Scale:	NA		Job No: P1203365



Key:

- Approx borehole location and I.D
- O Approximate GMB location and I.D

Martens & Associates Pty Ltd ABN 85 070 240 890		Environment Water Wastewater Geotechnical Civil Management		
Drawn:	MLK			
Approved:	AN	Borehole and GMB Locations	Figure 2	
Date:	01.03.2013		SK302	
Scale:	NA		Job No: P1203365	



Notes:

- Source (NSW Natural Resource Atlas). Site location is approximate only. Licensed bores = purple dots.

Martens & Associates Pty	Ltd ABN 85 070 240 890	Environment Water Wastewater Geotechnical Civil Managemen				
Drawn:	MLK					
Approved:	AN	Site and Surrounding Licensed Bores	Figure 3			
Date:	01.03.2013		SK303			
Scale:	NA		Job No: P1203365			

11	Attachment D – MUSIC Model	Catchment Areas
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SOIL TYPES

		Soil Types in top 0.5m - Real Data Inputs for MUSIC											
Layer 1	Depth	SSC (MUSIC guidelines)	FC (MUSIC Guidelines)	Layer 2	Depth	SSC (MUSIC guidelines)	FC (MUSIC Guidelines)	elines) Weighted average SSC Weighted average FC Inf a Inf b DRR (%)			DBR (%)		
LOAMY SAND	0.3	139	69	CLAY	0.2	93	68	120.6	68.6	270	1.9	64	34

PRE DEVELOPMENT CATCHMENT AREAS

RECEIVING NODE	CATCHMENT ID	TOTAL AREA (HA)	IMPERVIOUS AREA (HA)	%	PERVIOUS AREA (HA)	%	EMC CATEGORY
	C1 AG	10.52	0.0	0%	10.5	100%	AGRICULTURAL
-	C1 FOREST	4.39	0.0	0%	4.4	100%	FOREST
	C2 AG	3.38	0.0	0%	3.4	100%	AGRICULTURAL
	C2 FOREST	16.73	0.0	0%	16.7	100%	FOREST
02	C3	6.54	0.0	0%	6.5	100%	FOREST
U2	C5	11.21	0.0	0%	11.2	100%	FOREST
	C6	11.52	0.0	0%	11.5	100%	FOREST
00	C8r	0.887	0.0	0%	0.9	100%	FOREST
06	C4	6.67	0.0	0%	6.7	100%	FOREST
	C7	8.88	0.0	0%	8.9	100%	FOREST
03	C8	10.40	0.0	0%	10.4	100%	FOREST
04	C14	3.99	0.0	0%	4.0	100%	FOREST
04	C15	2.90	0.0	0%	2.9	100%	FOREST
	C9	4.38	0.0	0%	4.4	100%	FOREST
	C10	18.47	0.0	0%	18.5	100%	FOREST
OS	C10ag	4.44	0.0	0%	4.4	100%	AGRICULTURAL
	C10comm	1.49	0.6	40%	0.9	60%	COMMERCIAL
	C11	1.72	1.7	100%	0.0	0%	INDUSTRIAL
	C12	1.77	1.8	100%	0.0	0%	ROAD
	TOTAL	130			•		

RECEIVING NODE	CATCHMENT	Total Area	Bioswale Area	Road Area	%Pervious Road*	House Area	Residential Node	% Impervious (Res)	%Pervious (Res)	NODE
	C1 FOREST	1.06						0%	100%	FOREST
	WETLAND 1	0.3474								
	C1	12.36	0.4201	4.35	0.41	2.96	4.63	1%	99%	RESIDENTIAL
	C1 Tourist	0.62					0.6	90%	10%	
01	C2 FOREST A	2.66						0%	100%	FOREST
	C2	10.19	0.3291	2.40	0.38	2.91	4.55	1%	99%	RESIDENTIAL
	C2 UPSLOPE	0.55								
	C1 UPSLOPE	0.87								
	TOTAL	28.65								
	C2 Forest b	2.58						0%	100%	FOREST
	C3 FOREST	3.67						0%	100%	FOREST
	C3	16.80	0.4331	4.87	0.42	4.77	6.73	1%	99%	RESIDENTIAL
	WETLAND 3	0.7981	0.1551	1.07	0.12		0.75	170	3370	NEOID EITH II LE
	C5 FOREST A	2.78						0%	100%	FOREST
02	WETLAND5(b1)	0.1403						070	100/0	T GINES !
	C5 WETLAND5(a)	0.3419								
	C5 A	4.33	0.0895	1.12	0.42	1.07	2.05	1%	99%	RESIDENTIAL
	C7	3.47	0.0033	0.0	0.12	2.08	1.39	0%	100%	RESIDENTIAL
	BASIN B7	0.1211				-195		***		
	TOTAL	35.03								
	C8r	0.89		0.89	0.50					ROAD
06	C4	4.99	0.0625	0.22	0.38		4.71	0%	100%	RESIDENTIAL
	WETLAND 4	0.2497	0.0023	0.22	0.20		7.72	070	10070	RESIDEITIAE
	C5 FOREST B	5.30						0%	100%	FOREST
	Wetland 5	0.2234						070	100/0	TOREST
	WETLAND5(b2)	0.5077								
03	C5 B	11.55	0.3856	4.16	0.41	2.80	4.21	1%	99%	RESIDENTIAL
	C5 B	11.55	0.5050	4.10	0.41	2.00	7,21	170	5570	RESIDEITIAE
	C9	2.67						0%	100%	FOREST
	TOTAL	20.24						***		
	C23b	2.63						0%	100%	FOREST
04	C8	6.86	0.6863	1.50	0.50	0.0	4.68	100%	0%	
04	BASIN C8	0.3991	0.0003	1.50	0.30	0.0	4.00	100/0	070	INDOSTRIAL
	TOTAL	9.89								
	C10	2.45						0%	100%	FOREST
	C11	1.72					1.7	100%	0%	INDUSTRIAL
	C15a	2.13					2.1	0%	100%	RESIDENTIAL
	WETLAND 15B	0.6646					2.1	070	100/0	KESIDEIVIIAE
	C15b	5.41						0%	100%	FOREST
	C12	1.01					1.0	90%	10%	RESIDENTIAL
	C13	0.84	0.0296	0.17	0.50		0.64	100%	0%	INDUSTRIAL
	C14	1.77	0.0230	1.8	0.30		0.04	100%	0%	ROAD
05	C14 C16	3.97		1.0				0%	100%	FOREST
	C17	1.89						0%	100%	FOREST
	C18	1.99						0%	100%	AGRICULTURAL
	C19	0.62	0.0000	0.2	0.5	0.153	0.32	0%	100%	RESIDENTIAL
	C20	1.82	0.0954	0.2	0.5		0.95	0%	100%	RESIDENTIAL
	C21	0.60	0.0554	0.0	0.5	0.430	0.55	0%	100%	FOREST
	C22	1.49		0.0			1.5	40%	60%	COMMERCIAL
	C23a	1.96					1.5	0%	100%	FOREST
	TOTAL	30.3						070	100/0	
L	TOTAL	130				L				

TOTAL 130

^{*} where bioswales are on road then pervious area cannot be 50%

12 Attachment E – Bioretention Basin and Wetland MUSIC Input Parameters



WETLAND INPUT PARAMETERS

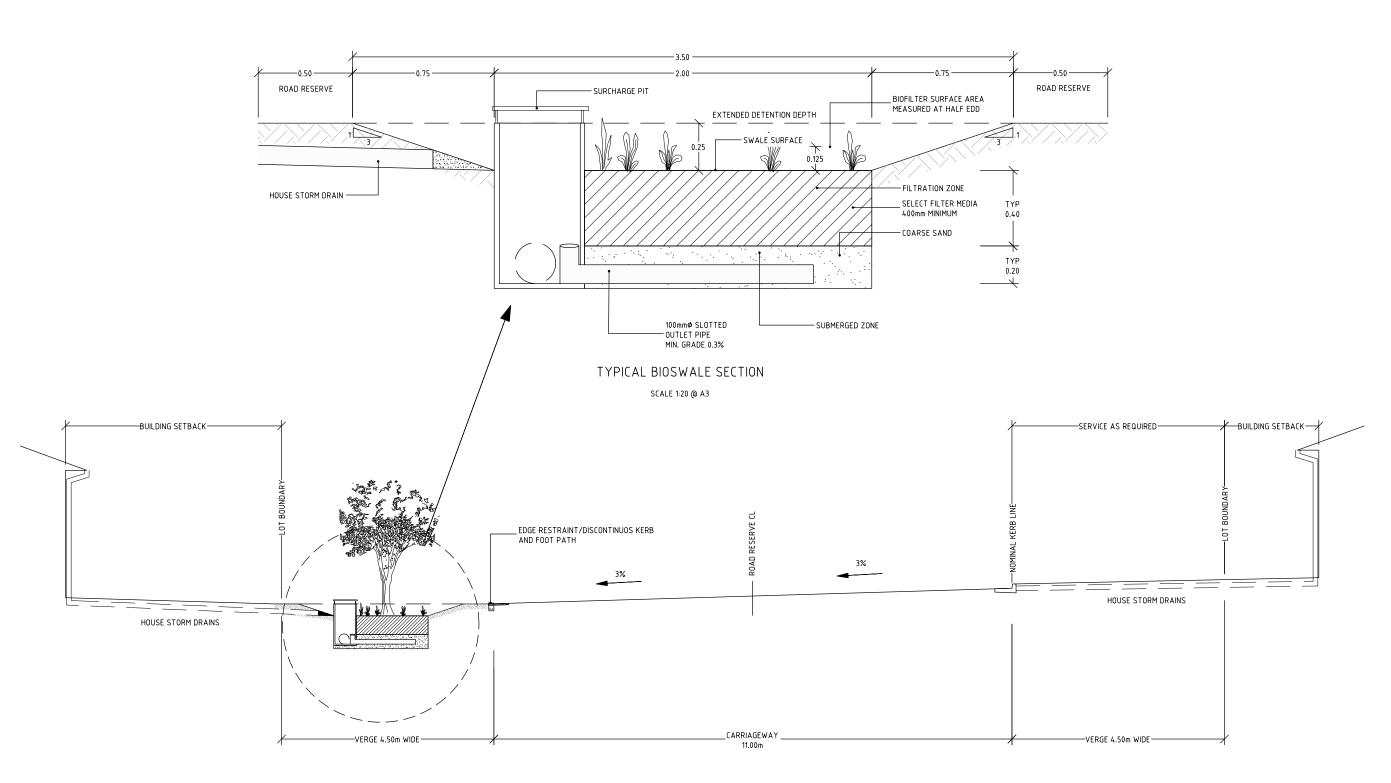
Node Name	Wetland 3	Wetland 4	Wetland 5b 1+2	Wetland 1	Wetland 5	Wetland 15B	
Inlet Properties - Low Flow By-pass (cubic metres per sec)	0	0	0	0	0	0	{cubic metres per sec}
Inlet Properties - High Flow By-pass (cubic metres per sec)	100	100	100	100	100	100	{cubic metres per sec}
Inlet Properties - Inlet Pond Volume (cubic metres)	0	0	0	0	0	0	{cubic metres}
Storage Properties - Surface Area (square metres)	10869	2423	6236	3311	2053	6471	{square metres}
Storage Properties - Extended Detention Depth (metres)	0.4	0.5	0.4	0.5	0.5	0.5	{metres}
Storage Properties - Permanent Pool Volume (cubic metres)	820	200	570	260	74.2	510	{cubic metres}
Storage Properties - Exfiltration Rate (mm/hr)	3.6	3.6	3.6	3.6	3.6	3.6	{mm/hr}
Storage Properties - Evaporative Loss as % of PET	125	125	125	125	125	125	
Outlet Properties - Equivalent Pipe Diameter (mm)	110	55	90	65	40	90	{mm}
Outlet Properties - Overflow Weir Width (metres)	660	20	10	20	10	10	{metres}
Outlet Properties - Notional Detention Time (hrs)	67.7	67.5	58.0	66.1	108.2	67.3	{hrs}

BASIN INPUT PARAMETERS

Node Name	B7 BASIN	Basin 8	
Inlet Properties - Low Flow By-pass (cubic metres per sec)	0	0	{cubic metres per sec}
Inlet Properties - High Flow By-pass (cubic metres per sec)	100	100	{cubic metres per sec}
Storage Properties - Extended Detention Depth (metres)	0.5	0.5	{metres}
Storage Properties - Surface Area (square metres)	1211	3991	{square metres}
Filter and Media Properties - Filter Area (square metres)	1099	3991	{square metres}
Filter and Media Properties - Unlined Filter Media Perimeter (metres)	140	252	{metres}
Filter and Media Properties - Saturated Hydraulic Conductivity (mm/hr)	90	90	{mm/hr}
Filter and Media Properties - Filter Depth (metres)	0.4	0.65	{metres}
Filter and Media Properties - TN Content of Filter Media (mg/kg)	500	500	{mg/kg}
Filter and Media Properties - Orthophosphate Content of Filter Media (mg/kg)	40	40	{mg/kg}
Infiltration Properties - Exfiltration Rate (mm/hr)	3.6	3.6	{mm/hr}
Outlet Properties - Overflow Weir Width (metres)	35	7	{metres}
Outlet Properties - Submerged Zone Depth (metres)	0.2	0	{metres}

13 Attachment F - Typical Bioretention Swale, Basin and Wetland Design

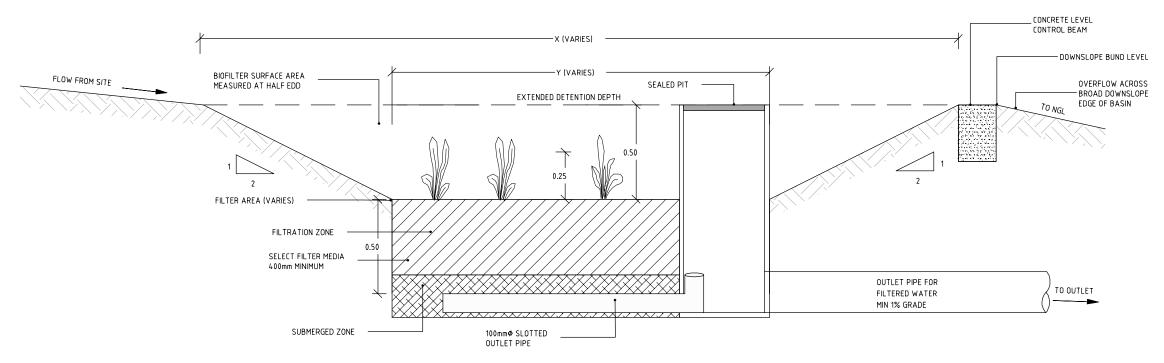




TYPICAL SECTION ROAD 20m WIDE

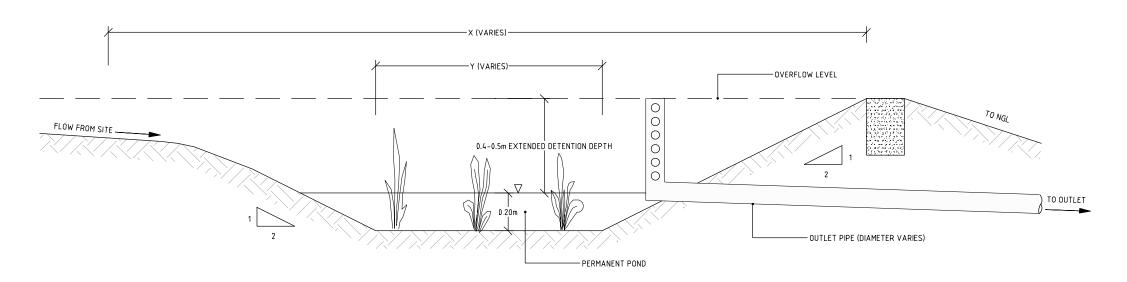
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	Approved:	AN	TYPICAL BIOSWALE SECTION CULBURRA WEST, NSW	SK001
	Drawn: KT Approved: AN TYPICAL BIOSI CULBURRA Date: 01.03.2013 Outle 040 100 100 100 100 100 100 100 100 100	MIXED USE SUBDIVISION		
(C) Copyright Martens & Associates Pty Ltd This drawing must not be reproduced in whole or part without prior written consent of Martens & Associates Pty Ltd	Scale @A3:	1:20	6/37 Leighton Place, Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767 Email: mail@martens.com.au Internet: http://www.martens.com.au	Project: File: Revision: P1203365 JD02V01 A



TYPICAL BIOREMEDIATION BASIN SECTION

SCALE 1:20 @ A3



TYPICAL WETLAND SECTION

SCALE 1:20 @ A3

0 0.2 0.4 0.6 0.8 1.0	Martens & Associates Pt	ty Ltd ABN 85 070 240 890	Environment Water Wastewater Geotechnical Civil Management		
0 0.2 0.4 0.6 0.8 1.0	Drawn:	KT	TYPICAL BIOREMEDIATION BASIN SECTION AND	Drawing No./ID:	
UNITS - METRES	Approved:	AN	TYPICAL BIOREMEDIATION BASIN SECTION AND TYPICAL WETLAND SECTION SK002 CULBURRA WEST, NSW		
	Date:	10.10.2013	MIXED USE SUBDIVISION		
	Scale @A3:	1:20	6/37 Leighton Place, Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767 Email: mail@martens.com.au Internet: http://www.martens.com.au	Project: File: Revision: P1203365 JD02V02 A	

14	Attachment G – Groundwater Quality Laboratory Results





Envirolab Services Pty Ltd

ABN 37 112 535 645 12 Ashley St Chatswood NSW 2067 ph 02 9910 6200 fax 02 9910 6201 enquiries@envirolabservices.com.au www.envirolabservices.com.au

CERTIFICATE OF ANALYSIS 48959

Client:

Martens & Associates Pty Ltd

6/37 Leighton Place Hornsby NSW 2077

Attention: Ben Rose

Sample log in details:

Your Reference: P1002842JC01V01, Culburra

No. of samples: 3 Waters, 60 Soils

Date samples received: 30/11/10
Date completed instructions received: 30/11/10

Analysis Details:

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: 7/12/10

Date of Preliminary Report: 01/12/2010

Issue Date: 7/12/10

NATA accreditation number 2901. This document shall not be reproduced except in full.

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Tests not covered by NATA are denoted with *.

Results Approved By:

Pasialieucz.
Kasjan Paciuszkiewicz

Chemist

Nick Sarlamis
Inorganics Supervisor

Envirolab Reference: 48959 Revision No: R 01



Client Reference: P1002842JC01V01, Culburra

Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-4	48959-5	48959-6	48959-7	48959-8
Your Reference		2842/1	2842/1	2842/1	2842/2	2842/2
Depth		0.5	1.0	1.5	0.2	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/201
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/201
pH 1:5 soil:water	pH Units	5.1	5.0	8.1	5.5	4.7
Electrical Conductivity 1:5 soil:water	μS/cm	57	97	80	23	43
Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-9	48959-10	48959-11	48959-12	48959-1
Your Reference		2842/2	2842/24	2842/24	2842/24	2842/24
Depth		1.5	0.2	1.0	1.5	2.0
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/201
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/201
pH 1:5 soil:water	pH Units	5.0	5.3	4.8	4.8	4.9
Electrical Conductivity 1:5 soil:water	μS/cm	23	21	55	58	58
Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-14	48959-15	48959-16	48959-17	48959-1
Your Reference		2842/13	2842/13	2842/13	2842/3	2842/3
Depth		0.2	0.5	1.0	0.2	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	_	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/201
Date analysed	_	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/201
pH 1:5 soil:water	pH Units	5.1	5.5	5.2	5.3	5.2
Electrical Conductivity 1:5 soil:water	μS/cm	33	24	66	35	56
•	<u>'</u>					
Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-19	48959-20	48959-21	48959-22	48959-2
Your Reference		2842/3	2842/4	2842/4	2842/4	2842/18
Depth		1.0	1.0	1.5	2.0	0.2
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/201
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/201
pH 1:5 soil:water	pH Units	4.9	4.8	4.7	4.6	5.3
Electrical Conductivity 1:5 soil:water	μS/cm	52	63	68	76	18

Envirolab Reference: 48959 Revision No: R 01

Client Reference: P1002842JC01V01, Culburra

	Miscellaneous Inorg - soil						
	Our Reference:	UNITS	48959-24	48959-25	48959-26	48959-27	48959-28
	Your Reference		2842/18	2842/18	2842/19	2842/19	2842/19
	Depth		0.5	1.0	0.2	0.5	1.5
	Type of sample		Soil	Soil	Soil	Soil	Soil
	Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
	Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
	pH 1:5 soil:water	pH Units	5.1	4.9	5.5	4.9	4.7
	Electrical Conductivity 1:5 soil:water	μS/cm	34	44	30	51	83
,							
	Miscellaneous Inorg - soil						
	Our Reference:	UNITS	48959-29	48959-30	48959-31	48959-32	48959-33
	Your Reference		2842/22	2842/22	2842/6	2842/6	2842/6
	Depth		0.2	0.5	0.2	0.5	2.5
	Type of sample		Soil	Soil	Soil	Soil	Soil
	Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
	Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
	pH 1:5 soil:water	pH Units	5.7	5.3	4.7	4.5	6.1

21

58

480

1,200

710

μS/cm

Envirolab Reference: 48959 Revision No: R 01

Electrical Conductivity 1:5 soil:water

Client Reference: P1002842JC01V01, Culburra

sPOCAS field test						
Our Reference:	UNITS	48959-34	48959-35	48959-36	48959-37	48959-3
Your Reference		2842/1	2842/1	2842/1	2842/11	2842/1
Depth		0.5	1.0	1.5	0.5	1.0
Type of sample		Soil	Soil	Soil	Soil	Soil
pHF (field pH test)*	pH Units	5.4	5.1	5.1	5.3	4.7
pHFox (field peroxide test)*	pH Units	4.5	4.1	4.2	4.4	3.8
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight
sPOCAS field test						
Our Reference:	UNITS	48959-39	48959-40	48959-41	48959-42	48959-4
Your Reference		2842/24	2842/24	2842/24	2842/24	2842/1
Depth		0.5	1.0	1.5	2.0	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
pHF (field pH test)*	pH Units	5.1	5.0	5.1	5.2	5.3
pHFox (field peroxide test)*	pH Units	4.0	4.0	4.1	4.2	4.2
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight
sPOCAS field test						
Our Reference:	UNITS	48959-44	48959-45	48959-46	48959-47	48959-4
Your Reference	UNITS	2842/13	2842/4	2842/4	2842/4	2842/4
		1.0	0.5	1.0	1.5	2.0
Depth Type of sample						
Type of sample		Soil	Soil	Soil	Soil	Soil
pHF (field pH test)*	pH Units	5.4	5.3	4.9	4.8	4.9
pHFox (field peroxide test)*	pH Units	4.4	4.3	4.0	4.0	4.0
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight
sPOCAS field test						
Our Reference:	UNITS	48959-49	48959-50	48959-51	48959-52	48959-
Your Reference		2842/4	2842/19	2842/19	2842/19	2842/
Depth		2.5	0.5	1.0	1.5	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
pHF (field pH test)*	pH Units	4.5	5.1	4.8	4.9	5.5
pHFox (field peroxide test)*	pH Units	3.8	4.2	3.9	3.9	4.5
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight
sPOCAS field test						
Our Reference:	UNITS	48959-54	48959-55	48959-56	48959-57	48959-5
Your Reference		2842/5	2842/6	2842/6	2842/6	2842/6
Depth		1.0	0.5	1.0	1.5	2.0
Type of sample		Soil	Soil	Soil	Soil	Soil
pHr (field pH test)*	pH Units	5.2	4.5	4.7	5.0	5.2
pHFox (field peroxide test)*	pH Units	4.1	3.6	4.0	4.5	4.4
	Prionis					
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

Envirolab Reference: 48959 Revision No: R 01

sPOCAS field test						
Our Reference:	UNITS	48959-59	48959-60	48959-61	48959-62	48959-63
Your Reference		2842/6	2842/6	2842/21	2842/21	2842/20
Depth		2.5	3.0	0.5	1.0	1.5
Type of sample		Soil	Soil	Soil	Soil	Soil
pHr (field pH test)*	pH Units	5.8	5.6	5.2	5.3	5.0
pHFox (field peroxide test)*	pH Units	5.7	5.3	4.1	4.7	4.2
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

Miscellaneous Inorganics				
Our Reference:	UNITS	48959-1	48959-2	48959-3
Your Reference		2842/GMB01/	2842/GMB02/	2842/GMB06/
		25.11.2010	25.11.2010	26.11.2010
Depth		-	-	-
Type of sample		Water	Water	Water
Date prepared	-	30/11/2010	30/11/2010	30/11/2010
Date analysed	-	30/11/2010	30/11/2010	30/11/2010
Electrical Conductivity	μS/cm	4,900	250	18,000
Total Dissolved Solids (grav)	mg/L	2,900	180	13,000
рН	pH Units	5.2	5.1	5.6
Nitrate as N in water	mg/L	0.01	0.1	<0.005
Hardness	mgCaCO3	280	8	2,600
	/L			
NOx as N in water	mg/L	0.02	0.1	0.007
Ammonia as N in water	mg/L	0.3	0.02	0.1
Total Nitrogen in water	mg/L	0.7	0.4	0.3
Phosphorus - Total	mg/L	<0.05	<0.05	<0.05
Phosphate as P in water	mg/L	<0.05	<0.05	<0.05
Silicon*- Dissolved	mg/L	36	36	15
Strontium - Dissolved	mg/L	0.2	<0.01	1.2
Titanium - Dissolved	mg/L	<0.02	<0.02	<0.02

Ion Balance				
Our Reference:	UNITS	48959-1	48959-2	48959-3
Your Reference		2842/GMB01/	2842/GMB02/	2842/GMB06/
		25.11.2010	25.11.2010	26.11.2010
Depth		-	-	-
Type of sample		Water	Water	Water
Date prepared	-	30/11/2010	30/11/2010	30/11/2010
Date analysed	-	30/11/2010	30/11/2010	30/11/2010
Calcium - Dissolved	mg/L	10	0.6	130
Potassium - Dissolved	mg/L	8.0	0.6	13
Sodium - Dissolved	mg/L	950	38	3,400
Magnesium - Dissolved	mg/L	62	1.6	560
Hydroxide Alkalinity (OH ⁻) as CaCO ₃	mg/L	<0.1	<0.1	<0.1
Bicarbonate Alkalinity as CaCO ₃	mg/L	23	7	46
Carbonate Alkalinity as CaCO ₃	mg/L	<0.1	<0.1	<0.1
Total Alkalinity as CaCO ₃	mg/L	23	7	46
Sulphate, SO4	mg/L	330	22	720
Chloride, Cl	mg/L	1,300	40	6,000
Ionic Balance	%	3.5	3.1	3.9

All metals in water-dissolved				
Our Reference:	UNITS	48959-1	48959-2	48959-3
Your Reference		2842/GMB01/	2842/GMB02/	2842/GMB06/
Donath		25.11.2010	25.11.2010	26.11.2010
Depth Type of sample		- Water	- Water	- Water
Date prepared	-	2/12/2010	2/12/2010	2/12/2010
Date analysed	-	2/12/2010	2/12/2010	2/12/2010
Aluminium-Dissolved	μg/L	260	39	210
Boron-Dissolved	μg/L	200	70	40
Barium-Dissolved	μg/L	71	7	93
Beryllium-Dissolved	μg/L	<0.5	<0.5	0.6
Cadmium-Dissolved	μg/L	1.9	1	3.2
Cobalt-Dissolved	μg/L	52	<1	67
Chromium-Dissolved	μg/L	<1	<1	<1
Copper-Dissolved	μg/L	3	<1	7
Iron-Dissolved	μg/L	1,800	11	13
Manganese-Dissolved	μg/L	950	7	1,100
Molybdenum-Dissolved	μg/L	<1	<1	<1
Nickel-Dissolved	μg/L	38	<1	67
Vanadium-Dissolved	μg/L	<1	<1	<1
Zinc-Dissolved	μg/L	100	42	140
Arsenic-Dissolved	μg/L	2	<1	9
Mercury-Dissolved	μg/L	<0.4	<0.4	<0.4
Lead-Dissolved	μg/L	15	<1	3
Selenium-Dissolved	μg/L	<1	<1	<1

Method ID	Methodology Summary
LAB.1	pH - Measured using pH meter and electrode in accordance with APHA 20th ED, 4500-H+.
LAB.2	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA2510 20th ED and Rayment & Higginson.
LAB.63	pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions.
LAB.18	Total Dissolved Solids - determined gravimetrically by drying the sample, in accordance with APHA 20th ED, 2540-C.
LAB.55	Nitrate - determined colourimetrically based on EPA353.2. Soils are analysed following a water extraction.
Metals.20 ICP-AES	Determination of various metals by ICP-AES.
LAB.57	Ammonia - determined colourimetrically based on EPA350.1, Soils are analysed following a water extraction.
LAB.66	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen.
LAB.60	Phosphate water extractable - determined colourimetrically based on EPA365.1
LAB.6	Alkalinity - determined titrimetrically in accordance with APHA 20th ED, 2320-B.
LAB.81	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 21st ED, 4110-B.
LAB.41	Gravimetric determination of the total solids content of water.
Metals.22 ICP-MS	Determination of various metals by ICP-MS.
Metals.21 CV-AAS	Determination of Mercury by Cold Vapour AAS.

QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
Miscellaneous Inorg - soil						Base II Duplicate II %RPD		
Date prepared	-			6/12/20 10	48959-4	6/12/2010 6/12/2010	LCS-1	6/12/2010
Date analysed	-			6/12/20 10	48959-4	6/12/2010 6/12/2010	LCS-1	6/12/2010
pH 1:5 soil:water	pH Units		LAB.1	[NT]	48959-4	5.1 5.1 RPD: 0	LCS-1	100%
Electrical Conductivity 1:5 soil:water	μS/cm	1	LAB.2	<1.0	48959-4	57 53 RPD: 7	LCS-1	107%

QUALITY CONTROL	UNITS	PQL	METHOD	Blank
sPOCAS field test				
pHF (field pH test)*	pH Units		LAB.63	[NT]
pHFox (field peroxide test)*	pH Units		LAB.63	[NT]

QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
Miscellaneous Inorganics						Base II Duplicate II %RPD		
Date prepared	-			30/11/2 010	[NT]	[NT]	LCS-W1	30/11/2010
Date analysed	-			30/11/2 010	[NT]	[NT]	LCS-W1	2/12/2010
Electrical Conductivity	μS/cm	1	LAB.2	<1.0	[NT]	[NT]	LCS-W1	104%
Total Dissolved Solids (grav)	mg/L	5	LAB.18	<5	[NT]	[NT]	LCS-W1	106%
рН	pH Units		LAB.1	[NT]	[NT]	[NT]	LCS-W1	102%
Nitrate as N in water	mg/L	0.005	LAB.55	<0.005	[NT]	[NT]	LCS-W1	91%
Hardness	mgCaCO 3/L	3	Metals.20 ICP-AES	<3	[NT]	[NT]	[NR]	[NR]
NOx as N in water	mg/L	0.005	LAB.55	<0.005	[NT]	[NT]	LCS-W1	91%
Ammonia as N in water	mg/L	0.005	LAB.57	<0.005	[NT]	[NT]	LCS-W1	93%
Total Nitrogen in water	mg/L	0.1	LAB.66	<0.1	[NT]	[NT]	LCS-W1	86%
Phosphorus - Total	mg/L	0.05	Metals.20 ICP-AES	<0.05	[NT]	[NT]	LCS-W1	97%
Phosphate as P in water	mg/L	0.005	LAB.60	<0.005	[NT]	[NT]	LCS-W1	101%
Silicon*- Dissolved	mg/L	0.2	Metals.20 ICP-AES	<0.2	[NT]	[NT]	LCS-W1	100%
Strontium - Dissolved	mg/L	0.01	Metals.20 ICP-AES	<0.01	[NT]	[NT]	LCS-W1	90%
Titanium - Dissolved	mg/L	0.02	Metals.20 ICP-AES	<0.02	[NT]	[NT]	LCS-W1	96%

QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
Ion Balance						Base II Duplicate II %RPD		,
Date prepared	-			30/11/2 010	[NT]	[NT]	LCS-W1	30/11/2010
Date analysed	-			30/11/2 010	[NT]	[NT]	LCS-W1	30/11/2010
Calcium - Dissolved	mg/L	0.5	Metals.20 ICP-AES	<0.5	[NT]	[NT]	LCS-W1	91%
Potassium - Dissolved	mg/L	0.5	Metals.20 ICP-AES	<0.5	[NT]	[NT]	LCS-W1	103%
Sodium - Dissolved	mg/L	0.5	Metals.20 ICP-AES	<0.5	[NT]	[NT]	LCS-W1	100%
Magnesium - Dissolved	mg/L	0.5	Metals.20 ICP-AES	<0.5	[NT]	[NT]	LCS-W1	92%
Bicarbonate Alkalinity as CaCO ₃	mg/L	0.1	LAB.6	<0.1	[NT]	[NT]	LCS-W1	104%
Carbonate Alkalinity as CaCO ₃	mg/L	0.1	LAB.6	<0.1	[NT]	[NT]	[NR]	[NR]
Total Alkalinity as CaCO ₃	mg/L	0.1	LAB.6	<0.1	[NT]	[NT]	LCS-W1	104%
Sulphate, SO4	mg/L	1	LAB.81	<1.0	[NT]	[NT]	LCS-W1	108%
Chloride, Cl	mg/L	1	LAB.81	<1.0	[NT]	[NT]	LCS-W1	94%
Ionic Balance	%		LAB.41	[NT]	[NT]	[NT]	[NR]	[NR]
QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
All metals in water-dissolved						Base II Duplicate II %RPD		
Date prepared	-			2/12/20 10	48959-1	2/12/2010 2/12/2010	LCS-W1	02/12/2010
Date analysed	-			2/12/20 10	48959-1	2/12/2010 2/12/2010	LCS-W1	02/12/2010
Aluminium-Dissolved	μg/L	10	Metals.22 ICP-MS	<10	48959-1	260 260 RPD: 0	LCS-W1	103%
Boron-Dissolved	μg/L	5	Metals.22 ICP-MS	<5	48959-1	200 190 RPD: 5	LCS-W1	83%
Barium-Dissolved	μg/L	1	Metals.22 ICP-MS	<1	48959-1	71 67 RPD: 6	LCS-W1	99%
Beryllium-Dissolved	μg/L	0.5	Metals.22	<0.5	48959-1	<0.5 <0.5	LCS-W1	80%

48959-1

48959-1

48959-1

48959-1

48959-1

48959-1

1.9 || 2.0 || RPD: 5

52 || 52 || RPD: 0

<1 || <1

3 || 3 || RPD: 0

1800 || 1800 || RPD: 0

950 || 950 || RPD: 0

ICP-MS

Metals.22

ICP-MS

Metals.22

ICP-MS

Metals.22

ICP-MS

Metals.22

ICP-MS

Metals.22

ICP-MS

Metals.22

ICP-MS

<0.1

<1

<1

<1

<10

<5

0.1

1

10

5

μg/L

μg/L

μg/L

μg/L

μg/L

μg/L

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Cadmium-Dissolved

Cobalt-Dissolved

Chromium-Dissolved

Copper-Dissolved

Iron-Dissolved

Manganese-Dissolved

LCS-W1

LCS-W1

LCS-W1

LCS-W1

LCS-W1

LCS-W1

100%

96%

95%

91%

91%

91%

Client Reference: P1002842JC01V01, Culburra UNITS PQL QUALITY CONTROL **METHOD** Blank Duplicate Sm# **Duplicate results** Spike Sm# Spike % Recovery All metals in Base II Duplicate II %RPD water-dissolved Molybdenum-Dissolved Metals.22 48959-1 <1 || <1 LCS-W1 99% μg/L 1 <1 ICP-MS Nickel-Dissolved Metals.22 48959-1 38 || 38 || RPD: 0 LCS-W1 89% μg/L 1 <1 ICP-MS Metals.22 Vanadium-Dissolved 48959-1 <1 || <1 LCS-W1 95% μg/L <1 ICP-MS Zinc-Dissolved Metals.22 48959-1 100 || 100 || RPD: 0 LCS-W1 95% μg/L 1 <1 ICP-MS Arsenic-Dissolved Metals.22 48959-1 LCS-W1 90% 1 2 || 2 || RPD: 0 μg/L <1 ICP-MS Mercury-Dissolved Metals.21 μg/L 0.4 < 0.4 48959-1 <0.4 || <0.4 LCS-W1 100% CV-AAS Lead-Dissolved μg/L 1 Metals.22 <1 48959-1 15 || 15 || RPD: 0 LCS-W1 96% ICP-MS Selenium-Dissolved 92% Metals.22 48959-1 LCS-W1 μg/L 1 <1 <1 || <1 ICP-MS **QUALITY CONTROL UNITS** Dup. Sm# **Duplicate** Spike Sm# Spike % Recovery Miscellaneous Inorg - soil Base + Duplicate + %RPD Date prepared 48959-14 6/12/2010 || 6/12/2010 LCS-2 6/12/2010 Date analysed 48959-14 6/12/2010 || 6/12/2010 LCS-2 6/12/2010 pH 1:5 soil:water pH Units 48959-14 5.1 || 5.0 || RPD: 2 LCS-2 100% **Electrical Conductivity 1:5** 48959-14 33 || 34 || RPD: 3 LCS-2 106% µS/cm soil:water **QUALITY CONTROL** UNITS Dup. Sm# Duplicate Miscellaneous Inorg - soil Base + Duplicate + %RPD Date prepared 48959-25 6/12/2010 || 6/12/2010 Date analysed 48959-25 6/12/2010 || 6/12/2010 48959-25 4.9 || 5.0 || RPD: 2 pH 1:5 soil:water pH Units **Electrical Conductivity 1:5** μS/cm 48959-25 44 || 54 || RPD: 20

Envirolab Reference: 48959 Revision No: R 01

soil:water

Report Comments:

Phosphate:PQL raised due to sample matrix.

Asbestos ID was analysed by Approved Identifier:

Asbestos ID was authorised by Approved Signatory:

Not applicable for this job

Not applicable for this job

Asbestos counting was analysed by Approved Counter:

@ERROR
Asbestos counting was authorised by Approved Signatory:

@ERROR

INS: Insufficient sample for this test PQL: Practical Quantitation Limit NT: Not tested

NA: Test not required RPD: Relative Percent Difference NA: Test not required

<: Less than >: Greater than LCS: Laboratory Control Sample

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples. **Duplicate**: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike: A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist. **LCS (Laboratory Control Sample)**: This comprises either a standard reference material or a control matrix (such as a blank

sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batched of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes and LCS: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable.

Envirolab Reference: 48959 Revision No: R 01 Page 13 of 13

15 Attachment H – Agency Consultation



Megan Kovelis

From: Dollery, Ian <dolleryi@shoalhaven.nsw.gov.au>

Sent: Thursday, 15 March 2012 8:52 AM

Megan Kovelis To:

Subject: RE: West Culburra subdivision

Megan

At this point in time I can't foresee any problem with doing so. Without the policy and the development coming direct to council, we would probably place conditions on a consent requiring similar outcomes.

Regards

San Dollery Subdivision Engineer

Shoalhaven City Council

202 4429 3308 | **3**02 4429 3178





Please consider the environment before printing this e-mail notice.

From: Megan Kovelis [mailto:mkovelis@martens.com.au]

Sent: Wednesday, 14 March 2012 4:12 PM

To: Dollery, Ian Cc: Andrew Norris

Subject: RE: West Culburra subdivision

lan,

Thank you for sending that information through. As discussed, our current MUSIC modelling approach is to achieve a 'neutral or beneficial impact' when comparing the pre- and post-development scenarios. Based on the information provided, we will also consider the pollutant objectives in Table 5.2 of the draft DCP.

Do you anticipate that Council would be happy with this modelling approach?

Kind Regards,

Martens & Associates Pty Ltd

Megan Kovelis **Environmental Scientist** BEnvSc (Hons1)



Martens & Associates Pty Ltd Unit 6/37 Leighton Place Hornsby, NSW 2077 P + 61 2 9476 9999 F + 61 2 9476 8767

www.martens.com.au

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From: Dollery, Ian [mailto:dolleryi@shoalhaven.nsw.gov.au]

Sent: Tuesday, 13 March 2012 4:36 PM

To: Megan Kovelis

Subject: West Culburra subdivision

Megan

Hope this helps!

Regards

San Dollery Subdivision Engineer Shoalhaven City Council

202 4429 3308 | **3**02 4429 3178

http://shoalhaven.nsw.gov.au



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Megan Kovelis

From: allan.lugg@dpi.nsw.gov.au

Sent: Thursday, 14 February 2013 12:25 PM

To: Megan Kovelis

Cc: trevor.daly@dpi.nsw.gov.au

Subject: MP09_0088 West Culburra Urban Expansion - Stormwater Modelling

Hi Megan,

as discussed, I can confirm that we have discussed the modelling approach being undertaken for the proposed West Culburra subdivision by Martens and Associates.

From our discussion, I understand that the modelling will compare pre-development conditions with post-development conditions and aim to achieve a Neutral or Beneficial Impact upon Curleys Bay and the Crookhaven River estuary (where there are numerous oyster farms) with respect to suspended sediment, nitrogen and phosphorus. I believe that is a reasonable approach.

As discussed, I also recommend that you give some consideration to the potential impacts upon bacterial levels and the potential implications for oyster farming.

Regards Allan

Allan Lugg | Senior Fisheries Conservation Manager

NSW Department of Primary Industries

4 Woollamia Road | PO Box 97 | HUSKISSON NSW 2540

T: 02 4428 3401 | F: 02 4441 8961 | M: 0409 912 686 | E: <u>Allan.Lugg@dpi.nsw.gov.au</u>

W: http://www.dpi.nsw.gov.au/fisheries

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Megan Kovelis

From: Miles Boak <Miles.Boak@environment.nsw.gov.au>

Sent: Friday, 8 February 2013 2:11 PM

To: Megan Kovelis

Subject: FW: West Culburra Proposed Subdivision - Water Quality Modelling

Attachments: DOC10-22366 DECCW DG-EARs & Attachments 24 May 2010.pdf; ATT00001..txt;

ATT00002..htm

Hi Megan

OEH are happy with the approach taken for water quality assessment - of applying MUSIC modelling guidelines with a view to achieving neutral and beneficial impact on water quality. OEH provided comments in this regard on the West Culburra DGRs in May 2010 (attached) which provide more detail.

Cheers Miles Boak

Miles Boak Conservation Planner - Regional Operations Office of Environment and Heritage NSW Department of Premier and Cabinet PO Box 733, Queanbeyan, NSW 2620 T: 02 62297095 M: 0427919192

W: www.environment.nsw.gov.au

From: Megan Kovelis [mailto:mkovelis@martens.com.au]

Sent: Wednesday, 14 March 2012 12:28 PM

To: Thompson Julian **Cc:** Andrew Norris

Subject: West Culburra Proposed Subdivision - Water Quality Modelling

Julian,

I appreciate your time this morning. As discussed, based on Council DCP water quality requirements and NSW OEH requirements for the nearby West Culburra Golf Course, we are undertaking our MUSIC modelling to achieve neutral or beneficial impacts (pre development versus post development) for the proposed subdivision development.

MUSIC inputs (EMC's, pervious area parameters etc) are based on NSW CMA (2010) 'Sydney Metropolitan: Draft NSW MUSIC Modelling Guidelines'.

I trust that OEH agree with this modelling approach.

Kind Regards,

Martens & Associates Pty Ltd

Megan Kovelis Environmental Scientist BEnvSc (Hons1)



16 Attachment I - Borelogs



CLI	EN	Г	Α	llen Pric	e & As	sociates	Pty	Ltd	COMMENCED 22.11.10 COMPLETED 22.11.10 REF BH				11						
PRO	IJΕ	СТ	E	ngineeri	ing Ser	vices			LOGGED	GT	CHECKED		AN			Sheet 1			• •
SIT	E		С	ullburra	Road,	West Cu	Ilbu	rra	GEOLOGY	Siltstone	VEGETAT	ION (Grasses			PROJECT	NO . P1	002842	
EQUI	PMEN	NT			Hydraulic /	Auger			EASTING	NA	RL SURFA	CE I	NA						
				ISIONS		1.75m depth			NORTHING	NA	ASPECT	ı	North			SLOPE	2-39		
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А	Nil	N	М	-0.25 - -0.45			sc	SILTY CLAYEY SAND				L		0.4	2842/1/0	T.			0.5m bgl —
А	Nil	N	М	0.6 - 0.9			CL	SILTY CLAY - Brown/o tending to clay	orange, grave with gravels	els (1-15mm, 35%), decreasing.	F St							В	Bentonite Seal
Α	Nil	N	М	1.0			СН	CLAY - Gre	y/orange/red	mottled.	VSt		-	1.0	2842/1/1	.0	[] •		UPVC Pipe. 1.0
А	Nil	N	М	- - 1.6			CL	SANDY CLAY/EX SILTSTONE - Ligh gravels		v, cream bands,	VSt	MI	D ,	1.5	2842/1/1	.5) //==	등 한 <u>1</u>	.5m bgl
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HA S	Ha	nd aug	ade			→ Wat			Н	Very Stiff VD Very	Dense		sture con e sample			penetro Field den	sity		N	Agricultural	
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A	Nil	N	М	0.6		 	CL	CLAY – Red, moderat mottles inc	tely plastic, w creassing with				A	0.5	2842/2/0	.5 + Att			Bentonite Seal	_
А	Nil	N	М	1.0 1.1			СН	CLAY – Red, mediun	n plasticity, g	rey/brown mottles.	St		А	1.0	2842/2/1	.0		73 23	UPVC Pipe.	1.0
Α	Nil	N	М	1.2			СН	CLAY - Grey with	h minor red/b	rown mottles.	VSt		А	1.2	2842/2/1	.2	A.			_
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А	Nil	N	D				CL	CLAY - EXTREMEL Clay to sandy			VSt		A	2.5	2842/2/2	5				3.0
			М	4.0 - - - - - - - - - - - - - - - - - - -				gie	гулеалогоміі.				А	4.5	2842/2/4	.5			4.05m bgl ' Sand Pack UPVC Screen	4.0
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А	Nil	N	w	- - - -			CL EW	CLAY - Dark gı weat	rey/brown, cla hered siltston		VSt		A	7.0	2842/2/	7.0				-
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Α	Nil	N	М	0.2	(*) (********		CL	SILTY CLAY								0.25r	ı bgl—	Concrete Bentonite Seal
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А	Nil	N	М	0.8		Ŀ		CL	CLAY - Yellow/br siltstone band			F St									Bentonite Seal
				1.0 _{1.05}		Ι.					•				Α	1.0	2842/3/1.		<u></u>	7 ×	UPVC Pipe. 1.0
Α	Nil	N	М	− −1.25				CL/ HW	SANDY CLAY/HIGH	LY WEATHE Orange/grey.	RED SILTSTONE	VSt			Α	1.2	2842/3/1.	2			
А	Nil	N	М	1.6				CL HW	CLAY - HIGHLY V	VEATHERED		VSt			А	1.5	2842/3/ 1.5	; ³	7		1.565m bgl
	Nil	N	М	-		E		CL	Grey with red/orange CLAY - MODERATELY			VSt									Sand Pack.
A	IVII	IN	IVI	2.0 2.1				MW EW	SILTSTONE - (А	2.0	2842/3/2.)		133 134 134	UPVC Screen. 2.0
А	Nil	N	D	- - - - - - - - - - - - -				SC EW		EXTREMELY - Grey/pink/i m grained sai	ed, fine to	VSt			A	2.5	2842/3/2.	5			3.0
Α	Nil	N	D	3.2				MW	MODERATELY V	VEATHERED	SILTSTONE -								4]E E		-
A	Nil	N	D	- - - - - - - - - - - -				HW/ EW	OI HIGHLY/EXTREMEI	range brown.	RED SILTSTONE.				В	4.0	2842/3/4.)			4.0
Α	Nil	N	D					MW/ SW			VEATHERED							4 <u>.565</u> m <u>bgl</u>			Well end plug.
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SILTSTONE.										MPI INI	G & TES	TING					CI ASS	6.0 7.0 8.0 8.0 SIFICATION			
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CL	IEN ⁻	Γ	Α	llen Pri	ce & As	sociates	Pty	Ltd	COMMENCED	23.11.10	COMPLETE	D 2	3.11.10			REF		BH4
PR	OJE	СТ	E	ngineeı	ing Se	vices			LOGGED	GT	CHECKED	А	N			Sheet 1		
SIT			С	ullburr		West Cu	ıllbı	ırra	GEOLOGY	Siltstone	VEGETATION	_	one			PROJECT	NO. P1	002842
-	IPMEI			1010110	Hydraulic				EASTING	NA NA	RL SURFAC	_				OL ODE	0.00	,
EXC				ISIONS		5.5m depth		M 2	NORTHING	NA NTA	ASPECT	N	orth	SA		SLOPE	2-39 STING	⁶
МЕТНОБ	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION	GRAPHIC LOG	CLASSIFICATION	DESCRII Soil type, texture, structure, r particle characteristics, org-	PTION OF STR	ATA asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)				DETAILS Well Cover
_				-	-> ± α	`*'*:*		CILTY CAND Drawn		0	8		A	0.2	2842/4/0	.2		Concrete -
A	Nil Nil	N N	M	0.3		× × × ×	SM	SILTY SAND – Brown CLAY - Brown/orange	e, mottles inci	reasing with depth,	S		A	0.5	2842/4/0			-
А	Nil	N	М	1.0			CL	gravels (1-	10mm, appro	· · · · · · · · · · · · · · · · · · ·		F	А	1.0	2842/4/1	.0		0.6m bgl Bentonite Seal UPVC Pipe. 1.0
А	Nil	N	М	1.8			CL HW	CLAY - HIGHLY V Grey with red/orange			VSt		А	1.5	2842/4/1	.5		1.26m bgl
А	Nil	N	М	2.0 _ - - - - - -			CL MW EW	CLAY - MODERATELY SILTSTONE - (VSt		A	2.0	2842/4/2 2842/4/2			2 <u>0</u>
Α	Nil	N	D	3.0 - - - - - - - - - - - - - - - - - - -			SC	CLAYEY SAND/E SILTSTONE - G mediui		orange, fine to	VSt		В	4.0	2842/4/4	.0 4 <u>.26m</u> bgl		3.0
Α	Nil	N	D	5.0 - - - - - - 5.5			EW/ MW	EXTREMELY/MC SILTSTONE	_ , ,,				A	5.0	2842/4/5	.0		5 <u>0</u>
				6.0 - - - - - -				Borehole to extremely/mode	erminated at crately weathe									6 <u>.0</u>
				7.0 - - - - - - -														- 7 <u>.0</u> - - - - - - -
				8.0 - - - - - - - - - - - -														8 <u>0</u> - - - - - - - 9.0
N B E H S P	Na Ex H Ba Ex A Ha Ha T Pu	itural existing ckhoe cavate nd aug ind sp sh tub ger	expos excar buck or ger ade e	THOD S ure S vation S et R	UPPORT H Shoring C Shotcre B Rock Bo iil No supp	te X Not olts ∇7 Wat	e obse measu er leve	erved D Dry L Lo red M Moist M Mi I W Wet H Hig Wp Plastic limit R Re low WI Liquid limit	ow VS oderate S gh F efusal St VSt H	SISTENCY	ose A Ai B Bi Dense U U D D se M M	uger sa ulk sam ndisturl isturbe oisture		pr S V: D:		nic cone ometer nsity	S'	LASSIFICATION YMBOLS AND OIL DESCRIPTION USCS
						EXCAVATI	ON L	OG TO BE READ IN CONJU	JNCTION WITH	ACCOMPANYING REP	ORT NOTE	S ANI	O ABBRE	VIATIO	SNC			
1									MARTENS &	ASSOCIATES PTY LTD		Τ						

CL	IEN	Т	Α	llen Prid	ce & As	sociates	Pty	Ltd	COMMENCED	23.11.10	COMPLETI	ED :	23.11.10			REF		BH6	
_	OJE	СТ	E	ngineer	ing Ser	vices			LOGGED	GT	CHECKED		AN			Sheet 1	of '	_	
SIT			С	ullburra		West Cu	ıllbu	ırra	GEOLOGY	Siltstone	VEGETATI	_	None			PROJECT	NO . P1	002842	
-	IPMEI AVAT		DIMEN	ISIONS	Hydraulic / 0.1mØ X 5				EASTING NORTHING	NA NA	RL SURFA	_	NA North			SLOPE	1-2	%	
				ION DA		<u> </u>		M.A	TERIAL DA	ATA	•			SA	MPLIN	G & TES			
МЕТНОВ	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org	PTION OF STR mottling, colour, pl anics, secondary a intamination, odor	asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)		WATER	WELL	DETAILS Well (Cover
Α	Nil	N	М	0.1	W		CL	SILTY SANDY	CLAY – Dark	arev/brown.	S					C. 6	+	Concre	ete -
А	Nil	N	М	-			CL	SILTY SAND C			s		A	0.2	2842/6/0				_
A	Nil	N	М	- 0.45 -		 	CL	CLAY - Red/orange w			St		A	0.5	2842/6/0	.5		-0.5mb	igl –
				0.7		 		with depth, minor g	ravels (1-10	nm, approx 5%).							4	Bentonit	e Seal
А	Nil	N	М	1.0 - 1.3	*******		СН	CLAY - Grey/cream wi plastic, gravel	th red/brown s (1-5mm, ap	mottles, moderately oprox 20%).	St		А	1.0	2842/6/1	.0	#7 34 35 35 45 #1	UPVC	Pipe. 1.0
													А	1.5	2842/6/1	.5	Z	j	=
A	Nil	N	М	_ _ _ _ 			CL HW	CLAY - HIGHLY V Light grey with red r			VSt		А	2.0	2842/6/2	.0	39 37 37 37	Sand	Pack. – 2 <u>.0</u>
				_ _ _ _		-=							А	2.5	2842/6/2	.5	70 <u></u>	2.33mb	·gl
				2.8										_				UPVC	Screen
A	Nil Nil	N N	M D	3.0			MW CL/	SILTSTONE	E - Light brow	n, gravels	VSt		В	3.0	2842/6/3	.0 .			3.0
				_		== -	FIVV	CLAY/HIGHLY WEATI	HERED SILT	STONE - Light grey./			A	3.5	2842/6/3	.5		Ö	
A NII N M 3.0 CL SANDY CLAY - MODERATELY WEATHERED SILTSTONE - Light brown, gravels											VSt		В	4.5	2842/6/4	.5 <u>5.33</u> m bgJ		Well end p	4.0 4.0 - - - - - - - - - - - - - - - - - - -
5.33mbgl == 5												DLASSIFICAT							
N B E H S P	Ex H Ba Ex A Ha Ha T Pus	xisting ckhoe cavat and au and sp sh tub iger	buck or ger ade e	vation SC et RE Ni	H Shoring C Shotcrete Rock Bo I No suppo	lts ل Wat	measu er leve	rred M Moist M Molel W Wet H Hi. Wp Plastic limit R Reflow WI Liquid limit	oderate S gh F efusal St VSt H	SISTENCY	B B B B Dense U U D D D B B B B B B B B B B B B B B B	luger s lulk sa Indistu Iisturb Ioistur	6 & TESTING sample mple irbed sample ed sample e content ample (x mm)	pr S V: D	D Pocket p Standard S Vane sh CP Dynam penetro D Field der /S Water sa	nic cone ometer nsity	est S	SYMBOLS AN SOIL DESCRI Y USCS N Agricultu	ID IPTION
	CC Concrete Corer EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS																		
			7							ASSOCIATES PTY LTD						orin	1		

CLI	EN	Γ	A	llen Pric	e & As	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLETE	24.1	1.10			REF	TP9
PR	OJE	СТ	E	ngineeri	ing Ser	vices			LOGGED	GT	CHECKED	AN				Sheet 1 of	1
SIT	E		С	ullburra	Road,	West Cu	ıllbu	ırra	GEOLOGY	Siltstone	VEGETATIO	N Non	e			PROJECT NO.	P1002842
EQU	PMEN	NT			Backhoe				EASTING	NA	RL SURFAC	E NA			•		
EXC	VAT	ION D	IMEN	ISIONS	0.4m X 2.0	m X 2.5m de	pth		NORTHING	NA	ASPECT	Sou	rth				-3%
	EX	CAV	ΆT	ION DA				MA	TERIAL DA	ATA				SA	MPLIN	G & TESTIN	G
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	L PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, n particle characteristics, orga	PTION OF STR nottling, colour, pla anics, secondary a intamination, odou	sticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	ΑI	RESULTS DDITIONAL OB	
	Nil	N	M	0.1		* * * * *	SM	ORGANIC SILTY	' SAND – Da	k grey/brown.		L	В	0.2	2842/9/0.2	2	
ВН	Nil	N	М	-0.35 -		× × × ×	SM	SILTY SAND – Light g	rey/grey, gra	vels (1-5mm, 10%).		L	В	0.5	2842/9/0.5	5	
вн	Nil	N	М				CL	CLAY - Orange/brov	vn mottled, m	oderately plastic.	F St						-
вн	Nil	N	М	1.0 - - 1.4			CL	CLAY - Grey/red/orar	nge mottled, r	noderately plastic.	VSt		В	1.0	2842/9/1.0	0	1 <u>.0</u> - - -
вн	Nil	N	М	_			CL/ HW	CLAY/HIGHLY W Grey/pink/red/orange, to extremely we	siltstone grav	vels bands, tending	VSt		В	1.5	2842/9/1.		- - - -
вн	Nil	N	М	2.0			MW	MODERATELY W With grey	/EATHERED		VSt		В	2.0	2842/9/2.0	0	2.0
			AAE A	2.5	PROPERTY	MATTE			ered siltstone		CAMO						5.0 6.0
E(N X BH E H/ S P1	Na Ex Ex Ha Ha	tural edisting ckhoe cavato aug	exposi excav bucke or ger ade	ure SH vation SC et RB		ts 🅎 Wat	e obse measu er leve	erved D Dry L Lo red M Moist M M. H W Wet H Hig Wp Plastic limit R Re low WI Liquid limit	w VS oderate S gh F fusal St VSt H	DENSITY	ose A Au B Bul Dense U Un D Dis se M Mo	ger sample k sample disturbed sturbed s isture co	e d sample ample	pp S VS DO	Pocket pe Standard S Vane she CP Dynami penetror D Field dens S Water sar	penetration test ar c cone meter sity	CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION USCS N Agricultural
		ncrete	Core	<u>r</u>			21	00 TO DE DE 15	NOTION		ODT :: 5 == :		ADD==	n. = :	ONG		
					E	-XCAVATIO	JN L	OG TO BE READ IN CONJU	INCTION WITH	ACCOMPANYING REP	URINOTES	AND A	ARBKE/	/ΙΑΤΙ(JNS		

CLI	EN	Γ	Al	len Pric	e & Ass	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLETE	24.1	1.10		REF TP10
PRO	ΟJΕ	СТ	Eı	ngineer	ing Serv	vices			LOGGED	GT	CHECKED	AN			Sheet 1 of 1
SIT	E		C	ullburra	Road,	West Cu	ıllbu	ırra	GEOLOGY	Siltstone	VEGETATIO	N Non	е		PROJECT NO. P1002842
EQUI	PMEN	NT			Backhoe				EASTING	NA	RL SURFAC	E NA			•
_				SIONS		m X 2.0m de	pth		NORTHING	NA	ASPECT	Nort	h West		SLOPE 2-3%
	EX	CAV	AT	ON DA				M.A	TERIAL DA	ATA				SA	MPLING & TESTING
МЕТНОВ	SUPPORT	WATER	MOISTURE	DEPTH (M)	L PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, n particle characteristics, orga fill, co	anics, secondary a intamination, odou	sticity, rocks, oxidation, ind minor components, r.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
BH BH	Nil Nil	N N	M	0.1		× * * × × ×	SM	ORGANIC SILTY				L L	В	0.2	2842/10/ 0.2
вн	Nil	N	М	0.3 - 0.5 - 0.8			CL	SILTY SAND – Light g			F St		В	0.5	2842/10/ 0.5
ВН	Nil	N	М	1.0 - 1.3			CL	CLAY - Grey/red/orar	nge mottled, r	noderately plastic.	VSt		В	1.0	2842/10/ 1.0 1 <u>.0</u> –
вн	Nil	N	М				CL/ EW	CLAY/EXTREMELY Grey minor mott siltstone band weat	les, moderate	ely weathered moderately	VSt		В	1.5	2842/10/ 1.5
								Test pit terminated weat	at 2.0m on m hered siltston						- - - - - - - -
				3.0 - - - - - -											3 <u>.0</u> - - - - - - -
				4.0 - - - -											4 <u>.0</u> - - - - - - -
				 											5 <u>.0</u> - - - -
															6 <u>.0</u>
				- - - - -											- - - - - - - -
				7.0 - - -											- 7 <u>.0</u> - - - -
				_ _ _											- - -
				8.0 -											8 <u>.0</u>
				- - - -											- - - -
				_											
N X BH E HA S PT A	Na Ex Ex Ha Ha Pus Au	tural e disting ckhoe cavato nd aug nd spa sh tube	exposi excav bucke or ger ade e	ure SH vation SC et RE Nil	Rock Bolt No suppo	ts <u>▼</u> Wat ort <u></u> Wat → Wat	e obse measu er leve er outf er inflo	erved D Dry L Lo red M Moist M M. H W Wet H Hig Wp Plastic limit R Re low WI Liquid limit	w VS oderate S gh F fusal St VSt H F	SISTENCY	se A Au B Bul Dense U Un D Dis se M Mo Ux Tut	ger sample k sample disturbed sturbed s isture co be sampl	e d sample ample ntent e (x mm)	PP S VS DO FE W	Pocket penetrometer Standard penetration test S Vane shear Penetrometer penetrometer penetrometer Pield density S Water sample

CLI	EN	Γ	A	llen Pric	ce & As	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLETED	24.11	.10			REF	TP12	
PRO	ΟJΕ	СТ	E	ngineer	ing Ser	vices			LOGGED	GT	CHECKED	AN				Sheet 1		
SIT	E		С	ullburra	Road,	West Cu	ıllbu	ırra	GEOLOGY	Siltstone	VEGETATIO	None				PROJECT N	D. P1002842	
EQUI	PMEN	ΝT			Backhoe				EASTING	NA	RL SURFACE	NA						
EXC	VAT	ION D	IMEN	ISIONS	0.4m X 2.0	m X 2.2m de	pth		NORTHING	NA	ASPECT	North			:	SLOPE	2-3%	
	EX	CAV	/AT	ION DA				M.A	TERIAL DA	ATA				SA	MPLIN	3 & TEST	ING	
МЕТНОБ	SUPPORT	WATER	MOISTURE	DEPTH (M)	M PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org- fill, co	ntamination, odou	asticity, rocks, oxidation, and minor components, ir.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	ΑΙ		LTS AND OBSERVATIONS	
BH BH	Nil Nil	N N	M	0.1		× × × ×	SM	ORGANIC SILTY	/ SAND – Da	rk grey/brown.		<u> </u>	В	0.2	2842/12/0	.2		
ы	1411	- 1	IVI	0.3	83) 88 88	<u> </u>	SIVI	SILTY SAND – Light g	rey/grey, gra	vels (1-5mm, 10%).								
ВН	Nil	N	М	0.5			CL	CLAY - Orange/brov	vn mottled, m	oderately plastic.	F St		В	0.5	2842/12/0	.5		
вн	Nil	N	М	1.0 - 1.3		 	CL	CLAY - Grey/red/orar	nge mottled, r	noderately plastic.	VSt		В	1.0	2842/12/1	.0		1 <u>.0</u> - -
BH Nil N M CLAY/EXTREMELY WEATHERED SILTSTONE - Grey minor mottles, moderately weathered siltstone. CLAY/EXTREMELY WEATHERED SILTSTONE - Grey minor mottles, moderately weathered siltstone. Test pit terminated at 2.2m on moderately weathered siltstone.															- - - - 2.0			
				-				Test pit termina weat	ted at 2.2m o hered siltston	n moderately e.								3.0
				5.0 - - - - - - - - - - - - - - - - - - -														5 <u>.0</u>
				 														8.0 8.0 9.0
N X BH E HA S PT A	Na Ex Ex Ha Ha Pus Au	tural e disting ckhoe cavato nd aug nd spa sh tube	exposi excav bucke or ger ger ade	ure SH vation SC et RE Nil	3 Rock Bol I No suppo	ts <u>▼</u> Wate ort 	e obse measu er leve er outf er inflo	erved D Dry L Lo red M Moist M Mi I W Wet H Hig Wp Plastic limit R Re low WI Liquid limit	w VS oderate S gh F ffusal St VSt H F	SISTENCY	se A Aug B Bull Dense U Und D Dis se M Moi Ux Tub	ING & TE er sample sample listurbed s surbed sa sture con e sample	sample mple tent (x mm)	PP S VS DO FE W	S Vane she CP Dynami penetror D Field dens S Water sar	penetration tes ar c cone neter sity	CLASSIFICATIC SYMBOLS AND t SOIL DESCRIPT Y USCS N Agricultura	FION

CLI	EN	Γ	Al	len Pric	e & Ass	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLETE	D 24	1.11.10			REF	TP14
PRO	ΟJΕ	СТ	Eı	ngineeri	ing Serv	vices			LOGGED	GT	CHECKED	ΑN	N			Sheet 1 c	
SIT	E		C	ullburra	Road,	West Cu	ıllbu	rra	GEOLOGY	Siltstone	VEGETATIO	N No	one			PROJECT NO	. P1002842
EQUI	PMEN	NT			Backhoe				EASTING	NA	RL SURFAC	E NA	4				
_				SIONS		m X 1.5m de	pth		NORTHING	NA	ASPECT	No	orth			SLOPE	2-3%
	EX	CAV	'AT	ON DA				MA	TERIAL DA	ATA				SA	MPLIN	G & TEST	ING
МЕТНОБ	SUPPORT	WATER	MOISTURE	DEPTH (M)	L PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, n particle characteristics, orga	PTION OF STR nottling, colour, pla anics, secondary a ontamination, odou	sticity, rocks, oxidation, nd minor components,	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	A		.TS AND DBSERVATIONS
BH BH	Nil Nil	N N	M M	0.1 -0.25	***	× × ×	SM	ORGANIC SILTY	′ SAND – Da	k grey/brown.		L L	В	0.2	2842/14/	0.2	_
вн	Nil	N	М	- 0. <u>35</u> - 0.5			CL	SILTY SAND – Light g CLAY - Orange/brov			F St		В	0.5	2842/14/		
вн	Nil	N	М	0.8		<u> </u>	CL	CLAY - Light grey/gr	rey with brow	n/orange mottled.	VSt						<u>-</u>
вн	Nil	N	М	1.0			EW	EXTREMELY WEAT	HERED SILT	STONE BANDS.	VSt		В	1.0	2842/14/	1.0	1.0
вн	Nil	N	М	_ _ _			MW	MODERATELY V Grey	VEATHERED , minor mottle		VSt		В	1.2	2842/14/	1.2	-
				1.5 _ _				Test pit termina					В	1.5	2842/14/	1.5	
				_ 2.0				weat	hered siltston	e.							_ 2 <u>.0</u>
				_													- - -
				- - -													- - -
				3.0 													3 <u>.0</u> -
				- - -													<u>-</u> -
				_ _ _													- - -
				- 4.0													4 <u>.0</u>
				_ _ _													- - -
				_													- - -
				_ 													- - 5 <u>.0</u>
				- - -													- - -
				- - -													- - -
				_ _ 													6 <u>.0</u>
				_ _ _													- - -
				_ _ _													- - - -
																	- 7 <u>.0</u>
																	- - - -
				_ _ _													- - -
				<u>8.0</u>													- 8 <u>.0</u> -
																	- - - -
				_ _ _													- - -
				<u>9</u> .0		<u></u>											9.0
N	Na	tural e	xposi	ure SH	JPPORT Shoring	WATER N None	e obse	rved D Dry L Lo	w VS	SISTENCY DENSITY Very Soft VL Very Loos	se A Au	iger sar		pp	Pocket pe	enetrometer	CLASSIFICATION SYMBOLS AND
X BF	E) I Ba	dsting ckhoe	excav bucke	ration SC et RE	Shotcrete Rock Boll	x Notits Wat		red M Moist M Mo I W Wet H Hig	oderate S gh F	Soft L Loose Firm MD Medium D	B Bu Dense U Ur	ılk samı ndisturb	ple ed sample	S VS	Standard Vane she	penetration test ear	SOIL DESCRIPTION
E HA	. На	cavato	ger	Nil	No suppo	ort ≛ -		Wp Plastic limit R Re	VSt	Stiff D Dense Very Stiff VD Very Dens	D Di se M Mo	sturbed sisture	sample content	D	CP Dynam penetro	ic cone meter	Y USCS
S PT	Pus	nd spa sh tuba				→ Wat	er inflo	w		Hard Friable	Ux Tu	be sam	nple (x mm)) Field den S Water sa		N Agricultural
A CC	Au Cor	ger ncrete	Core	r													
					E	XCAVATIO	ON LO	OG TO BE READ IN CONJU	INCTION WITH	ACCOMPANYING REP	ORT NOTES	SAND	ABBRE\	/IATI	ONS		

CLI	EN	Γ	A	llen Pri	ce & As	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLETE	24.11	.10			REF	TP15	
PR	OJE	СТ	E	ngineer	ing Ser	vices			LOGGED	GT	CHECKED	AN				Sheet 1 of		
SIT	E		С	ullburra	a Road,	West Cu	ıllbu	ırra	GEOLOGY	Siltstone	VEGETATIO	None				PROJECT NO.	P1002842	
EQU	PMEN	NT			Backhoe				EASTING	NA	RL SURFACI	NA NA						
_				ISIONS		0m X 2.7m de	pth		NORTHING	NA	ASPECT	North				SLOPE	1-2%	_
	EX	CAV	AT	ION DA	_			M A	TERIAL DA	ATA				SA	MPLIN	G & TESTI	NG	_
МЕТНОБ	SUPPORT	WATER	MOISTURE	DEPTH (M)	L PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, orga	PTION OF STR nottling, colour, pla anics, secondary a ntamination, odou	asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	А	RESUL [*] DDITIONAL O	TS AND BSERVATIONS	
BH BH	Nil Nil	N N	M	0.1	88	* * *	SM	ORGANIC SILTY	′ SAND – Da	rk grey/brown.		L	В	0.2	2842/15/	0.2		
вн	Nil	N	М				CL	SILTY SAND – Light o			F St		В	0.5	2842/15/	0.5		11111
вн	Nil	N	М	1.0 - - - - -			CL	CLAY - Grey/red/orar	nge mottled, r	noderately plastic.	VSt		В	1.0	2842/15/ 2842/15/			1.0
N N M N N																2.0		
				_ 2.7											2842/15/	2.6		-
					UPPORT	WATER		weat	hered siltston			ING & TI					CLASSIFICATION	3.0 4.0 4.0 5.0 6.0 7.0 7.0 8.0 9.0
N X Bi E H/ S P A	Na Ex Ex Ha Ha Pus Au	tural edisting ckhoe cavate nd aug nd spats sh tube ger	exposi excav bucke or ger ger ade	ure SI vation Si et RI Ni	H Shoring C Shotcrete	N None X Note Its	e obse measu er leve	erved D Dry L Lo red M Moist M Mi I W Wet H Hig Wp Plastic limit R Re low WI Liquid limit	w VS oderate S gh F ifusal St VSt H	Very Soft VL Very Loos Soft L Loose Firm MD Medium E Stiff D Dense Very Stiff VD Very Dense Hard riable	B Bul Dense U Und D Dis se M Mo	per sample sample disturbed turbed sa sture con e sample	e sample mple itent	pp S VS D(Pocket pe Standard Vane she CP Dynam penetro Field den S Water sa	ic cone meter sity	SYMBOLS AND SOIL DESCRIPTION Y USCS N Agricultural	·Ν
	. 001	ncrete	JUIE			EXCAVATION	ON L	OG TO BE READ IN CONJU	INCTION WITH	I ACCOMPANYING REP	ORT NOTES	AND A	BBRE	/IATIC	ONS			\neg
			_									1						\neg

CLI	ENT	Γ	Α	llen Pric	ce & As	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLETE	D 24	.11.10		R	REF	TP16
PR	ΟJE	СТ	E	ngineeri	ing Ser	vices			LOGGED	GT	CHECKED	ΑN	1				1
SIT	E		С	ullburra	Road,	West Cu	ıllbu	ırra	GEOLOGY	Siltstone	VEGETATION	NO NO	ne		PR	ROJECT NO.	P1002842
EQU	PMEN	ΙT			Backhoe				EASTING	NA	RL SURFAC	E N	4				
				ISIONS		m X 2.4m de	pth		NORTHING	NA	ASPECT	No	orth				-3%
	EX	CAV	AT	ION DA				M.A	ATERIAL DA	NTA				SA	MPLING	& TESTIN	G
МЕТНОD	SUPPORT	WATER	MOISTURE	DEPTH (M)	M PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, orga	PTION OF STR mottling, colour, pla anics, secondary a ontamination, odou	sticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	ADD	RESULTS	S AND SERVATIONS
ВН		N	М	0.1		× × ×	SM	ORGANIC SILTY					В	0.2	2842/16/ 0.2		
ВН	Nil	N	М	0.4		* × * *	SM	SILTY SAND – Light o	grey/grey, gra	vels (1-5mm, 10%).		L					_
ВН	Nil	N	М				CL	CLAY - Light brown/g	grey mottles, ı	moderately plastic.	F St		В	0.5	2842/16/ 0.5		- - -
вн	Nil	N	М	1.0			CL	CLAY - Grey with			VSt		В	1.0	2842/16/ 1.0		1.0
				1.2 - - -				CLAY - HIGHLY WEAT	with depth. THERED SIL	STONE - Grey with			В	1.5	2842/16/ 1.5		- - - -
ВН	Nil	N	М	_ 2.0 _ _			CL HW	minor red/orange mo plastic, mottles ind bands/gravels tending to extre	creasing with (1-10mm, ap	depth, siltstone oprox 20%),	VSt		В	2.0	2842/16/ 2.0		_ 2 <u>.0</u> _ _
				2.4 - -				Test pit termina	ated at 2.4m o				В	2.4	2842/16/ 2.4		
								weat	nered sitistori	с.							3 <u>.0</u>
				- - -													- - - -
				_ _ _ <u>4.0</u>													- - - - 4.0
				- - -													- - -
				- - - -													_ - - -
				5.0 _ _ _ _ _ _													5 <u>.0</u> - - - -
				_ _ _ 													- - - 6 <u>.0</u>
				- - - - -													- - - - - -
																	- - 7 <u>.0</u> -
				- - - -													- - -
				_													=
				8.0													8.0
				- - -													- - -
				- - - - 9.0													- - - - 9.0
				THOD SU	JPPORT Shoring	WATER N. Non				SISTENCY DENSITY			TESTING		Docket sens	rometor	CLASSIFICATION
N X Bl	Ex	tural e disting okhoe	exca	vation SC		N None X Note ts V7 Wat		red M Moist M Me	oderate S	Very Soft VL Very Loo Soft L Loose Firm MD Medium D	В Ві	iger sai ilk sam indisturb		S	Pocket penetr Standard pen S Vane shear		SYMBOLS AND SOIL DESCRIPTION
E H/	Ex	cavato nd aug	or		No suppo			Wp Plastic limit R Re	fusal St	Stiff D Dense Very Stiff VD Very Dens	D Di	sturbed	sample content		CP Dynamic co		Y USCS
S P1	Ha Pus	nd spa	ade			→ Wat			Н	Hard Friable			ple (x mm)		D Field density S Water sample		N Agricultural
A C	Au C Cor	ger ncrete	Core	r											·		
						XCAVATION	ON LO	OG TO BE READ IN CONJU	JNCTION WITH	ACCOMPANYING REP	ORT NOTE	S AND	ABBRE	VIATIO	ONS		

CLI	EN	Γ	Α	llen Pric	ce & As	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLET	ED	24.11.10			REF	TP20
PR	OJE	СТ	E	ngineer	ing Ser	vices			LOGGED	GT	CHECKED		AN			Sheet 1 of	
SIT	E		С	ullburra	Road,	West Cu	ıllbu	ırra	GEOLOGY	Siltstone	VEGETATI	ION	None			PROJECT NO.	P1002842
EQUI	PMEN	ΝT			Backhoe				EASTING	NA	RL SURFA	CE	NA				
				ISIONS		0m X 2.2m de	pth		NORTHING	NA	ASPECT		North Wes			SLOPE	1-2%
Щ	EX	CA	/AT	ION DA				M.A	ATERIAL DA	ATA				S	AMPLIN	IG & TESTI	NG
МЕТНОВ	SUPPORT	WATER	MOISTURE	DEPTH (M)	L PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org	PTION OF STR mottling, colour, pla anics, secondary a ontamination, odou	asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	Δ		TS AND BSERVATIONS
вн	Nil	N	М	0.2		×××	SM	SILTY SA	ND – Dark gr	ey/grey.		L	- в	0.2	2842/20/	10.2	-
вн	Nil	Υ	W	-0.35		× × ×	SM	SILTY CLAYEY	SAND – Brov	vn/light brown.		L		0.2	201220	0.2	_
ВН	Nil	Υ	W	- 0 <u>.45</u> - 0.55			CL	CLAY - Orange/brown,	minor gravels	s, moderately plastic.	F St		В	0.5	2842/20/	0.5	
ВН	Nil	N	М				СН	CLAY - Red/grey, r moderati	ninor gravels ely to highly p	, orange mottled, plastic.	VSt		E				1.0 1.0 - - - - - - - - -
				<u>2.0</u>									В	2.0	2842/20/	2.0	2 <u>.0</u>
				2.0 2.2 - - - - - - - - - - - - -				Test pit termin	nated at 2.2m	on clays.				2.0	2842/20/	2.0	2.0
N X	Na Ex	tural e	expos exca	ure SF vation SC	JPPORT 1 Shoring 3 Shotcrete		e obse measu	rved D Dry L Lo red M Moist M M	ow VS oderate S	SISTENCY DENSITY Very Soft VL Very Los Soft L Losse	ose A A B B	luger : Bulk sa		p	Standard	enetrometer 1 penetration test	8.0 8.0 8.0
BH E HA S P1 A C0	H Ba Ex Ha Ha Pus Au	ckhoe cavate nd au nd sp sh tub ger ncrete	buck or ger ade e	et RE Nil	3 Rock Bol I No suppo	lts ل Wat	er leve er outf	el W Wet H Hi Wp Plastic limit R Re llow WI Liquid limit	gh F efusal St VSt H	Firm MD Medium Stiff D Dense Very Stiff VD Very Den Hard Friable	Dense U L D D se M M	Jndisti Disturb Toistu	urbed samp ned sample re content ample (x m	ole V m) F	/S Vane sh DCP Dynan penetro D Field der VS Water sa	ear nic cone ometer nsity	Y USCS N Agricultural
					E	EXCAVATI	ON LO	OG TO BE READ IN CONJU		ASSOCIATES BTV LTD	PORT NOTE	S Al	ND ABBR	EVIAT	IONS		

CL	IEN	Γ	Α	llen Pric	ce & As	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLET	ED 2	4.11.10			REF	TP21
-	OJE	СТ	E	ngineer	ing Se	rvices			LOGGED	GT	CHECKE) A	N.			Sheet 1 o	
SIT			С	ullburra		West C	ullbu	ırra	GEOLOGY	Siltstone	VEGETAT		lone			PROJECT NO.	P1002842
-	IPME			IOIONO	Backhoe	0 V 0 0 d	41-		EASTING	NA NA	RL SURFA		IA			OL ODE	4.00/
EXC				ION DA		.0m X 2.6m d	eptn	M 2	NORTHING	NA NTA	ASPECT	N	lorth West	S/		SLOPE	1-2% NG
МЕТНОВ	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRII Soil type, texture, structure, r particle characteristics, org-	PTION OF STR	EATA asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)		RESUL	TS AND DBSERVATIONS
					-≥ ± α	. GR	_					DEN		_			
ВН	Nil	N	M	_0.12		 	CL	SILTY SANDY			S S		В	0.2	2842/20/	0.2	
ВН	Nil	N	М	0.5		<u> </u>	CL	SILTY SAND C			3		В	0.5	2842/20/	0.5	-
ВН	Nil	N	М	0.8		<u> </u>	CL	CLAY - Red/orange wi with depth, minor g	ravels (1-10r	nm, approx 5%).	St						- -
вн	Nil	N	М	1.0 - - -			СН	CLAY - Grey/cream wi plastic, gravel			St		В	1.0	2842/20/	1.0	1 <u>.(</u> - - -
				1.6									В	1.5	2842/20/	1.5	-
				_ _ 			CL	CLAY - HIGHLY V					В	2.0	2842/20/	2.0	2 <u>.(</u>
ВН	Nil	N	М	- - -			HW	Light grey with red n increa	nottles, siltsto asing with de		VSt						
				2.6		<u> </u>		Test pit terminate	ad at 2 6m an	madarataly			В	2.6	2842/20/	2.6	
				<u>3.</u> 0					ered siltstone								3 <u>.(</u>
				E													
				-													-
				E													-
				4.0													4.0
				-													-
				E													-
				-													-
				5.0													5 <u>.(</u>
				-													-
				-													- -
				E													-
				- 6.0													6 <u>.0</u>
				-													
				_													-
				7.0 -													7 <u>.(</u>
				Ė													
				E													-
				-													-
				8.0													8 <u>. (</u>
				-													-
				E													
				-													
E					JPPORT	WATER	<u> </u>			SISTENCY DENSITY	SAM	IPLING	& TESTING	<u> </u> 3			9.0 CLASSIFICATION
N X B E H S P	Na Ex H Ba Ex A Ha Ha T Pus	itural e	expos exca buck or ger ade	ure SH vation SC et RE	H Shoring	N Nor te X Not olts ∇ Wa	ne obse measu ter leve	erved D Dry L Lo red M Moist M Mi I W Wet H Hig Wp Plastic limit R Re low WI Liquid limit	w VS oderate S gh F ifusal St VSt H	Very Soft VL Very Loc Soft L Loose Firm MD Medium Stiff D Dense Very Stiff VD Very Den Hard Friable VD	Dense A A Dense U D I D I	Auger sa Bulk sam Undistur Disturbe Moisture	ample	p S V D	Standard S Vane sho CP Dynam penetro D Field der	nic cone ometer nsity	SYMBOLS AND SOIL DESCRIPTION Y USCS N Agricultural
C	C Coi		Core	er		EXCAVAT	ON L	OG TO BE READ IN CONJU	INCTION WITH	H ACCOMPANYING REF	PORT NOTI	ES ANI	D ABBRE	VIATI	ONS		

PROJECT Engineering Services LOGGED JSF	CLI	EN	Γ	Α	llen Pri	ce & A	۱ss	ociates	Pty	Ltd	COMMENCED	24.11.10		COMPLETE	D 2	24.11.10			REF	:	В	H5	
SOUTHWISTONIAN SOUT	PR	OJE	СТ	E	ngineer	ing Se	erv	ices			LOGGED	JSF		CHECKED	(GT .			Sheet	1 of			
MATERIAL DATA	_			С	ullburra	_			llbu	rra					-				PROJEC	ΓNO. P	10028	342	
EXCAVATION DATA	-				1010110						+				_				OL ODE		,		
Description of STAAA 10 10 10 10 10 10 10	EXC						7 7 5	o.om deptn		M 2				ASPECT	- 1	NORTH	S	AMPI IN					
A NI N N D			-					(D	z	INIT	TI LINIAL DA	<u> </u>		$\overline{}$	×		T		10 W 1 L	011110	_		
A M N D D D D D D D D D D D D D D D D D D	МЕТНОD	SUPPORT	WATER	MOISTURE	DEPTH (M)	L M PENETRATIO H RESISTANCI	ω.	GRAPHIC LOG	CLASSIFICATIC	Soil type, texture, structure, r particle characteristics, orga	nottling, colour, pla anics, secondary a	asticity, rocks, oxidation	ion, ts,	CONSISTENCY	DENSITY INDE	TYPE	DEPTH (M)			₹ WELL	DE1	TAILS Well Cover	·
A NI N D D S SEPRENT NETFORM NOT D D S SUPPORT NOT NOT SERVICE	А	Nil	N	М	0.3			× × × × × ×	OL	ORGANIC SA	NDY SILT – I	Dark brown.		S		А	0.2	2842/5/0	0.2		Ţ.	Concrete	
A NI N D D D D D D D D D D	Α	Nil	N	М					CL	CLAY - Orange/bro tending grey with mino	own mottles, for brown and	irm grading stiff red mottles at de	f, epth.							•		Bentonite Sea 1.0m bgl UPVC Pipe	1.0
A NI N D S S SUPPORT WATER ED SILTSTONE ARE SILTSTONE AS A MY NO & TESTING BANDS. EXTREMELY WEATHERED SILTSTONE A NI N D S S SUPPORT WATER ED SILTSTONE BANDS. MODERATELY WEATHERED SILTSTONE BANDS. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone. B Sorehole terminated at 5.5m on moderately weathered siltstone	A	Nil	N	D					EW							А	1.5	2842/5/1	.5	72 72 73 74 75 75 75 75 75 75 75 75 75 75 75 75 75		1.68m bgl Sand Pack	
A NI N D D D D D D D D D D D D D D D D D															UPVC Scree	en. —							
A No N D 5 5 SW SLIGHTLY WEATHERED SILTSTONE. A No N D 5 5 SW SLIGHTLY WEATHERED WITH EXTREMELY WEATHERED WITH EXTREMELY WEATHERED SILTSTONE BANDS. MODERATELY WEATHERED SILTSTONE BANDS. Borehole terminated at 5.5m on moderately weathered siltstone. B	А	A NII N D																					
A NII N D \$\bar{a}\$ 0 \$\bar{a}	Α	A Nil N D = EW EXTREMELY WEATHERED SILTSTONE - Orange/grey mottled, dry. EW SLIGHTLY WEATHERED SILTSTONE.															_						
Borehole terminated at 5.5m on moderately weathered siltstone. Borehole terminated at 5.5m on moderately weathered siltstone.	A	Nil	N	D	5.0 -				MW				ELY			В	5.5	2842/5/5				<u>Well e</u> nd plug.	5.0
EQUIPMENT /METHOD SUPPORT MATER N Natural exposure SH Shoring X Existing excavation SC Shotcrete V Water level by BH Backbro bucket R R Rock Bolts X Not measured X SH Rock Bolts W Wet W Wet W Wet W W W W W W W W W W W					-											В	5.5	2842/5/5	5.5	<u> </u>	851 8		
EQUIPMENT / METHOD SUPPORT None observed D Dry L Low VS Very Soft VL Very Loose A Auger sample S Standard penetration tests of S Hand spade PT Push tube A Auger S Water inflow Water					- - - - - -																		6 <u>.0</u>
EQUIPMENT / METHOD SUPPORT None observed Non					7.0 - - - -																		7 <u>.0</u>
EQUIPMENT / METHOD SUPPORT WATER MOISTURE PENETRATION CONSISTENCY DENSITY SAMPLING & TESTING Not Natural exposure SH Shoring None observed D Dry L Low VS Very Soft VL Very Loose A Auger sample pp Pocket penetrometer SYMBOLS AND SYMBOL																							8 <u>.0</u>
EQUIPMENT / METHOD SUPPORT WATER MOISTURE PENETRATION CONSISTENCY DENSITY SAMPLING & TESTING Not Natural exposure Sh Shoring None observed D Dry L Low VS Very Soft VL Very Loose A Auger sample P Pocket penetrometer SYMBOLS AND SYMBOLS					- - - - -																		-
N Natural exposure SH Shoring N None observed D Dry L Low VS Very Soft VL Very Loose A Auger sample S Standard penetrometer SYMBOLS AND Solt DESCRIPTI Not measured M Moist M Moderate S Soft L Loose B Bulk sample S Standard penetration test Solt DESCRIPTI Not support Water level W Wet H High F Firm MD Medium Dense U Undisturbed sample U Undisturbed sample Dense D Disturbed sample DCP Dynamic cone penetrometer SYMBOLS AND Solt DESCRIPTI Not support Water outflow WI Liquid limit R Refusal St Stiff D Dense D Disturbed sample DCP Dynamic cone penetrometer SYMBOLS AND MODERATION SOIL DESCRIPTI Not support Water outflow WI Liquid limit R Refusal St Stiff U Dense D Disturbed sample DCP Dynamic cone penetrometer SYMBOLS AND MODERATION SOIL DESCRIPTI Not support Water outflow WI Liquid limit R Refusal St Stiff U Dense D Disturbed sample UX Tube sample (x mm) WS Water sample Water inflow Water inflow F Finable Water inflow WS Water sample					⊢ 9.0																		9.0
EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS MARTENS & ASSOCIATES PTY LTD	N BI E H/ S P	Na Ex Ex A Ha Ha F Pus	itural existing ckhoe cavate nd aug ind sp sh tub ger	expos excar buck or ger ade e	THOD SI ure SI vation Si et R	H Shorin C Shotor B Rock I	ng rete Bolts ppor	N None X Not r St ♥ Wate Wate	e obse measu er leve er outf er inflo	rved D Dry L Lo red M Moist M Mi I W Wet H Hig Wp Plastic limit R Re low WI Liquid limit	w VS oderate S gh F fufusal St VSt H H F	Very Soft VL N Soft L L Firm MD N Stiff D D Very Stiff VD V Hard Friable	Very Loos Loose Medium Do Dense Very Dense	se A Au B Bu ense U Ur D Di: e M Mo Ux Tu	iger s ilk san idistu sturbe sisture be sa	ample nple rbed sampl ed sample content mple (x mn	p S V D V	S Standard S Vane sh DCP Dynan penetri D Field de VS Water s	d penetration ear nic cone ometer nsity	r	SYME SOIL Y	OLS AND DESCRIPTION	

CL	IEN ⁻	Γ	Α	llen Pri	ce & A	lss	ociates	Pty	Ltd	COMMENCED	24.11.10		COMPLET	ED 2	4.11.10			REF		BH7	
PR	OJE	СТ	Е	ngineer	ing S	erv	ices			LOGGED	JSF		CHECKED	G	ST.			Sheet 1			
SIT			С	ullburra	_		Vest Cu	Ilbu	rra	GEOLOGY	Siltstone		VEGETAT	_	Grass			PROJECT	NO . P10	002842	
	IPMEI			IOIONO	Hydraul					EASTING	NA		RL SURFA	_	IA			01.005	40/		_
EXC				ISIONS) X 2	.5m depth		M 2	NORTHING	NA NTA		ASPECT	N	lorth West	S		SLOPE G & TES	4% STING		_
МЕТНОБ	SUPPORT	WATER	MOISTURE	DEPTH (M)	M PENETRATION	2	GRAPHIC LOG	CLASSIFICATION	DESCRII Soil type, texture, structure, r particle characteristics, org	PTION OF STR	ATA asticity, rocks, oxidend minor compor	dation, nents,	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)		RES	SULTS A	ND RVATIONS	
Α	Nil	N	М	0.1		\blacksquare	× × ×	OL	ORGANIC SA	NDY SILT -	Dark brown.		S		A	0.2	2842/7/0	2			=
A	Nil	N	М	0.3		-	× × ×	sc	CLAYEY SAND - Br	own, moist (a	lmost wet), Ic	ose.		L							_
А	Nil	N	М	- - - - - - 1.0		-	 	CL	CLAY - Orange/bro	own mottles, to brown and	irm grading s red mottles at	stiff, t depth.	F		A	1.0	2842/7/0				1.0
A	Nil	N	D	1.2 - - 1.6				EW	EXTREMELY W Grey, c	EATHERED lay like prope		-			А	1.5	2842/7/1	.5			_
А	Nil	N	D					MW	MODERATELY WEATHERE			ИELY					Bore	ehole left ope after drillinl	n and chec h and foun	ked 2 hours	2.0
N	Na	atural e	expos	ure SI	JPPORT 1 Shorir	ng	WATER N None	e obse	moderately MOISTURE PENErved D Dry L Lo	w VS	SISTENCY DE VerySoft VL		se A A	uger sa		р		enetrometer	CI	ASSIFICATION MBOLS AND	5.C.C.C.C.C.C.C.C.C.C.C.C.C.C.C.C.C.C.C
X BI E H. S P	E: H Ba Ex A Ha Ha T Pu Au	xisting ckhoe cavate and au and sp sh tub iger	excar buck or ger ade e	vation Si et RI Ni	Shotci Shotci Rocki No su	rete Bolts	X Not r Wate	measu er leve er outf	red M Moist M Mo I W Wet H Hig Wp Plastic limit R Re low WI Liquid limit	oderate S gh F fusal St VSt H	Soft L Firm MD Stiff D	Loose	Dense U U D E Se M M	lulk san Indistur Disturbe Ioisture		S V D		penetration tear ic cone meter asity		USCS USCS	N
	C Co	ncrete	Core	r		E	XCAVATIO	ON LO	OG TO BE READ IN CONJU	INCTION WITH	H ACCOMPANY	YING REP	ORT NOTE	S AN	D ABBRE	VIAT	ONS				_

CLI	EN	Γ	Α	llen Pric	ce & As	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLETE	D 24	1.11.10			REF	BH8
PR	ΟJΕ	СТ	E	ngineer	ing Ser	vices			LOGGED	JSF	CHECKED	G	Т			Sheet 1 of	
SIT	E		С	ullburra	Road,	West Cu	ıllbu	ırra	GEOLOGY	Siltstone	VEGETATIO	N G	rass			PROJECT NO. P	1002842
EQUI					Hydraulic A				EASTING	NA	RL SURFAC	-					
				ISIONS		2.5m depth			NORTHING	NA .	ASPECT	N	orth West			SLOPE 5%	
	EX	CAV	/AT	ION DA				MA	TERIAL DA	ATA				SA	MPLIN	G & TESTING	i
МЕТНОБ	SUPPORT	WATER	MOISTURE	DEPTH (M)	M PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, n particle characteristics, orga fill, co	anics, secondary a ntamination, odou	asticity, rocks, oxidation, and minor components, ir.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	Al	RESULTS DDITIONAL OBS	
A	Nil Nil	N N	M	0.1		× × × × × × ×	OL SC	ORGANIC SAI			S	L	A	0.2	2842/7/ 0.	2	
A	Nil	N	М	0.3 - - - - - 1.0 - - 1.3			CL	CLAYEY SAND - Bro	own mottles, f	irm grading stiff,	F		A	1.0	2842/7/ 0. 2842/7/ 1.		_ _ _ _ 1 <u>.0</u> _
А	Nil	N	D	-		===	EW	EXTREMELY W					А	1.5	2842/7/1.	5	=
				1.6				Grey, red mot EXTREMELY W	-								
Α	Nil	N	D	1.9			EW		clay like prop								_
A Nil N D 2.0 MW MODERATELY WEATHERED SILTSTONE - Grey. A 2.0 2842/7/2.0 Borehole dry after 2 hours.															2 <u>.0</u> _		
A Nil N D - MW MODERATELY WEATHERED SILTSTONE - Grey. Borehole dry after 2 hours. Borehole terminated at 2.5m on																	
	Grey. Borehole dry after 2 hours. Borehole dry after 2 hours.														nours		
																	5.0 6.0 7.0
																	- - - - 8.0 - - - - - - - - - - - - - - - - - - -
N X BH E HA S PT A	Na Ex Ex Ha Ha Pus	itural e	exposi excar bucke or ger ade e	ure SH vation SC et RE Nil	3 Rock Bol I No suppo	ts <u>▼</u> Wat ort 	e obse measu er leve er outf er inflo	erved D Dry L Lor red M Moist M Mo- el W Wet H Hig Wp Plastic limit R Re flow WI Liquid limit	w VS oderate S yh F fusal St VSt H F	SISTENCY	ose A Au B Bu Dense U Ur D Dis se M Mc Ux Tu	ger sa lk sam disturb sturbed isture be san	ple bed sample if sample content nple (x mm)	PF S VS DO FE W	Standard S Vane she CP Dynami penetro D Field den S Water sa	penetrometer Spenetration test	CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION Y USCS N Agricultural

CLI	EN	Γ	Α	llen Pric	e & As	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLETE	D :	24.11.10			REF	BH11
PRO	IJΕ	СТ	E	ngineer	ing Ser	vices			LOGGED	JSF	CHECKED		GT			Sheet 1 o	
SIT	E		С	ullburra	Road,	West Cu	ıllbu	rra	GEOLOGY	Siltstone	VEGETATION	ON	Eucalypts			PROJECT NO.	P1002842
EQUI					Hydraulic A				EASTING	NA	RL SURFAC	-	NA				
				ISIONS		2.0m depth			NORTHING	NA .	ASPECT	I	North East			SLOPE	4%
	EX	CAV	'AT	ION DA				MA	TERIAL DA	ATA				SA	MPLIN	G & TESTI	NG
МЕТНОD	SUPPORT	WATER	MOISTURE	DEPTH (M)	M PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, n particle characteristics, orga	PTION OF STR nottling, colour, pla anics, secondary a intamination, odou	sticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	A		TS AND DBSERVATIONS
Α	Nil	N	М	0.2		× × ×	OL	ORGANIC SAI	NDY SILT – [Dark brown.	s		А	0.2	2842/11/	0.2	
А	Nil	N	М				CL	CLAY - Orange/bro tending grey with mino	own mottles, f r brown and i	irm grading stiff, red mottles at depth.	F- St		A	1.0	2842/11/		- - - - 1 <u>.0</u> - -
А	Nil	N	D	_ _ _ _ _ _ _ _ _			EW						A	1.5	2842/11/	1.5	- - - -
А	Nil	N	D	2.0			MW									2.0	
A NII N D - EW EXTREMELY WEATHERED SILTSTONE - Grey with mottled. A 1.0 2842/11/1.0														2.0 			
				8.0 - - - - - - - - - - - - -													- - 8 <u>0</u> - - - - - - - - 9 <u>0</u>
N X BH E HA S PT A	Na Ex Ex Ha Ha Pus	tural e disting ckhoe cavato nd aug nd spa sh tube	exposi excar bucki or ger ger ade	THOD SL ure SH vation SC et RE Nil	Rock Bol No suppo	ts <u>▼</u> Wate ort 	e obse measu er leve er outf er inflo	rved D Dry L Lor red M Moist M Mc I W Wet H Hig Wp Plastic limit R Re low WI Liquid limit	w VS oderate S gh F fusal St VSt H F	SISTENCY	SE A AU B BU Dense U UI D DI SE M M UX TU	uger s ulk sa ndistu isturb oistur ube sa	mple irbed sample ed sample e content ample (x mm	PI S S D D D FI W	Standard S Vane she CP Dynam penetro D Field den 'S Water sa	ic cone meter sity	CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION Y USCS N Agricultural

CLI	EN	Г	Α	llen Pric	e & As	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLE	TED	24.11.10				REF	Е	3H13	
PRO	IJΕ	СТ	E	ngineer	ing Ser	vices			LOGGED	JSF	CHECKE	D	GT			- 1	Sheet 1			
SIT			С	ullburra		West Cu	llbu	rra	GEOLOGY	Siltstone	VEGETA	TION		s			PROJECT N	10 . P10	02842	
EQUI				1010110	Hydraulic A				EASTING	NA NA	RL SURF		NA			-	ODE	00/		
				ISIONS		2.5m depth		МД	NORTHING	NA NTA	ASPECT		North		SAM		LOPE	6% TING		
МЕТНОБ	SUPPORT	WATER	MOISTURE	DEPTH (M)	M PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRIF Soil type, texture, structure, n particle characteristics, orga	PTION OF STR	ATA asticity, rocks, oxidation, and minor components,	CONSISTENCY		DENSITY INDEX		DEPTH (M)		RESI	ULTS A	ND RVATIONS	5
А	Nil	N	М	- 0.25	3214		ML	ORGANIC SILTY/CLA	YEY SAND -	Dark brown, moist.	. S	'		А	0.2 28	842/13/ 0.	2			_
Α	Nil	0.4	М	-0.25 0.4			CL	SANDY CLA	Y - Light brow	wn, moist.	F									
А	Nil	0.4 N	w	_			CL	GRAVELLY CLA gravels (5- 10m			S- F			A	0.5 28	842/13/ 0.	5			-
A	Nil	N	М	0.7 - 1.0 - 1.3			CL	CLAY - Brown and or	•		F- St			A	1.0 28	842/13/ 1.	0			1 <u>.0</u>
А	Nil	Ν	М	F			EW	EXTREMELY W Brown/grey m						А	1.5 28	342/13/ 1.	5			-
Α	Nil	N M ZO 2842/13/2.0 MODERATELY WEATHERED SILTSTONE - Light grey. Borehole terminated at 2.5m on moderately weathered siltstone.															2 <u>.0</u> 2 <u>.0</u> - - -			
EC	Na	itural e	expos	3.0 	IPPORT 1 Shoring	WATER N Non		MOISTURE PENET	ration con:				IG & TEST	FING	pp Pr	ocket pen	etrometer		ASSIFICATI MBOLS ANI	
N X BH E HA S PT A	Na Ex Ex Ha Ha Pus	itural e kisting ckhoe cavato nd aug ind spa sh tube	exposi excar bucke or ger ade e	ure SH vation SC et RE Nil	H Shoring Shotcrete	N None ≥ X Not r ts ∇ Wate	e obse neasu er leve er outf	rved D Dry L Lor red M Moist M Mo I W Wet H Hig Wp Plastic limit R Re low WI Liquid limit	w VS oderate S gh F fusal St VSt H	Very Soft VL Very L Soft L Loose	Loose A B m Dense U D Dense M	Auger Bulk s Undis Distur Moistr	sample ample turbed sam bed samp ure conten sample (x	nple le t	S S VS V DCP FD F	ocket pen tandard p /ane shea Dynamic penetrom ield densi Vater sam	cone eter ty	SY	MBOLS AND DIL DESCRIP USCS	O PTION
	501		_010		E	EXCAVATIO	ON LO	OG TO BE READ IN CONJU	INCTION WITH	ACCOMPANYING R	EPORT NO	TES A	ND ABB	REVI	ATION	S				

CL	IEN	Γ	Α	len Pric	e & A	ssociate	s Pt	/ Ltd	COMMENCED	24.11.10	COMPLETE	D 2	4.11.10			REF	BH17	
PR	OJE	СТ	E	ngineer	ing Se	rvices			LOGGED	JSF	CHECKED	G	ST .			Sheet 1 of		
SIT			С	ullburra	_	l, West (ullb	ırra	GEOLOGY	Siltstone	VEGETATIO	-	ucalypts			PROJECT NO.	P1002842	
	IPME			010110	Hydrauli				EASTING	NA NA	RL SURFAC	_	IA			OL ODE	FD/	
EXC				SIONS		X 2.5m dept	1	MA	NORTHING	NA NTA	ASPECT	N	lorth West	SA		SLOPE G & TESTI	5% JG	
МЕТНОБ	SUPPORT	WATER	MOISTURE	DEPTH (M)	L PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, particle characteristics, org	PTION OF STR	ATA asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)		RESUL		
А	Nil	N	М	- 0.3		× ×	'x'	ORGANIC SILTY/CLA	YEY SAND -	Dark brown, moist.		L	А	0.2	2842/17/	0.2		_
А	Nil	N	М	1.0			CL	CLAY - Orange/bro tending grey with mind			F		A	1.0	2842/17/ 2842/17/			1.0
А	Nil	N	М	- - - -			- CL	CLAY - Grey with moist, sand in p SANDY CLAY - Gre	rofile from 1.	Bm, grades to	St		A	2.0		2.0		2.0
SANDY CLAY - Grey, with red mottles, moist, stiff.													CLASSIFICATION	3.0				
N X B E H S	Na Ex H Ba Ex A Ha Ha T Pus	atural existing ckhoe cavate and au and sp sh tub	exposi excar bucke or ger ade	ure SH vation SC et RE	JPPORT I Shorin C Shoter 3 Rock E I No sup	ete X N Bolts <u>V</u> V	one obs of meas ater lev	erved D Dry L Loured M Moist M Mel W Wet H Hi Wp Plastic limit R Refillow WI Liquid limit	ow VS oderate S gh F efusal St VSt H	SISTENCY DENSITY Very Soft VL Very Lor Soft L Loose Firm MD Medium Stiff D Dense Very Stiff VD Very Den Hard Friable VD	ose A Au B Bu Dense U Un D Dis se M Mo	ger sa lk sam distur sturbe isture	& TESTING ample nple bed sample d sample content mple (x mm)	pr S V D	S Vane she CP Dynam penetro Field der S Water sa	ic cone meter sity	SYMBOLS AND SOIL DESCRIPTIO Y USCS N Agricultural	
A C	Au C Coi	iger ncrete	Core	r				OG TO BE READ IN CONJU	JNCTION WITH	HACCOMPANYING REF	PORT NOTES	S ANI	D ABBRE	VIATI	ONS			

CLI	EN	Γ	Α	llen Pric	e & As	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLET	ΓED	24.11.10				REF	BH	I18
PR	IJΕ	СТ	E	ngineer	ing Ser	vices			LOGGED	JSF	CHECKE)	GT				Sheet 1		
SIT			С	ullburra		West Cเ	ıllbu	ırra	GEOLOGY	Siltstone	VEGETAT	ION		s			PROJECT NO	o . P100284	2
EQUI				1010110	Hydraulic A				EASTING NORTHING	NA NA	RL SURFA	ACE	NA Na -th-				01.005	4.00/	
				ISIONS		2.5m depth		MA	TERIAL DA		ASPECT		North		SΔ		SLOPE G & TEST	1-2% TING	
МЕТНОБ	SUPPORT	WATER	MOISTURE	DEPTH (M)	M PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRII Soil type, texture, structure, n	PTION OF STR	ATA sticity, rocks, oxidation, and minor components,	CONSISTENCY		DENSII Y INDEX	TYPE	DEPTH (M)			LTS AND	ATIONS
А	Nil	N	М	- 0.3	33 11	× × × × × ×	OL	ORGANIC SA	NDY SILT – I	Dark brown.	S	<u> </u>	_	А	0.2	2842/18/	0.2		-
A	Nil	Z	М	- - - - - - - - 1.0			CL	CLAY - Orange/bro tending grey with mino	own mottles, f r brown and i	irm grading stiff, ed mottles at depth.	F- St			A	1.0	2842/18/	1.0		- - - - 1 <u>.0</u> - - -
А	Nil	N	D	1.5 - - - - 2.0			EW	EXTREMELY WEAT properties, grey with	HERED SILT h red mottles	STONE - Clay like stiff to very stiff.	St- VSt			A		2842/18/			- - - 2.0
Α	Nil	N D																	
								moderately	weathered s	iltstone.									3.0 3.0 4.0 4.0 5.0 6.0
N X BH E HA S PT A	Na Ex Ex Ha Ha Pus	tural edisting ckhoe cavato aug	exposi excar bucke or ger ger ade	ure SH vation SC et RE Nil	Rock Bol No suppo	ts <u>▼</u> Wat ort 	e obse measu er leve er outf er inflo	rived D Dry L Lo red M Moist M Me I W Wet H Hig Wp Plastic limit R Re low WI Liquid limit	w VS oderate S gh F fusal St VSt H F	DENSITY VEVER STATE	pose A B B I Dense U D D D D Ux S	Auger Bulk s Undist Distur Moistu Tube s	G & TES sample ample turbed sar bed samp ure conten sample (x	mple le t mm)	S VS DC FD WS	Standard Vane she P Dynami penetro Field den S Water sa	ic cone meter sity	SYMBO SOIL D	IFICATION DLS AND ESCRIPTION JSCS Agricultural
						-XCAVATI	JN L	OG TO BE READ IN CONJU	INCTION WITE	ACCOMPANYING RE	PURT NOT	∟S A	IND ABB	KEV	IA I IC	NS.			

CL	IEN	Γ	Al	len Pri	ce & As	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLE	TED	24.11.10)		REF	BH19
PR	OJE	СТ	Eı	ngineer	ing Ser	vices			LOGGED	JSF	CHECKE	D	GT			Sheet 1	
SIT	Έ		C	ullburra	Road,	West C	ıllbu	rra	GEOLOGY	Siltstone	VEGETA	TION	Eucalypt	s		PROJECT NO	. P1002842
EQL	IPME	NT			Hydraulic				EASTING	NA	RL SURF	ACE	NA			1	
EXC				SIONS		2.5m depth			NORTHING	NA	ASPECT		North			SLOPE	2-3%
<u> </u>	EX	CA	/AT	ON DA		-	-	M.A	ATERIAL DA	ATA		_			SAMPLI	NG & TEST	ING
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	L PENETRATION H RESISTANCE		CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org- fill, co	ontamination, odo	asticity, rocks, oxidation, and minor components, ur.	CONS		DENSITY INDEX	TYPE	DЕРТН (M)		TS AND OBSERVATIONS
A	Nil	N	М	0.1		× ×	× OL	ORGANIC SA	NDY SILT -	Dark brown.	S			Α (0.2 2842/1	9/ 0.2	
А	Nil	N	М	 			CL	CLAY - Orange/bro tending grey with mino	own mottles, 1 or brown and	firm grading stiff, red mottles at dep	th. F- St				0.5 2842/1 1.0 2842/1		- - - - - 1 <u>.0</u> - -
				- 1.6		<u> </u>								Α .	1.5 2842/1	9/ 1.5	-
А	Nil	N	D				EW	EXTREMELY WEA and grey mot highly weath	tles, clay like	properties,					2.0 2842/1		- - 2 <u>0</u> - - -
				2.5						+	Α :	2.5 2842/1	9/ 2.5				
									erminated at y weathered s								3.0 3.0
																	6 <u>.0</u> - - - - - - -
				- 7.0 													8.0
N B E H S P	E: H Ba Ex A Ha Ha T Pu Au	atural existing ckhoe ccavate and au and sp sh tub iger	exposi excave bucke or ger ade e	ire Si ation So et Ri Ni	JPPORT I Shoring Shotcret Rock Bo No supp	olts ل Wa	ne obse measu ter leve ter outf	rved D Dry L Lo red M Moist M Mi I W Wet H Hig Wp Plastic limit R Re low WI Liquid limit	ow VS oderate S gh F efusal St VSt H	Soft L Loos	/ Loose A se B ium Dense U se D Dense M	Auger Bulk s Undis Distur Moistr	IG & TES's sample ample turbed sample tbed sample grample (x	mple ble nt	S Standa VS Vanes DCP Dyna	amic cone trometer ensity	CLASSIFICATION SYMBOLS AND
\vdash	C Co	ıcrete	Core			EXCAVATI	ON LO	OG TO BE READ IN CONJU	JNCTION WITH	H ACCOMPANYING	REPORT NO	ΓES A	ND ABE	BREVI	ATIONS		
\vdash			-				`			ASSOCIATES DIVI					, .		

CL	IEN	Г	Α	len Prid	ce &	Ass	ociates	Pty	Ltd	COMMENCED	24.11.10	COMPLE	TED	24.11.1	10			REF	BH22
PR	OJE	СТ	E	ngineer	ing S	Serv	rices			LOGGED	BR	CHECKE	D	GT				Sheet 1	
SIT			С	ullburra	_		West Cu	ıllbu	rra	GEOLOGY	Siltstone	VEGETA						PROJECT N	O. P1002842
-	IPME		IMEN	SIONS	Hydra 0.95m		uger 2.5m depth			EASTING NORTHING	NA NA	RL SURF		NA North E	aet			SLOPE	1-2%
EXC				ON DA		IW A 2	z.om depin		M.A	TERIAL DA		ASPECT		NOTULE	ası	SA		G & TES	
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	L PENETRATION	RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRII Soil type, texture, structure, riparticle characteristics, orga	PTION OF STR	ATA asticity, rocks, oxidation, and minor components,	CONSISTENCY		DENSITY INDEX	TYPE	DEPTH (M)		RESL	JLTS AND . OBSERVATIONS
Α	Nil	N	М	_ 0.3			× × × × × ×	OL	ORGANIC SILT – Dark	k brown, grav	els (5-10mm, 30%)). S			Α	0.2	2842/22/	0.2	
А	Nil	N	М	- - - 0.8				CL	CLAY - Variable cold	ours (grey, re	d, yellow, brown).	F			Α	0.5	2842/22/	0.5	
А	Nil	N	D	1.0				EW	EXTREMELY WE SILTSTO	EATHERED F NE - Reddish					Α	1.0	2842/22/	1.0	1 <u>.</u>
А	Nil	N	D	- - - - -				EW	EXTREMELY WE SILT	EATHERED F STONE - Gre					Α	1.5	2842/22/	1.5	
А	Nil	N	D	2.0 _ _ _				EW							A	2.0	2842/22/	2.0	<u>2.</u>
Borehole terminated at 2.5m on extremely weathered siltstone.																			
A NII N D E EXTREMELY WEATHERED FINE GRAINED SILTSTONE - Grey, strength decreasing. A 2.0 2842/22/2.0 A 2.5 2842/22/2.5 Borehole terminated at 2.5m on														3 <u>.</u> 4 <u>.</u> 5 <u>.</u>					
	OLUDA:	AENIT	/MC	7.0	IDDOR	T	WATER		MOISTURE DENIE	FRATION COM	DISTENCY DENGITY				PTIMO				8 <u>.</u>
N B E H S P	H Ba Ex A Ha Ha T Pu	atural existing ckhoe ccavato ind aug ind spa sh tubo iger	exposi excav bucke or ger ger ade	ure St vation SC et RE Ni	JPPOR H Shor C Shor B Rock I No s	ring tcrete k Bolt:	s 🅎 Wat	e obse measu er leve er outf	rved D Dry L Lo red M Moist M Mo il W Wet H Hig Wp Plastic limit R Re low WI Liquid limit	w VS oderate S gh F fusal St VSt H	Soft L Loose	Loose A B Im Dense U D Dense M	Auger Bulk s Undis Distur Moistr	IG & TES r sample sample sturbed sambed samure conte sample (:	ample iple ent	pp S VS DC	Pocket pe Standard S Vane she CP Dynam penetro D Field den S Water sa	ic cone meter sity	CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION Y USCS N Agricultural
Г			_			Е	XCAVATION	ON LO	OG TO BE READ IN CONJU		ACCOMPANYING R		ES A	ND AB	BREV	/IATIC	ONS		

CLIEN		1			sociates	Pty	Lta	COMMENCED			COMPLETEL		10		┸	KEF	BH23	,
PROJE	СТ	1 -		ng Ser				LOGGED	BR		CHECKED	GT				heet 1 of		
SITE		Cul			West Cu	ıllbu	ırra	GEOLOGY	Siltstone		VEGETATIO	_			PI	ROJECT NO.	P1002842	
EQUIPMEN		INTENIOR		Hydraulic A				EASTING	NA		RL SURFACE	_	F4		01	OPE	4.00/	
EXCAVAT			N DAT		1.0m depth		NA.	NORTHING ATERIAL DA	NA NTA		ASPECT	North	Easi	64		& TESTII	1-2%	
METHOD SUPPORT	WATER	MOISTURE	DЕРТН (M)	M PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCR Soil type, texture, structure, particle characteristics, or	IPTION OF STR	ATA asticity, rocks, oxic	dation, ents,	CONSISTENCY	DENSITY INDEX	TYPE	DЕРТН (М)		RESUL ⁻		ıs
A Nil	N	М _	2		× × ×	OL	ORGANIC SILT – Da	rk brown, grav	els (5-10mm)	, 30%).	S		Α	0.2	2842/23/ 0.2			-
A Nil	N	M 0.	3			CL		CLAY - Grey.			S							
A Nil	N	M -		888888888888888888888888888888888888888	 	CL	CLAY - Variable co	lours (grey, re	d, yellow, bro	wn).	s		А	0.5	2842/23/ 0.5			- - -
A Nil	N	D 1.				EW	EXTREMELY W	EATHERED I		D			Α	1.0	2842/23/ 1.0			1.0
		9.0	0		<u></u>													9. <u>0</u>
N Na X E) BH Ba E Ex HA Ha S Ha PT Pus	atural e xisting ckhoe cavato ind aug ind spa sh tube iger	/ METH exposure excavati bucket or ger ade	OD SU SH ion SC RB	PPORT Shoring Shotcrete Rock Bol No suppo	ts <u>▼</u> Wat ort 	e obser measur er level er outflo	erved D Dry L L red M Moist M M H W Wet H H Wp Plastic limit R R low WI Liquid limit	ow VS loderate S igh F efusal St VSt H F UNCTION WITH	Very Soft VL Soft L Firm MD Stiff D Very Stiff VD Hard Friable	Loose Medium Do Dense Very Dense	se A Aug B Bull ense U Und D Dis e M Moi Ux Tub	ING & TE per sample s sample disturbed s turbed sar sture cont e sample	sample mple ent (x mm)	pp S VS DC FD WS	Pocket pene Standard pe S Vane shear CP Dynamic of penetrome D Field density S Water samp	netration test cone eter	CLASSIFICAT SYMBOLS AN SOIL DESCR Y USCS N Agriculti	TION ND IPTION

CL	EN	Γ	Α	len Pri	ce & A	۱ss	ociates	Pty	Ltd	COMMENCED	24.11.10		COMPLETI	ED	24.11.10			RE	F	BH24	1
PR	OJE	СТ	E	ngineer	ing S	erv	ices			LOGGED	JSF		CHECKED		GT			- 1	1 of		•
SIT	Ε		С	ullburra	Roa	d, V	Nest Cu	ıllbu	rra	GEOLOGY	Siltstone		VEGETATI	ON	Eucalypts	6		PROJI	ECT NO.	P1002842	
EQU	IPMEI	ΝT			Hydraul	lic Au	uger			EASTING	NA		RL SURFA	CE	NA						
EXC				SIONS		ЭХ2	2.6m depth			NORTHING	NA		ASPECT		North Eas			SLOPE		5%	
_	EX	CAV	/AT	ON DA				_	M.A	ATERIAL DA	ATA						SAMPL	ING &	restin	IG	
МЕТНОВ	SUPPORT	WATER	MOISTURE	DEPTH (M)	E PENETRATION	" NEGO 7110	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, orga	PTION OF STR mottling, colour, pla anics, secondary a ontamination, odou	asticity, rocks, oxidat and minor componen	tion, its,	CONSISTENCY	VENSITY INDEX		TYPE	DEPTH (M)		RESULT ONAL OE	S AND SSERVATION	NS
Α	Nil	N	М	0.2			× × ×	OL	ORGANIC SA	NDY SILT – I	Dark brown.		s			Α (0.2 2842	24/ 0.2			-
А	Nil	z	м					CL	CLAY - Orange/bro tending grey with mino	own mottles, f	irm grading stif red mottles at d	ff, lepth.	St- VSt			A	0.5 2842 1.0 2842	24/ 0.5 24/ 1.0 24/ 1.5			- - - - 1 <u>.0</u> - - - - -
				2.0 - 2.3												A :	2.0 2842	24/ 2.0			2 <u>.0</u> - - -
А	Nil	N	D	_ 26				EW	EXTREMELY WEA with red mott	ATHERED SII les, clav like	_TSTONE - Gre properties.	ey				A :	2.5 2842	24/ 2.5			-
	NI			2.6 					with red mott Borehole to	les, clay like erminated at weathered si	properties. 2.6m on						2042	241 2.3			3.0
N X	Na Ex	itural e kisting	exposi exca	re Stration SC	JPPORT H Shorir C Shoto	ng rete		e obse measu	rved D Dry L Lo red M Moist M Mo	w VS oderate S	Soft L	Very Loos Loose	se A A B B	luger Julk sa	G & TEST sample ample		S Stand	et penetrom lard penetra	eter tion test	CLASSIFICA SYMBOLS AI SOIL DESCR	ND
B H S P A C	Ex A Ha Ha F Pus Au	cavato nd aug nd spa sh tubo ger	ger ade	Ni	B Rock I No su	ippor	t ▼ ✓ Wat	er inflo	Wp Plastic limit R Re low Wl Liquid limit w	efusal St VSt H F	Stiff D I Very Stiff VD \ Hard Friable	Medium D Dense Very Dens	e M M Ux T	isturt loistu ube s	urbed sam bed sample re content ample (x r	e t mm)	VS Vane DCP Dy per FD Field WS Wate	shear namic cone etrometer density		Y USCS N Agricult	cural
\vdash			_			E	XCAVATIO	ON LO	OG TO BE READ IN CONJU		A SSOCIATES DE		ORT NOTE	S AI	ND ABBI	REVI	ATIONS				