

D2

Appendix D2

Malbec Properties Pty Ltd



Engineering Services and Stormwater Management Report: Proposed Residential Sub-division, South West Rocks, NSW.

ENVIRONMENTAL



WATER



WASTEWATER



GEOTECHNICAL



CIVIL



PROJECT
MANAGEMENT



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1 Introduction

1.1 Overview

This Engineering Services report has been prepared by Martens & Associates on behalf of Malbec Properties Pty Ltd ("The Proponent") with respect to their proposal to sub-divide the site for residential purposes.

It is prepared to form part of an Environmental Assessment Report to the Minister for Planning for approval under Part 3A of the *Environmental Planning and Assessment Act 1979*.

1.2 Scope

The scope of the report includes the review of the development in the context of the Director General's Environmental Assessment Requirements (DGEARs), particularly on land capability services, stormwater and water quality.

This report addresses the following issues:

- Project outline and site description.
- Site assessment and identification of development issues.
- Site management, including water quality and stormwater management.
- Land capability assessment.

This report draws on additional information from a number of completed specialist consultants reports (Section 1.3) and includes recommendations for management and mitigation measures to ensure that the proposed development promotes ecologically sustainable development and maintains the integrity of the surrounding environment.

1.3 Information Sources

This Engineering Services document has been prepared by Martens & Associates Pty Ltd and draws on information and investigations by specialist consultant studies completed for the site. These reports included:

- Douglas Partners (2007) - Hydrogeological and contamination assessment.
- Hackett Laboratory Services (2003) - Acid Sulphate Soils assessment.
- WBM Oceanics Australia Pty Ltd (2005) - flood study.
- Connell Wagner Pty Ltd (2007) - Flora and Fauna, Wallum Froglet Studies.

1.4 Proposed Development

The proposed development involves a residential sub-division including;

- Approximately 310 allotments of varying size,
- Associated services (water, electricity and sewer) and stormwater,
- Internal road network and through road to future development lands north of the site.

A site plan is provided as Attachment A.

These works will involve clearing and some reshaping and construction of development infrastructure, namely roads and services. The development will be serviced from Belle O'Conner Drive to the south and a connection road to the north.

2 Site Description

2.1 Location

South West Rocks is a coastal village located on the North Coast of NSW, approximately 35km northwest of Kempsey and in the Kempsey local government area (LGA).

The subject site has an overall area of 39.5 ha and comprises the following allotments:

- Lot 52 DP 831284
- Lot 84 DP 792945

The site is bounded by rural residential development to the east, Belle O'Connor Drive to the south, a golf course to the west, and the existing Saltwater creek to the north. This creek flows from the west out of the South West Rock Golf Course (north west of the site) to Saltwater Lagoon (north east of the site). Saltwater Lagoon is connected to the ocean by Saltwater Creek which, together, make up an intermittently closed and open lake or lagoon (ICOLL). The entrance is located at the western end of Trial Bay Beach and is closed 70% of the time (WBM, 2006) by a sand berm. Figure 1 shows the locality of the site in a regional context and indicates these features.

The proposed development is part of a larger land release area encompassing land to the north.



Figure 1: Approximate site locality and regional context. Source: Google Maps, 2008

2.2 Field investigations

Site investigations were undertaken by Martens in March, 2008, and included a walkover inspection of the site to assess the existing site's environment setting and determine any environmental conditions that may have potential to impact on the proposed development and or neighbouring properties.

2.3 Topography

The site slopes from the south to the north/north east towards Saltwater Creek. Site elevations vary between 5.0 – 5.5 mAHd to 1.0 – 1.5 mAHd adjacent to Saltwater Creek

The site is fairly flat with average slopes of <1 %. Slope grades are highest on the ridge located in the central region of the southern boundary.

The site conveys flow from two discrete catchments to the south which drain through the site and into the creek. The first, flowing into the western portion of the site, is approximately 39.5 ha and largely consists of rural/agricultural properties. The site for a recently approved residential subdivision lies within this catchment with the first stage of this subdivision having already been built. The stormwater modelling, assumes this catchment to be in its ultimate developed condition as the worse case scenario. The second catchment, feeding into the eastern portion of the site is approximately 34.7 ha and primarily consists of cleared grazing land.

2.4 Geology

The Dorrigo Kempsey 1:250,000 Geological Series Sheet indicates that the site is underlain by Quaternary aged alluvial and estuarine sediments typically comprising sands, silts and gravels. The former sediments are underlain by Smokey Cape and Kempsey Beds.

2.5 Soil Profile

Reference to the 1:100,000 Macksville Nambucca Soil Landscape Series Sheet 9436 (1999) indicates that two soil landscape groups that make up the site (Figure 2). Soils in the area of proposed development are primarily characterised as Clybucca (cy) and are comprised back barrier swamps overlying Pleistocene sands at elevations typically less than 5 mAHD. The southern portion of the site also partially contains the Korogoro (kr) landscape; consisting of low transgressive Pleistocene dunes.

Limitations associated with this soil landscape group include the following:

- Poor drainage
- Localised acid sulphate soil potential
- High run on (being on lower slopes)
- Flood Hazard
- Permanently high water table
- Groundwater pollution hazard
- Foundation hazard

3 Land Capability Assessment

3.1 Hydrogeological Assessment

A detailed Hydrogeological Assessment was conducted by Douglas Partners Pty Ltd (2007) as part of the LES for the rezoning of the wider release area including the subject site. Their investigation included land to the north as well as the subject site to the south. Field work was undertaken during July and August of 2007 and included the following:

- Ten bores were drilled, of which 4 were located at the site, to a general depth of 5m.
- Installation of a groundwater monitoring well at each bore.
- Rising head (slug) tests on each well.
- Measurement of field chemical parameters.
- Measurement of groundwater piezometric depths at each well.
- Survey of bores.
- Piezo cone penetration tests (CPTu) at 7 locations, 1 of which was located at the site, ranging from 2 m to 23 m.

The following sections summarise the findings of Douglas Partners' report and comment on their findings in the context of the development site, which is to the south of Saltwater Creek and forms only part of the overall Douglas Partners study area.

3.1.1 Subsurface Conditions

The investigation area was found to be underlain by basement clay overlain by sands. The basement clays were found to be at or close to the surface in the south western portion of the study area (including the current site), increasing in depth to the north east of the study area. Section 3.6 provides further geotechnical information on the site.

3.1.2 Water Table and Flow Directions

The hydraulic gradient was found to be typically in the order of 0.005 m/m and flow is generally in a northerly direction, towards the creek. Seepage rates vary from east to west, with the eastern side (containing permeable sands) having a seepage velocity of 3 to

100m/year (based on a typical porosity of 0.2), while the western portion of the site having a very low flow rate.

Piezometric surface measurements were taken after periods of dry weather and are not expected to represent conditions after rainfall events. Due to the presence of numerous confining layers, it is likely infiltration of rainfall will be impeded leading to perching of groundwater and surface ponding in low lying areas during and immediately following rainfall.

3.1.3 Implications for Proposed Development

Following their investigations Douglas Partners concluded that the development of the site (and the wider study area) for residential purposes may have a number of hydrogeological implications.

These included the following risks that are relevant to the subject site:

- Potential impact on the hydrogeological regime of the wetland to the north of the development area;
- Management of the high water table; and,
- ASS related risks during construction.

Mitigation measures have been designed to minimise the proposed development's impacts on the hydrogeological regime downstream of the development and are outlined in Section 4.1 and management of the high water table in Section 3.5.

Mitigation of ASS related risks is discussed in Section 3.4.

3.2 Water Table and Surface Water Interaction

The subsurface conditions at the site include a confining basement clay layer with a thin overlying, highly permeable sand layer. This results in the groundwater table and surface water system becoming intrinsically connected. For the purposes of water supply for local vegetation, the two sources of water act as a single water resource.

Due to this inter connection that any apparent transfer of water from surface flows to groundwater or vice-a-versa (as a result of future development) shall not adversely impact vegetation.

3.3 Flood Assessment

A flood study for Saltwater Creek and Lagoon was previously carried out by WBM Oceanics Australia (2005), on behalf of Kempsey Shire

Council, covering the Saltwater Creek catchment area which encompasses the proposed development site.

Design flood events, based on design rainfall estimates according to AR&R data, were modelled to determine the flooding regime in Saltwater Creek. Design events including the 1%, 5% and 20% AEP and the PMF (probable maximum flood) were mapped to indicate flood levels and extents. The sand berm at the entrance to Saltwater Creek which temporarily closes the Saltwater Creek entrance, in some cases affects the flooding during certain rainfall/runoff events. Therefore, three crest elevations of this sand berm were modelled in the WBM Oceanics Study (2.0, 2.5 and 3.0 mAHD) for the 1% AEP to determine the effect of this berm on flooding.

Results of the flood analysis indicate that the flood levels for the larger flood events (1%, 5%, 10%) upstream of the Phillip Drive Bridge are controlled by the bridge hydraulics and not the sand berm conditions. The constrictive effect of Phillip Drive Bridge results in flood levels on the site being controlled by channel hydraulics and catchment generation and not the downstream boundary condition of the outlet sand berm (WBM, 2005).

From the analysis it can be concluded that for the larger flood events (e.g. 1% AEP) flood levels upstream of Phillip Drive Bridge are controlled primarily by the bridge constriction. For more frequent events, Phillip Drive has sufficient flood conveyance capacity, and flood levels are controlled by channel hydraulics.

The site is not impacted by coastal inundation as ocean levels are too low to influence creek water levels during both dry weather and all flooding events to the 1 in 100 year event. Coastal Inundation under normal tidal conditions peaks at a level of 0.986 mAHD (MHWSS), which is considerably below the creek bed level adjacent to the site (approximately 2.0m from WBM 2004 Figure 6.1). Even with the largest estimated sea level rise of DECC (2007) maximum tidal levels will be considerably below local channel bed levels and very much lower than development area levels.

Impact of storm surge is considered through the site flood modelling assessment. The effects of storm surge would be comparable to the effects (in the modelling) of the outlet berm height. Therefore, even with the concurrence of storm surge / tidal conditions of 2.5 mAHD and the 1 in 100 yr flood the site is not adversely impacted.

Detailed flood analysis (WBM, 2004) found that the 1% AEP level for the subject site is 3.2 mAHD based on Figure 6.1 of WBM (2004) for downstream boundary condition (i.e. berm height) of 2.5m. PMF levels for the site were estimated to be 4.5m from the same source.

Developable areas have been identified on the site (WBM, 2006) as all lands more than 50m from the 3.0 mAHD contour. This places the entire development envelope outside of lands impacted by inundation by the design 1% AEP flood event. A development flood planning level (FPL) of 3.7 mAHD is recommended for the site. This is 0.5m above the 1% AEP in accordance with recommendations of the Floodplain Development Manual (2005).

3.4 Contamination Assessment

The potential for contamination risks at the site has been evaluated from a number of sources including;

- Information from previous studies,
- DA consent history search from Kempsey Shire Council, and
- Review of historical aerial photographs.

Following a review of the abovementioned sources of information the only potential contamination sources in the locality of the site were found to be the former Caltex and Shell depots. These previous depots are located 1km to the north of the subject development site and are of a sufficient distance from the site not to pose a risk to site development. Further assessment of the potential impact from these sites is included below.

3.4.1 Previous Studies

Douglas Partners previously carried out a Contamination Assessment of the larger rezoning area at the subject site for Kempsey Shire Council. The investigation consisted of a review of all available documentation, field observations and the collection and analysis of soil and groundwater samples. Testing has also been carried out by Caltex and Shell with remediation of the depot sites having been recently completed.

The investigations on the Caltex and Shell sites have confirmed that there has been no evidence of migration of contaminants in the southerly direction (some contamination was observed to be moving to the north away from the subject site). Testing of soils at the depot sites and in the vicinity on the adjacent property to the south showed concentrations lower than that considered to be a contamination risk by the EPA. Based on these previous investigations as well as the distance of the subject site (ie 1km south of depots) the risk of contamination of the subject site from these sources is considered to be negligible and therefore is not a risk to site development.

3.4.2 .DA Consent History

A DA consent history search was undertaken by Kempsey Shire Council for each lot to identify any potential sources of site contamination. The results are summarised in Table 1.

Table 1: Results of DA consent history search; Lot 84 DP 792945 and Lot 52 DP 831284 (Kempsey Shire Council).

Allotment	Year	Application	Result
Lot 84 DP 792945	1992	Dwelling Additions	Approved
	1998	Garage	Approved
Lot 52 DP 831284	1999	Dwelling	Approved
	2002	Additions to dwelling	Approved
	2002	Garage	Approved
	2002	Internal road and creek crossing	Approved
	2005	Subdivision in 4 lots	Refused
	2007	Subdivision (boundary adjustment)	Approved
	2007	Subdivision	Pending

Based on results of a historical DA search for both allotments, there have been no previous land uses that would lead to a risk of site contamination.

3.4.3 Historical Aerial Photograph Analysis

Aerial photographs of the site were obtained from the NSW Department of Lands. These covered the period from 1956 to the present and were used to assess changes in the site and surrounding area's landuse to identify potential sources of land contamination. Findings are summarised in Table 2.

Table 2: Assessment of historical aerial photographs.

Year	Description
1956	Site is approximately 60% cleared. No access roads present or surrounding residential development. No residential development along Phillip Drive.
1974	Evidence of poorly drained land directly to the south and west of the site. Residential development has occurred on the western boundary. No evidence of vegetation clearing on-site. Caltex and Shell Depots located on Phillip Drive approximately 1km north of the site. Saltwater Lagoon and Creek has undergone very little change.
1980	Belle O'Conner Street now provides access to the site. Construction of golf course, north west of the site, has commenced. Increased residential development surrounding the site. Swampy areas to the west are no longer evident and areas to the south of the site are less extensive suggesting drainage works. Caltex and Shell depots remain unchanged.
2000	Golf course has expanded west and south, and STP has now been constructed to the north west of the site. No obvious vegetation clearance on site. Fire trails and drainage channels have been constructed. Very little evidence of previous swampy/inundated areas to the west and south of the site. Depots on Phillip Drive are no longer present. Lagoon and Saltwater Creek have undergone very little change throughout period.
2008	No significant on site change since 2000.

From analysis of historical aerial photographs, the former Caltex and Shell depots, located on Phillip Drive during the 1970's and 1980's, present the only potential source of contamination in the locality. The risk of this affecting the subject site development is considered to be negligible given:

- the distance (approximately 1km) between the depots and the subject site and the prevailing hydrogeological regime;
- remediation works carried out by Caltex and Shell since the decommissioning of the site; and
- subsequent soil testing carried out by Douglas Partners and others demonstrating lower concentrations than that considered to be a contamination risk.

Further there is documented evidence of the northward migration of contaminants in the groundwater, with no evidence of migration to the south. In any case, the subject site is 1 km to the south, and upslope from Saltwater Creek, which lies between the Caltex/Shell sites and the site and therefore this is not considered to be a risk to development.

3.4.4 Conclusion

A review of previous investigations and studies carried out in the area, a search of previous DA's and review of historical aerial photographs of the site identifying past land uses has led to the conclusion that the risk of contamination on the site is characterised as negligible and does not pose a risk to the residential development of the site.

3.5 Acid Sulphate Soils Assessment

Acid Sulphate Soils (ASS) mapping sourced from on-line GIS mapping provided by NSW Natural Resources (2008) shows potential for ASS on the site. Figure 3 shows the ASS mapping for the site.

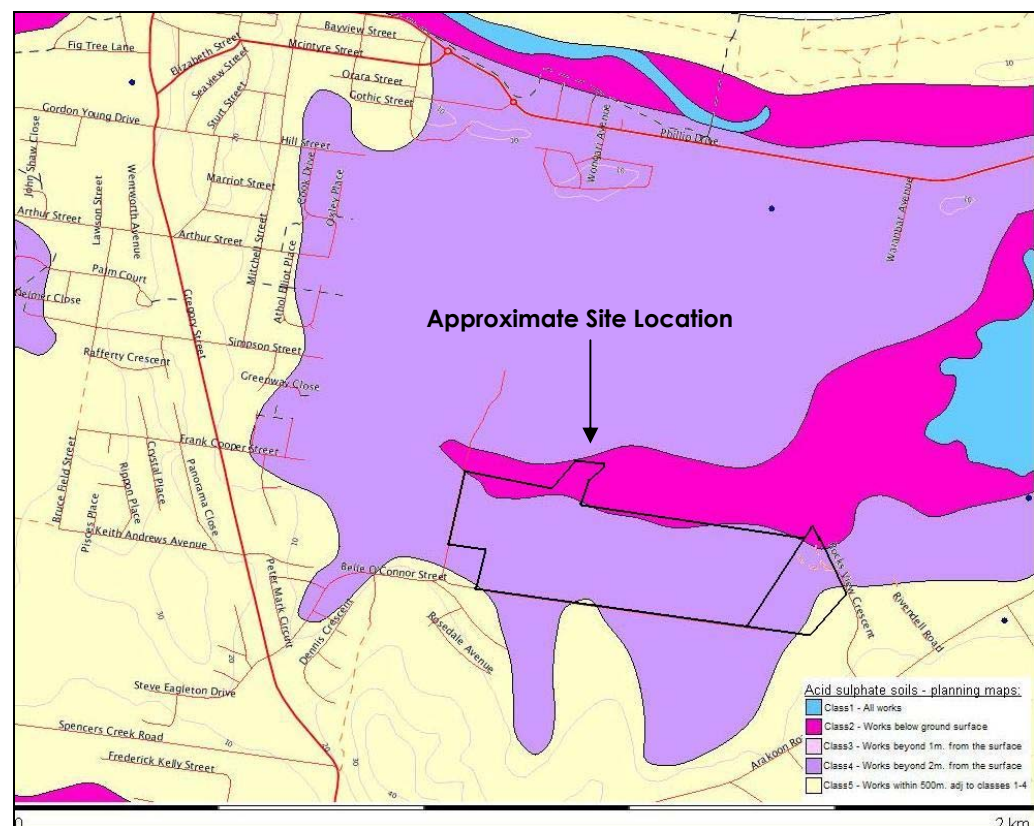


Figure 3: Acid Sulphate Soils site map (Source: NSW Natural Resources, 2008).

The mapping indicates a high potential for ASS less than 1m below ground level (Class 2) to the north, along the existing drainage line. Elsewhere, ASS are likely to be at depths of greater than 2m below ground level (Class 4).

Given that mapping shows potential for ASS on the site, and in accordance with Kempsey Shire Council's DCP 30, a preliminary ASS assessment including site soil testing was undertaken by Hackett Laboratory Services in January 2003. Testing was undertaken across a larger area which included land to the north as well as the subject site. Test pits were sampled to a depth of 2m as this was considered to be

the extent of site disturbance that would occur for residential development.

Six test pits (TP) were excavated in total, with two test pits (TP 5 and TP 6) located within the proposed development site on Lot 52, DP 831284. Attachment A shows the approximate locations of the Hackett Laboratory test pits. The results of these tests are provided in Table 3 below.

Table 3: ASS sampling results (Hackett Laboratory Services).

Test pit	Sample Depth (mm)	Watertable Depth (mm)	pH _f ¹	pH _{Fox} ²	Peroxide Reaction ³
5	0-400	-	-	-	-
	400-800	-	5.13	4.89	0
	800-1200	1200	4.82	4.79	0
	1200-2000	-	4.83	4.80	0
6	0-400	-	5.51	4.94	-
	400-2000	1600	5.36	5.02	0
	2000 +	-	5.71	4.81	1

Note: ¹ *In-situ* pH of saturated soil sample. ² *In-situ* pH with 30% peroxide reaction. ³ Peroxide rating as follows: 0 = No reaction after 5 mins; 1= Slight reaction within 5 mins; 2= Medium reaction within 5 mins; 3= Strongly effervescent within 5 mins.

Using pH_f and post peroxide oxidation pH_{Fox} criteria (ASSMAC, 1998, p12) all soils with a pH of ≤ 4.0 are considered actual ASS. Soils with pH_f > 4.0 and pH_{Fox} < 3.0 are classified as potential ASS. On the basis of this classification system, none of the samples are classified as potential or actual ASS.

The proposed development meets the provisions of DCP 30 by identifying the potential ASS risk at the site. The preliminary ASS assessment undertaken by Hackett Laboratory Services has clarified that the risk of encountering ASS is unlikely within the top 2m of soil. However, as a risk management measure and in accordance with the steps outlined in Council's DCP 30, an ASS Management Plan should be instigated if works are proposed at depths below 2 m or likely to result in water table changes below 2m depth. A land capability assessment, including ASS mapping, for the site is appended in Attachment C.

3.6 Geotechnical Assessment

Douglas Partners (2007) carried out a geotechnical assessment of the overall rezoning area as part of the LES for the site. This assessment included 4 bores excavated on the subject site. Table 4 summarises the results of each bore log.

Table 4: Summary of Strata Depths (Douglas Partners, 2007)

Bore/CPTu	3	4	5	6	106
Surface Level (AHD)	3.35	5.14	4.35	3.25	3.4
Water Table Depth (m)	2.39	2.43	0.71	1.07	0.7
Water Table Level (AHD)	0.97	2.71	3.65	2.17	2.7
Depth of Sand Layers (m)	0 – 0.85	NE	0.8 – 2.4	0 – 2.3 3.4 – >5.0	0 – 2.3 3.4 – 3.7 4.7 – 5.3
Depth to Basement Clay (m)	0.85	0.2	2.4	NE	6.2
Termination Depth (m)	5.0	5.0	5.0	5.0	18

Results of site testing confirm the site is underlain by basement clay layers. These are overlain with sand inter-bedded with clay layers increasing in depth in the north east to about 6 m or more. No indurated sand was encountered at the site. Locations of bores excavated by Douglas Partners can be found on the site plan provided in Attachment A.

As demonstrated in Table 3, the water table is shallow in parts of the site, with some low lying areas showing evidence of surface ponding, most likely to occur after periods of rainfall.

From on-site investigations (Douglas Partners, 2007) it can be concluded that the presence of a shallow groundwater table may have implications for the design of the proposed development.

A shallow water table can have engineering implications for building footings, pavements, drainage and services as well as serviceability of parks and gardens. It is likely that drainage measures will be required to control increases in groundwater levels due to rainfall events and season variations in rainfall.

3.7 Site Servicing Assessment

An investigation of the site services available to the site was undertaken to confirm that the development can be readily serviced by water,

sewer and other necessary utilities. The results of this investigation are summarised in Table 5 below.

Table 5: Results of site servicing investigations.

Utility	Contact	Servicing Available (Y/N)
Water	Macleay Water	Y
Sewer	Macleay Water	Y
Power	Country Energy	Y
Telecommunications	Telstra	Y
Gas	AGL	N
	ELGAS (gas cylinders)	Y
Waste Disposal	Kempsey Shire Council	Y (once dwellings are occupied)

Consultation with utility providers has indicated that all relevant services can be readily provided to the site, with the exception of town gas, which is not provided in the South West Rocks area. As an alternative, Elgas deliver and 'top-up' gas cylinders in the South West Rocks area – making gas available on a house-by-house basis.

Preliminary discussions with Macleay Water (Anne Maree Burke, 8/09/2008) suggested that during the initial phase of development, connection to an existing 100mm water supply main (currently servicing adjacent development to the south of Belle O'Conner Drive) may be possible. Ultimately it was suggested the site would be connected to a 300-450mm potable trunk supply main from the Macleay Water town water reservoirs to the south of the site.

Where levels allow, connection of site development to the Macleay Water sewage pump station is considered acceptable by Macleay Water (Anne Maree Burke, 8/09/08). The need for possible augmentation of pumps and chamber capacity shall be assessed by Macleay Water as the proposal progresses. Where levels do not allow connection to the existing SPS, an alternative solution shall be developed in accordance with Macleay Water. STP capacity is not considered.

Macleay Water indicated that both water and sewer would be readily available to the site and provision of these services is scheduled for the development time frame.

Attachment B provides the results of the services search for the site conducted subsequent to discussions with utility providers.

3.8 Sediment and Erosion Control

Prior to the commencement of construction works at the site, sediment and erosion control structures shall be implemented to prevent erosion and soil loss at the site and sedimentation of downstream ecosystems. Typical sediment and erosion control structures likely to be required at the site include;

- Sediment fencing,
- Straw bales,
- Stabilised site access,
- Stabilised stockpile locations, and
- Diversion bunds.

All sediment and erosion control structures are to be installed and maintained in accordance with Landcom's 'Soils and Construction Handbook: Managing Urban Stormwater' (2004).

4 Stormwater Management Methodology

4.1 Planning Context

The relevant planning controls and policies that have been considered as part of the formulation of the stormwater management for the site have been summarised in the Sections below.

4.1.1 Kempsey Shire Council Local Environment Plan (LEP) 1987

According to the Kempsey Shire Council LEP, the site falls into 3 zones. Compliance of the proposed development with relevant zone objectives is summarised in Table 6 below.

Table 6: Stormwater Compliance Assessment: Kempsey Shire Council LEP (1987)

LEP Zone	Relevant Objectives	Development Compliance
Zone 2(a): Residential Zone	To provide areas for low density residential development.	The proposed development is part of a larger land release scheme to make the area available for residential development. The proposed sub-division therefore complies with this objective.
Zone 7 (a): Wetlands Protection Zone	To protect the water quality and supply so that the continuing operation of wetland ecosystems is not jeopardised.	The Stormwater Management Plan for the site considers both water quality and quantity. Modelling has been completed to ensure these characteristics closely reflect that of the existing site (i.e. pre-development).
Zone 7 (b)	To protect the environmental qualities and values of natural habitats.	The protected habitat area to the north of the site has been provided with a 50m buffer to the residential development. The proposed water cycle management plan has been designed to maintain water levels and improve its stormwater quality to ensure no adverse impact on this water-dependant habitat area.
	To permit the roads and services to cross habitat areas in a manner that has minimal adverse impacts on habitat values	There are no roads or associated services proposed to cross the habitat area at the north of the site.

4.1.2 Kempsey Shire Council DCP 36; 'D5 – Stormwater Drainage Design' (2000).

The Kempsey DCP 36 is based on the AUSPEC guidelines for stormwater drainage design. The stormwater treatment and management system for the site has been designed in accordance with these guidelines which gives model input parameters and sizes stormwater treatment structures and their associated construction components.

Kempsey Shire Councils DCP 36: D5 – Stormwater Drainage Design, indicates that where development increases the peak flow rate a detention basin is to be provided to limit the post development flows to be less than or equal to the pre-development flows for all storms up to and including the 1 in 100 year event. **Alternatively**, the downstream drainage system is to be upgraded to accommodate the increase in peak flow rate.

The proposed development area drains to adjacent vegetated lands, thence to Saltwater Creek, thence to Saltwater Lagoon. The only built infrastructure affected by the flows from Saltwater Creek is the road bridge at Phillip Drive over the creek. The stormwater modelling indicates that the increase in flow to Saltwater Creek as a result of development is insignificant compared to the total flow in Saltwater Creek. Additionally, Saltwater Lagoon will serve to attenuate any marginal increases in flow before they reach the bridge at Phillip Drive.

It is therefore concluded that, any increase in flows from the site post-development would be attenuated and would not impact on stormwater infrastructure (primarily the bridge at Phillip Drive).

4.1.3 Flood Planning – WBM Oceanics Flood Study

The WBM Oceanics (2004) Flood Study determined flood levels for the subject site. Further, the LES for the rezoning of the site incorporated the recommendations from the Saltwater Creek and Lagoon Estuary Management Plan recommendation of adopting a 50m buffer to the 3.0 mAHD contour. The adaptation of this setback by the development means the development footprint is clear of 1% AEP flood inundation extent.

4.1.4 Saltwater Creek Estuary Management Plan (Saltwater EMP)

The primary aim of the Saltwater EMP is to achieve an equitable balance between opportunities for future development and ensuring such development does not degrade the natural values of the area. The EMP outlines a number of objectives for future management in the catchment. The objectives relevant to stormwater management and water quality at the site are summarised in Table 7.

Table 7: Development compliance with Saltwater EMP Water Quality objectives

Objective	Compliance
Reduce the existing urban stormwater pollutant loads entering Saltwater Creek and Lagoon.	Stormwater management at the site aims to treat water to a standard that is equal to or better than the existing water quality.
Ensure that the water quality of Saltwater Creek and Lagoon is compatible with the recreational uses of the estuary.	The proposed development will supply runoff to the estuary system which is of equal or better quality than that of the existing and thus have no impact on the current recreational use of the Creek and Lagoon.
Ensure that the contamination of the former oil terminal sites does not degrade the existing or future estuarine environment of Saltwater Creek and Lagoon.	Not applicable. The proposed development will not result in the former oil terminal sites being a source of contamination.
Reduce the impact of on-site sewage treatment systems on the surface water quality of Saltwater Creek and Lagoon.	Not Applicable. The development will be serviced by reticulated town sewer.
Prevent the generation of acidic runoff resulting from activities carried out on potentially acid sulphate soils surrounding Saltwater Creek and Lagoon.	As a risk management measure, an ASS Management Plan will be instigated for works that are proposed at depth of 2m or more.

4.1.5 Protection of Vegetation and Stormwater Management

A portion of the site, towards Saltwater Creek, has been identified as habitat of higher biodiversity value and is to be conserved as a 'Conservation Zone' as part of the rezoning of the site. This zone also contains a SEPP 14 wetland and the Flora and Fauna Study indicates that a vegetation community adjacent to the creek has a structural affinity with the EEC Swamp Schlerophyll Forest on coastal floodplains.

Therefore, water quality and quantity as well as the drainage scheme are a consideration in the development design to ensure that the hydrological regime, nutrient and sediment loads draining to these sensitive areas, do not have an adverse impact. As such, it is important that nutrient and sediment loads from the development are managed.

4.2 Demonstration of Compliance with DGEARs

4.2.1 Hydrological Regime on-site

The identified shallow and variable groundwater table, if not mitigated by engineering works, has the potential to result in: degradation of road pavements; poor drainage; and foundation settlement. To mitigate potential adverse effects a range of works are recommended for the site development. These should include:

- Construction of sub-soil drainage for road pavements to be placed as low in the profile as possible to maximise the moisture stability of sub-grade and pavements. As roads are located adjacent to drainage swales the roadside swales will form the discharge point for pavement sub-soil drains.
- The construction of road drainage swales shall form a series of artificial drains across the site. These will act to limit the rise of groundwater tables on the site.
- Building foundation zones will be drained with sub-soil drainage systems to maximise soil moisture stability. These drainage systems shall discharge to the roadside drainage swales. This is standard engineering practice in areas with shallow groundwater tables, is not expected to have significant water cycle impacts; and is appropriately considered at dwelling construction approval stage.

4.2.2 Hydrological Regime Downstream of the Site

The development of the site will increase impervious areas (roofs, driveways, roads, footpaths etc) thereby potentially reducing the groundwater recharge that would feed the groundwater system.

This effect has the potential to lower groundwater table which will have a number of potential practical and environmental impacts. These impacts have to be assessed in order to determine whether they require to be mitigated. The potential impacts are discussed as follows:

- The lowering of the water table in the development area in regards to protection of road pavements and structures as well as limiting watertable rise that could create potential ponding issues is a positive aspect to site development;
- Impacting the groundwater table downstream of the development area may have adverse effects on water-dependant ecosystems and habitat. This effect would need to be mitigated in the stormwater management system for the site;

- Exposure of acid sulphate soils due to water table lowering is not a concern for depths less than 2m from ground level. An ASS Management Plan would need to be instigated to mitigate effects of lowering the water table more than 2m which would be unlikely as swales and subsoil drains on the site would not exceed this depth,
- Increased saltwater intrusion from Salt Water Lagoon is not a concern as long as the groundwater table depth is maintained in the immediate vicinity downstream of the development area.

A more detailed assessment of the potential for these impacts and the associated amelioration measures are discussed below.

4.2.2.1 *Assessment and Mitigation*

The potential to affect the hydrological regime on downstream habitats is considered an important factor to be mitigated. Mitigation of this impact is proposed through measures that achieve a post development hydrological regime to these areas which is comparable to the pre-development regime, with the volume of groundwater infiltration being maintained through Water Sensitive Urban Design Measures (WSUD) such as the provision of infiltration and bioretention swales and flow spreading and downstream wetland at 'end of line' rather than a pit and pipe system. Detailed analysis of the effect of the proposed development on the rates of runoff and infiltration (groundwater recharge) on the site has been completed using the MUSIC modelling package.

This analysis investigated the effectiveness of a number of measures that would be incorporated into the drainage design for the site to ensure an acceptable post development outcome. These measures are designed to ensure a post development hydrogeological regime in downstream habitat areas to maintain the pre-development regime. The following mitigation measures are recommended to ameliorate potential impacts on downstream habitats:

1. The provision of grassed swales in road reserves to increase the infiltration of stormwater runoff (compared to a pit and pipe solution) thus balancing the loss of infiltration capacity from increased runoff from impervious surfaces. A site drainage system utilising swales has the effect of recharging of groundwater systems and therefore retaining existing flow regime to habitat downstream of the site.
2. Installation of an infiltration / surface flow spreading structure at the end of the two main drainage swales conveying stormwater through the site from upstream catchments.

4.2.2.2 Net impact

By maintaining the overall rate of groundwater recharge through the utilisation of the WSUD measures outlined above the potential hydrogeological impacts on downstream vegetation are appropriately mitigated. It is important to note that the relative differences between volumes of surface flow and groundwater are not critical on this site as the two systems are closely linked due to the shallow groundwater table, the relatively permeable soils and the measures employed to recharge the groundwater throughout the site.

This means that any redistribution of water from the surface flow regime to the shallow groundwater regime does not constitute a loss of water to the downstream eco-systems. Rather it simply alters the mode of delivery of this water to these systems.

4.2.3 Flood Management

A Flood Study was carried out by WBM Oceanics (2005) which identified the 1 in 100 yr flood extents for the site. The Estuary Management Plan for Saltwater Lagoon identified the 3.0 mAHD contour plus a 50m buffer as an appropriate development extent line to ameliorate effects on the downstream receiving waters and habitats.

This buffer provides an appropriate freeboard for the development to the 1 in 100 yr ARI flood level.

For the purposes of risk mitigation it is recommended that a flood planning level be set for the site at 3.7 mAHD being 0.5 m above the local 1% AEP flood inundation level determined by WBM. The FPL should be adopted as the minimum floor level for any habitable rooms in future developments on the site.

Flood levels determined by WBM Oceanics (2005) also shows that the site has connectivity to the South West Rocks area via Belle O'Conner Drive during the 1% AEP. This therefore provides egress for occupiers from the site during such an event.

Keeping these management measures in mind, the proposed development complies with the provisions in the NSW Floodplain Development Manual as follows;

- The development design utilises the merit approach to comply with the Flood Prone Land Policy by recognising flood prone areas of the site. In accordance with this policy, FPL's have been set to provide a 0.5m freeboard above the 1% AEP flood level. The principles of ecologically sustainable development (ESD) and future impacts of climate change have also been considered.

- Effective floodplain risk management has been applied to the development design by considering and managing the three (3) types of flood risk as follows;
 - **Existing flood risk:** There is currently no development to manage on flood prone lands
 - **Future flood risk:** Future flood prone lands have been identified and appropriate FPL's set to 0.5m above the 1% AEP level. The site has connectivity with South West Rocks during this event allowing site egress.
 - **Continuing flood risk:** In the case of rarer events (e.g. the PMF) we recommend Belle O'Conner Drive levels be set at a minimum of 4.5 mAHD to allow for continued egress from the site in all events including the PMF.
- A thorough Flood Study has been completed by WBM Oceanics (2005) and determines hydrologic aspects, as well as water levels, velocities, hazard categories (in accordance with the Floodplain Management Manual, 2005) and controlling features (namely the sand berm and Phillip Drive Bridge). These factors have all weighed in selecting FPL's.
- The purpose of this report is to draw together the results of the above study and thus provide a Floodplain Risk Management Study which provides flood management options.
- In accordance with the Floodplain Development Manual, the developer has sought the advice from a number of experts in the field to identify potential impacts and provide mitigation options.

4.2.4 Effect of Climate Change Induced Sea Level Rise and Rainfall Pattern Change.

Sea level rise and changes to rainfall patterns are considered to be likely results of greenhouse gas induced climate change. Consideration of the impacts of these in future development is considered necessary. Sea level rise impacts on the site would be limited to downstream conditions for the local drainage system as the increased water levels will be insufficient to cause widespread site inundation. Similarly, changes to rainfall patterns may impact site hydrology.

WBM Oceanics modelling found that Phillip Drive Bridge is the hydraulic control for the Saltwater Creek flood regime upstream of the bridge and, therefore, the subject site for most events. Analysis completed assumed a downstream boundary condition out to the ocean of 2.5m (sand berm height). Current predicted sea level rise over 100 years varies from 0.18 to 0.91m (DECC, 2007) depending on the parameters adopted.

Assuming a 0.91 m increase above the mean high water summer solstice (MHWSS) sea level of 0.986 mAHD the resultant MHWSS with climate induced sea level rise may be as high as 1.9 mAHD. This is still below the outlet height considered in modelling (with sand berm crest height at 2.5 mAHD), and therefore the modelling demonstrates that the bridge remains the hydraulic control for flood levels on the subject site irrespective of climate change induced sea level rise which is therefore considered not to pose additional risks to the proposed development.

Review of DECC (2007) indicated that increased rainfall intensity of the order of 5 – 10% is possible for the Northern Rivers area (this is in the lower end of the state wide range of up to 29%). WBM (2004) indicated the 1% AEP flood passed 150m³ to the ocean. As only approximately 1/3 of the catchment is upstream of the site it is estimated 50m³/s passes the site.

Assuming a 10% increase in this flow, an additional 5m³/s may pass the site. Given a flood flow width of approximately 250m (from Figure 6.18 of WBM, 2004) and flood velocities of approximately 0.1m/s (Figure 6.18 of WBM, 2004) the rise in flood levels is 200mm. This possible future increase in flood levels as a result of changed rainfall pattern will be readily accommodated with the provided 500mm freeboard between the 1% AEP level and the adopted site FPL.

5 Stormwater Management

5.1 Stormwater and Water Quality Modelling

A number of models and software packages were used to assess the stormwater treatment and management system and confirm it satisfies relevant water quality and water quantity criteria. These models are discussed below.

- DRAINS – DRAINS has been used to analyse site hydrology and to design road side swales.
- MUSIC – has been used to evaluate a pre- and post-development pollutant loads from the site. The performance of the stormwater management system was investigated and refined to achieve specified water quality objectives. In particular this model was used to assess the hydrological impact on the downstream wetland/vegetation area at the north of the site and on the water quality implications of the development.
- RAFTS – XP RAFTS was used to assess the impact of the development on catchment flows and to assess the case for on-site detention systems.

6 Stormwater Quantity

6.1 Drainage Overview

6.1.1 Off-Site Catchments

Two upslope catchment areas drain through the site from the south of Belle O'Conner Street. It is proposed that these flows be conveyed through formed grassed swales sized for the 1 in 100 year ARI peak flow. These swales will be designed so as to facilitate the infiltration of stormwater into the groundwater aquifer to ensure adequate recharge of the groundwater table beneath the wetlands to the north and will also provide water quality improvement prior to discharge.

6.1.2 Roadside Drainage Swales

The stormwater management system for the site includes roadside drainage swales designed to convey site runoff to the main drainage swales traversing the site. Grassed swales are proposed for drainage as a water sensitive urban design system which acts as a water quality treatment and facilitates infiltration into the subsurface groundwater system.

6.1.3 Outlet Structures

The two major drainage swales traversing the site will discharge to the downstream wetland areas through level spreaders. These evenly disperse and control upslope flows and allow a portion of flow to infiltrate into the groundwater prior to reaching sensitive downstream habitats. The provision of appropriately design outlet structures shall ensure that sensitive receiving environments are not adversely impacted by the larger magnitude, low frequency storm events.

Detailed design of the outlet structures will need to ensure the prevention of scour and erosion and will serve to provide the natural dispersion and infiltration of stormwater into the wetland areas. The detailed design of the two level spreader structures will be developed at construction certificate stage.

6.1.4 OSD

On-site detention (OSD) is used in development to attenuate development induced increases in flows where downstream assets are potentially impacted. The stormwater modelling demonstrates that the proposed development shall have negligible impacts on downstream ecological systems and no significant impact on downstream infrastructure.

The modelling also demonstrates that localised increases in downstream flows (immediately downstream of the site), are attenuated through the passage of flows through saltwater creek and saltwater lagoon prior to reaching any downstream infrastructure (being Phillip Drive bridge) and adjacent caravan park. Minor changes in the hydrology of infrequent major events shall not affect the site's receiving environments as ecological systems are reliant on the hydrology of the more frequent small events, which contribute 99.5% of long term average flows to the system (BMT WBM, 2007), and overall availability of water resources, which do not change.

Therefore, it is concluded that OSD is not necessary on the site, as the minimal increase in flow from major, infrequent storms will not adversely impact downstream ecological systems and, in accordance with Council's DCP 36, OSD is not required as any local flow increases do not impact on downstream infrastructure. The overall water balance is not significantly affected as the groundwater is recharged through a suite of proposed WSUD measures.

6.1.5 Hydrological Effect

The stormwater management system has been designed to maintain ecologically relevant aspects of the hydrological regime of downstream EECs, riparian areas and the Saltwater Lagoon system.

Minor frequent storm events are identified by BMT WBM (2007) *Saltwater Lagoon and Creek Catchment Stormwater Management Strategy* as contributing 99.5% of long term average flows to the system. Total flows (via surface and shallow sub-surface flow paths) from these events to the downstream environments are not significantly altered by the development through the implementation of WSUD measures, therefore, it can be concluded that these receiving environment's ecological qualities shall not be compromised.

Infrequent storm events do not generally impact on the environmental quality of receiving environments except where excessive flow concentration and velocities result in localised scour and erosion. Design measures to mitigate these potential impacts include level spreaders and appropriate outlet energy dissipation devices.

The system has been designed to maintain an adequate water supply to downstream environments through the combination of surface and shallow groundwater flows. The system of swales and level spreaders facilitate the infiltration of excess generated stormwater thus maintaining groundwater levels. Swales shall maintain surface water flows to adjacent vegetation, control high velocity flows and provide water quality treatment to appropriate pre-development levels.

6.2 Swale Design

6.2.1 DRAINS Model Set-up

A DRAINS model was utilised to size the roadside swales and major swales for the development. The model was based on 10 sub-catchments. These sub-catchments were then further subdivided into smaller sub-catchments to determine individual road swale width requirements. Both the 20 year and 100 year ARI events were considered for design purposes.

For the purposes of swale and road design, the following design parameters have been used;

1. Swales are located on one side of the road only.
2. There is a minimum horizontal distance of 1.0 m between the top of bank and edge of road pavement.
3. Swale side slopes have been designed to be 1 (V) in 5 (H).
4. Pavement centre line is located on the road reserve centre line.
5. Swales have been designed to contain the 1 in 5 year flow.
6. An additional 2.5 m of adjoining gutter flow together with the swale contain the 1 in 100 year flow.
7. Roads have been assumed to have a single crossfall towards the swale.

6.2.2 DRAINS Results

DRAINS modelling was used to create the roadside swale network. Swale widths ranging from 2.0 m to 5.5 m are required with corresponding centre line depths of 200 – 550 mm. Table 7 provides swale sizes for each sub-catchment to accommodate the 1 in 100 ARI event.

Table 7: Drains Results: Minimum Swale Requirements

	Catchment	Minimum Swale Depth/Width (m) to Hold 100 yr ARI
Roadside Swales	1	0.55/5.5
	3	0.40/4.0
	4	0.35/3.5
	5	0.35/3.5
	7	0.30/3.0
	8	0.55/5.5
	9	0.50/5.0
Major Drainage Swales	2	0.87/15.0

Note: Assumes 3.5m wide verge on upslope side of road for services and footpath.

In addition to the above, peak velocities, depths and depth by velocity product resulting from the 1 in 100 year ARI critical duration storm were analysed for each of the main trunk drainage swales within the sub-division, to check their compliance with Kempsey Shire Council (2000) stormwater drainage guidelines. These guidelines state that the maximum allowable depth by velocity product for overland flow paths is 0.60 m²/s. Results of these analyses are summarised in Table 8 below.

Table 8: Drains Results - Maximum flow depth, velocity and depth by velocity product per swale.

Catchment	Maximum Depth of Flow in Swale in 1 in 100 year ARI (m)	Maximum Flow Velocity in Swale in 1 in 100 year ARI (m/s)	Maximum Depth by Velocity Product in Swale in 1 in 100 year ARI (m ² /s)
1	0.59	0.60	0.35
2	0.82	1.15	0.94 ¹
3	0.37	0.89	0.33
4	0.40	0.64	0.26
5	0.45	0.89	0.40
6	0.65	1.14	0.73 ¹
7	0.40	0.91	0.36
8	0.62	0.98	0.60
9	0.52	0.56	0.29

Note: ¹. Flow depth by velocity product considered to be acceptable as both swales from catchments do not spill over sub-division roads.

From the above results, it may be seen that the maximum depth by velocity product in each of the main trunk drainage swales adjacent to sub-division roads is less than or equal to 0.60 m²/s, with the exception of swales draining catchments 2 and 6. The depth by velocity product for the swales draining catchments 2 and 6 is considered to be acceptable however, as the peak flows in these two swales are contained within the swales and do not spill onto adjacent site roads.

6.3 Stormwater Retention

6.3.1 RAFTS Model Set-up

A RAFTS hydrological model was developed to determine the increase in stormwater flows due to proposed development, compare them with pre-development flows, and to ascertain whether there is a requirement for onsite detention (OSD).

A summary of the inputs used in the RAFTS model is provided in: Table 9 (catchment details); Table 10 (link details); Figure 4 (model layout) and in the context of topographic base mapping in Attachment F. The model is described as follows:

1. The site is modelled as two separate nodes for both existing and developed conditions. Site catchments were approximately 11.03 ha and 14.91 ha respectively. Existing site conditions were modelled as 100% pervious surface area, whilst developed conditions assumed approximately 50% of the site surface area was impervious and the remainder pervious.
2. Each site catchment has an upstream catchment which is routed through the proposed site drainage swales (for the post-development model).
3. Lag times (travel times for the peak flow from catchments to travel the length of the reach / link between catchments) on links between catchments were determined based on measured creek channel distances and assumed flow velocities.
4. Wider catchment areas draining to the inlet of Saltwater Lagoon and to Saltwater Creek upslope of the Phillip Drive bridge
5. Saltwater Lagoon with an assumed capacity of approximately 145 ML in addition to standing water within the lagoon. All additional flows were assumed to spill from the lagoon once flows reached the lagoon through a 20 m wide broad outlet channel.
6. Approximate values of impervious and pervious areas of each catchment based on aerial photos and previous site investigations.

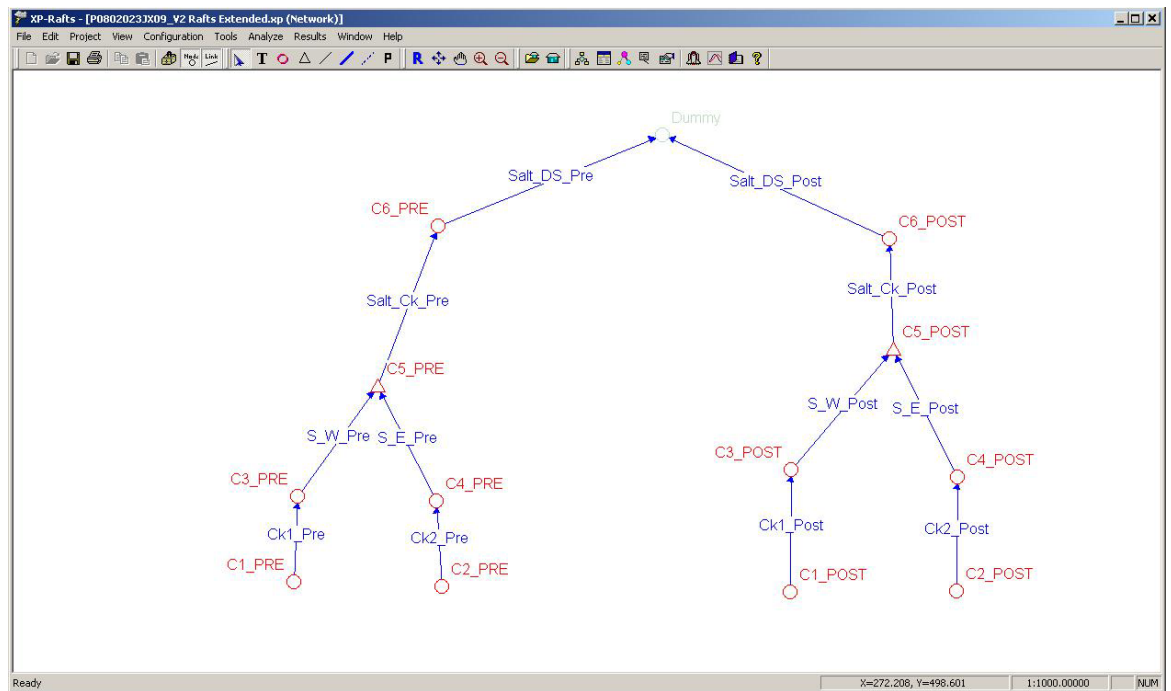


Figure 4: RAFTS model layout.

Table 9: RAFTS model catchments for the Saltwater Creek catchment.

Catchment	Description	Area (ha)	Impervious Area (%)	Average Catchment Slope (%)
PRE-DEVELOPMENT				
C1_Pre	Catchment upslope of western half of site	39.20	5.0	4.7
C2_Pre	Catchment upslope of eastern half of site	36.29	1.0	2.2
C3_Pre	Western half of site	11.03	0.0	0.6
C4_Pre	Eastern half of site	14.91	0.0	0.8
C5_Pre	Catchment of Saltwater Creek to the entrance of Saltwater Lagoon	447.46	8.5	5.0
C6_Pre	Catchment of Saltwater Creek to Phillip Drive	242.61	4.9	3.7
POST-DEVELOPMENT				
C1_Post	Catchment upslope of western half of site	39.20	5.0	4.7
C2_Post	Catchment upslope of eastern half of site	36.29	1.0	2.2
C3_Post	Western half of site	11.03	48.1	0.6
C4_Post	Eastern half of site	14.91	49.7	0.8
C5_Post	Catchment of Saltwater Creek to the entrance of Saltwater Lagoon	447.46	8.5	5.0
C6_Post	Catchment of Saltwater Creek to Phillip Drive	242.61	4.9	3.7
Dummy	Dummy node placed into model to allow existing and developed catchments to be analysed simultaneously	0.001	0.0	1.0

Table 10: Details of links used in RAFTS modelling of Saltwater Creek catchment.

Link	Description	Approximate Distance to Downslope Catchment (m)	Adopted Lag Time (mins)
Ck1_Pre	Swale through western half of site	320	10.7
Ck2_Pre	Swale through eastern half of site	240	8.0
S_W_Pre	Saltwater Creek to entrance of Saltwater Lagoon	1250	41.7
S_E_Pre	Saltwater Creek to entrance of Saltwater Lagoon	720	24.0
Salt_Ck_Pre	Saltwater Creek between Saltwater Lagoon and Phillip Drive	1600	53.3
Salt_DS_Pre	Saltwater Creek downslope of Phillip Drive	n/a	0.0
Ck1_Post	Swale through western half of site	320	10.7
Ck2_Post	Swale through eastern half of site	240	8.0
S_W_Post	Saltwater Creek to entrance of Saltwater Lagoon	1250	41.7
S_E_Post	Saltwater Creek to entrance of Saltwater Lagoon	720	24.0
Salt_Ck_Post	Saltwater Creek between Saltwater Lagoon and Phillip Drive	1600	53.3
Salt_DS_Post	Saltwater Creek downslope of Phillip Drive	320	0.0

6.3.2 RAFTS Results

RAFTS modelling results for the 1 in 20 year and 1 in 100 year ARI storm events for both the pre- and post-development conditions are summarised in Table 11. The critical storm duration for the Saltwater Creek catchment to Phillip Drive was 3 hours, most likely due to the attenuation effects of Saltwater Lagoon on shorter duration storm events. The critical storm duration for the subject site was found to be 2 hours.

Table 11: Summary of RAFTS modelling results for the Saltwater Creek catchment including the subject site.

Catchment	1 in 20 year ARI Peak Flow Rate (m ³ /s) ¹			1 in 100 year ARI Peak Flow Rate (m ³ /s) ¹		
	Pre-dev	Post-dev	Change	Pre-dev	Post-dev	Change
C1	5.67	5.67	0.00	7.60	7.60	0.00
C2	4.25	4.25	0.00	6.01	6.01	0.00
C3	6.55	7.06	0.51 (7.8%)	8.80	9.65	0.85
C4	5.62	5.80	0.18 (3.2%)	8.00	8.21	0.21 (2.6%)
C5	19.03	19.20	0.17 (0.9%)	27.83	28.04	0.21 (0.8%)
C6	40.89	41.28	0.39 (1.0%)	42.33	42.99	0.66 (1.6%)

Notes: ¹. Peak flow rate arising from the catchment critical duration 3 hour storm event. Peak flow rates for the subject site are greater for the 120 minute duration storm events.

RAFTS modelling shows that discharge of stormwater from the proposed development to the Saltwater Creek system (i.e. C3 and C4) without OSD results in minor local increases in flow. Attenuation of these increased flows through other catchments effects and passage through the large retarding basin of Saltwater Lagoon mean that at the Phillip Drive bridge development effects are minimal (1.0 – 1.6 % of total flows). The increases in flow during major, infrequent storm events are shown to be minimal and therefore attenuation of flows on the site is not necessary.

Importantly, analysis shows that the modelled change in water levels within Saltwater Lagoon are extremely small being 4.1 mm and 4.3 mm for the 1 in 20 and 1 in 100 yr ARI events respectively. These modelled changes are all considered to be within the RAFTS model's margin of error and indicate effectively no change.

6.3.3 Council OSD Requirements

In accordance with Council requirements, as there is little or no effect on downstream drainage infrastructure DCP 36 does not require the inclusion of site OSD within the development.

6.4 Receiving Environment Hydrology Impact

MUSIC modelling was used to assess the impact of the proposed development on long term average surface flows to the downslope environments. Modelling indicated that the existing (i.e. pre-development) stormwater flow to downslope areas was decreased by approximately 32% under the site development plan. This is due to an increase in stormwater infiltration to the shallow groundwater table (as allowed by the swale network) which more than negates increased runoff resulting from impervious areas. This transfer of flows to the shallow sub-surface system does not reflect a loss in water supply to

downstream environments, but rather a change in its passage downstream.

As the surface and groundwater systems are intrinsically connected at the site (see Section 3.2), the change in surface water hydrology shall not detrimentally affect water supply to downstream environments. Water infiltrated by swales enters the shallow groundwater system and remains accessible to downstream vegetation thus having negligible impact.

To manage any possible localised effects of urbanisation such as increased instantaneous flows swale outlets are designed to spread the stormwater flows over a wide area. This shall dissipate energy so that outlet velocities do not result in a risk of erosion associated with point discharges.

Modelling indicates that the proposed development shall result in a slight increase in storm flows for major, infrequent storm events. It is noted that these contribute a small proportion (0.5% BMT WBM, 2007) of the total catchment flow to Saltwater Lagoon and therefore have a minimal effect on the lagoon ecosystem. These result in a modelled level increase of 4.1 - 4.3 mm in the lagoon (1 in 20 and 100 yr ARI storms respectively) which is considered to be within the resolution of the model's accuracy and is considered negligible. This confirms the conclusion of Section 6.1.4 that OSD is not required to attenuate development flows.

7 Stormwater Quality

7.1 Water Quality Objectives

In accordance with the objectives for future management as detailed in the Saltwater Lagoon Estuary Management Plan, water quality modelling was undertaken to satisfy the requirement that the post-development water quality be equal to or better than the pre-development water quality entering downstream areas.

7.2 Treatment Train Philosophy

The stormwater quality treatment strategy for the site incorporates a number of stormwater quality improvement devices (SQIDs) configured in series to form a 'treatment train'. The treatment train philosophy focuses on water conservation, 'at source' control, and 'end of line' control to ensure treatment objectives are satisfied. The individual SQIDs are outlined in the following sub-sections.

7.2.1 Swales

A network of roadside swales and two main drainage swales that traverse the site are used to direct flow to downstream receiving waters. These structures shall provide water quality treatment through the removal of suspended solids and nutrients. These also allow for considerable infiltration of stormwater into the subsurface system thus allowing additional capture of pollutants by the swale.

7.2.2 Flow Spreader

A flow spreader is proposed to be used as an 'end of line' treatment structure on the main swale at the outlet of catchment 6 (Attachment D). Native endemic macrophytes and wetland vegetation species are to be used within this structure to assist in filtering out nutrients and sediments prior to stormwater discharge to the adjacent conservation zone. The flow spreader will aid in dissipating flow energy prior to its release over a larger area.

7.3 MUSIC Modelling

7.3.1 Model Overview

The MUSIC model was utilised to generate the pre- and post-development water quality impacts to ensure water quality objectives were achieved through the use of proposed water quality treatment system.

7.3.2 Model Set-up

The following set-up and parameters were used in the pre- and post-development MUSIC models;

- A pre-development model consists of 3 catchment areas: the site; and 2 upslope catchments.
- The post-development model consists of 10 sub-catchments, with each sub-catchment consisting of a contributing urban area; road area; and a treatment swale area. The 2 upslope catchments flow into swales.
- Areas for contributing catchments are provided in Table 12 (pre-development) and Table 13 (post-development)
- Pollutant concentrations from the Australian Runoff Quality handbook (ARQ) are used for the pre- and post-development models (Table 14).
- Swale discharge from catchment 6 passes through a treatment wetland area.
- Attachment E provides the MUSIC layouts for pre- and post-development models.

Table 12: Pre-Development MUSIC areas

Contributing Area	Area (Ha)	% Impervious
'Site'	26.570	1
Upslope Catchment 2	39.520	20
Upslope Catchment 6	34.680	4

Table 13: Post-Development MUSIC areas¹

Sub-Catchment	Lot Area (Ha)	Roads Area (Ha) ²	Swale Area (Ha) ³
1	2.10	0.44	0.05
2	5.07	1.50	0.30
3	0.76	0.39	0.05
4	0.82	0.34	0.04
5	0.82	0.35	0.04
6	3.83	1.31	0.25
7	0.84	0.37	0.04
8	2.73	1.05	0.13
9	0.87	0.37	0.06
10	0.6	0.00	0.00

Notes: ¹ 'Upslope Catchments of 39.52 and 34.68 ha flow to Swales 2 and 6 respectively; ² Roads area in MUSIC = road reserve area – swale area; ³ Modelled swale area is half the actual roadside swale length x average width to account for the progressive inflow of stormwater.

Table 14: Pre- and post-development ARQ categories.

Model	MUSIC node	ARQ Category
Pre-	Site Pre-Development	"Forest"
	Upslope Catchment 2	"Forest"
	Upslope Catchment 6	"Forest"
Post-	Urban nodes	"Urban: Residential"
	Roads nodes	"Urban: Roads"

7.3.3 Water Quality Results

Water quality results are described for the following paramaters;

- Pollutant load.
- Pollutant concentration.

Pollutant load allows comparison with the targets set out for Saltwater Creek and Lagoon, as stated in the Saltwater EMP. These targets call for

developments to have no net increase in pollutant/nutrient loads. Similarly, the EMP sets water targets as equal to or better than the existing water quality. The model was run to include drainage swales and wetlands as water quality treatment structures. Optimal post-development pollutant concentrations are achieved (Table 14) through the provision of a wetland (flow spreader) at the outlet of catchment 6 (Attachment D and the MUSIC layout in Attachment E). This flow spreader shall have a surface area of approximately 750m² and a design depth of 200mm and shall have the dual effect of spreading flows into the downstream wetland area and water quality improvement.

Table 15: Pre- versus post-development (treatment provided)

Parameter	Pre-Development (kg/yr)	No Treatment (kg/yr)	With Treatment (kg/yr)	% Load Reduction (pre vs with treatment)	Criteria Met (Y/N)
Suspended Solids	32 100	75 300	5 660	82	Y
Phosphorus	125	190	43	65	Y
Nitrogen	531	1 070	474	11	Y
Flow	501 ML/y	616 ML/y	339 ML/y	32	Y

Results in Table 15 indicate that the inclusion of drainage swales and the flow spreader at the end of catchment 6 satisfies the performance objective of achieving 'neutral or beneficial' (i.e. post-development is equal to or less than the pre-development) pollutant discharge outcomes. Modelling indicates that the inclusion of the swales also result in a decrease in runoff, however as discussed earlier, this reduction can be attributed to an increase in groundwater recharge, not water that is lost from the system. Therefore, there is no net change to the water resource available to downstream ecosystems. To appropriately balance the water quality and flow maintenance objectives the wetland has been assumed to be lined to reduce infiltration of flows.

Previous hydrogeological studies and the site investigations carried out by Douglas Partners (2007) and Jellife (2000) indicated that the implementation of infiltration measures such as trenches and swales, and end-of-line water quality treatment ponds could be successfully implemented on the site. This has been attributed to the site's hydrogeological profile and composition of soils. These measures shall ensure maintenance of the groundwater table and hydrological regime, for the protection of downstream water bodies such as Saltwater Creek and Lagoon, as well as vegetation communities. It is

therefore concluded that the proposed subdivision development (with the recommended water treatment measures) is unlikely to cause any significant long term change to the hydrology of the local site.

8 Development Impact Mitigation

8.1 Water quality

The design of the bioremediation system achieves the targets set for the site, i.e. that the post development water quality is equal to or better than that of the pre-development quality.

8.2 Water Quantity

The surface and sub-surface flow systems are intrinsically connected at the site due to the shallow groundwater table. Although, as a result of the proposed development, results of modelling predicts surface flow to reduce overall by approximately 32%, this can be accounted for by the fact that groundwater infiltration has increased (rather than the reduction being as a result of water 'lost' from the system). As such, the net effects are considered negligible and of little impact to the surrounding environment.

Analysis of the catchment response concluded that changes to peak design flows at the catchment outlet at Phillip Drive bridge will be marginal (ie 1.0 – 1.6 %) as a result of the proposed development. Modelling indicates that water levels within Saltwater lagoon shall remain unchanged (modelled difference of 4.1 and 4.3 mm are within the models margin of error).

8.3 Flooding

The footprint of the proposed development has been designed such that, in accordance with recommendations made in the Saltwater Creek Flood Study (WBM Oceanics, 2006), it is above the 1 in 100 year flood extent. In addition to this, a 50m buffer has been provided to ameliorate effects on the downstream receiving waters and habitat. This buffer also sets the development extent for the site free of flood effects.

The potential impacts of climate change induced sea level rise have been considered in site development. Assuming a 0.91m sea level rise (worst case over 100 years based on DECC, 2007), the post-climate change mean high water summer solstice water level would be 1.9 mAHD. Such a level is 0.6 m below the modelled outlet condition for Saltwater Creek (i.e. the predicted sand berm crest height). It is concluded that the current hydraulic control (Phillip Drive Bridge) on the Saltwater Creek system will control the flood levels at the site even with the consideration of sea level rise and shall effectively buffer the

Saltwater Lagoon system and therefore the flood levels affecting the subject site from predicted sea level changes.

8.4 Drainage Configuration

The proposed drainage configuration for the site has been designed to ensure groundwater recharge and conveyance of flows from the site into Saltwater Creek (and subsequently Saltwater Lagoon).

Roadside swales convey surface flows from hardstand areas towards Saltwater Creek while still allowing infiltration into the groundwater. This way, the groundwater dependant ecosystem and the SEPP 14 wetlands within the conservation zone are not adversely affected.

Major grassed swales traverse the site and convey flow from upstream catchments across the site and into the Saltwater Creek and Lagoon ecosystem. These swales also facilitate infiltration of surface flows into the groundwater system during low flow events. The outlet structures control these flows to prevent erosion and scouring and evenly spread flows to prevent any adverse effect on the surrounding habitat area, whilst maintaining the existing flow regime to downstream environmentally sensitive areas.

8.5 SEPP 14 Wetlands Protection

The proposed drainage system outlined above and throughout this report protects the SEPP 14 wetlands as follows;

1. Roadside swales allow infiltration from hardstand areas to the aquifer. By preventing any significant impact on groundwater systems, the SEPP 14 wetlands are protected.
2. The outlet structures (flow spreaders and energy dissipaters) ensure that during high flow events (i.e. storm events) scour and erosion of SEPP 14 wetlands does not occur.
3. The proposed bioremediation system for the site achieves water quality targets and so protects downstream environments, including the SEPP 14 wetlands from water quality related degradation; such as eutrophication.

8.6 Monitoring

Monitoring of downstream receiving environments shall occur during the construction phase and during the revegetation establishment phase (up to 6 months after development is completed). We recommend the monitoring principles, outlined in Table 16, be included as part of the consent conditions:

Table 16: Schedule of Monitoring to Occur During the Construction and Revegetation Establishment Phase.

Monitoring	Action	Frequency
Water Quality Monitoring	Water quality monitoring shall occur at the each of the site's discharge points and at a location downstream, within Saltwater Creek. Parameters to be monitored include; • pH • Temperature • Dissolved Oxygen • TN, TP and SS • Turbidity	Monitoring shall occur at each location monthly during the construction phase and quarterly during the establishment phase.

All monitoring and subsequent maintenance works are to be carried out and completed by a suitably qualified contractor. Water quality monitoring is to be undertaken in accordance with the Australian Standard and the terms of the Laboratory NATA accreditation.

9 Conclusions and Recommendations

9.1 Overview

The integrated water cycle management plan developed for the site brings together the results of the stormwater quantity and quality assessment, hydrogeological assessment and flood analysis to form an overall water management plan which satisfies performance standards adopted for the site being a neutral or beneficial impact on the system.

The recommendations made below are considered best practice sustainable engineering solutions and satisfy the principles of Water Sensitive Urban Design and specific performance standards of Council.

9.2 Components of Site Water Management System

From modelling results the following treatment structures have been recommended to sustainably manage stormwater at the site:

1. Road side swales - included on the site to safely and effectively convey flows to downstream wetlands and receiving waters; provide a means to infiltrate increased runoff into the groundwater table; and for water quality treatment.
2. Two main swales (Swale 2 and 6) are proposed to direct drainage from upslope catchments (catchment 2 and 6) across the site and into receiving waters. As with road side swales, these also provide groundwater replenishment and significant water quality treatment.
3. Flow Spreader - proposed to provide an 'end of line' treatment structure at the end of Swale 6. This structure will remove nutrients and suspended solids and shall provide for the even distribution of flows over a wide area before discharging into the downstream habitat and receiving waters.
4. Sub-soil drains – provided to manage episodically shallow groundwater and protection road pavements and other assets from adverse impact.

9.3 Conclusion and Management Outcomes

Outcomes of flooding, stormwater and water quality results together form the integrated water cycle management plan for the site. Assessment of the performance of these components of the water cycle management plan conclude that:

- Hydrological analysis of the existing site has shown that the shallow groundwater table is a site constraint that requires to be managed. The proposed development shall, by design, impact on site groundwater levels. The development also has potential to impact on surface runoff volumes and water quality if not appropriately managed.
- To mitigate the impact on the downstream hydrological regime water management systems are proposed to achieve a regime which maintains or improves that of the existing environment.
- Two (2) 'major' grass swales shall divert upslope catchment drainage to downstream receiving waters whilst providing water quality treatment.
- Road side swales of varying sizes will collect stormwater from road and pavement areas and divert these flows to downstream wetlands and receiving waters and sensitive habitats. Both roadside and major swales have been sized to appropriately convey the 20 year (in swale) and 100 year (swale plus gutter flow) ARI events.
- The swales also act as 'at source' water quality treatment devices and allow for infiltration into the groundwater table underlying the site. This infiltration ensures the aquifer in lands downstream from the site is appropriately recharged.
- By providing swales which allow for groundwater infiltration, resulting stormwater flows are considered to adequately reflect that of the existing environment. A 32% component of surface flow (as indicated in MUSIC result) is recharged into the groundwater infiltration. As surface and groundwater flows are intrinsically connected at the site, this impact is considered acceptable.
- Modelling results indicate that the provision of an artificial wetland (with a surface area of 750m²) will further treat stormwater from catchment 6 thus achieving a total site outcome which satisfies the 'neutral or beneficial' pollution reduction objectives.

- The addition of the flow spreader at the outlet from swale 6 shall also serve to distribute flows over a wider area which shall reduce potential impacts that may arise from the concentration of flows at the outlet.
- Assessment of peak flow velocities from site swales indicates that proposed swales will adequately convey the peak 1 in 100 year ARI flows from the sub-division to areas downslope of the subject site.
- Results indicate a significant improvement in post-development water quality (compared to pre-development) when swales and the artificial wetland are provided. This treatment train therefore effectively manages stormwater at the site in a sustainable fashion to ensure the underlying aquifer and surrounding water-dependant ecosystems are not negatively impacted or degraded.
- Assessment of site flooding information indicates a design 1 in 100 yr ARI flood inundation level of 3.2 mAHD applies to the site. FPL's have been set at 1% AEP level plus 0.5 mAHD to place the entire development footprint outside the flood zone.
- The Estuary Management Plan recommended a development extent of 50 m from the 3.0 mAHD contour. This extent has been adopted for development planning.
- Modelling of the proposed water management measures determined that there would be negligible change to the downstream hydrology of Saltwater Creek. Post-development levels within the Lagoon would effectively not be changed as a result of the development and there is minimal downstream infrastructure downstream of the site no OSD is therefore required for the site in accordance with DCP 36.
- The results of modelling for the individual components of this assessment together form this integrated water cycle management plan.
- Incorporation of the recommended water cycle management plan and its components into the site design, will satisfy relevant Council requirements and objectives with the proposed site development constituting ecologically sustainable development.

Connell Wagner Pty Ltd (2007) 'South West Rocks LES Investigations: Detailed Wallum Froglet Study'.

Connell Wagner Pty Ltd (2007) 'Kempsey Shire Council: *Saltwater Development Area; Phillip Drive & Belle O'Conner Street, South West Rocks. Local Environmental Study*'.

Connell Wagner Pty Ltd (2005) 'Flora and Fauna Report; South West Rocks LES. Kempsey Shire Council.'

Douglas Partners (2007) 'Report on Hydrogeological Assessment: Proposed Residential Subdivision off Phillip Drive, South West Rocks.'

Hackett Laboratory Services Pty Ltd: Acid Sulphate Soils testing: 07/01/2003

Kempsey Shire Council (October 2000) *Aus-Spec-1-D5 Stormwater Drainage Design*.

Kendall and Kendall (2003) *Vegetation Mapping* in 'Saltwater Developments Area; Phillip Drive and Belle O'Conner Street, South West Rocks: Local Environment Study' (Connell Wagner, 2007)

WBM Oceanics Australia (2006) 'Estuary Management Study and Plan: Saltwater Creek and Lagoon; South West Rocks.'

WBM Oceanics Australia (2006) 'Saltwater Creek Flood Study: Final Draft Report'.

11 **Attachment A – Site Plan and Catchment Plan**



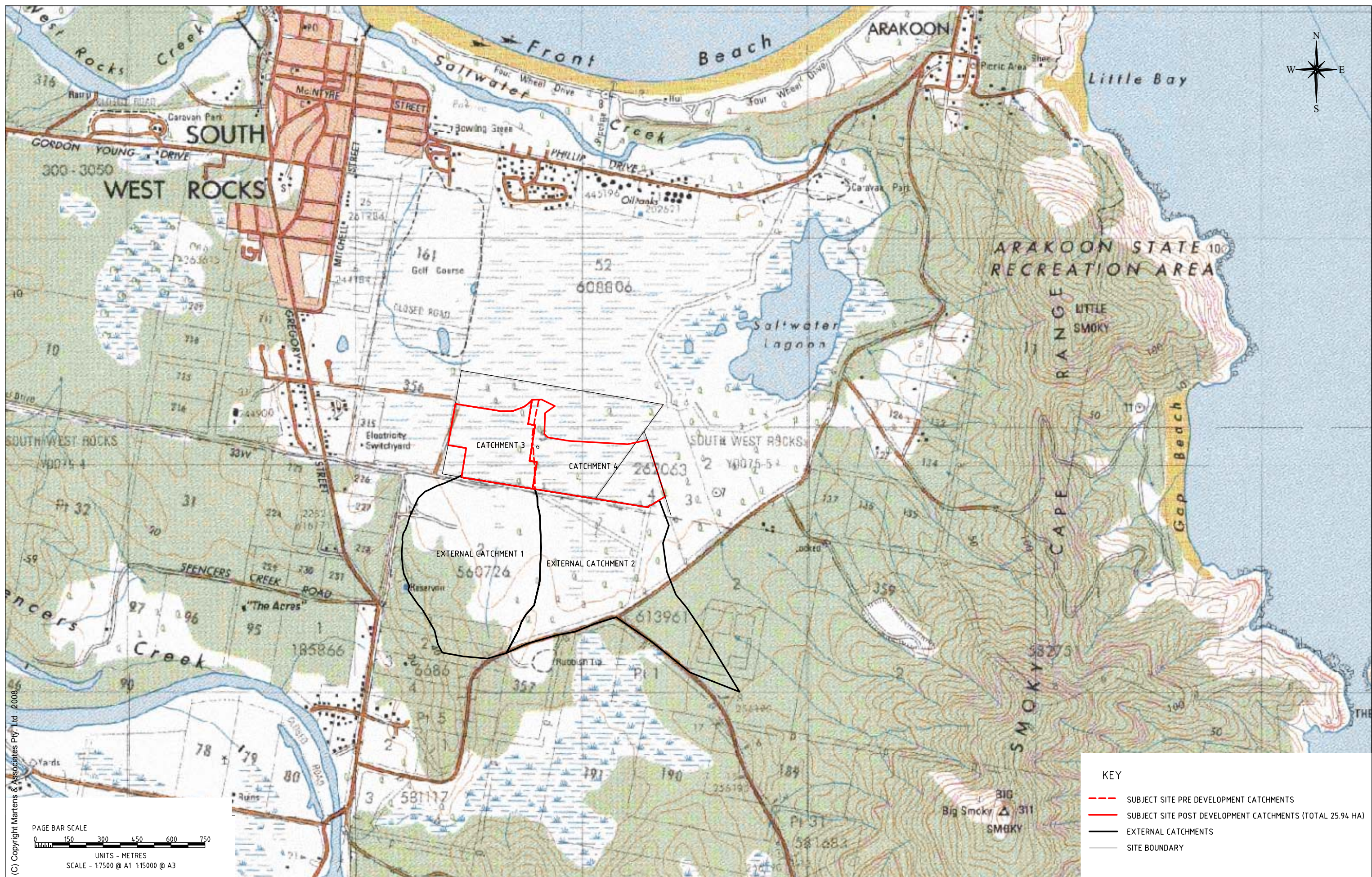
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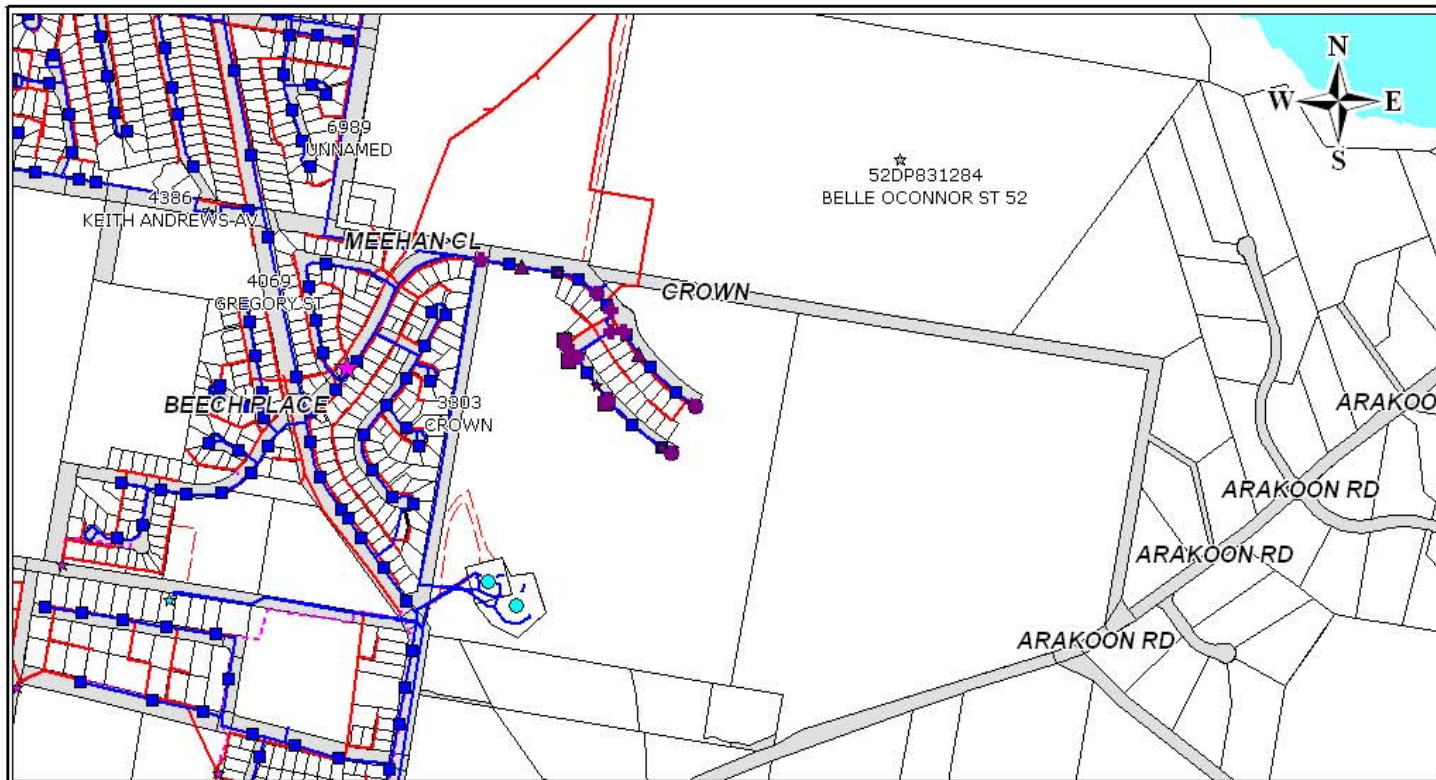
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CLIENT/ PROJECT		TITLE		DESIGNED:	DATUM:	SHEET 1 OF 1 SHEETS	REV.	DESCRIPTION	DATE	ISSUED
MALBEC PROPERTIES PTY LTD		SITE PLAN AND PREVIOUS TESTING LOCATIONS BY CONSULTANTS: PROPOSED SUBDIVISION, SOUTH WEST ROCKS, NSW.		MLB	mAHd		1.0	ENGINEERING SERVICES REPORT	14.05.2008	MLB
				DRAWN:	HORIZONTAL RATIO:	PAPER SIZE:	2.0	AMENDED	29.10.2008	MLB
				MLB	1:1250 @ A1 1:2500 @ A3		3.0	FINAL AMENDED	29.01.2009	MLB
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	DRAWING NUMBER: P0802023JD04_V3	REVIEWED: AN	VERTICAL RATIO: 1:1250 @ A1 1:2500 @ A3					



12 **Attachment B – Dial Before You Dig Results**



DISCLAIMER

There is no warranty that the data on this map does not contain errors and Macleay Water shall not be liable for any loss, damage or injury suffered by the user or any other person consequent upon the existence of errors.

No guarantee as to the accuracy of the data is given.

LEGEND

SEWER

- Sewermain
- Risingmain
- ★ Pump Station
- Manhole
- RECYCLED WATER**
- Watermain
- ▲ Air Valve
- Hydrant
- ★ Flushing Valve
- + Stop Valve

WATER

- Watermain
- ★ Pump Station
- ★ Production Bore
- Reservoir
- Hydrant
- + Stop Valve

MACLEAY WATER

**DIAL
BEFORE YOU DIG
WATER AND SEWER
LOCALITY PLAN**



FOR FURTHER ENQUIRIES
Councils Customer First Centre
Phone No 6566 3200



DUTY OF CARE



IMPORTANT:

- Please read and understand all the information and disclaimers provided below.
- Sketches and Plans provided by Telstra are circuit diagrams only and indicate the presence of telecommunications plant in the general vicinity of the geographical area shown; exact ground cover and alignments cannot be given with any certainty and cover may alter over time. Telecommunications plant seldom follow straight lines and careful on site investigation is essential to uncover and reveal its exact position.
- Due to the nature of Telstra plant and the age of some cables and records, it is impossible to ascertain the location of all Telstra plant. The accuracy and/or completeness of the information can not be guaranteed and, accordingly Telstra plans are intended to be indicative only.

"DUTY OF CARE"

When working in the vicinity of telecommunications plant you have a legal "Duty of Care" that must be observed. The following points must be considered:-

1. It is the responsibility of the owner and any consultant engaged by the owner, including an architect, consulting engineer, developer, and head contractor to design for minimal impact and protection of Telstra plant. Telstra will provide free plans and sketches showing the presence of its network to assist at this design stage.
2. It is the owner's (or constructor's) responsibility to:-

a) Request plans of Telstra plant for a particular location at a reasonable time before construction begins.

b) Visually locate Telstra plant by hand digging (pot-holing) where construction activities may damage or interfere with Telstra plant (see "Essential Precautions and Approach Distances" section for more information).

c) Contact Telstra's **Network Integrity Group** (see below for details) if Telstra plant is wholly or partly located near planned construction activities.

DAMAGE:

ANY DAMAGE TO TELSTRA'S NETWORK MUST BE REPORTED TO 132203 IMMEDIATELY.

- The owner is responsible for all plant damage when works commence prior to obtaining Telstra plans, or failure to follow agreed instructions.
- Telstra reserves all rights to recover compensation for loss or damage to its cable network or other property including consequential losses.

CONCERNING TELSTRA PLANS:

- **Phone 1100 - Dial Before You Dig** for free plans of Telstra plant locations. Please give at least 2 business days notice.
- Telstra plans and information provided are **valid for 60 days** from the date of issue.
- Telstra retains copyright in all plans and details provided in conjunction with your request. These plans and or details should be disposed of by shredding or any other secure disposal method after use.
- Telstra plans or other details are provided for the use of the applicant, its servants, or agents, and shall not be used for any unauthorised purpose.
- Please contact the **Network Integrity Help Desk** (see below for details) immediately should you locate Telstra assets not indicated on these plans.
- Telstra, its servants or agents shall not be liable for any loss or damage caused or occasioned by the use of plans and or details so supplied to the applicant, its servants and agents, and the applicant agrees to indemnify Telstra against any claim or demand for any such loss or damage.
- Please ensure Telstra plans and information provided remains on-site at all times throughout your construction phase.

ESSENTIAL PRECAUTIONS and APPROACH DISTANCES:

NOTE: If the following clearances cannot be maintained, please contact the Network Integrity Help Desk (see below for details) for advice on how best to resolve this situation.

1. On receipt of plans and sketches and before commencing excavation work or similar activities near Telstra's plant, **carefully locate this plant first** to avoid damage. Undertake prior manual exposure such as potholing when intending to excavate or work **closer** to Telstra plant than the following approach distances.

- Where Telstra's plant is in an area where road and footpaths are well defined by kerbs or other features a minimum clear distance of 600mm must be maintained from where it could be reasonably presumed that plant would reside.
- In non established or unformed reserves and terrain, this approach distance must be at least 1.5 metres.
- In country/rural areas which may have wider variations in reasonably presumed plant presence, the following minimum approach distances apply:
 - a) Parallel to major plant: 10 metres (for IEN, optic fibre and copper cable over 300 pairs)
 - b) Parallel to other plant: 5 metres
- Note: Even manual pot-holing needs to be undertaken with extreme care, commonsense and employing techniques least likely to damage cables. For example, orientate shovel blades and trowels parallel to the cable rather than digging across the cable.
- If construction work is parallel to Telstra plant, then careful hand digging (pot-holing) at least every 5m is required to establish the location of all plant, hence confirming nominal locations before work can commence.

2. Maintain the following minimum clearance between construction activity and **actual location** of Telstra Plant.

Jackhammers/Pneumatic Breakers	<i>Not within 1.0m of actual location.</i>
Vibrating Plate or Wacker Packer Compactor	<i>Not within 0.5m of Telstra ducts. 300mm compact clearance cover before compactor can be used across Telstra ducts.</i>
Boring Equipment (in-line, horizontal and vertical)	<i>Not within 2.0m of actual location. Constructor to hand dig (pot-hole) and expose plant.</i>
Heavy Vehicle Traffic (over 3 tonnes)	<i>Not to be driven across Telstra ducts (or plant) with less than 600mm cover. Constructor to check depth via hand digging.</i>
Mechanical Excavators, Boring and Tree Removal	<i>Not within 1.0m of actual location. Constructor to hand dig (pot-hole) and expose plant.</i>

- All Telstra pits and manholes should be a minimum of 1.2m in from the back of kerb after the completion of your work.
- All Telstra conduit should have the following minimum depth of cover after the completion of your work:-
- **Footway 450mm**
- **Roadway 450mm at drain invert and 600mm at road centre crown**
- For clearance distances relating to Telstra pillars, cabinets and RIMs/RCMs please contact the Network Integrity Help Desk (see below for details).

FURTHER ASSISTANCE:

Over-the-phone assistance can be obtained by calling the **Network Integrity Help Desk**.

Where on-site location is provided, the owner is responsible for all hand digging (pot-holing) to visually locate and expose Telstra plant.

If plant location plans or visual location of Telstra plant by digging reveals that the location of Telstra plant is situated wholly or partly where the owner plans to work, then **Telstra's Network Integrity Group** must be contacted through the **Network Integrity Help Desk** to discuss possible engineering solutions.

NOTE:

If Telstra relocation or protection works are part of the agreed solution, then payment to Telstra for the cost of this work shall be the responsibility of the principal developer or constructor. The principal developer or constructor will be required to provide Telstra with the details of their proposed work showing how Telstra's plant is to be accommodated and these details must be approved by the Regional Network Integrity Manager prior to the commencement of site works.

RURAL LANDOWNERS - IMPORTANT INFORMATION

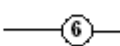
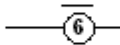
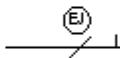
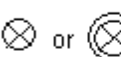
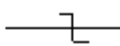
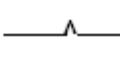
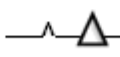
Where Telstra owned cable crosses agricultural land, Telstra will provide a one off free on-site electronic cable location. Please note that the exact location of cables can only be verified by visual proving by pot holing, which is not covered by this service. The Network Integrity Helpdesk Officer will provide assistance in determining whether a free on-site location is required. Please ring the Network Integrity Helpdesk Officer as listed above.

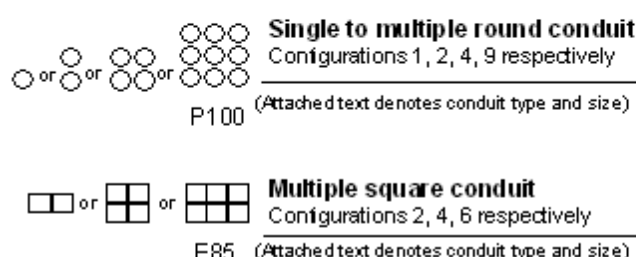
PRIVACY NOTE

Your information has been provided to Telstra by DBYD to enable Telstra to respond to your DBYD request. Telstra keeps your information in accordance with its privacy statement entitled "Protecting Your Privacy" which can be obtained from Telstra either by

A GUIDE TO READING PLANS

Telstra Corporation Limited
ABN 33 05 1775 556

	Exchange (major cable present)		Cable jointing pit (number indicating pit type)
	Footway access chamber (can vary from 1-lid to 12-lid)		Buried cable jointing pit (number indicating pit type)
	Roadway access chamber		Elevated cable joint (above ground joint on buried cable)
	Pillar/cabinet (above the ground / free standing)		Cable loop (direct buried)
	Above ground complex equipment housing (eg RIM) Please Note: This equipment is powered by 240V electricity.		Telstra Plant in shared utility trench
	Public telephone Please Note: This equipment is powered by 240V electricity.		Aerial Cable (above ground)
	Direct buried cable		Aerial cable (attached to joint use pole e.g. power)
			SMOF Optical fibre cable direct buried



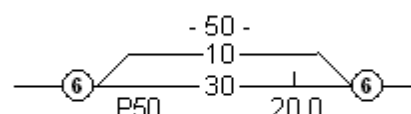
Some examples of conduit type and size:

A - Asbestos cement, P - PVC / plastic, C - Concrete, GI - Galvanised iron, E - Earthenware.

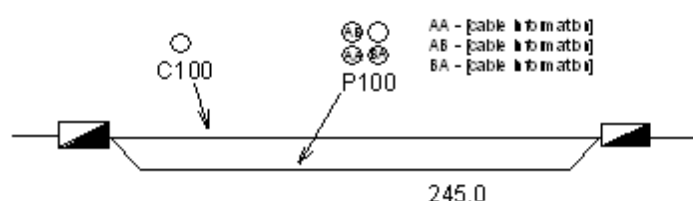
Conduit sizes *nominally* range from 20mm to 100mm.

P50	50mm PVC conduit
P100	100mm PVC conduit
A100	100mm asbestos cement conduit
E 85	85mm square earthenware conduit

Some examples of how to read Telstra plans:



One 50mm PVC conduit (P50) containing a 50-pair and a 10-pair cable between two 6-pits, 20.0m apart, with a direct buried 30-pair cable along the same route.



Two separate conduit runs between two footway access chambers (manholes) 245m apart. A nest of four 100mm PVC conduits (P100) containing assorted cables in three ducts (one being empty) and one empty 100mm concrete duct (C100) along the same route.

WARNING: Telstra's plans show only the presence of cables and plant. They only show their position relative to road boundaries, property fences etc. at the time of installation and Telstra does not warrant or hold out that such plans are accurate thereafter due to changes that may occur over time.

DO NOT ASSUME DEPTH OR ALIGNMENT of cables or plant as these vary significantly.

The customer has a DUTY OF CARE when excavating near Telstra cables and plant. Before using machine excavators TELSTRA PLANT MUST FIRST BE PHYSICALLY EXPOSED BY SOFT DIG (potholing) to identify its location.

Telstra will seek compensation for damages caused to its property and losses caused to Telstra and its customers.

ACCREDITED PLANT LOCATERS (For your area)

On-site assistance should be sought from an **Accredited Plant Locator** if the telecommunications plant cannot be located within 2.5 metres of the locations indicated on the drawings provided.

On-site advice should be obtained from a suitably qualified contractor highly skilled in locating Telstra plant if there is any doubt whatsoever about the actual location of the telecommunications plant, the best method for locating the telecommunications plant or the correct interpretation of the drawings provided. In the case where Telstra plant is outside a recognised road reserve Telstra recommends that the **Network Integrity Help Desk** is contacted for assistance prior to engaging an Accredited Plant Locator.

For the assistance of customers Telstra has established strict criteria to assess the skill of contractors that may be engaged by owners requiring Telstra plan locating services to perform any of the following activities if requested to do so by the owner:

- review Telstra's plans to assess the approximate location of Telstra plant;
- advise owners of the approximate location of Telstra plant according to the plans;
- advise owners of the best method for locating Telstra plant;
- advise owners of the hazards of unqualified persons attempting to find the exact location of Telstra plant and working in the vicinity of Telstra plant without first locating its exact position.
- perform trial hole explorations by hand digging (pot-holing) to expose Telstra plant with a high degree of skill, competence and efficiency and utilising all necessary safety equipment.

Telstra has provided a number of contractors with certification as an Accredited Plant Locator.

A list of Accredited Plant Locaters operating in your area is attached. Accredited Plant Locaters are certified by Telstra to perform the tasks listed above. Owners may engage Accredited Plant Locaters to perform these services, however Telstra does not give any warranty in relation to these services that Accredited Plant Locaters are competent or experienced to perform any other services.

The attached list provides the names and contact details for Accredited Plant Locaters who service your area and can provide you with assistance in locating Telstra plant on site. These organisations have been able to satisfy Telstra that they have a sound knowledge of telecommunications plant and its sensitivity to disturbance; appropriate equipment for locating telecommunications plant and competent personnel who are able to interpret telecommunications plans and sketches and understand safety issues relevant to working around telecommunications plant. They are also able to advise you on the actions which should be taken if the work you propose will/could result in a relocation of the telecommunications plant and/or its means of support.

We recommend that you engage the assistance of one of these Accredited Plant Locaters as a step towards discharging your Duty of Care obligations when seeking the location of Telstra's telecommunications plant.

Please Note:

1. The details of any contract, agreement or retainer for site assistance to locate telecommunications plant shall be for you to decide and agree with the organisation engaged. Telstra is not a party to any contract entered into between an owner and an Accredited Plant Locator. The Accredited Plant Locaters are able to provide guidance concerning the extent of site investigations required.
2. Payment for the site assistance will be your responsibility and payment details should be agreed before the engagement is confirmed.
3. Telstra does not accept any liability or responsibility for the performance of or advice given by an Accredited Plant Locator. Accreditation is an initiative taken by Telstra towards the establishment and maintenance of competency standards. However, performance and the advice given will always depend on the nature of the individual engagement.
4. Each Accredited Plant Locator has been issued with a certificate which confirms the Accreditation. Each year Telstra will reassess the accreditation and where appropriate will issue a letter confirming the accreditation for the next calendar year. You have the right to request the organisation you engage to show evidence of this certificate and its currency.
5. The Accredited Plant Locator is required to service each engagement with the personal attendance of at least one accredited employee who has satisfactorily completed a Telstra approved employee accreditation training course. These people will carry a certification card issued by Telstra.
6. Neither the Accredited Plant Locator nor any of its employees are an employee or agent for Telstra and Telstra is not liable for any damage or loss caused by the Accredited Plant Locator or its employees.
7. The attached list contains the current names and contact details of Accredited Plant Locaters who service your area, however, these details are subject to change.

Accredited Plant Locaters:

Name and Address	Phone Number	Ask for:
ABLE2C - Port Macquarie	02 65820355	Steve Roberts - 0411636499 Colin Channell - 0412655130
ADVANCED GROUND LOCATIONS - Newcastle	02 4930 3195	Steve Fraser - 0412 497488 Darren Fraser - 0402 -071617
A.I.D Locations - Newcastle, Hunter	Ph: 02 4960 0800 Fax: 02 4960 0801	Steve Dennis - 0410493827 Brett Furner - 0406422501
Barry Schultz Fibre & Pipe Locations	02 88147233 0416 068 060	Barry Schultz
CABLE & PIPE LOCATIONS - Coffs Harbour.	02 66491234 or 0408 730 430	Shane Buckley
CHRIS BATES AND ASSOCIATES - Maitland	02 4930 5811 OR 0408 427 391	Chris Bates
HUNTER GROUND SEARCH - Newcastle	02 4954 7239	Alan Hunter 0418 684819 Brad Hunter 0438 684819 Scott Hunter 0409 327345
Int-Elect Electrical Pty Ltd	Ph: 02 4947 2333 Mob: 0404 000 441	Mark Gallagher
K & K Directional Drilling - Tamworth	Ph: 02 6762 6424 Fax: 02 6762 6424	Klinton & Kate Williams
MIDCOAST UNDER-ROAD BORING- Stroud	02 4994 5211	Wanda Russell
MURRAY's EARTHMOVING - Tamworth	02 6765 3266 0427 166 486	Col Murray Shane Murray
NEVILLE FRANKLIN ELECTRICAL - Coffs Harbour.	02 66536693 or 0418 660 823	Nev Franklin
NORTH WEST CIVIL- Tamworth	02 67628911 0438914875	Rob Terry
RUBICOF PTY LTD - Cessnock	02 4990 5718 02 4991 2600 (Fax)	John Boesen 0418 683451 Don Hughes 0418 227108 Brian Watton 0418 103 265
RUTHERFORD ELECTRICAL ENGINEERING - Maitland	02 4932 7344	Office staff
SEEK LOCATIONS PTY LTD - Forster.	02 6555 8550 or 0407 256 858 02 65 591617	Brad Rae Brian Hanson
SHOULDERS PASTORAL - Coomba	0265 542062 or 0408 542062	Mark Johnston

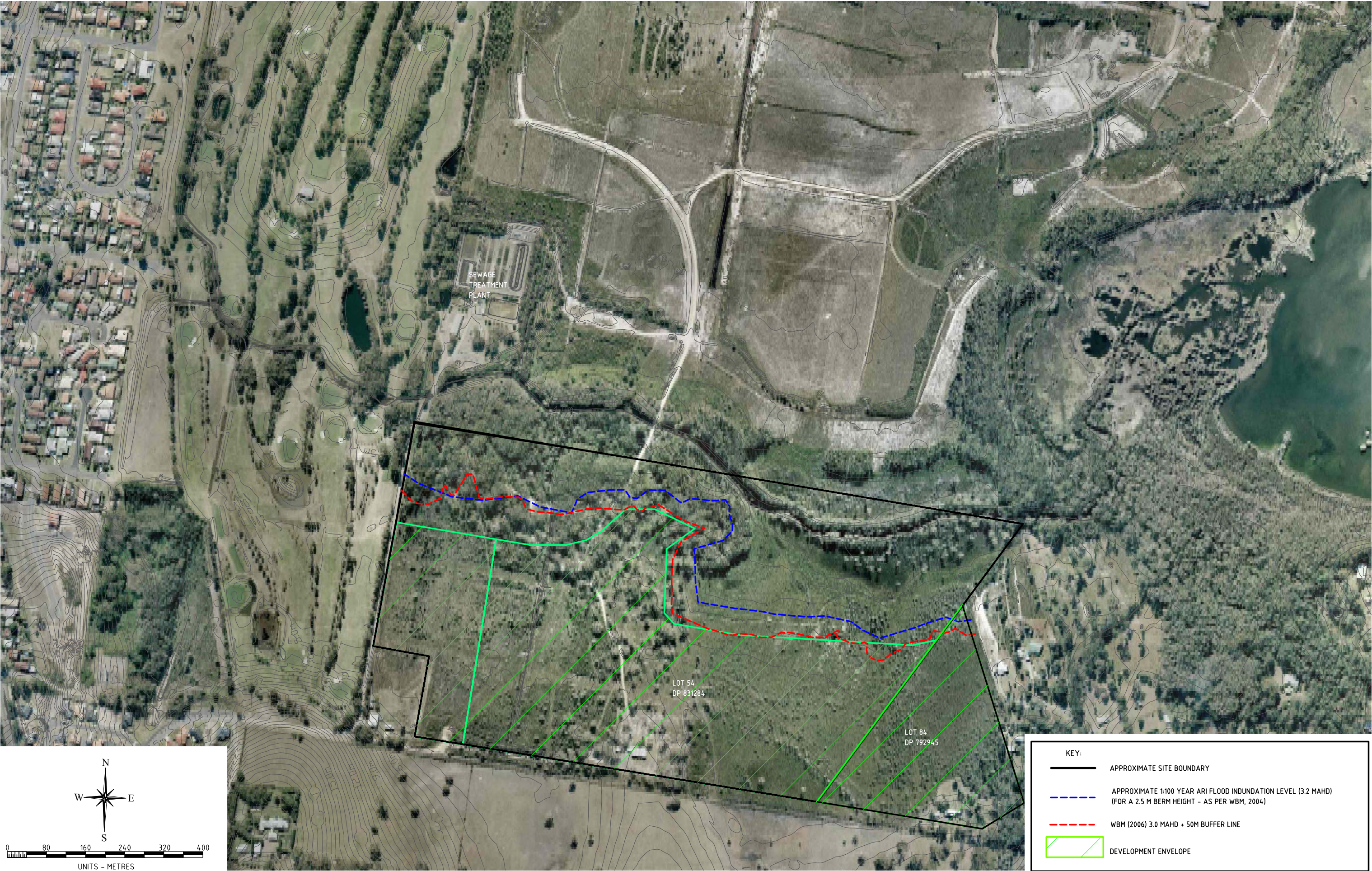
13 **Attachment C – Land Capability Assessment**

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COVER SHEET

1. COVER SHEET
2. FLOOD ASSESSMENT
3. ACID SULPHATE SOILS ASSESSMENT
4. SOIL ERODABILITY ASSESSMENT

 MARTENS & ASSOCIATES PTY LTD Sustainable Solutions Environmental - Geotechnical - Civil Hydraulic - Wastewater Engineers Unit 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	CLIENT/ PROJECT	TITLE		DESIGNED:	DATUM:	SHEET 1 OF 4 SHEETS	REV.	DESCRIPTION	DATE	ISSUED
	MALBEC PROPERTIES PTY LTD	COVER SHEET: LAND CAPABILITY ASSESSMENT		MLB	NA		1	1	LAND CAPABILITY ASSESSMENT	14.05.2008
	THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY All measurements in m unless otherwise specified.	PROJECT MANAGER: MR ANDREW NORRIS	DRAWING NUMBER: P0802023J003_V2	DRAWN:	HORIZONTAL RATIO:	PAPER SIZE: A1 / A3	2	AMENDED	22.10.08	ASN
				MLB	NA					
				REVIEWED:	VERTICAL RATIO:					
				ASN	NA					



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MARTENS & ASSOCIATES PTY LTD
Sustainable Solutions
Environmental - Geotechnical - Civil
Hydraulic - Wastewater Engineers

Unit 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>

CLIENT/PROJECT
MALBEC PROPERTIES PTY LTD
THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY All measurements in m unless otherwise specified.

TITLE
DEVELOPMENT CONSTRAINTS; FLOOD ASSESSMENT PROPOSED RESIDENTIAL SUB-DIVISION, PHILLIP DRIVE, SOUTH WEST ROCKS, NSW.
PROJECT MANAGER: MR ANDREW NORRIS
DRAWING NUMBER: P0802023JD03_V2

DESIGNED:	DATUM:	SHEET	REV.	DESCRIPTION	DATE	ISSUED
MLB/BR/ASN	AHD	2	1	LAND CAPABILITY ASSESSMENT	14.05.2008	ASN
DRAWN:	HORIZONTAL RATIO:	OF 4	2	AMENDED	30.10.08	ASN
MLB/BR	1:5000 @ A3 1:2500 @ A1	SHEETS				
REVIEWED:	VERTICAL RATIO:	PAPER SIZE:				
ASN	1:5000 @ A3 1:2500 @ A1	A1 / A3				

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KEY:

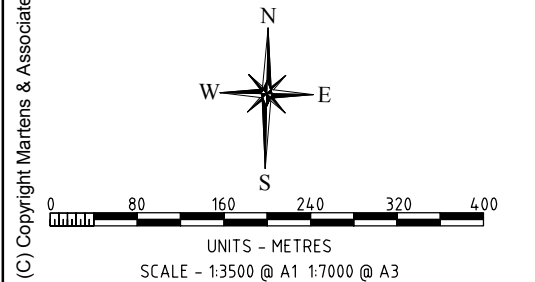
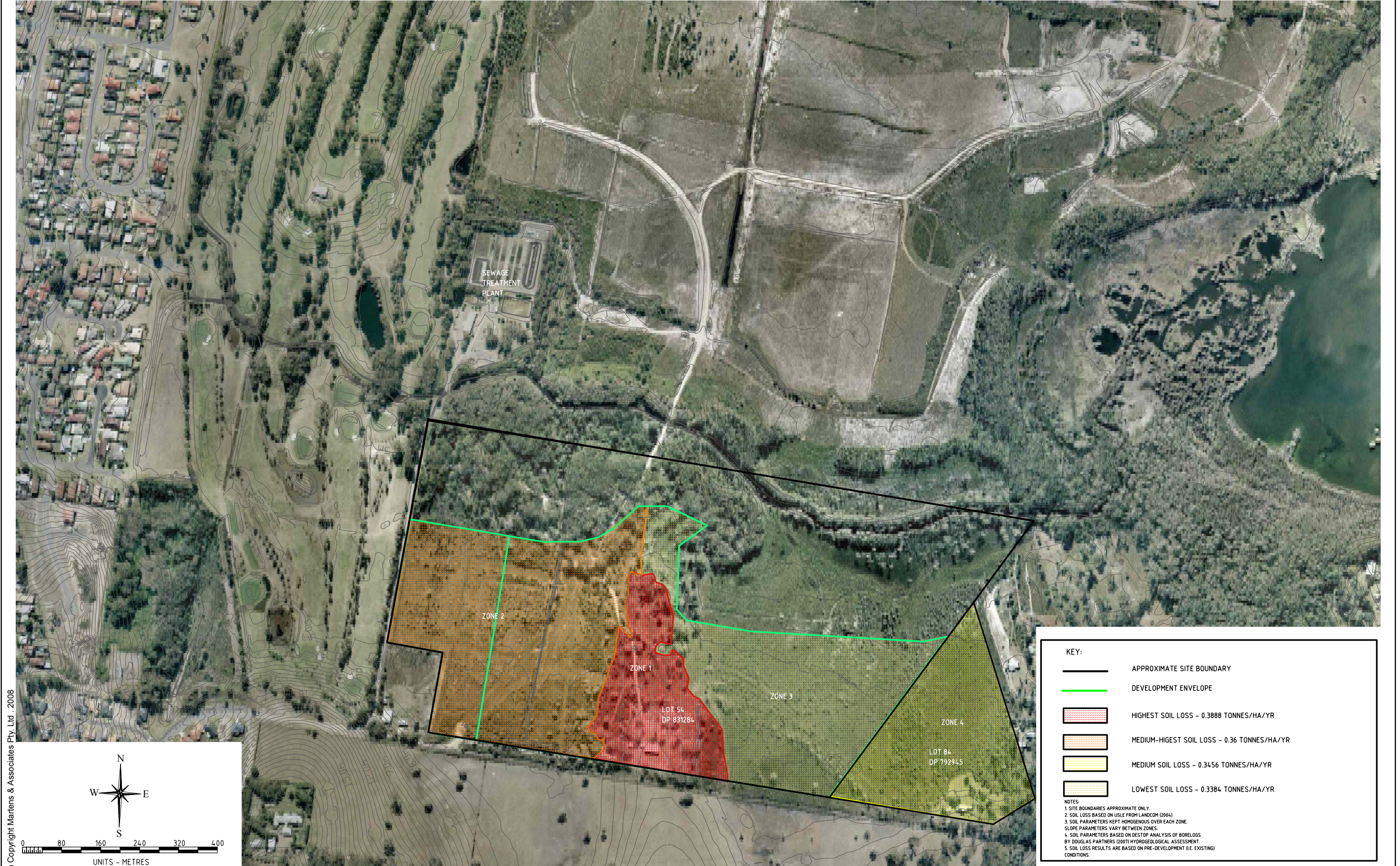
APPROXIMATE SITE BOUNDARY

DEVELOPMENT ENVELOPE

NOTES:
1. SITE BOUNDARIES APPROXIMATE ONLY.
2. ASS AREAS BASED ON NSW NATURAL RESOURCES (2008) AND ARE APPROXIMATE ONLY.

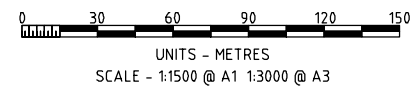
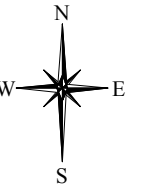
Unit 6/ 37 Leighton Place Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767 Email: mail@martens.com.au Internet: http://www.martens.com.au MARTENS & ASSOCIATES PTY LTD Environmental - Geotechnical - Civil Hydraulic - Wastewater Engineers	CLIENT/ PROJECT MALBEC PROPERTIES PTY LTD	TITLE DEVELOPMENT CONSTRAINTS; ACID SULPHATE SOILS ASSESSMENT PROPOSED RESIDENTIAL SUB-DIVISION, PHILLIP DRIVE, SOUTH WEST ROCKS, NSW.	DESIGNED: MLB	DATUM: AHD	SHEET 3 OF 4 SHEETS	REV.	DESCRIPTION	DATE	ISSUED
						1	LAND CAPABILITY ASSESSMENT	14.05.2008	ASN
						2	AMENDED	22.10.08	ASN
THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY All measurements in m unless otherwise specified.	PROJECT MANAGER: MR ANDREW NORRIS	DRAWING NUMBER: P0802023JD03_V2	REVIEWED: ASN	VERTICAL RATIO: 1:5000 @ A3 1:2500 @ A1	PAPER SIZE: A1 / A3				

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MARTENS & ASSOCIATES PTY LTD Sustainable Solutions Environmental - Geotechnical - Civil Hydraulic - Wastewater Engineers Unit 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	CLIENT/ PROJECT MALBEC PROPERTIES PTY LTD	TITLE DEVELOPMENT CONSTRAINTS; SOIL LOSS POTENTIAL PROPOSED RESIDENTIAL SUB-DIVISION, PHILLIP DRIVE, SOUTH WEST ROCKS, NSW.	DESIGNED: MLB	DATUM: AHD	SHEET 4 OF 4 SHEETS	REV.	DESCRIPTION	DATE	ISSUED
						1	LAND CAPABILITY ASSESSMENT	15.05.2008	ASN
						2	AMENDED	22.10.08	ASN
THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY All measurements in m unless otherwise specified.	PROJECT MANAGER: MR ANDREW NORRIS	DRAWING NUMBER: P0802023JD03_V2	REVIEWED: ASN	VERTICAL RATIO: 1:5000 @ A3 1:2500 @ A1	PAPER SIZE: A1 / A3				

14 **Attachment D – Stormwater Management System**



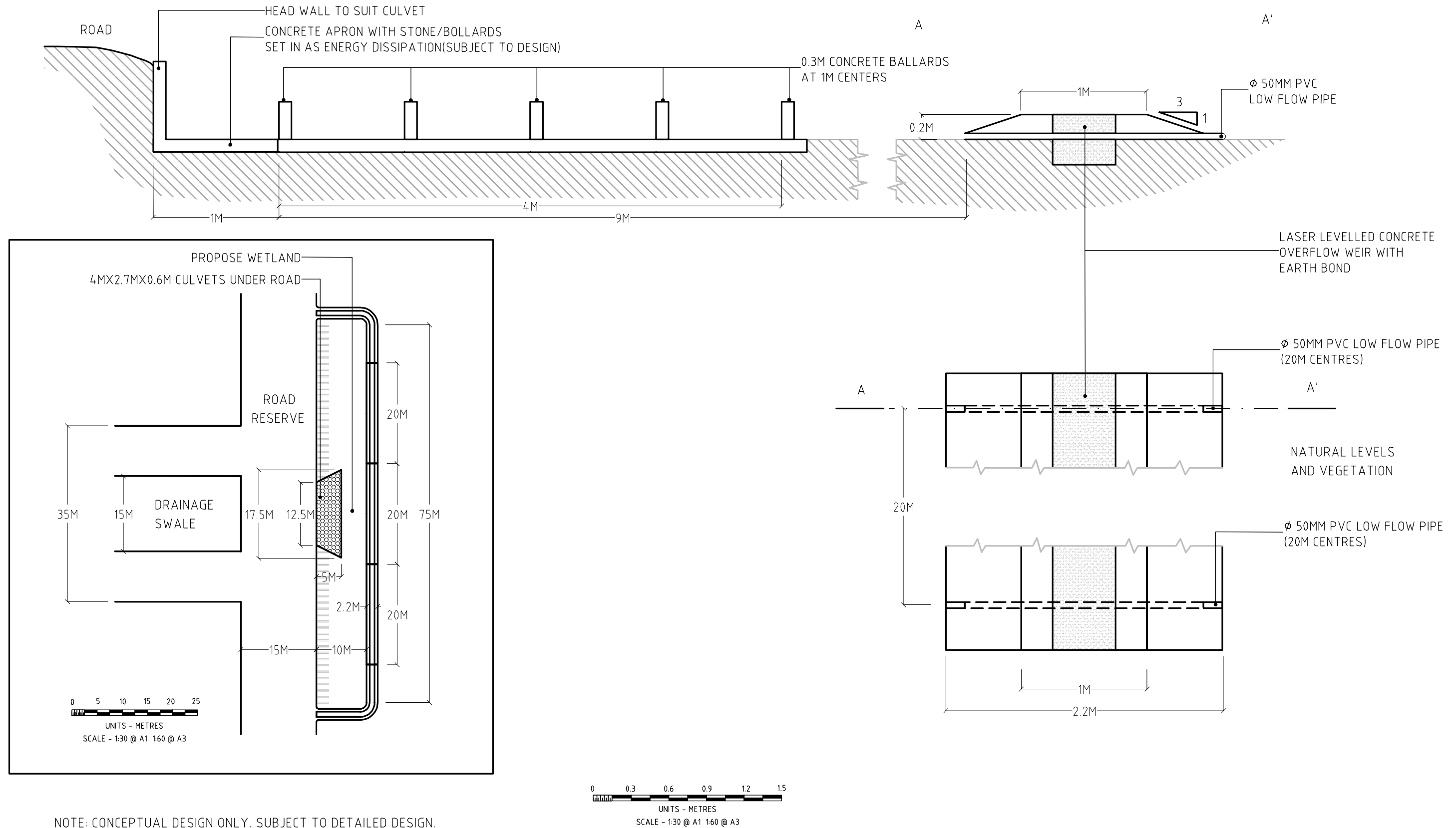
KEY

 GRASSED DRAINAGE SWALE

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 MARTENS & ASSOCIATES PTY LTD Sustainable Solutions Environmental - Geotechnical - Civil Hydraulic - Wastewater Engineers 6/27 Leighton Place Hornsby, NSW 2077 Australia Phone: (02) 9476 8777 Fax: (02) 9476 8767 Email: mail@martens.com.au Internet: http://www.martens.com.au	CLIENT/PROJECT	TITLE		DESIGNED:	DATUM:	SHEET 1 OF 1 SHEETS	REV.	DESCRIPTION	DATE	ISSUED
	MALBEC / SOUTH WEST ROCKS	STORMWATER MANAGEMENT PLAN		MLB/MGD	R.L.		1	1	DRAFT - NOT FOR DISTRIBUTION	02.07.08
	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	DRAWING NUMBER: P0802023JD05_V1_S1	DRAWN:	HORIZONTAL RATIO:	PAPER SIZE: A1 / A3	2	REVISED LOT LAYOUT	25.11.08	ASN
				MLB	1:1500 @ A1 1:3000 @ A3					
				REVIEWED:	VERTICAL RATIO:					
ASN	1:1500 @ A1 1:3000 @ A3									

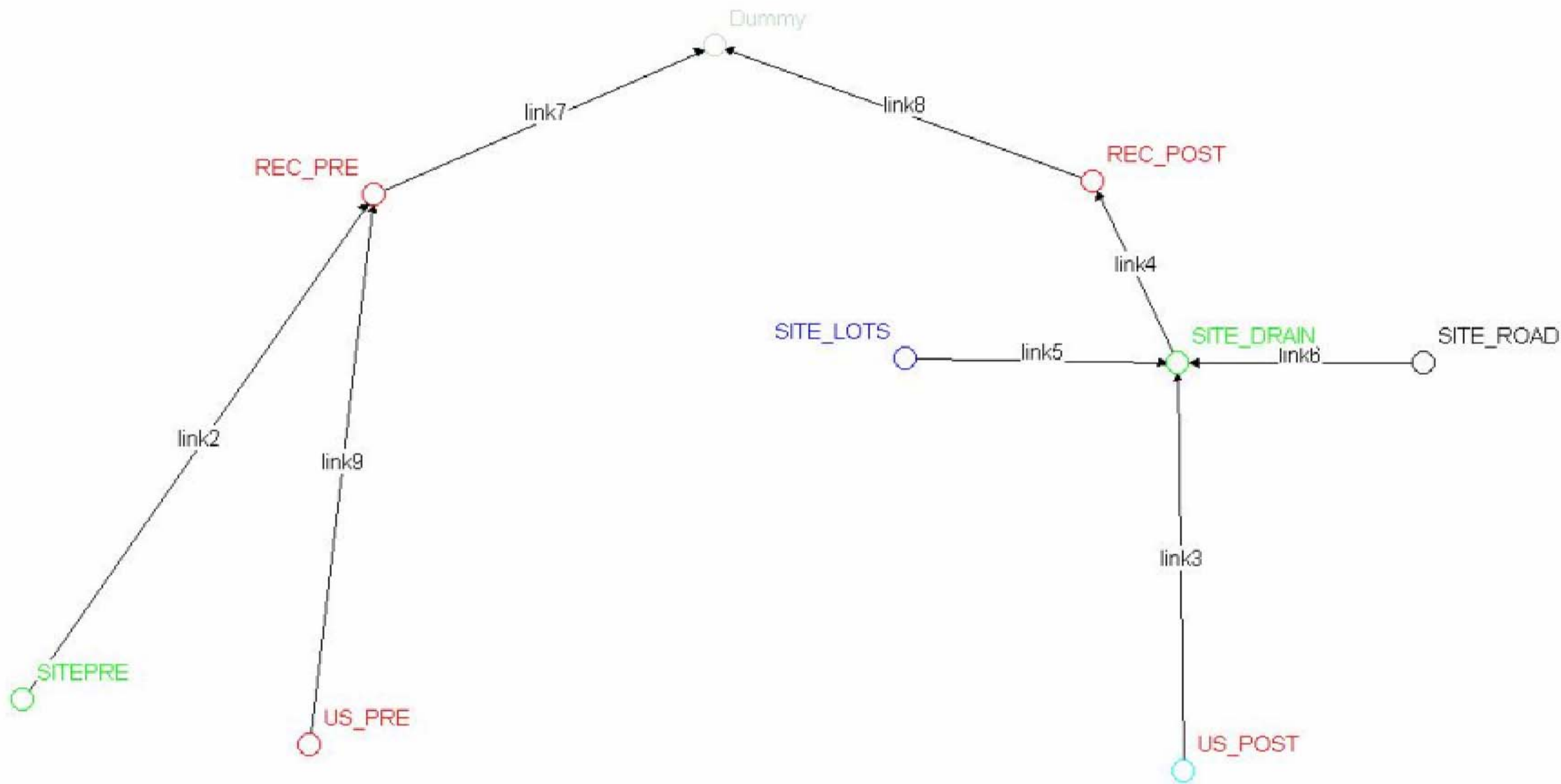
SWALE OUTLET STRUCTURE



NOTE: CONCEPTUAL DESIGN ONLY. SUBJECT TO DETAILED DESIGN.

15 **Attachment E – MUSIC Layout**

16 Attachment F – RAFTS Layout



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REV.	DESCRIPTION	DATE	ISSUED
1	DRAFT: NOT FOR DISTRIBUTION	03.07.08	ASN