Appendix 6

Water Cycle Management Plan

LANDPARTNERS
built environment consultants

2A Carrington Street
PO Box 1134
LISMORE NSW 2480

Tel (02) 6627 5600
Fax (02) 6621 7664

email: lismore@landpartners.com.au
www.landpartners.com.au

URBAN DESIGN • SURVEYING • URBAN PLANNING • ENVIRONMENTAL CONSULTING
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Water Cycle Management Plan

(Including Treatment System Design and Performance Modelling)

For River Oaks Estate – Pacific Highway Ballina, NSW

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John Harper
Environmental Engineer

Bruce Hammond
Senior Civil Engineer

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benchmark IN QUALITY AS/NZS ISO 9001

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The report relies on information supplied by the client and on findings obtained using accepted survey and assessment methodology. Specific survey methodology is described in the relevant section of the report.

While due care was taken during field survey and report preparation, LandPartners accepts no responsibility for any omissions that may have occurred due to the nature of the survey methodology.

Conclusions to the report are professional opinions and LandPartners cannot guarantee acceptance or consent of the relevant determining/ consent authorities.

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1. Introduction

LandPartners Limited ("LandPartners") has been commissioned by PMM Sydney Pty Ltd on behalf of Rayshield Pty. Ltd to undertake a Water Cycle Management Plan assessment of Lots 1, 2, 3 and 5 DP1074242 and part Lot 269 on DP755684 Pacific Highway, North Ballina, regarding the proposed "*Riveroaks Estate*" residential subdivision. The actual subdivision and playing fields are proposed to be occurring on Lots 1, 3 & 5 DP 1074242 whilst drainage and flood way works occur on Lot 2 and the access Link Road traverses both Lot 1 DP1074242 and part Lot 269 DP 755684.

The filling of Lots 1, 3 & 5 DP1074242 and part Lot 269 have been approved under a previous DA 2002/566 with a Construction Certificate for this works issued on 19/12/07. Fig 1 Appendix 1 highlights the approved filling areas on Lots 1, 3 & 5 DP 1074242.

Ballina Shire Council requires a Stormwater Management System (SMS) that maintains nil pollutant load increase during both development and construction activities. To do this LandPartners (LP) has investigated the following issues:

- Stormwater attenuation both pre and post development;
- Stormwater quality and treatment capabilities; and
- The requirements of Council's DCP No13 – Stormwater Management.

1.1 Site Description and Proposal

The proposal site (i.e. Lots 1, 2, 3 and 5 DP1074242 and part Lot 269 DP755684) is located along the Pacific Highway, Ballina in north-eastern New South Wales (NSW). Not with standing the previous approval and issued Construction Certificate for the filling of Lots 1, 3 & 5 DP1074242 and part Lot 269 as noted above, we describe below the natural terrain prior to that filling works commencing.

The Subject Site has a total area of approximately 44.7 ha and is best described as flat land which has recently been predominantly cleared of vegetation under another approval Some Swamp Oak vegetation however still occurs within Lot 269. The area of the site previously approved for filling and noted above is approximately 24 Ha. The Subject Site is currently zoned 2(a) - Residential and 1(d) – Rural (Urban Investigation) in the Ballina Local Environmental Plan (1987). The location of the Subject Site is shown in Appendix 1 Fig 1.

A single dwelling currently occurs on Lot 2. Exiting infrastructure includes powerlines which run in a north- south direction over the proposed playing field area.

The proposed development entails the subdivision of the northern portion of the subject land into 236 residential lots and a child care centre that will potentially provide for up to 269 future dwellings. The layout is shown on Fig 2. The project application seeks project approval for the subdivision of land, the provision of roads (including the Link Road), open space, recreational areas, allocated land for a childcare centre and associated infrastructure, including minor land re-contouring for drainage purposes.

The Subject Site will be accessed from the Pacific Highway via the proposed Link Road which is located partially on Lot 2 DP 1074242 and Lot 269 DP 755684. The proposed intersection to the Highway is subject to a previous consent DA 2002/566 which was

issued by Ballina Shire Council and is not included in this development application. DA 2002/566 approved a road corridor for the proposed Link Road. This application will only refer to the construction of that portion of the Link Road that exists within the aforementioned approved corridor within the development site.

The proposed development which is shown in Appendix1 Fig 2 will also include construction of several internal roads.

A geological assessment of the site indicates that subsurface groundwater was located at depths of approximately 1.0m. The geology is Quaternary alluvium materials overlain by Pleistocene sands.

1.2 Site Drainage

The land prior to filling is generally flat with no defined overland slope variant. Ground heights range from 0.3 in drainage channels and low lying areas to 1.6m AHD. A waterway traverses the site from the sites south western corner, travelling first north east to the northern boundary and then heading generally in a south easterly direction. The water way picks up flows from the Pacific Highway and catchments to the north of the highway at two culvert crossings, directing this water generally in a south easterly direction through the site. The water way exits the site along the south eastern portion of the site and spreads over into the adjoining vegetated lowlands located on adjacent Lots 269 & 268 DP755684. This area then drains into North Creek canal via a single 600mm RCP with flood gate. These drainage channels are shown in Appendix 1 - Fig 1 & Fig 3 – LM070113-CV14C.

The flat grades within the water way are such that water flows only occur when upstream heads overcome both the flat channel grades and any downstream tidal influences.

A man made channel connects to the natural water course at the south west corner of the subject site and travels south along the western boundary of Lot 2. Flow from the natural water course noted above is partially diverted along this man made channel during rain events. This channel discharges into another channel at its southern end through a 600 mm dia RCP with no flood gate attachment. This channel is running generally west to east along the southern boundary of Lot 2 & Lot 1 DP 1003816 and traverses the Council STP until discharging into North Creek Canal through a single 600 mm dia RCP with flood gate.

Drainage into North Creek Canal of all water courses traversing the site is ultimately via the two afore mentioned 600 mm dia. concrete pipes with flood gate attachments. Both of these flood gates are in disrepair and are not operating properly. In particular the northern most flood-gate which drains the low lying areas on Lots 269 & 268 DP 755684 only partially opens during low tide and as such presents a constriction to the effective drainage of these areas.

2. Stormwater Quality

In order to demonstrate compliance with the aim of a "nil pollutant load increase" as described in Section 1 above, the alternative criteria listed in Table 1 of Ballina DCP No13 may also be invoked.

Table 1 – Pollutant Treatment Objectives[1]

Operational Phase

Pollutant	ESD Treatment Objective
Suspended Solids	80% retention of the average annual load
Total Phosphorous	45% retention of the average annual load
Total Nitrogen	45% retention of the average annual load
Litter	Retention of litter greater than 5mm for flows up to 25% of the 1-year ARI peak flow
Coarse sediment	Retention of sediment coarser than 0.125mm for flows up to 25% of the 1 year ARI peak flow
Oil & Grease	In areas with concentrated hydrocarbon deposition, no visible oils for flows up to 25% of the 1-year ARI peak flow

Construction Phase

Suspended Solids	Effective treatment of 90% of daily runoff events (eg. <4-month ARI). Effective treatment equates to a 50%ile suspended solid concentration of 50mg/L
Other pollutants	Limit the application, generation and migration of toxic substances to the maximum extent practicable

The following qualitative objectives are incorporated into the SMS:

- Maximise the potential infiltration of stormwater within individual catchments where feasible.
- Minimise the volume of stormwater flowing off impervious roof areas within private lots and directly into the piped stormwater drainage system.
- Maximise the use of vegetated flow paths.
- Minimise the concentration of overland flows from one property to the next.

In order to address each of the objectives, the following Water Sensitive Urban Design (WSUD) measures and Best Management Practices (BMP's) are proposed for the development:

- A 'Treatment Train' approach.
- The installation of Rainwater tanks.
- Use of natural overland flow and vegetated flow paths in non built-up areas.
- Use of litter racks to remove debris and coarse sediment from conveyed water coming from impervious surfaces.
- Use of flow dissipaters at piped stormwater outlets.

[1] BSC Development Control Plan 13 – Stormwater Management, March 2004

- The use of sedimentation basins pre development and bio retention systems post development.

MUSIC modelling has been undertaken to confirm system performances. Outputs showing mean annual flow loadings pre and post development are given in the tables in the following section.

A "Works Process Strategy for the Management of Stormwater" (WPS) will be developed that will outline monitoring procedures to test whether the works achieve the stated objectives and goals of this "Water Cycle Management Strategy".

3. Stormwater Treatment and Management

This report aims to quantify pre and post development stormwater pollutant export loadings for the proposed development.

3.1 Overview

Urban development consisting of roads, buildings, carparks and pathways results in an increase in the impervious areas associated with the land upon which the development is situated. These surfaces accumulate a range of pollutants during dry periods and then transport them rapidly to receiving waters during rainfall events. As a result, there is the potential for:

1. Site discharge stormwater flow rates to be significantly higher after development; and
2. Increased pollutant volumes coming from the development and causing adverse impacts on downstream water bodies and ecosystems.

Appropriate mitigation measures need to be implemented in order to minimise or eliminate these impacts.

3.2 Assessment of Treatment Devices

Rainwater Tanks

Due to the flat terrain of this site and the difficulties that this causes with maintaining effective drainage and stormwater management, the use of rainwater tanks to attenuate stormwater runoff is recommended. Negligible pollution treatment is considered necessary to be given to roof water, however, with its reuse and containment within rainwater tanks a small percentage of various pollutants can be assumed removed from the overall site runoff. More importantly, the volumes retained on-site are not driving more polluted water through potential treatment features. Due however to the inability to quantify available storage within a rain water tank at the time of a storm event, any attenuating effects have not been included in the modelling.

Sediment / Litter Traps

Sedimentation / litter traps are to be installed within each street stormwater drainage pit and, upstream of the site detention basins. They consist of a removable litter basket that sits in each pit. Its purpose is to trap gross sediment and litter prior to these pollutants entering the final drainage swales and detention structures.

Litter Racks / Pollutant Trap

A litter rack is a treatment device, usually consisting of a series of metal bars located across a channel or pipe, designed to capture coarse sediment, trash and vegetation carried in stormwater. Litter racks trap coarse sediments and debris before they enter an overland flow path, sedimentation pond, or other stormwater treatment device, thereby preserving their capacity and efficiency. Litter and runoff debris is therefore concentrated at a single location for ready removal. These structures will be incorporated at all final site discharge points.

Grassed Swale

All of the overland flow/piped flow from the site will be captured in a number of different grassed swales located throughout the site. Stormwater will be transported via swales through various bio retention systems and eventually offsite. The proposed location of these swales is shown in Appendix 1 - Fig 4.

Water flow and storage in the swale will provide stormwater treatment and will also attenuate stormwater flows. Water that remains after surcharging will seep away. Such storages rely on both biological and physical processes for the treatment of stormwater pollutants.

Sedimentation Basins / Bio-retention Systems

A sedimentation (retention) basin is a water impoundment structure which receives storm water runoff and contains it for a period of time to allow the following purposes to take place:

1. settling the predominantly fine sediment and the pollutants associated with them. The majority of *coarse* sediment such as litter and leaves are to be removed from the stormwater by other methods (e.g. litter racks / pollutant traps) prior to entering the basin;
2. attenuating the storm water flow to match the pre developed site ARI 5yr flows with the post developed 20 yr flow; and
3. providing a discharge mechanism that can disperse the outlet stormwater into overland flow paths/grassed swales.

During the construction phase it is proposed to incorporate a number of sedimentation basins as a part of the site sedimentation and erosion control plan. These basins will be constructed prior to the commencement of bulk earthworks and will be designed to cater for stormwater flows emanating from the site (see Appendix 1 - Fig 3). Stormwater flows from the Pacific Highway will not be treated but will be diverted through and around the site. They will not enter the sedimentation basins.

After construction is completed sedimentation basins will be filled and a number of bio retention systems will be introduced to ensure that post development flows are in accordance with the stated goals of this report (see Appendix 1 - Fig 4).

3.3 Overview of Proposed Stormwater Management

Proposed Treatment Train for the Developed Site

The proposed stormwater treatment train is as shown in Appendix 1 - Fig 4.

Within catchment 1 stormwater will be directed to a bio retention basin within that catchment before discharging into the existing drainage channel along the western boundary of Lot 2.

Catchments 2 and 3 will have stormwater captured and piped to discharge points into a grassed swale located along the southern boundary of Lot 1. Catchment 4 will include a grass swale within the central divided road. This catchment will also direct stormwater into the southern boundary swale. The stormwater from catchments 2, 3 and 4 will then be channelled via this swale into a detention storage device before discharging into drains directing the water in a southerly direction through Lot 2. Detailed design will determine whether to direct this water into the existing drainage channel along the western boundary

of Lot 2 or whether to direct it into a new drain to be created within an easement running north south through Lot 2 and discharging into the low areas on the southern boundary of Lot 2. This second arrangement is detailed in Fig 4.

Catchments 5,6,7,8 and 9 will discharge to the south into the proposed playing fields which will be designed to act as a flood storage basin. Catchment 7 will also incorporate a central grass swale running north south within the central divided road. From the playing field / detention basin the stormwater will discharge to the north south swale running through Lot 2.

A floodway will be constructed through Lot 2 to the south. See below for further discussion of the flood way.

Highway Drainage

Stormwater flows originating from the highway easement and to the north of the highway will be diverted around the western and northern boundaries of the estate without undergoing treatment. The existing highway drainage system permits a limited volume of stormwater from catchments to the north of the highway to enter the water way and flow through the site through two (2) pipe crossings. We will divert these flows as described below.

There are two (2) highway pipe crossings fronting the northern boundary of the site.

1. The most western pipe highway culvert consists of 2x600 mm diameter RC pipes. These currently link into the water way running through the site by draining through 2x600 mm diameter RC pipes within the property. The outlet of the highway culvert is 0.31 AHD. This connection into the site drainage channel will be discontinued and the flows diverted to the west along a newly constructed table drain and low flow pipe within the highway easement. The system is to be designed such that the low flow pipe provides an immediate drainage path for small flows and prevents significant upstream ponding in minor rainfall events. As the storm flows increase the flow surcharges out of the low flow pipe and into an open channel of sufficient capacity to take the flow being allowed across the highway coupled with that which is emanating directly from the highway itself. At the north western extremity of the site the flows will be piped along the Lot 1 site western boundary, within a drainage easement, to discharge into the Lot 2 existing western diversion channel. Any surcharge will flow into the proposed floodway.
2. The second highway culvert consists of 1x600mm diameter RC pipe. It drains into a 575mm diameter pipe that then links into the water way drainage channel running through the site. Outlet RL of the highway culvert is 0.33 AHD. This connection will be discontinued and the flows will be diverted to the east along a newly constructed table drain and low flow pipe drainage system within the highway road easement similar to that as noted above. Suitable drainage will be constructed beneath the new Highway/Link Road roundabout to allow the continuation of this flow east and into the existing open drainage network draining to north creek canal adjacent to the bridge.

A typical detail drainage system is shown on Fig 4 in Appendix 1.

Floodway & Impacts of Filling

As noted previously in Section 1. Introduction, the assessment of the potential impacts on local flooding as a result of the filling of Lots 1, 3, 5 & Part Lot 269 has been previously assessed under DA 2002/566. The site currently has a Construction Certificate approval for the placing and compacting of approximately 286,000m3 of suitable fill material to an average height of RL 2.1 m AHD onto Lots 1,3 & 5 DP 1074242 & Part Lot 269. Not with standing this, we have undertaken the following additional studies in order to address the DGEARS requirements in relation to this application and in particular where they relate to Ballina Shire Councils Flood Plain Management Study.

Preliminary floodway design has been undertaken in consultation with Ballina Shire Council and BMT WBM Pty Ltd. Utilising Councils latest flood model and incorporating the effects of storm surge and rising sea levels. As a result of running a number of simulated flood events with different floodway alignments and configurations, the floodway design as indicated on the attached plans confirms that impacts associated with the fill material being placed to final design heights within the estate can be mitigated by a floodway such as proposed in this report.

The proposed location and dimensions of the floodway is shown attached in Appendix 1 - Fig 3.

4. Preliminary Storage Sizing

4.1 Methodology

Catchment hydrology is investigated in accordance with *Australian Rainfall and Runoff – A Guide to Flood Estimation* (AR&R) first published in 1987 by the Institution of Engineers, Australia. Stormwater storage volumes have been calculated in accordance with the Northern Rivers Local Government (NRLG) development and design manual, version 2 2007 (on-site storage detention design). Sediment control basins have been determined in accordance with "Managing Urban Stormwater, 4th Edition – Soils and Construction"

4.2 Hydrology

Construction Phase

During the construction phase of the development there will be fill placed on the site therefore increasing the potential amount of sediments within discharging stormwater runoff.

Sediment retention basins are dams or impoundments designed to intercept sediment laden runoff and retain most sediment and other materials, thereby protecting downstream waterways from pollution. The pre developed site was dived up into 4 catchments and a sediment basin sized for each catchment. The basins have been sized allowing for either Type C and Type F fill (as classed in section 6.6.3 (c) of "Managing Urban Stormwater, 4th Edition – Soils and Construction") to be used. Type C fill is generally of a sandy nature whilst Type F fill is a of clay nature. Results are shown in the table below:

Total Basin Volume Type F Fill

Site Catchment	C_v	R x-day y-%ile	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
1	0.70	28.6	5.3	1061.06	531	1591.59
2	0.70	28.6	5.1	1021.02	511	1531.53
3	0.70	28.6	5.4	1081.08	541	1621.62
4	0.70	28.6	4.4	880.88	440	1321.32

Total Basin Volume Type C Fill

Site	$Q_{tc, 0.25}$ (m^3/s)	Area factor	Depth of settling zone (m)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
1	0.420	2000	0.3	504	504	1007
2	0.404	2000	0.3	485	485	969
3	0.428	2000	0.3	513	513	1026
4	0.359	2000	0.3	431	431	862

Refer to Appendix 1 - Figure 3 Sediment and Erosion Control Plan for details.

Operational Phase

Rainfall intensities are determined from NRLG IFD data from ALSTONVILLE (tropical fruit station) and runoff coefficients determined in accordance with AR&R. A time of concentration for each catchment (see Appendix 1 - Fig 4) was adopted for the pre development scenario using the probabilistic method. For the developed scenario, t_c was approximated to be half of the pre developed as a conservative approach.

To determine the OSD required post development for the site, a 5 year storm event pre development and a 20 year storm event post development where compared as per "NRLG Development and Design Manual Version 2, 2007". Results are shown in the table below.

Catchment	Area (ha)	Required Storage (m^3)
1	2.34	165
2	2.35	164
3	1.31	84
4	5.58	710
5	1.58	92
6	1.45	84
7	5.17	636
8	1.35	88
9	3	173
Total	**24**	**2200**

From the results shown in the table above, on-site detention required for the developed site was calculated to be a volume of **2200 m^3** using equation:

$$[(Q^{20}_{dev} - Q^{5}_{undev}) \times (tc^{20}_{dev}) \times (60/1000)].$$

Storage will be provided within the stormwater basins, grassed swales and sports field.

Hydrological calculations for the construction and operational phase appear in Appendix 2.

Effects of Global Warming

The flood study undertaken by WBM has taken into account the possible effects of sea level rises in its flood modelling. After taking these factors into account, the 1 in 100 year flood level was determined to be 2.1 m AHD.

At drainage discharge points into streams having tidal influence, flood gates will be installed to minimise potential adverse salination effects.

Flood Gates

One (1) new flood gate installations and the upgrading of one (1) existing flood gate are proposed. These are shown in Appendix 1 - Fig 3.

Discussions have been undertaken with Fisheries regarding the preferred style of flood gate to be installed. It is proposed that manually adjustable flood gates will be utilised so that the existing flow and tidal regimes can be maintained through manual adjustment of the gates.