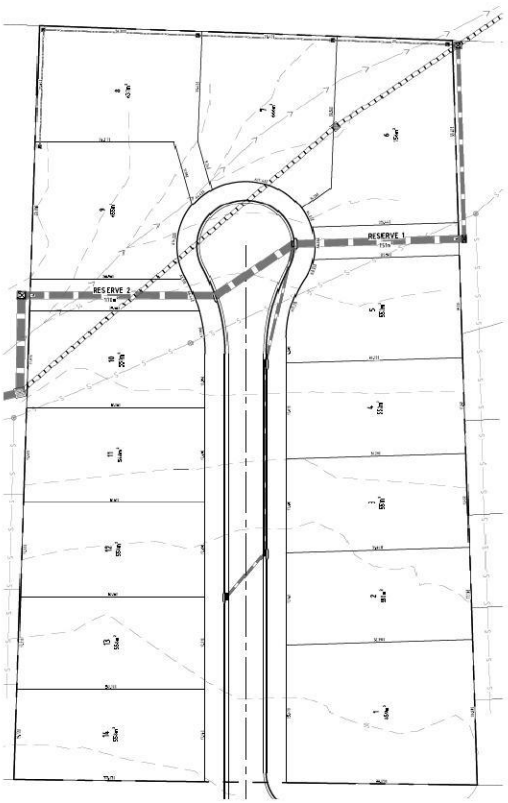

94-100 EXPLORERS WAY, ST CLAIR

Stormwater Management and WSUD Strategy

Prepared for Silky Property Group

June 2015

Revision A

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Document Status

Rev. no.	Issue Date	Document purpose	Approved for issue		
			Author	Approved by	Date
A	5/06/2015	Issued for DA Submission	B.Badek	P. Diversi	5/06/2015

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LIST OF APPENDICIES

1 INTRODUCTION

1.1 General

Diversi Consulting have been engaged by Silky Property Group to undertake a stormwater management assessment and develop a Stormwater Management and Water Sensitive Urban Design (WSUD) Strategy for the proposed residential development at 94 -100 Explorers Way, St Clair.

1.2 Purpose of this report

The purpose of this report is to describe the analysis undertaken and proposed stormwater management and WSUD measures recommended to adequately cater for the runoff on-site.

1.3 The Site

The subject development area is located in the suburb of St Clair in the Penrith City Council (PCC) Local Government Area (LGA). It is located at 94-100 Explorers Way, St Clair, adjacent to the M4 Western Motorway. The site is bounded by Explorers Way to the south, residential houses to the east and west, adjoins road reserve along part of the western boundary and adjoins the drainage reserve along the M4 Western Motorway. **Figure 1** below shows the location and boundary of the proposed site.

Figure 1: *Locality Plan*

The site is approximately 1.057ha and generally falls at approximately 2-3% north east towards the M4 Western Motorway. The site currently comprises of a single two-storied dwelling, with a number of small sheds/cottages and sparse vegetation. The rear of the site had previously been classed as undevelopable due to an existing gully through the site draining waters from Ashwick Circuit to a headwall in the M4 Western Motorway drainage reserve.

The drainage through the site consists of a defined gully/overland flow path and piped drainage system comprising of a 600mm DIA pipe. Please refer to **Appendix B** for survey plans showing the existing drainage system. Further details on the street drainage system draining to the gully at the rear of the site is provided in Section 2. The location of the existing overland flow path can be seen in **Photo 1** which is an easterly view from the western boundary of the subject site.

Photo 1: *View along northern boundary of subject site*

1.4 Proposed Development

The rear portion of the site has recently been re-zoned as residential allowing for residential subdivision of this portion of the site that has previously been zoned for open space.

The proposed development consists of a 14 lot residential subdivision with associated road and stormwater drainage infrastructure. A copy of the subdivision plan is included in **Appendix A**.

In order to address Penrith City Council's water quality requirements individual raingardens are proposed on each lot, in combination with proprietary devices within the road system. Concept drawings showing the proposed stormwater management for the site are included in **Appendix A.**

1.5 Council and Authority Requirements

The site is located within the Penrith City Council (PCC) local government area and as such the following specific requirements and guidelines have been adopted;

- **Penrith City Council** Water Sensitive Urban Design (WSUD) Policy (2013);
- **Penrith City Council** WSUD Technical Guidelines (2013);
- **Penrith City Council** DCP (2014);
- **Draft NSW MUSIC Modelling Guideline** Catchment Management Authority (2010);
- **Australian Runoff Quality** A Guide to Water Sensitive Urban Design (2006); and
- **Australian Rainfall and Runoff** 3rd Edition – Volume1 and 2 (1997).

2 STORMWATER MANAGEMENT

2.1 General

The stormwater is to be conveyed via a standard pit and pipe network. As part of the proposed works, stormwater quality may be treated by a combination of 'at-source' and 'end of line' gross pollutant traps and filtration devices including raingardens.

In order to determine and model the proposed water quality treatment train for the site, a water quality model was developed using a stormwater computer program called Model for Urban Stormwater Improvement and Conceptualisation (MUSIC) by eWater which was developed for the design and analysis of urban stormwater drainage.

This report is to be read in conjunction with the flood study prepared for the site prepared by Diversi Consulting dated 05/06/2015. This report details the hydraulic and hydrological calculations used for the Flood study in regards to peak flow calculations.

The stormwater management strategy has been driven by a number of requirements and guidelines provided by PCC. These guidelines have been utilised in conjunction with industry best practice to develop the proposed stormwater management strategy and to address the relevant controls prescribed by PCC.

2.2 Objectives

The objective of this Stormwater Management and WSUD Strategy is to provide performance targets and nominate a stormwater management strategy to achieve the following objectives;

- Minimise the impacts on the catchment relating to increased run-off from the proposed development works.
- Minimise potable water demand.
- Minimise the impacts from the development on the quality of stormwater run-off.
- Minimise the disturbance on adjacent catchments relating to soil erosion and sediment generated from construction works.
- Integrate WSUD measures into the design of the proposed development to enhance aesthetics and amenity.
- Minimise the potential impact of the development works on the existing groundwater.
- Ensure that the benefits and values of the strategy are consistent with the principles of ecologically sustainable development (ESD).
- Reduce pollutant loadings for Gross pollutants (GP), Total Suspended Solids (TSS), Total Phosphorus (TP), and Total Nitrogen (TN) by 90%, 85%, 60% and 45% respectively.

2.3 Trunk Stormwater Management

The trunk stormwater drainage for the site has been analysed and designed in accordance with the Flood Study report by Diversi Consulting dated 05/06/2015. Under this proposal the trunk drainage through the site conveying the upstream catchment has been upgraded to twin 1500 by 900 box culverts. Please refer to this report for further details.

2.4 Minor Stormwater Drainage Infrastructure

The minor stormwater drainage for the proposed road has been designed to cater for the 20% AEP stormwater event, conveyed via a conventional pit and pipe stormwater drainage system. The proposed stormwater drainage pipe network is to be designed generally with a minimum longitudinal grade of 0.5%. Overland flows from major (greater than 20% AEP) storm events will be contained within and conveyed via the proposed roads. The concept minor stormwater drainage network is shown in detail on the Concept Stormwater Management Plan contained in **Appendix A** of this report.

2.5 On-site Detention (OSD)

Peak flows upstream and downstream of the site in the 20% and 1% AEP event have been assessed in the flood study report by Diversi Consulting dated 05/06/2015. As the site is located at the downstream end of the overall catchment draining to the M4 it was found that there are minimal impacts downstream of the development in the post development scenario. In summary the report found that;

- In the 1% AEP event there is;
    - Significant reductions in overland flows throughout the upstream street network,
    - A minor increase in overland flows at the southern end of Ashwick circuit, with overland flows increasing from 49l/s to 134/s. This increase is considered negligible as flows are still wholly contained within the kerb and gutter, with a maximum depth of 98mm and maximum Vd of 0.1m^2/s.
    - A minor increase in overland flows downstream of the site discharging to the headwall along the M4, with overland flows increasing from 3.85m^3/s to 4.0m^3/s. The overall discharge to the headwall in the post developed case is also increased from 4.73m^3/s to 4.9m^3/s, an increase of 0.17m^3/s.
    - Flood levels downstream of the site generally remain the same, with a slight increase of 0.01m in comparison to the pre-development scenario.

- In the 20% AEP event there is;
    - A marginal increase in overland flows downstream of the site discharging to the headwall along the M4, with overland flows increasing from 2.14m^3/s to 2.49m^3/s. The overall discharge to the headwall in the post developed case is increased from 3.02m^3/s to 3.39m^3/s, an increase of 0.37m^3/s.
    - Flood levels downstream of the site are increased by up to 0.03m in comparison to the pre-development scenario.

The proposed WSUD measures for the site, including rainwater tanks and raingardens on each lot will provide some OSD measures. These WSUD measures have not been included in the assessment of peak flows for the site and will likely reduce the peak flows downstream. As there is only a marginal increase in peak flows downstream of the site and it has been shown in the flood study dated 05/06/2015 by Diversi that the stormwater system downstream has adequate capacity to accommodate flows generated from the development it is considered that OSD is not required.

2.6 Water Conservation

The water conservation objectives for the development as a whole will be in accordance with PCC's Development Controls 2014 and as detailed in PCC's WSUD Policy Guidelines (Penrith City Council, 2013) as follows;

- To reduce consumption of potable water for all development types within the City.
- To use harvested rainwater, treated urban stormwater or treated wastewater for non-potable substitution where appropriate.

Each future dwelling application within the proposed subdivision will be expected to demonstrate compliance with State Environmental Planning Policy - Building Sustainability Index (BASIX) as required.

2.7 Erosion, Sediment and Pollution Control

The majority of pollutant generation will occur during the construction phase of the development, therefore appropriate erosion and sediment control measures will be implemented as per the plan attached within **Attachment C**.

Erosion, sediment and pollution control measures will be implemented during the course of the construction works in accordance Penrith City Council's DCP and Engineering Guide and NSW Office of Environment and Heritage Managing Urban Stormwater guide (Blue Book). The impacts of soil erosion and sedimentation on adjacent roadways, properties and waterways will be minimised through a series of devices including;

- Stabilised site access and truck cleaning facilities (such as a shaker pad).
- Silt fences and inlet sediment barriers.

3 WSUD STRATEGY

3.1 General

This WSUD strategy has been developed in accordance with Penrith City Council requirements and guidelines as well as industry best practice. The proposed treatment train consists of rainwater tanks, GPT devices and rain gardens, It is designed to manage the pollutant loads from the 'first flush' stormwater flows as well as treating excess nutrients generated from development areas.

Model for Urban Stormwater Improvement Conceptualisation (MUSIC) is a stormwater quality modelling software program that has been developed by the Cooperative Research Centre for Catchment Hydrology (CRC) and has been used to simulate the performance of the proposed stormwater quality treatment train and demonstrate the effectiveness of the proposed measures against the stormwater water quality treatment targets set by PCC.

MUSIC modelling parameters have been adopted from Penrith Councils WSUD guidelines for all inputs including rainfall and evaporation, rainfall-runoff parameters, pollution generation parameters and treatment node parameters. Penrith Council's WSUD DA Submission checklist is contained within **Appendix C** of this report.

3.2 Proposed Stormwater Treatment Measures

This WSUD strategy prescribes the use of three (3) major components as detailed below;

a) **Rainwater Tanks:** Rainwater tanks on each lot will be provided to address BASIX requirements, collecting stormwater run-off from roof areas in order to both reduce the stormwater run-off from these impervious areas and also reduce potable water demand by re-using the collected stormwater for toilet flushing, laundry, irrigation, etc. Given the large lot sizes between 550-600m^2 a minimum 2,000L Rainwater tank on each lot will be required to address BASIX requirements. This has been included in the MUSIC model using Penrith Councils re-use rates for internal and external uses.

b) **Rain Gardens:** Rain gardens will be provided on each lot, draining to the available interallotment line at either the front or rear of each lot. For modelling purposes this has been modelled as a single raingarden. The total filter area required for the subdivision will be proportioned to each lot based on lot areas subject to detailed design. Each raingarden consists of the following;

- The filler medium is to be at least 750mm deep with a maximum extended detention depth before spilling of 300 mm.
- The first 500mm of the filter medium will comprise of sandy loam and will need to have the following specifications:
    - Saturated Hydraulic Conductivity of 250mm/hr;
    - Particle size of 0.45mm;
    - Organic Matter Content is to be less than 5% (w/w);
    - The filter has to have a ph between 5.5 and 7.5; and

- The electrical conductivity (EC) is to be below 1.2dS/m.

Due to the surrounding clay soil type to avoid potential salinity problems an impermeable HDPE liner is necessary to prevent any water infiltrating into the surrounding area. To reduce the risk of clogging filter material and increase the lifespan of each raingarden, we recommend a silt trap/screen is to be located upstream where possible. The surface of each raingraden is to be planted in accordance with Penrith City Councils requirements. All modelling inputs for the raingardens has been adopted from Penrith Councils WSUD requirements.

c) **GPT Units:** Enviopod inserts in the kerb inlet pits and a VortSentry/ CDS style unit is proposed in order to collect coarse sediments, litter and other debris and assist to reduce the pollutant loading generated from the roads. Both the enviropods and CDS Unit have been specified within the MUSIC Modelling as recommended by Stormwater 360.

3.3 WSUD Model Setup

The proposed development site has been divided into sub-catchments to represent the varying surface types and impervious percentages, divided into three main categories being roof, landscape (urban) and road. Table 3.1 below summarises the sub catchments by category and the impervious percentage applied.

Table 3.1 *– Summary of Catchments*

Catchment	Impervious %	Area
Roof	100	0.177ha
Roof Bypass	100	0.178ha
Landscape	33	0.532ha
	Subtotal; Lot area	0.887ha
Road (pavement)	100	0.093
Road reserve (grass)	0	0.077
	Subtotal; Road area	0.17
	Total Site area	1.057ha

Of the total lot area, 40% is approximated as the roof area with a maximum 50% of the roof draining to a rainwater tank. To achieve an average site coverage of 60% on all lots a 33% impervious fraction (to account for driveway and paths) has been applied to the landscaped portion of the lots. Both a pre-developed and post developed scenario has been included in the model to allow assessment of Stream Erosion Index (SEI). Refer to **Appendix D** for the MUSIC-Link report. Figure 3.1 on the following page shows a schematic of the MUSIC Model Layout.

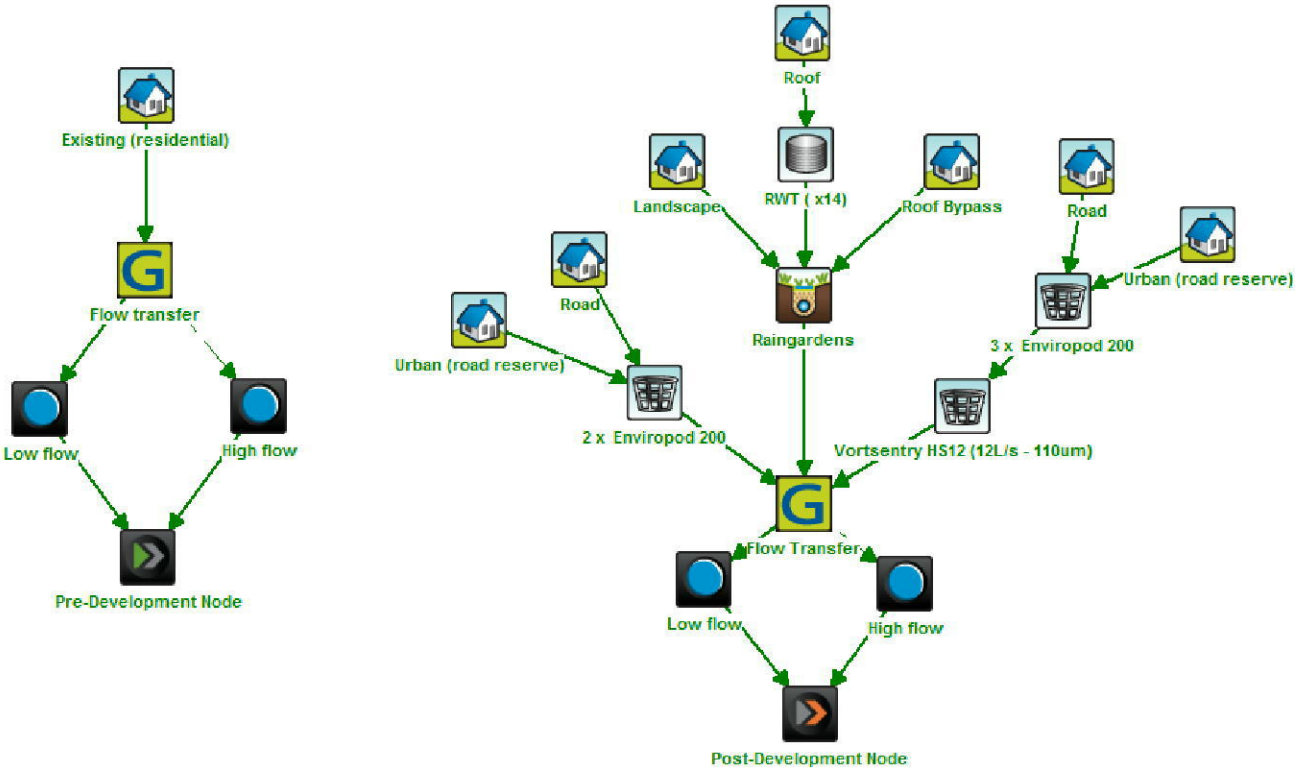

Figure 3.1 : MUSIC Model Layout and Catchment Areas

3.4 Results

The estimated total pollution source loads and treatment train reductions have been determined from the MUSIC modelling results and are summarised in **Table 3.2**.

Table 3.2 : Proposed Treatment Train Effectiveness

Pollutant	Sources	Residual Load	Reduction
Total Suspended Solids (kg/yr)	507	71.1	86%
Total Phosphorus (kg/yr)	1.07	0.415	61.2%
Total Nitrogen (kg/yr)	9.12	3.55	61%
Gross Pollutants (kg/yr)	120	2.4	98%

Table 3.2 above shows that Council's water quality objectives for TSS, TP, TN and GP is achieved. To achieve these results a minimum total raingarden filter surface area of 190m^2 is required, with maximum 1:4 batters assumed for the raingarden configuration. A sensitivity analysis was undertaken to check whether Council's water quality targets are achieved should home owners opt to construct vertical walls to the raingardens (ie. Filter area = surface area in MUSIC). It was found that with a filter area of 190m^2 Councils water quality requirements are achieved. This therefore equates to each lot providing raingardens at a rate of 214m^2/ha.

3.5 Stream Forming Flows

An assessment of Stream Forming Flows within the development site has been undertaken in accordance with PCC's WSUD Technical Guidelines (2013) and the Draft NSW MUSIC Modelling Guide (2010). As per PCC's requirements, a target Stream Erosion Index (SEI) of **3.5** has been adopted, based on a stream forming flow threshold of 50% of the 2yr ARI natural flows).

The 2yr ARI pre-developed peak flow has been determined from the DRAINS modelling undertaken in the Flood Study prepared by Diversi Consulting dated 05/06/2015. The 2yr ARI pre-developed peak flow from the site was calculated as 119l/s. The critical flow rate or stream forming flow rate for the site is therefore 59l/s.

A generic treatment node has been used in the MUSIC modelling with a flow transfer function to splil flow between primary and secondary links, with the secondary link conveying waters in excess of the crtical stream forming flow of 59l/s. Using the methodology prescribed in the Draft NSW MUSIC Modelling Guide, the pre-development mean annual flow above the stream forming threshold determined using MUSIC is **66.9_E^{-3} ML/yr** and the post-development mean annual flow above the stream forming threshold determined using MUSIC is 57.1_E^{-3} **ML/yr**. Based on these figures the calculated SEI for the proposed development is **0.85** which is well below PCC's target of **3.5** and below Councils ideal target of 1.0.

3.6 Operation and Maintenance Plan

To ensure the WSUD strategy operates as designed regular maintenance is required. A draft Operation and Maintenance Plan is contained within **Appendix E**. Operations and maintenance costs will be dependent on the GPT device selected, details to be provided at detailed design.

4 CONCLUSION AND RECOMMENDATIONS

The proposed Stormwater Management and WSUD Strategy has been developed to achieve the following objectives;

- Minimise the impacts on the catchment relating to increased run-off from the proposed development works.
- Minimise potable water demand.
- Minimise the impacts from the development on the quality of stormwater run-off.
- Minimise the disturbance on adjacent catchments relating to soil erosion and sediment generated from construction works.
- Integrate WSUD measures into the design of the proposed development to enhance aesthetics and amenity.
- Minimise the potential impact of the development works on the existing groundwater.
- Ensure that the benefits and values of the strategy are consistent with the principles of ecologically sustainable development (ESD).

By meeting these objectives the Stormwater Management and WSUD Strategy will;

- Provide safe and effective conveyance of the stormwater run-off (up to and including the 5% AEP storm flows) by means of stormwater pits and pipes.
- Provide treatment of the stormwater runoff to meet or exceed Council's requirements.
- Conserve potable water by harvesting and reusing rainwater by means of rainwater reuse tanks that will be used for toilet flushing and irrigation purposes.

The WSUD Strategy that has been proposed is uniform with typical approaches adopted for residential subdivisions within the Penrith City Council LGA, and as an integrated system is consistent with the requirements of such a system in relation to reliability, community acceptance and future management responsibilities.

5 REFERENCE LIST

BMT WBM Pty. Ltd. (2010). R.B17048.001.01. *Draft New South Wales MUSIC Modelling Guidelines*. Broadmeadow, NSW: Sydney Metrolpolitan Catchment Authority.

Engineers Australia. (2006). Australian Rainfall Quality. *A Guide to Water Sensitive Urban Design*. Crows Nest, NSW: Engineers Media.

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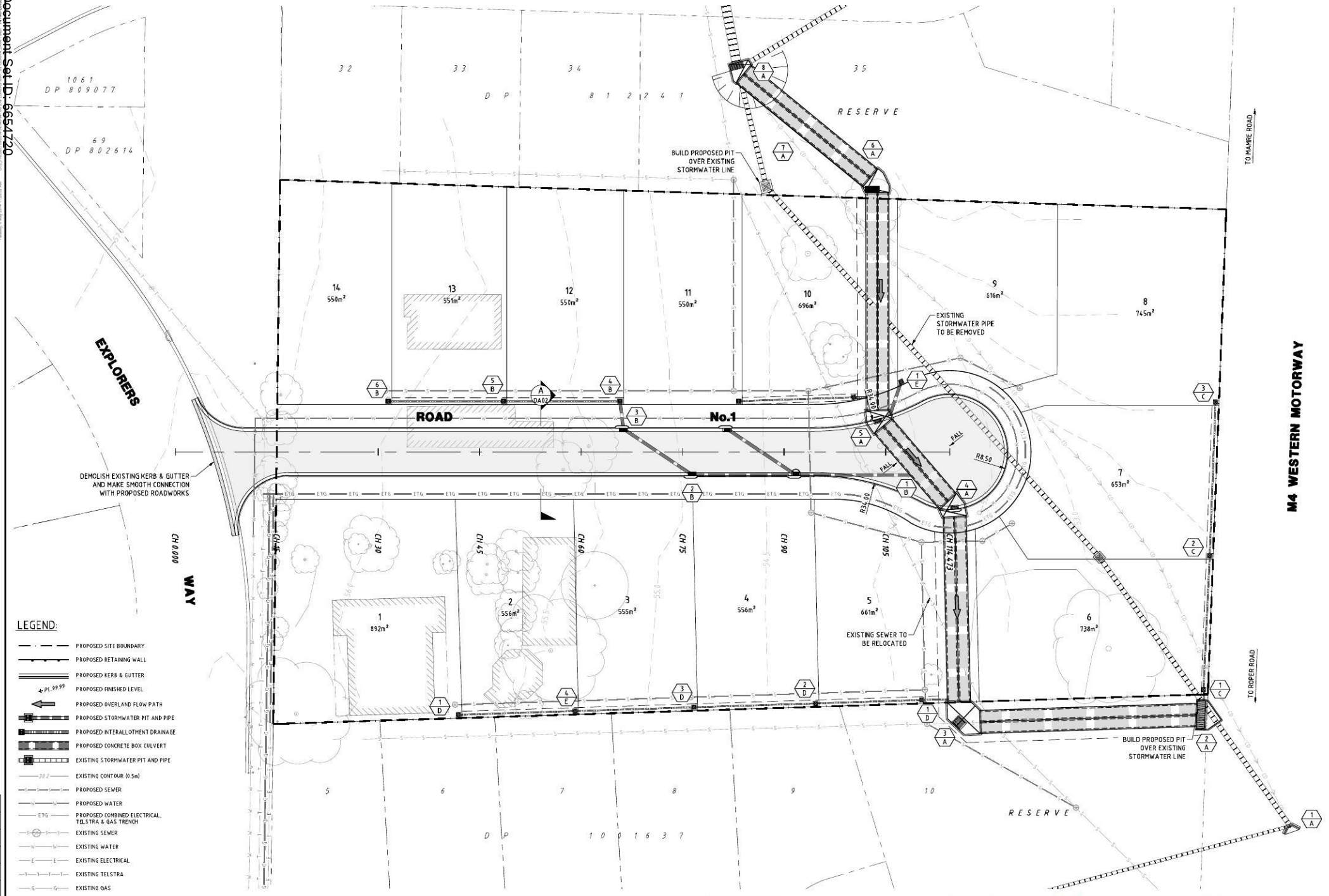
Penrith City Council. (2013). Penrith City Council. *WSUD Technical Guidelines*. Penrith, NSW: Penrith City Council.

Appendix A

Stormwater Management Plan



LEGEND:

- PROPOSED SITE BOUNDARY
- PROPOSED RETAINING WALL
- PROPOSED KERB & GUTTER
- PROPOSED FINISHED LEVEL (PL 99.99)
- PROPOSED OVERLAND FLOW PATH
- PROPOSED STORMWATER PIT AND PIPE
- PROPOSED INTERALLOTMENT DRAINAGE
- PROPOSED CONCRETE BOX CULVERT
- EXISTING STORMWATER PIT AND PIPE
- EXISTING CONTOUR (0.5m)
- PROPOSED SEWER
- PROPOSED WATER
- PROPOSED COMBINED ELECTRICAL, TELSTRA & GAS TRENCH
- EXISTING SEWER
- EXISTING WATER
- EXISTING ELECTRICAL
- EXISTING TELSTRA
- EXISTING GAS

REV	DATE	AMENDMENT / DESCRIPTION	BY	APP'D
A	5/06/2015	ISSUED FOR DA APPROVAL	RLP	DLG

NOT FOR CONSTRUCTION

DRAWING DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE

DESIGNED	R.L.P.	15/05/2015
CHECKED	D.L.G.	25/05/2015
APPROVED	P.G.D.	26/05/2015
SCALE	1:250 (A1)	

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BAULKHAM HILLS, NSW 2153
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www.diversi.com.au

CLIENT: SILKY PROPERTY GROUP

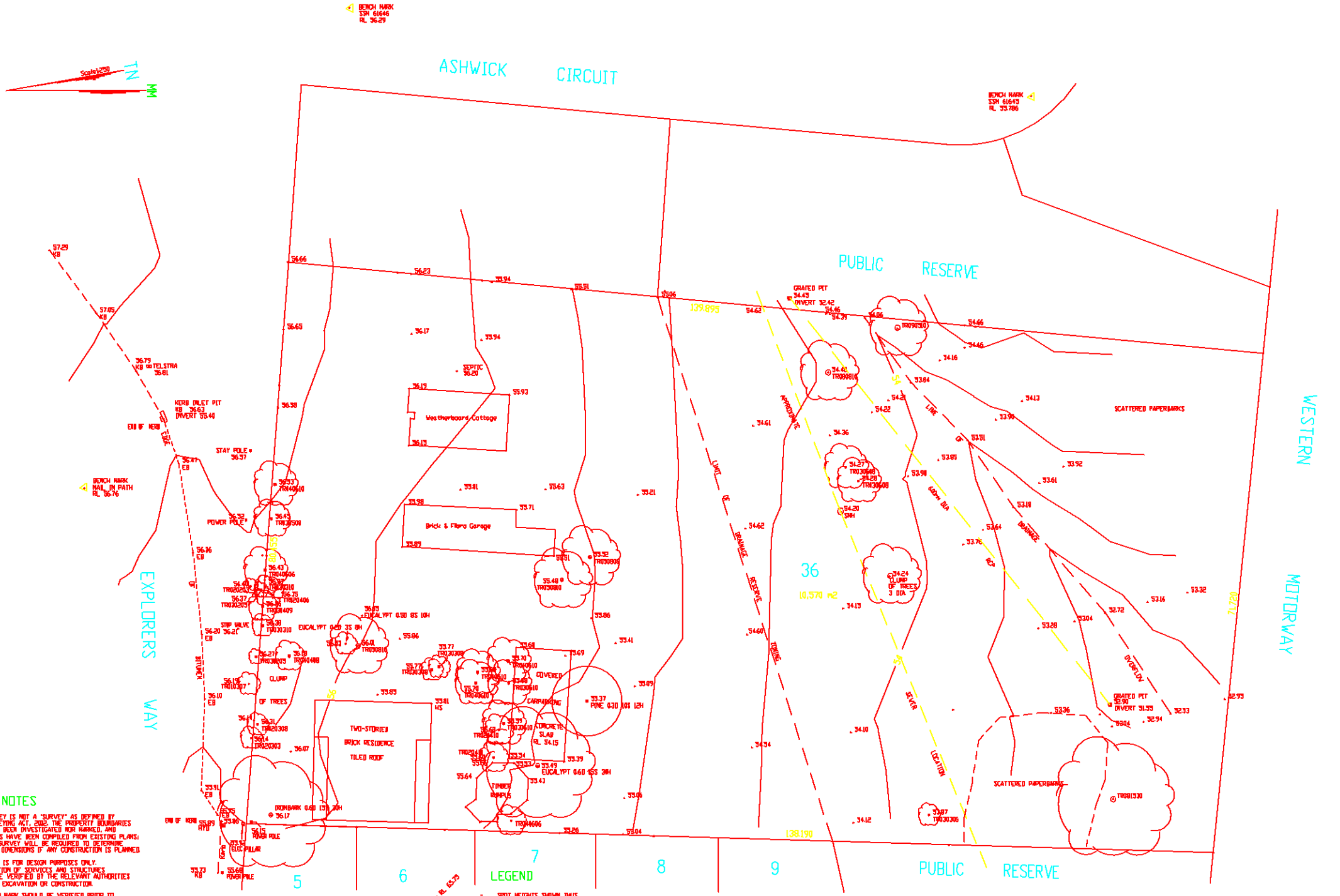
PROJECT: PROPOSED RESIDENTIAL SUBDIVISION 94-100 EXPLORERS WAY, ST. CLAIR

TITLE: ROADWORKS AND STORMWATER DRAINAGE LAYOUT PLAN

PROJECT No.: 14140 | DRG No.: DA03 | Rev.: A

Appendix B

Survey Plan



NOTES

1. THIS SURVEY IS NOT A "SURVEY" AS DEFINED BY THE SURVEYING ACT, 2002. THE PROPERTY BOUNDARIES HAVE NOT BEEN INVESTIGATED NOR MARKED AND DIMENSIONS HAVE BEEN COMPILED FROM EXISTING PLANS. FURTHER SURVEY WILL BE REQUIRED TO DETERMINE BOUNDARY DIMENSIONS IF ANY CONSTRUCTION IS PLANNED.
2. THIS PLAN IS FOR DESIGN PURPOSES ONLY. THE POSITION OF SERVICES AND STRUCTURES SHOULD BE VERIFIED BY THE RELEVANT AUTHORITIES PRIOR TO EXCAVATION OR CONSTRUCTION.
3. THE BENCH MARK SHOULD BE VERIFIED PRIOR TO COMMENCEMENT OF ANY EXCAVATION OR CONSTRUCTION.
4. THE POSITION OF FEATURES RELATIVE TO BOUNDARIES IS DIAGRAMMATIC ONLY & ANY OFFSETS SHOWN ARE APPROXIMATE PENDING FURTHER SURVEY DEFINITION.
5. ORIGIN OF LEVELS - SYDNEY WATER SEWER

LEGEND

RL 65.35 - SPOT HEIGHTS SHOWN THUS

TR 08030 - TREES SHOWN THUS WITH APPROXIMATE HEIGHT OF CANOPY TRUNK & SPREAD SHOWN TO SCALE
TR 08030 DENOTES TREE 0.60,10S,30H
TR denotes Paperbark Tree unless noted otherwise

PROJECT	CLIENT	WARREN ELDRIDGE	LEVELS ON AUSTRALIAN HEIGHT DATUM
DETAIL & CONTOUR SURVEY AT No.94-100 EXPLORERS WAY, ST CLAIR BEING LOT 36 IN D.P. 239502 PENRITH L.G.A.	NR D. FINIANOS	6 Jane Rd, Aust CONSULTING SURVEYOR & REAL ESTATE VALUER P.O. Box 477, PENRITH VILLE 2124 Ph. 9481 9831 Fax. 9980 9931	CONTOUR INTERVAL 0.5 METRES SCALES PLAN 1:250 @A1 LONGITUDINAL SECTION HORI. 1:500 VERT. 1:100 CROSS SECTIONS 1:100 DATE 6-4-11 PLAN NO. 167-1

Appendix C

WSUD Checklist

7. CHECKLISTS

7.1. Appendices – Development Application Checklist (lodged with DA)

Water Sensitive Urban Design
Development Application Checklist

Site/ Project Name	94-100 Explorers Way, St. Clair		
Lot and DP Number:	LOT 36 DP 239502	**DA Number:**	

	Information Required with DA Submission:	**Y**	**N**
1	Has a Water Sensitive Urban Design Strategy been submitted as part of the development application?	✓	
2	Is a BASIX Certificate required? If so, Yes - Attach certificate with DA		✓
3	Has the digital version of MUSIC and report on the MUSIC model using data prescribed outlined in Council's Technical Guideline been attached? Have stormwater quality retention criteria (TSS 85%, TP 60%, and TN 45%) and water quantity / drainage requirements been met and documented in the WSUD Strategy? If relevant, have the Water Conservation, Quantity and quantity targets been achieved?	✓ ✓ ✓	
4	Does WSUD Strategy contain the following information? • Review of the **WSUD principles** and ensure that these are considered throughout development of the WSUD strategy. • Confirmation of the **WSUD objectives** that are relevant to the development application. • Confirmation of the **WSUD targets** for potable water conservation, stormwater quality management and stormwater quality management that are relevant to the development application. • Complete a **site analysis** to evaluate the site characteristics that potentially will impact on the feasibility of WSUD for the site. • **WSUD measures** that would be appropriate for the development considering the development scale, site characteristics, stormwater quality management function and stormwater quantity management function. • A **preliminary WSUD strategy** that positions the selected WSUD measures in appropriate locations and arranges the measures in an appropriate series. • **Numerical modelling** utilising MUSIC software to evaluate appropriate sizes of the WSUD measures. • **Concept designs** of the WSUD measures. • **WSUD strategy report** that summarises the methodology and WSUD outcomes, and provide this with the development application for the site.	✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓	
5	Have the conceptual plans of the proposed stormwater treatment measures been included on the plans? (Detailed engineering plans will be required for the construction certificate)	✓	

6	Has a Draft Operation and Maintenance Plan which includes details on the following been provided? • Site description (area, imperviousness, land use, annual rainfall, topography etc) • Site access description • Likely pollutant types, sources and estimated loads • Locations, types and descriptions of measures proposed • Operation and maintenance responsibility (council, developer or owner) • Inspection methods • Maintenance methods (frequency, equipment and personnel requirements including Work Health and Safety requirements) • Landscape and weed control requirements • Operation and maintenance costs • Waste management and disposal options, and • Reporting.	✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓	

Appendix D

MUSIC-Link Report

PENRITH CITY COUNCIL

music@link

MUSIC-*link* Report

Project Details		Company Details	
Project:	94-100 Explorers Way	**Company:**	Diversi Consulting
Report Export Date:	27/05/2015	**Contact:**	Basia Badek
Catchment Name:	14140-WSUD-RevA5	**Address:**	Suite 103, 29-31 Solent Circuit, Norwest Business Park, NSW 2153
Catchment Area:	2.114ha	**Phone:**	88831113
Impervious Area*:	59.14%	**Email:**	basia.badek@diversi.com.au
Rainfall Station:	67113 PENRITH		
Modelling Time-step:	6 Minutes		
Modelling Period:	1/01/1999 - 31/12/2008 11:54:00 PM		
Mean Annual Rainfall:	691mm		
Evapotranspiration:	1158mm		
MUSIC Version:	6.1.0		
MUSIC-link data Version:	5.6		
Study Area:	Penrith		
Scenario:	Penrith Development		

* takes into account area from all source nodes that link to the chosen reporting node, excluding Import Data Nodes

Treatment Train Effectiveness		Treatment Nodes		Source Nodes	
Node: Post-Development Node	**Reduction**	**Node Type**	**Number**	**Node Type**	**Number**
Flow	11.1%	Rain Water Tank Node	1	Urban Source Node	8
TSS	85.9%	Bio Retention Node	1		
TP	61.2%	Generic Node	2		
TN	61%	GPT Node	3		
GP	98%				

Comments

Some default parameters have been left as per MUSIC where unspecified by Councils guidelines. Base flow parameters associated with roof catchments are void - as these catchment are 100% impervious.

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Raingardens	Hi-flow bypass rate (cum/sec)	None	99	0.064
Bio	Raingardens	PET Scaling Factor	2.1	2.1	2.1
GPT	2 x Enviropod 200	Hi-flow bypass rate (cum/sec)	None	99	0.04
GPT	3 x Enviropod 200	Hi-flow bypass rate (cum/sec)	None	99	0.06
GPT	Vortsentry HS12 (12L/s - 110um)	Hi-flow bypass rate (cum/sec)	None	99	0.012
Post	Post-Development Node	% Load Reduction	None	None	11.1
Post	Post-Development Node	GP % Load Reduction	90	None	98
Post	Post-Development Node	TN % Load Reduction	45	None	61
Post	Post-Development Node	TP % Load Reduction	60	None	61.2
Post	Post-Development Node	TSS % Load Reduction	85	None	85.9
Pre	Pre-Development Node	% Load Reduction	None	None	0
Urban	Existing (residential)	Area Impervious (ha)	None	None	0.053
Urban	Existing (residential)	Area Pervious (ha)	None	None	1.003
Urban	Existing (residential)	Total Area (ha)	None	None	1.057
Urban	Landscape	Area Impervious (ha)	None	None	0.177
Urban	Landscape	Area Pervious (ha)	None	None	0.354
Urban	Landscape	Total Area (ha)	None	None	0.532
Urban	Road	Area Impervious (ha)	None	None	0.033
Urban	Road	Area Impervious (ha)	None	None	0.06
Urban	Road	Area Pervious (ha)	None	None	0
Urban	Road	Area Pervious (ha)	None	None	0
Urban	Road	Total Area (ha)	None	None	0.033
Urban	Road	Total Area (ha)	None	None	0.06
Urban	Roof	Area Impervious (ha)	None	None	0.177
Urban	Roof	Area Pervious (ha)	None	None	0
Urban	Roof	Total Area (ha)	None	None	0.177
Urban	Roof Bypass	Area Impervious (ha)	None	None	0.178
Urban	Roof Bypass	Area Pervious (ha)	None	None	0
Urban	Roof Bypass	Total Area (ha)	None	None	0.178
Urban	Urban (road reserve)	Area Impervious (ha)	None	None	0
Urban	Urban (road reserve)	Area Impervious (ha)	None	None	0
Urban	Urban (road reserve)	Area Pervious (ha)	None	None	0.022
Urban	Urban (road reserve)	Area Pervious (ha)	None	None	0.055
Urban	Urban (road reserve)	Total Area (ha)	None	None	0.022
Urban	Urban (road reserve)	Total Area (ha)	None	None	0.055

Only certain parameters are reported when they pass validation

PENRITH CITY COUNCIL

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Failing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Pre	Pre-Development Node	GP % Load Reduction	90	None	-2.08
Pre	Pre-Development Node	TN % Load Reduction	45	None	-2.05
Pre	Pre-Development Node	TP % Load Reduction	60	None	0
Pre	Pre-Development Node	TSS % Load Reduction	85	None	-1.53
Rain	RWT (x14)	Threshold Hydraulic Loading for C** (m/yr)	0	0	3500
Rain	RWT (x14)	Total Nitrogen - C** (mg/L)	0	0	1.4
Rain	RWT (x14)	Total Phosphorus - C** (mg/L)	0	0	0.13
Rain	RWT (x14)	Total Suspended Solids - C** (mg/L)	0	0	12
Urban	Roof	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.32
Urban	Roof	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.82
Urban	Roof	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.1
Urban	Roof Bypass	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.32
Urban	Roof Bypass	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.82
Urban	Roof Bypass	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.1

Only certain parameters are reported when they pass validation

Appendix E

Draft Operation and Maintenance Manual

Table E1 Maintenance and Monitoring Schedule

Maintenance Action	Frequency	Responsibility	Procedure
Gross Pollutant Traps			
Unit clean / inspection	*Six monthly	Maintenance Contractor	In accordance with manufacturers specifications
Rainwater Tanks			
Prevent mosquito breeding	*Monthly	Owner	In accordance with tank manufacturer maintenance specifications
Clean tank of sludge	2-3 yearly	Maintenance Contractor	In accordance with tank manufacturer maintenance specifications
Bio-Retention Basins and Swales			
Inspect screen and clean	*Six monthly	Owner	Remove grate(s) and screens if required to clean them.
Check attachment of screens to wall of pits	*Annually	Maintenance Contractor	Remove grate(s) and screen(s). Ensure screen fixings are secure. Repair as required.
Check screen(s) for corrosion	*Annually	Maintenance Contractor	Remove grate(s) and examine screen(s) for rust or corrosion, especially at corners or welds.
Inspect walls (internal and external, if appropriate) for cracks or spalling	*Annually	Maintenance Contractor	Remove grate(s) to inspect internal walls. Repair as required. Clear vegetation from external walls if necessary and repair as required.
Inspect grate(s) for damage or blockage	*Six monthly	Owner	Check both sides of a grate for corrosion, (especially corners and welds) damage or blockage.
Inspect outlet pipe & remove any blockage	*Six monthly	Maintenance Contractor	Remove grate(s) and screen(s). Ventilate underground storage if present. Check orifices and remove any blockages in outlet pipe. Flush outlet pipe to confirm it drains freely. Check for sludge/debris on upstream side of return line.
Inspect subsoil drainage system	*Six monthly	Maintenance Contractor	Inspect, clean and flush subsoil drainage system.
Basin vegetated/open areas	*Two monthly	Owner	Inspect basins for litter, debris and weeds and clear as required.