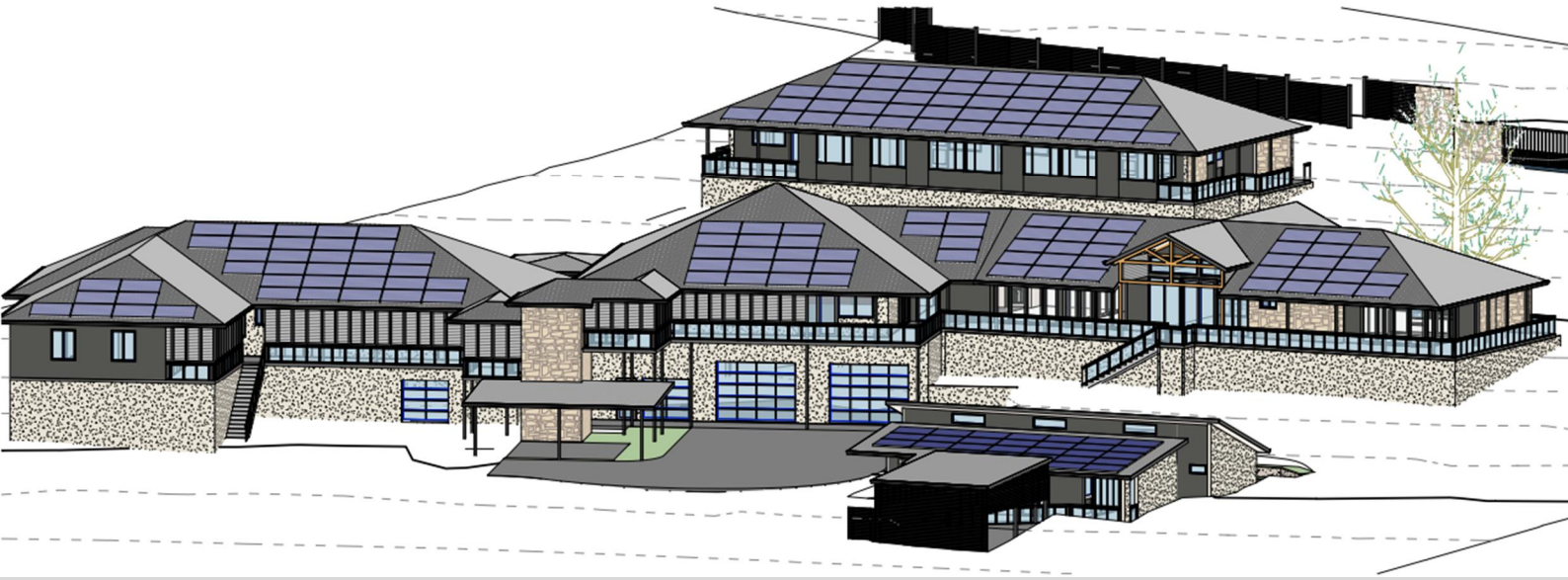


Stormwater Assessment
8 Austin Place, ORCHARD HILLS NSW

Therian Pty Ltd

Planit
September 2018
Document No: J082-SW_RPT01

Document Status

Version	Document type	Reviewed by	Checked by	Date Issued
1	Preliminary Assessment	W. Cooper	B. Gohl	29/03/2016
2	Report	W. Cooper	B. Gohl	20/04/2016
3	Report	M. Kamphorst	B. Gohl	5/07/2017
4	Report	M. Plain	B. Gohl	21/12/2017
5	Report	M. Plain	B. Gohl	18/04/2018
6	Report	M. Plain	M. Plain	20/09/2018

Project Details

Project Name:	Stormwater Assessment – 8 Austin Place, Orchard Hills
Client	Assistance Dogs Australia
Client Project Manager	Therian Pty Ltd
Authors	N. van Oers
Planit Reference:	J082-SW-RPT01

OSD Design Certification

This is to certify that the OSD system has been design in accordance with the Penrith City Council policy: Stormwater Drainage Guidelines for Building Development.

Acknowledged by: Matt Plain
NER Accreditation: 3037028
Date: 20/09/2018

Signed: 

Contents

1. Introduction

1.1. Background

Planit Consulting has been engaged by Assistance Dogs Australia (ADA) to prepare a Stormwater Assessment for the proposed development at 8 Austin Place, Orchard Hills (Lot 23 DP239091), known here in as the subject site.

1.2. Scope

Specifically, this report details the following:

- Undertake catchment analysis to identify existing stormwater catchments and determine the ultimate treatment/detention area required for each catchment.
- Undertake hydrology calculations and determine detention basin sizing requirements.
- Prepare a conceptual stormwater network diagram over the proposed development footprint of the site including indicative locations of trunk pipe system, open channel flow paths & stormwater detention / retention areas.
- Report on opportunities for Water Sensitive Urban Design principles to be utilised and options for water quality treatment 'in train' or 'end of line' solutions. These would include opportunity for rainwater harvesting/re-use, bio-retention swales and basins.
- Provide 'Music' software results for the treatment train to determine nutrient removal & suspended solids removal & stormwater flow reduction rates.
- Identify advantages & disadvantages of stormwater management options presented in the report and provide final recommendations for preferred stormwater management strategy.
- Report on all findings to ensure compliance with Council's DCP.

This report has been prepared in accordance with the guidelines provided by Penrith City Council. The completed design checklist as per the Stormwater Drainage Specification for Building Developments has been included as Appendix A.

1.3. Description of Subject Site

The subject site is located at 8 Austin Place, Orchard Hills, NSW. The site area occupies approximately 2.192ha and currently consists of 4 buildings and under cover parking area, two open parking areas and an internal access road. The rest of the site comprises open grassed areas with trees located throughout, with the northern section of the lot contains a large number of trees where, based on the survey contours, the site's assumed stormwater discharge point is located. Refer to Figure 1 for location of subject site.

Figure 1 | Subject Site

1.4. Rainfall

The six-minute rainfall data and evapotranspiration values have been taken from Penrith Lakes AWS and was applied to the stormwater quality model (MUSIC) for this assessment. Rainfall data for the on-site detention assessment has been sourced from the Bureau of Meteorology.

1.5. Description of Development

The applicant proposes to construct a new guide dog training facility including commercials building, space for an internal road network, multiple car parking areas, an upgraded entry/exit driveway, upgrading the entry road (Austin Place, which has not been included in the assessment) and open exercise areas which have been assumed to be grassed. This will result in an increase in roof and hardstand areas compared to the existing site. It is proposed to use Water Sensitive Urban Design (WSUD) measures to and treat stormwater as per Councils development guidelines. The proposed development layout is illustrated in Figure 2.

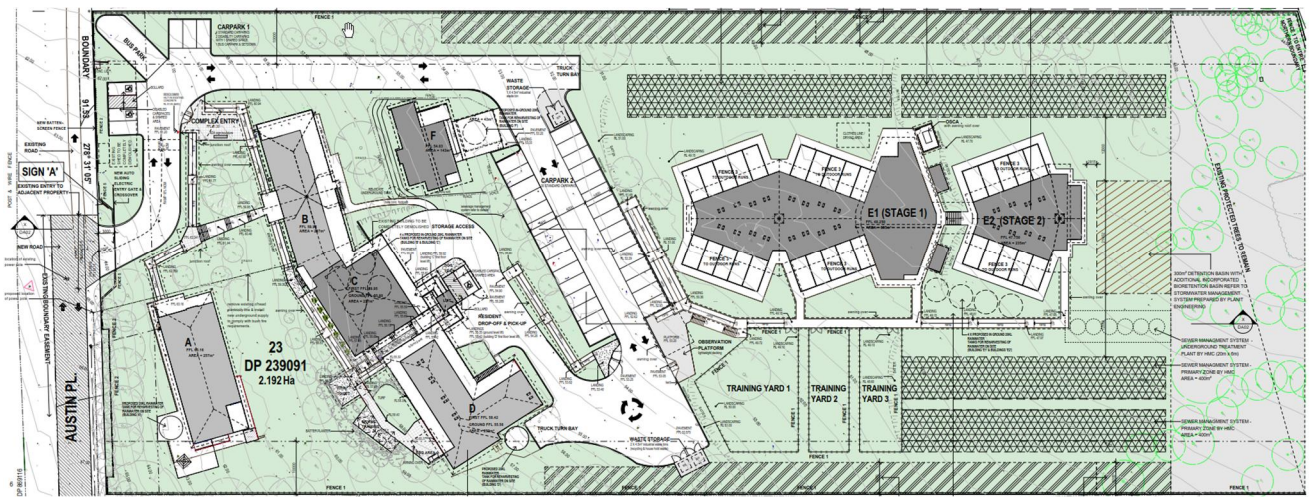


Figure 2 | Proposed Development Layout

2. On Site Detention

The intensity, frequency and duration (IFD) values for the site was derived from the Bureau of Meteorology's IFD generator. The Location of the rainfall data was selected at Orchard Hills Treatment Works NSW due to extensive historical data available for use in 'DRAINS' modelling. Figure 3 shows the values used in accordance with the AR&R87 design guidelines.

Location: 33.800S 150.700E Issued: 17/3/2016

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

Duration	Average Recurrence Interval						
	1 YEAR	2 YEARS	5 YEARS	10 YEARS	20 YEARS	50 YEARS	100 YEARS
5Mins	74.3	96.2	126	143	166	196	219
6Mins	69.5	90.0	118	134	156	184	206
10Mins	56.8	73.6	96.1	109	127	150	168
20Mins	41.3	53.5	69.7	79.3	91.8	108	121
30Mins	33.5	43.3	56.5	64.3	74.4	87.9	98.2
1Hr	22.7	29.4	38.3	43.6	50.5	59.6	66.7
2Hrs	15.1	19.5	25.4	28.9	33.4	39.4	44.0
3Hrs	11.8	15.3	19.9	22.6	26.1	30.7	34.3
6Hrs	7.81	10.1	13.0	14.8	17.0	20.1	22.3
12Hrs	5.10	6.59	8.56	9.71	11.2	13.2	14.8
24Hrs	3.25	4.22	5.58	6.40	7.46	8.87	10.0
48Hrs	1.98	2.60	3.54	4.13	4.88	5.89	6.68
72Hrs	1.44	1.91	2.64	3.11	3.70	4.50	5.13

(Raw data: 29.46, 6.63, 1.91, 59.3, 13.12, 4.48, skew=0.02, F2=4.3, F50=15.79)

Figure 3 | IFD values

A preliminary hydraulic assessment incorporating the site's on-site detention requirements was carried out using DRAINS software. The pre-developed site was modelled as a single catchment with a total area of 1.852m^2 including paved fraction of 15% and with a time of concentration of 5 minutes. This nominal catchment area discounts the tree protection zone on the downstream end of the site as it is not proposed to not disturb portion of the lot.

The post-developed site has been modelled as follows (Refer Appendix A for corresponding catchment areas):

- Western Road:
  - Paved fraction: 54%.
  - Time of concentration: 5min.
  - Detention basin footprint: 74m^2 (shared with the Lower Catchment).
  - Detention Depth: 300mm.
  - OSD Volume: 23.9m^3.
  - Basin outlet: 900x900 field inlet pit with 300dia RCP @ 1%.
- Upper Catchment:
  - Paved fraction: 40%.
  - Time of concentration: 5min.
  - Detention basin footprint: 200m^2.
  - Detention Depth: 500mm.
  - OSD Volume: 100m$^{3.}$
  - Basin outlet: 900x900 field inlet pit with 300dia RCP @ 1%
- Lower Catchment:
  - Paved fraction: 37%.
  - Time of concentration: 5min.

- Detention basin footprint: 74m^2 (shared with the Western Road Catchment).
- Detention Depth: 300mm.
- OSD Volume: 9m^3.
- Basin outlet: 900x900 field inlet pit with 300dia RCP @ 1%.

Outflow from basins is controlled by the pit and pipe size. No requirement for orifice-controlled outflow has been identified to achieve the desired post-development flowrates.

It is noted that eleven (11) rainwater tanks with a capacity of 20kl each are proposed for use on the site in various locations. These tanks however are for rainwater harvesting purposes only and do not form part of the stormwater flow mitigation strategy. Tank locations on the plan (Appendix A) are included for clarity purposes.

Refer Figure 4 for the schematic model setup. An electronic copy of the model can be made available on request. A summary of results of the storm event for the pre-and post-development sites for ARI's ranging from 2 years to 100 years is resented in Table 1. It is evident that 'worst case' post-development peak flows have been reduced to magnitudes less than those pre-development flows.

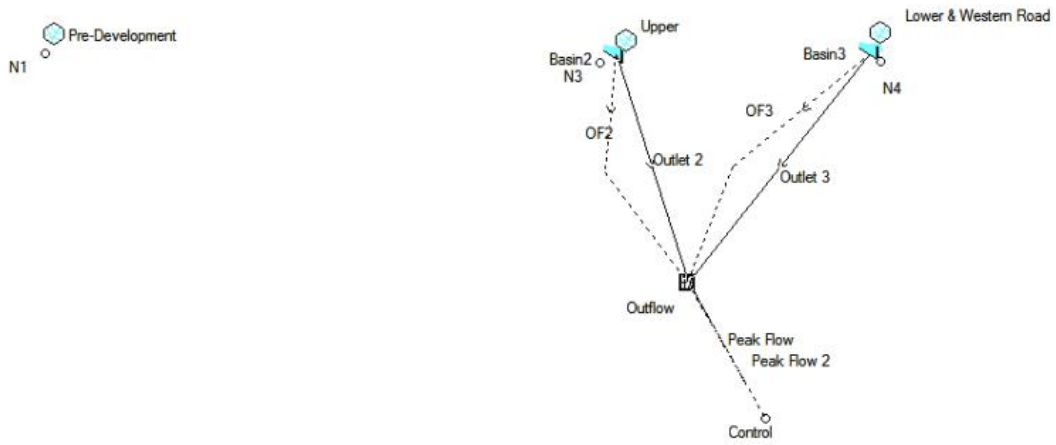


Figure 4 | Pre- and Post-Development Discharge Rate (100-years ARI)

DRAINS Modelling Results Worst Case Peak flows (m^3/s)						
Scenario	ARI					
	2 Years	5 Years	10 Years	20 Years	50 Years	100 Years
Pre-developed	0.296	0.487	0.570	0.671	0.760	0.875
Post-developed	0.274	0.367	0.400	0.451	0.495	0.632

Table 1 | Preliminary OSD Modelling Results

Based on the modelling results, it was determined that the largest piped flow discharging from any detention basin for the worst-case 100-year ARI event will be 0.228m^3/s which corresponds to a velocity of 3.23m/s. Energy dissipaters are proposed at the downstream ends of each basin outflow pipe to reduce flow velocities to 2m/s. Refer Appendix B for typical details and Appendix D for preliminary calculations.

3. External Catchment Drainage

A raised earth landscaped mound has been proposed along the eastern boundary of the site. To prevent interruptions in through flow from external catchments, it is proposed to establish a grassed swale directly to the east of the mound to redirect flow downstream over the subject site.

The extent of the external catchment has been determined using the length of the earth mound as per the layout plan (Appendix B) and aerial imagery of the area (SIX maps) containing height contours. It has been determined that this catchment is 0.83ha in area and the fraction impervious has been estimated at 5%. Refer Figure 5 for the outline of this external catchment

Figure 5 | External Catchment Outline (SIX Maps, 2018)

A model has been developed using DRAINS using the following parameters:

- External Catchment:
  - Elevation: 55.0m AHD
  - Area: 0.83ha
  - Impervious Fraction: 5%
  - Time of Concentration: 5 minutes
- Swale:
  - Length: 90m
  - Side slopes: 1 in 6
  - Longitudinal slope: 6.33%
  - Manning's n: 0.03
- Downstream Discharge Point:
  - Elevation: 49.3m AHD

It has been determined that the maximum flow depth for a storm event with a 5-minute duration and a 100-year ARI (worst-case event) is 0.16m. Accordingly, it has been proposed to provide a 2m swale with side slopes at 1:6 grade (depth=0.167m) along the eastern boundary for the full length of the mound.

4. Stormwater Quality

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) has been utilised as the key water quality modelling tool for this project. MUSIC is a continuous simulation water quality model used to evaluate the short and long-term performance of stormwater improvement devices that are configured in series or in parallel to form a 'treatment train'. MUSIC enables the end-user to determine if proposed systems can meet specified water quality objectives.

The model considers suspended solids, total nitrogen and total phosphorus, which are typical components and key indicators of stormwater runoff. The key MUSIC inputs are:

- Rainfall and evaporation data (As provided by Penrith City Council).
- Catchment area and percentage impervious.
- Soil storage parameters.
- Pollutant event mean concentrations for source nodes (As provided by Penrith City Council WSUD Technical Guidelines, Version 3, June 2015).

All input parameters to the model were derived from climate data supplied by Penrith City Council or estimated from the MUSIC model guidelines (2010) and other published papers.

MUSIC model outputs include treatment train effectiveness; These outputs are expressed in terms of pollutant reduction as shown in Figure 7.

4.1. Water Quality Objectives

The water quality objectives as listed in Item 3.2 Stormwater Quality, as per Penrith City Council Policy EH 003: Water Sensitive Urban Design (WSUD) Policy, must be satisfied as per Figure 7 below.

Figure 8 identifies the source node and storm flow parameters that have been used for the MUSIC modelling as per the requirements in Penrith City Council WSUD Technical Guidelines 2015.

Performance Criteria

Stormwater quality requirements for all development types identified in Table 1 are:

- Pollution load reductions:
  a. 90% reduction in the post development mean annual load of total gross pollutant (greater than 5 mm)
  b. 85% reduction in the post development mean annual load of Total Suspended Solids (TSS)
  c. 60% reduction in the post development mean annual load of Total Phosphorus (TP)
  d. 45% reduction in the post development mean annual load of Total Nitrogen (TN)

Figure 7 | Penrith City Council Water Quality Objectives

Land-use category		Log10 TSS (mg/L)		Log10 TP (mg/L)		Log10 TN (mg/L)	
		Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow
General urban (incl. public open space)	Mean	2.15	1.20	-0.60	-0.85	0.30	0.11
Residential	Std Dev	0.32	0.17	0.25	0.19	0.19	0.12
Industrial							
Commercial							
Road Areas	Mean	2.43	---*	-0.30	---*	0.34	---*
	Std Dev	0.32	---*	0.25	---*	0.19	---*
Roof Areas	Mean	1.30	---*	-0.89	---*	0.30	---*
	Std Dev	0.32	---*	0.25	---*	0.19	---*

Figure 8 | Penrith City Council MUSIC Stormwater Quality Source Nodes

4.2. Modelling Results

Figure 9 and Table 2 show the MUSIC setup and treatment train results using two individual bioretention basins (125m^2 total area) to achieve council's nominated treatment targets. These basins shall be located within the respective detention basin. However, treatment (extended detention) volumes have not been included in on-site detention calculations. Roof water tanks (11x 20KL) proposed for on-site re-use (refer architectural plans) have been included to the model. It has been assumed that the roof area does not include base flow parameters as per Council's specification, however we have assumed that the roof water will connect to the internal network and subsequently will enter the Bioretention basins. Since final design levels are not available, the proposed treatment layout is indicative only and will be refined as part of detailed design.

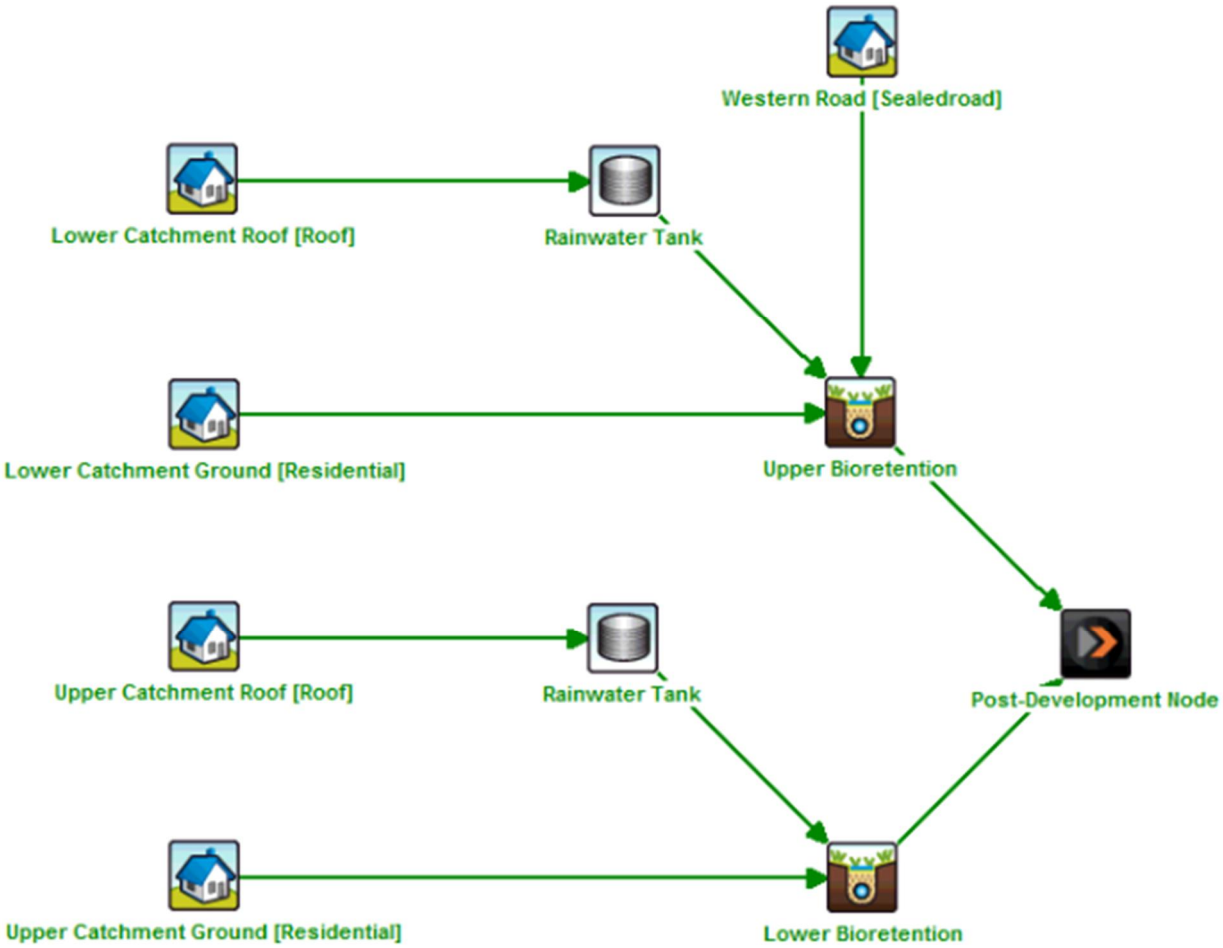


Figure 9 | MUSIC Setup

MUSIC Results							
Pollutant	Sources		Residual Load		% Reduction		
	Pre	Post	Pre	Post	Pre	Post	Objectives
Total Suspended Solids (kg/yr)	524	604	524	96.6	0..00	85.0	85
Total Phosphorous (kg/yr)	0.882	1.3	0.882	0.447	0.00	65.6	60
Total Nitrogen (kg/yr)	6.55	10.7	6.55	4.65	0.00	56.5	45
Gross Pollutants (kg/yr)	78.7	154	78.7	8.42	0.00	94.5	90

Table 2 | Overall Preliminary Development Treatment Train Results

A draft maintenance manual for the operational phase of the bioretention basins is included as Appendix B. Planting and detailing of the basin shall be in accordance with Section 6.1 of the Penrith City Council WSUD Technical guidelines.

5. Summary

This Stormwater assessment has been undertaken in accordance with Penrith City Council Development Guidelines.

Specifically, to adequately mitigate the adverse effects from changes in hydrologic conditions, the development will incorporate:

- Two separate bioretention basins.
- Two separate filtration areas totalling 125m^2 contained within detention basins.
- Two separate detention basins with a total storage volume of 131m^3.
- A 2m wide swale shall be constructed along the eastern boundary to capture any external catchment.

The preliminary stormwater management strategy for the developed case was found to provide adequate pollutant removal efficiencies with respect to Penrith City targets utilising the appropriately sized Bioretention basins, and the northern tree area as the point of discharge. In addition, increases in stormwater quantity as a result of the increased impervious portion of the site can be adequately mitigated.

In conclusion, the above design complies with Penrith City Councils Development Design Specification for stormwater water quality and quantity. As no final design levels have been provided, the proposed layout is indicative only and may change during the detailed design phase. However, the minimum requirements for stormwater features have been identified to cater for this project.

Final location and arrangement of stormwater infrastructure is to be confirmed during the detail design stage.

6. References

The information presented herein has been prepared with reference to the following:

- Penrith Development Control Plan 2014, Volume 1.
- Water by design, MUSIC Modelling Guidelines, Version 1.0, 2010.
- Penrith City Council Policy Document, EH 003, Waste Water Urban Design (WSUD) Policy.
- Penrith City Council WSUD Technical Guidelines, Version 3, June 2015.

Appendix A | Stormwater Design Checklist

7. APPENDICES

APPENDIX A

CHECKLIST FOR STORMWATER CONCEPT PLAN (SCP)

Survey Information	Yes	No	NA
1. Site boundaries	■	☐	☐
2. North point	■	☐	☐
3. Services within the public footway	☐	☐	■
4. Site features, including tree, structures, depressions	■	☐	☐
5. Contours at 0.1m for flat sites ranging to 0.5m for steep sites and extending 10m into adjoining properties	■	☐	☐
6. Top of kerb levels	☐	☐	■
7. Boundary levels	■	☐	☐
8. Benchmarks	☐	☐	■
9. Levels to AHD where site is affected by overland flow, flooding or where works on Council's drainage network are required	☐	☐	■
General	**Yes**	**No**	**NA**
1. Plans to scale of 1:100 or 1:200 1:500 provided	☐	■	☐
2. Designer's name, qualifications, contact details provided	■	☐	☐
3. Design report, including details of any variations provided	■	☐	☐
4. Plan number and date of issue shown	■	☐	☐
5. Consistency between stormwater, architectural and landscape plans	■	☐	☐
6. 1% AEP overland flow extents shown	■	☐	☐
7. Development layout, building envelope and proposed driveway locations shown	■	☐	☐
8. Drainage calculations to support the proposed design submitted	■	☐	☐
9. Proposed finished floor, garage and ground surface levels shown	■	☐	☐

10. Compliance with freeboard requirements	☐	☐	■
11. Location and level of proposed retaining walls indicated	☐	☐	■
12. Appropriate tail water selected	☐	☐	■
13. No adverse impact on other properties or the stormwater network	■	☐	☐
14. Mainstream flood / local overland flow flood report (if any)	☐	☐	■
Drainage Layout	**Yes**	**No**	**NA**
1. Pipe size, grade and invert level indicated	☐	☐	■
2. Pit location, size, invert level and surface level indicated	☐	☐	■
3. Proposed connection point to Council's stormwater system	☐	☐	■
OSD	**Yes**	**No**	**NA**
1. A catchment plan showing areas draining to the OSD system.	■	☐	☐
2. Location and size of OSD system and WSUD measures shown	■	☐	☐
3. Location and level of OSD discharge points shown	■	☐	☐
4. Compliance with detention volume required	■	☐	☐
5. Compliance with less than 15% of site area bypassing OSD system	■	☐	☐
6. Compliance with the Permissible Site Discharge (PSD) requirements	■	☐	☐
7. Compliance with OSD storage depths	■	☐	☐
8. Overland flows clear from the OSD system	■	☐	☐
9. OSD storage located within common areas, clear of private courtyards and accessible from the street	■	☐	☐
10. Overflow weir provided and shown	■	☐	☐
11. Details of discharge control pit shown	■	☐	☐
12. Orifice details and calculations shown	■	☐	☐
13. Typical sections of OSD storage, including basin invert level, centreline level of outlet orifice, top water level, finished surface levels provided	■	☐	☐
14. Provision of design certification of the OSD system in accordance with this policy	■	☐	☐

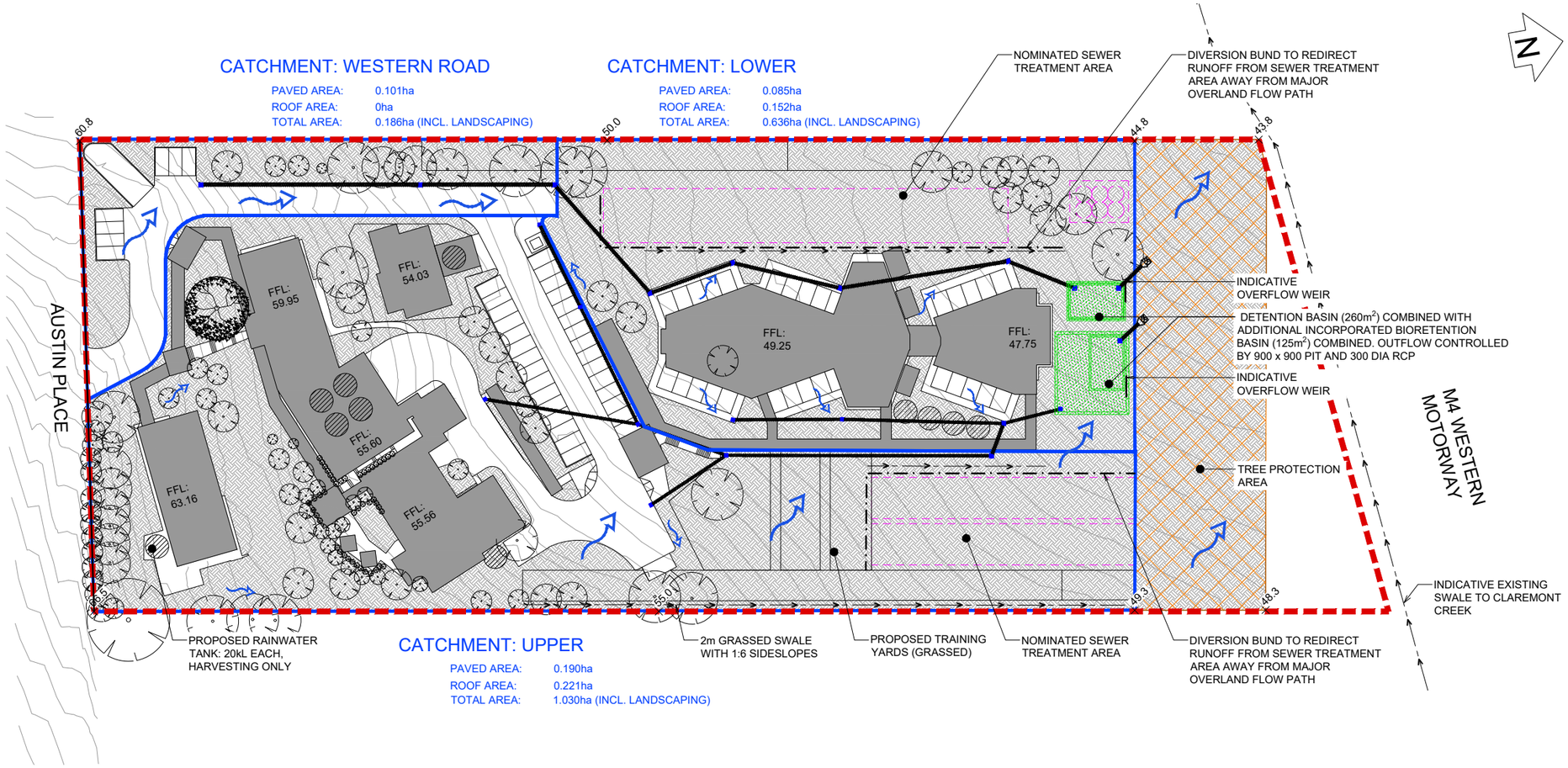
Others	Yes	No	NA
1. Location of Council's drainage easements, private inter-allotment easements shown (if any)	☐	☐	■
2. Location and details of basement pump-out system provided (if any)	☐	☐	■
3. Location and details of overland flow path shown (if any)	■	☐	☐

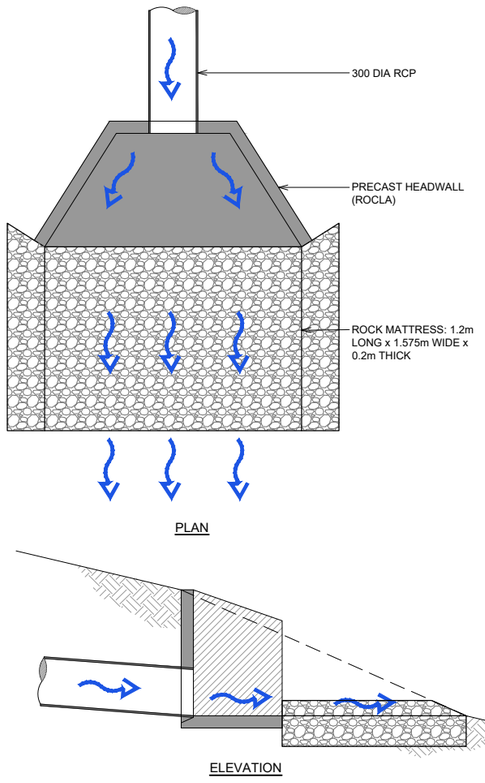
Appendix B | Stormwater Assessment Drawings

100mm AT ORIGINAL SIZE

LEGEND

- DEVELOPMENT BOUNDARY
- CATCHMENT BOUNDARY
- OVERLAND FLOW ARROW
- 0.5m CONTOURS
- LANDSCAPED AREA
- PAVED AND ROAD AREA
- ROOF AREA
- BIORETENTION AREA
- TREE PROTECTION AREA
- NEW/ EXISTING SWALE
- DIVERSION BUND
- PROPOSED DRAINAGE NETWORK
- EFFLUENT DISPOSAL AREA
- PROPOSED RAINWATER TANK: 20kL EACH



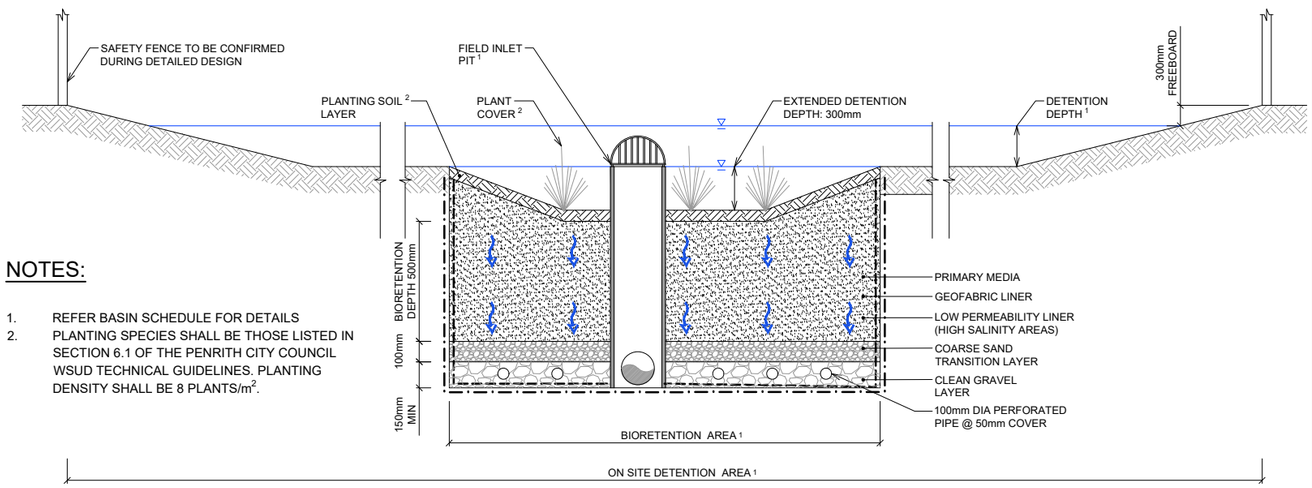


BASIN OUTLET DETAIL

SCALE: NOT TO SCALE

BASIN SCHEDULE

CATCHMENT	WESTERN ROAD/ LOWER	UPPER
DETENTION AREA: TOB	85m²	230m²
DETENTION AREA: BOB	74m²	200m²
DETENTION DEPTH	300mm	500mm
DETENTION VOLUME	23.9m³	107.5m³
BIORETENTION AREA: TOB	72.6m²	72.6m²
BIORETENTION AREA: BOB	62.5m²	62.5m²
BIORETENTION DEPTH	300mm	300mm
BIORETENTION VOLUME	20.3m³	20.3m³
OUTFLOW PIT TYPE	900x900 FI	900x900 FI
OUTFLOW PIPE TYPE	300mm RCP	300mm RCP



NOTES:

1. REFER BASIN SCHEDULE FOR DETAILS
2. PLANTING SPECIES SHALL BE THOSE LISTED IN SECTION 6.1 OF THE PENRITH CITY COUNCIL WSUD TECHNICAL GUIDELINES. PLANTING DENSITY SHALL BE 8 PLANTS/m².

COMBINED DETENTION AND BIORETENTION BASIN TYPICAL DETAIL

SCALE: NOT TO SCALE

PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DATE	DRAWN	DESIGN	CHECK	APPROVED
A	ISSUED FOR APPROVAL	19/04/16	TV	TV	BG	BG
B	CHANGES TO LAYOUT	03/07/17	TV	TV	BG	BG
C	CHANGES TO LAYOUT	18/12/17	NVO	NVO	MP	MP
D	ISSUED FOR COUNCIL COMMENTS	18/04/18	NVO	NVO	BG	MP
E	CHANGES IN LAYOUT	20/09/18	NVO	NVO	MP	MP

SCALES:
0 5 10 20 30
Full Size 1:500 ; Half Size 1:1000
Scale (m)
DO NOT SCALE FROM DRAWING

DRAWN BY: N. VAN OERS (BEng)
DESIGN BY: N. VAN OERS (BEng)
APPROVED BY:
DATE:
THIS DRAWING MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED

PLANIT CONSULTING
SUITE 9A, 80-84 BALLINA STREET
PO BOX 161
LENNOX HEAD NSW 2478
TELEPHONE: 02 6687 4666
ABN: 99 613 049 568
EMAIL: administration@planitconsulting.com.au

CLIENT: ASSISTANCE DOGS AUSTRALIA
C/- THERIAN PTY LTD
UNIT 10, 75 WATERWAY DRIVE
COOMERA
QLD 4209

LOCAL GOVERNMENT AUTHORITY: PENRITH CITY COUNCIL

PROJECT: ADA DOG TRAINING FACILITY
DRAWING TITLE: DRAINAGE LAYOUT PLAN

ORIGINAL SIZE:	PLANIT JOB No.:	DRAWING No.:	REV:
A1	J082	0001	E

CAD FILE: I:\J082 - SWMP - ASSISTANCE DOGS AUSTRALIA\6 - CAD\J082 - ASSITANCE DOGS SMP REV C.DWG PLOTTED BY: NIEKV PLOT DATE: 25/09/2018 5:13:17 PM

Appendix C | Bioretention Basin Maintenance Manual

Suite 9A, 80-84 Ballina Street, Lennox head NSW 2478
PO Box 161, Lennox Head NSW 2478
(02) 6687 4666
www.planitengineering.com.au

DRAFT MAINTENANCE PLAN FOR BIORENTENTION AND DETENTION BASINS

1. INSPECTION

Following construction, bioretention systems should be inspected every 1 to 3 months (or after each major rainfall event) for the initial vegetation establishment period to determine whether the bioretention zone requires maintenance or the media requires replacement. The following critical items should be monitored:

- Ponding, clogging and blockage of the filter media;
- Establishment of desired vegetation/plants and density; and
- Blockage of the outlet from the bioretention system.

After an initial establishment period of 1 year, inspections may be extended to the frequencies shown in Maintenance and Inspection Checklist for Bioretention Systems (Section 3).

2. MAINTENANCE

The following maintenance activities will be required with inspection frequencies shown in the Maintenance and Inspection Checklist:

- Maintenance of flow to and through the system;
- Maintaining the surface vegetation;
- Preventing undesired overgrowth vegetation/weeds from taking over the area;
- Removal of accumulated sediments; and
- Debris and litter removal.

3. MAINTENANCE AND INSPECTION CHECKLIST

- Removal of debris and litter (every six months), ensure the following are clear of debris and litter:
  - Basin surface;
  - Inlet and outlet area; and
  - Overflow area.
- Trench surface vegetation (every six months), inspect and make good the following:
  - Condition of vegetation;
  - Maintenance and trimming of vegetation;
  - Weeds; and
  - Erosion.
- Dewatering (every six months), inspect and make good the following:
  - Trench surface dewatering between storms;
  - Condition of top soil layer; and
  - Condition of planting media.
- Outlet pit and overflow channel (annual), inspect and make good the following:
  - General pit and grate condition;
  - Deterioration of concrete structures; and
  - Erosion.

Appendix D | Energy Dissipater Design Calculations

Energy Dissipater Calculation Details

Flow From Pipe	0.23	m^3/s	From DRAINS Model
Velocity From Pipe	3.23	m/s	
Apron Details			From Austroads
Length	1.2	m	0.9m minimum required
Stone Diameter	100	mm	d50
Width	1.575	m	Based on Rocla standard culvert size
Downstream Hydraulic Details			Using Manning's Equation
Manning's n	0.039		
Flow width	1.575	m	
Flow height	0.117	m	
Flow Cross-sectional Area	0.184275	m^2	
Hydraulic Radius	0.102	m	
Slope	5	%	Assumed
Resulting Flow	0.23	m^3/s	
resulting Velocity	1.27	m/s	