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Strategic Environmental & Engineering Consulting

Concept Stormwater and Water Quality Management Report

for the Proposed Subdivision of Lot 91 in DP 751270 Bell Street, Thirlmere

Prepared by:

Jason Armstrong
SEEC Reference 17000055-SWM-01 REV00

29TH June 2017

Strategic Environmental and Engineering Consulting

PO Box 1098, Bowral NSW 2576
phone: (02) 4862 1633 • fax: (02) 4862 3088 • email: reception@seec.com.au

Document Certification

This report has been developed based on agreed requirements as understood by SEEC at the time of investigation. It applies only to a specific task on the nominated lands. Other interpretations should not be made, including changes in scale or application to other projects.

Any recommendations contained in this report are based on an honest appraisal of the opportunities and constraints that existed at the site at the time of investigation, subject to the limited scope and resources available. Within the confines of the above statements and to the best of my knowledge, this report does not contain any incomplete or misleading information.

Jason Armstrong
Senior Civil Designer
SEEC

29th June 2017

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1 Introduction

Strategic Environmental and Engineering Consulting (SEEC) have been commissioned by Rein & Warry Pty and Co on behalf of the owners of Lot 91, DP 751270 45 Bell Street, Thirlmere (the 'Subject Site', Figure 1) to prepare this *Concept Stormwater and Water Quality Management Plan*. It is required to accompany a Development Application to Wollondilly Shire Council to subdivide the existing semi-rural zoned allotment into seventeen new residential allotments with each lot averaging approximately 600m^2 in size.

The aim of this *Concept Stormwater and Water Quality Management Report* is to:

- Identify areas of the site that could be potentially effected by localised flooding;
- Identify existing stormwater infrastructure adjacent to the site;
- Identify Pre and Post development stormwater flows from the site;
- Discuss Pre and Post development stormwater quality objectives;
- Provide concept Stormwater and Water Quality Management practices to be incorporated into the development of the site.

Figure 1 - Site Locality Plan

2 The Proposal

It is proposed to subdivide the existing semi-rural zoned allotments into seventeen new residential allotments, with each lot averaging approximately 600m^2 in area.

3 The Site

3.1 Site Location and General Topographical Details

'The Site' comprises Lot 91, DP 751270, 45 Bell Street Thirlmere and has a combined area of approximately 1.29 ha. It is located on the fringe of the existing urban area (Figure 2) and is located approximately 400 m south east of the main centre of Thirlmere.

There is one existing dwelling on the site along with various outbuildings/sheds. The site is reasonably flat with a constant fall from the south boundary to the northern boundary of the development of approximately 2-2.5 percent. There is an existing dam located on the southern boundary of the site with an overflow directed to an overland flow path (1st order stream) in the middle of the site draining to a low point (sag pit) in Bell Street.

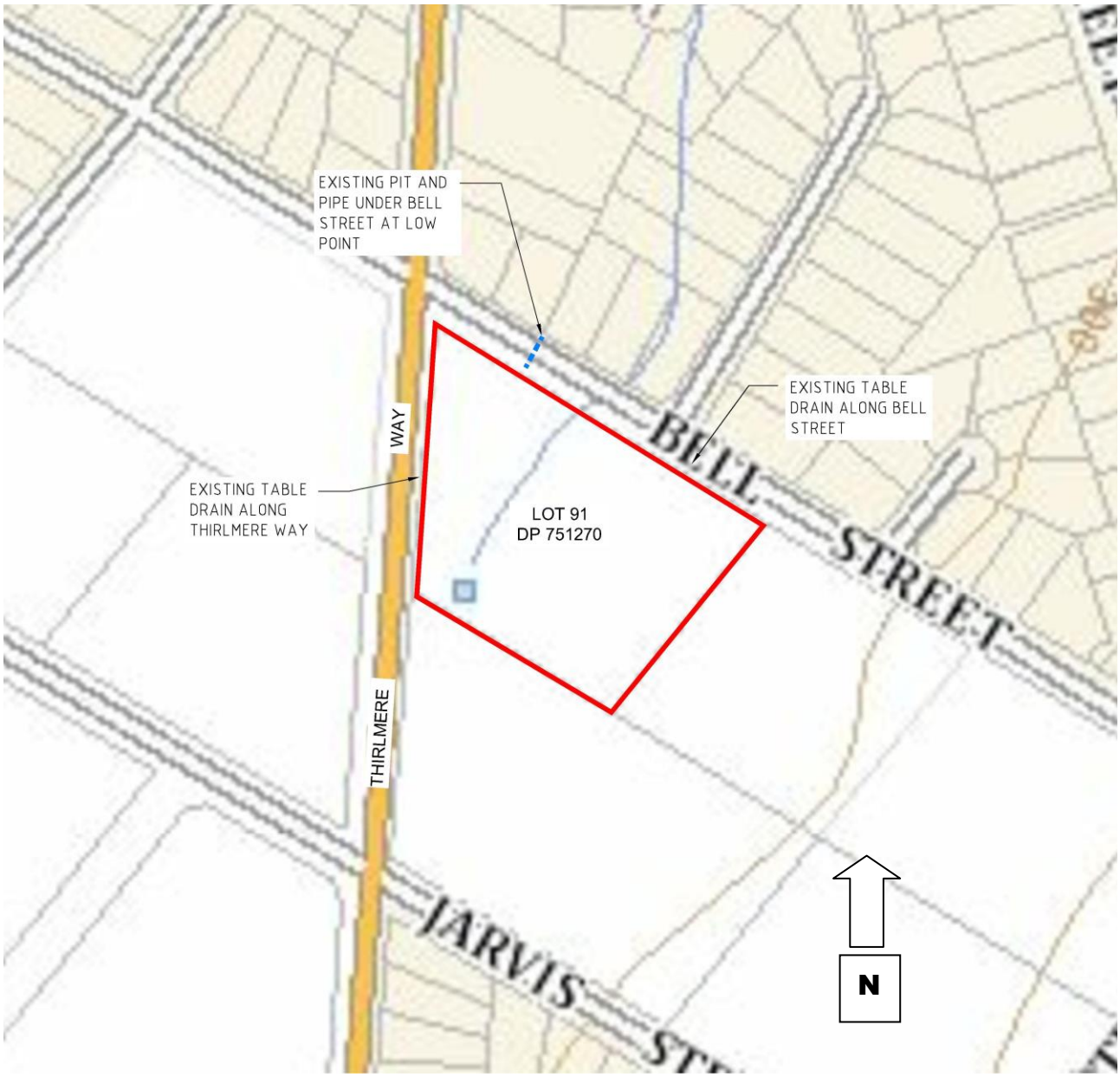


Figure 2 – Development Area

4 Hydrology

4.1 Rainfall Data

The Intensity Frequency Duration (IFD) rainfall data for the site is based on data presented in Australian Rainfall and Runoff (1987 IFD data) and site specific calculations for Thirlmere. A copy of the IFD Chart and table for the site is attached in Appendix A.

4.2 Catchment Areas

The existing and proposed catchment areas are shown in Figures 3 and 4.

4.3 Pre and Post Development Hydrology

A DRAINS model was set-up using the ILSAX hydrological model to determine the total pre-development and post development flows from the site and from the upstream sub-catchment for all storm events ranging from 1 year ARI to 100 year ARI. The computer model also contained the following parameters:

- Paved (impervious) area depression storage (mm) = 1
- Supplementary area depression storage (mm) = 1
- Grassed (pervious) area depression storage (mm) = 5
- Soil Type = 3
- AMC (Antecedent Moisture Condition) = 3

The model includes the existing urban development upstream on the eastern side of Thirlmere Way but does not include the catchment on the western side of Thirlmere Way. These flows are to be diverted north along Thirlmere Way within a new piped drainage system to be constructed as part of the adjoining development. (Development Application numbers 010.2015.00000854.001, 010.2015.00000854.001 & 010.2015.00000854.001).

The resultant combined flows from each of the sub-catchments are shown in Table 1 for both the pre-development and post development scenarios. Refer to Figures 3 and 4 for each contributing catchment size and location, pre and post development.

Table 1 – Pre and Post Development Peak Flows

Storm Event ARI (Yr)	Pre-Development (m^3/s)	Post-Development No OSD (m^3/s)
1	0.264	0.44
2	0.47	0.672
5	0.794	1.02
10	0.97	1.21
20	1.25	1.5
50	1.53	1.71
100	1.81	1.99

The resultant post development flows indicate a significant increase in stormwater run-off from the site without any on site detention. Section 6 outlines how these increased flows would be managed within the development area so that downstream properties would not be impacted.

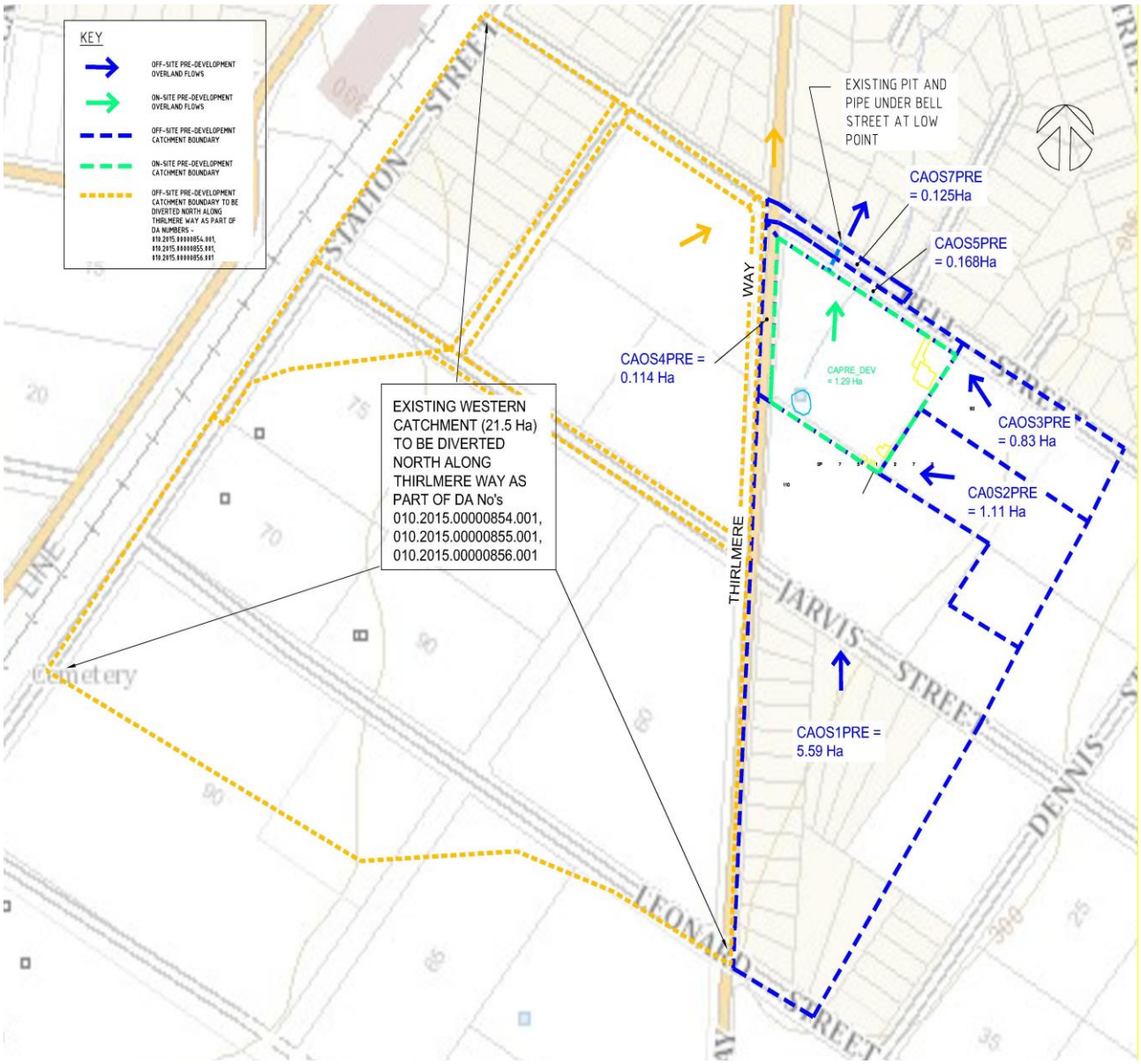


Figure 3 – Existing Site Catchment Plan

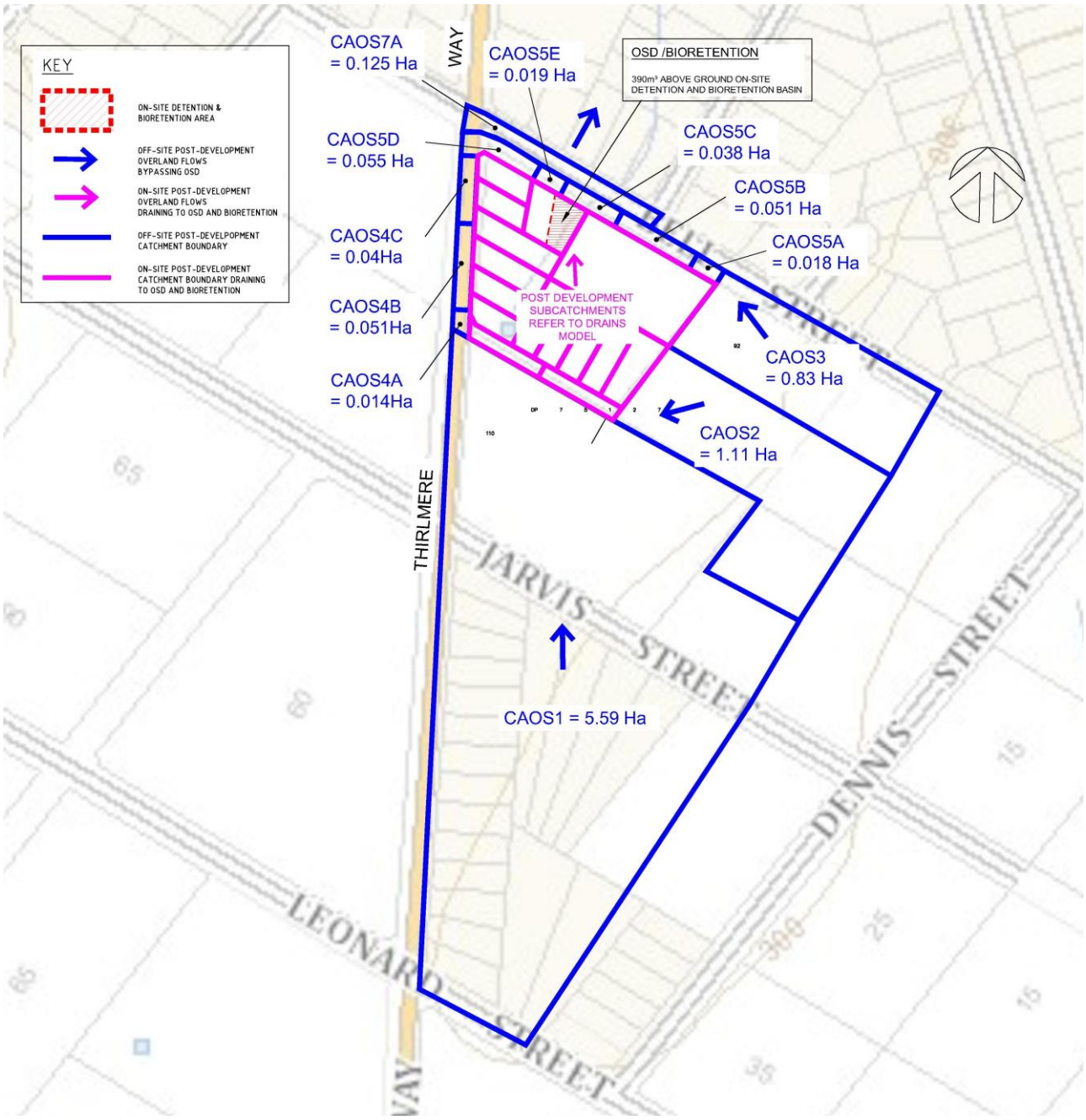


Figure 4 – Concept Development Site Catchment Plan

5 Flooding

The site is located at the bottom of a 30.7 Ha catchment and is subject to localised flooding during significant storm events, particularly at the low point in Bell Street. This localised flooding is exacerbated due to blockage of the downstream overland flow path within the nominated drainage easement. This easement is located within existing downstream residential properties and is intermittently blocked by vegetation, fencing and some minor structures/garden sheds etc.

As previously discussed in Section 4.3, Council requested that the 21.5 Ha catchment to the west of Thirlmere Way (Figure 4) be diverted to the north along Thirlmere Way via a new pipe drainage system. This would significantly reduce the size of the catchment draining to the low point and existing 750 diameter RCP in Bell Street, reducing it from 30.7 Ha to just 9.2 Ha. Drainage modelling undertaken in DRAINS shows that the existing 750 dia. RCP is sufficient to take flows from this reduced catchment for the 10 year ARI event.

It is also recommended that Council enforce the downstream easement's overland flow path by ensuring that any illegal structures or vegetation are removed from the stormwater easement and that clear openings with mesh screens are provided where existing fencing crosses the easement.

6 Concept Surface Water Management Plan

The following stormwater management principles would be adopted as part of the development.

6.1 Construction Phase Erosion and Sediment Control

6.1.1 During Subdivision

A construction-phase Soil and Water Management Plan (SWMP) will be required before commencing work on this development. This Plan will be prepared in accordance with the guidelines and recommendations in Landcom (2004). The SWMP is to be developed to incorporate the following generic principles:

(i) Sediment fencing is to be used downslope of any construction area until works are complete (Standard Drawing SD 6-8, Landcom, 2004).

(ii) Topsoil will be stripped off any construction areas and stockpiled following Standard Drawing SD 4-1 (Landcom, 2004) for later re-use.

(iii) The upslope catchment length of exposed soil areas will be kept below 80 m. Any slope length exceeding 80 m will have a berm installed to direct overland flows onto well-protected, vegetated lands.

(iv) Show the location and sizing of sediments basins, if required, depending on the size of the area of exposed soils and any stage construction of the development.

(v) Construction traffic access is to be limited to the minimum required for efficient construction. Areas not essential for construction purposes are to be protected from traffic entry through the use of barrier and/or sediment fencing. Table 2 contains details of access limitations during construction in accordance with Landcom (2004).

(vi) Any required pipe/culvert outlets shall be stabilised with riprap and geo-textile underlay (Standard Drawing SD 5-8, Landcom, 2004). Downslope of the riprap a good cover of vegetation is necessary.

(vii) While C-factors are likely to rise to 1.0 during the work's program, they will not exceed those given in Table 3.

(viii) Diversion berms will be used to divert "clean" runoff from upslope of any construction areas away. Discharges are to be onto a stabilised, well-vegetated area, preferably using a level spreader or sill.

(ix) Rapidly rehabilitate disturbed lands to bring C-factors down to acceptable levels (see Table 3) and minimise the risk of erosion.

(x) Areas of concentrated flow (e.g. drainage pathways, swales etc.) are to be protected using appropriate erosion control measures (see Table 2). We suggest an appropriate biodegradable Rolled Erosion Control Product (RECP) such as

coconut fibre matting or jute matting to provide stable ground cover until vegetation regenerates for low velocity concentrated flows.

(xi) Dust Control Measures during earthworks. This would include re-using water from sediment basins and spaying exposed areas via water cart.

The requirements of the SWMP would be implemented until at least 90 percent of the site was stabilised with hard surfaces or satisfactory vegetation.

Table 2 - Limitations to access during construction works

Land use	Limitation	Comments
Construction areas	Limited to 5 (preferably 2) metres from the edge of any essential construction activity as shown on the engineering plans	All site workers should clearly recognise these areas that, where appropriate, are identified with barrier fencing (upslope) and sediment fencing (downslope) or similar materials.
Access areas	Limited to a maximum width of 5 metres	The site manager will determine and mark the location of these zones on site. They can vary in position so as to best conserve existing vegetation and protect downstream areas while being considerate of the needs of efficient works activities. All site workers will clearly recognise these boundaries
Remaining lands, including re-veg areas	Entry prohibited except for essential management works	Thinning of growth might be necessary, for example, for fire reduction or weed removal

Table 3 - Maximum Acceptable C-Factors at Nominated Times During Works

Lands	Maximum *C*-factor	*Remarks*
Waterways and other areas subjected to concentrated flows (e.g. table drains), post construction	0.05	Applies after ten working days from completion of formation and before they are allowed to carry any concentrated flows. Flows will be limited to those shown in Table 5.2 of Landcom (2004). Foot and vehicular traffic will be prohibited in these areas
Stockpiles, post construction	0.1	Applies after ten working days from completion of formation. Maximum C-factor of 0.10 equals 60% ground cover
All lands, including waterways and stockpiles during construction	0.15	Applies after 20 working days of inactivity, even though works might continue later. Maximum *C*-factor of 0.15 equals 50% ground cover

6.1.2 Individual Houses

Each new home construction would implement a lot-scale Erosion and Sediment Control Plan (ESCP) to the requirements of Landcom (2004). It would be important this is done to protect any stormwater quality devices installed as part of the development.

6.2 Stormwater Drainage System

6.2.1 Earthworks

It is envisaged that some minor site earthworks and re-grading would be required for the installation of the new road and stormwater drainage infrastructure. All lots would drain to a road or interalottment drainage system.

6.2.2 Road Drainage

(i) Thirlmere Way

A new kerb and gutter and associated lane widening is to be constructed along the eastern side of Thirlmere Way for the full length of the development frontage. The new kerb and gutter would include driveway laybacks for access to each allotment. It is also proposed to construct a new piped drainage system along Thirlmere Way with intermittently-spaced, grated kerb inlet pits. This new piped drainage line would extend down past the development site and connect into the proposed drainage line to be constructed downstream in Thirlmere Way as part of the adjacent development located on the western side of Thirlmere Way. Refer to drawing STW02 (Appendix C).

The new trunk drainage system would be designed to convey all storms up to and including the 10 year ARI event in accordance with Section D5.04(4) of Wollondilly Shire Council's *'Design Specifications for Subdivision and Engineering Standards'*.

Storm flows greater than 10 year ARI and up to the 100 year ARI would be conveyed overland within the road system.

(ii) Bell Street

A new roll kerb and gutter and associated lane widening is to be constructed along the southern side of Bell Street for the full length of the development frontage.

It is proposed to construct a new piped drainage system along the southern side of Bell Street with intermittently-spaced, grated kerb inlet pits. The new trunk drainage system would be designed to convey all storms up to and including the 10 year ARI event in accordance with Section D5.04(4) of Wollondilly Shire Council's *'Design Specifications for Subdivision and Engineering Standards'*.

Storm flows greater than 10 year ARI and up to the 100 year ARI would be conveyed overland within Bell Street and directed to the exiting low point and 750 diameter pipe in Bell Street.

(iii) Proposed New Road 1

The proposed new Road 1 is to be a half-road construction. A roll kerb and gutter is to be constructed along the northern side of the development.

It is also proposed to construct a new piped drainage system under the proposed roll kerb with intermittently-spaced, grated kerb inlet pits. The new trunk drainage system would be designed to convey all storms up to and including the 10 year ARI event in accordance with Section D5.04(4) of Wollondilly Shire Council's *'Design Specifications for Subdivision and Engineering Standards'*.

Storm flows greater than 10 year ARI and up to the 100 year ARI would be conveyed overland within the kerb and gutter along the road network. Refer to drawing STW01 (Appendix C).

6.2.3 Site and Inter-allotment Drainage & Flood Management

Surface water flows from individual lots would be conveyed to the streets and inter-allotment drainage lines located in dedicated drainage easements. These will also form dedicated overland flow paths for storms greater than the minor storm piped flow. Refer to drawing STW01 Appendix C for concept stormwater layout system design capacity.

6.2.4 Rainwater Tanks

Each new dwelling would be fitted with a rainwater tank to capture roof runoff. Each tank would:

(i) Have a capacity of 10,000 L (minimum).

(ii) Have the top 5,000 L of the tank(s) dedicated to on-site detention.

(iii) Have a first-flush device.

(iv) Be screened to prevent the entry of leaves, twigs and mosquitos.

(v) Be plumbed to toilet and laundry, and at least one outdoor tap.

(vi) Overflow to either a nearby gutter or directly into a bioretention swale (if required for water quality purposes).

(vii) Be topped up from mains supply and that would require a back-flow prevention valve.

In addition to the above, each house is to employ water saving fittings with three-star rating or better. The tanks would be used to contribute to the total on-site detention requirements.

6.2.5 On-Site Detention

As discussed in Section 4.3, post development flows would increase due to increased impervious area without on-site detention. Flow will be reduced by the provision of rainwater tanks for the capture and use of rainwater within each dwelling (Section 6.2.1) and an above-ground on-site detention (OSD) basin located at the end of the catchment and located in a drainage reserve. Together, these would limit post-development flows to no more than pre-development flows.

The location of the OSD basin is shown on the Concept Stormwater Drainage Plan – STW01 (Appendix C). The required OSD storage volume and post development outflow for all storms from the 1 Year to the 100 Year ARI storm events have been summarised in Table 4 below.

Table 4 – On-Site Detention Basin Size Summary

Storm Event ARI (Yr)	Pre-Development (m^3/s)	Post-Development No OSD (m^3/s)	Post-Development With OSD (m^3/s)	OSD1 Storage Provided (m^3)
1	0.264	0.44	0.27	222
2	0.47	0.672	0.448	249
5	0.794	1.02	0.74	272
10	0.97	1.21	0.884	289
20	1.25	1.5	1.116	327
50	1.53	1.71	1.374	361
100	1.81	1.99	1.642	391

The on-site detention basin is to be constructed using a combination of an earthen berm and block retaining wall. Discharge from the OSD would be controlled using a discharge control pit fitted with an orifice plate.

It is proposed to use the road network to convey all off-site upstream flows around the development so that they bypass the on-site detention basin.

6.2.6 Bioretention Basin

A 100m^2 bioretention basin is to be constructed within the base of the above ground on-site detention basin.

The bioretention basin would have the following characteristics:

- Have a filter area of 100 m^2
- Have a 300 mm ponding depth

- Have an overflow weir at the surface
- Have a 400 mm thick filtration layer of loamy sand (see spec. below)
- Have a 100 mm thick transition zone
- Have a 300 mm thick drainage layer
- Be unlined to allow infiltration into the naturally-permeable soils
- Be planted with moisture loving species such as *Carex* and *Juncus* at 8 plants/m^2

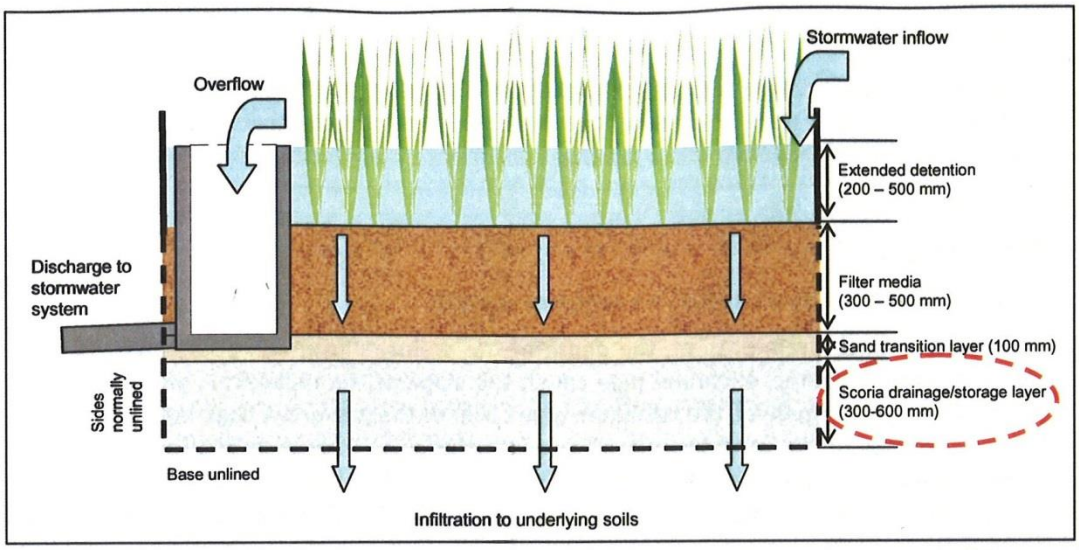


Figure 5 – Typical Section Through Bioretention Basin

Bioretention Basin Media Specification

The filtration media will be well-graded loamy sand with:

- *Hydraulic conductivity (ASTM F1815-06) between 250 and 300 mm/hour*
- *pH between 5.5 and 7.5*
- *Organic content less than 5 percent*
- *Electrical conductivity less than 1.2 dS/m*
- *Orthophosphate content less than 20 mg/kg*
- *Total nitrogen content <400 mg/kg*

Subject to adequate hydraulic conductivity the following particle size distribution is a guide:

Clay and silt	*< 3%*	*(<0.05 mm)*
Very fine sand	*5-30%*	*(0.05 - 0.15 mm)*
Fine sand	*10-30%*	*(0.15 - 0.25 mm)*
Med-Coarse sand	*40-60%*	*(0.25 - 1.0 mm)*
Coarse sand	*7-10%*	*(1.0 - 2.0 mm)*
Fine gravel	*<3%*	*(>2.0 mm)*

The filtration media will be compacted with one pass of a vibratory plate compacter or drum roller.

The transition layer shall be clean, well-graded sand containing little or no clay and silt (<2%). D15 of the transition layer must be <5 x D85 of the filter media.

The drainage layer shall be 2 - 7 mm washed screenings with <2% silt and clay.

6.2.7 Diversion Swales

Diversion swales located within Bell Street are to have a 1m wide base, 1 in 4 side slopes and minimum 300 deep and to be lined with turf for ease of maintenance.

7 Water Quality Modelling

7.1 Pollutant Reduction Targets

The Wollondilly Shire Council has a Water Sensitive Urban Design Policy that states their required pollutant reduction targets as:

- 70% reduction of gross pollutants (trash, litter, vegetation >5mm)
- 80% reduction in average annual load of coarse sediment
- 45% reduction in average annual load of total phosphorous
- 45% reduction in average annual load of total nitrogen
- 90% reduction in average annual load of hydrocarbons, motor oil & grease

7.2 Water Quality Modelling Introduction

Pre and post development sediment and pollutant loads were modelled using MUSIC (Model for Urban Stormwater Improvement Conceptualisation), developed by the CRC for Catchment Hydrology (now eWater).

MUSIC contains algorithms based on the known stormwater runoff, pollutant generation from typical land uses and the performance characteristics of common stormwater quality treatment measures. These data are derived from research undertaken by eWater and others in Australia and overseas. The models have been developed using MUSIC default parameters (Tables 6 and 7) which has calibrated data for various land uses. Statistics are produced in MUSIC for the following parameters:

- Flow (ML/yr)
- TSS - Total Suspended Solids (kg/yr)
- TP - Total Phosphorus (kg/yr)
- TN - Total Nitrogen (kg/yr)
- Gross Pollutants (kg/yr).

7.3 Climate Data

Creation of a MUSIC catchment file requires an associated meteorological data file that includes rainfall and evapotranspiration. The data used here is supplied by SCA (2012), in particular for Zone 3 which covers land located near to the site (Figure 6 and Table 5).

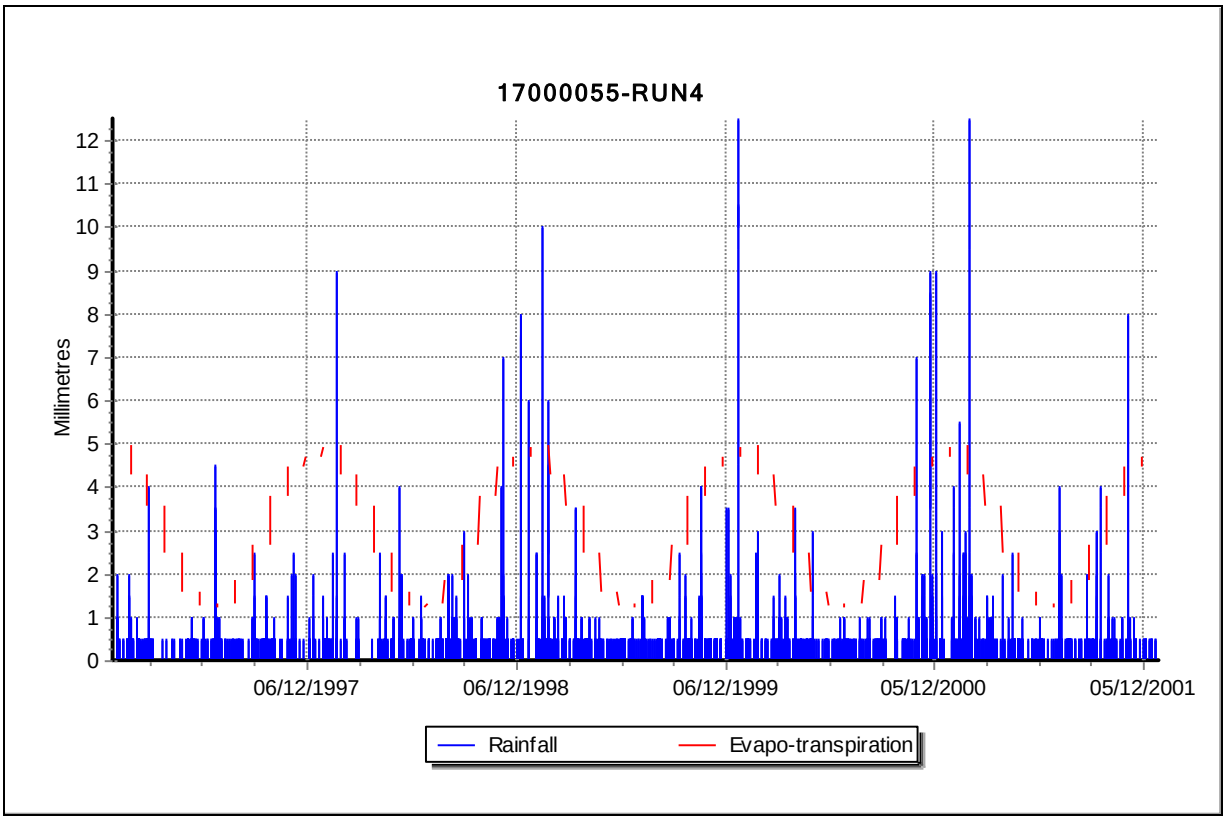
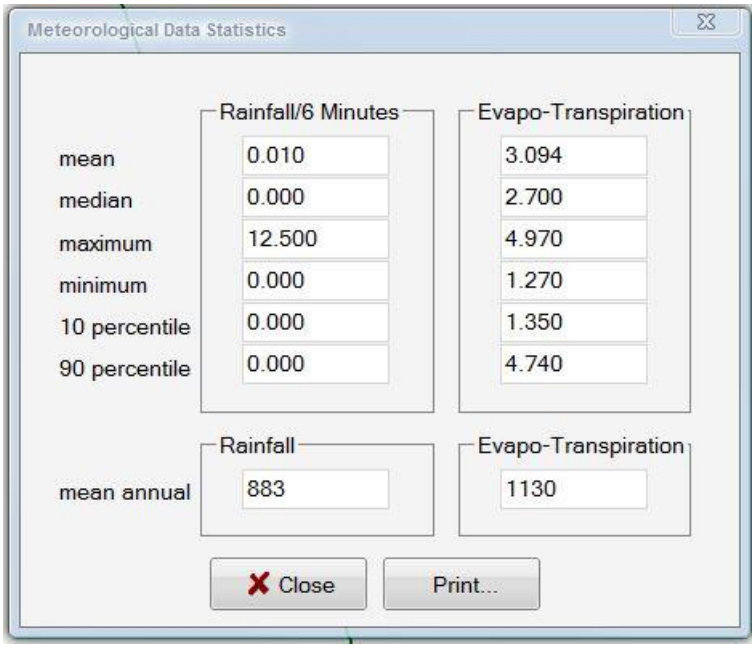


Figure 6 – Time Series Graph for Adopted Rainfall Data (6 minute timestep)

Table 5 – Rainfall and Evapotranspiration Statistics



7.4 Source Node Data

Table 6 presents the stormflow concentration parameters of the various surfaces and land uses. They are the MUSIC default values. Table 7 presents the adopted pervious area runoff properties based on a clay loam soil (SCA, 2012).

Table 6 - Storm flow concentrations (mg/L)

	TSS mean (log mean)	TSS std dev (log std dev)	TP mean (log mean)	TP std dev (log std dev)	TN mean (log mean)	TN std dev (log std dev)
Mixed Urban Land	141 (2.15)	2.09 (0.32)	0.251 (-0.6)	1.78 (0.25)	2 (0.3)	1.55 (0.19)
Roofs	20 (1.3)	2.1 (0.320)	7.8 (-0.89)	1.8 (0.25)	1.78 (0.25)	1.55 (0.19)

Table 7 - Pervious Area Properties

	Clay Loam Soil
Soil storage capacity mm	119
Initial storage %	30
Field capacity mm	99
Infiltration capacity coefficient	180
Infiltration capacity exponent	3
Groundwater initial depth mm	30
Daily recharge rate %	25
Daily baseflow rate %	25
Daily deep seepage rate %	0

7.5 Other Assumptions

For the purpose of modelling we have assumed:

- Each new lot will be developed with a new house having a roof area of 300 m^2
- At least 80% of the roof would drain to its associated rainwater tank
- The remaining land on each lot has an impervious area sufficient to ensure that the total level of imperviousness equals 70% as required by the Wollondilly Shire Council Subdivision and Engineering Standard
- Each new home would have a 10 kL rainwater tank with 5 kL of that dedicated to domestic use. The anticipated demands on that 5 kL are:

- Indoor use at 470 L/day per house (based on a four-bedroom home – toilet and laundry use - SCA, 2012)
- Outdoor use at 55 kL/year (SCA, 2012)

- All catchment areas upstream of the development (south-east) will be diverted around the site and will not flow into the proposed stormwater system
- Overland flow paths will include a swale as an initial stormwater treatment
- The site will include a 400m3 above ground detention basin incorporating a 100m^2 bioretention basin.
- The bio-filtration filter media will be 400mm deep (excluding the drainage layer) and have a hydraulic conductivity of 100mm/hr – 300mm/hr.

7.6 Treatment Train Effectiveness (Results)

A screenshot of the model is provided below. It highlights the break-up of the catchment areas into roof areas that drain to a rainwater tank and areas that flow directly to the stormwater system.

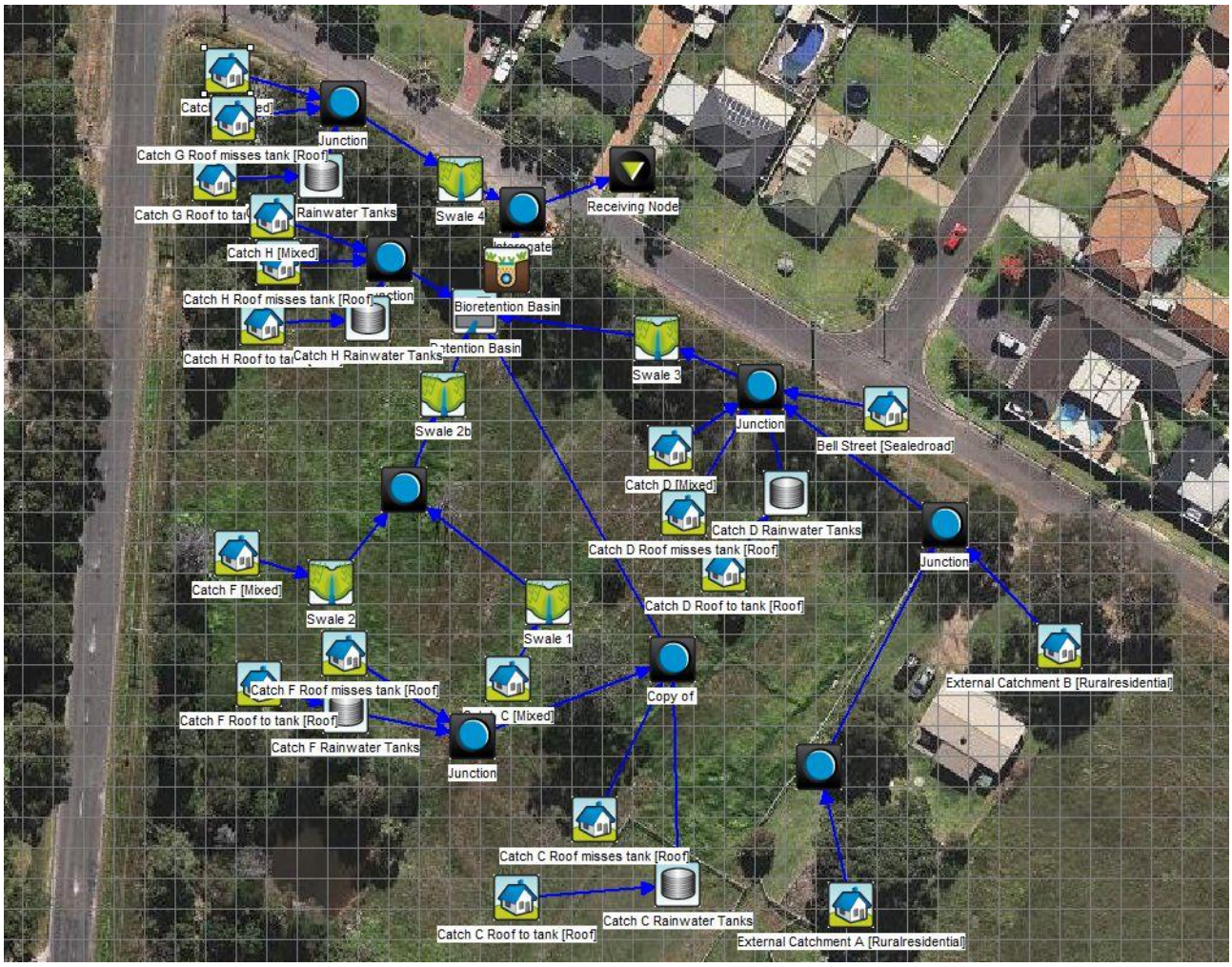
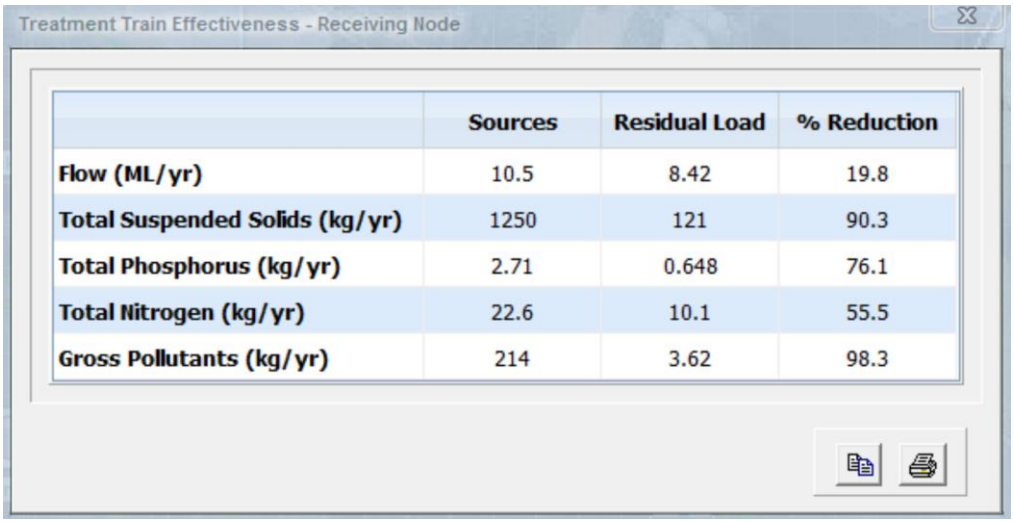


Figure 7 - MUSIC Model Layout

Table 8 below provides the results of the MUSIC modelling. The target reductions for nitrogen and phosphorous (45%) are more than met. The target reduction for total suspended solids (80%) is also more than met.

Table 8 - MUSIC Results[1]



	Sources	Residual Load	% Reduction
Flow (ML/yr)	10.5	8.42	19.8
Total Suspended Solids (kg/yr)	1250	121	90.3
Total Phosphorus (kg/yr)	2.71	0.648	76.1
Total Nitrogen (kg/yr)	22.6	10.1	55.5
Gross Pollutants (kg/yr)	214	3.62	98.3

The results indicate that the bio-fitration area can be redcued and still achieve the desired standard of pollutant removal. This allows for some refinement during detailed design should it not be possible to achieve the nominated filter areas e.g. detailed survey differs from current survey. If the filter area can be reduced, it will allow the additional area to act as a sediment forebay and make cleaning and maintenenace much easier during operation.

7.7 Monitoring and Maintenance

7.7.1 The Developer's Responsibilities

The WSC Subdivision and Engineering Standard states that the developer shall be responsible for cleaning and maintenance of all water quality and detention systems including detention pits, GPTs, bio-retention ponds and filtration pits for a period of three (3) years from the date of Certificate of Practical Completion for the development or the last stage of the development or for any period specified as part of a Voluntary Planning Period Agreement.

It goes on to state that the Developer shall be responsible for cleaning and maintenance of the devices or measures not included in a Voluntary Planning Agreement, for a period of three (3) years from the date of Certificate of Practical Completion. A maintenance and cleaning bond shall be lodged with Council at the time of issue of Certificate of Practical Completion equivalent to 10% of the installation cost or a minimum $3000. At the end of the maintenance period the devices or measures must be cleaned and any defects repaired prior to hand over to Council and release of bond.

[1] SEEC Internal reference = 17000055-RUN9

7.7.2 The Council's Responsibilities

Council would ultimately become responsible for the trunk drainage and the subdivision-scale water quality structures (i.e. the onsite detention basin and the bioretention basin). The bioretention basin would require ongoing maintenance to the requirements of Water by Design (2012b). A copy of this document is freely available from www.waterbydesign.com.au.

7.7.3 The Residents' Responsibilities

The rainwater tank collection system (gutters, pipes, rainwater tanks, pumps and valves) would be maintained by each home owner. They would require periodic inspection and maintenance but the requirements are not great. Periodically the home owners would check all inlets, outlets and pumps for stability and operational performance.

The tanks would be fitted with a back-flow prevention valve such that mains water can be used when the tank level falls below 5 percent. The valve must be checked annually by a registered plumber to the requirements of AS/NZS 2845.1:2010.

8 Recommendations

The following recommendations have been determined based on this stormwater and water quality assessment:

- The site slopes sufficiently to ensure stormwater drainage would not be problematic.
- On-site detention is to be provided in rainwater tanks located on each lot and also within an above-ground OSD basin located within a dedicated reserve. This is to ensure that post development peak flows are controlled and are no greater than pre-development flows.
- WSUD features are to be installed that include rainwater tanks on individual lots and a bioretention basin to be incorporated into the subdivision and to meet Upper Nepean Stormwater Management Plan and Council's required stormwater quality targets. Preliminary computer modelling using MUSIC has been used to show compliance can be met.
- The site is currently affected by some localised flooding during large storm events. With this in mind, new stormwater drainage infrastructure is to be constructed within the development and along Thirlmere Way & Bell Streets to manage stormwater from within and around the development. This, in conjunction with the installation of on-site detention for the development and the diversion of the western upstream catchment to the north along Thirlmere Way, would alleviate some of the minor flooding issues that currently occur in Bell Street during larger these storm events.

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9 References

Engineers Australia (1987) – Australian Rainfall and Runoff, Volumes 1 & 2

Landcom (2004). Managing Urban Stormwater. Volume 1; Soils and Construction.

NSW Government (2001) - *Floodplain Management Manual: The Management of Flood Liable Land.*

SCA (2012). Using MUSIC in Sydney's Drinking Water Catchment. Sydney Catchment Authority, Penrith, NSW.

Water By Design (2012)b. *Transferring Ownership of Vegetated Stormwater Assets (Version 1).* Healthy Waterways Ltd (Brisbane).

Wollondilly Shire Council *(2011) - Local Environmental Plan 2011 LEP 2011.*

Wollondilly Shire Council *(2011) - Development Control Plan DCP 2011.*

10 Appendices

10.1 Appendix A – IFD Table and Chart

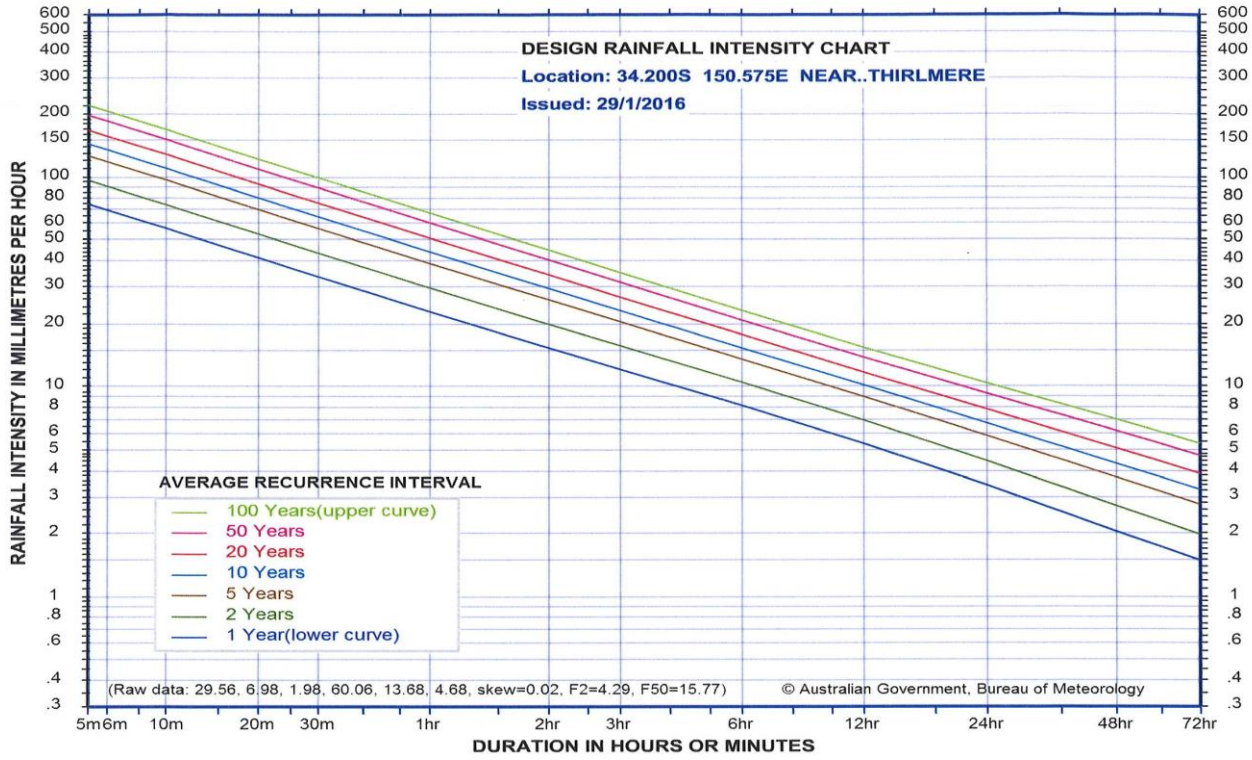
Intensity-Frequency-Duration Table

Location: 34.200S 150.575E NEAR.. THIRLMERE Issued: 29/1/2016

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

	Average Recurrence Interval						
Duration	1 YEAR	2 YEARS	5 YEARS	10 YEARS	20 YEARS	50 YEARS	100 YEARS
5Mins	74.3	96.3	126	144	167	197	221
6Mins	69.5	90.1	118	135	156	185	207
10Mins	56.9	73.7	96.6	110	128	151	169
20Mins	41.3	53.6	70.0	79.8	92.5	109	122
30Mins	33.5	43.4	56.8	64.7	75.1	88.8	99.3
1Hr	22.8	29.6	38.7	44.1	51.1	60.5	67.6
2Hrs	15.3	19.8	25.9	29.4	34.1	40.2	44.9
3Hrs	12.1	15.7	20.4	23.1	26.7	31.5	35.1
6Hrs	8.14	10.5	13.5	15.3	17.7	20.7	23.1
12Hrs	5.37	6.92	8.96	10.2	11.7	13.8	15.4
24Hrs	3.40	4.43	5.84	6.69	7.80	9.27	10.4
48Hrs	2.04	2.70	3.69	4.30	5.09	6.15	6.98
72Hrs	1.49	1.98	2.75	3.24	3.86	4.70	5.37

(Raw data: 29.56, 6.98, 1.98, 60.06, 13.68, 4.68, skew=0.02, F2=4.29, F50=15.77)



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10.2 Appendix B – Site Survey Plan (Over page)

BELL WAY

THIRLMERE WAY

WREN PLACE

KATHLEEN STREET

BUS SHELTER

MANHOLE

BM BOLT
RL 292.02 (AHD)

BM BOLT
RL 295.32 (AHD)

LETTER BOX PIT
IL 289.38 (APPROXIMATE)

POINT

DAM

91

92

110

DP 751270

M.G.A.

NOTE:

THIS PLAN IS PREPARED FOR DETAIL AND LEVEL PURPOSES ONLY AND AS SUCH THE BOUNDARIES OF THE LAND HAVE NOT BEEN SURVEYED OR MARKED.

ANY STRUCTURES RELATED TO PHYSICAL FEATURES (BUILDINGS, TREES, ETC.) MUST BE CONFIRMED PRIOR TO FINAL DESIGN.

ALL SERVICES MUST BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

THIS DETAIL SURVEY IS NOT A 'SURVEY' AS DEFINED BY THE SURVEYORS ACT 1929. IF ANY CONSTRUCTION IS PLANNED IT WOULD BE ADVISABLE TO CARRY OUT FURTHER SURVEY WORK TO DETERMINE THE BOUNDARY DIMENSIONS.

AUSTRALIAN HEIGHT DATUM (AHD) HAS BEEN OBTAIN FROM GNSS OBSERVATIONS UTILISING SmartNet Aus. IF AHD HEIGHT IS CRITICAL ADDITIONAL SURVEY CONNECTIONS TO LOCAL CO-ORDINATED MARKS SHOULD BE MADE.

DISCLAIMER OF LIABILITIES TO ANY THIRD PARTIES : THIS PLAN IS MADE SOLELY FOR THE USE AND BENEFIT OF THE CLIENT NAMED ABOVE AND NO LIABILITY OR RESPONSIBILITY WHATSOEVER IS ACCEPTED TO ANY THIRD PARTY WHO MAY RELY ON THIS PLAN WHOLLY OR IN PART. ANY THIRD PARTIES ACTING OR RELYING OF THIS PLAN WHETHER WHOLLY OR IN PART ARE IN BREACH OF OUR COPYRIGHT AND DO SO AT THEIR OWN RISK.

LEGEND:

	CONCRETE
- - - - -	OVERHEAD WIRES
TP	TELSTRA PIT
H	HYDRANT
SV	STOP VALVE
PP	POWER POLE
IL	INVERT LEVEL

NO INVESTIGATION OF UNDERGROUND SERVICES HAS BEEN MADE. ALL RELEVANT AUTHORITIES SHOULD BE NOTIFIED PRIOR TO ANY EXCAVATION ON OR NEAR THE SITE

DEVELOPERS & EXCAVATORS MAY BE HELD FINANCIALLY RESPONSIBLE BY THE ASSET OWNER SHOULD THEY DAMAGE UNDERGROUND NETWORKS.

www.dialbeforeyoudig.com.au
DIAL1100 BEFORE YOU DIG

chadwickcheng consulting surveyors
suite 317 / 5 celebration drive norwest business park nsw 2153
po box 7979 baulkham hills business centre nsw 2153
p: 88832622 f: 88832633 e: admin@cca.net.au

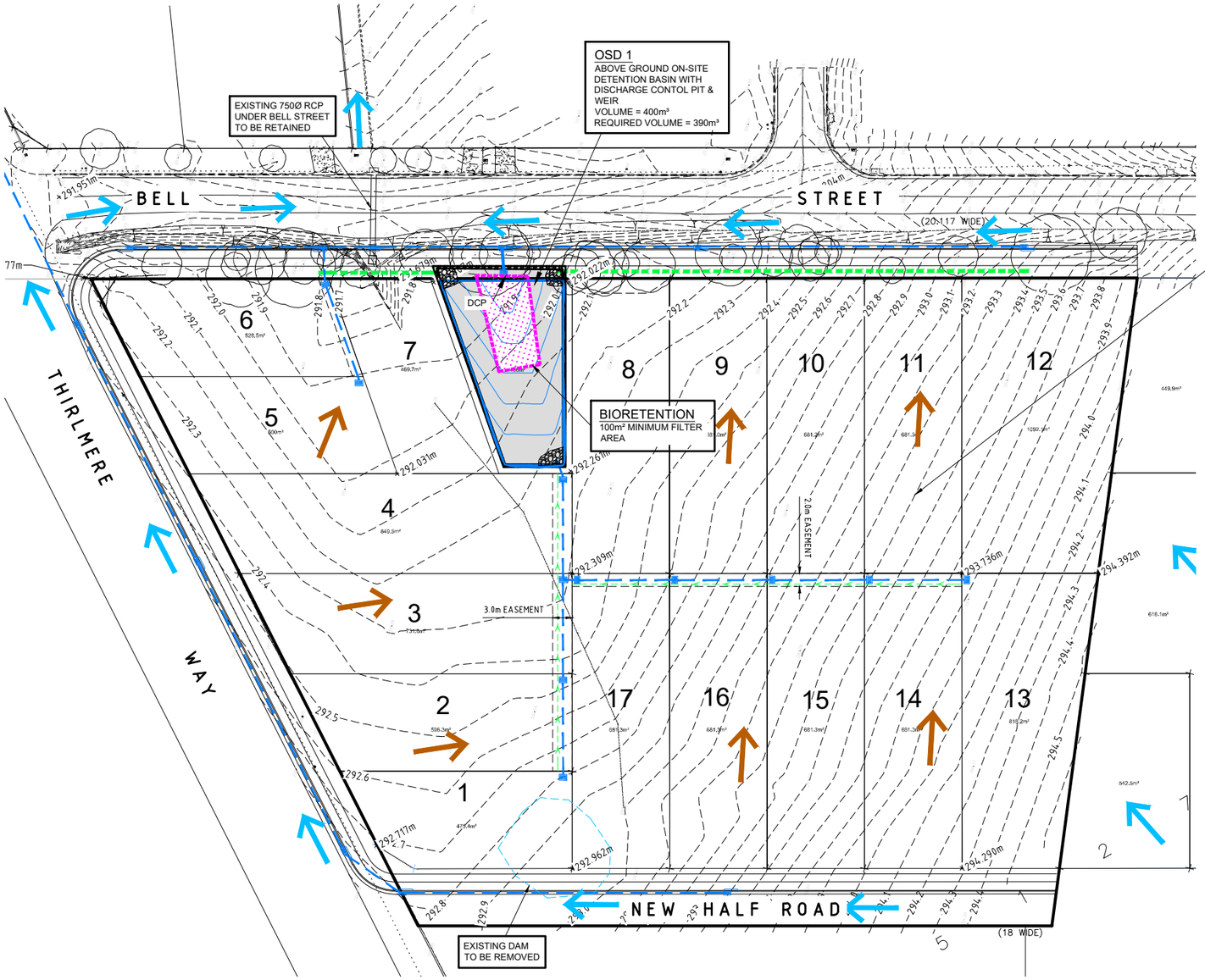
PLAN SHOWING SPOT LEVELS OVER LOT 91 IN DP 751270 AND STREET DETAILS AT BELL STREET, THIRLMERE

SHEET 1 OF 1 SHEETS

DATUM AHD | RATIO 1 : 400 (A1) | REFERENCE 36066/D-MGA-2d

DATE 12.10.2016 | PRINCIPAL GDS

10.3 Appendix C – Concept Stormwater Management Plans



CONCEPT STORMWATER DRAINAGE PLAN

SCALE 1:400

0 4 8 12 16 20m

Scale: 1:400 (A1 SHEET)

LOT SPECIFIC WATER QUALITY REQUIREMENTS

EACH LOT IS TO HAVE A MIN. 10,000L RAINWATER TANK.
THIS IS TO INCORPORATE 5,000 LITRES FOR WATER QUALITY RE-USE PURPOSES AND AN ADDITIONAL 5,000 LITRES FOR ON-SITE DETENTION

KEY

- 100m² BIORETENTION AREA
- 400m³ ABOVE GROUND ON-SITE DETENTION BASIN
- OFF-SITE OVERLAND FLOWS BYPASSING OSD
- ON-SITE OVERLAND FLOWS DRAINING TO OSD
- GRASSED SWALE DRAIN WITHIN DRAINAGE EASMENT TO DIRECT MAJOR OVERLAND FLOWS
- PROPOSED STORMWATER DRAINAGE LINE AND PIT
- ROCK RIP-RAP SCOUR PROTECTION

ON SITE DETENTION CALCULATIONS

SITE DETAILS

SITE AREA = 1.29 Ha
% IMPERVIOUS AREA = 80%
AREA DRAINING TO OSD = 1.29 Ha (OSD IS A COMBINATION 5,000L IN EACH RAINWATER TANK AND STORAGE IN THE ABOVE GROUND DETENTION BASIN (OSD 1)

PRE AND POST DEVELOPMENT SITE DISCHARGES & STORAGE VOLUMES

Storm Event ARI (Yr)	Pre-Development (m^3/s)	Post-Development No OSD (m^3/s)	Post-Development With OSD (m^3/s)	OSD1 Storage Provided (m^3)
1	0.264	0.44	0.27	222
2	0.47	0.672	0.448	249
5	0.794	1.02	0.74	272
10	0.97	1.21	0.884	289
20	1.25	1.5	1.116	327
50	1.53	1.71	1.374	361
100	1.81	1.99	1.642	391

PROVIDED ON SITE DETENTION (OSD)

ON-SITE DETENTION IS TO BE PROVIDED WITHIN THE FOLLOWING -

RAINWATER TANKS = 17 NEW LOTS x 5m³	=	85m³
OSD 1 - ABOVE GROUND STORAGE	=	400m³
TOTAL OSD STORAGE PROVIDED	=	485m³

STORMWATER DESIGN NOTES

GENERAL

1. THIS PLAN IS A CONCEPT ONLY AND IS NOT TO BE USED FOR CONSTRUCTION. FULL CIVIL DESIGN DRAWINGS ARE TO BE OBTAINED & ISSUED TO THE CERTIFYING AUTHORITY FOR APPROVAL PRIOR TO THE COMMENCEMENT OF ANY EARTHWORKS.
2. IT IS THE CONTRACTORS RESPONSIBILITY TO LOCATE & LEVEL ALL EXISTING SERVICES PRIOR TO THE COMMENCEMENT OF ANY EARTHWORKS.
3. ALL PIPES TO HAVE MIN 300mm COVER IF LOCATED WITHIN PROPERTY.
4. ALL WORK DO BE DONE IN ACCORDANCE WITH AS/NZ 3500.3:2003 AND COUNCIL SPECIFICATIONS.

SITE CONTOURS

1. DETAIL SURVEY SHOWN HAS BEEN SUPPLIED BY CHADWICK CHENG CONSULTING SURVEYORS.

LOCATION OF STRUCTURES

1. THE LOCATION OF RAINWATER TANKS WITHIN EACH LOT HAS NOT BEEN SHOWN. THEIR FINAL LOCATIONS WILL BE DETERMINED BY THE FINAL ARRANGEMENT OF THE BUILDINGS FOR EACH LOT.
2. THE LOCATION OF STRUCTURES SHOWN INDICATE THE POSSIBLE ARRANGEMENT OF STORMWATER AND WATER QUALITY CONTROL DEVICES THAT WOULD SATISFY COUNCIL REQUIREMENTS.
3. FLOOR LEVELS OF ALL BUILDINGS TO BE SET A MINIMUM OF 300mm ABOVE THE TOP WATER LEVEL OF ANY ADJACENT ABOVE GROUND OSD STORAGE/BIORETENTION BASIN OR OVERLAND FLOW PATHS.

REQUIRED STORMWATER AND WATER QUALITY DEVICES

1. ON SITE DETENTION - REFER TO ON SITE DETENTION CALCULATIONS
2. RAINWATER TANKS - MINIMUM 10,000L RAINWATER TANKS MUST BE PROVIDED FOR EACH LOT. THESE RAINWATER TANK STORAGE VOLUMES ARE TO BE PROVIDED FOR RE-USE AS SPECIFIED IN THE CONCEPT STORMWATER AND WATER QUALITY MANAGEMENT REPORT BY SEEC AND ARRANGED IN ACCORDANCE WITH THE TYPICAL RAINWATER TANK RE-USE SYSTEM DETAIL ON SHEETDA02. THE TOP 5,000L OF THE TANK(S) VOLUME IS TO BE COUNTED TOWARDS ON SITE DETENTION. ALL TANK OVERLFOWS ARE TO DRAIN TO THE STREET DRAINAGE OR INTERALLOTTMENT DRAINAGE SYSTEMS.
4. BIORETENTION BASIN WILL NOT BE INSTALLED (MADE ACTIVE) UNTIL THE CATCHMENT IT DRAINS IS 70% DEVELOPED.
5. ALL STORMWATER DRAINAGE STRUCTURES TO BE IN ACCORDANCE WITH WOLLONDILLY SHIRE COUNCIL CONSTRUCTION SPECIFICATION AS LISTED IN THE FOLLOWING-

DRAWING NUMBER	DRAWING DESCRIPTION
WSC.D1.8	150 INTEGRAL KERB & GUTTER AND VEHICULAR CROSSINGS FOR FORMED K&G CONSTRUCTION
WSC.D1.9	VEHICULAR FOOTPATH CROSSINGS FOR KERB AND GUTTER -CROSS SECTIONS
WSC.D1.10	VEHICULAR FOOTPATH CROSSINGS FOR DISH CROSSINGS - CROSS SECTIONS
WSC.D1.12	STANDARD KERB AND GUTTERS
WSC.D1.15	STANDARD RESIDENTIAL VEHICULAR CROSSING USING PAVERS
WSC.D1.16	DRIVEWAY STANDARD RURAL PIPE CROSSING
WSC.D1.17	STANDARD PRAM RAMP CROSSING
WSC.D1.23	STANDARD RESIDENTIAL VEHICULAR CROSSING USING CONCRETE
WSC.D5.3	COMPONENTS FOR MISCELLANEOUS PITS
WSC.D5.4	PRECAST COMPONENTS FOR KERB INLET GULLY PIT TO WSC.D5.5
WSC.D5.5	STANDARD KERB INLET GULLY PIT
WSC.D5.6	STANDARD JUNCTION PIT
WSC.D5.7	STANDARD GRATED GULLY PIT IN CONCRETE ACCESSWAYS
WSC.D5.8	CONCRETE INSPECTION PIT AND MINOR DRAINAGE DETAILS
WSC.D5.10	STANDARD GRATED KERB INLET PIT
WSC.D5.11	STANDARD SURCHARGE PITS
WSC.D5.12	STANDARD PATHWAY GRATED PIT

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
00	29/06/17	J.M.A	M.R	M.P	FOR DA APPROVAL
A	03/05/17	J.M.A	M.R	J.A	DRAFT ISSUE - FOR DISCUSSION

DRAWING STATUS

DESIGN BY	J.M.A
DRAWN BY	M.R
FINAL APPROVAL	M.P
SCALE: (on A1 Original)	1:400

DA

North

CLIENT
MR BRAD CARPENTER
C/O – REIN & WARRY AND CO SURVEYORS

SEEC
Suites 7 & 8, 68-70 Station Street
PO Box 1098, Bowral NSW 2576.
(t) 02 4862 1633
(f) 02 4862 3088
email: reception@seec.com.au
WWW.SEEC.COM.AU

PROJECT TITLE
PROPOSED SUBDIVISION
LOT 91, DP 751270
45 BELL STREET
THIRLMERE

DRAWING TITLE
CONCEPT STORMWATER DRAINAGE PLAN

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
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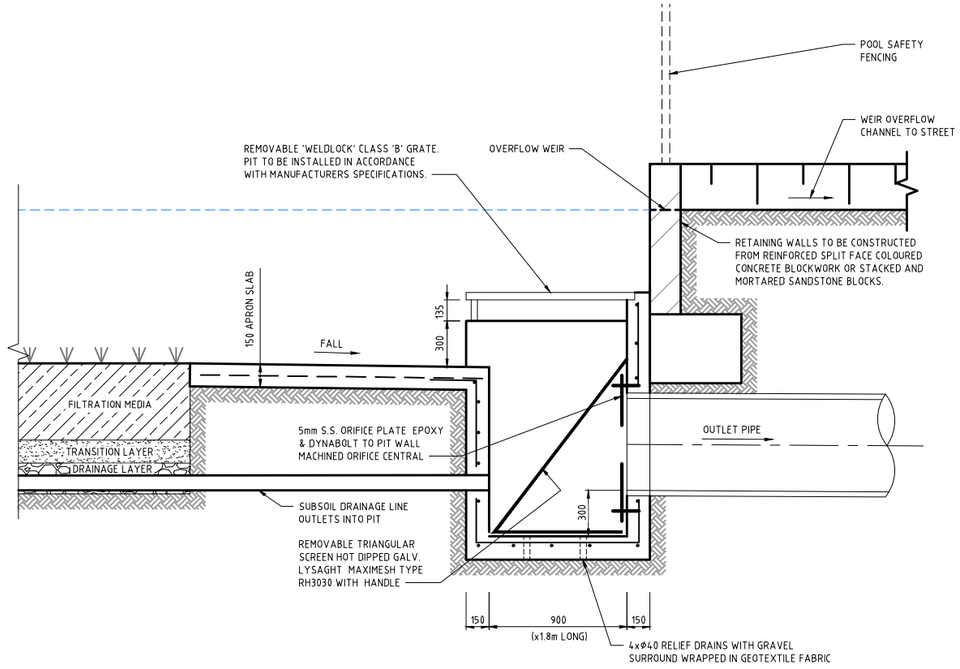
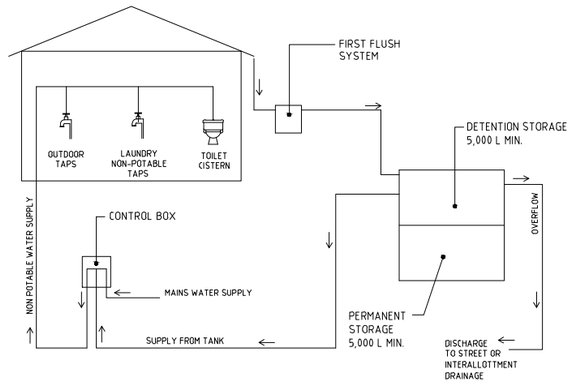


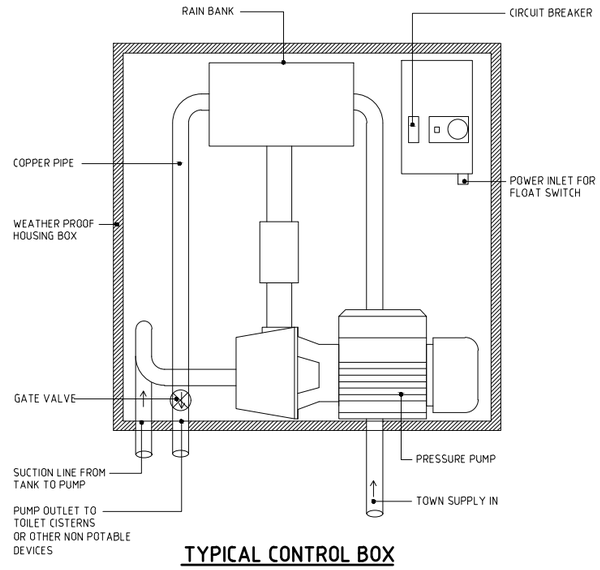
TYPICAL CROSS SECTION THROUGH DETENTION BASIN OUTLET PIT

SCALE 1:20



TYPICAL WATER SUPPLY CYCLE

NOT TO SCALE



TYPICAL CONTROL BOX

NOT TO SCALE

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00	29/06/17	J.M.A	M.R	M.P	FOR DA APPROVAL
A	03/05/17	J.M.A	M.R	J.A	DRAFT ISSUE – FOR DISCUSSION

DRAWING STATUS	
DESIGN BY	J.M.A
DRAWN BY	M.R
FINAL APPROVAL	M.P
SCALE: (on A1 Original)	AS SHOWN
DA	

North

CLIENT
MR BRAD CARPENTER
C/O – REIN & WARRY AND CO SURVEYORS

SEEC
Suites 7 & 8, 68-70 Station Street
PO Box 1098, Bowral NSW 2576.
(t) 02 4862 1633
(f) 02 4862 3088
email: reception@seec.com.au
WWW.SEEC.COM.AU

PROJECT TITLE
PROPOSED SUBDIVISION
LOT 91, DP 751270
45 BELL STREET
THIRLMERE

DRAWING TITLE
CONCEPT STORMWATER DRAINAGE SECTIONS & DETAILS

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
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