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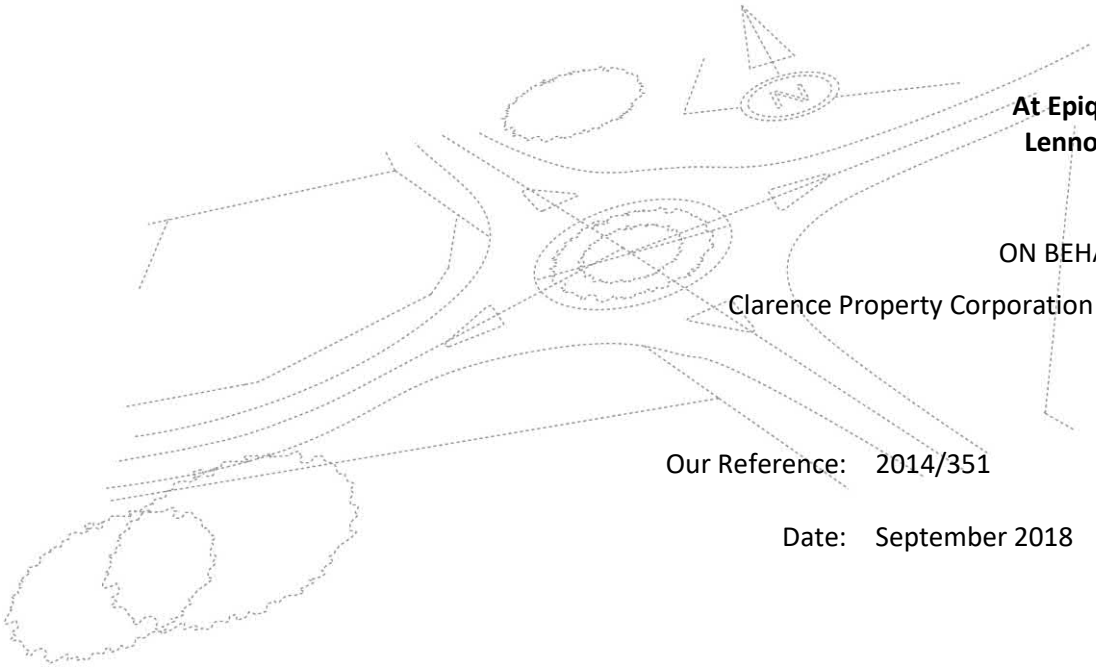
Engineering Services Report

Residential Development
Epiq Lennox – Super Lot 5
Concept Approval 07_0026

Upon:
Lot 5 DP 1239938



At Epiq Estate
Lennox Head

ON BEHALF OF:
Clarence Property Corporation Pty Ltd

Our Reference: 2014/351

Date: September 2018

Newton Denny Chapelle
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Revision History

REVISION #	DATE	DESCRIPTION	ORIGINATOR	APPROVED
A	15/08/2018	Issued for DA	CP	DC
B	27/09/2018	Issued for Approval	CP	DC

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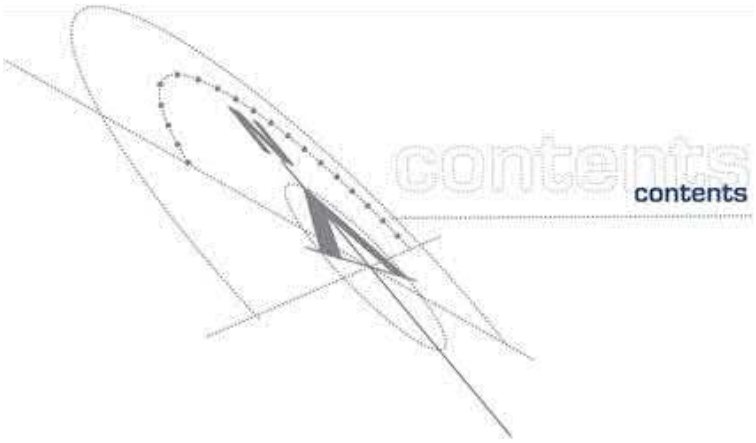


Table of Contents

Appendices

Appendix A **Concept Engineering Plans**

Plan Number	Plan Name
14351-S5-DA-CI-00	Site Plan
14351-S5-DA-BE-00	Bulk Earthworks Plan
14351-S5-DA-BE-11	Bulk Earthworks – Section A & B
14351-S5-DA-BE-12	Bulk Earthworks – Section C & D
14351-S5-DA-CI-01	Civil Works Plan
14351-S5-DA-CI-11	Civil Works Longsection – MC01
14351-S5-DA-CI-12	Civil Works Longsection – MC01 & MC02
14351-S5-DA-CI-13	Civil Works Longsection – MC03
14351-S5-DA-CI-14	Civil Works Longsection – MC04
14351-S5-DA-CI-21	Civil Services Plan
14351-S5-DA-CI-22	Civil Services Plan – Sewer Rising Main

Appendix B **Acid Sulfate Soil Management Plan - Geolink**

Appendix C **Access Assessment – Bitzios Consulting**

Appendix D **MUSIC Model**

Appendix E **Engineering Advice Sewer Pump Station – Willow + Sparrow Engineering**

Appendix F **H2One – Hydraulic Assessment of the Dual Reticulation Network**

Executive Summary

This Engineering Services Report is to accompany the Modification to Major Project 07_0026 to secure approval to change the land use designation from a retirement village to a 145 lot integrated residential subdivision upon Lot 5 DP 1239938 forming part of the Estate known as Epiq Lennox. The site is known as Super Lot 5 and covers an area of approximately 4.17Ha to the east of Montwood Drive and the south of Snapper Drive.

The development has been previously approved (Department of Planning approval 07_0026) with several stages constructed, approved or pending approval on the site. This report details the engineering design elements required for the development to comply with the relevant polices, standards and regulations required for a residential development in the Ballina Shire Council Local Government Area. Significant engineering design has previously been undertaken for the site as part of greater development approval. The following components have been assessed:

- Bulk Earthworks – The development has been filled as part of previous stages of the development. 2,220m³ of fill is expected with retaining walls required along the northern and western boundaries of the site. The maximum retaining wall height is expected to be 2.2m.
- Traffic – Based on the previously approved and constructed stages of the Epiq Lennox development the surrounding road network has sufficient capacity for the proposed development (4,110vpd capacity vs 2,174vpd expected traffic).
- Road Layout and Pedestrian Access – Road reserve and carriageway widths are at or above the minimum widths specified in the Northern Rivers Local Government Standards. A 1.35m wide footpath connection will be installed throughout the development.
- Stormwater – Additional Gross Pollutant Traps have been installed throughout the greater Epiq Estate to ensure the stormwater treatment targets are achieved for the development. Additional stormwater pipes will be installed underneath Montwood Drive to cater for the peak storm flows generated from the site.
- Potable and Recycled Water Reticulation – Water connections will be supplied to all lots with connection to the greater Lennox Head. Water mains and connection points will be provided generally in accordance with water reticulation modelling conducted by H2One.
- Sewer Reticulation – All lots will be provided with a gravity sewer connection to a new pump station in the South West Corner of the site. The rising main from this pump station will discharge into the existing gravity sewer network adjacent to Snapper Drive.

1 Introduction

Newton Denny Chapelle has been engaged by Clarence Property Corporation Ltd to prepare an Engineering Services Report to accompany the application for 145 Torrens Title Residential Lot Subdivision. The site is located in Lennox Head and has previously been known as the Pacific Pines Estate, now referred to as Epiq Lennox.

The total development site is approximately 80.5ha in size with this application relating specifically to the area known as Super Lot 5 (refer Figure 1-1). The site is approximately 4.17Ha in size.

Figure 1-1 – Epiq Estate Development Site

This report relates to the bulk earthworks, traffic, stormwater and servicing requirements of the site. Several elements of the engineering design have already been completed as part of previous approvals (eg stormwater) for the Estate. This report is intended to append the original designs where necessary and also demonstrate that the proposed engineering modifications meet the relevant concept approval conditions.

2 Report Scope

This report focuses on providing sufficient concept engineering design details to facilitate a thorough understanding of the proposed works. The works covered by this report include new infrastructure for traffic, stormwater (quality and attenuation) and servicing provisions for the proposed development.

It is recognised that a subsequent submission of detailed engineering design plans and specifications are required to be made before final approval of the development by Ballina Shire Council. At this stage any minor amendments of the design elements proposed will be addressed to meet any of the concerns raised through the approvals process. The concepts and calculations outlined in this report and associated plans shall not be used for construction without the written permission of Newton Denny Chapelle.

2.1 Reference Documents

The following documents have been used in the preparation of this report:

- Gilbert + Sutherland, *Revised Stormwater Assessment & Management Plan, Pacific Pines Estate, Montwood Drive & Hutley Drive, Lennox Head, New South Wales, July 2014*
- Ballina Shire Council, *Ballina Development Control Plan 2012 - Chapter 3 – Urban Development*
- Cardno Eppell Olsen, *Pacific Pines Estate, Traffic and Transport Statement, November 2011*
- Ballina Shire Council – *Stormwater Management Standards for Development – 2015*
- Ardill Payne and Partners, P*roject Application Stage 1, Engineering Report – Pacific Pines Subdivision*
- Water Services Association of Australia, *Sewerage Code of Australia, WSA 02-2002*
- Geolink, *Water Reticulation Hydraulic Analysis – Addendum Report*
- Geolink, *Investigation of Gravity Sewer Augmentation on Hutley Drive*
- Cardno Eppell Olsen, Pacific Pines Estate, Traffic & Transport Statement, November 2011
- Northern Rivers Local Government – *Development Design Manual*
- Ballina Shire Council, *Development Control Plan - Chapter 13 – Stormwater Management 2006*
- SMEC Urban, *Pacific Pines Estate - Water Reticulation Hydraulic Analysis,* March 2012
- SMEC Urban, *Pacific Pines Estate – Dual Reticulation Analysis,* Letter Dated 30 March 2012
- Newton Denny Chapelle, *Engineering Services Report (Modification 5 to Concept approval 07_0026),* Dated November 2016

3 Site Description

The site consists of a vacant development lot created as part of the subdivision works. The site has been previously filled and is currently being used for Erosion and Sediment control and storage for the Release 3 site (immediately to the north of Super Lot 5).

The areas surrounding the development site can be summarised as:

- Northern Boundary – Is formed with the extension of Snapper Drive. This is currently being constructed as part of the Release 3 works. Upon completion the adjacent land will be higher than the site.
- Eastern Boundary – Is formed with the Conservation Management Zone. The adjoining land is generally lower than the site.

- Southern Boundary – Is formed with the Conservation Management Zone. The adjoining land is generally lower than the site.
- Western Boundary – Is formed with Montwood Drive. The site is generally higher than Montwood Drive.

4 Bulk Earthworks

The site has been filled as part of previous stages of Epiq Lennox. The Release 3 temporary sediment basin is currently located on the northern portion of the site. Upon completion of Release 3 this basin will be backfilled to a Level 1 Standard. All building sites will be filled to a level greater than 3m AHD above the prescribed level of 2.65m AHD for flooding. Filling to this level is not expected to have adverse effects on upstream properties.

The only lots potentially affected by a higher fill height are those directly north of the site. These lots form part of Epiq Release 3 with the boundary between the development stages formed by the extension of Snapper Drive. The SL5 site is lower than the adjacent Snapper Drive. Provision has been made within SL5 for the 100 year ARI overland flow path from the adjacent Release 3 stage.

Retaining walls will be required along the northern and western boundaries of the site. The walls along the northern boundary will be in cut to a maximum depth of 2.2m expected. The retaining walls along the western boundary will be in fill to a maximum height of 1.6m. The site is expected to require 2,220m³ of additional fill (excluding remediating the temporary sediment basin) with a maximum fill depth of 2.0m and cut depth of 1.75m.

4.1 Acid Sulfate Soils

The site is mapped as having Class 2 and Class 5 Acid Sulfate Soils (Ballina LEP 2012), refer to Figure 4-1.

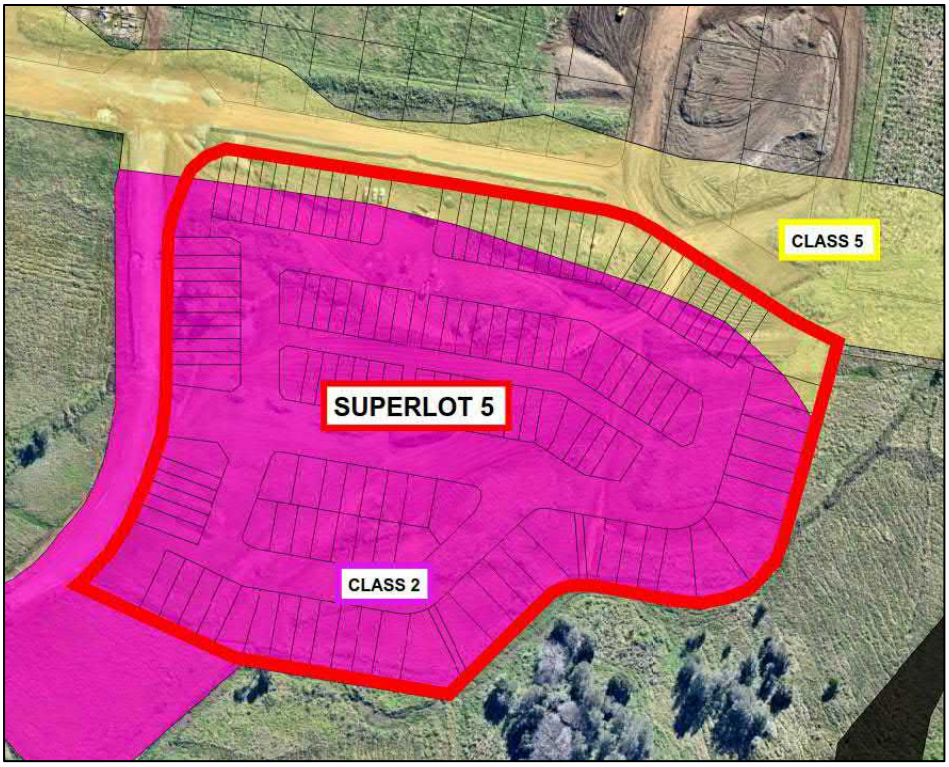


Figure 4-1 - Acid Sulfate Soils

The site has previously been filled as part of previous stages of the Epiq Lennox Development. Any excavation below the original natural surface level will be will be undertaken in accordance with the Acid Sulfate Soil Management Plan – Pacific Pines Stage 1B plan prepared by Geolink (dated 27/08/2014). This plan is attached in Appendix B.

5 Road Layout and Site Access

The site will have two access points to the surrounding Road Network (being Montwood Drive and Snapper Drive). The proposed development will involve the construction of four new Roads. A summary of the proposed Roads is presented in Table 5-1:

Table 5-1 - Summary of Proposed Roads

Road	Length (m)	Carriageway Width (m)	Reserve Width (m)	Road Hierarchy	Maximum Grade
Road 1 (B)	515	Variable 7 – 10m	Variable 15 – 20m	Local Street	<5%
Road 2 (A)	44	10	20	Local Street	9%
Road 3 (D)	190	7	15	Local Street	<5%
Road 4 (C)	182	6	8	Access Lane	<5%
Total:	**931**				

A 1.35m wide footpath will be provided along one side of all public Roads (with the exception of the access lane) with connection to the surrounding footpath network in Montwood and Snapper Drives. Bus stops are located within 400m of the site along Snapper Drive. These have been constructed as part of previous stages of the Epiq Development.

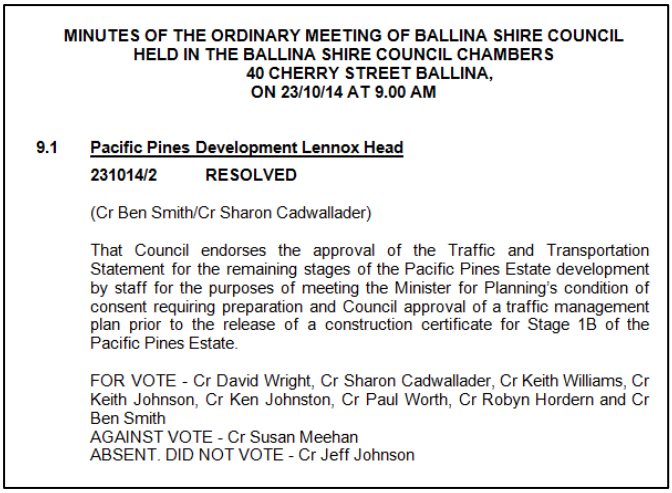
5.1 Intersection Analysis

An analysis of the immediate surrounding road network has been undertaken by Bitzios Consulting. Bitzios recommend a that a BAR and BAL treatment is provided at the Montwood Drive access. An alternate CHR(s) treatment only is also suggested. This assessment is attached in Appendix C.

6 Traffic Assessment

6.1 Background Information

Previous studies of the traffic generated by the greater Epiq development site have been undertaken by Carndo Eppell Olsen and updated by Newton Denny Chapelle as part of the Modification 5 to Concept Approval 07_0026. These studies have identified that the extension of Hutley Drive is needed to service the fully developed site. Without the extension of Hutley Drive the existing surrounding Road network has an approved capacity of 7,456vpd. This daily traffic volume has been approved in the Ballina Shire Council Ordinary Council meeting on the 23rd October 2014 (refer Figure 6-1).



MINUTES OF THE ORDINARY MEETING OF BALLINA SHIRE COUNCIL
HELD IN THE BALLINA SHIRE COUNCIL CHAMBERS
40 CHERRY STREET BALLINA,
ON 23/10/14 AT 9.00 AM

9.1 Pacific Pines Development Lennox Head

231014/2 RESOLVED

(Cr Ben Smith/Cr Sharon Cadwallader)

That Council endorses the approval of the Traffic and Transportation Statement for the remaining stages of the Pacific Pines Estate development by staff for the purposes of meeting the Minister for Planning's condition of consent requiring preparation and Council approval of a traffic management plan prior to the release of a construction certificate for Stage 1B of the Pacific Pines Estate.

FOR VOTE - Cr David Wright, Cr Sharon Cadwallader, Cr Keith Williams, Cr Keith Johnson, Cr Ken Johnston, Cr Paul Worth, Cr Robyn Hordern and Cr Ben Smith
AGAINST VOTE - Cr Susan Meehan
ABSENT. DID NOT VOTE - Cr Jeff Johnson

Figure 6-1 - Excerpt from Council Meeting Minutes 23/10/2014

The approved traffic capacity relates to the available capacity of the surrounding road network being Montwood Drive and Henderson Lane. The existing road network has a surveyed volume of 1,712 for Montwood Drive and 1,634vpd for Henderson Lane leaving an excess of 4,110vpd for the Epiq development to utilise.

6.2 Daily Traffic Generation

The daily traffic generation for the proposed development has been estimated based on the traffic generation rates for medium density developments outlined in the *Ballina Shire Council, Ballina Road Contribution Plan – Version 4*. The total daily vehicle trips for the development are outlined in Table 6-1:

Table 6-1 - Traffic Generation Rates

Land Use	Qty	Units	Traffic Generation Rates	
			Daily Vehicle Trip Rate	Total Daily Vehicle Trips
Medium Density Residential	145	Dwellings	6.45	936

Local trip generation rates for the residential component of the development are considered appropriate for the estimation of traffic generated and have been previously accepted as part of Modification 5 to the Concept Plan. Averaging the data for all regional sites (Coffs Harbour, Lismore, Orange, Wagga Wagga and Wollongong) investigated the RMS Technical Direction 2013/04a results in an average daily trip rate of 6.33. The adopted local rate of 6.45 vpd is considered appropriate when applying the aggregate survey data as suggested by the RMS.

6.3 Local Road Network

As detailed in Modification 5 to the Concept Approval 07_0026 the surrounding Road network has insufficient capacity to service the entire Epiq Lennox development until the northern connection of Hutley Drive is constructed. The surrounding Road network has an approved capacity of 7,456vpd.

The existing Road network has a surveyed volume of 3,346vpd leaving and excess of 4,110vpd for the Epiq Estate to utilise. The previously approved and constructed stages of Epiq are expected to generate 2,174vpd (including this development, refer Table 6-2). These volumes have been determined from the traffic generation rates outlined in the Ballina Shire Roads Contributions Plan (6.45/dwelling). In accordance with the RMS recommendations, 25% of the trips are internal with the 75% of the total trips generated utilising the surrounding external Road network.

Table 6-2 - Daily Vehicle Trips Generated by the Development

Epiq Releases	Residential (vpd)			Medium Density (vpd)*		
	I[1]	E[2]	T[3]	I[1]	E[2]	T[3]
1A+	82	247	329	0	0	0
1B+	-	-	-	-	-	-
2 (SL8+ST3)+	132	397	528.9	0	0	0
3 (ST2+ST6)+	194	581	774	0	0	0
4+	56	169	225.8	26	79	105
Super Lot 5 (this application)	0	0	0	234	702	936
Totals:	**464**	**1393**	**1858**	**260**	**781**	**1041**
External Traffic Total:	**2174**					

*The number of dwellings has been based on the maximum density allowed for the zoning (1 dwelling/250m² - total area 6,906m²)

+ Previously approved or constructed stage

[1] Internal Trips

[2] External Trips

[3] Total Trips

Based on the previously approved and constructed stages of the Epiq Lennox development the surrounding Road network has sufficient capacity for the proposed development (4,110vpd capacity vs 2,174vpd expected traffic). In accordance with the concept approval an assessment of the surrounding road network to confirm there is sufficient capacity for the development will be undertaken prior to the issue of a Subdivision Certificate.

6.4 Road Contributions

Estimated traffic contributions for the site have been calculated in accordance with the Ballina Shire Road Contribution Plan Version 4.1 and the Ballina Shire Council Fees and Charges 2018/2019. Based on the current Road Contribution rate of $12,061 and Road Administration Contribution $181 per equivalent residential lot the contributions for the development are expected to be approximately $1.775 million.

7 Stormwater Management

The site has been previously modelled by Gilbert and Sutherland ('Revised Stormwater Assessment & Management Plan' dated July 2014) to determine the quality treatment and attenuation requirements

for the site. The stormwater objectives for the site are defined in Condition B6 of the Pacific Pines – Concept Approval (MP 07_0026), see Figure 7-1 below:

> ***B6 Stormwater Management Plan***
>
> The proponent is to prepare a stormwater management plan for the entire site, prepared by a suitable qualified person(s) that includes detailed modelling for both water quality and quantity. The plan shall demonstrate:
>
> 1) That the project does not concentrate or lead to an increase in the volume or rate of flow of stormwater discharged from the site over and above pre-development flow conditions; and
> 2) That the project does not increase the average annual load of key stormwater pollutants in stormwater discharged from the site over and above pre-development conditions.
> 3) that all stormwater infrastructure is located outside the conservation zone area.
>
> The plan is to be prepared in accordance with the Water Sensitive Urban Design requirements of *Ballina Shire Combined Development Control Plan Chapter 13 – Stormwater Management.*
>
> The stormwater plan is to be submitted to and approved by Council prior to the issue of a Construction Certificate for Stage 1A.

Figure 7-1 - Excerpt from Concept Approval (MP 07_0026) - Stormwater Management Plan

The previously approved SWMP has been used as a first preference for the basis of this assessment. Where the proposed development differs from the original assumptions contemporary stormwater management standards have been applied.

7.1 Stormwater Quality

The stormwater from the site will be discharged to the WQCP (via the CMZ) in accordance with the Gilbert and Sutherland Stormwater Management Plan. Super Lot 5 forms part of Catchment 10 (refer Figure 7-2).

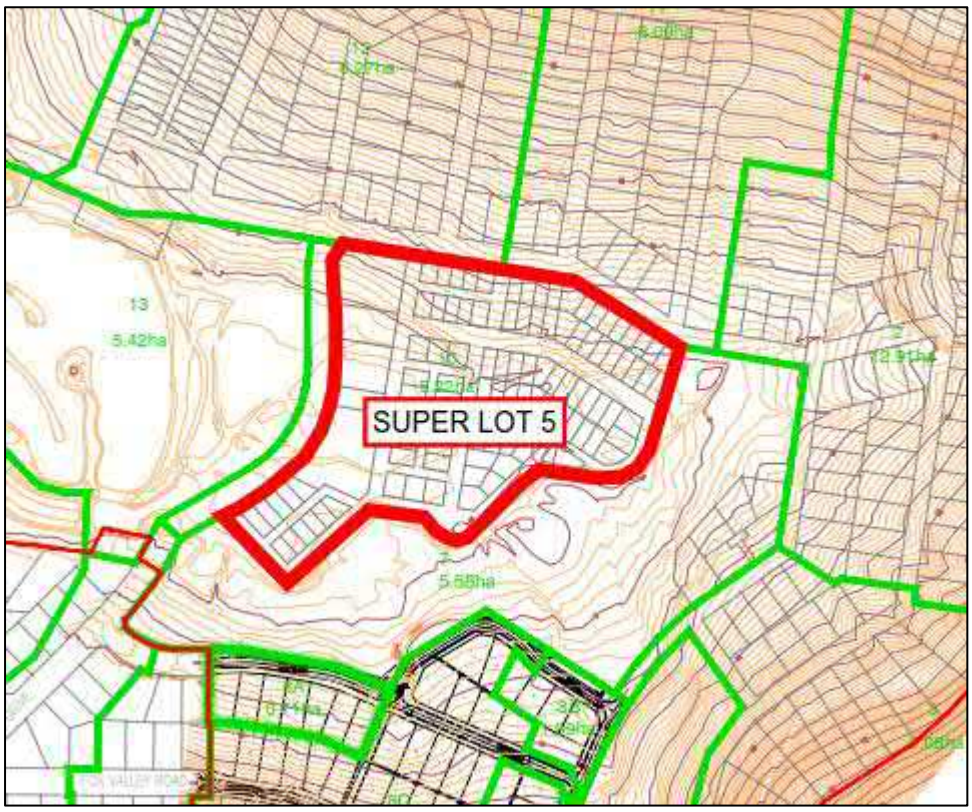


Figure 7-2 - Excerpt from G+S MUSIC Model Catchment Plan - DWG 10734-1.3-D

The stormwater quality modelling has been previously undertaken by Gilbert and Sutherland. This modelling shows that the development can achieve the required stormwater quality targets, refer Figure 7-3.

Table 4.3.2 Comparison of average annual pollutant loads

	Load reduction (%)		
	Suspended Solids	Total Nitrogen	Total Phosphorus
Existing	370,000	2,700	355
Developed	189,000	2,500	338
Change%	-48.9%	-7.4%	-5.0%

Figure 7-3 - G+S Modelling Results

The Gilbert and Sutherland MUSIC Model has been modified to reflect the changes to the greater Development. These include:

- Increase in Neighbourhood Shopping Centre as Part of MOD 5
- Actual impervious areas modelled in Super Lot 5
- Additional allowances added to Super Lot 7 for future development

The Catchments detailed by Gilbert and Sutherland have been modified as outlined in Figure 7-4;

Catchment	Area	Forest	Rural	Urban	Commercial	Townhouse
10	5.22	0.00	1.45	3.77	0.00	0.00
11	6.10	0.00	1.76	4.34	0.00	0.00
12	8.45	0.00	0.98	7.02	0.45	0.00
15	13.73	0.00	0.00	11.92	1.81	0.00
16	4.79	0.00	0.78	2.90	1.11	0.00

Figure 7-4 - Revised Water Quality Catchments

In addition to the original treatment devices proposed by Gilbert and Sutherland Gross Pollutant Traps have been installed or designed throughout the greater Epiq Development. These include:

- 3x Humegard Units installed as part of Release 2 (G+S Catchment 15);
- 1x Humegard Unit designed in Release 3 (G+S Catchment 11);
- 1x Humegard designed in the Neighbourhood Shopping Centre (G+S Catchment 15);
- 1x Humegard to be allowed for in the future design of Super Lot 7 (G+S Catchment 16).

The MUSIC model has been run with the revised information (shown in Appendix D). The results of the model are summarised in Table 7-1.

Table 7-1 - MUSIC Model Results

	Suspended Solids	Total Nitrogen	Total Phosphorus
Developed	181,000	2430	315

As shown above the revised treatment train for the greater Epiq Development results in less total annual pollutant loads than previously modelled by Gilbert and Sutherland. The proposed treatment levels are considered to satisfy the pollutant reduction targets approved in the greater Epiq Stormwater Management Plan.

7.2 Stormwater Attenuation

Stormwater attenuation for the site has been remodelled based on the actual impervious areas for the Super Lot 5 site. The Gilbert and Sutherland assumptions in relation to the impervious areas within Catchment 10 are considered to underestimate the actual stormwater runoff based on the current development layout. In remodelling the site, the new Ballina Shire Council Stormwater Management Standards for Development (SMSD) have been applied.

The catchment areas within Super Lot 5 have been determined from the design plans and are summarised in Table 7-2 (also refer to the attached Stormwater Catchment Plan):

Table 7-2 - Super Lot 5 Catchments

Catchment	Surface Type	Area (m^2)	Impervious Area (m^2)
North West	Roads	1075	1075
North West	Roof	2573	2573
North West	Other Imp	720	720
North West	Vegetation	1592	0
	Sub Total:	**5960**	**4368**
West	Roads	1675	1675
West	Roof	1677	1677
West	Other Imp	540	540
West	Vegetation	1996	0
	Sub Total:	**5888**	**3892**
South	Roads	3810	3810
South	Roof	11560	11560
South	Other Imp	3090	3090
South	Vegetation	11395	0
	Sub Total:	**29855**	**18460**
	Total:	**41703**	**8260**

The Greenfield Development Method 1 from the has SMSD been applied to ensure there are no adverse impacts on downstream users. Attenuation of the stormwater generated by the site is not proposed, with investigation of the capacity of the downstream flow paths investigated.

Super Lot 5 ultimately drains to the Water Quality Control Pond (WQCP) to the west of Montwood Drive. As part of the previous stages of the Epiq development three existing Road crossings have been provided beneath Montwood Drive, refer to Figure 7-5 below:

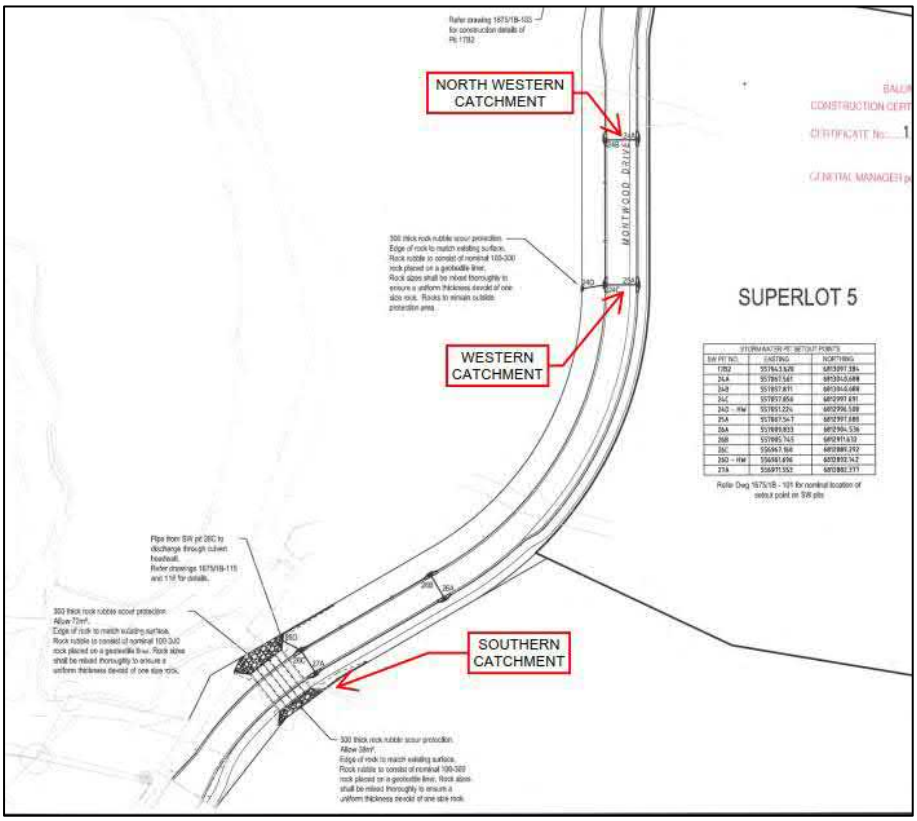


Figure 7-5 - Existing Culverts under Montwood Drive (Source: Geolink Plan 1675/1B 079)

The existing crossings beneath Montwood Drive can be summarised as:

- 24A-24B – existing Ø525mm RCP,
- 25A-24C – existing Ø525mm RCP,
- Box Culverts – Three existing 2100mmx750mm RCBC with two link slabs.

The two existing Ø525mm pipes under Montwood Drive capture small localised catchments along Montwood Drive. These catchments have been modelled as outlined in the Geolink Stage 1B design calculations. It is proposed to drain the North Western and Central Western portions of the site through these pipes.

The surrounding eastern catchments draining into the Box Culverts have been based on the WBNM Developed Catchments outlined by G+S, the current drainage design and Councils Works as Executed information for surrounding developments. The impervious areas for the surrounding catchments are based on housing density as outlined in the Drains user manual. The impervious areas for SL5 have been determined from the design plans. The stormwater catchments are outlined in Table 7-3 and Figure 7-6 below:

Table 7-3 - Summary of Surrounding Catchments

Catchment	Area	Lots/Ha	Paved Area (%)	Supplementary Area (%)	Grassed (%)
Release 3	4.59	8.5	35.50	2.94	61.56
CMZ	12.2	0	0.00	0.00	100.00
Release 5	12	7.3	24.00	2.37	73.63
External Catchment 1	17.68	2.77	5.00	1.50	93.50
External Catchment 2	6.14	6.14	8.50	1.50	90.00
Stage 1A	4.73	9.3	48.00	3.50	48.50

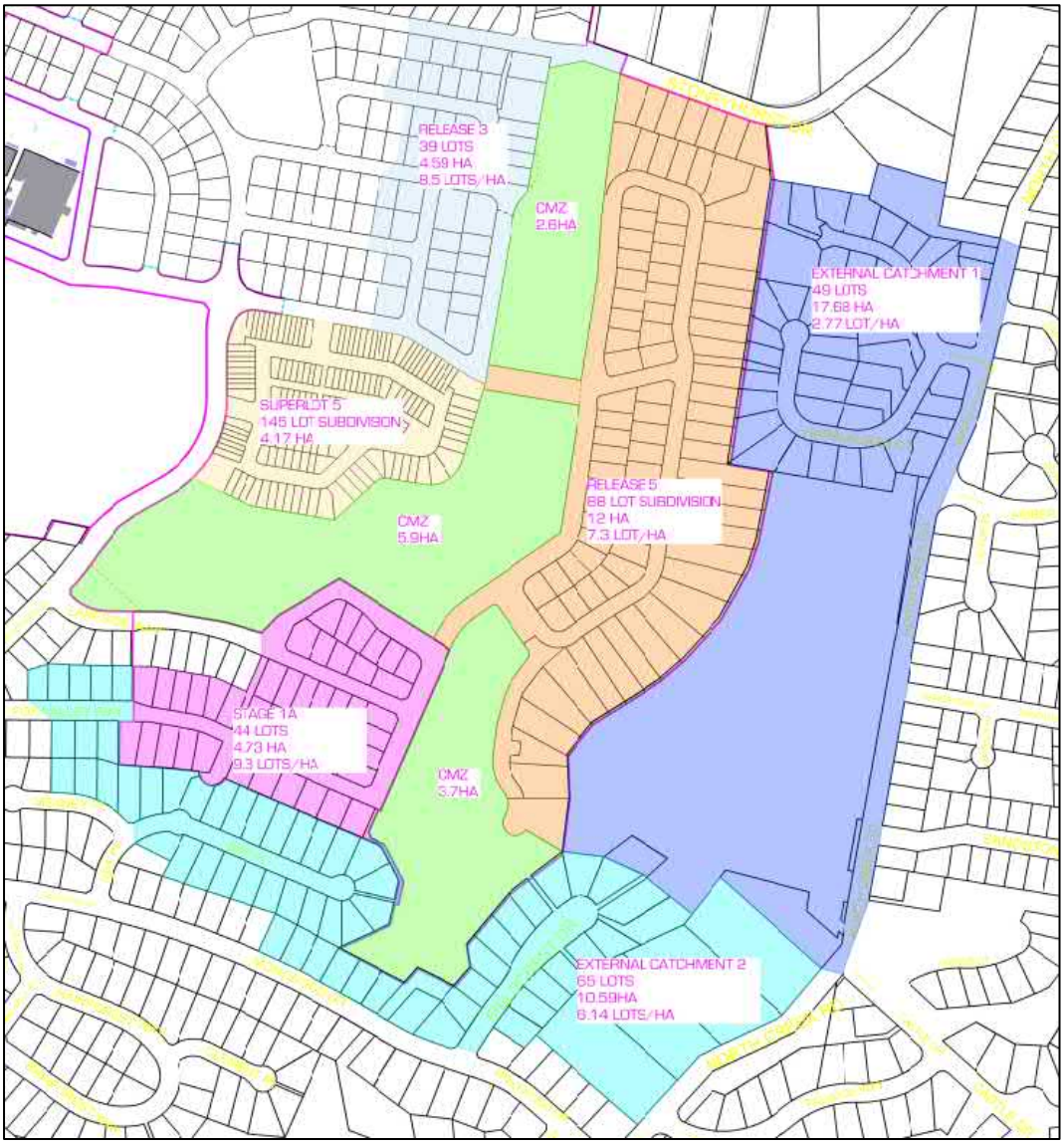


Figure 7-6 - Catchment Areas

For modelling purposes, the all the upstream catchments have been modelled as a single larger hybrid catchment. A time of concentration of 5 minutes for paved surfaces and 20 minutes for grassed areas has been adopted in the modelling.

7.2.1 Drains Model

The concept for the stormwater design is to utilise the spare capacity in the Ø525mm pipes under Montwood Drive by draining the northern and western portions of the site through these pipes. The capacity of the existing box culverts will be supplemented by the installation of a new Ø1050mm pipe to handle the flows generated by SL5.

The following Drains model has been developed for the site:

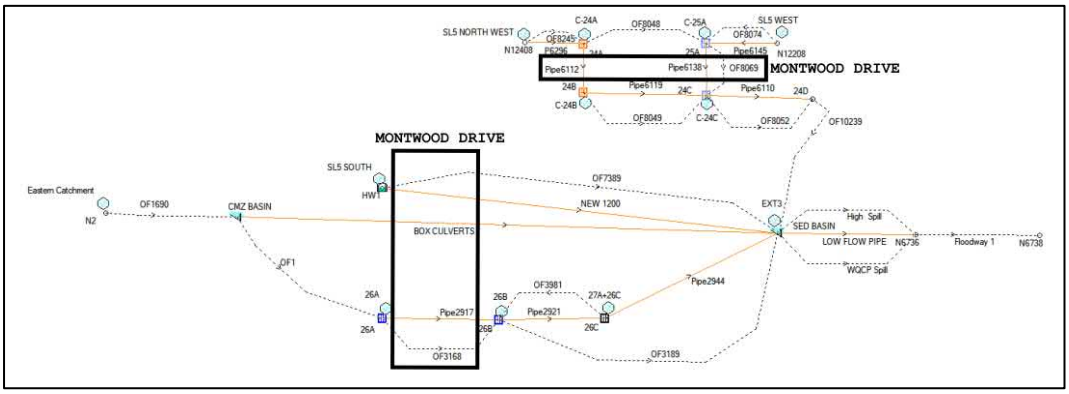


Figure 7-7 - Drains Model

The upstream low lying CMZ area and the low-lying area around the Sediment Basin to the west of Montwood Drive have been modelled as attenuation basins as they will provide storage during storm events. The area of these basins has been determined from site survey, LIDAR and design information. The Drains model considers the culverts from the CMZ basin as the low level. To this end Drains does not provide the functionality to provide blockage factors to the inlets with a loss factor of 0.5 being adopted instead.

The model has been run over the 5, 20 and 100 year ARI events with the results presented in Figure 7-8 to Figure 7-10:

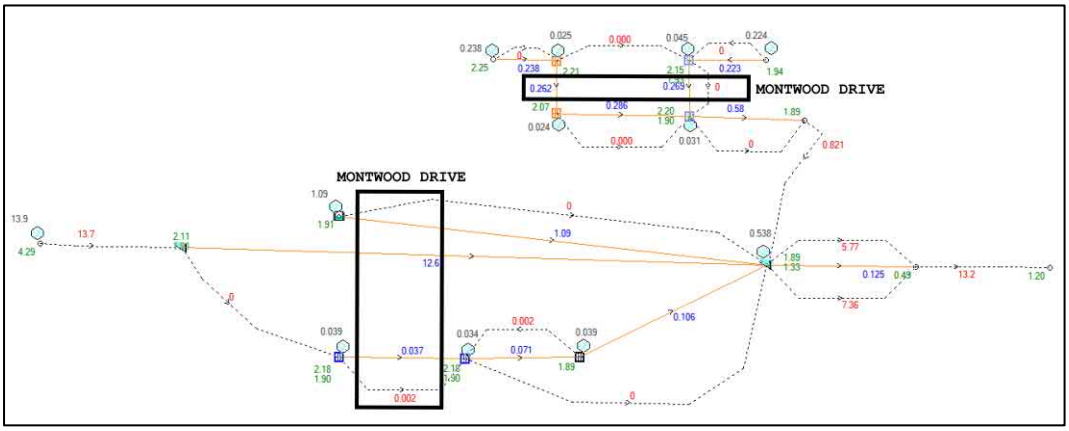


Figure 7-8 - Drains Results 5 Year ARI

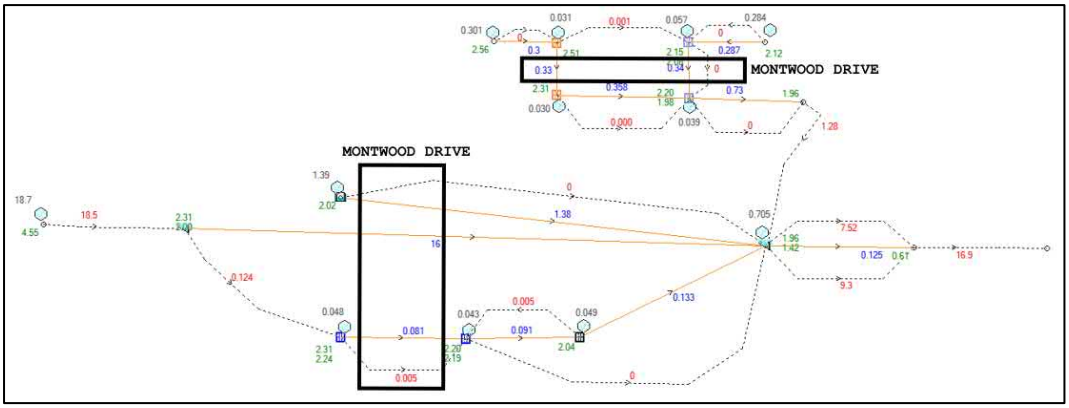


Figure 7-9 - Drains Results 20 Year ARI

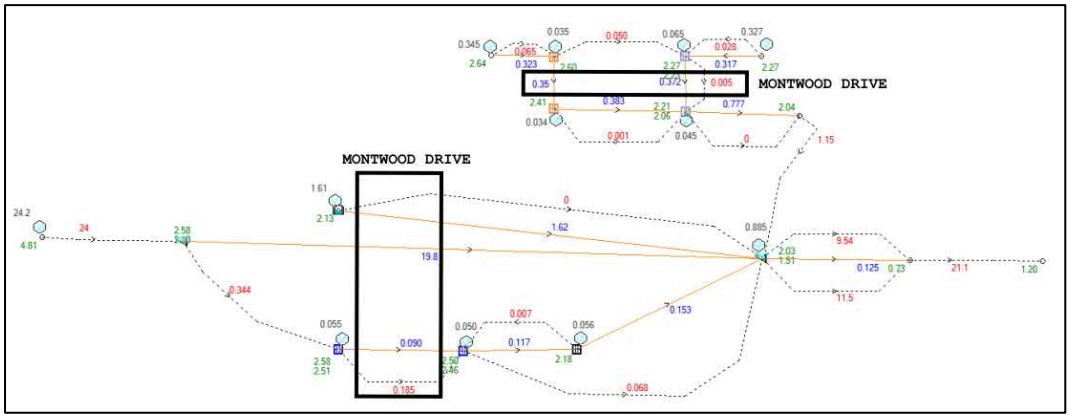


Figure 7-10 - Drains Results 100 Year ARI

As shown above the proposed downstream Ø525mm pipe network and the new Ø1050mm pipe have sufficient capacity to service SL5 for the 5, 20 and 100 year storm events. The existing Ø675mm outlet pipe (Pit 24C – 24D) downstream from the two Ø525mm pipes will be upgraded to a Ø900mm pipe to ensure it does not constrict the flows in the pipe network. It is noted that the Ø525mm pipe network surcharges in the 100 year storm event (eg 0.005m³/s occurs across Montwood Drive between pits 25A to 24C). This flow is less than 200mm deep with a depth*velocity product of less than 0.3m²/s (below the major event limits specified in QUDM Section 7.4).

The proposed new Ø1050mm pipe beneath Montwood Drive has sufficient capacity to handle the 100 year storm flows generated by SL5. It is noted that box culverts have been previously sized by Geolink for the 100 year storm event with no Road flow. The Drains model estimates the approach flow at 24m³/s above that of 22m³/s by Geolink. It is considered that the flow through the box culverts can be ignored when assessing the cross drainage under Montwood Drive in relation to SL5. This is because the new Ø1050mm pipe has sufficient capacity to convey all flows generated by SL5. The adjacent eastern catchment that drains through the box culverts has been primarily modelled to assess the capacity of other downstream assets, refer Section 7.2.2.

7.2.2 Downstream Assets

The Water Quality Control Pond (WQCP) is located immediately downstream of the box culverts under Montwood Drive. The water from upstream is first received in a smaller sediment basin. This basin has three outlets being:

- Primary outlet – 225mm FRC pipe with vertical inlet riser,
- Lower level spillway – Allows lower level flows into the deep water zone and the greater WQCP treatment area,
- Higher level spillway – Provides a bypass around the WQCP for higher level flows. Flows discharge into floodway one and then to the Ballina Nature Reserve.

Once the water passes through the WQCP it enters a floodway that discharges to adjacent reserve and North Creek. A downstream water level of 1.2m has been assumed in the modelling for the 100 year event. The spillways have been modelled as overland flow paths with the cross section of the weir outlets determined from the design plans. The maximum water level observed over the spillway weirs in the modelling is 1.84m. This is below the top spillway level of 2.10m. The downstream assets (being the outlets spillways and floodway) are considered to have sufficient capacity in the 100 year event to handle the proposed storm flows.

7.3 Summary of Stormwater Devices

The stormwater devices required for the site are outlined in Table 7-4.

Table 7-4 - Stormwater Management Devices

Location	Quality	Attenuation
Public Devices		
Release 2*	3x Humegard GPT	-
Release 3*	1x Humegard GPT	-
Shopping Centre*	1x Humegard GPT	-
Super Lot 7*	1x Humegard GPT	-
Montwood Drive Culverts	-	Ø1050mm Pipe
Outlet Pipe 24C-24D	-	Ø900mm upgraded outlet Pipe
Private Devices		
None Proposed	-	-

*These devices have been installed or are to be installed in addition to those originally proposed by Gilbert and Sutherland

8 Sewer Services

The development cannot be drained to the existing surrounding gravity sewer network. A new sewer pump station will be installed in the south west corner of the site adjacent to Montwood Drive. All lots within this development will be provided with a gravity sewer connection to the new pump station.

The expected sewer equivalent demand for the development is outlined in Table 8-1:

Table 8-1 - Expected Potable Water Demand

Type of Development	Quantity	Units	Rate	Equivalent Tenements
Multi-Residential Lots (3 Bdrm)	145	Lot	1	145
Existing Entitlement	1	Lot	-1	-1
			Total ET:	**144**

A new rising main will be installed to connect the proposed pump station to the existing gravity sewer main running along Snapper Drive. The capacity of the downstream network is sufficient and has been addressed in the Letter Report from Willow + Sparrow Engineering attached to this report.

9 Water Reticulation

9.1 Potable Water Reticulation

Each residential lot will be provided with a potable and water connection. Super Lot 5 will have three connection points to the surrounding water reticulation network. These are:

- The North West corner of the site from the 200mm main within Snapper Drive;
- The North East corner of the site from the 200mm main within Snapper Drive;
- The South West corner of the site from the 200mm main within Montwood Drive.

Modelling of the capacity of the surrounding potable water network has been undertaken by H2One (assessment attached to this report). This report details sufficient ET allowance for the proposed development. The connection points detailed in this report are generally in accordance with those of the proposed development. This model can be updated during the subsequent design phases as required by Ballina Shire Council.

The expected potable water demand for the development is outlined in Table 9-1

Table 9-1 - Expected Water Demand

Type of Development	Quantity	Units	Rate	Equivalent Tenements
Multi-Residential Lots (3 Bdrm)	145	Lot	0.8	116
Existing Entitlement	1	Lot	-1	-1
			Total ET:	**115**

9.2 Recycled Water Reticulation

Each residential lot will be provided with a recycled water connection. Super Lot 5 will have three connection points to the surrounding water reticulation network. These are:

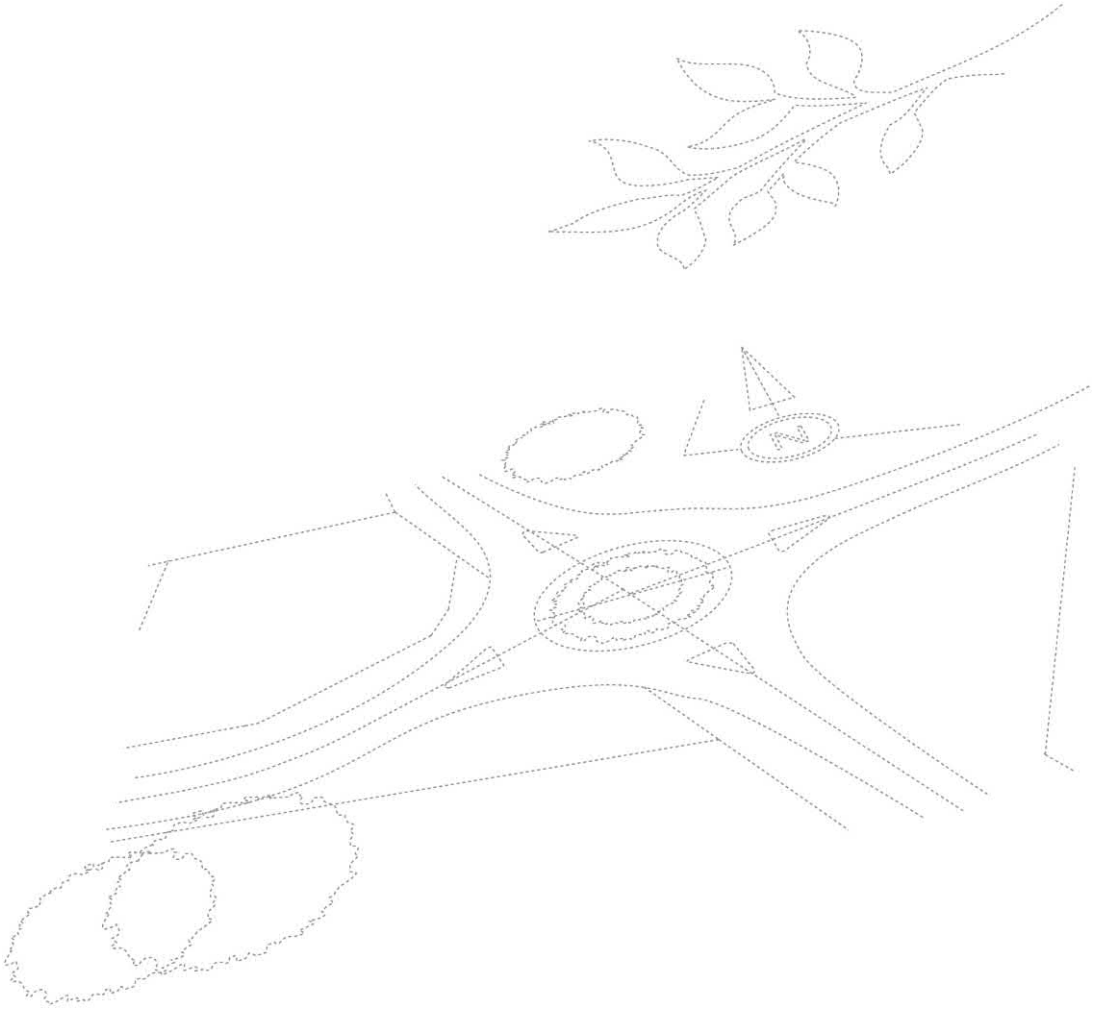
- The North West corner of the site from the 200mm main within Snapper Drive;
- The North East corner of the site from the 200mm main within Snapper Drive;
- The South West corner of the site from the 250mm main within Montwood Drive.

Modelling of the capacity of the surrounding recycled water network has been undertaken by H2One (assessment attached to this report). This report details sufficient ET allowance for the proposed development. The connection points detailed in this report are generally in accordance with those of the proposed development. This model can be updated during the subsequent design phases as required by Ballina Shire Council.

10 Sediment and Erosion Control

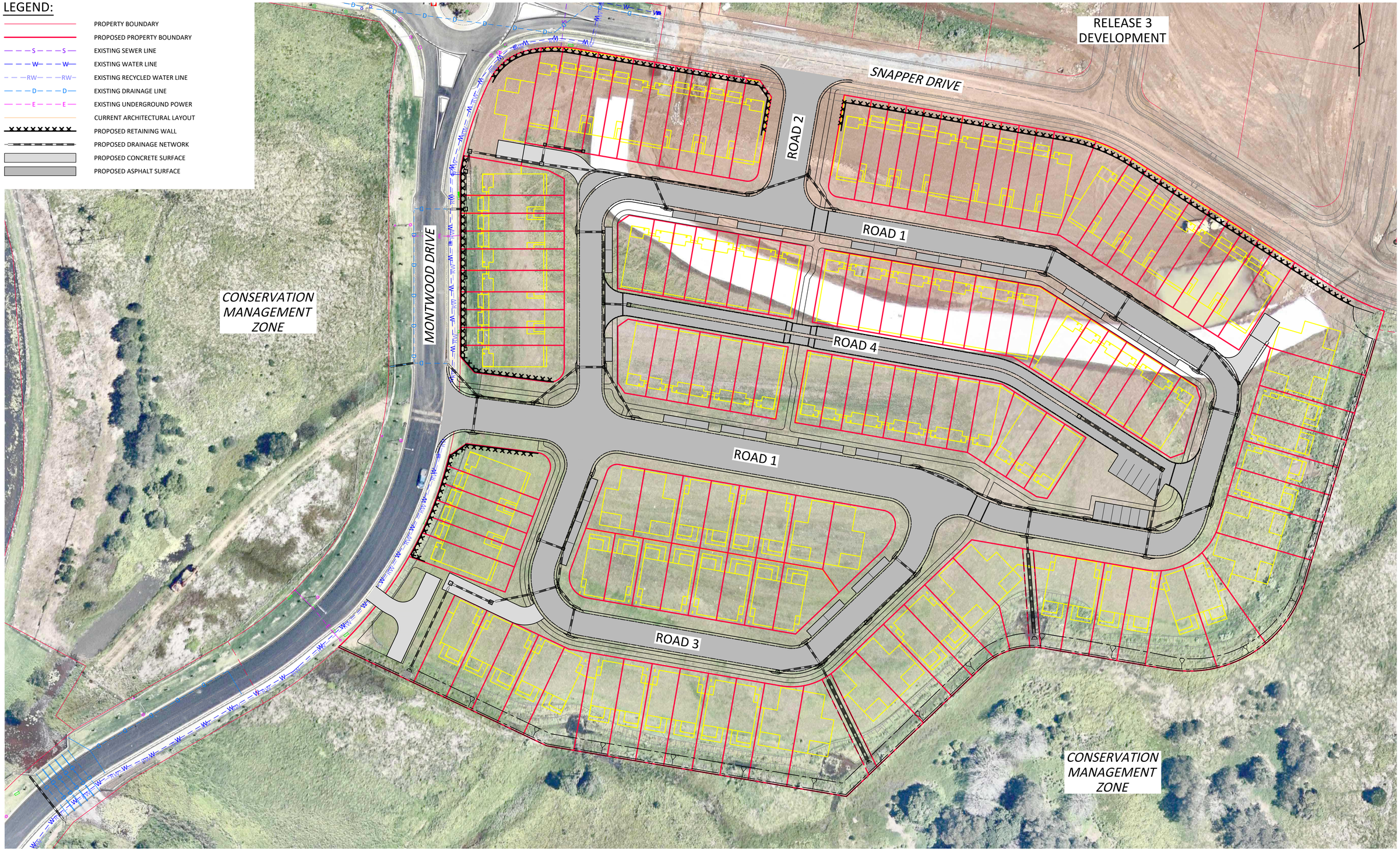
During construction sediment and erosion control measures will be installed to ensure the loss of soil from the site is minimised. All control measures will be installed prior to the commencement of construction and be in accordance with Managing Urban Stormwater-Soils & Construction Volume 1 (2004) by Landcom.

Appendix A Concept Engineering Plans



LEGEND:

- PROPERTY BOUNDARY
- PROPOSED PROPERTY BOUNDARY
- EXISTING SEWER LINE
- EXISTING WATER LINE
- EXISTING RECYCLED WATER LINE
- EXISTING DRAINAGE LINE
- EXISTING UNDERGROUND POWER
- CURRENT ARCHITECTURAL LAYOUT
- PROPOSED RETAINING WALL
- PROPOSED DRAINAGE NETWORK
- PROPOSED CONCRETE SURFACE
- PROPOSED ASPHALT SURFACE



SITE PLAN

SCALE 1:500

FOR APPROVAL

REV	DESCRIPTION	BY	APP.	DATE
B	FOR COUNCIL APPROVAL	DY	CP	10.08.18
A	FOR CLIENT REVIEW	DY	CP	08.05.18

REVISIONS

SCALES SHOWN ARE FOR AN A1 SIZE ORIGINAL DRAWING

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Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

SCALES

HORIZ. DATUM	MGA
VERT. DATUM	AHD
SURVEY	NDC
DRAWN	DY
DESIGN	DY
APPROVED	CP
DATE	08.05.2018

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CLARENCE PROPERTY

EPIQ ESTATE - LENNOX HEAD, NSW, 2478
SUPER LOT 5
SITE PLAN

Reference No.	DRAWING No.	REVISION
2014/351	14351-S5-DA-CI-00	B

Plot Date: 10 Aug, 2018 CAD File Name: K:\Jobs\2014\14351 - Clarence Property\Superlot 5\Engineering\Engineering Plans\Drawings\14351-S5-DA-CI-00.dwg

LEGEND:

- PROPERTY BOUNDARY
- PROPOSED PROPERTY BOUNDARY
- EXISTING SEWER LINE
- EXISTING WATER LINE
- EXISTING RECYCLED WATER LINE
- EXISTING DRAINAGE LINE
- EXISTING UNDERGROUND POWER

CONTOURS

- EXISTING (0.5m INTERVALS)
- DESIGN (0.25m INTERVALS)

BULK EARTHWORKS

- RETAINING WALL
- EARTHWORKS PAD
- 1% EARTHWORKS PAD GRADE

DEPTH RANGE

CUT
- -1.75m TO -1.50m
- -1.50m TO -1.25m
- -1.25m TO -1.00m
- -1.00m TO -0.75m
- -0.75m TO -0.50m
- -0.50m TO -0.25m
- -0.25m TO 0.00m

FILL
- 0.00m TO 0.25m
- 0.25m TO 0.50m
- 0.50m TO 0.75m
- 0.75m TO 1.00m
- 1.00m TO 1.25m
- 1.25m TO 1.50m
- 1.50m TO 1.75m
- 1.75m TO 2.00m

RELEASE 3 DEVELOPMENT

SNAPPER DRIVE

MONTWOOD DRIVE

ROAD 1 (MC01)

ROAD 2 (MC02)

ROAD 3 (MC03)

ROAD 4 (MC04)

PAD 1 (MP01)

PAD 2 (MP02)

PAD 3 (MP03)

PAD 4 (MP04)

PAD 5 (MP05)

PAD 6 (MP06)

PAD 7A (MP07A)

PAD 7B (MP07B)

PAD 8 (MP08)

PAD 9 (MP09)

PAD 10 (MP10)

PAD 11 (MP11)

PAD 12 (MP12)

PAD 13 (MP13)

PAD 14 (MP14)

PAD 15 (MP15)

PAD 16 (MP16)

PAD 17 (MP17)

PAD 18A (MP18A)

PAD 18B (MP18B)

PAD 19A (MP19A)

PAD 19B (MP19B)

PROPOSED RETAINING WALL 1.6m HIGH MAX.

PROPOSED RETAINING WALL 2.2m HIGH MAX.

MAXIMUM CUT DEPTH = 1.75m

PROPOSED RETAINING WALL 1.5m HIGH MAX.

PROPOSED RETAINING WALL 1.6m HIGH MAX.

CONSERVATION MANAGEMENT ZONE

CONSERVATION MANAGEMENT ZONE

EXISTING BATTER TOE TO BE RELOCATED 0.5m FROM CMZ BOUNDARY AND REPLACED WITH A PROPOSED 1 IN 2 BATTER

MAXIMUM FILL DEPTH = 2.00m

A BE-11

B BE-11

C BE-12

D BE-12

PLAN

SCALE 1:500

FOR APPROVAL

REV	DESCRIPTION	BY	APP.	DATE
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A	FOR CLIENT REVIEW	DY	CP	08.05.18

REVISIONS

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Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

SCALES

HORIZ. DATUM	MGA
VERT. DATUM	AHD
SURVEY	NDC
DRAWN	DY
DESIGN	DY
APPROVED	CP
DATE	08.05.2018

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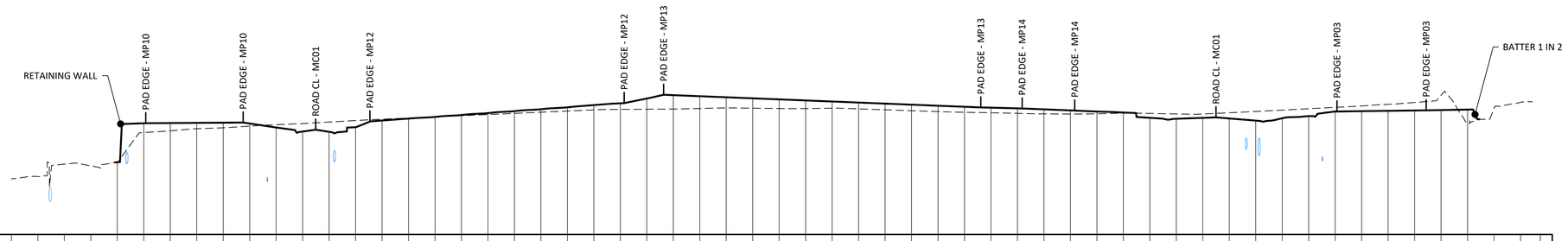
CLARENCE PROPERTY

EPIQ ESTATE - LENNOX HEAD, NSW, 2478
SUPER LOT 5
BULK EARTHWORKS
PLAN

Reference No.	DRAWING No.	REVISION
2014/351	14351-S5-DA-BE-01	B

Plot Date: 10 Aug, 2018 CAD File Name: K:\Jobs\2014\14351 - Clarence Property\Superlot 5\Engineering\Engineering Plans\Drawings\14351-S5-DA-BE-01.dwg



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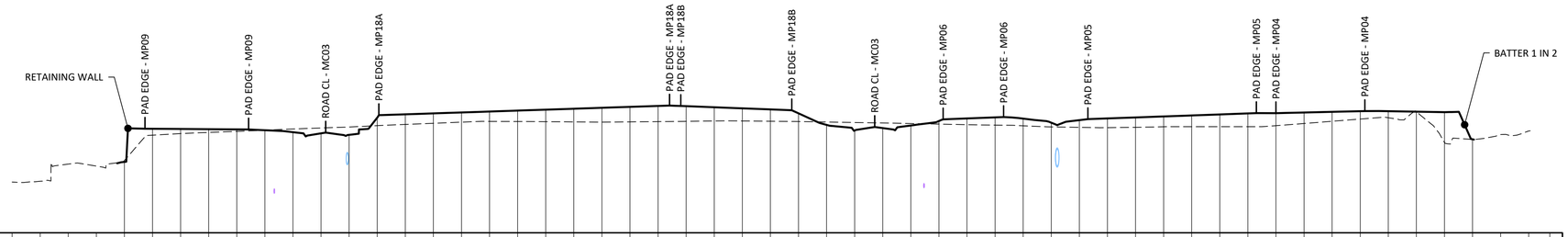
EXISTING SURFACE	2.101	2.188	2.657	2.591	2.724	3.852	3.918	3.994	4.031	4.093	4.147	4.192	4.248	4.304	4.357	4.400	4.444	4.487	4.532	4.576	4.620	4.663	4.707	4.726	4.733	4.740	4.760	4.782	4.772	4.759	4.758	4.771	4.746	4.712	4.678	4.643	4.617	4.599	4.576	4.557	4.551	4.561	4.579	4.574	4.554	4.552	4.599	4.648	4.699	4.751	4.802	4.856	4.918	4.987	5.259	4.277	4.834	4.992	5.014
DESIGN SURFACE					2.730	4.201	4.210	4.217	4.225	4.193	4.041	3.889	3.878	4.054	4.306	4.379	4.443	4.515	4.587	4.660	4.732	4.804	4.889	4.957	5.136	5.265	5.225	5.185	5.145	5.105	5.065	5.025	4.985	4.945	4.905	4.865	4.825	4.791	4.766	4.728	4.688	4.645	4.608	4.408	4.372	4.407	4.383	4.302	4.393	4.472	4.648	4.659	4.672	4.685	4.701	4.719				

BULK EARTHWORKS SECTION - SECTION B

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



DATUM R.L. 0.00

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EXISTING SURFACE	1.804	1.833	2.441	2.370	2.571	3.470	3.526	3.566	3.604	3.646	3.689	3.725	3.758	3.807	3.851	3.891	3.931	3.959	3.955	3.948	3.940	3.932	3.941	3.950	3.961	3.973	3.973	3.964	3.953	3.936	3.919	3.902	3.883	3.863	3.842	3.827	3.803	3.763	3.746	3.737	3.747	3.767	3.771	3.770	3.770	3.807	3.883	3.963	4.042	4.088	4.301	3.213	3.500	3.491	3.616	3.626
DESIGN SURFACE					2.519	3.697	3.690	3.682	3.675	3.645	3.576	3.533	3.480	4.090	4.210	4.243	4.276	4.309	4.342	4.375	4.409	4.442	4.475	4.508	4.500	4.461	4.422	4.384	4.245	3.835	3.635	3.721	3.813	3.972	4.063	4.101	4.057	3.913	4.004	4.064	4.099	4.135	4.170	4.206	4.241	4.251	4.275	4.298	4.322	4.322	4.304	4.287	3.323				

BULK EARTHWORKS SECTION - SECTION A

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

FOR APPROVAL

REV	DESCRIPTION	BY	APP.	DATE
B	FOR COUNCIL APPROVAL	DY	CP	10.08.18
A	FOR CLIENT REVIEW	DY	CP	08.05.18

REVISIONS

SCALES SHOWN ARE FOR AN A1 SIZE ORIGINAL DRAWING

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Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

0 1 2 4 6
Full Size 1:100 ; Half Reduction 1:200
SCALE (m)

SCALES

APPROVALS	
HORIZ. DATUM	MGA
VERT. DATUM	AHD
SURVEY	NDC
DRAWN	DY
DESIGN	DY
APPROVED	CP
DATE	08.05.2018

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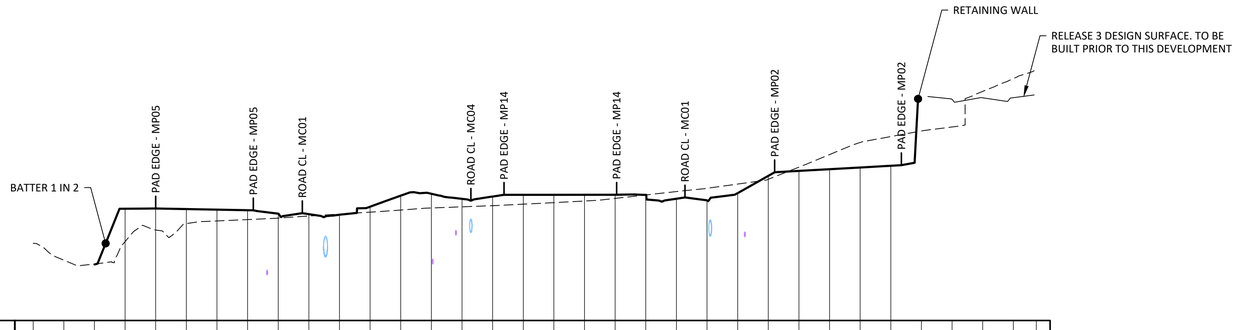
CLARENCE PROPERTY

EPIQ ESTATE - LENNOX HEAD, NSW, 2478
SUPER LOT 5
BULK EARTHWORKS
SECTIONS - SECTION A & SECTION B

Reference No.	DRAWING No.	REVISION
2014/351	14351-S5-DA-BE-11	B

Plot Date: 10 Aug, 2018 CAD File Name: K:\Jobs\2014\14351 - Clarence Property\Superlot 5\Engineering\Engineering Plans\Drawings\14351-S5-DA-BE-11.dwg



DATUM R.L. 0.50

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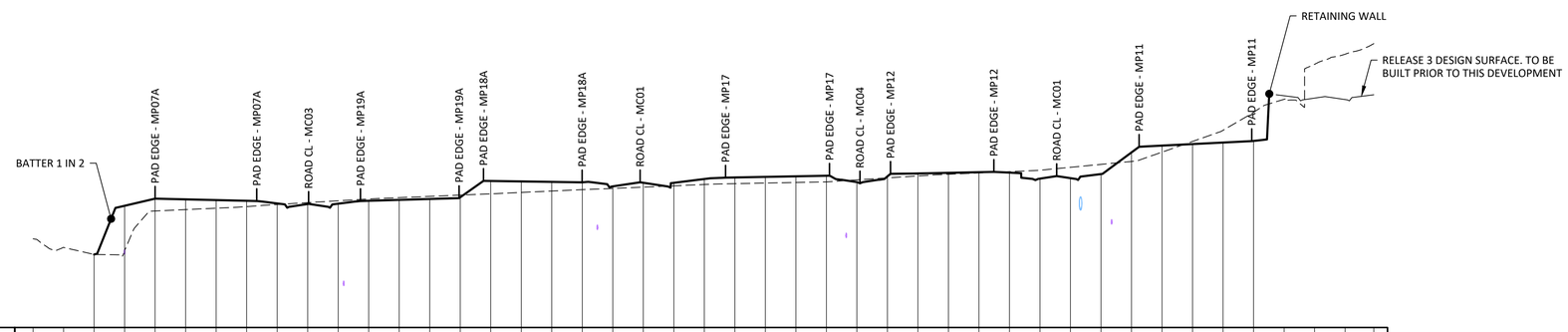
EXISTING SURFACE	3.021	2.607	2.458	3.076	3.454	3.662	3.751	3.795	3.843	3.911	3.974	4.038	4.105	4.174	4.211	4.248	4.298	4.348	4.400	4.486	4.598	4.710	4.816	4.954	5.110	5.506	5.916	6.312	6.504	6.686	6.818	7.979	8.400	8.652
DESIGN SURFACE				4.149	4.157	4.138	4.120	4.101	3.987	3.971	3.952	4.215	4.576	4.637	4.472	4.545	4.603	4.604	4.604	4.605	4.600	4.476	4.417	4.658	5.222	5.384	5.439	5.495	5.551					

BULK EARTHWORKS SECTION - SECTION D

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



DATUM R.L. -0.50

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EXISTING SURFACE	2.405	2.127	1.890	2.009	3.316	3.361	3.406	3.459	3.528	3.589	3.649	3.709	3.752	3.794	3.836	3.876	3.923	3.969	4.015	4.054	4.097	4.140	4.183	4.210	4.230	4.249	4.268	4.334	4.398	4.463	4.518	4.560	4.603	4.650	4.746	4.841	4.937	5.242	5.593	5.958	6.547	6.972	8.118	8.448	8.795
DESIGN SURFACE			1.891	3.485	3.719	3.696	3.673	3.649	3.563	3.543	3.555	3.649	3.678	3.708	3.763	4.298	4.284	4.269	4.254	4.121	4.239	4.237	4.362	4.413	4.432	4.451	4.470	4.262	4.447	4.545	4.565	4.586	4.573	4.375	4.390	4.525	5.234	5.455	5.505	5.555	5.609					

BULK EARTHWORKS SECTION - SECTION C

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

FOR APPROVAL

REV	DESCRIPTION	BY	APP.	DATE
B	FOR COUNCIL APPROVAL	DY	CP	10.08.18
A	FOR CLIENT REVIEW	DY	CP	08.05.18

REVISIONS

SCALES SHOWN ARE FOR AN A1 SIZE ORIGINAL DRAWING

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Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

0 1 2 4 6
Full Size 1:100 ; Half Reduction 1:200
SCALE (m)

SCALES

APPROVALS	
HORIZ. DATUM	MGA
VERT. DATUM	AHD
SURVEY	NDC
DRAWN	DY
DESIGN	DY
APPROVED	CP
DATE	08.05.2018

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CLARENCE PROPERTY

EPIQ ESTATE - LENNOX HEAD, NSW, 2478
SUPER LOT 5
BULK EARTHWORKS
SECTIONS - SECTION C & SECTION D

Reference No.	DRAWING No.	REVISION
2014/351	14351-S5-DA-BE-12	B

Plot Date: 10 Aug, 2018 CAD File Name: K:\Jobs\2014\14351 - Clarence Property\Superlot 5\Engineering\Engineering Plans\Drawings\14351-S5-DA-BE-12.dwg

LEGEND:

- PROPERTY BOUNDARY
- PROPOSED PROPERTY BOUNDARY
- EXISTING SEWER LINE
- EXISTING WATER LINE
- EXISTING RECYCLED WATER LINE
- EXISTING DRAINAGE LINE
- EXISTING UNDERGROUND POWER

PROPOSED

- ROAD CONTROL LINE
- RETAINING WALL
- DRAINAGE
- SEWER
- PROPOSED CONCRETE SURFACE
- PROPOSED ASPHALT SURFACE
- PROPOSED THRESHOLD SURFACE TREATMENT

PLAN

SCALE 1:500

FOR APPROVAL

REV	DESCRIPTION	BY	APP.	DATE
B	FOR COUNCIL APPROVAL	DY	CP	10.08.18
A	FOR CLIENT REVIEW	DY	CP	08.05.18

REVISIONS

SCALES SHOWN ARE FOR AN A1 SIZE ORIGINAL DRAWING

0 5 10 20 30
Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

SCALES

HORIZ. DATUM	MGA
VERT. DATUM	AHD
SURVEY	NDC
DRAWN	DY
DESIGN	DY
APPROVED	CP
DATE	08.05.2018

APPROVALS

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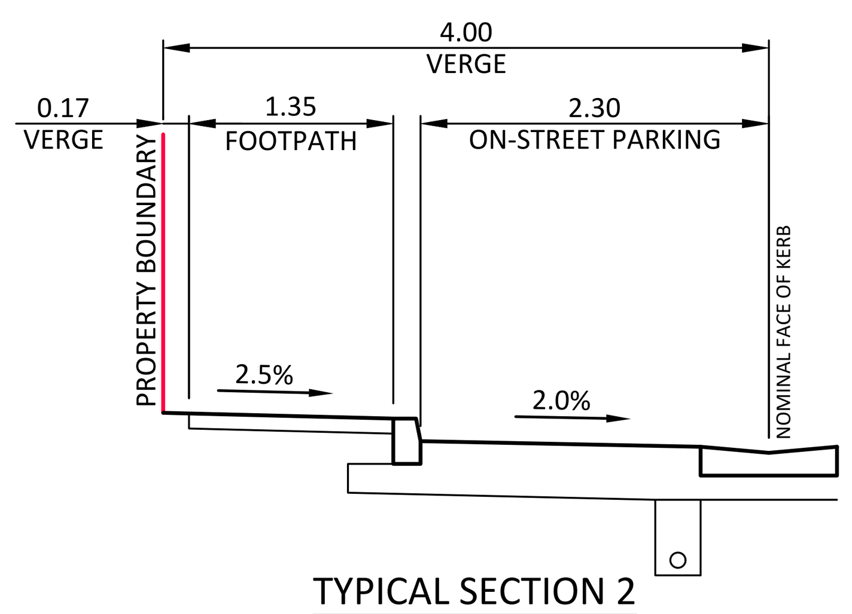
CLARENCE PROPERTY

EPIQ ESTATE - LENNOX HEAD, NSW, 2478
SUPER LOT 5
CIVIL WORKS
PLAN

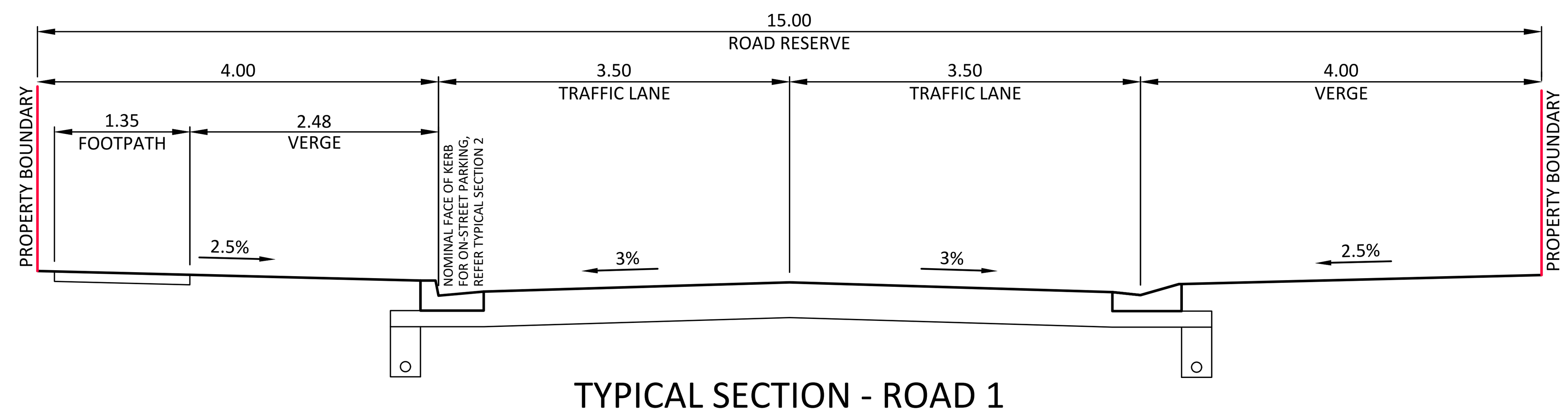
Reference No.	DRAWING No.	REVISION
2014/351	14351-S5-DA-CI-01	B

Plot Date: 10 Aug, 2018 CAD File Name: K:\Jobs\2014\14351 - Clarence Property\Superlot 5\Engineering\Engineering Plans\Drawings\14351-S5-DA-CI-01.dwg

CONTROL LINE MC01

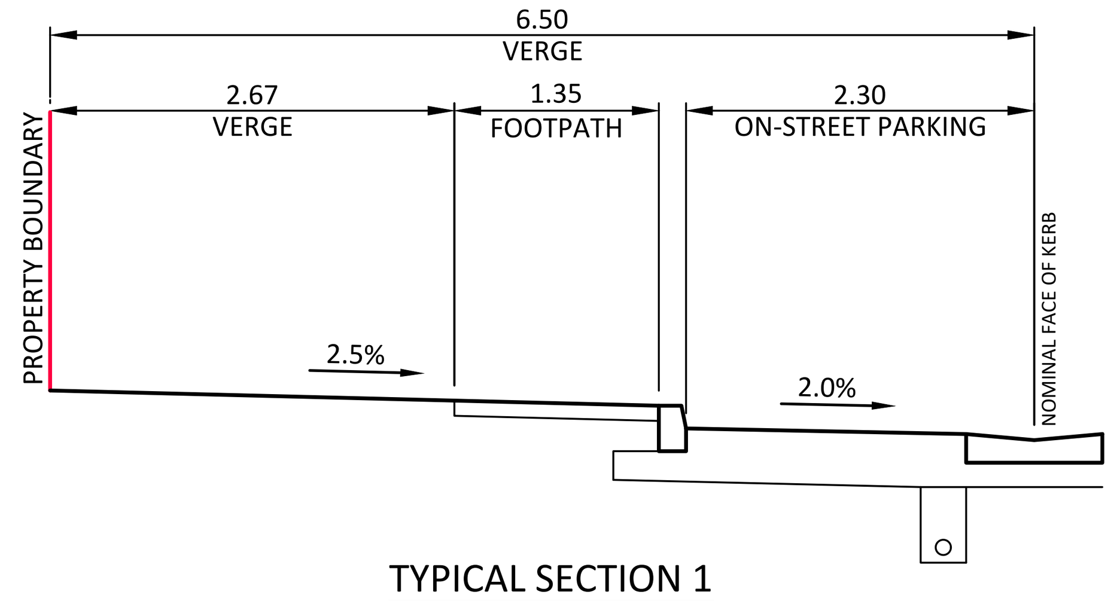


TYPICAL SECTION 2
ON-STREET PARKING

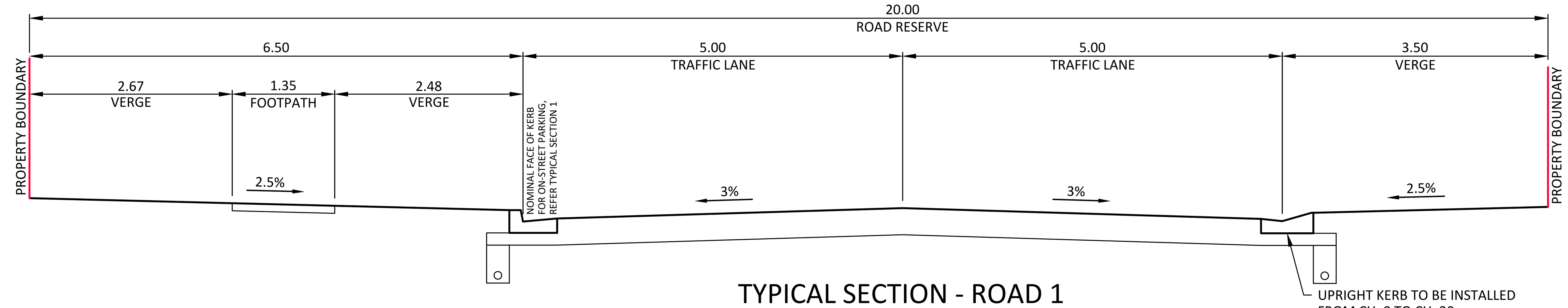


TYPICAL SECTION - ROAD 1
SCALE 1:50
CH. 140 TO END

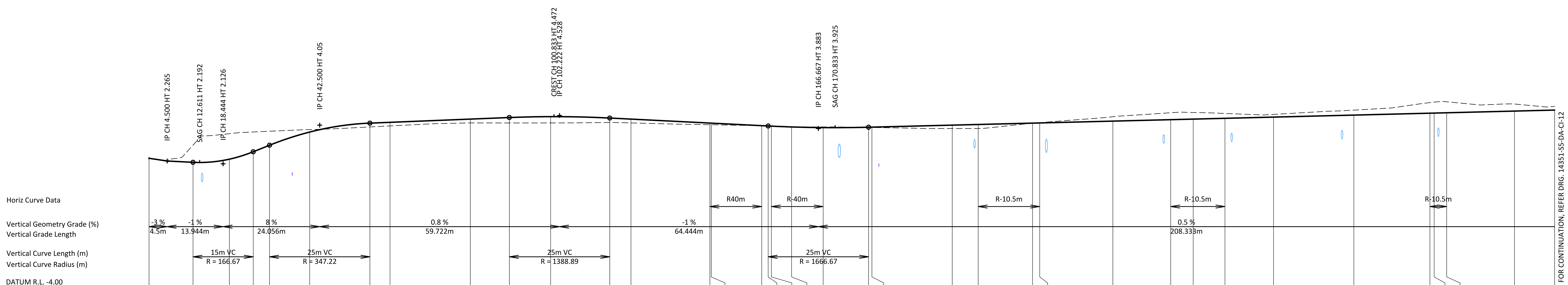
CONTROL LINE MC01



TYPICAL SECTION 1
ON-STREET PARKING



TYPICAL SECTION - ROAD 1
SCALE 1:50
START TO CH. 140



DATUM R.L. -4.00

DEPTH TO EXISTING SURFACE	-0.005	-0.853	-1.269	-0.984	-0.698	-0.121	0.189	0.179	0.189	0.270	0.312	0.222	0.190
DESIGN HEIGHT	2.400	2.201	2.356	2.726	3.050	3.706	4.150	4.190	4.350	4.428	4.472	4.403	4.350
EXISTING SURFACE	2.405	3.053	3.625	3.710	3.748	3.827	3.961	4.011	4.161	4.158	4.160	4.181	4.160
CHAINAGE	0	10.944	20	25.944	30	40	55	60	80	89.722	100	114.722	120

DEPTH TO EXISTING SURFACE	0.082	0.080	0.011	0.004	-0.000	-0.018	-0.033	0.012	0.018	0.169	0.200	0.005
DESIGN HEIGHT	4.153	4.150	4.024	4.008	4.001	3.960	3.928	3.946	3.950	4.050	4.082	4.150
EXISTING SURFACE	4.071	4.070	4.013	4.005	4.001	3.978	3.960	3.934	3.932	3.881	3.883	4.145
CHAINAGE	139.65	140	152.56	154.167	154.953	160	167.864	179.167	180	200	206.463	220

DEPTH TO EXISTING SURFACE	-0.016	-0.218	-0.345	-0.329	-0.242	-0.134	-0.247	-0.528	-0.546	-0.545	-0.351	-0.184
DESIGN HEIGHT	4.159	4.250	4.322	4.350	4.390	4.450	4.550	4.645	4.650	4.666	4.750	4.800
EXISTING SURFACE	4.175	4.468	4.667	4.679	4.632	4.584	4.797	5.172	5.196	5.211	5.101	4.984
CHAINAGE	221.776	240	254.399	260	267.902	280	300	318.949	320	323.118	340	350

LONGITUDINAL SECTION MC01

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

FOR APPROVAL

REV	DESCRIPTION	BY	APP.	DATE
B	FOR COUNCIL APPROVAL	DY	CP	10.08.18
A	FOR CLIENT REVIEW	DY	CP	08.05.18

REVISIONS

SCALES SHOWN ARE FOR AN A1 SIZE ORIGINAL DRAWING
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0 1 2 4 6 Full Size 1:100 ; Half Reduction 1:200 SCALE (m)
0 0.5 1 2 3 Full Size 1:50 ; Half Reduction 1:100 SCALE (m)

SCALES

HORIZ. DATUM	MGA
VERT. DATUM	AHD
SURVEY	NDC
DRAWN	DY
DESIGN	DY
APPROVED	CP
DATE	08.05.2018

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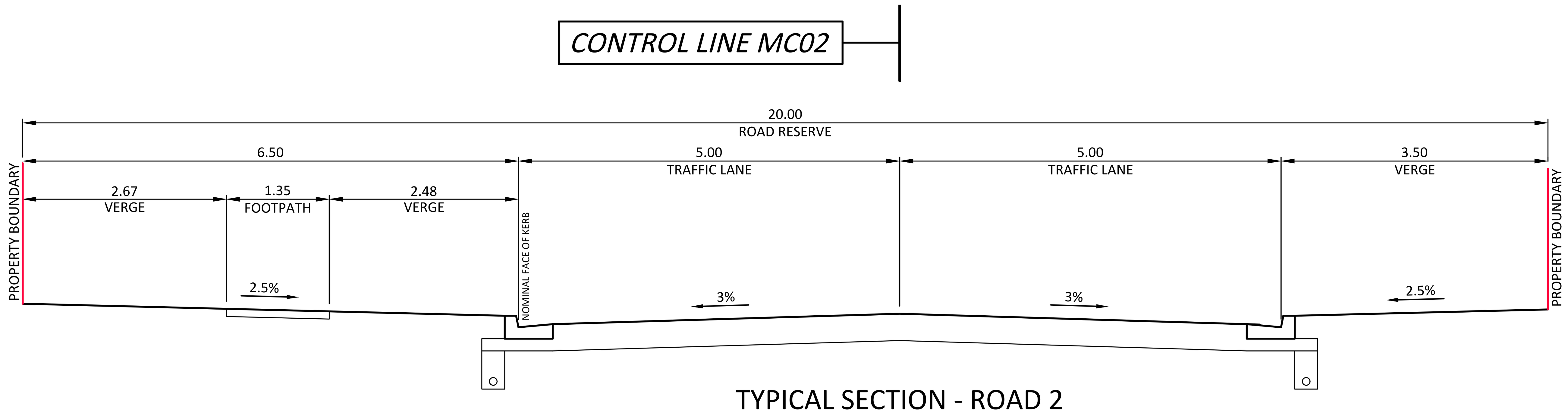
CLARENCE PROPERTY

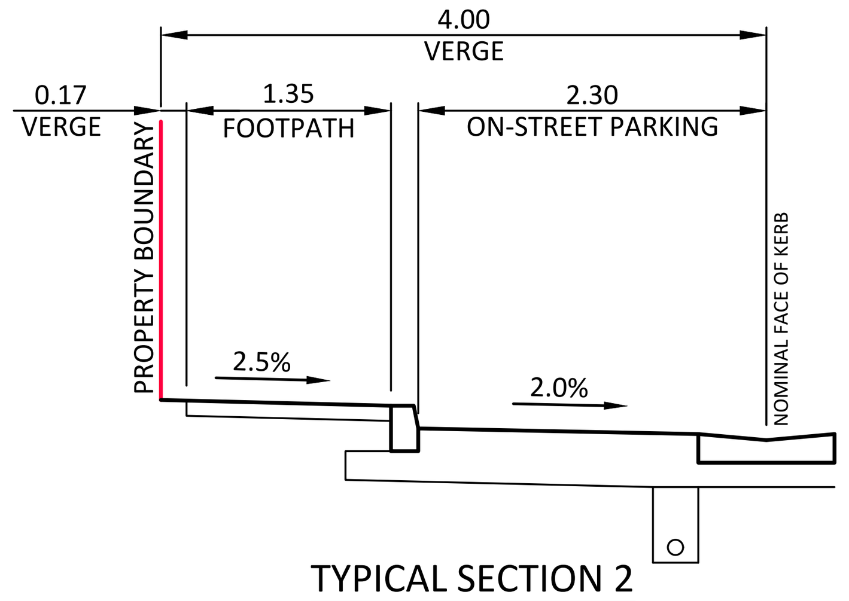
EPIQ ESTATE - LENNOX HEAD, NSW, 2478
SUPER LOT 5
CIVIL WORKS
LONGITUDINAL SECTION - MC01

Reference No. 2014/351
DRAWING No. 14351-S5-DA-CI-11
REVISION B



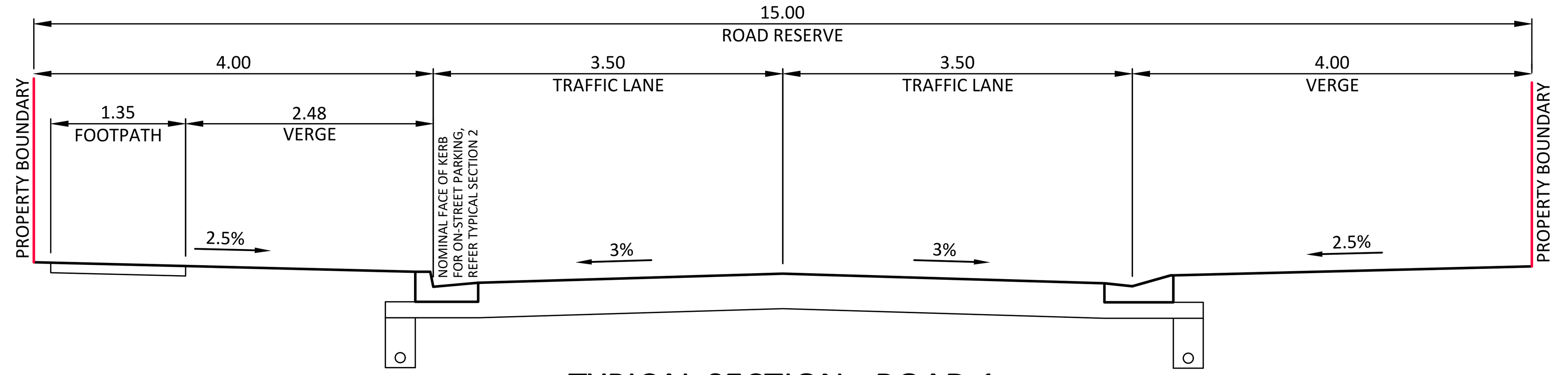
TYPICAL SECTION - ROAD 2

SCALE 1:50



TYPICAL SECTION 2

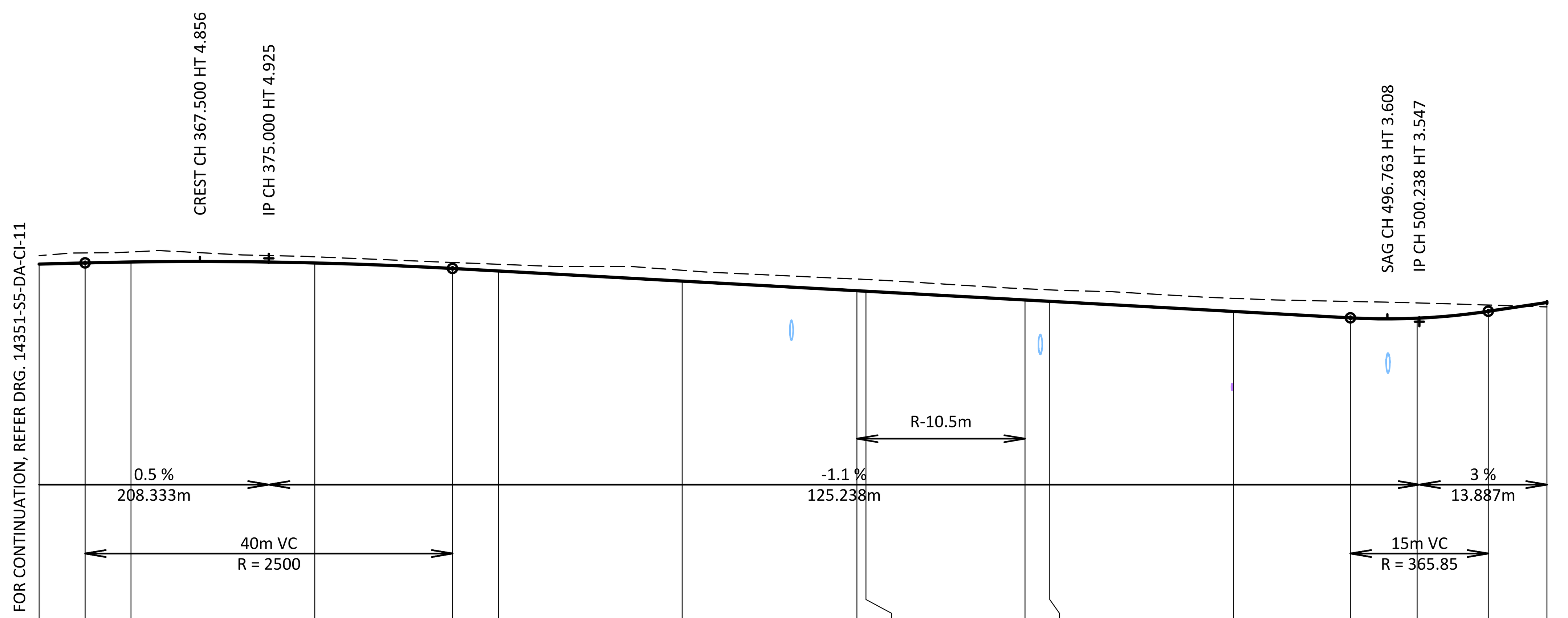
ON-STREET PARKING



TYPICAL SECTION - ROAD 1

SCALE 1:50

CH. 140 TO END



Horiz Curve Data

Vertical Geometry Grade (%) — 0.5 % | -1.1 % | 3 %

Vertical Grade Length — 208.333m | 125.238m | 13.887m

Vertical Curve Length (m) — 40m VC | 15m VC

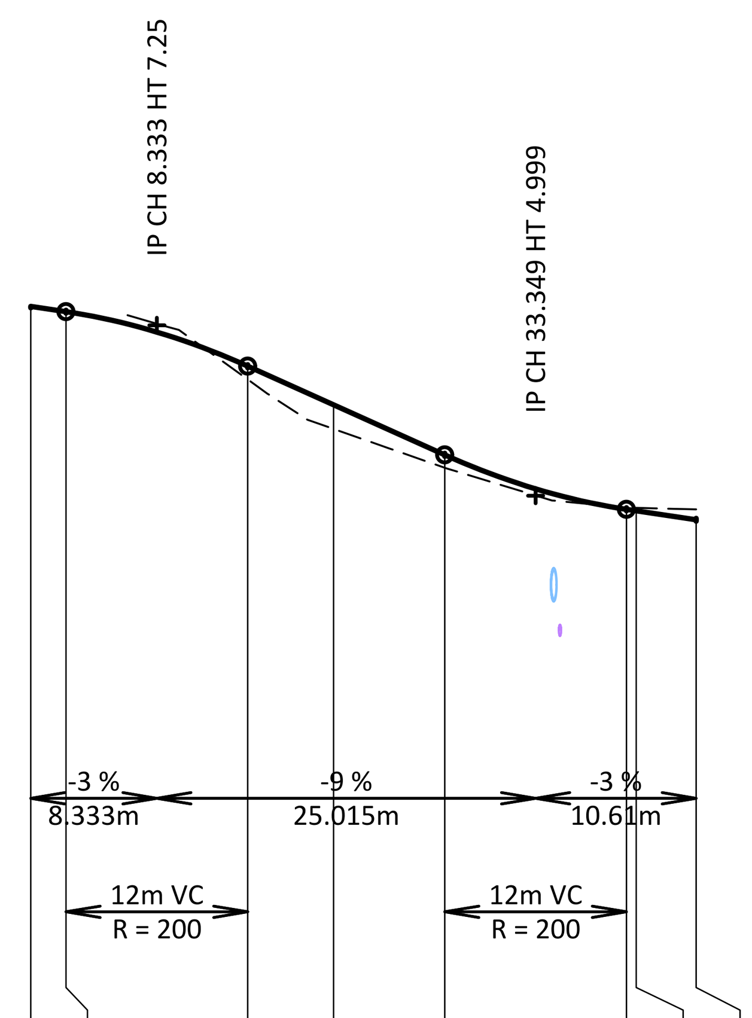
Vertical Curve Radius (m) — R = 2500 | R = 365.85

DATUM R.L. -3.00

DEPTH TO EXISTING SURFACE	DESIGN HEIGHT	EXISTING SURFACE	CHAINAGE
-0.184	4.800	4.984	350
-0.218	4.825	5.043	355
-0.219	4.845	5.064	360
-0.134	4.825	4.959	380
-0.130	4.705	4.835	395
-0.146	4.650	4.796	400
-0.235	4.430	4.665	420
-0.254	4.221	4.475	439.018
-0.256	4.210	4.466	440
-0.243	4.020	4.263	457.314
-0.249	3.990	4.239	460
-0.285	3.770	4.055	480
-0.357	3.630	3.987	492.738
-0.332	3.622	3.954	500
-0.136	3.772	3.909	507.738
0.095	3.964	3.869	514.125

LONGITUDINAL SECTION MC01

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



Horiz Curve Data

Vertical Geometry Grade (%) — -3 % | -9 % | -3 %

Vertical Grade Length — 8.333m | 25.015m | 10.61m

Vertical Curve Length (m) — 12m VC | 12m VC

Vertical Curve Radius (m) — R = 200 | R = 200

DATUM R.L. -2.00

DEPTH TO EXISTING SURFACE	DESIGN HEIGHT	EXISTING SURFACE	CHAINAGE
	7.500		0
	7.430		2.333
0.176	6.710	6.534	14.333
0.319	6.200	5.881	20
0.171	5.539	5.367	27.349
-0.023	4.819	4.842	39.349
-0.039	4.799	4.839	40
-0.137	4.680	4.817	43.959

LONGITUDINAL SECTION MC02

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

FOR APPROVAL

REV	DESCRIPTION	BY	APP.	DATE
B	FOR COUNCIL APPROVAL	DY	CP	10.08.18
A	FOR CLIENT REVIEW	DY	CP	08.05.18

REVISIONS

SCALES SHOWN ARE FOR AN A1 SIZE ORIGINAL DRAWING

Full Size 1:500 ; Half Reduction 1:1000 SCALE (m)

Full Size 1:100 ; Half Reduction 1:200 SCALE (m)

Full Size 1:50 ; Half Reduction 1:100 SCALE (m)

SCALES

HORIZ. DATUM	MGA
VERT. DATUM	AHD
SURVEY	NDC
DRAWN	DY
DESIGN	DY
APPROVED	CP
DATE	08.05.2018

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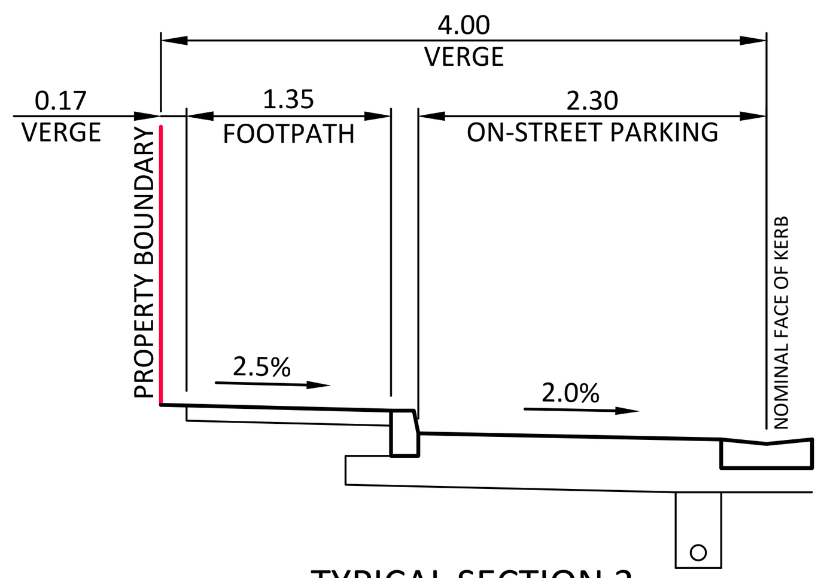
CLARENCE PROPERTY

EPIQ ESTATE - LENNOX HEAD, NSW, 2478
SUPER LOT 5
CIVIL WORKS
LONGITUDINAL SECTION - MC01 & MC02

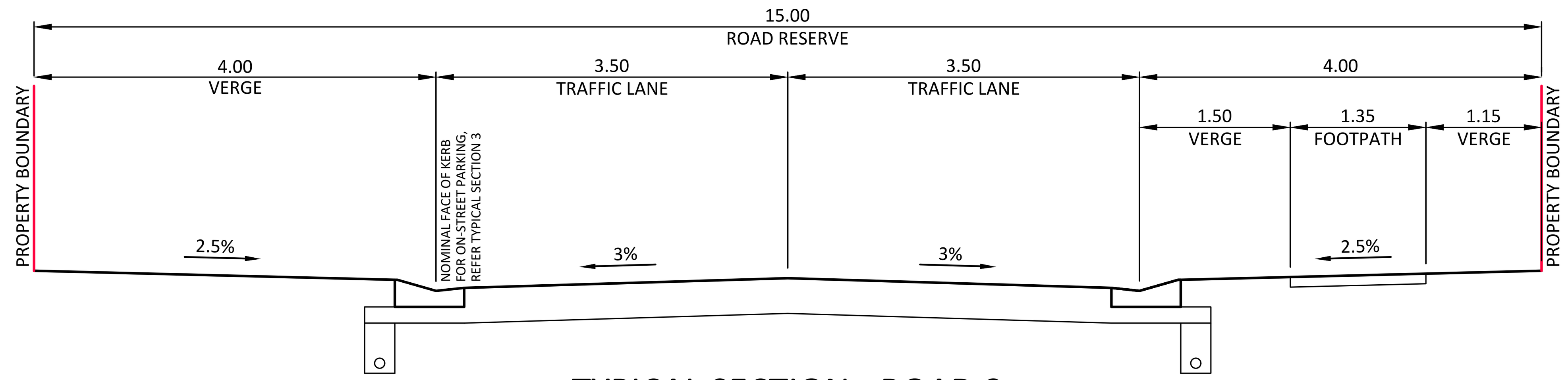
Reference No. 2014/351

DRAWING No. 14351-S5-DA-CI-12

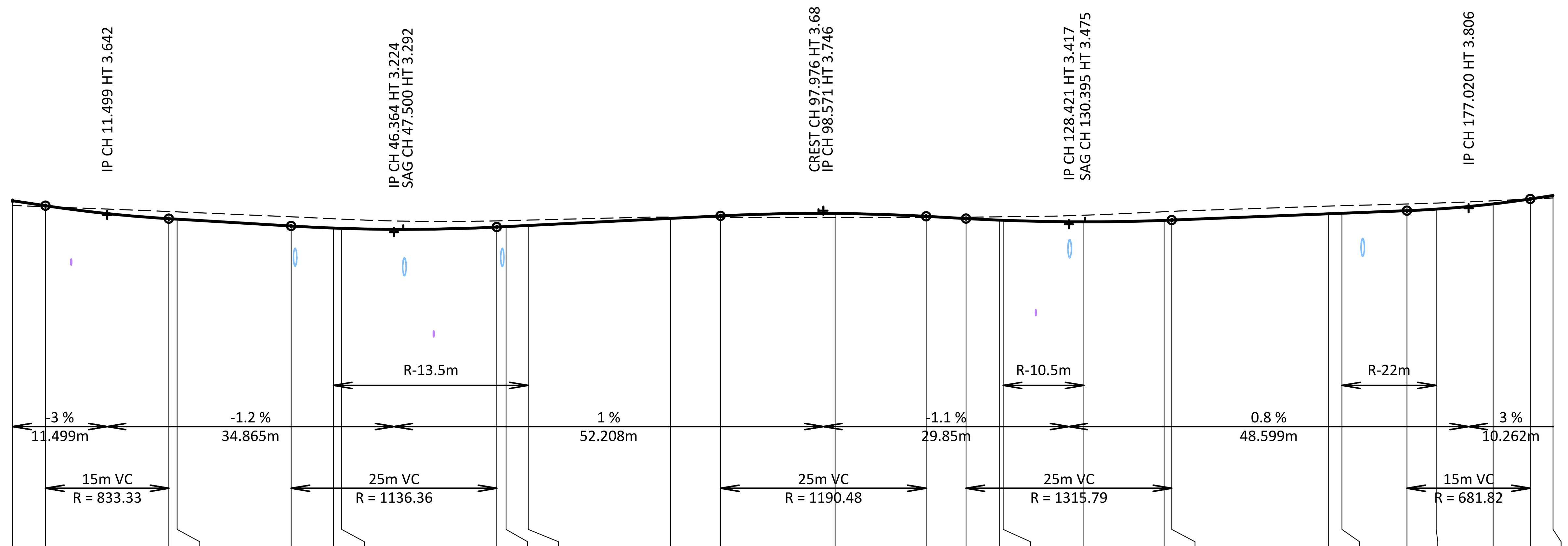
REVISION B



TYPICAL SECTION 3
ON-STREET PARKING



TYPICAL SECTION - ROAD 3
SCALE 1:50



DEPTH TO EXISTING SURFACE	0.111	0.026	-0.174	-0.177	-0.224	-0.226	-0.224	-0.150	-0.144
DESIGN HEIGHT	3.987	3.867	3.552	3.540	3.374	3.324	3.317	3.349	3.360
EXISTING SURFACE	3.876	3.841	3.726	3.717	3.598	3.549	3.540	3.499	3.504
CHAINAGE	0	3.999	18.999	20	33.864	39.012	40	58.864	60

DEPTH TO EXISTING SURFACE	-0.130	-0.029	0.036	0.100	0.029	-0.032	-0.082	-0.086	-0.161
DESIGN HEIGHT	3.387	3.560	3.621	3.679	3.608	3.555	3.516	3.513	3.475
EXISTING SURFACE	3.517	3.589	3.585	3.578	3.579	3.587	3.598	3.599	3.636
CHAINAGE	62.694	80	86.071	100	111.071	115.921	120	120.438	130.244

DEPTH TO EXISTING SURFACE	-0.211	-0.212	-0.189	-0.187	-0.163	-0.147	-0.076	0.002	0.058
DESIGN HEIGHT	3.510	3.517	3.670	3.683	3.746	3.784	3.911	4.031	4.114
EXISTING SURFACE	3.721	3.729	3.859	3.870	3.909	3.931	3.987	4.029	4.056
CHAINAGE	140	140.921	160	161.617	169.52	173.078	180	184.52	187.282

LONGITUDINAL SECTION MC03
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

FOR APPROVAL

REV	DESCRIPTION	BY	APP.	DATE
B	FOR COUNCIL APPROVAL	DY	CP	10.08.18
A	FOR CLIENT REVIEW	DY	CP	08.05.18

REVISIONS

SCALES SHOWN ARE FOR AN A1 SIZE ORIGINAL DRAWING
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Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)
0 1 2 4 6
Full Size 1:100 ; Half Reduction 1:200
SCALE (m)
0 0.5 1 2 3
Full Size 1:50 ; Half Reduction 1:100
SCALE (m)

SCALES

HORIZ. DATUM	MGA
VERT. DATUM	AHD
SURVEY	NDC
DRAWN	DY
DESIGN	DY
APPROVED	CP
DATE	08.05.2018

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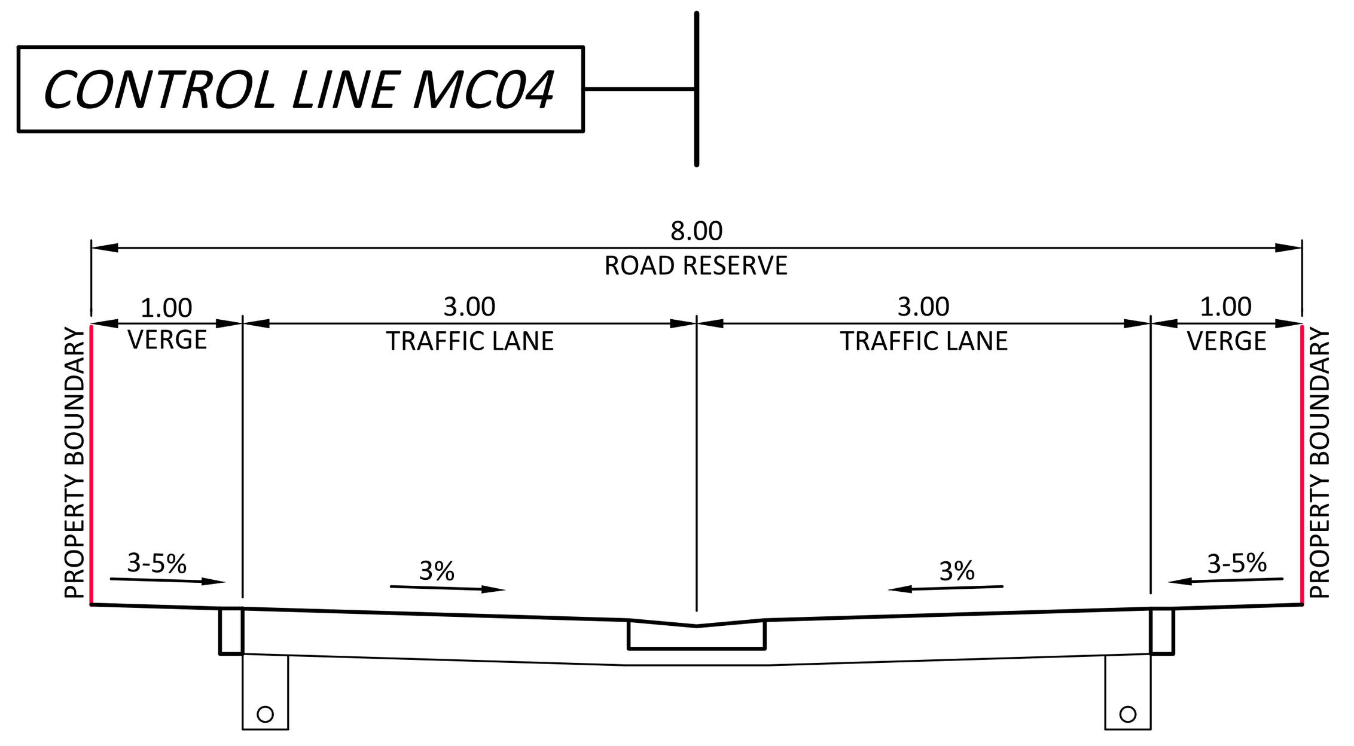
CLARENCE PROPERTY

EPIQ ESTATE - LENNOX HEAD, NSW, 2478
SUPER LOT 5
CIVIL WORKS
LONGITUDINAL SECTION - MC03

Reference No.	DRAWING No.	REVISION
2014/351	14351-S5-DA-CI-13	B

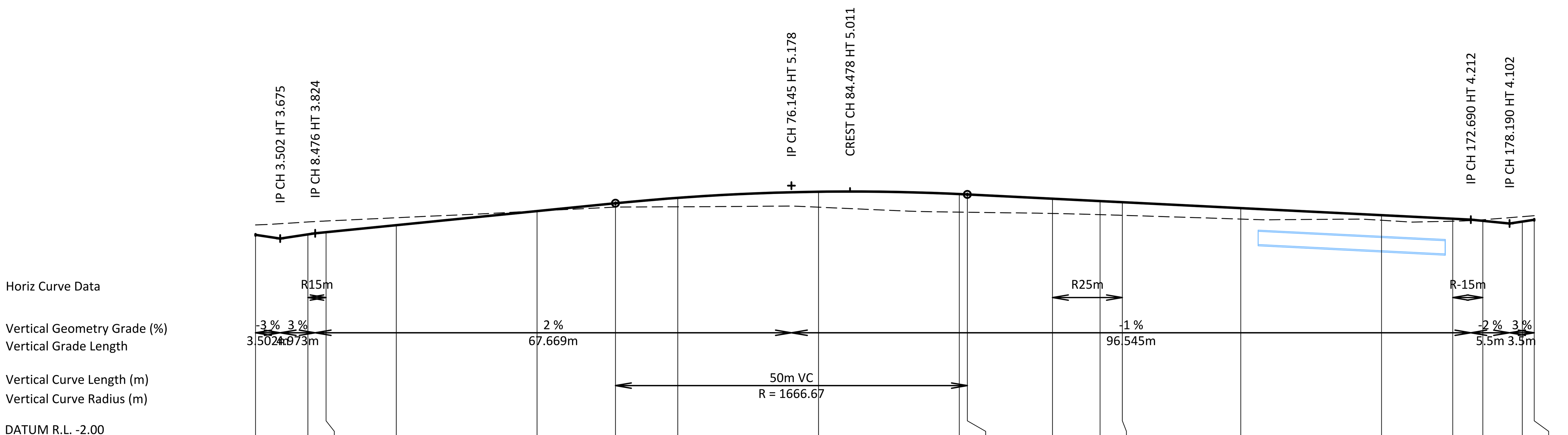
THIS PLAN IS NOT FOR CONSTRUCTION UNLESS STAMPED BY THE PRINCIPAL CERTIFYING AUTHORITY AND ISSUED WITH A NUMERICAL REVISION

Plot Date: 10 Aug, 2018 CAD File Name: K:\Jobs\2014\14351 - Clarence Property\Superlot 5\Engineering\Engineering Plans\Drawings\14351-S5-DA-CI-13.dwg



TYPICAL SECTION - ROAD 4

SCALE 1:50



DEPTH TO EXISTING SURFACE	-0.282	-0.353	-0.319	-0.212	-0.004	0.109	0.254	0.439	0.513	0.505	0.419
DESIGN HEIGHT	3.780	3.793	3.855	4.055	4.455	4.678	4.831	5.005	4.939	4.928	4.807
EXISTING SURFACE	4.062	4.146	4.174	4.267	4.459	4.569	4.577	4.566	4.425	4.422	4.388
CHAINAGE	0	7.441	10.016	20	40	51.145	60	80	100	101.145	113.242

DEPTH TO EXISTING SURFACE	0.385	0.372	0.310	0.145	0.070	-0.030	-0.141	-0.117
DESIGN HEIGHT	4.739	4.707	4.539	4.339	4.238	4.178	4.157	4.207
EXISTING SURFACE	4.354	4.335	4.229	4.194	4.168	4.208	4.297	4.324
CHAINAGE	120	123.17	140	160	170.117	174.388	180	181.69

LONGITUDINAL SECTION MC04

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

FOR APPROVAL

REV	DESCRIPTION	BY	APP.	DATE
B	FOR COUNCIL APPROVAL	DY	CP	10.08.18
A	FOR CLIENT REVIEW	DY	CP	08.05.18

REVISIONS

SCALES SHOWN ARE FOR AN A1 SIZE ORIGINAL DRAWING

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Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

0 1 2 4 6
Full Size 1:100 ; Half Reduction 1:200
SCALE (m)

0 0.5 1 2 3
Full Size 1:50 ; Half Reduction 1:100
SCALE (m)

SCALES

HORIZ. DATUM	MGA
VERT. DATUM	AHD
SURVEY	NDC
DRAWN	DY
DESIGN	DY
APPROVED	CP
DATE	08.05.2018

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CLARENCE PROPERTY

EPIQ ESTATE - LENNOX HEAD, NSW, 2478
SUPER LOT 5
CIVIL WORKS
LONGITUDINAL SECTION - MC04

Reference No.	DRAWING No.	REVISION
2014/351	14351-S5-DA-CI-14	B

LEGEND:

- PROPERTY BOUNDARY
- PROPOSED PROPERTY BOUNDARY
- EXISTING SEWER LINE
- EXISTING WATER LINE
- EXISTING RECYCLED WATER LINE
- EXISTING DRAINAGE LINE
- EXISTING UNDERGROUND POWER

PROPOSED SERVICES

- DRAINAGE
- SEWER
- SEWER RISING MAIN
- WATER - POTABLE
- WATER - RECYCLED
- OVERLAND FLOW PATH - 100 YEAR ARI

RELEASE 3 DEVELOPMENT

SNAPPER DRIVE

MONTWOOD DRIVE

ROAD 1

ROAD 2

ROAD 3

ROAD 4

DRAINAGE TO CONNECT TO EXISTING NETWORK

PROPOSED SEWER RISING MAIN. FOR PLAN OF THEN ALIGNMENT, REFER TO DRG. 14351-S5-DA-CI-22

DRAINAGE TO CONNECT TO EXISTING NETWORK

EXISTING DRAINAGE SECTION TO BE UP-SIZED TO Ø900. SEWER RISING MAIN TO RUN BENEATH DRAINAGE

PROPOSED ELECTRICAL SERVICE AREA FOR PMT

PROPOSED SEWER RISING MAIN SECTION TO BE UNDER-BORED

PROPOSED Ø1050 PIPE CULVERT BETWEEN EXISTING WING WALLS

PROPOSED SEWER PUMP STATION AREA (FINAL ARRANGEMENT TO BE CONFIRMED)

PROPOSED OVERLAND FLOW PATH AND DRAINAGE EASEMENT

PROPOSED OVERLAND FLOW PATH AND DRAINAGE EASEMENT

CONSERVATION MANAGEMENT ZONE

CONSERVATION MANAGEMENT ZONE

PLAN

SCALE 1:500

FOR APPROVAL

REV	DESCRIPTION	BY	APP.	DATE
B	FOR COUNCIL APPROVAL	DY	CP	10.08.18
A	FOR CLIENT REVIEW	DY	CP	08.05.18

REVISIONS

SCALES SHOWN ARE FOR AN A1 SIZE ORIGINAL DRAWING

0 5 10 20 30

Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

SCALES

HORIZ. DATUM	MGA
VERT. DATUM	AHD
SURVEY	NDC
DRAWN	DY
DESIGN	DY
APPROVED	CP
DATE	08.05.2018

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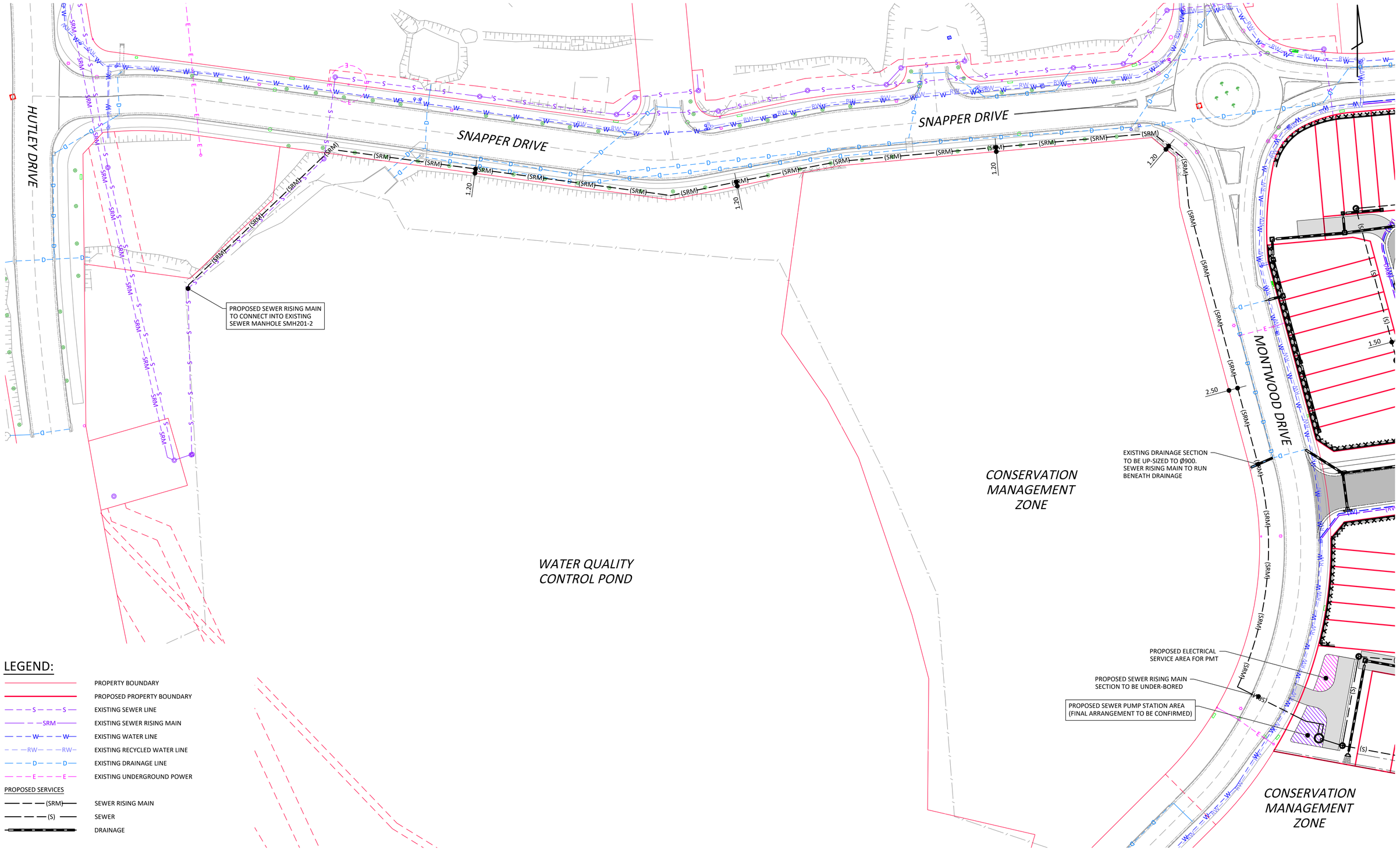
CLARENCE PROPERTY

EPIQ ESTATE - LENNOX HEAD, NSW, 2478
SUPER LOT 5
CIVIL SERVICES
PLAN

Reference No.	DRAWING No.	REVISION
2014/351	14351-S5-DA-CI-21	B

Plot Date: 10 Aug, 2018 CAD File Name: K:\Jobs\2014\14351 - Clarence Property\Superlot 5\Engineering\Engineering Plans\Drawings\14351-S5-DA-CI-21.dwg



LEGEND:

- PROPERTY BOUNDARY
- PROPOSED PROPERTY BOUNDARY
- EXISTING SEWER LINE
- EXISTING SEWER RISING MAIN
- EXISTING WATER LINE
- EXISTING RECYCLED WATER LINE
- EXISTING DRAINAGE LINE
- EXISTING UNDERGROUND POWER

PROPOSED SERVICES

- SEWER RISING MAIN
- SEWER
- DRAINAGE

PLAN

SCALE 1:500

FOR APPROVAL

REV	DESCRIPTION	BY	APP.	DATE
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A	FOR CLIENT REVIEW	DY	CP	08.05.18

REVISIONS

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0 5 10 20 30
Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

SCALES

HORIZ. DATUM	MGA
VERT. DATUM	AHD
SURVEY	NDC
DRAWN	DY
DESIGN	DY
APPROVED	CP
DATE	08.05.2018

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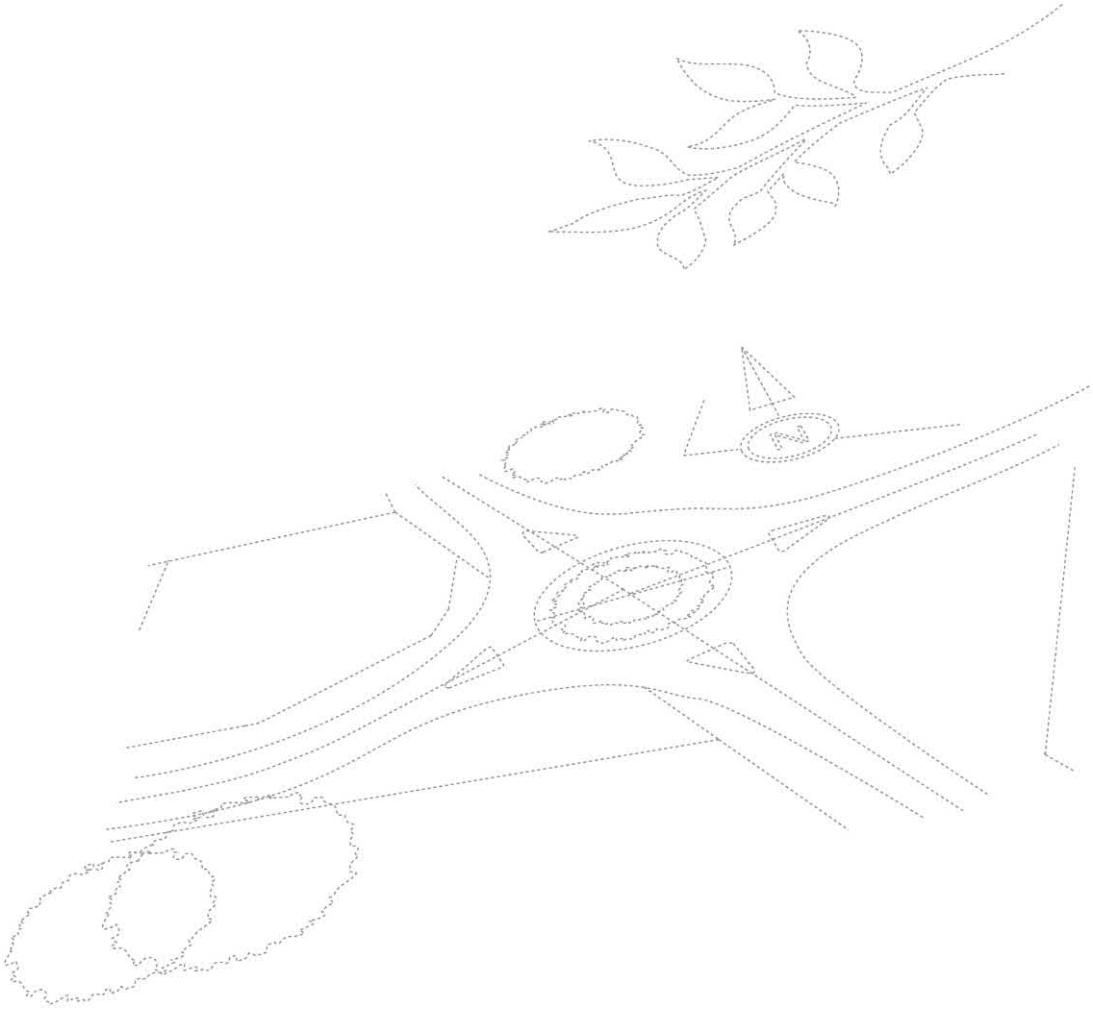
CLARENCE PROPERTY

EPIQ ESTATE - LENNOX HEAD, NSW, 2478
SUPER LOT 5
CIVIL SERVICES - SEWER RISING MAIN
PLAN

Reference No.	DRAWING No.	REVISION
2014/351	14351-S5-DA-CI-22	B

Appendix B Acid Sulfate Soil Management Plan



Acid Sulfate Soil Management Plan

Pacific Pines Stage 1B

Prepared for: Royal Bank of Scotland

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PO Box 1446
Coffs Harbour NSW 2450
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info@geolink.net.au

UPR	*Description*	*Date Issued*	*Issued By*
1675-1321	First issue	27/08/2014	DMT

Table of Contents

1 Background

1.1 Introduction

This Acid Sulfate Soil Management Plan (ASSMP) has been prepared by GeoLINK for the Royal Bank of Scotland and its development partner Lend Lease, for the approved residential development known as Pacific Pines, Lennox Head.

The ASSMP details strategies to mitigate potential environmental impacts associated with the disturbance of acid sulfate soils during construction of Stage 1B of the Pacific Pines development.

This Acid Sulfate Soil Management Plan specifically addresses Condition E3 of the Project Plan approval, which requires:

> *An Acid Sulfate Soil Management Plan shall be prepared by a suitably qualified person in accordance with the Acid Sulfate Soil Assessment Guidelines (Acid Sulfate Soil Management Advisory Committee, 1998). The Management Plan shall be submitted to and approved by the Certifying Authority prior to the issue of a Construction Certificate.*

1.2 The Site

The Stage 1B residential subdivision is located at Montwood Drive, Lennox Head, on land known as Lot 234 DP 1104071. The whole of this property has an area of approximately 80.5 hectares, with Stage 1B occupying the lower western part of the lot.

1.3 The Approved Development

Stage 1B is part of a larger residential subdivision approved by the NSW State Government under MP_0026, which includes a *Concept Approval* for the whole of the Pacific Pines estate and a *Project Approval* for Stage 1.

The development subject to the Project Approval is described as:

A 61 lot residential subdivision comprising:

1. *Fifty one residential lots ranging in size from 600 m^2 to 900 m^2.*
2. *Seven super lots for future development as follows:*
   a) *Super Lot 1 (1.44 ha).*
   b) *Super Lot 3 (0.21 ha).*
   c) *Super Lot 4 (0.18 ha).*
   d) *Super Lot 5 (4.2 ha).*
   e) *Super Lot 6 (0.24 ha).*
   f) *Super Lot 7 (5.59 ha).*
   g) *Super Lot 8 (4.98 ha).*
3. *Two open space lots of 910 m^2 and 641 m^2.*
4. *Earthworks.*
5. *Associated roads and civil works.*
6. *Landscaping.*

Stage 1B of the approved subdivision is described in Condition A2 of the project Approval as:

> *Stage 1B – Subdivision of Super Lots 1, 3, 4, 5, 6, 7 and 8, the extension of Montwood Drive, the construction of Main Street, construction of internal roads adjoining the east and north boundaries of Super Lot 1, the construction of Hutley Drive and the western link for the playing fields adjacent to the site and revegetation of the 100 metre buffer to littoral rainforest in the north west of the site.*

1.4 Acid Sulfate Soil Assessment

Gilbert & Sutherland Pty Ltd (G&S) previously prepared *The Soil Survey, Acid Sulfate Assessment, Stormwater Management Plan, Surface Water Assessment and Environmental Management Plan Pacific Pines, Lennox Head* (G&S 2001).

The purpose of the assessment was to determine the presence, extent and nature of acid sulfate soils at the site. The assessment focused on the area of the water quality control pond, but is considered relevant to the adjacent Stage 1B.

Potential acid sulfate soils were identified at the site. These were generally of a moderate severity for coarse sands to fine silty sands and of high severity for silty clays.

G&S advised that *"excavated material should be reinterred below the water table or treated with lime. This would involve sampling every 1,000 m^3 of excavated material to determine appropriate liming rates."*

2.1 Acid Sulfate Sampling and Analysis

Person Responsible	Contractor's Site Manager, Environmental Consultant
Objective	To identify any ASS and PASS during Stage 1B earthworks at the site and determine their acid generating potential prior to treatment.
Performance Criteria	All AASS & PASS material is identified and appropriate treatment procedures are determined prior to excavation.
Implementation Strategy	Initial acid sulfate soil investigations indicate that ASS and PASS are likely to be encountered during the Stage 1B works. Prior to excavation commencing, sampling and testing of material is to be undertaken in proposed excavation areas, where the depth of excavation will go below 5 mAHD, in accordance with the following protocol: **Frequency**: Chromium Suite analysis will be conducted for each soil colour or texture change encountered below 5 mAHD, with a minimum sample frequency of one test per 1000 m^3 of material to be excavated. **Sample size:** Soil samples should be more than 0.3 kg in weight with a brief soil texture description accompanying each sample. **Sampling:** Soil samples will be collected in sealed containers that exclude air. **Handling and storage:** Samples to be sent to a laboratory for analysis ASAP. Samples to be frozen if storage is required. **Laboratory analysis:** Samples to be analysed using the Chromium Suite method, with the liming rate specified (where required).
Monitoring	The sampling and analysis of material shall be tracked by the Environmental Consultant and Site Manager. Records shall be kept of volumes to be excavated, location of sampling and laboratory results.
Auditing	The Environmental Consultant to audit the sampling and analysis process every three months.
Reporting	ASS analytical results including interpretation and liming rates shall be reported to the Site Manager and kept on site.
Identification of Incident or Failure	Insufficient sampling or failure to sample as identified by material tracking records and/or test results and/or procedures.
Potential Corrective Actions	Undertake additional sampling as required to the thoroughly identify the nature of the material to be disturbed. Consultation with an Environmental Consultant to determine appropriate rates for additional sampling.

2.2 Acid Sulfate Soil Treatment

Person Responsible	Contractor's Site Manager, Environmental Consultant.
Objective	No acidic or potentially acidic soils are to be disturbed or excavated without appropriate testing and/or treatment by neutralisation of the acid generation potential of the material.
Performance Criteria	All ASS material has been appropriately neutralised and verified prior to final placement.
Implementation Strategy	Acid sulfate soil excavation to be conducted according to the following treatment measures. **Lime treatment** Soils requiring treatment will be placed in spatially tracked lots within bunded areas that have an impermeable base. Materials used to construct the bund areas will be free from acid sulfate soils. The bunded areas will be prepared with surface liming at the rate of 0.2 x average net acid generating potential per square metre or at the minimum rate of 1 kg/m^2. The bunded areas shall have a leachate collection system. Any water discharged from the bunded areas must comply with the water quality criteria listed in the Stormwater Works Process Strategy. Soils selected for treatment will be treated with lime at the rate specified by the laboratory, including a mixing factor of safety of 1.5. Uniform mixing must be achieved. A potential approach is to spread material to a depth of <300 mm, apply lime at the determined rate and mix with a rotary hoe or disc plough. Stockpiling of untreated ASS material within the bunded areas should be kept to a minimum and in general accordance with the requirements for Short Term Stockpiling as per the ASSMAC guidelines. A layer of lime slurry shall be applied to exposed cut faces immediately following the excavation to the maximum depth to neutralise the soils exposed to oxidation. **Validation testing** Following lime treatment, verification testing shall be performed at the rate of one sample per 250 m^3 of treated material. Any material that exceeds TAA thresholds but does not exceed oxidisable sulfur concentrations (e.g. material that is high in organic matter or iron oxides) shall be treated with lime at the appropriate application rate, but will not require validation testing to be undertaken. **Excavation works and timing of stockpiling/treatment** All excavation works and stockpiling of untreated acid sulfate materials shall be carried out in such a manner that: ▪ The surface area of materials exposed to oxidation is minimised. ▪ The length of time the untreated materials are exposed to air is minimised. ▪ Provides for a system of suitable diversion drains or embankments to divert surface waters away from the stockpiles and the excavation area. ▪ Ensures that any unforeseen groundwater seepage and/or leachate and/or stormwater runoff within the excavation area is collected and not released from the site, untested and untreated to any stormwater drain or waters (including groundwater). ▪ Ensures that any leachate and/or stormwater runoff which has been in contact with acid sulfate materials or contaminants is collected and not released from the site, untested and untreated to any stormwater drain or waters (including groundwater).

	Supply of neutralising agent A supply of neutralising agent or agricultural lime shall be kept onsite at all times for treatment of acid sulfate soils. The supply shall be stored in a covered and bunded area to prevent accidental release to the environment. A supply of hydrated lime shall be kept onsite at all times for treatment of acidic waters (if encountered). Storage requirements for hydrated lime shall be as specified for a neutralising agent or agricultural lime and in accordance with the manufacturer's MSDS.
Monitoring	The treatment of ASS material shall be tracked by the Environmental Consultant and Site Manager. Records shall be kept of actual volumes excavated, liming rates applied, and validation testing results.
Auditing	The Environmental Consultant to audit the ASS treatment process every three months. Alternatively, auditing may be carried out by an independent consultant. The audit should include an inspection of site activities, complaints, corrective actions and reporting to assess compliance with the provisions outlined within the ASSMP.
Reporting	Records including testing results and material tracking are to be kept on site during the construction phase and should be available for inspection at all times.
Identification of Incident or Failure	Further investigation would only be required if: ▪ Verification sampling tests fail, indicating the insufficient application of lime. ▪ The formation of jarosite in exposed or excavated soils was observed. ▪ Areas of green-blue water or extremely clear water occurred. ▪ Rust-coloured deposits on plants and on the banks of drains or water bodies were noted. ▪ A sulfurous odour was detected. ▪ The pH of related water bodies dropped substantially below background levels.
Potential Corrective Actions	Retesting of materials in the vicinity of excavation. Any need for additional lime in specific lots would be assessed and applied with thorough mixing.

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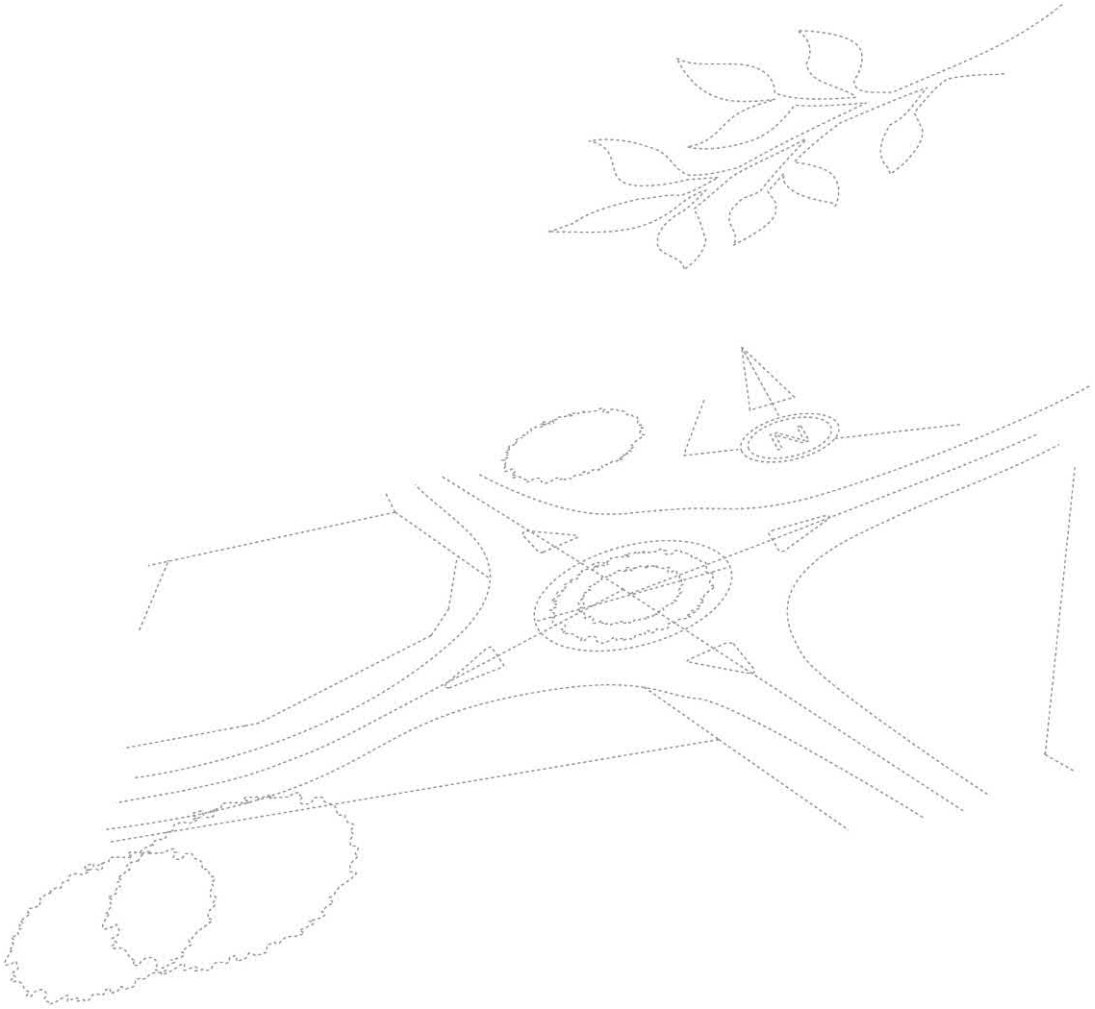
Appendix C Access Assessment



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Our Reference: P3518.004L
Your Reference:

22 May 2018

Newton Denny Chapelle
PO Box 1138
Lismore NSW 2480

Attention: Chris Pickford
Sent via email: cpickford@newtondennychapelle.com.au

Dear Chris

RE : SUPER LOT 5 MONTWOOD DRIVE – TOWNHOUSE DEVELOPMENT – ACCESS ASSESSMENT

1.0 INTRODUCTION

1.1. Background

Bitzios Consulting has been commissioned by Clarence Property Corporation Pty Ltd to prepare an access assessment for the proposed townhouse development located on the corner of Montwood Drive and Snapper Drive (Super Lot 5) as shown in Figure 1.1.

Source: Near Maps 2018

Figure 1.1: Site Location

1.2. Proposed development

The proposed development includes 146 townhouses with 350 on-site car parking spaces. The subject site is accessible via Montwood Drive and Snapper Drive as shown in Figure 1.2.

Source: TVS Architects

Figure 1.2: Site Accesses

Development Plans are provided in Attachment 1.

1.3. Existing Conditions

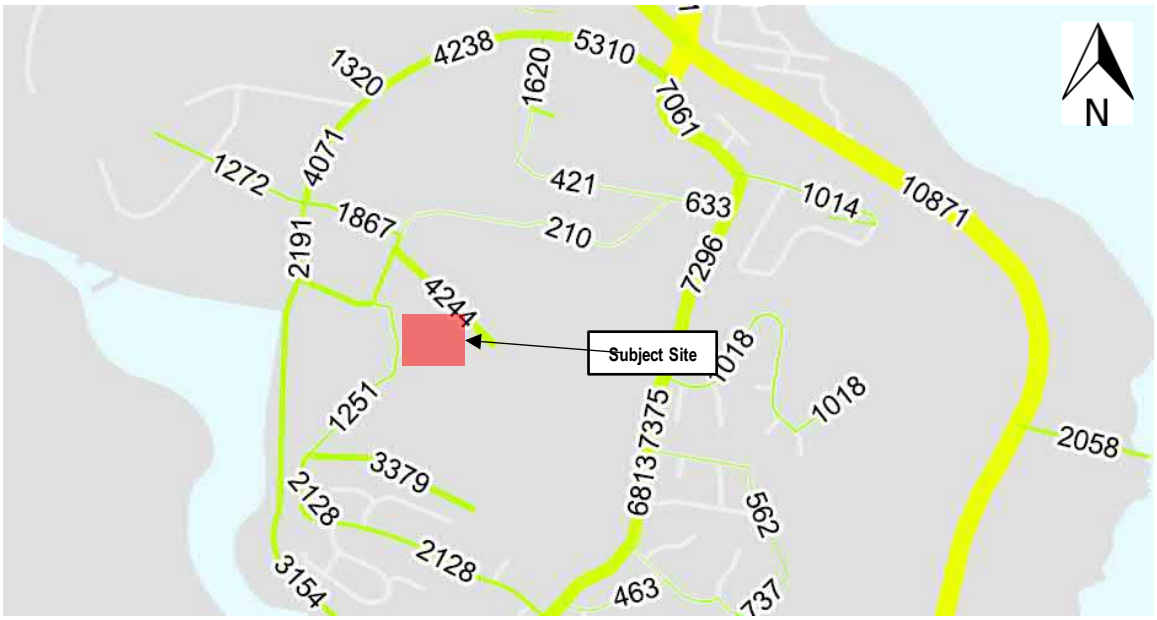
The existing road network surrounding the subject site (including sections of Montwood Drive and Snapper Drive) is presently under-construction and not open to traffic. As such, no background traffic volumes can be obtained from the surrounding road network for inclusion in this assessment.

2.0 TRAFFIC ASSESSMENT

2.1. Forecast Traffic Volumes

Given that background traffic volumes cannot be obtained, the traffic assessment will rely on forecast background traffic volumes for the surrounding road network.

As a part of the *Ballina Shire 2014 Strategic Model* prepared by Cardno for Ballina Shire Council, traffic modelling was conducting using TRACKS modelling software. The report provides year 2036 daily traffic volumes from the TRACKS model for the entire Ballina LGA, including the subject site. Figure 2.1 illustrates the subject site location and surrounding forecast traffic volumes.



Source: Ballina Shire Council Section 94 Update Daily Total Volume

Figure 2.1: Ballina LGA 2036 Forecast Daily Traffic Volumes

Based on the daily traffic volumes outlined in this model, it is estimated that Montwood Drive and Snapper Drive will accommodate approximately 2,000 vehicles per day (vpd) in the year 2036.

However, the southern link of Hutley Drive connecting the Hutley Drive / Snapper Drive intersection and Skennars Head Road is not expected to be constructed for several years. It is also unclear when the northern Hutley Drive extension will be constructed. As such, it is expected that traffic volumes on Montwood would be significantly higher than outlined in the TRACKS model prior to the construction of these links. Traffic demand and capacity analysis of the road network without the construction of the Hutley Drive links was conducted by Cardno in the *Pacific Pines Concept and Project Approval Response to Ballina Shire Council Request for Further Information* (2014). As per this report, expected daily traffic on Montwood Drive is 4,070vpd for Network Option 2 (access via Montwood Drive and Henderson Lane only).

It should be noted that Scenario 2 traffic volumes are expected future volumes only and may not be a true indication of actual traffic. Furthermore, it is possible that the additional network links will be constructed prior to complete development of the area. As such, these forecasted future traffic volumes may not be realised. As such, a sensitivity test is proposed considering 3,400vpd on Montwood Drive.

As such, the following site access assessment will be conducted considering the following scenarios:

- Scenario 1 (Strategic Model): 2,000vpd on Montwood Drive;
- Scenario 2 (Cardno Network Option 2): 4,070vpd on Montwood Drive; and
- Sensitivity Test: 3,400vpd on Montwood Drive.

In all scenarios, it is expected that daily traffic volumes on Snapper Drive in the vicinity of the proposed access will be similar, at an estimated 2,000vpd for the year 2036. It is expected that 10% of the total daily trips occur in both the AM and PM peak hour volumes. The Traffic Management Plan for the Pacific Pines Estate Lennox Head prepared by Cardno for Lendlease, advises the distribution for development traffic to be 75% from the north and 25% from the south.

Figure 2.2 illustrates the 2036 forecast AM and PM peak hour volumes for Hutley Drive and Snapper Drive for Scenario 1 (2,000vpd).

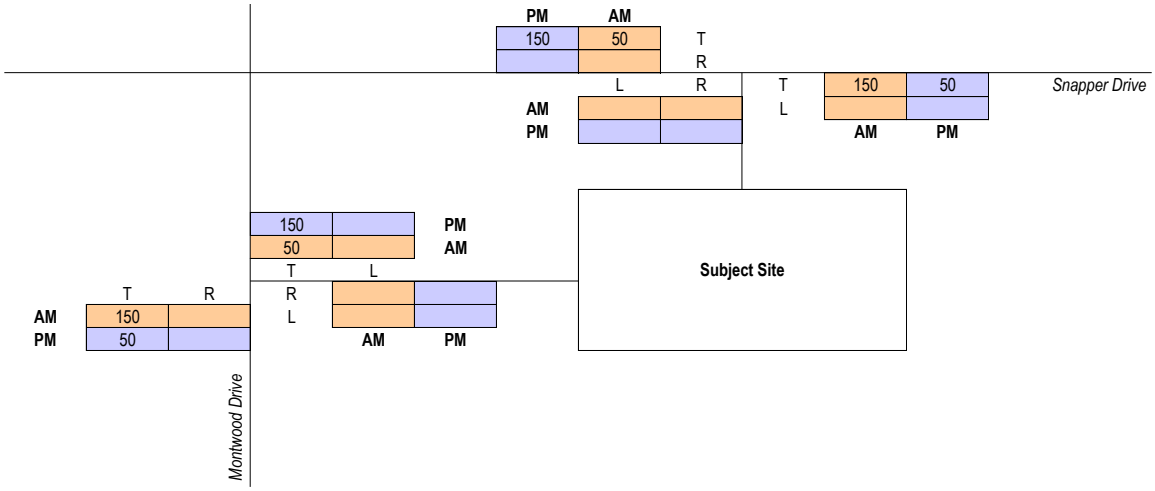


Figure 2.2: 2036 Forecast AM and PM Peak Hour Volumes

Figure 2.3 illustrates the 2036 forecast AM and PM peak hour volumes on Hutley Drive and Snapper Drive for Scenario 2 (4,070 vpd).

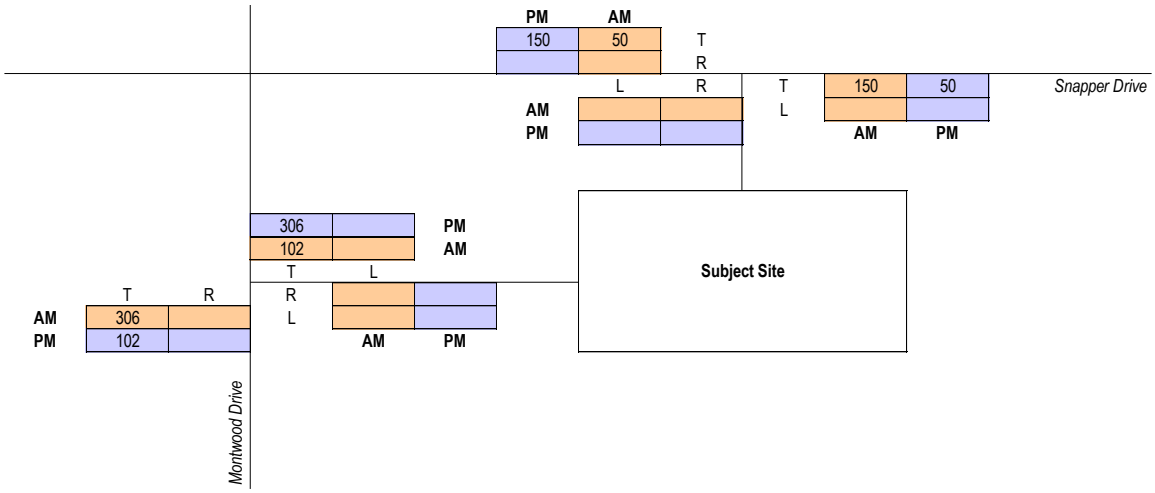


Figure 2.3: Scenario 2 - 2036 Forecast AM and PM Peak Hour Volumes

Figure 2.4 illustrates the 2036 forecast AM and PM peak hour volumes on Hutley Drive and Snapper Drive for the Sensitivity Test (3,400 vpd).

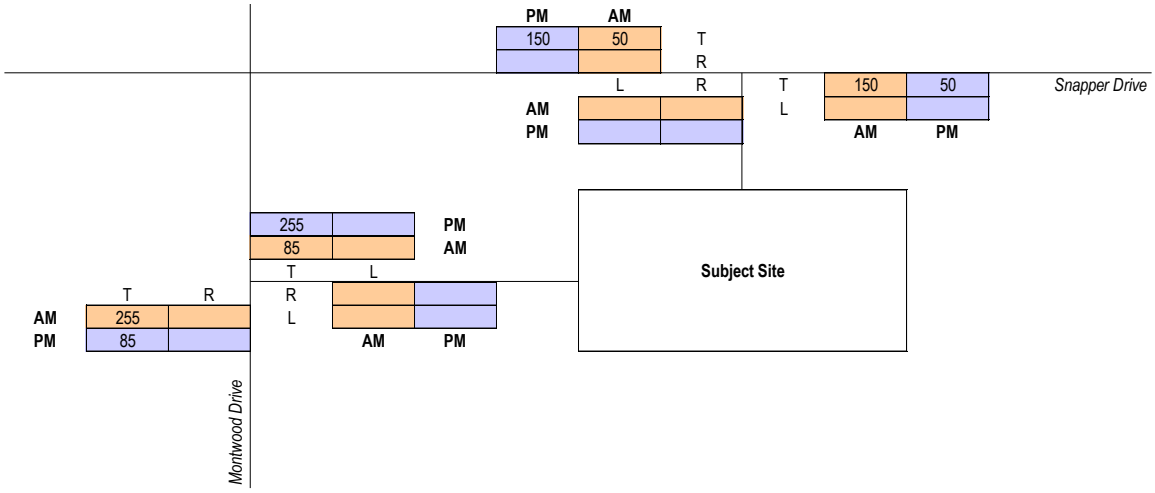


Figure 2.4: Sensitivity Test - 2036 Forecast AM and PM Peak Hour Volumes

2.2. Development Traffic

Traffic generation rates for the proposed development were sourced from the Roads and Maritime Services (RMS) *Guide to Traffic Generating Developments (2002).* The rates applicable to the proposed development and resultant traffic generation are shown in Table 2.1.

Table 2.1: Peak Hour Development Trip Generation

Land Use	Source	Quantity	AM Trip Rate	PM Trip Rate	AM Trips	PM Trips
Medium-density Residential	RMS (2002)	146	0.65	0.65	95	95

The development is anticipated to generate 96 trips during the AM and PM peak hours. The IN:OUT trips splits during AM and PM peak hours would be in line with those typically expected for a residential land use. The traffic splits and resultant trips for this development are shown in Table 2.2.

Table 2.2: Development Traffic Directional Split

Land Use	AM Split %		PM Split %		AM Split Trip		PM Split Trip	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT
Medium-density Residential	20%	80%	70%	30%	19	76	67	29

The distribution of development traffic has been based on the assumed Pacific Pines Estate distribution as illustrated in Figure 2.5.

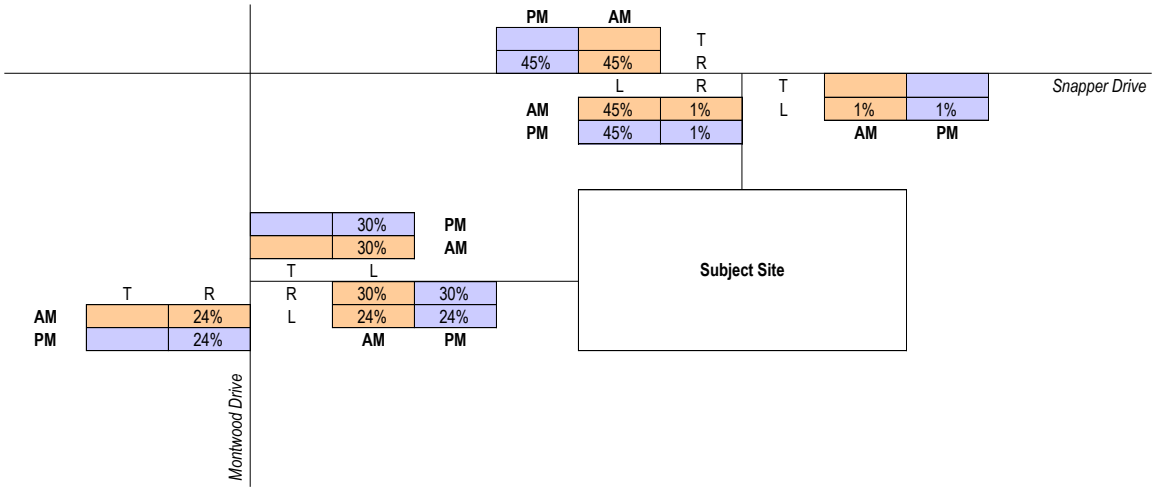


Figure 2.5: Development Traffic Distribution

Estimated development traffic volumes are provided in Figure 2.6.

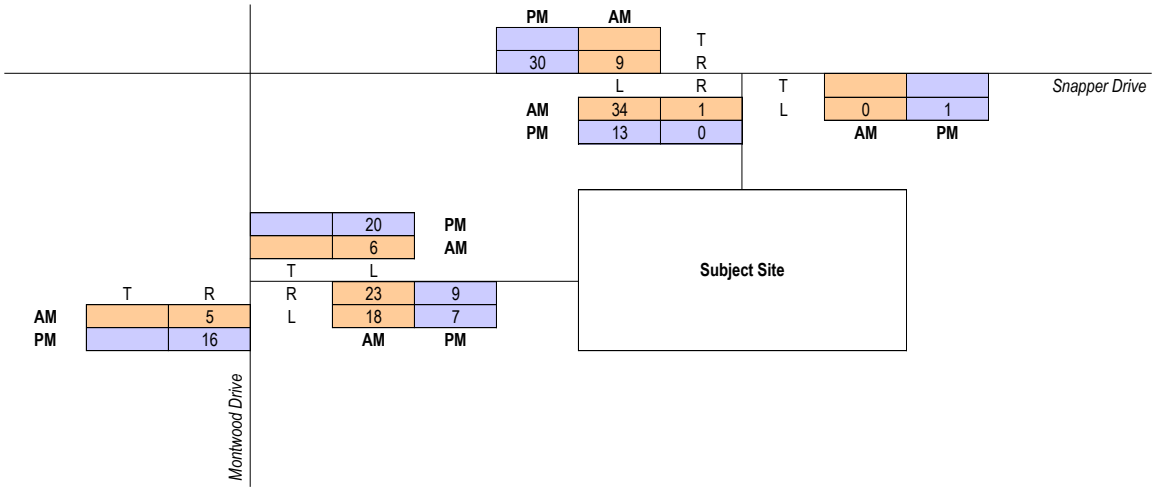


Figure 2.6: Development Traffic Volumes

2.3. Design Traffic Volumes

The design traffic volumes are calculated by combining the forecast background traffic and the proposed development traffic. The year 2036 design traffic volumes for Scenario 1, Scenario 2 and the Sensitivity Test are summarised in Figure 2.7, Figure 2.8 and Figure 2.9 respectively.

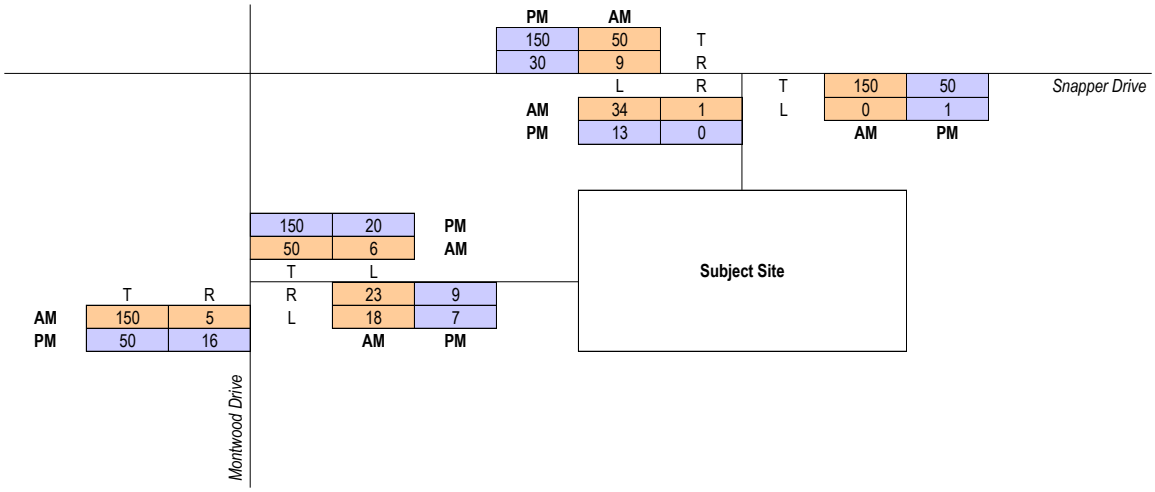


Figure 2.7: Scenario 1 - 2036 Design Traffic Volumes

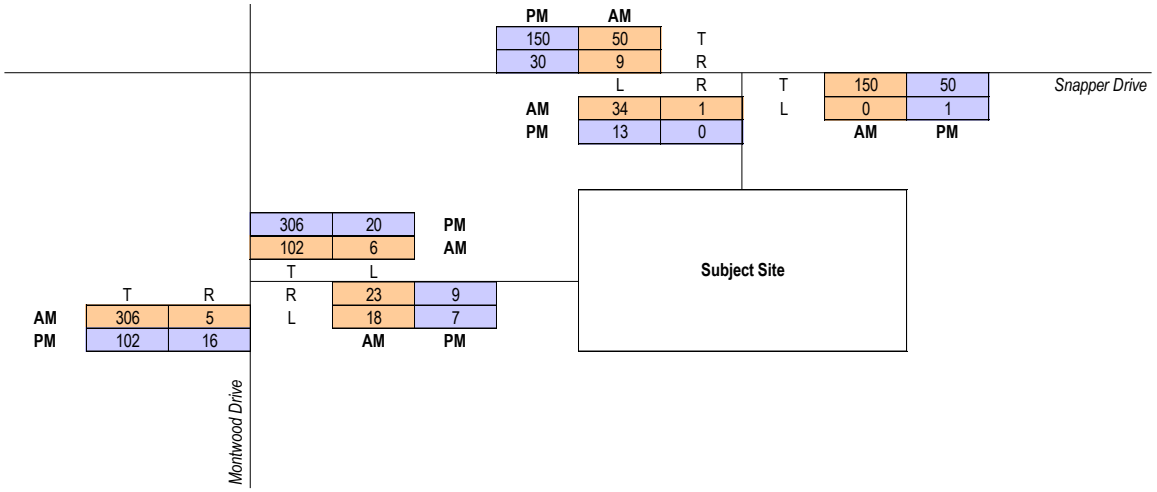


Figure 2.8: Scenario 2 - 2036 Design Traffic Volumes

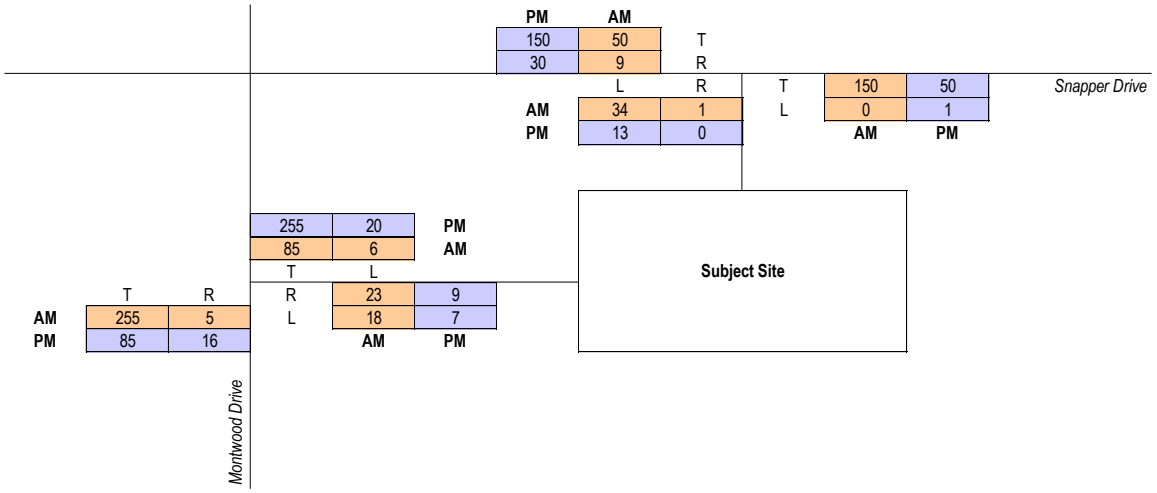


Figure 2.9: Sensitivity Test - 2036 Design Traffic Volumes

2.4. Turn Warrants Assessment

A turn warrants assessment was undertaken for the proposed accesses on Montwood Drive and Snapper Drive in accordance with the *Austroads Guide to Road Design Part 4 Intersections and Crossings: General*.

Snapper Drive Access

Figure 2.10 and Figure 2.11 respectively show the eastbound right and westbound left turn warrants assessment on Snapper Drive for the 2036 development traffic volumes for all scenarios.

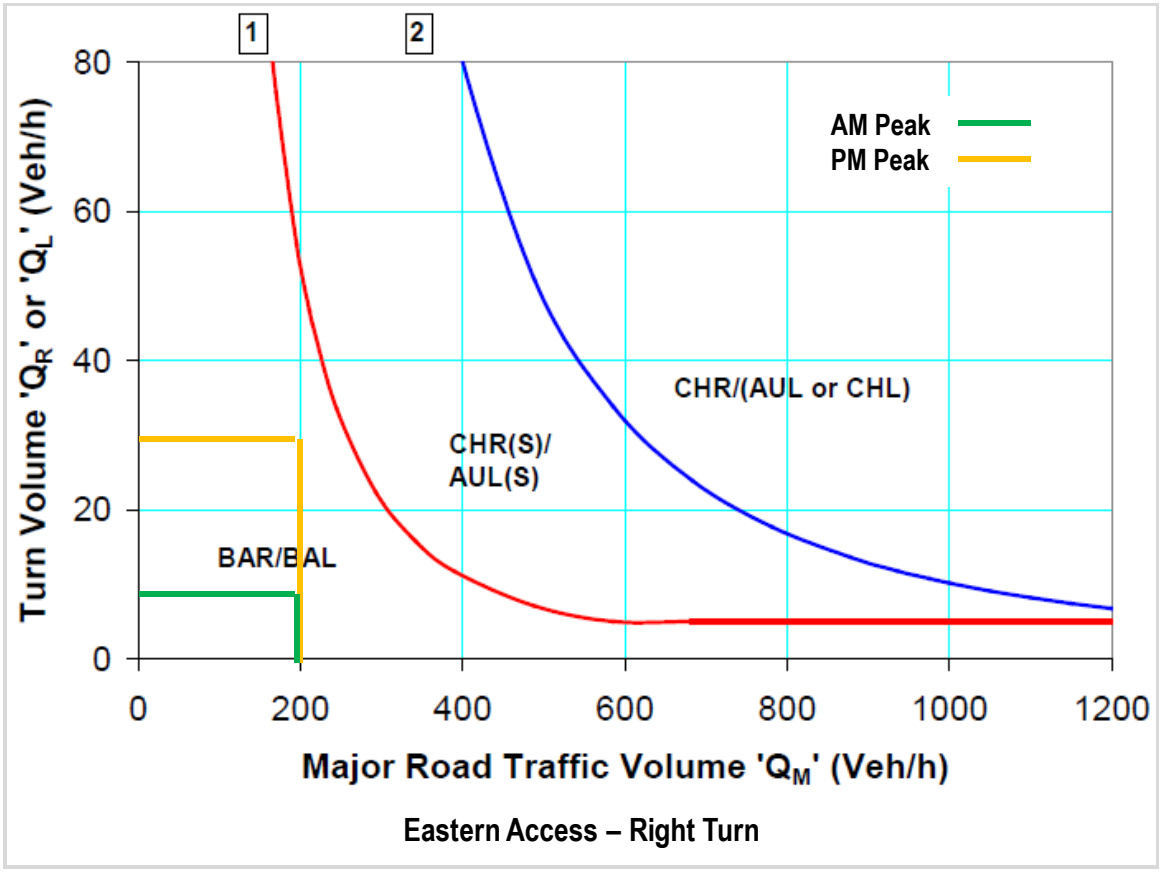


Figure 2.10: 2036 Turn Warrants Assessment – Snapper Drive Eastbound Right Turn

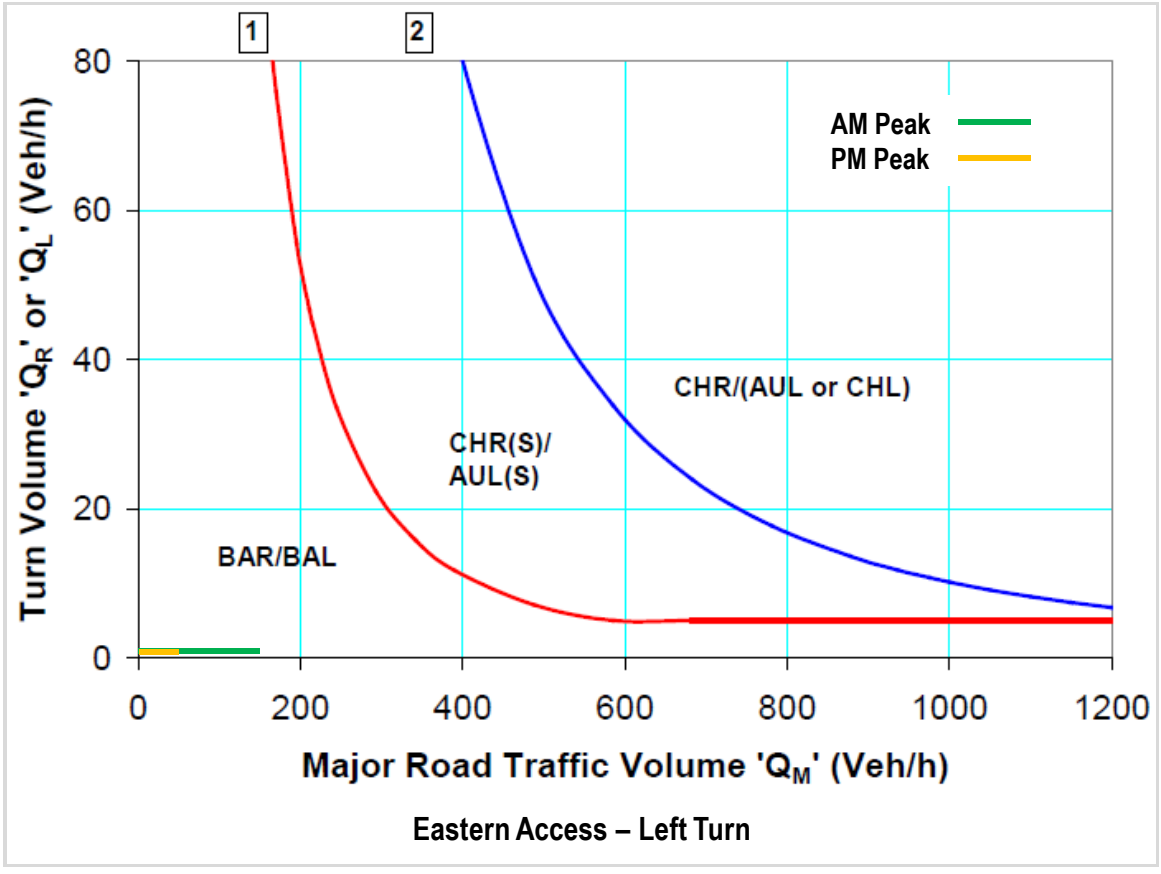


Figure 2.11: 2036 Turn Warrants Assessment – Snapper Drive Westbound Left Turn

As shown in Figure 2.10 and Figure 2.11, the proposed development requires a basic right (BAR) turn treatment for Snapper Drive eastbound and basic left (BAL) for Snapper Drive westbound into the subject site.

Western Access

Figure 2.12 and Figure 2.13 respectively show the northbound right and southbound left turn warrants assessment on Montwood Drive for the Scenario 1 (2,000 vpd) 2036 development traffic volumes.

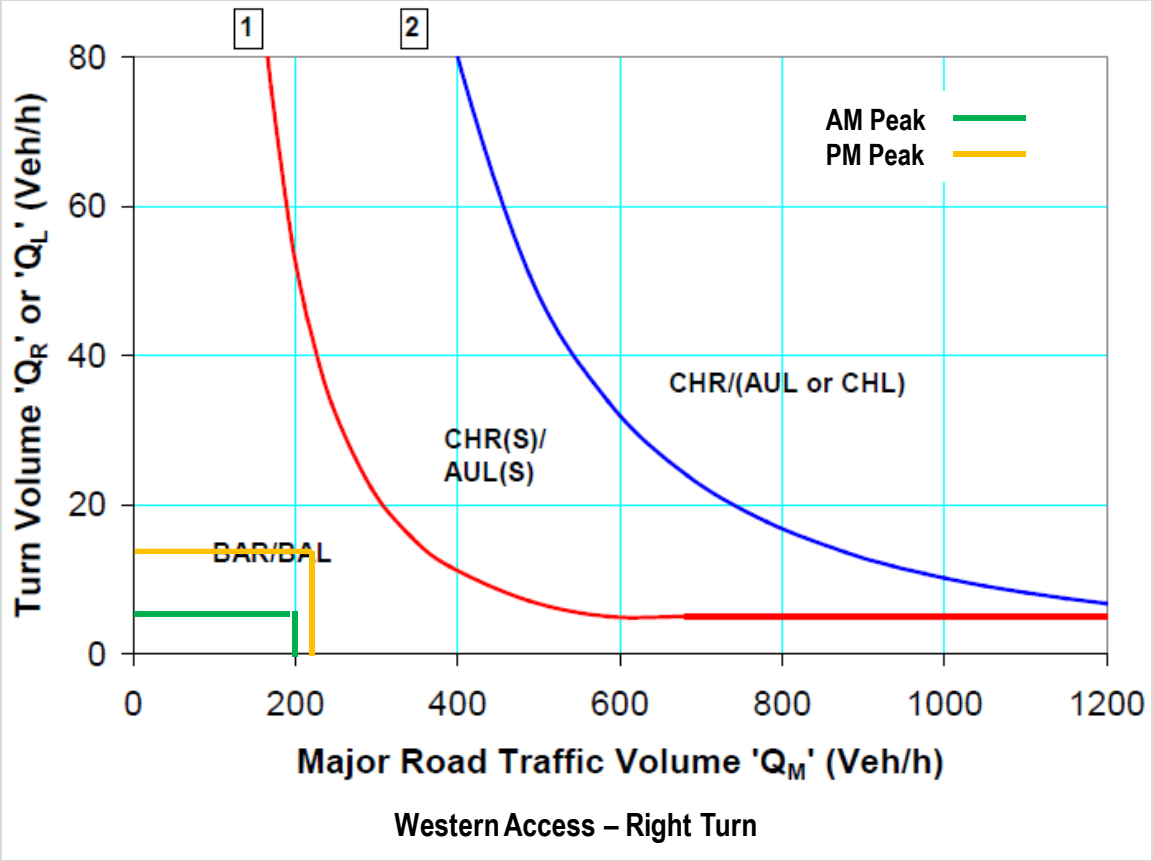


Figure 2.12: Scenario 1 2036 Turn Warrants Assessment – Montwood Drive Southbound Right Turn

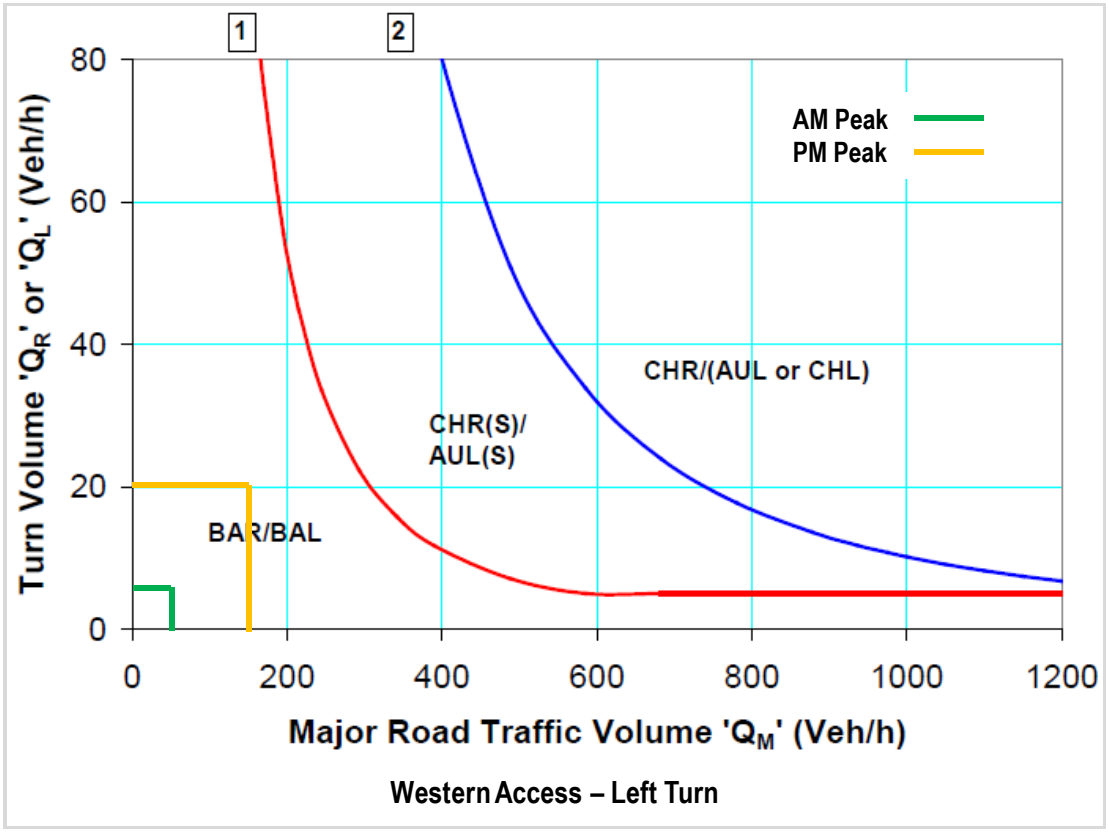


Figure 2.13: **Scenario 1 2036 Turn Warrants Assessment – Montwood Drive Southbound Left Turn**

Figure 2.14 and Figure 2.15 respectively show the northbound right and southbound left turn warrants assessment on Montwood Drive for the Scenario 2 (4,070vpd) 2036 development traffic volumes.

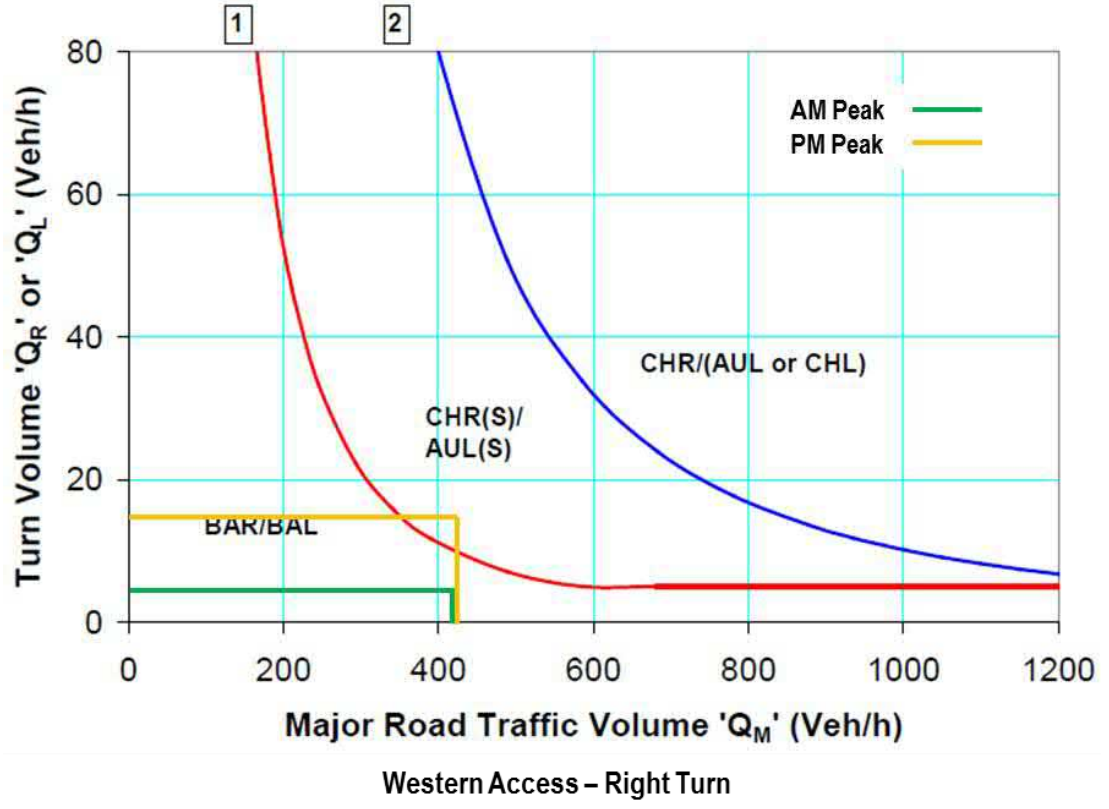


Figure 2.14: **Scenario 2 2036 Turn Warrants Assessment – Montwood Drive Northbound Right Turn**

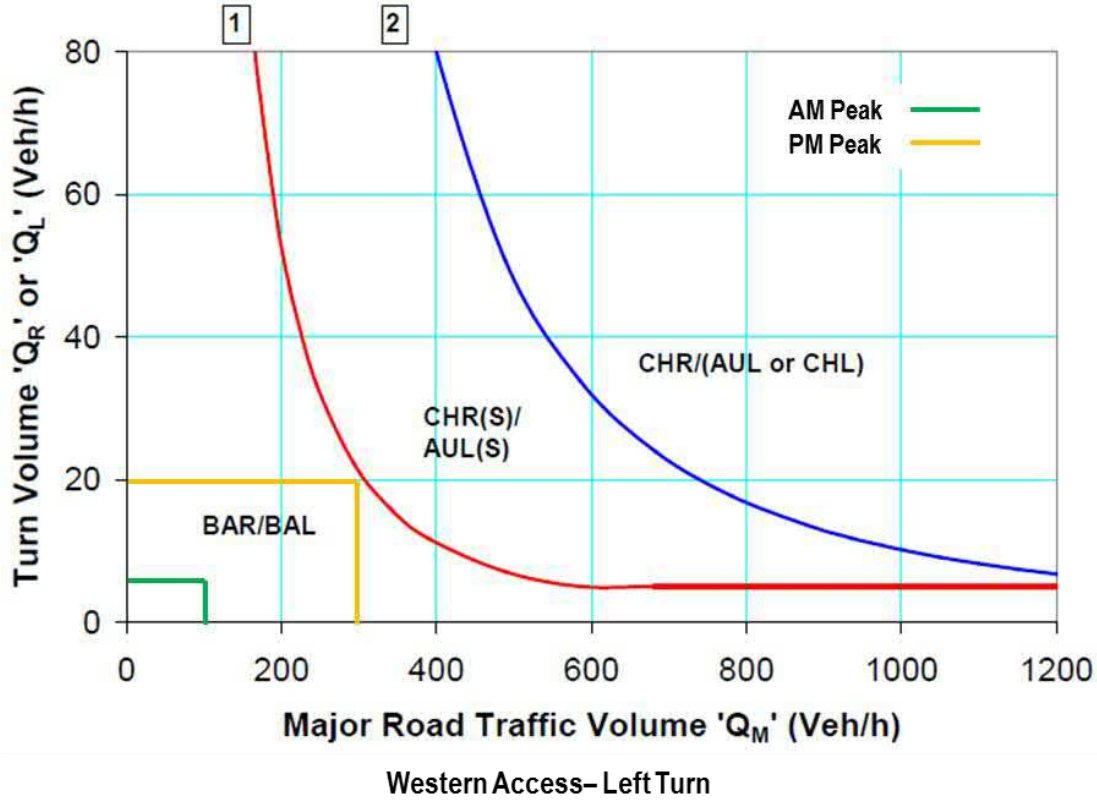


Figure 2.15: Scenario 2 2036 Turn Warrants Assessment – Montwood Drive Southbound Left Turn

Figure 2.16 and Figure 2.17 respectively show the northbound right and southbound left turn warrants assessment on Montwood Drive for the Scenario 3 (3,500vpd) 2036 development traffic volumes.

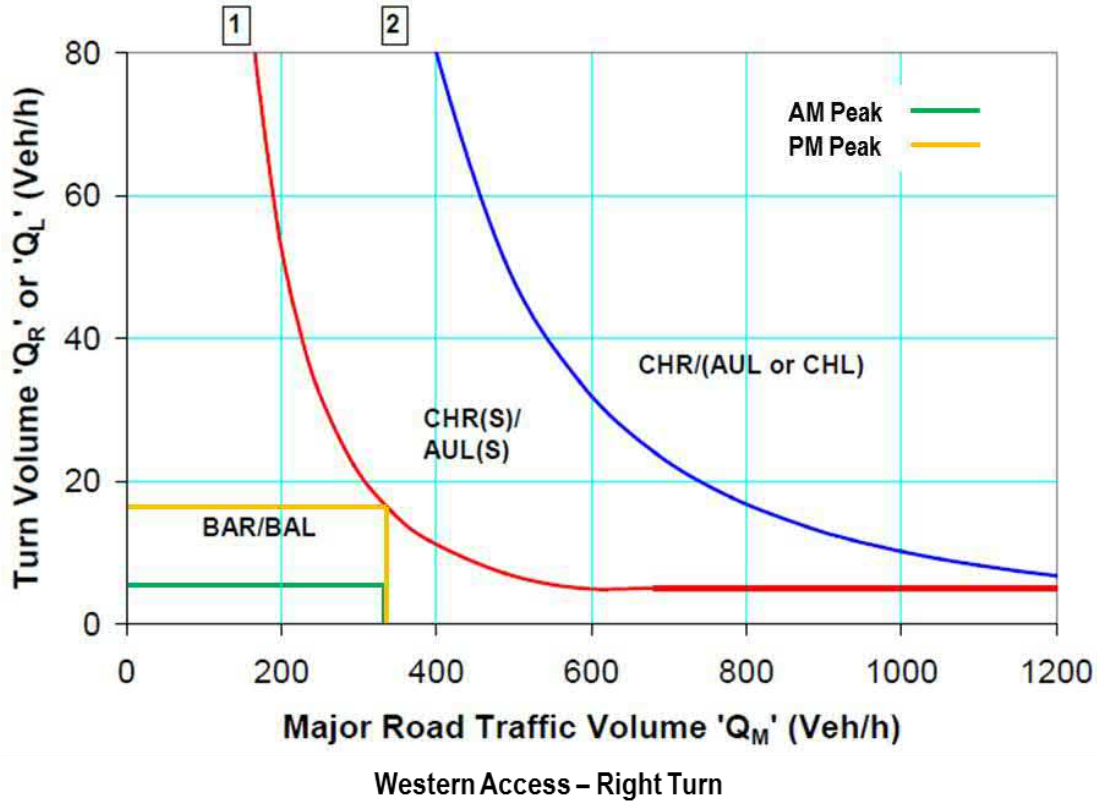
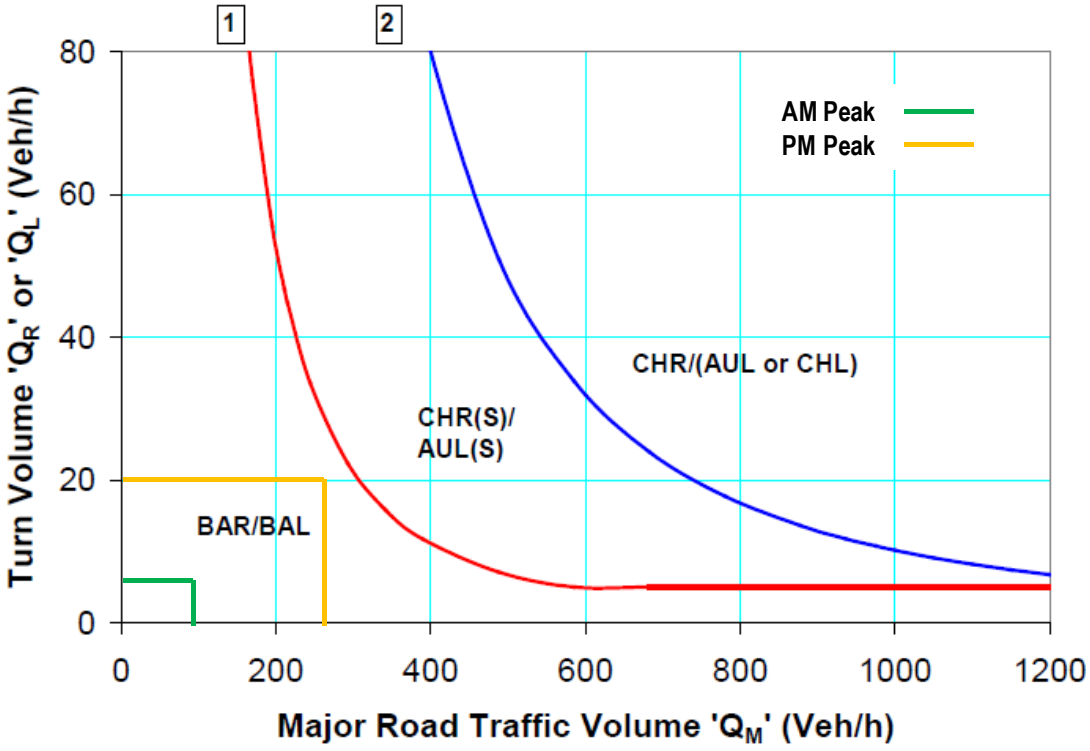


Figure 2.16: Sensitivity Test 2036 Turn Warrants Assessment – Montwood Drive Northbound Right Turn



Western Access – Left Turn

Figure 2.17: Sensitivity Test 2036 Turn Warrants Assessment – Montwood Drive Southbound Left Turn

Summary

As per the turn warrants assessment above the required turn treatments for each movement under each traffic scenario are summarised in Table 2.3. It is noted that the turn warrants assessment indicates that the need for a CHR(s) treatment for the Montwood Drive right-turn is triggered approximately with Sensitivity Test traffic volumes (3,400vpd).

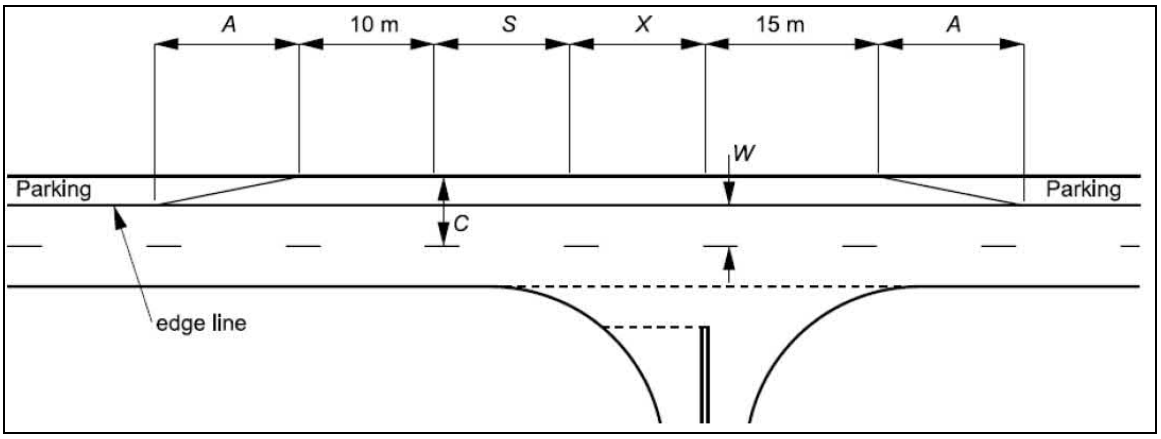
Table 2.3: Required Turn Treatment Summary

Access	Scenario	Daily Traffic Volume	Left-turn Treatment	Right-turn Treatment
Eastern (Snapper Drive)	All	2,000vpd	BAL	BAR
Western (Montwood Drive)	1	2,036vpd	BAL	BAR
	2	4,070vpd	BAL	CHR(S)
	Sensitivity Test	3,400vpd	BAL	BAR

3.0 RECOMMENDED TURN TREATMENTS

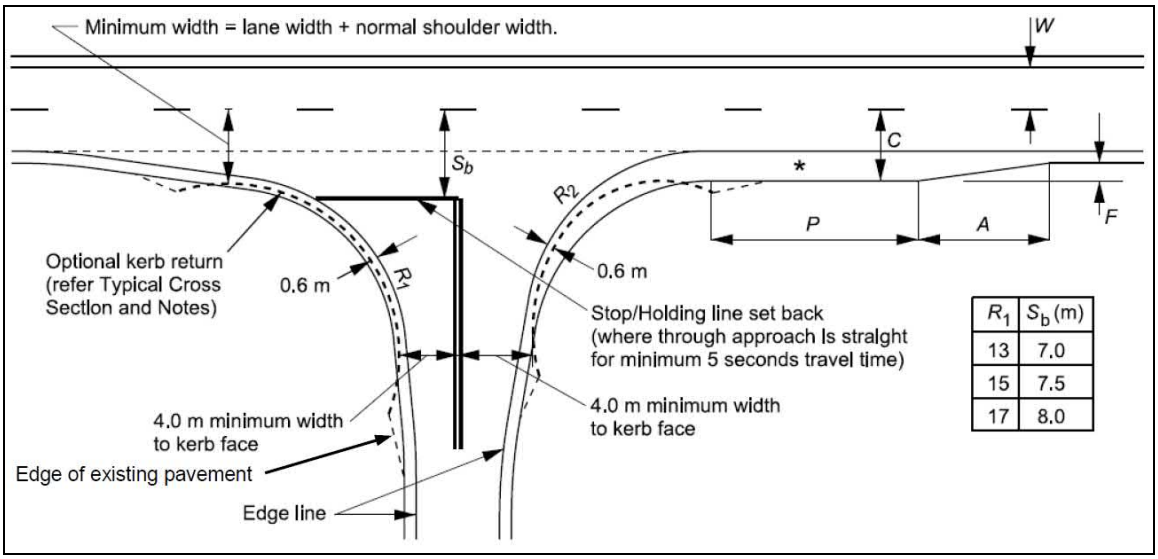
3.1. Typical Turn Treatments

Basic Right (BAR), Basic Left (BAL) and Short Channelised Right (CHR(s)) turn treatments are recommended for this development with typical turn treatment designs shown below in Figure 3.1, Figure 3.2 and Figure 3.3 respectively.



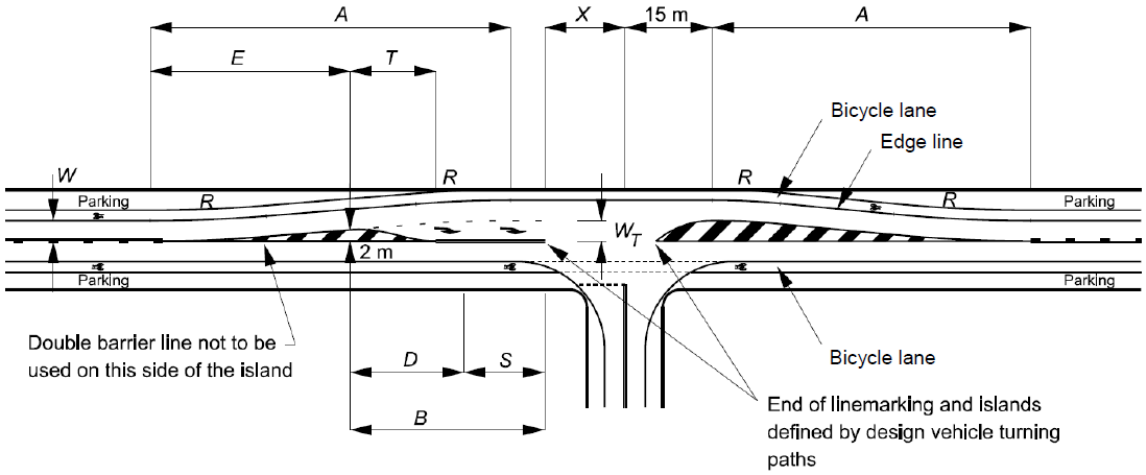
Source: Austroads Guide to Road Design Part 4A

Figure 3.1: Typical Basic Right Turn Treatment



Source: Austroads Guide to Road Design 4A

Figure 3.2: Typical Basic Left Turn Treatment



Source: Austroads Guide to Road Design 4A

Figure 3.3: Typical Short Channelised Right Turn Treatment

3.2. Snapper Drive Turn Treatments

Noting that Snapper Drive has a roadway width of 7.5m with no provision for on-street parking or sufficient road reserve width for widening, BAR and BAL turn treatments cannot not be accommodated at the proposed northern development access. Notwithstanding this, it is recommended that 'No Stopping' zones are provided along the Snapper Road frontage to ensure vehicles do not stop or park within proximity to the proposed northern development access. The length of this "No Stopping" zone shall as shown for the recommended BAL/BAR treatment for Montwood Drive as shown in Figure 3.4.

3.3. Montwood Drive Turn Treatments

Montwood Drive Basic Right Turn Treatment

A basic right-turn treatment for the proposed Montwood development access considers the following parameters:

- Roadway width – Montwood Drive = 9.0m
- Actual Carriageway width, C_A = 4.5m
- Minimum Required Carriageway width, C_M = 6.0m
- Lane width, W = 3.5m
- Design vehicle speed, V = 60km/h
- Storage length, S = 12.5m
- Design vehicle turning path (based on 10.2m Refuse Collection Vehicle), X = 15.0m
- Taper Length, A = 21.0m (based on C_M and W)

Montwood Drive Basic Left Turn Treatment

A basic left-turn treatment for the proposed Montwood development access considers the following parameters:

- Roadway width – Montwood Drive = 9.0m
- Actual Carriageway width, C_A = 4.5m
- Minimum Required Carriageway width, C_M = 6.0m
- Lane width, W = 3.5m
- Formation width, F = 1.0m
- Design vehicle speed, V = 60km/h
- Minimum Length of Parallel Widened Shoulder, P = 5.0m
- Design vehicle turning path (based on 10.2m Refuse Collection Vehicle), R_2 = 15m
- Taper Length, A = 29.0m (based on C_m and W)

Montwood Drive Short Channelised Right Turn Treatment

A short channelised right-turn treatment for the proposed Montwood development access considers the following parameters:

- Roadway width – Montwood Drive = 9.0m
- Through lane width, W = 3m
- Turning lane width, Wt = 3m
- Design speed of major road approach, V = 60km/h
- Total auxiliary lane length, B = 30m
- Lateral movement length, A = 50m
- Length from start of taper to 2m taper width, E = 33m
- Diverge / deceleration distance, D = 25m
- Storage length to cater for one design turning vehicle, S = 10.2m
- Total length of auxiliary lane, B = 33.8m
- Taper length, T = 15m
- Desirable turning radius, R = 175m
- Design vehicle turning path (based on 10.2m Refuse Collection Vehicle), X = 15.0m

3.4. Montwood Drive Recommended Turn Treatment

Noting that Montwood Drive is constructed with a carriageway width of 9m and insufficient road reserve width for widening, a CHR(s) and a BAL turn treatment cannot both be accommodated at the proposed western development access (as per the turn warrants assessment for Scenario 2).

As such, it is recommended that a BAR and a BAL treatment be provided at the Montwood Drive access. This treatment is deemed to be sufficient as the development fronts low-speed roads in a residential environment. Furthermore, traffic volumes are only large enough to trigger the warrant for a CHR(s) under worst case forecasted traffic volumes (Scenario 2) and volumes are just large enough to trigger this treatment in the PM peak hour only. This indicates that any safety or efficiency impacts associated with providing a BAR treatment as opposed to a CHR(s) treatment is expected to be negligible.

A sketch of the recommended Montwood Drive access layout (not to scale) is provided in Figure 3.4.

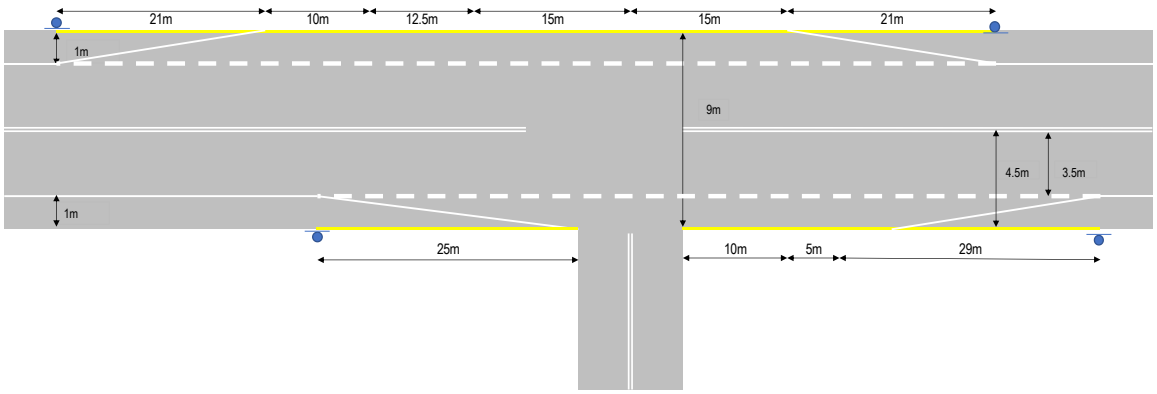


Figure 3.4: Montwood Drive Access Arrangement (recommended)

An alternate option is to provide a CHR(s) treatment and no left-turn treatment, as shown in Figure 3.5. However, it is noted that a CHR(s) treatment at the access location would direct traffic around the turn pocket in a way that could increase the risk to pedestrians, particularly considering an existing shared path is constructed directly adjacent to the kerb. The lateral movement of through traffic also poses a hazard to on-road cyclists. Finally, no escape route is available for southbound through traffic behind a left turning vehicle increasing the risk of rear-end or off-path type crashes. However, it is noted that the increased risk to southbound vehicles is expected to be low as vehicle speed will be reduced due to the proximity of the Montwood Drive / Snapper Drive roundabout.

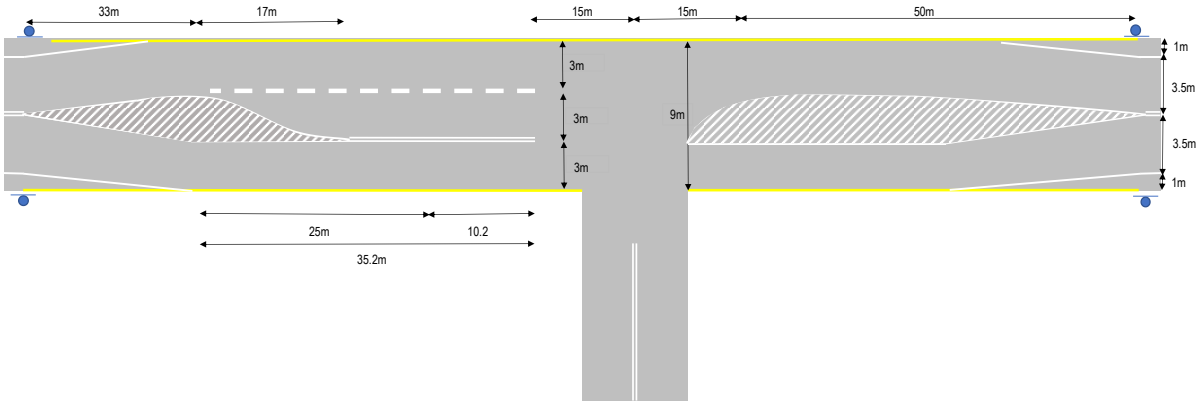


Figure 3.5: Montwood Drive Alternate Access Arrangement

3.5. Signage and Linemarking Requirements

No stopping zones are to be provided to ensure sufficient width is provided for through traffic and vehicles performing turn manoeuvres into the development accesses. 'No Stopping' zones extending past driveway accesses along the development frontage also ensure sight lines to approaching vehicles are maintained. The 'No Stopping' zone should be provided through the installation of No Stopping (R5-400) signs, with supplementary continuous yellow edge lines as shown in Figure 3.4 and Figure 3.5. All other delineation at the Montwood Drive access shall be in accordance with the relevant typical BAR/BAL/CHR(s) turn treatments outlined in the Austroads Guide to Road Design Part 4.

To mitigate any risk of rear-end type crashes that occur as a result of vehicles slowing or stopping to turn right into the development, it is also recommended that warning signage be provided in advance of the access for northbound vehicles. In accordance with AS1742.2 a "Side Road Intersection" (w2-4) is recommended to be placed 60-80m from the proposed access fronting northbound traffic. If not already implemented a "Roundabout Ahead" (w2-7) warning sign is also recommended to be placed approximately 80m from the Montwood Drive / Snapper Drive roundabout.

Should you require any further information, do not hesitate to call me.

Yours faithfully

Adrian Bitzios
Principal Traffic Engineer and Transport Planner
BITZIOS CONSULTING

ATTACHMENT 1

DEVELOPMENT PLANS

TERRACES HOMES AT
PACIFIC PINES ESTATE

TVS architects

No.	Unit Type
33	Type A - 5m
63	Type B - 6m
35	Type C - 7m
15	Type D - 9.9m
146	Total

On Street Parking Provided
41

0 8 16 24 32 40

Scale (m) 1 : 400 @A1
Scale (m) 1 : 800 @A3

Terrace Homes Development

Pacific Pines Estate – Lennox Heads

Site Plan
5551.19.02.M

TVS architects

18/05/2018 12:26:19 PM ©TVS architects

Snapper Drive

Montwood Drive

ROAD A

ROAD B

ROAD B

ROAD B

ROAD B

ROAD C

ROAD B

ROAD B

ROAD B

ROAD B

ROAD D

ROAD D

ROAD D

Legend
Type A - Living Area
Type B - Living Area
Type C - Living Area
Type D - Living Area
Garage
Wet Area
Bedroom
Terrace/Balcony

1 / 100.00 Site - Ground Floor Plan
1 : 400

0 2 4 6 8 10
Scale (m) 1 : 100 @A1
Scale (m) 1 : 200 @A3

Terrace Homes Development
Pacific Pines Estate – Lennox Heads

Site Layout Plan - Ground Floor
5551.15.03.D

N

TVS architects

18/05/2018 12:26:49 PM TVS architects

Main Street

Montwood Drive

1
3.17
Site - Level 1 Floor Plan
1 : 400

Legend
Type A - Living Area
Type B - Living Area
Type C - Living Area
Type D - Living Area
Garage
Wet Area
Bedroom
Terrace/Balcony

0 2 4 6 8 10
Scale (m) 1 : 100 @A1
Scale (m) 1 : 200 @A3

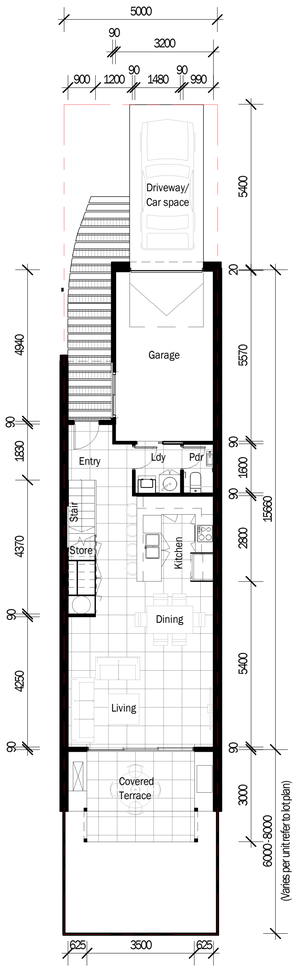
Terrace Homes Development
Pacific Pines Estate – Lennox Heads

Site Layout Plan - Level 1
5551.15.04.D

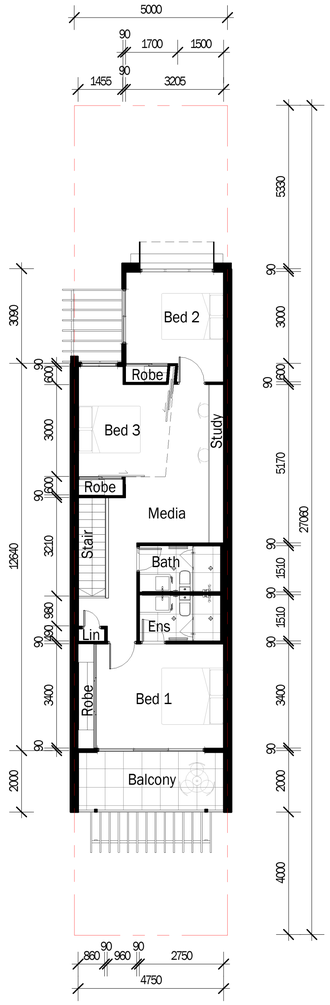
N

TVS architects

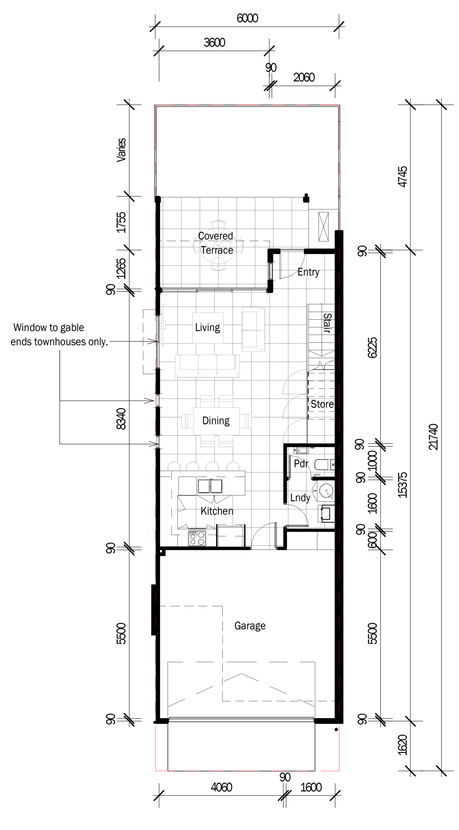
18/05/2018 12:27:02 PM ©TVS architects



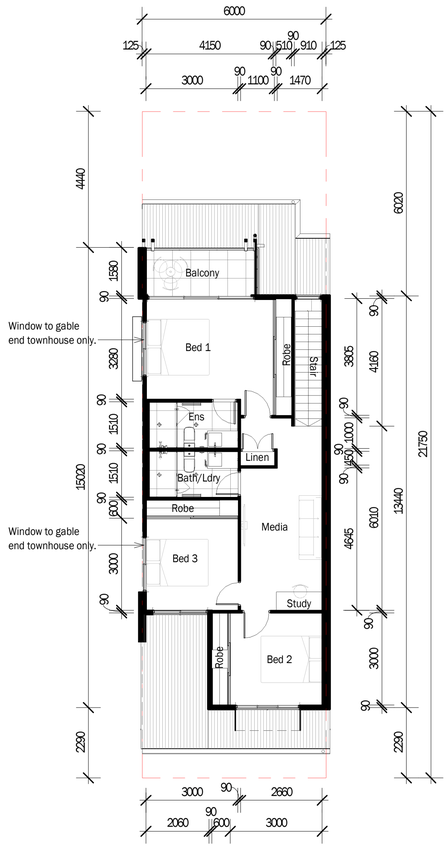
1 Type A (5m) - Ground Floor
1 : 100



2 Type A (5m) - Upper Floor
1 : 100



3 Type B (6m) - Ground Floor
1 : 100



4 Type B (6m) - Upper Floor
1 : 100

Type A - 5m Townhouse	
Name	Area
Garage	19.03 m²
GF Living	51.44 m²
Terrace	11.14 m²
L1 Living	70.46 m²
Balcony	10.00 m²
	162.07 m²

Type B - 6m Townhouse	
Name	Area
Terrace	13.53 m²
GF Living	52.96 m²
Garage	34.58 m²
L1 Living	69.49 m²
Balcony	5.59 m²
	176.15 m²

	No.	Unit Type
	33	Type A - 5m
	63	Type B - 6m
	35	Type C - 7m
	15	Type D - 10.3m
	146	Total

0 2 4 6 8 10
Scale (m) 1 : 100 @A1
Scale (m) 1 : 200 @A3

Terrace Homes Development
Pacific Pines Estate – Lennox Heads

Typical Units Type A & B
5551.15.10.B

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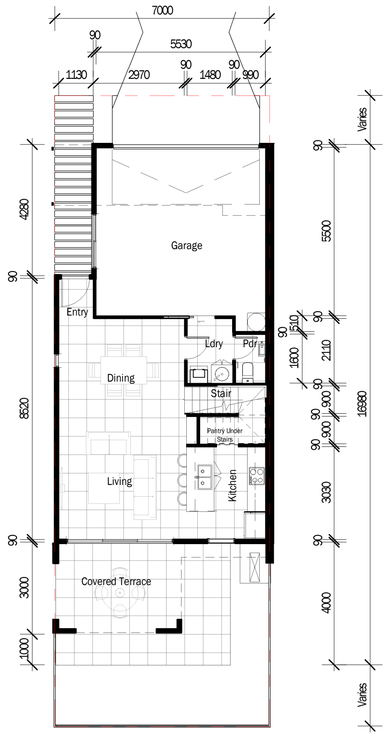
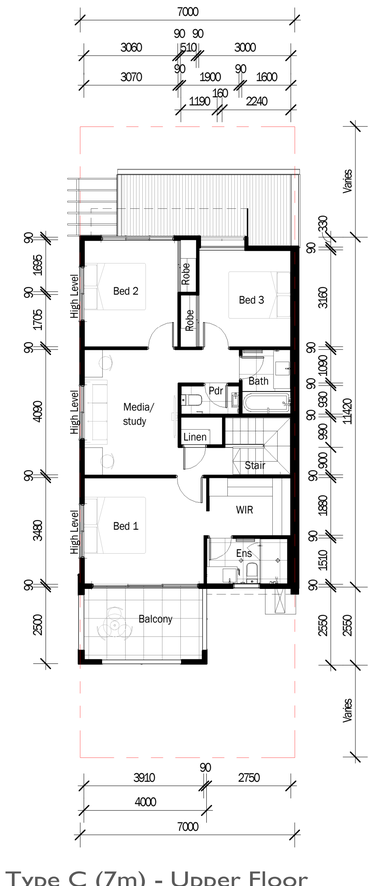
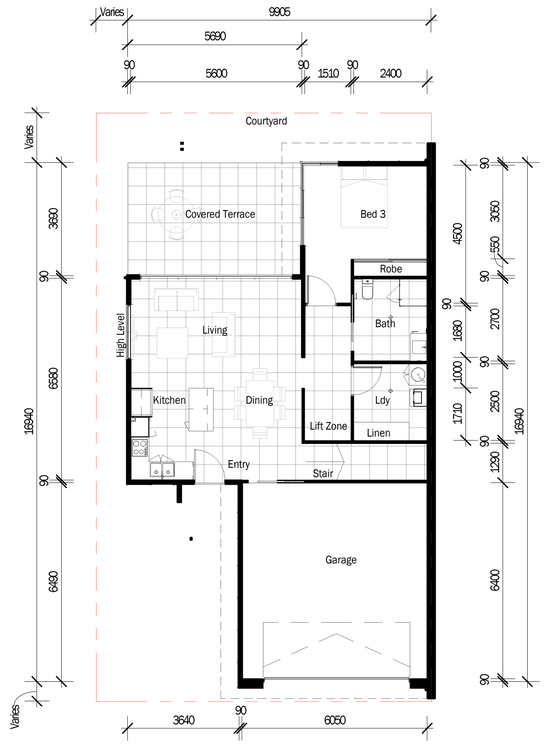


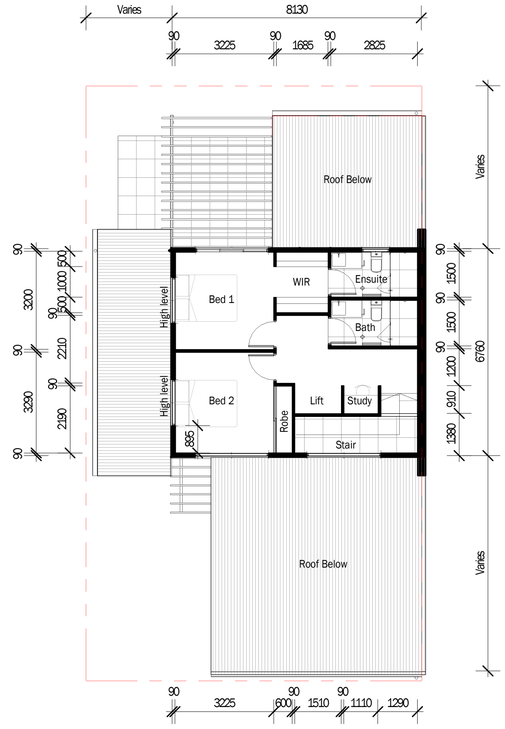
1 Type C (7m) - Ground Floor
1 : 100



2 Type C (7m) - Upper Floor
1 : 100



3 Type D (9.9m) - Ground Floor
1 : 100



4 Type D (9.9m) - Upper Floor
1 : 100

Type C - 7m Townhouse	
Name	Area
Garage	32.57 m²
GF Living	52.92 m²
Terrace	22.90 m²
L1 - Living	75.41 m²
Balcony	10.31 m²
	194.11 m²

Type D - 9.9m Townhouse	
Name	Area
Terrace	21.00 m²
GF Living	82.51 m²
Garage	40.66 m²
L1 - Living	48.64 m²
	192.81 m²

No.	Unit Type
33	Type A - 5m
63	Type B - 6m
35	Type C - 7m
15	Type D - 10.3m
146	Total

0 2 4 6 8 10
Scale (m) 1 : 100 @A1
Scale (m) 1 : 200 @A3

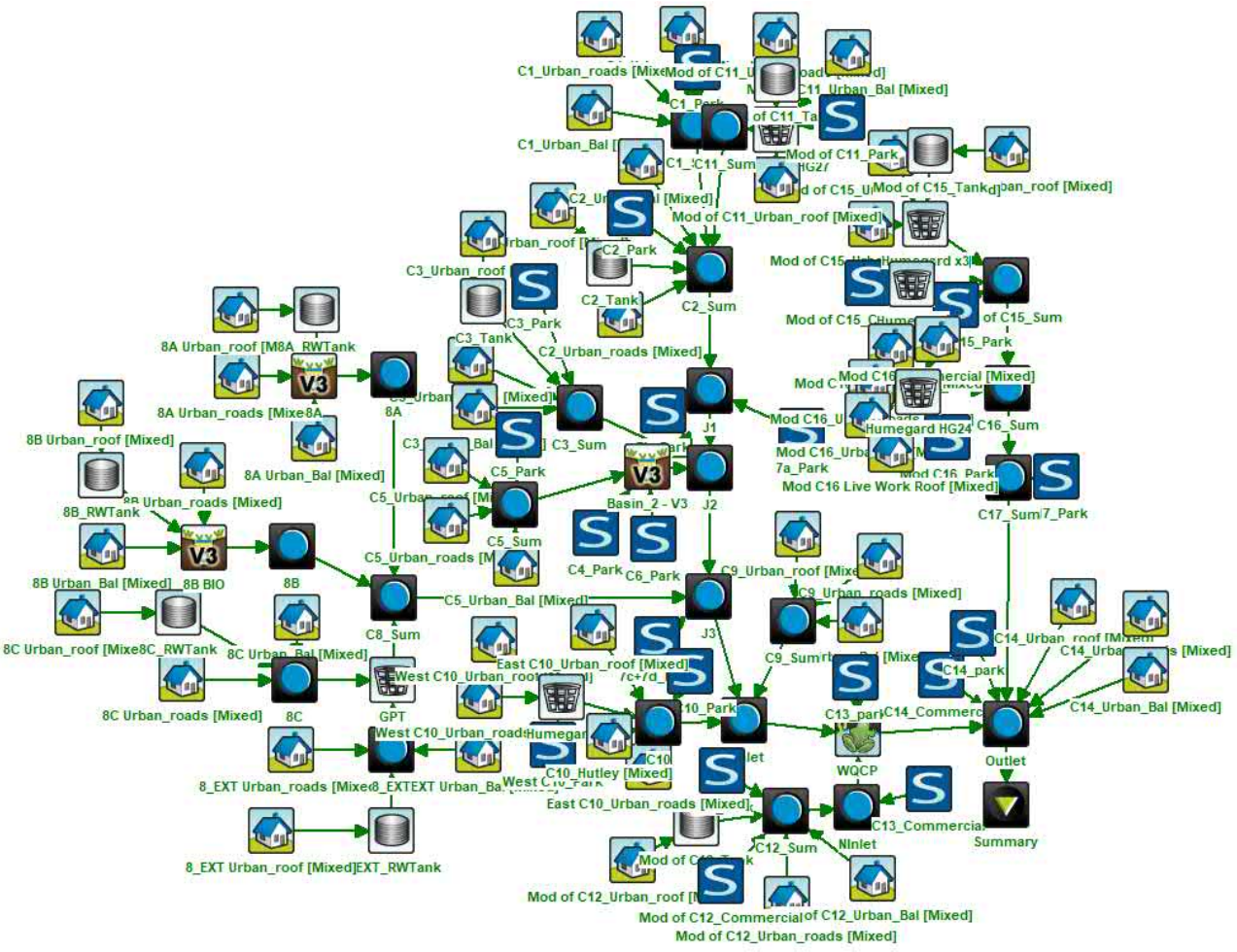
Terrace Homes Development
Pacific Pines Estate – Lennox Heads

Typical Units Type C & D
5551.15.11.B

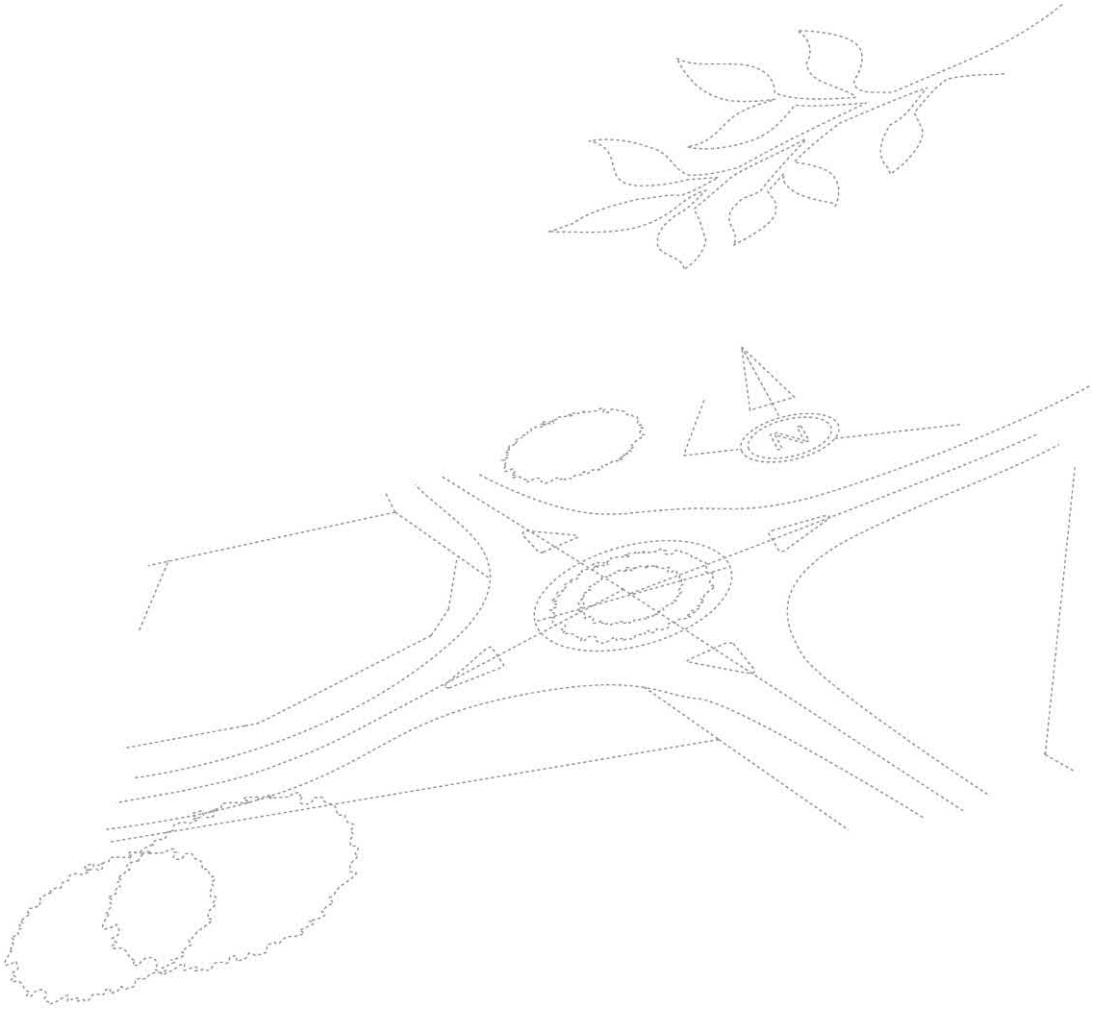
TVS architects

18/05/2018 12:28:00 PM TVS architects

Appendix D MUSIC Model



Appendix E Sewer Rising Main Assessment



Project Reference: WASENG-NDC003

Willow+ Sparrow

10 May 2018

Newton Denny Chapelle Pty Ltd
PO Box 1138
Lismore NSW 2480

ENGINEERING ADVICE AND DETAILED DESIGN OF SEWER PUMP STATION – EPIQ ESTATE, LENNOX HEAD

Dear Chris Pickford,

Further to my previous advice dated 7 May 2018, and the provision of additional as-constructed information (from your office) concerning the existing DN225 gravity sewer, I note that the steeper downstream grades of the gravity sewer enable additional flows. A grade of 0.89% enables approximately 400 ET. Therefore, injection of flows from 'Super Lot 5' into the sewer at SMH201-2 as shown on the plan in Appendix A provides a suitable option, given that the catchment, including 'Super Lot 5', totals 393 ET.

Investigation was also undertaken as to the adequacy of the existing DN300 rising main along Hutley Drive from Byron Street in Lennox Head as an alternative injection point. There is available capacity in the main, however it is required to accommodate the additional loading from the future growth of Lennox Head and is therefore not an available option.

No further investigation was carried out on the trunk gravity sewer along Hutley Drive due to the downstream suitability of the existing DN225 main to accommodate flows. Injecting at this point would also appear to be a slightly cheaper option due to length and location.

Please do not hesitate to contact me if you wish to discuss further.

Kind Regards,

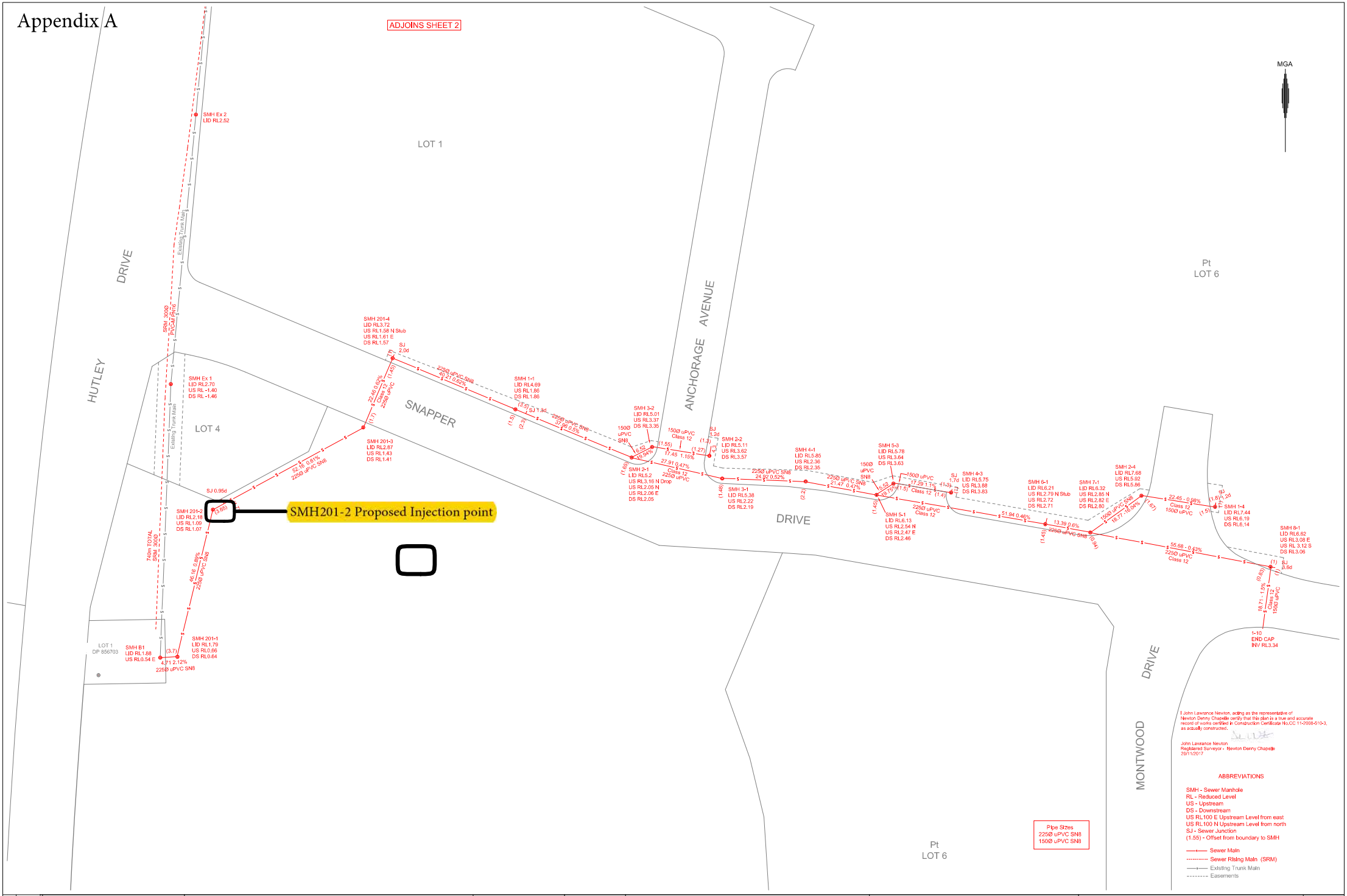
Willow+ Sparrow
ENGINEERING+DESIGN

MICHAEL CHAMBERLAIN
Bch. App Sc., BEng (hon), RPEng, RPEQ

+061 401 415 220
michael@waseng.com.au

waseng.com.au

Appendix A



Rev	Date	Amendment
A		
B		
C		
D		
E		
F		
G		

Notes :

Design :
Survey : NDC
Drawn : DS
Approved:
Datum : AHD

Scale: 500@A1

Newton Denny Chapelle
Surveyors Planners Engineers
Email: office@newtondennychapelle.com.au

Lismore
Suite 1
31 Carrington St. Lismore 2480
T: 66 221011 F: 66 224088

Casino
100 Barker St. Casino 2470
T & F : 66 625000

Client:
CLARENCE PROPERTY CORPORATION P/L
EPIQ ESTATE
LENNOX HEAD

Project :
SEWER - SUMMARY
WORK AS EXECUTED

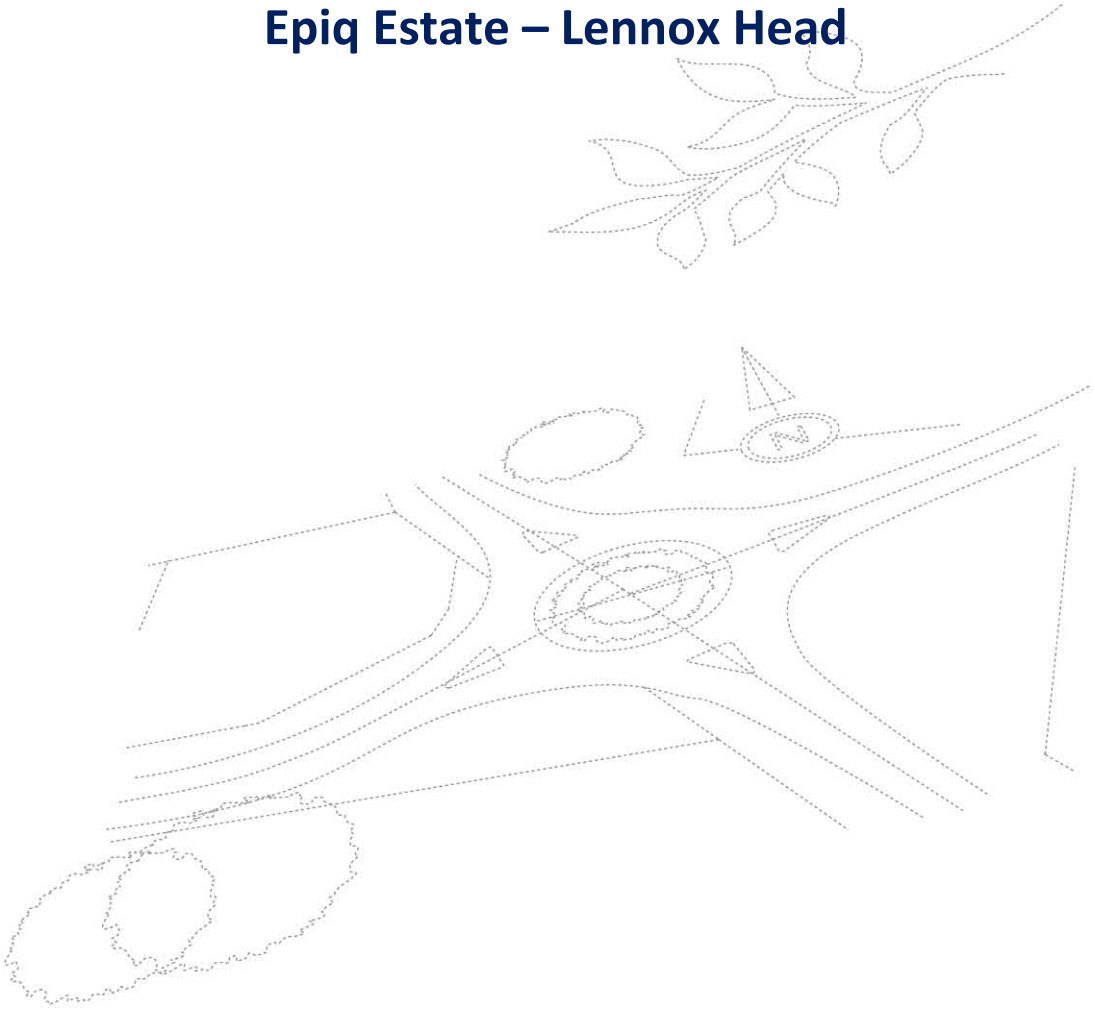
Date 7 December 2017

Ref No. 14351/1B

Sheet 1/3

Dwg File: K:\Jobs\2014\14351 - Clarence Property\Stage 1B\Surveying\AutoCAD\WAX\14351 Stage 1B Linen And WAX_Rev 2 Sewer.dwg - Sewer Summary 1

Appendix F H2One - Hydraulic Assessment of the Dual Reticulation Water Supply Network Epiq Estate – Lennox Head



H2ONE

EPIQ Estate All Stages
Lennox Head NSW 2478

Hydraulic Assessment of the Dual Reticulation Water Supply Network

For Ballina Shire Council Approval

FINAL Report V2 - 12 May, 2017

H2One Pty Ltd

Water, Sewer and Stormwater Engineering Specialists

H2One Pty Ltd

ABN 20 130 354 764

P 07 5503 0044

E info@H2One.com.au

W h2one.com.au

Reviewed by RPEQ	Reg. No.	Signed	Date
Joshua May	18064		12 May, 2017

Version	Date	Author	Reviewer
DRAFT - V1	28 April, 2017	D Colledge	J May
DRAFT - V2	3 May, 2017	D Colledge	J May
FINAL - V1	10 May, 2017	D Colledge	J May
FINAL - V2	12 May, 2017	D Colledge	J May

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Background

EPIQ Estate is a Master Planned urban development located in Lennox Head, NSW, approximately 30 km's south of Byron Bay. The site has an estimated land area of 80 hectares and is proposed for residential, commercial, retail, open space and conservation land use. The development is scheduled for completion via a number of stages, with ultimate development projected within the next three - five years. Stage 1A, comprising of 51 residential freehold lots, has been constructed with Stage 1B and Super Lot 8 (Release 2) currently under construction. All remaining stages are currently in the planning or Development Application (DA) phase. The remaining development stages (including those currently under construction) are expected to consist of the following.

- 503 x residential freehold allotments
- 27 x medium density dwellings
- 4.4 x Ha community sporting field with community centre
- Child care centre
- 5,500 m^2 Gross Floor Area (GFA) of commercial and retail precinct
- Park, conservation area and open space throughout the site.

A potable water and recycled water service strategy has previously been developed for EPIQ Estate, with connection to Ballina Shire Council's (BSC) existing network at the southern and northern site boundaries. To confirm the proposed strategy and associated infrastructure sizing, H2One Pty Ltd was engaged to complete a hydraulic modelling analysis of the dual reticulation system, in accordance with BSC's adopted Design Standards; *New South Wales Development Design Specification, D11, Water Supply* (2009).

The results of the assessment and confirmed reticulation layout plans are presented in this report.

1.2 Objectives

The key objectives of the project were as follows:

1. Estimate ultimate potable water and recycled water demands for EPIQ Estate.
2. Develop potable water and recycled water hydraulic models for the proposed distribution systems.
3. Complete a standard flow and fire flow hydraulic analysis to confirm infrastructure sizing/layout, in accordance to BSC's Design Standards.
4. Issue an RPEQ certified hydraulic assessment report and associated concept design layout plans.

1.3 Potable Water Supply Strategy

The potable water supply service strategy for EPIQ Estate consists of a High Level Zone (HLZ) and Low Level Zone (LLZ) supply regime, with the ultimate construction of a 1.5 ML storage tank at the northern end of the development site. The construction of this storage tank will be undertaken by BSC sometime after the completion of the EPIQ Lennox Estate, as the demand in the greater Lennox Head area increases. In the interim, a pressure reducing valve will be installed at this location to reduce the pressures to acceptable levels for the LLZ. This was previously developed in liaison with BSC as a long-term strategy to rectify storage deficiencies in the region.

The HLZ will be located at the northern end of the site and is directly serviced by BSC's existing Basalt Court tank (RL 73.4 m AHD), via an encircled trunk system of DN450 and DN300 mains along North Creek Road, Henderson Lane and Montwood Drive. The HLZ will service approximately 167 residential allotments with elevated ground levels west and south of the proposed tank.

The LLZ water tank will be constructed on elevated ground levels to the north-east of the site (RL 48 m AHD), with upstream supply from the Basalt Court tank via an existing DN200 trunk main along Stoneyhurst Drive. The LLZ tank will service majority of the development and neighbouring properties to the north and south.

Note BSC's hydraulic model was not available for the project and the LLZ boundary has yet to be determined. For these reasons, the proposed storage volume of the tank (1.5 ML) could not be assessed with the information available. It is therefore recommended BSC confirm the LLZ boundary and tank storage volume prior to detailed design.

1.4 Recycled Water Supply Strategy

EPIQ Estate's recycled water network will be serviced from the south, via BSC's future proposed storage tank and DN250/200 trunk mains along Montwood Drive. The development's internal trunk infrastructure will be sized to provide adequate service to downstream customers, north of the site.

2 METHODOLOGY

2.1 Desired Standards of Service

The Design Standards of BSC's *New South Wales Development Design Specification, D11, Water Supply* (2009) were adopted for the project. Where assessment criteria was not available within BSC's Design Standards, the Water Services Association of Australia (WSAA) *Water Supply Code of Australia, WSA 03* (2011) was assumed. A summary of relevant provisions are presented in Table 1 below.

Table 1. Design specifications adopted for the analysis

Provision	Specification
Residential peak instantaneous potable demand	0.12 L/s/ET
Residential peak instantaneous recycled demand	0.03 L/s/ET
Minimum standard flow network pressure	20 m
Maximum standard flow network pressure	78 m
Maximum pipe velocity	3.0 m/s
Maximum head loss	5 m head/km for <=DN150 3 m head/km >=DN200
Minimum fire flow network pressure	12 m at peak demand
Fire flow at hydrant	11 L/s
Hazen Williams pipe friction co-efficient	<= 150 diameter, 100 >150 <300 diameter, 110

2.2 Demand Assessment

A demand assessment of the development was undertaken to estimate peak flows attributed to the proposed land use type and density, for both potable and recycled water supply. This was calculated using BSC's adopted peak instantaneous unit rates for potable water (0.12 L/s/ET) and recycled water (0.03 L/s/ET), in conjunction with demand rates adopted from Water Directorate's *Section 64, Determinations of Equivalent Tenements Guidelines* (2009).

Refer below for a summary of the demand estimation for the EPIQ Estate, at ultimate development.

Table 2. Demand estimation for the proposed development

Site Land Use and Density	Demand Rate	ET	Potable Peak Flow (L/s)	Recycled Peak Flow (L/s)
503 + 51 x residential freehold lots	1 ET/Lot	554.0	66.5	16.6
25 x medium density dwellings (west of Hutley Dr)	1 ET/dwelling	25.0	3.0	0.8
Commercial precinct (5,500 m^2 GFA)	0.6 ET/100m^2	33.0	4.0	1.0
Child care centre (90 children)	0.06 ET/child	5.4	0.7	0.2
5 x park/open space	1 ET/lot	5.0	0.6	0.2
Community Centre (23 flushing units)	1.1 ET/flushing unit	25.3	3.0	NA
Sports fields (4.4 Ha)	20 ET/Ha	88.0	NA	2.6
	TOTAL	**735.7**	**77.8**	**21.4**

Note: The 5 park allotments were allocated 1 ET to account for potential water usage from public toilets, taps, wash down etc.

2.3 Hydraulic Model Assessment

The methodology adopted for the hydraulic assessment is as follows.

1. An InfoWater dual reticulation hydraulic model was developed for EPIQ Estate, based on the service supply strategies determined from previous consultant studies, refer Appendix 1. The pipe layouts were introduced to a base model as a background layer, and model node/hydrant elements drawn manually.
2. All pipes were initially allocated the minimum allowable size (DN100) and assigned the relevant Hazen Williams Roughness co-efficient.
3. The following data was subsequently introduced to the hydraulic model.
    a. Potable water valve and tank arrangement for the proposed LLZ and HLZ systems
    b. Potable water boundary conditions:
        i. HLZ standard flow and fire flow, peak hour: 71.0 m head at both Henderson Lane (north-east) and Fieldcrest Drive (south-east), assuming Fieldcrest Drive will be directly serviced from the Basalt Court reservoir.
        ii. LLZ standard flow and fire flow, peak hour: 50.0 m head, based on the Minimum Operating Level (MOL) of the proposed supply tank with a ground level of RL 48 m AHD.
    c. Recycled water boundary conditions:
        i. Standard flow, peak hour: 74.0 m head at Montwood Drive. The development's network was also required to meet downstream boundary conditions of 70.0 m head @ 10.6 L/s and 69.0 m head @ 21.5 L/s, for Henderson Lane and Hutley Drive respectively. This was to ensure adequate service is achieved for downstream connections.
4. A standard flow and fire flow hydraulic analysis was undertaken on the potable water reticulation layout, where pipe sizes were systematically increased and/or connections adjusted to achieve relevant Design Standards.
5. A standard flow hydraulic analysis was undertaken on the recycled water reticulation layout, where pipe sizes were systematically increased and/or connections adjusted to achieve relevant Design Standards. Note a fire flow analysis was not completed on the recycled water network, as BSC has allocated this service to the potable system only.
6. Modelling results were then verified and deliverables prepared.

3 RESULTS

3.1 Potable Water

As per the methodology described in Section 2.3 of this report, a standard flow and fire flow hydraulic analysis was undertaken on the proposed potable water service strategy. The analysis identified that the infrastructure presented in Table 3 and Appendix 2 achieved BSC's Design Standards. Refer to Appendices 2 through 7 for detailed modelling results.

Table 3. Summary of potable water infrastructure

Description	Location	Diameter (DN)	Length (m)
Potable water reticulation pipe	Throughout site	100	6,420
Potable water reticulation pipe	Throughout site	150	1,390
Potable water reticulation pipe	Montwood Dr and Stoneyhurst Dr	200	2,460
Potable water trunk pipe	Centre of the site	300	420
Potable water tank (1.5 ML)	Northern end of site	NA	NA

Note: Potable water tank volume to be confirmed by BSC

A summary of the hydraulic modelling results is as follows.

- The HLZ presented a standard flow and fire flow minimum pressure of 22.5 m and 19.6 m respectively, at node J112.
- The HLZ presented a standard flow maximum pressure of 55 m (node J168), at the eastern boundary of the site.
- The LLZ presented a standard flow and fire flow minimum pressure of 26.0 m and 19.5 m respectively, at node J64.
- The LLZ presented a standard flow maximum pressure of 46 m (node J198).

In summary, the service strategy provided adequate supply to the potable network receiving an average network pressure of 38 m. Due to varied elevations across the site, isolated areas received pressures marginally above and below 22 m and 70 m, respectively.

3.2 Recycled Water

As per the methodology described in Section 2.3 of this report, a standard flow hydraulic analysis was undertaken on the proposed recycled water service strategy. The analysis identified that the infrastructure presented in Table 4 and Appendix 4 achieved BSC's Design Standards. Refer to Appendices 4 through 7 for detailed modelling results.

Table 4. Summary of recycled water infrastructure

Description	Location	Diameter (DN)	Length (m)
Recycled water reticulation pipe	Throughout site	100	7,800
Recycled water reticulation pipe	Southern end of site	150	50
Recycled water reticulation pipe	Throughout site	200	2,145
Recycled water trunk pipe	Montwood Dr	250	520

A summary of the hydraulic modelling results is as follows.

- The network presented a standard flow minimum pressure of 22.5 m, at node J112.
- The network presented a standard flow maximum pressure of 69 m, at node J216.
- A pressure differential was unable to be maintained in favour of the potable system, to reduce the risk of potential cross-contamination.

Similarly to the potable water system, the service strategy provided adequate supply to the recycled water network receiving an average network pressure of 54 m. Due to varied elevations across the site, isolated areas received pressures marginally above and below 22 m and 70 m, respectively.

4 CONCLUSION

EPIQ Estate is a Master Planned urban development located in Lennox Head, NSW, approximately 30 km's south of Byron Bay. The development is scheduled for completion via a number of stages, with ultimate development projected within the next three - five years. The remaining development stages will consist of the following.

- 503 x residential freehold allotments
- 27 x medium density dwellings
- 4.4 x Ha community sporting field with community centre
- Child care centre
- 5,500 m^2 Gross Floor Area (GFA) of commercial and retail precinct
- Park, conservation area and open space throughout the site.

H2One Pty Ltd was engaged to confirm the proposed potable water and recycled water service strategy, in accordance with Ballina Shire Council's (BSC) adopted Design Standards; *New South Wales Development Design Specification, D11, Water Supply* (2009), to service EPIQ Estate at ultimate development.

The hydraulic analysis determined that the dual reticulation service strategy presented in Appendices 2 and 4 satisfies the minimum Design Standards and is therefore recommended for BSC approval. Detailed modelling results can be observed in Appendices 2 through 7.

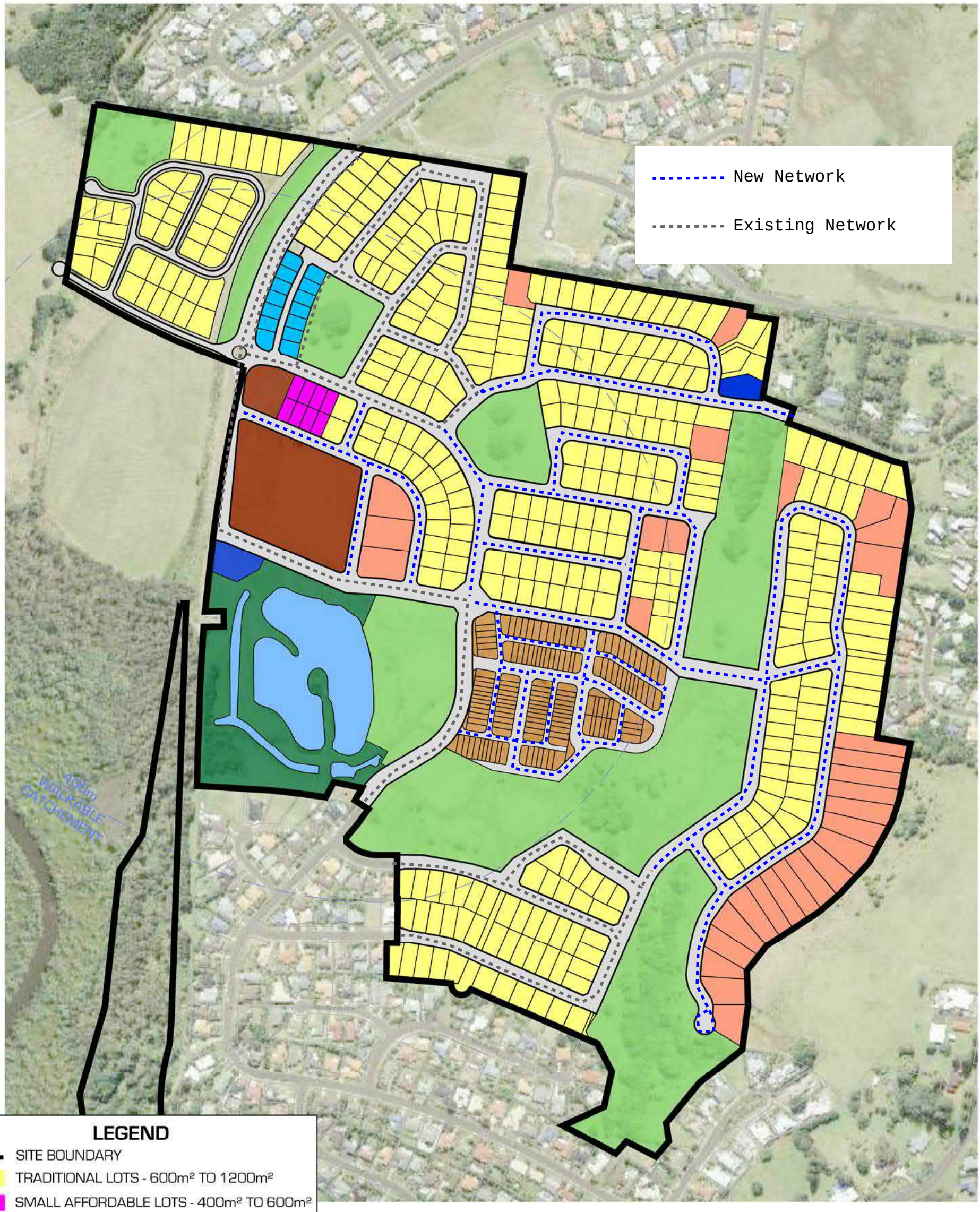
5 REFERENCES

Water Directorate (2009) "*Section 64, Determinations of Equivalent Tenements Guidelines*"

Ballina Shire Council (2009) "*New South Wales Development Design Specification, D11, Water Supply*"

6 APPENDICES

Appendix 1. EPIQ Estate Site Layout



LEGEND

- SITE BOUNDARY
- TRADITIONAL LOTS - 600m² TO 1200m²
- SMALL AFFORDABLE LOTS - 400m² TO 600m²
- LARGE LOTS - >1200m²
- INDEPENDENT / ASSISTED UNITS AND RETIREMENT COURT YARD LOTS
- PARK COURT LOTS - 400m² - 600m²
- CONSERVATION / PARK / OPEN SPACE
- DRAINAGE RESERVE
- COMMUNITY USE
- NEIGHBOURHOOD CENTRE

0 50 100 150 200 250

1cm = 50m
1:5000

SOURCE:
Plans prepared by geolink - Pacific Pines Estate - Lennox Head 1675 - 1028
Illustration C6 - Movement Network Dated: August 2012.

NOTE:
This preliminary layout has been completed in accordance with the instructions provided by Epiq Lennox Head.
In this respect preliminary desktop data has been used to form this layout. The final layout is subject to the completion of a detailed survey & engineering plans. Accordingly, the conclusions reached within this report may be modified by the author upon the completion of the final design plans & site inspection. Newton Denny Chapelle accepts no responsibility for any loss or damage suffered, however so arising, to any person or corporation who may use or rely on this report.

REV	DATE	AMENDMENT
A		
B		
C		
D		
E		

SOURCE PLAN: www.maps.six.nsw.gov.au - accessed 14.11.16

k:\ jobs \2014\ 14351 - clarence property \masterfile\ planning\ planning plans\ ndc plans \cad files\ geo link update \geo link plan setsdwg - c8 - lot topographies

Newton Denny Chapelle
Surveyors Planners Engineers
Email: office@newtondennychapelle.com.au
LISMORE 31 Carrington St. Lismore 2480 PH: 6622 1011
CASINO 100 Barker St. Casino 2470 PH: 6662 5000
ABN: 86 220 045 469

EPIQ LENNOX HEAD ILLUSTRATION C8 - LOT TOPOGRAPHIES

CLIENT: CLARENCE PROPERTY CORPORATION
LOCATION: LOT 234 DP1104071 LENNOX HEAD NSW
DATE: 16.11.16 REF: 14/351
SCALE: 1 : 4000 @ A3 DRAWN: bk

Proposed main
- 100
- 150
- 200
- 300

Proposed reservoir

Model node

Existing lot

Proposed lot

High Level Zone

Future Residential
47 ET

Lowest pressure SF and FF (LLZ)

Lowest pressure SF and FF (HLZ)

A PRV will be installed in the interim of tank construction (50 m setting)

Boundary Condition 71 m

Boundary Condition 71 m

CV

CV

CV

J12 J90 J46 J44 J92 J18 J42 J258 J260 J64 J80 J14 J62 J16 J38 J20 J22 J24 J40 J94 J66 J60 J36 J68 J78 J32 J264 J48 J70 J26 J28 J50 J52 J76 J74 J282 J54 J72 J280 J284 J102 J84 J86 J108 J104 J242 J244 J248 J118 J114 J116 J112 J110 J228 J126 J122 J124 J234 J236 J146 J232 J256 J274 J276 J168 J142 J140 J196 J198 J222 J200 J186 J188 J184 J216 J210 J212 J214 J220 J204 J208 J192 J136 J138 J96 J218 J100 J106 J130 J132 J270 J134 J180 J178 J172 J98 J156 J152 J170 J154 J160 J166 J150 J158 J162 J164 J148

Note: Pipe layout is indicative only, schematic not for construction purpose

N W E S

H2ONE

H2One Pty Ltd
PO Box 3625
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DESIGNED:	D Colledge
DRAWN:	D Colledge
CHECKED:	J May
APPROVED:	J May
CLIENT PM:	
H2ONE PM:	J May

NOTE: DESIGN NOT TO BE AMENDED WITHOUT H2ONE PTY LTD ACCEPTANCE

No.	REVISION	APPROVED
C	REVISED ISSUE - 11 MAY 2017	
B	REVISED ISSUE - 03 MAY 2017	
A	ORIGINAL ISSUE - 28 APR 2017	

DATUM:
HORIZ: MGA94 (ZONE 56)
HEIGHT: AHD

SCALE:
0 100 200
Metres

SURVEYED BY / DATE:

SURVEY CHECKED:

H2ONE REFERENCES

PROJECT NO:
1611162

FILE REFERENCE:

CAD FILE:

Newton Denny Chapelle
SURVEYORS PLANNERS ENGINEERS

NEWTON DENNY CHAPELLE
PO BOX 1138
LISMORE NSW 2480

EPIQ Estate All Stages
Lennox Head NSW 2478

Appendix 2. Potable Water Supply
Pipe Reticulation Layout (Node Labels)

ORIGINAL ISSUE DATE:
APR, 2017

DATE SCANNED:

DRG No:

REV:

Proposed main

- 100
- 150
- 200
- 300

Proposed reservoir

Model node

Existing lot

Proposed lot

High Level Zone

Future Residential
47 ET

Boundary Condition 71 m

Boundary Condition 71 m

CV

CV

CV

P97 P101 P25 P27 P29 P23 P31 P351 P111 P47 P15 P19 P37 P49 P109 P59 P67 P69 P53 P407 P65 P119 P127 P397 P123 P131 P117 P121 P115 P125 P159 P219 P221 P361 P187 P189 P395 P237 P239 P287 P281 P247 P135 P265 P251 P267 P263 P257 P285 P413 P415 P235 P293 P167 P171 P173 P165 P169 P163 P175 P177 P183 P185 P201 P199 P379 P377 P343 P345 P309 P311 P307 P153 P151 P149 P147 P299 P143 P139 P137 P141 P145 P79 P77 P85 P87 P203 P207 P209 P223 P367 P319 P321 P325 P327

Note: Pipe layout is indicative only, schematic not for construction purpose

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A	ORIGINAL ISSUE - 28 APR 2017	

DATUM:
HORIZ: MGA94 (ZONE 56)
HEIGHT: AHD

SCALE:
0 100 200
Metres

SURVEYED BY / DATE: SURVEY CHECKED:

H2ONE REFERENCES

PROJECT NO: 1611162

FILE REFERENCE:

CAD FILE:

Newton Denny Chapelle
SURVEYORS PLANNERS ENGINEERS

NEWTON DENNY CHAPELLE
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LISMORE NSW 2480

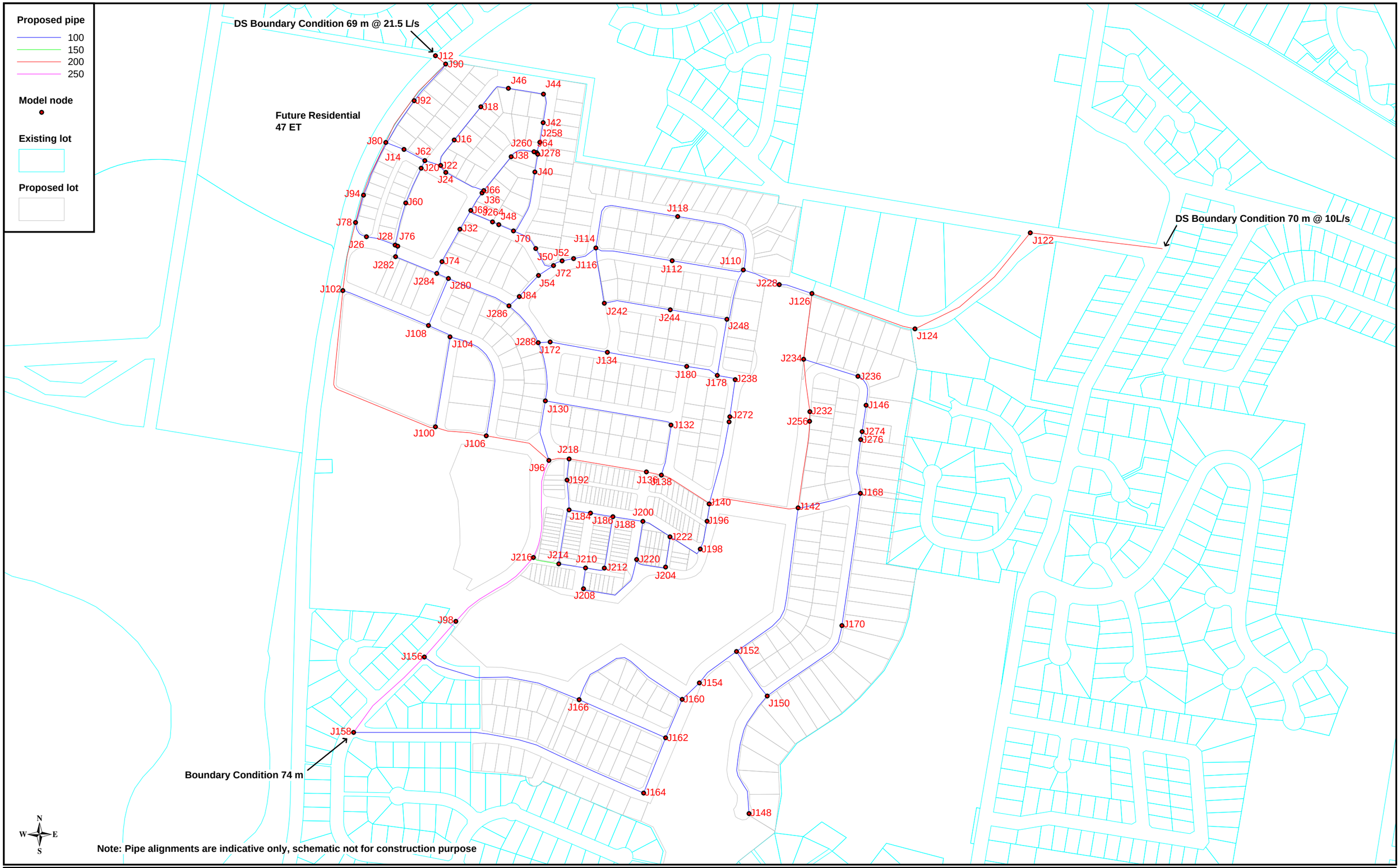
EPIQ Estate All Stages
Lennox Head NSW 2478

Appendix 3. Potable Water Supply
Pipe Reticulation Layout (Pipe Labels)

ORIGINAL ISSUE DATE: APR, 2017

DATE SCANNED:

DRG No: REV:



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NOTE: DESIGN NOT TO BE AMENDED WITHOUT H2ONE PTY LTD ACCEPTANCE

No.	REVISION	APPROVED
B	REVISED ISSUE - 03 MAY 2017	
A	ORIGINAL ISSUE - 28 APR 2017	

DATUM:
HORIZ: MGA94 (ZONE 56)
HEIGHT: AHD

SCALE:
0 100 200
Metres

SURVEYED BY / DATE:

SURVEY CHECKED:

H2ONE REFERENCES

PROJECT NO: 1611162

FILE REFERENCE:

CAD FILE:

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LISMORE NSW 2480

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Lennox Head NSW 2478

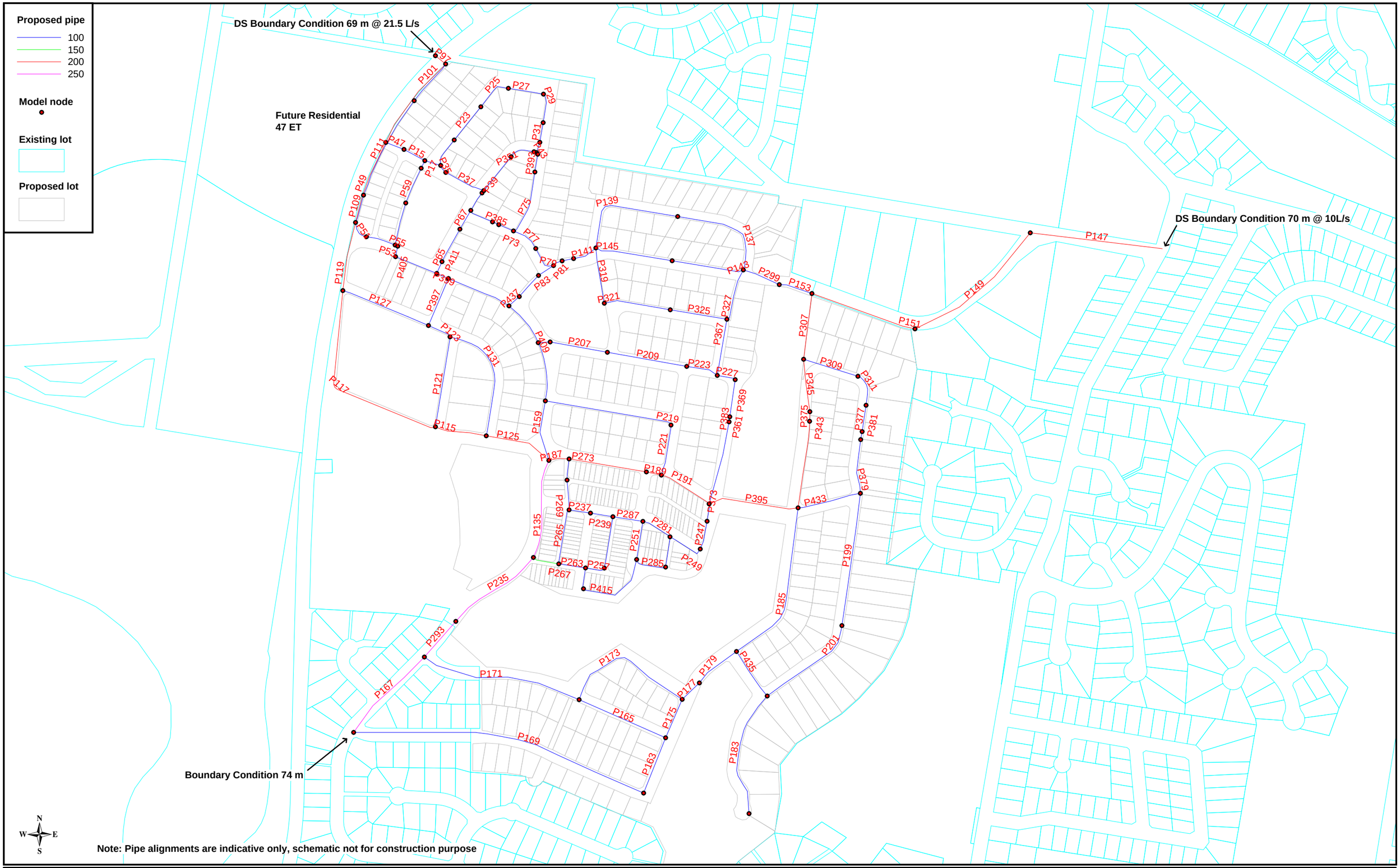
Appendix 4. Recycled Water Supply
Pipe Reticulation Layout (Node Labels)

ORIGINAL ISSUE DATE: APR, 2017

DATE SCANNED:

DRG No:

REV:



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DESIGNED:	D Colledge
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CHECKED:	J May
APPROVED:	J May
CLIENT PM:	
H2ONE PM:	J May

NOTE: DESIGN NOT TO BE AMENDED WITHOUT H2ONE PTY LTD ACCEPTANCE

No.	REVISION	APPROVED
B	REVISED ISSUE - 03 MAY 2017	
A	ORIGINAL ISSUE - 28 APR 2017	

DATUM:
HORIZ: MGA94 (ZONE 56)
HEIGHT: AHD

SCALE:
0 100 200
Metres

SURVEYED BY / DATE: | SURVEY CHECKED:

H2ONE REFERENCES

PROJECT NO: 1611162

FILE REFERENCE:

CAD FILE:

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SURVEYORS PLANNERS ENGINEERS

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LISMORE NSW 2480

EPIQ Estate All Stages
Lennox Head NSW 2478

Appendix 5. Recycled Water Supply
Pipe Reticulation Layout (Pipe Labels)

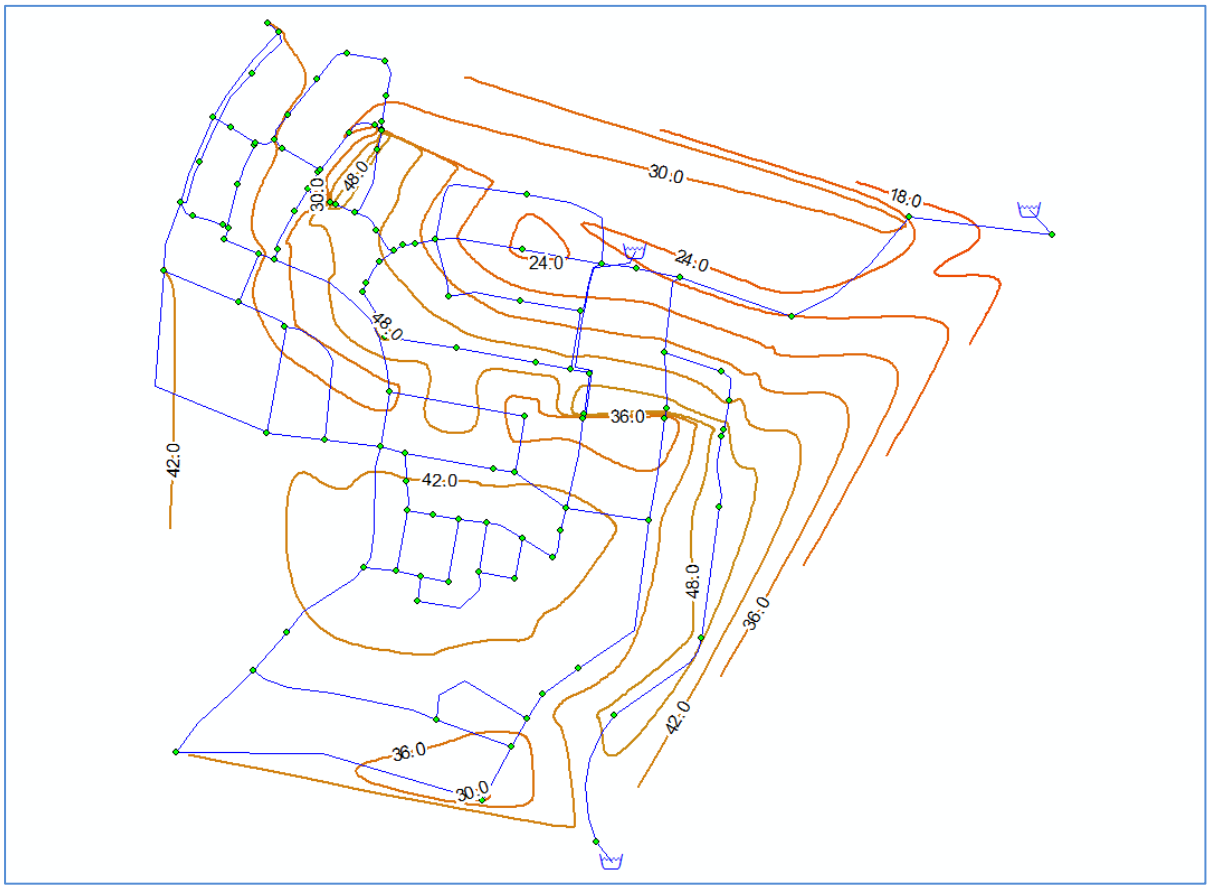
ORIGINAL ISSUE DATE: APR, 2017

DATE SCANNED:

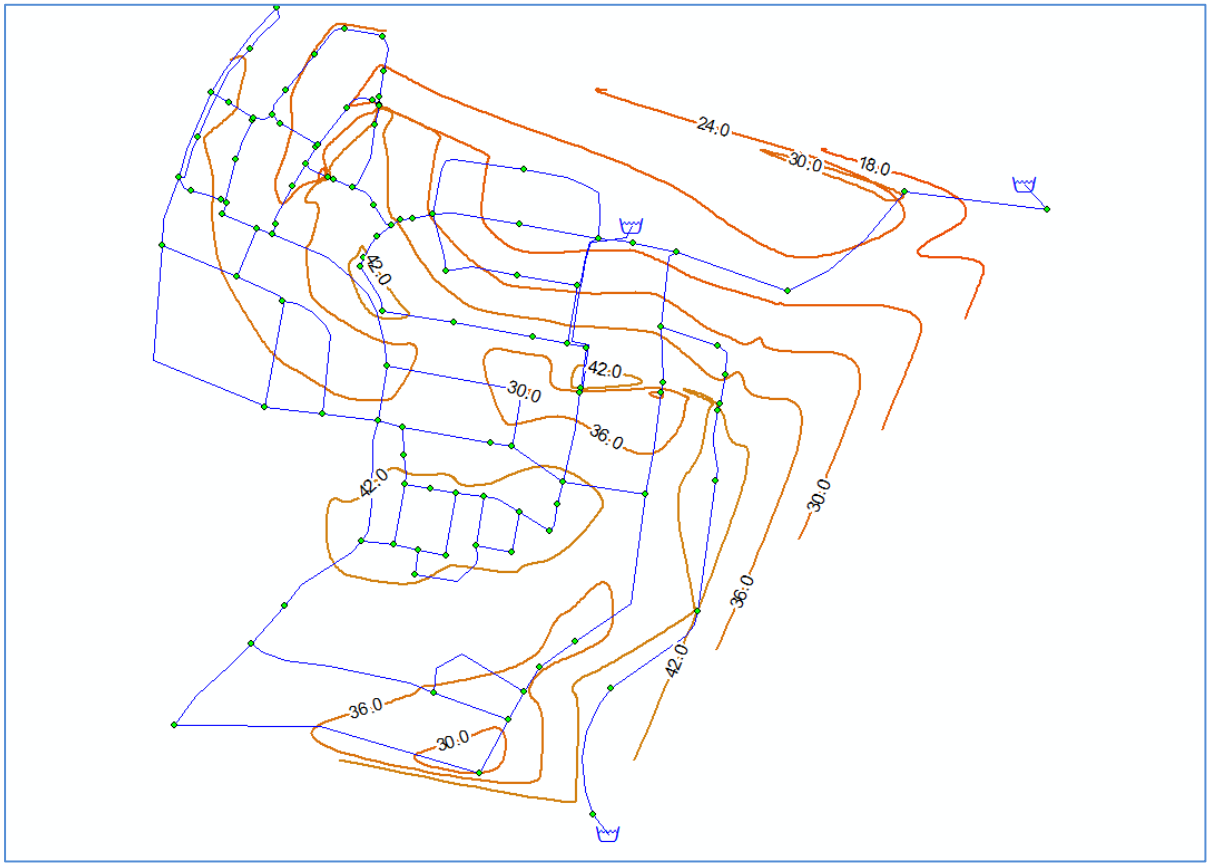
DRG No: | REV:

Appendix 6. Screenshot of Hydraulic Modelling Results

POTABLE WATER – Standard Flow Peak hour (pressure, m)



POTABLE WATER - Fire Flow Peak hour (pressure, m)



RECYCLED WATER - Standard Flow Peak hour (pressure, m)

Appendix 7. Raw Modelling Results

Pipes - Potable Water

Pipe ID	Pipe DN (mm)	HW Co-efficient	Length (m)	SF PH Flow Rate (L/s)	SF PH Velocity (m/s)	SF PH Head loss (m/km)
P101	200	110	144.5	0.5	0.02	0.0
P103	100	100	71.4	0.5	0.07	0.1
P109	100	100	64.8	1.2	0.15	0.6
P111	100	100	141.2	0.3	0.04	0.0
P115	200	110	79.4	18.3	0.58	2.7
P117	200	110	320.5	10.2	0.33	0.9
P119	200	110	95.3	7.0	0.22	0.5
P121	150	110	146.5	5.7	0.32	1.3
P123	150	110	72.3	5.6	0.32	1.2
P125	200	110	75.9	23.0	0.73	4.2
P127	150	110	109.9	2.2	0.13	0.2
P131	100	100	191.6	2.3	0.30	2.1
P135	200	110	167.2	1.6	0.05	0.0
P137	100	100	168.7	2.2	0.27	1.8
P139	100	100	182.9	0.4	0.05	0.1
P141	150	110	28.7	3.3	0.19	0.5
P143	150	110	109.0	6.9	0.39	1.8
P145	150	110	118.4	5.1	0.29	1.1
P147	200	110	194.4	16.8	0.54	2.3
P149	200	110	211.0	16.8	0.54	2.3
P15	100	100	39.6	1.7	0.22	1.2
P151	200	110	160.1	16.8	0.54	2.3
P153	200	110	60.2	12.4	0.39	1.3
P159	100	100	74.2	0.1	0.02	0.0
P163	150	110	82.8	0.3	0.02	0.0
P165	100	100	107.9	0.2	0.02	0.1
P167	200	110	151.3	1.9	0.06	0.0
P169	150	110	422.9	1.9	0.10	0.2
P17	100	100	4.4	1.0	0.13	0.5
P171	100	100	259.6	0.7	0.10	0.2
P173	100	100	173.1	0.6	0.08	0.1
P175	100	100	42.6	1.4	0.18	0.8
P177	100	100	39.6	3.5	0.45	4.5
P179	100	100	59.2	3.5	0.45	4.5
P183	100	100	182.6	3.0	0.38	3.3
P185	100	100	239.7	4.3	0.54	6.4
P187	200	110	33.8	24.5	0.78	4.7
P189	200	110	28.7	30.4	0.97	7.0
P19	100	100	28.2	2.8	0.35	2.8
P191	200	110	85.0	36.1	1.15	9.6
P199	100	100	180.0	1.2	0.16	0.6
P201	100	100	160.8	2.1	0.26	1.7
P203	100	100	68.0	1.4	0.17	0.8
P207	100	100	98.1	1.2	0.16	0.6
P209	100	100	108.6	0.5	0.06	0.1
P21	100	100	39.8	2.1	0.26	1.7
P219	100	100	186.3	3.1	0.39	3.4
P221	100	100	77.0	4.4	0.56	6.7
P223	100	100	48.2	0.5	0.06	0.1
P227	100	100	28.1	0.0	0.00	0.0
P23	100	100	61.9	1.1	0.14	0.5
P235	200	110	138.4	2.6	0.08	0.1
P237	100	100	35.6	1.7	0.21	1.1
P239	100	100	35.7	1.7	0.21	1.1
P247	150	100	39.8	12.8	0.72	6.7
P249	150	100	48.8	11.4	0.65	5.5
P25	100	100	57.0	0.5	0.06	0.1
P251	100	100	67.2	0.4	0.05	0.1
P257	100	100	39.1	0.6	0.08	0.2
P259	100	100	86.6	1.8	0.24	1.3

P263	100	100	33.8	1.1	0.13	0.4
P265	100	100	84.0	1.3	0.17	0.7
P267	100	100	44.5	1.1	0.14	0.5
P269	100	100	40.5	0.9	0.11	0.3
P27	100	100	51.7	0.1	0.02	0.0
P273	200	110	122.4	29.2	0.93	6.4
P275	100	100	38.1	2.1	0.27	1.8
P281	100	100	53.2	6.4	0.81	13.5
P283	100	100	55.5	5.0	0.64	8.6
P285	100	100	49.1	3.8	0.48	5.1
P287	100	100	37.6	4.8	0.61	7.8
P29	100	100	49.3	0.1	0.02	0.0
P293	200	110	69.3	2.6	0.08	0.1
P299	200	110	48.2	12.4	0.39	1.3
P307	100	100	108.2	3.7	0.47	4.8
P309	100	100	82.2	2.0	0.26	1.6
P31	100	100	35.2	0.7	0.09	0.2
P311	100	100	44.8	1.2	0.15	0.6
P319	100	100	79.8	0.6	0.07	0.2
P321	100	100	98.2	0.6	0.07	0.2
P325	100	100	83.4	1.1	0.15	0.6
P327	100	100	74.2	3.3	0.43	4.1
P343	100	100	140.4	0.8	0.10	0.3
P345	100	100	75.8	0.8	0.10	0.3
P35	100	100	16.2	0.7	0.09	0.2
P351	100	100	41.2	0.9	0.12	0.4
P361	300	120	122.3	57.2	0.81	2.6
P365	150	110	16.0	3.3	0.19	0.5
P367	100	100	79.8	2.2	0.28	1.9
P369	100	100	54.4	0.0	0.00	0.0
P37	100	100	57.7	0.2	0.03	0.0
P373	150	100	31.5	14.0	0.79	8.0
P375	100	100	13.9	0.0	0.00	0.0
P377	100	100	39.5	0.4	0.05	0.1
P379	100	100	95.0	0.4	0.05	0.1
P381	100	100	10.4	0.4	0.05	0.1
P383	100	100	7.4	0.0	0.00	0.0
P385	100	100	7.8	0.0	0.00	0.0
P387	100	100	11.6	0.7	0.09	0.2
P389	100	100	10.0	0.7	0.09	0.2
P39	100	100	3.9	1.4	0.18	0.9
P393	100	100	25.4	0.0	0.00	0.0
P395	200	110	112.3	5.8	0.18	0.3
P397	100	100	71.9	1.0	0.12	0.3
P399	100	100	22.1	0.3	0.04	0.0
P401	300	120	295.3	57.2	0.81	2.6
P405	100	100	17.3	1.3	0.16	0.6
P407	100	100	51.5	1.3	0.16	0.6
P409	100	100	257.3	2.9	0.37	3.2
P41	100	100	63.6	1.7	0.21	1.1
P411	100	100	15.4	2.6	0.32	2.4
P413	100	100	33.4	1.7	0.21	1.1
P415	100	100	117.6	2.9	0.37	3.2
P43	100	100	1.2	0.0	0.00	0.0
P47	100	100	27.2	1.7	0.22	1.2
P49	200	110	124.8	5.3	0.17	0.3
P51	150	100	25.8	0.6	0.03	0.0
P53	150	110	43.9	0.6	0.03	0.0
P55	150	110	8.5	0.6	0.03	0.0
P57	100	100	61.5	1.9	0.24	1.4
P59	100	100	56.2	1.0	0.13	0.5
P65	100	100	57.6	2.6	0.34	2.6
P67	100	100	34.2	2.2	0.28	1.8
P69	100	100	27.3	1.4	0.18	0.9
P71	100	100	35.5	0.0	0.00	0.0
P73	100	100	27.5	0.4	0.05	0.1
P75	100	100	93.8	0.8	0.11	0.3

P77	100	100	39.4	1.4	0.18	0.9
P79	100	100	39.1	1.9	0.24	1.5
P81	150	110	14.3	3.3	0.19	0.5
P83	150	110	24.5	1.4	0.08	0.1
P85	150	110	34.4	1.4	0.08	0.1
P87	150	110	14.1	1.4	0.08	0.1
P97	200	110	19.1	0.0	0.00	0.0

Note 1: "SF" is "standard flow", "PH" is "peak hour" and "HW" is "Hazen-Williams"

Note 2: A small number of pipes presented minimum head loss (m/km) failures while remaining well below the 3 m/s maximum flow velocity standard. Further investigation revealed that upsizing these pipes didn't significantly improve system pressures as the pipe lengths were too low to have a meaningful impact on head loss. As a result, the head loss (m/km) "failures" were disregarded.

Pipes - Recycled Water

Pipe ID	Pipe DN (mm)	HW Co-efficient	Length (m)	SF PH Flow Rate (L/s)	SF PH Velocity (m/s)	SF PH Head loss (m/km)
P101	200	110	144.5	19.3	0.6	3.0
P103	100	100	71.4	2.4	0.3	2.2
P109	100	100	64.8	2.7	0.3	2.6
P111	100	100	141.2	2.7	0.3	2.6
P115	200	110	79.4	21.2	0.7	3.6
P117	200	110	320.5	18.4	0.6	2.7
P119	200	110	95.3	17.2	0.5	2.4
P121	100	100	146.5	2.2	0.3	1.8
P123	100	100	72.3	4.3	0.6	6.6
P125	200	110	75.9	24.5	0.8	4.7
P127	100	110	100.0	2.0	0.3	1.4
P131	100	100	191.6	2.8	0.4	2.9
P135	250	110	167.2	39.1	0.8	3.7
P137	100	100	168.7	1.1	0.1	0.5
P139	100	100	182.9	0.6	0.1	0.2
P141	100	100	28.7	2.0	0.3	1.6
P143	100	100	109.0	1.3	0.2	0.7
P145	100	100	118.4	0.9	0.1	0.3
P147	200	110	194.4	0	0.0	0.0
P149	200	110	211.0	10.6	0.3	1.0
P15	100	100	39.6	3.4	0.4	4.1
P151	200	110	160.1	10.6	0.3	1.0
P153	100	100	60.2	1.5	0.2	1.0
P159	100	100	74.2	3.5	0.4	4.5
P163	100	100	82.8	2.8	0.4	2.8
P165	100	100	107.9	0.9	0.1	0.3
P167	250	110	151.3	50.3	1.0	6.0
P169	100	100	422.9	3.1	0.4	3.6
P17	100	100	4.4	0.9	0.1	0.4
P171	100	100	259.6	3.0	0.4	3.2
P173	100	100	173.1	1.7	0.2	1.1
P175	100	100	42.6	3.3	0.4	3.9
P177	100	100	39.6	4.6	0.6	7.2
P179	100	100	59.2	4.6	0.6	7.2
P183	100	100	182.6	0.2	0.0	0.0
P185	100	100	239.7	2.1	0.3	1.7
P187	200	110	33.8	11.0	0.4	1.1
P189	200	110	28.7	12.3	0.4	1.3
P19	100	100	28.2	2.5	0.3	2.2
P191	200	110	85.0	10.8	0.3	1.0
P199	100	100	180.0	1.6	0.2	0.7
P201	100	100	160.8	1.8	0.2	1.0
P203	100	100	66.6	3.8	0.5	5.1
P207	100	100	98.1	0.5	0.1	0.1
P209	100	100	108.6	0.1	0.0	0.0
P21	100	100	39.8	0.5	0.1	0.1
P219	100	100	186.3	0.8	0.1	0.3
P221	100	100	77.0	1.2	0.1	0.5

P223	100	100	48.2	0.1	0.0	0.0
P227	100	100	28.1	2.5	0.3	2.4
P23	100	100	61.9	0.8	0.1	0.2
P235	250	110	138.4	47.3	1.0	5.3
P237	100	100	35.6	0.7	0.1	0.2
P239	100	100	35.7	0.7	0.1	0.2
P247	100	100	39.8	2.6	0.3	2.5
P249	100	100	48.8	2.9	0.4	3.1
P25	100	100	57.0	0.9	0.1	0.3
P251	100	100	67.2	0.1	0.0	0.0
P257	100	100	39.1	1.9	0.2	1.5
P259	100	100	86.6	1.6	0.2	1.1
P263	100	100	33.8	4.4	0.6	6.7
P265	100	100	84.0	3.5	0.4	4.4
P267	150	100	44.5	8.2	0.5	3.0
P269	100	100	40.5	2.5	0.3	2.3
P27	100	100	51.7	1.0	0.1	0.4
P273	200	110	122.4	12.6	0.4	1.4
P275	100	100	38.1	2.2	0.3	1.8
P281	100	100	53.2	1.8	0.2	1.3
P283	100	100	55.5	1.1	0.1	0.5
P285	100	100	49.1	1.4	0.2	0.8
P287	100	100	37.6	2.0	0.3	1.6
P29	100	100	49.3	1.1	0.1	0.5
P293	250	110	69.3	47.3	1.0	5.3
P299	100	100	48.2	1.5	0.2	1.0
P307	200	100	108.2	12.3	0.4	1.6
P309	100	100	82.2	1.4	0.2	0.7
P31	100	100	35.2	1.2	0.2	0.6
P311	100	100	44.8	1.6	0.2	0.9
P319	100	100	79.8	0.9	0.1	0.4
P321	100	100	98.2	0.9	0.1	0.4
P325	100	100	83.4	1.4	0.2	0.8
P327	100	100	74.2	0.8	0.1	0.3
P343	200	100	140.4	11.5	0.4	1.4
P345	200	100	75.8	11.1	0.4	1.3
P35	100	100	16.2	1.9	0.2	1.5
P351	100	100	41.2	0.3	0.0	0.1
P361	100	100	122.3	2.5	0.3	2.4
P365	100	100	16.0	2.0	0.3	1.6
P367	100	100	79.8	2.2	0.3	1.9
P369	100	100	54.4	2.5	0.3	2.4
P37	100	100	57.7	2.1	0.3	1.7
P373	100	100	31.5	2.3	0.3	1.9
P375	200	100	13.9	11.3	0.4	1.3
P377	100	100	39.5	1.8	0.2	1.2
P379	100	100	95.0	2.0	0.3	1.5
P381	100	100	10.4	1.8	0.2	1.2
P383	100	100	7.4	2.5	0.3	2.4
P385	100	100	7.8	1.2	0.2	0.6
P387	100	100	11.6	1.2	0.2	0.6
P389	100	100	10.0	0.4	0.1	0.1
P39	100	100	3.9	2.0	0.3	1.5
P393	100	100	25.4	1.8	0.2	0.9
P395	200	110	112.3	10.2	0.3	0.9
P397	100	100	71.9	1.7	0.2	1.1
P399	100	100	22.1	1.3	0.2	0.7
P405	100	100	17.3	3.0	0.4	3.3
P407	100	100	51.5	3.0	0.4	3.3
P409	100	100	117.9	2.5	0.3	2.4
P41	100	100	63.6	0.1	0.0	0.2
P411	100	100	15.4	1.2	0.1	0.6
P413	100	100	33.4	2.1	0.3	1.8
P415	100	100	117.6	1.8	0.2	1.3
P429	100	100	7.2	0.6	0.1	0.1
P43	100	100	1.2	1.8	0.2	0.9
P431	100	100	74.1	4.4	0.6	6.6

P433	100	100	98.3	0.6	0.1	0.1
P435	100	100	80.3	2.3	0.3	1.7
P437	100	100	32.1	1.2	0.2	0.5
P47	100	100	27.2	3.4	0.4	4.1
P49	200	110	124.8	15.9	0.5	2.1
P51	100	100	25.8	1.3	0.2	0.7
P53	100	100	43.9	1.3	0.2	0.7
P55	100	100	8.5	1.3	0.2	0.7
P57	100	100	61.5	0.9	0.1	0.4
P59	100	100	56.2	0.9	0.1	0.4
P65	100	100	57.6	1.2	0.1	0.6
P67	100	100	34.2	1.0	0.1	0.4
P69	100	100	27.3	2.2	0.3	1.8
P71	100	100	35.5	1.2	0.2	0.6
P73	100	100	27.5	1.2	0.2	0.6
P75	100	100	93.8	1.8	0.2	0.9
P77	100	100	39.4	3.0	0.4	3.1
P79	100	100	39.1	3.0	0.4	3.1
P81	100	100	14.3	1.8	0.2	1.3
P83	100	100	24.5	1.2	0.2	0.5
P85	100	100	34.4	1.2	0.2	0.5
P97	200	110	19.1	21.5	0.7	3.7

Note: A small number of pipes presented minimum head loss (m/km) failures while remaining well below the 3 m/s maximum flow velocity standard. Further investigation revealed that upsizing these pipes didn't significantly improve system pressures as the pipe lengths were too low to have a meaningful impact on head loss. As a result, the head loss (m/km) "failures" were disregarded

Nodes - Potable Water

Node ID	Demand (ET)	RL AHD (m)	SF PH Demand (L/s)	SF PH Pressure (m)	Fire Flow (L/s)	FF PH Pressure (m)
J100	20.0	5.0	2.40	40.9	11	38.8
J102	45.3	4.0	5.44	41.6	11	39.1
J104	20.0	12.0	2.40	33.7	11	31.3
J106	20.0	7.0	2.40	39.1	11	37.3
J108	20.0	9.0	2.40	36.6	11	34.2
J110	0.0	46.0	0.00	24.5	11	22.5
J112	14.3	48.0	1.72	22.3	11	19.6
J114	14.3	38.0	1.72	32.2	11	29.2
J116	0.0	33.0	0.00	37.2	11	34.1
J118	14.3	46.0	1.72	24.2	11	19.7
J12	0.0	10.0	0.00	35.5	11	32.6
J122	0.0	40.0	0.00	31.5	11	31.0
J124	0.0	48.0	0.00	23.1	11	22.0
J126	6.8	48.0	0.82	22.7	11	21.3
J130	0.0	13.0	0.00	33.5	11	31.0
J132	11.0	16.0	1.32	31.3	11	28.7
J134	14.3	25.0	1.72	45.1	11	39.2
J136	10.3	7.0	1.24	40.6	11	39.7
J138	11.0	7.0	1.32	40.9	11	40.0
J14	0.0	6.0	0.00	39.5	11	36.3
J140	10.3	5.0	1.24	43.9	11	43.5
J142	6.3	9.0	0.76	39.9	11	39.3
J146	6.8	29.0	0.82	41.0	11	34.0
J148	6.8	26.0	0.82	45.0	11	45.0
J150	7.8	20.0	0.94	50.4	11	47.4
J152	6.3	11.0	0.76	36.0	11	32.4
J154	0.0	8.0	0.00	38.6	11	35.2
J156	0.0	5.0	0.00	41.4	11	39.5
J158	0.0	5.0	0.00	41.4	11	39.4
J16	8.0	10.0	0.96	35.3	11	30.1
J160	12.6	8.0	1.51	38.4	11	35.3
J162	12.8	14.0	1.54	32.4	11	29.4
J164	12.8	18.0	1.54	28.4	11	25.5

J166	12.8	8.0	1.54	38.4	11	35.0
J168	6.8	16.0	0.82	54.0	11	46.4
J170	6.8	21.0	0.82	49.1	11	42.2
J172	0.0	21.0	0.00	49.1	11	44.3
J178	14.3	26.0	1.72	44.1	11	38.9
J18	5.0	10.0	0.60	35.3	11	29.1
J180	0.0	25.0	0.00	45.1	11	39.5
J184	10.3	2.0	1.24	44.4	11	42.0
J186	0.0	2.0	0.00	44.3	11	41.7
J188	10.3	3.0	1.24	43.3	11	40.6
J192	10.3	5.0	1.24	41.4	11	39.2
J196	10.3	3.0	1.24	45.1	11	43.2
J198	11.3	2.0	1.36	45.3	11	42.5
J20	0.0	8.0	0.00	37.5	11	33.9
J200	10.3	3.0	1.24	43.4	11	40.7
J204	10.3	2.0	1.24	44.4	11	41.1
J208	10.3	2.0	1.24	44.3	11	41.1
J210	10.3	2.0	1.24	44.3	11	41.5
J212	10.3	2.0	1.24	44.3	11	41.1
J214	10.3	2.0	1.24	44.3	11	42.0
J216	1.0	2.0	0.12	44.4	11	42.7
J218	21.3	6.0	2.56	40.6	11	39.2
J22	0.0	10.0	0.00	35.4	11	31.3
J220	10.3	2.0	1.24	44.4	11	41.3
J222	0.0	2.0	0.00	44.6	11	41.9
J228	0.0	46.0	0.00	24.6	11	23.0
J232	6.8	20.0	0.82	50.1	11	41.9
J234	6.8	32.0	0.82	38.2	11	35.0
J236	6.8	32.0	0.82	38.0	11	31.6
J238	0.0	24.0	0.00	46.1	11	39.8
J24	4.0	10.0	0.48	35.4	11	31.1
J242	0.0	32.0	0.00	38.2	11	34.0
J244	14.3	38.0	1.72	32.2	11	27.6
J248	0.0	38.0	0.00	32.2	11	28.6
J256	6.3	18.0	0.76	30.8	11	29.3
J258	0.0	18.0	0.00	27.3	11	20.8
J26	0.0	6.0	0.00	39.6	11	36.9
J260	2.0	18.0	0.24	27.3	11	21.0
J264	0.0	18.0	0.00	27.4	11	21.8
J270	0.0	16.0	0.00	33.2	11	32.9
J272	0.0	17.0	0.00	53.1	11	44.8
J274	0.0	20.0	0.00	50.0	11	42.7
J276	6.8	18.0	0.82	52.0	11	44.6
J278	0.0	20.0	0.00	50.1	11	38.2
J28	0.0	8.0	0.00	37.6	11	34.8
J280	0.0	9.0	0.00	36.6	11	33.8
J282	0.0	8.0	0.00	37.6	11	34.6
J284	0.1	12.0	0.12	33.6	11	30.6
J32	4.0	14.0	0.48	31.5	11	27.4
J36	0.0	15.0	0.00	30.4	11	26.0
J38	6.0	16.0	0.72	29.3	11	23.5
J40	7.0	22.0	0.84	48.1	11	37.2
J42	7.0	16.0	0.84	29.3	11	22.6
J44	0.0	11.0	0.00	34.3	11	27.5
J46	3.0	10.0	0.36	35.3	11	28.6
J48	3.0	20.0	0.36	50.1	11	42.1
J50	4.0	28.0	0.48	42.1	11	37.0
J52	0.0	32.0	0.00	38.2	11	35.0
J54	0.0	28.0	0.00	42.2	11	38.8
J60	7.0	8.0	0.84	37.5	11	33.9
J62	0.0	8.0	0.00	37.5	11	34.0
J64	0.0	20.0	0.00	25.3	11	18.9
J66	0.0	15.0	0.00	30.4	11	26.0
J68	6.0	15.0	0.72	30.4	11	26.1
J70	2.0	24.0	0.24	46.1	11	39.1
J72	0.0	30.0	0.00	40.2	11	36.9
J74	0.0	12.0	0.00	33.6	11	30.6

J76	0.0	8.0	0.00	37.6	11	34.8
J78	0.0	6.0	0.00	39.6	11	37.0
J80	25.0	6.0	3.00	39.5	11	36.8
J84	0.0	24.0	0.00	46.2	11	42.7
J86	0.0	23.0	0.00	47.2	11	43.7
J90	0.0	10.0	0.00	35.5	11	32.6
J92	7.0	6.0	0.84	39.5	11	35.5
J94	7.0	6.0	0.84	39.5	11	35.6
J96	0.0	7.0	0.00	39.5	11	37.9
J98	0.0	5.0	0.00	41.4	11	39.6

Nodes - Recycled Water

Node ID	Demand (ET)	RL AHD (m)	SF PH Demand (L/s)	SF PH Pressure (m)	Fire Flow (L/s)	FF PH Pressure (m)
J100	20.0	5.0	0.60	65.7	N/A	N/A
J102	108.0	4.0	3.24	65.8	N/A	N/A
J104	20.0	12.0	0.60	58.4	N/A	N/A
J106	20.0	7.0	0.60	64.0	N/A	N/A
J108	20.0	9.0	0.60	60.9	N/A	N/A
J110	0.0	46.0	0.00	24.3	N/A	N/A
J112	14.3	48.0	0.43	22.2	N/A	N/A
J114	14.3	38.0	0.43	32.2	N/A	N/A
J116	0.0	33.0	0.00	37.1	N/A	N/A
J118	14.3	46.0	0.43	24.2	N/A	N/A
J12	716.7	10.0	21.50	58.8	N/A	N/A
J122	353.3	40.0	10.60	30.0	N/A	N/A
J124	0.0	48.0	0.00	22.2	N/A	N/A
J126	6.7	48.0	0.20	22.4	N/A	N/A
J130	0.0	13.0	0.00	58.0	N/A	N/A
J132	11.0	16.0	0.33	55.0	N/A	N/A
J134	14.3	25.0	0.43	45.5	N/A	N/A
J136	10.3	7.0	0.31	64.1	N/A	N/A
J138	11.0	7.0	0.33	64.0	N/A	N/A
J14	0.0	6.0	0.00	63.4	N/A	N/A
J140	10.3	5.0	0.31	66.0	N/A	N/A
J142	6.3	9.0	0.19	61.9	N/A	N/A
J146	6.7	29.0	0.20	41.6	N/A	N/A
J148	6.7	26.0	0.20	45.1	N/A	N/A
J150	7.7	20.0	0.23	51.1	N/A	N/A
J152	6.3	11.0	0.19	60.3	N/A	N/A
J154	0.0	8.0	0.00	63.7	N/A	N/A
J156	0.0	5.0	0.00	68.1	N/A	N/A
J158	0.0	5.0	0.00	69.0	N/A	N/A
J16	8.0	10.0	0.24	59.6	N/A	N/A
J160	12.7	8.0	0.38	64.0	N/A	N/A
J162	12.7	14.0	0.38	58.2	N/A	N/A
J164	12.7	18.0	0.38	54.4	N/A	N/A
J166	12.7	8.0	0.38	64.2	N/A	N/A
J168	6.7	16.0	0.20	54.8	N/A	N/A
J170	6.7	21.0	0.20	50.0	N/A	N/A
J172	1.0	21.0	0.03	49.5	N/A	N/A
J178	14.3	26.0	0.43	44.5	N/A	N/A
J18	5.0	10.0	0.15	59.6	N/A	N/A
J180	0.0	25.0	0.00	45.5	N/A	N/A
J184	10.3	2.0	0.31	69.3	N/A	N/A
J186	0.0	2.0	0.00	69.3	N/A	N/A
J188	10.3	3.0	0.31	68.2	N/A	N/A
J192	10.3	5.0	0.31	66.3	N/A	N/A
J196	10.3	3.0	0.31	68.0	N/A	N/A
J198	11.3	2.0	0.34	69.0	N/A	N/A
J20	0.0	8.0	0.00	61.6	N/A	N/A
J200	10.3	3.0	0.31	68.2	N/A	N/A
J204	10.3	2.0	0.31	69.2	N/A	N/A
J208	10.3	2.0	0.31	69.3	N/A	N/A
J210	10.3	2.0	0.31	69.3	N/A	N/A

J212	10.3	2.0	0.31	69.3	N/A	N/A
J214	10.3	2.0	0.31	69.5	N/A	N/A
J216	1.0	2.0	0.03	70.0	N/A	N/A
J218	21.3	6.0	0.64	65.3	N/A	N/A
J22	0.0	10.0	0.00	59.6	N/A	N/A
J220	10.3	2.0	0.31	69.2	N/A	N/A
J222	0.0	2.0	0.00	69.1	N/A	N/A
J228	0.0	46.0	0.00	24.3	N/A	N/A
J232	6.7	20.0	0.20	50.6	N/A	N/A
J234	6.7	32.0	0.20	38.5	N/A	N/A
J236	6.7	32.0	0.20	38.6	N/A	N/A
J238	0.0	24.0	0.00	46.5	N/A	N/A
J24	4.0	10.0	0.12	59.6	N/A	N/A
J242	0.0	32.0	0.00	38.2	N/A	N/A
J244	14.3	38.0	0.43	32.2	N/A	N/A
J248	0.0	38.0	0.00	32.3	N/A	N/A
J256	6.3	18.0	0.19	52.7	N/A	N/A
J258	0.0	18.0	0.00	51.7	N/A	N/A
J26	0.0	6.0	0.00	63.6	N/A	N/A
J260	2.0	18.0	0.06	51.7	N/A	N/A
J264	0.0	18.0	0.00	51.8	N/A	N/A
J270	0.0	16.0	0.00	54.7	N/A	N/A
J272	0.0	17.0	0.00	53.6	N/A	N/A
J274	0.0	20.0	0.00	50.7	N/A	N/A
J276	6.7	18.0	0.20	52.7	N/A	N/A
J278	0.0	20.0	0.00	49.7	N/A	N/A
J28	0.0	8.0	0.00	61.6	N/A	N/A
J280	0.0	9.0	0.00	60.8	N/A	N/A
J282	0.0	8.0	0.00	61.7	N/A	N/A
J284	0.0	12.0	0.00	57.9	N/A	N/A
J286	4.0	22.0	0.12	48.1	N/A	N/A
J288	0.0	20.0	0.00	50.5	N/A	N/A
J32	6.0	14.0	0.18	55.8	N/A	N/A
J36	7.0	15.0	0.21	54.7	N/A	N/A
J38	7.0	16.0	0.21	53.7	N/A	N/A
J40	0.0	22.0	0.00	47.8	N/A	N/A
J42	3.0	16.0	0.09	53.7	N/A	N/A
J44	3.0	11.0	0.09	58.7	N/A	N/A
J46	4.0	10.0	0.12	59.7	N/A	N/A
J48	0.0	20.0	0.00	49.8	N/A	N/A
J50	0.0	28.0	0.00	42.0	N/A	N/A
J52	7.0	32.0	0.21	38.1	N/A	N/A
J54	0.0	28.0	0.00	42.1	N/A	N/A
J60	0.0	8.0	0.00	61.6	N/A	N/A
J62	0.0	8.0	0.00	61.6	N/A	N/A
J64	6.0	20.0	0.18	49.7	N/A	N/A
J66	2.0	15.0	0.06	54.7	N/A	N/A
J68	0.0	15.0	0.00	54.8	N/A	N/A
J70	0.0	24.0	0.00	45.8	N/A	N/A
J72	0.0	30.0	0.00	40.1	N/A	N/A
J74	0.0	12.0	0.00	57.8	N/A	N/A
J76	25.0	8.0	0.75	61.6	N/A	N/A
J78	0.0	6.0	0.00	63.6	N/A	N/A
J80	25.0	6.0	0.00	63.3	N/A	N/A
J84	0.0	24.0	0.00	46.1	N/A	N/A
J90	7.0	10.0	0.21	58.9	N/A	N/A
J92	7.0	6.0	0.21	63.0	N/A	N/A
J94	0.0	6.0	0.00	63.4	N/A	N/A
J96	0.0	7.0	0.00	64.3	N/A	N/A
J98	0.0	5.0	0.00	67.7	N/A	N/A