

CIVIL ENGINEERING REPORT: DEVELOPMENT APPLICATION

PROPOSED DEVELOPMENT: 107 HAUSSMAN DRIVE THORNTON NSW

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1 INTRODUCTION

1.1 Introduction

Avid Project Management Pty Ltd (APM), on behalf of McCloy Thornton, proposes to subdivide and perform infrastructure works to enable development of a parcel of land, Lot 2 DP1145348, as a retirement village in Thornton, NSW.

This report, which accompanies APM submission for a Development Application, provides a summary of the design principles and planning objectives for stormwater management for the development. The stormwater management has been prepared to demonstrate that the requirements of Maitland City Council have been met for the development to suit the layout proposed by McCloy Group. The plan demonstrates that the water quality and water quantity criteria will be satisfied for the site.

1.2 Scope

Costin Roe Consulting Pty Ltd has been commissioned by Avid Project Management Pty Ltd (APM) on behalf of McCloy Group to prepare this Engineering Report in support of the proposed Development Application for a proposed retirement village.

This report provides a summary of the design principles and planning objectives for the following civil engineering components of the project:

- Stormwater Management including stormwater quantity and quality;
- Erosion & Sediment Control.

The engineering objectives for the development are to create a site which, based on the proposed architectural layout, responds to the topography and site constraints, to provide an appropriate and economical stormwater management system which incorporates best practice in water sensitive urban design consistent with the requirements of council's water quality objectives.

A set of drawings have been prepared to show the proposed finished levels, retaining walls, stormwater drainage and water quality requirements for the development. These drawings are conceptual only and are subject to change during detail design.

1.3 Authority Jurisdiction

The consent authority is Maitland City Council. The requirements of the Maitland City Council *Manual of Engineering Standards (MOES)* apply.

2 DEVELOPMENT SITE

2.1 Existing Site

The site is currently undeveloped and is located in the suburb of Thornton on Lot 2, DP1145348 as shown in **Figure 1.2** and comprises a total area of 18.97 Ha. The land is the site of a former quarry used for clay bricks and as such has extensive excavation, clearing and earthworks activities over the land.

The site is bounded by Raymond Terrace Road to the north, undeveloped land to the east, residential development to the south, Hausman Drive and an existing electricity sub-station to the west.



Figure 2.1. Locality Map (Source: Nearmap 2017)

2.2 Proposed Development

The proposed development is for a retirement village consisting of numerous residential dwellings and recreational facilities. A series of circulation roads are proposed on the site with access into the development being made from Hausman Drive on the south-west of the site. The site levels and stormwater management system has been designed to be sympathetic to the existing landform whilst integrating the new development footprint into the former quarry activities and regrading the land to suit a more formalised development footprint.

The overall property comprises a total area of 18.97Ha and development is proposed over 13.3Ha of the property. Provision for bio-retention systems in landscaped areas

within the retirement village have been made. An on-site detention basin is proposed to be located to the east of the development.

An indicative layout of the development has been produced by Jackson Teece and can be seen in **Figure 2.2** below.



Figure 2.2. Site Configuration (Source: Jackson Teece Architects)

3 WATER QUANTITY MANAGEMENT

3.1 General Design Principles

Maitland City Council (in common with many other local authorities) adopts the principles of Water Quantity Management, also known as “On-site Detention (OSD)”, to ensure the cumulative effect of development does not have a detrimental effect on the existing stormwater infrastructure and watercourses located within their LGA downstream from the particular site.

Section 8 of *MCC Manual of Engineering Standards - Stormwater* requires that “*The purpose for the control of flow-rate and quality of stormwater runoff from new development is to minimise potential adverse effects generated from development on the downstream environment, and to maintain as close as practically possible the pre-developed flow regime, with the employment of storage structures for retention such as earth basins, usually incorporating pollution control facilities (wetlands, GPT’s etc).*”

A hydrological analysis was undertaken to estimate the impact of the development of the site on the downstream receiving waters to assess the effect of an increase in stormwater flow as a result of the development

3.2 Methodology

Modelling of stormwater runoff quantity was considered only for the existing case and for the operational phase of the development. As such, the detention basin has been sized for a total catchment of 13.30 Ha per the Jackson Teece Masterplan.

3.3 Existing & Post Development Peak Flows

Intensity/Frequency/Duration (IFD) data was adopted from councils Subdivision and Development Guidelines used in conjunction with rational method calculations to estimate peak flows for the site and surrounding catchments.

The attenuation volume for the interim detention has been assessed based on attenuating the post development flow to pre-development flow for storms ranging from 1 in 1 year ARI to 1 in 100 year ARI. The pre-development site discharge volumes for the site are provided in **Table 2.1** below.

ARI	Design Storm Duration	Peak Flow (m3/s)		
		Undeveloped	Developed	
		Site	Site	Site
			(No Attenuation)	(With Attenuation)
1	30 mins	0.171	1.98	0.169
	1hr	0.357	2.14	0.199
	2hr	0.427	2.13	0.212
	3hr	0.357	1.17	0.208
	6hr	0.392	0.717	0.213
	12hr	0.389	0.62	0.204
	24hr	0.252	0.383	0.199
10	20 mins	0.746	4.56	0.291
	30 mins	1.06	4.53	0.463
	1hr	1.43	4.28	0.638
	2hr	1.52	4.36	0.673
	3hr	1.17	2.33	0.652
	6hr	1.18	1.48	0.684
	12hr	1.07	1.3	0.673
	24hr	0.707	0.825	0.61
100	20 mins	1.83	6.93	0.699
	30 mins	2.25	6.3	0.982
	1hr	2.7	6.12	1.42
	2hr	2.87	6.22	1.49
	3hr	2.23	3.38	1.36
	6hr	1.91	2.18	1.38
	12hr	1.7	1.93	1.53
	24hr	1.12	1.23	1.06

Table 2.2. Pre-Development Flows

Post- development site discharge volumes, as well as the provided detention volumes and depths for Basin 1 are provided in **Table 2.3** below.

ARI	Duration (mins)	Peak Flow (m³/s)						Depth (mm)	Storage (m³)
		No Attenuation	With Attenuation						
			Q1 Orifice	Q10 Orifice (2x375)	High Weir	Emergency	Total		
1	6hr	0.717	0.213	0	0	0	0.213	690	2100
10	6hr	1.48	0.276	0.408	0	0	0.684	1170	4010
100	12hr	1.93	0.297	0.524	0.711	0	1.53	1470	5420

Table 2.2. Basin Detention System Flow and Volume Requirements

As shown in **Table 2.2** above, an active detention storage of 5,500m³ is required to attenuate the post development flows to pre-development flows for the 13.30Ha catchment 1 flows,

The detention system will comprise of an above ground, earth-formed basin with maximum depths of 1500mm. The final details for the system will be provided as part of the Construction Certificate Design stage of the project.

4 STORMWATER QUALITY CONTROLS

4.1 Regional Parameters

There is a need to provide a design which incorporates the principles of Water Sensitive Urban Design (WSUD) and to target pollutants that are present in the stormwater so as to minimise the adverse impact these pollutants could have on receiving waters and to also meet the requirements specified by MCC.

MCC has nominated, in Section 6 of their *Manual of Engineering Standards 2014*, the requirements for stormwater quality to be performed on a catchment wide basis. These are presented in terms of annual percentage pollutant reductions on a developed catchment and are as follows:

Gross Pollutants	70%
Total Suspended Solids	80%
Total Phosphorus	45%
Total Nitrogen	45%
Free Oil and Grease	90%

4.2 Proposed Stormwater Treatment System

All developed areas are required to be treated by Stormwater Treatment Measures (STM). The STM shall be sized according to the whole catchment area of the Site. The STM's for the development are based on a treatment train approach as discussed in the NSW EPA document *Managing Urban Stormwater: Treatment Techniques* to ensure that all of the objectives above are met.

Components of the treatment train for the development are as follows:

- Tertiary treatment of site water will be via 600m² of bio-retention system situated in landscaped areas on site.
- Supplementary treatment of site water will be via a 2500m³ permanent pond

The water quality solution, as modelled with MUSIC, is based on achieving the required pollution reduction targets for the overall catchment.

4.3 Stormwater Quality Modelling

4.3.1 Introduction

The MUSIC model was chosen to model water quality. This model, released by the Cooperative Research Centre for Catchment Hydrology (CRCCH), is a standard industry model for this purpose. MUSIC (the Model for Urban Stormwater Improvement Conceptualisation) is suitable for simulating catchment areas of up to 100 km² and utilises a continuous simulation approach to model water quality.

By simulating the performance of stormwater management systems, MUSIC can be used to predict if the proposed systems and changes to land use are appropriate for their catchments and capable of meeting specified water quality objectives (CRC 2002). The water quality constituents modelled in MUSIC, of relevance to this report, include Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN).

The pollutant retention criteria set out in Section 8 of MCC's Stormwater Drainage Manual and nominated in Section 4.1 of this report were used as a basis for assessing the effectiveness of the selected treatment trains.

The MUSIC model "*13452.00 Thornton Rev2.sqz*" was set up to examine the effectiveness of the water quality treatment train and to predict if MCC requirements have been achieved. The layout of the MUSIC model is presented in **Appendix C**.

As discussed, the water quality solution, as modelled with MUSIC, is based on achieving the required pollution reduction targets for the overall.

4.3.2 Rainfall Data

Six minute pluviographic data for the nearby weather station was sourced from the Bureau of Meteorology (BOM) as nominated below. Evapo-transpiration data for the period was sourced from the Maitland Monthly Areal PET data set supplied with the MUSIC software.

Input	Data Used
Rainfall Station	61078 (Williamstown)
Rainfall Period	1995 to 2008
Mean Annual Rainfall (mm)	1125
Evapotranspiration	1735
Model Timestep	6 minutes

4.3.3 Rainfall Runoff Parameters

Parameter	Value
Rainfall Threshold	1.00
Soil Storage Capacity (mm)	170
Initial Storage (% capacity)	30
Field Capacity (mm)	70
Infiltration Capacity Coefficient a	210
Infiltration Capacity exponent b	4.7
Initial Depth (mm)	10
Daily Recharge Rate (%)	50
Daily Baseflow Rate (%)	5
Daily Seepage Rate (%)	0

4.3.4 Pollutant Concentrations & Source Nodes

In the absence of specific MCC requirements, pollutant concentrations for source nodes are based on parameters adopted by the Sydney Catchment Management Authority. The modelled land use parameters are as per those shown in **Table 4.1.:**

	Roof Areas	Sealed Road/	Landscape/
Impervious Area Properties			
Rainfall Threshold (mm)	0.3	1.5	1.5
Pervious Area Properties			
Soil Storage Capacity (mm)	94	94	94
Initial Storage (% of capacity)	30	30	30
Field Capacity (mm)	70	70	70
Infiltration Capacity Coefficient a	135	135	135
Infiltration Capacity Coefficient b	4	4	4
Groundwater Properties			
Initial Depth (mm)	10	10	10
Daily Recharge Rate (%)	10	10	10
Daily Baseflow Rate (%)	10	10	10
Daily Seepage Rate (%)	0	0	0
Total suspended Solids			
Baseflow Concentrations			
Mean (log mg/L)	1.2	1.2	1.15
Std Dev (log mg/L)	0.17	0.17	0.17
Serial Correlation (R Squared)	0	0	0
Stormflow Concentrations			
Mean (log mg/L)	1.3	2.43	1.95
Std Dev (log mg/L)	0.32	0.32	0.32
Serial Correlation (R Squared)	0	0	0
Total Phosphorous			

Baseflow Concentrations			
Mean (log mg/L)	-0.85	-0.85	-1.22
Std Dev (log mg/L)	0.19	0.19	0.19
Serial Correlation (R Squared)	0	0	0
Stormflow Concentrations			
Mean (log mg/L)	-0.89	-0.3	-0.66
Std Dev (log mg/L)	0.25	0.25	0.25
Serial Correlation (R Squared)	0	0	0
Total Nitrogen			
Baseflow Concentrations			
Mean (log mg/L)	0.11	0.11	-0.05
Std Dev (log mg/L)	0.12	0.12	0.12
Serial Correlation (R Squared)	0	0	0
Stormflow Concentrations			
Mean (log mg/L)	0.3	0.34	0.3
Std Dev (log mg/L)	0.19	0.19	0.19
Serial Correlation (R Squared)	0	0	0

Table 4.1. Pollutant Concentrations

The MUSIC model has been setup with a treatment train approach based on the pollutant concentrations in **Table 4.1** above.

4.3.5 Treatment Nodes

Bio-retention & pond nodes have been used in the modelling of the development.

There is one bio-retention basin proposed which will be provided in accordance with industry best practice and the guidelines of the Monash University Facility for Advancing Water Biofiltration with the following parameters:

Bioretention

Parameter	Value	
<u>Storage Properties</u>		
Extended Detention Depth	300	mm
Storage Surface Area	600	m ² (minimum)
<u>Filter and Media Properties</u>		
Filtration Area	600	m ²
Saturated Hydraulic Conductivity	200	mm/hr
Filter Depth	500	mm

Pond

Parameter	Value
<u>Storage Properties</u>	
Extended Detention Depth	1500 mm
Storage Surface Area	2500 m ² (minimum)
Permanent Pool Volume	2500m ³

4.3.6 Results

Table 4.2 shows the results of the MUSIC analysis. The reduction rate is expressed as a percentage and compares the post-development pollutant loads without treatment versus post-development loads with treatment.

	Source	Residual Load	% Reduction
Total Suspended Solids (kg/yr)	15500	2420	84.4
Total Phosphorus (kg/yr)	26.2	10.6	59.4
Total Nitrogen (kg/yr)	196	108	45.1
Gross Pollutants (kg/yr)	2700	0	100

Table 4.2. MUSIC analysis results

The model results indicate that, through the use of the STM in the treatment train, pollutant load reductions for Total Suspended Solids, Total Phosphorous, Total Nitrogen and Gross Pollutants will meet the requirements of MCC's MOES on an overall catchment basis.

4.3.7 Modelling Discussion

MUSIC modelling has been performed to assess the effectiveness of the selected treatment trains and to ensure that the pollutant retention requirements of MCC's MOES have been met.

The MUSIC modelling has shown that the proposed treatment train of STM will provide stormwater treatment which will meet MCC requirements in an effective and economical manner.

Hydrocarbon and oil & grease removal cannot be modelled with MUSIC software. As a residential zone it is expected to have a minimal level of hydrocarbons. Potential sources of hydrocarbons and/or oil & grease which drain to the stormwater system would be limited to leaking engine sumps or for accidental fuel spills/leaks and leaching of bituminous pavements (car parking only). The potential for these pollutants is low and published data from the CSIRO indicates that average concentrations from residential sites are in the order of 10mg/L and we would expect source loading from this site to be near to or below this concentration. Hydrocarbon pollution would also be limited to surface areas which will be treated via bioretention which is known to be effective in the treatment of hydrocarbons in stormwater.

Given the expected low source loadings of hydrocarbons and oil/grease and removal efficiencies of the treatment devices we consider the MCC requirements have been met.

4.4 Stormwater Harvesting

Stormwater harvesting refers to the collection of stormwater from the developments internal stormwater drainage system for re-use in non-potable applications. Stormwater from the stormwater drainage system can be classified as either rainwater, where the flow is from roof areas only, or stormwater where the flow is from all areas of the development. Rainwater tanks have not been allowed for in the modelling of this site.

4.5 Maintenance and Monitoring

It is important that each component of the water quality treatment train is properly operated and maintained. In order to achieve the design treatment objectives, an indicative maintenance schedule has been prepared (refer to **Table 4.5** below).

Note that inspection frequency may vary depending on site specific attributes and rainfall patterns in the area. In addition to the maintenance requirements below it is also recommended that inspections are made following heavy rainfall or major storm events. Event heavy rain inspections should be carried out as soon as practicable following an intense period of rainfall, (i.e. greater than 100mm over 48 hours), as measured at Raymond Terrace (Kinross) Station No.061031.

Table 4.5. Indicative Maintenance Schedule

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
SWALES/ LANDSCAPED AREAS			
Check density of vegetation and ensure minimum height of 150mm is maintained. Check for any evidence of weed infestation	Six monthly	Maintenance Contractor	Replant and/or fertilise, weed and water in accordance with landscape consultant specifications
Inspect swale for excessive litter and sediment build up	Six monthly	Maintenance Contractor	Remove sediment and litter and dispose in accordance with local authorities' requirements.
Check for any evidence of channelisation and erosion	Six monthly/ After Major Storm	Maintenance Contractor	Reinstate eroded areas so that original, designed swale profile is maintained
Weed Infestation	Three Monthly	Maintenance Contractor	Remove any weed infestation ensuring all root ball of weed is removed. Replace with vegetation where required.
Inspect swale surface for erosion	Six Monthly	Maintenance Contractor	Replace top soil in eroded area and cover and secure with biodegradable fabric. Cut hole in fabric and revegetate.
RAINWATER TANK			
Check for any clogging and blockage of the first flush device	Monthly	Maintenance Contractor	First flush device to be cleaned out
Check for any clogging and blockage of the tank inlet - leaf/litter screen	Six monthly	Maintenance Contractor	Leaves and debris to be removed from the inlet leaf/litter screen
Check the level of sediment within the tank	Every two years	Maintenance Contractor	Sediment and debris to be removed from rainwater tank floor if sediment level is greater than the maximum allowable depth as specified by the hydraulic consultant

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
INLET & JUNCTION PITS			
Inside Pit	Six Monthly	Maintenance Contractor	Remove grate and inspect internal walls and base, repair where required. Remove any collected sediment, debris, litter.
Outside of Pit	Four Monthly/ After Major Storm	Maintenance Contractor	Clean grate of collected sediment, debris, litter and vegetation.
STORMWATER SYSTEM			
General Inspection of complete stormwater drainage system	Bi-annually	Maintenance Contractor	Inspect all drainage structures noting any dilapidation in structures and carry out required repairs.
OSD SYSTEM			
Inspect and remove any blockage from orifice	Six Monthly	Maintenance Contractor/ Owner	Remove grate and screen to inspect orifice.
Inspect trash screen and clean	Six Monthly	Maintenance Contractor/ Owner	Remove grate and screen if required to clean it.
Inspect flap valve and remove any blockage.	Six Monthly	Maintenance Contractor/ Owner	Remove grate. Ensure flap valve moves freely and remove any blockages or debris.
Inspect pit sump for damage or blockage.	Six Monthly	Maintenance Contractor/ Owner	Remove grate & screen. Remove sediment/ sludge build up and check orifice and flap valve is clear.
Inspect storage areas and remove debris/ mulch/ litter etc likely to block screens/ grates.	Six Monthly	Maintenance Contractor/ Owner	Remove debris and floatable materials.
Check attachment of orifice plate and screen to wall of pit	Annually	Maintenance Contractor	Remove grate and screen. Ensure plate or screen mounted securely, tighten fixings if required. Seal gaps if required.
Check orifice diameter is correct and retains	Five yearly	Maintenance Contractor	Compare diameter to design (see Work-as-Executed) and ensure

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
sharp edge.			edge is not pitted or damaged.
Check screen for corrosion	Annually	Maintenance Contractor	Remove grate and screen and examine for rust or corrosion, especially at corners or welds.
Inspect overflow weir and remove any blockage	Six monthly	Maintenance Contractor/ Owner	Ensure weir is free of blockage.
Inspect walls for cracks or spalling	Annually	Maintenance Contractor	Remove grate to inspect internal walls, repair as necessary.
Check step irons	Annually	Maintenance Contractor	Ensure fixings are secure and irons are free from corrosion.

5 EROSION & SEDIMENT CONTROL PLAN

5.1 Background

During the construction phase of the development, an Erosion and Sediment Control Program will be implemented to minimise water quality impacts. The program shall include measure such as temporary sediment basins, silt fences, cut-off drains for polluted stormwater and diversion channels for clean stormwater run-off.

The following sections provide information to identify controls and procedures that will be incorporated into the Erosion and Sediment Control program.

5.2 Pre-Construction

The following minimum requirements are to be met prior to commencement of construction:

- Protection of downstream receiving waters.
- Sediment fences are to be constructed on the upstream edges of the designated buffer strips and at the base of fill embankments.
- Areas for plant and construction material storage are to be designated along with associated drains and spillage holding ponds.
- Diversion banks are to be created at the upstream boundaries of construction activities to ensure upstream runoff is diverted around any exposed areas. Catch drains are to be created at the downstream boundary of construction activities.
- Silt fences and/or sand bags are to be placed along the catch drains to slow flow, reduce scour and capture some sediment from runoff.
- Construction of temporary sediment basins.
- Site personnel are to be educated to the sediment and erosion control measures implemented on site.
-

5.3 During Construction

The following minimum requirements are to be met during construction:

- Progressive stabilisation of disturbed area including paving and re-vegetation of filled areas and filled batters.
- Construction activities are to be confined to the necessary construction areas.
- The provision of a construction exit (truck shaker) to minimise the tracking of debris from tyres of vehicles leaving the site onto public roads. Only one construction exit will be nominated to limit the movement of construction equipment.
- Topsoil and temporary stockpile location will be nominated to coincide with areas already disturbed. A sediment fence is to be constructed around the downstream side of the stockpile and a diversion drain at the upstream side if required.
- Regular inspection and maintenance of silt fences, sediment basins and other erosion control measures are to be made. Following rainfall events greater than

50mm inspection of erosion control measures and removal of collected material should be undertaken. Replacement of any damaged measures should be performed immediately.

5.4 Post Construction

The following minimum requirements are to be met post construction:

- The contractor/ developer will be responsible for the maintenance of erosion and sediment control devices from the possession of the site until the site is accepted “Off Maintenance” or until stabilisation has occurred to the satisfaction of the superintendent, PCA and/or council.
- Key stormwater areas requiring maintenance for operational phase of the project following construction are piped stormwater system, bio-retention areas, field inlet pit inserts and rainwater tanks.

6 CONCLUSION

This Civil Engineering Details Report has been prepared in support of the Development Application associated with the subdivision and development of the land at Lot 2, DP1145348 at Thornton, NSW.

A civil engineering strategy for the site has been developed which provides a best practice solution within the constraints of the existing landform and proposed subdivision layout. Within this design a stormwater quantity management strategy has been developed to reduce peak flows in stormwater leaving this site. The stormwater management strategy for the development has been designed in accordance with *Maitland City Council Manual of Engineering Standards (MOES)*.

During the construction phase, a Sediment and Erosion Control Plan will be in place to ensure the downstream drainage system and receiving waters are protected from sediment laden runoff.

The details contained in this report provides sufficient information to demonstrate to the consent authority that legal discharge points and a stormwater management strategy is available for the development, and that the requirements associated with the strategy can be met. It is recommended the management strategies in this report be approved and incorporated into the future detailed design and individual lot development applications.

7 REFERENCES

- Manual of Engineering Standards (2013), Maitland City Council
- Construction and Establishment Guidelines – Swales, Bioretention Systems and Wetlands Manual (1988)
- Managing Urban Stormwater, Soils and Construction (1998) – The Blue Book, Landcom

8 GLOSSARY

Afflux	The rise in water level upstream of a hydraulic structure such as a bridge or culvert, caused by losses incurred from the hydraulic structure.
	The change in flood surface or depth as a result in a modification or change to the hydraulic flood model scenario.
Australian Height Datum (AHD)	National survey datum corresponding approximately to mean sea level.
Annual Exceedance Probability (AEP)	The chance of a flood of a given size or larger occurring in any one year, generally expressed as percentage probability. For example, a 100-year ARI flood is a 1% AEP flood. An important implication is that when a 1% AEP flood occurs, there is still a 1% probability that it could occur the following year.
Average Recurrence Interval (ARI)	Is statistically the long term average number of years between the occurrence of a flood as big as, or larger than the selected flood event. An ARI is the reciprocal of the AEP.
Catchment	The catchment at a particular point is the area of land which drains to that point.
Depth to velocity value (DV)	A ratio of flow depth and velocity used as a measure of safety for pedestrians and vehicles subject to flood water. Normally a maximum DV of 0.4 is recommended for pedestrian safety and 0.6 for vehicles.
Design floor level	The minimum (lowest) floor level specified for a building.
Design flood	A hypothetical flood representing a specific likelihood of occurrence (for example the 100- year or 1% probability flood). The design flood may comprise two or more single source dominated floods.
Development	Existing or proposed works which may or may not impact upon flooding. Typical works are filling of land, and the construction of roads, floodways and buildings.
Discharge	The rate of flow of water measured in terms of volume over time. It is not the velocity of flow which is a measure of how fast the water is moving rather than how much is moving. Discharge and flow are interchangeable.
Digital Terrain Model (DTM)	A three-dimensional model of the ground surface that can be represented as a series of grids with each cell representing an elevation (DEM) or a series of interconnected triangles with

	elevations (TIN).
Effective warning time	The available time that a community has from receiving a flood warning to when the flood reaches their location.
First Flush	The initial surface runoff of a rainstorm. During this phase, water pollution in areas with high proportions of impervious surfaces is typically more concentrated compared to the remainder of the storm.
Flood	Above average river, creek, channel or other flows which overtop banks and inundate floodplains or urban areas.
Flood awareness	An appreciation of the likely threats and consequences of flooding and an understanding of any flood warning and evacuation procedures. Communities with a high degree of flood awareness respond to flood warnings promptly and efficiently, greatly reducing the potential for damage and loss of life and limb. Communities with a low degree of flood awareness may not fully appreciate the importance of flood warnings and flood preparedness and consequently suffer greater personal and economic losses.
Flood behaviour	The pattern / characteristics / nature of a flood.
Flooding	The State Emergency Service uses the following definitions in flood warnings: <i>Minor flooding:</i> causes inconvenience such as closing of minor roads and the submergence of low level bridges <i>Moderate flooding:</i> low-lying areas inundated requiring removal of stock and/or evacuation of some houses. Main traffic bridges may be covered. <i>Major flooding:</i> extensive rural areas are flooded with properties, villages and towns isolated and/or appreciable urban areas are flooded.
Flood frequency analysis	An analysis of historical flood records to determine estimates of design flood flows.
Flood fringe	Land which may be affected by flooding but is not designated as a floodway or flood storage.
Flood hazard	The potential threat to property or persons due to flooding.
Flood level	The height or elevation of flood waters relative to a datum (typically the Australian Height Datum). Also referred to as “stage”.

Flood liable land	Land inundated up to the probable maximum flood – flood prone land.
Floodplain	Land adjacent to a river or creek which is inundated by floods up to the probable maximum flood that is designated as flood prone land.
Flood Planning Levels (FPL)	Are the combinations of flood levels and freeboards selected for planning purposes to account for uncertainty in the estimate of the flood level.
Flood proofing	Measures taken to improve or modify the design, construction and alteration of buildings to minimise or eliminate flood damages and threats to life and limb.
Floodplain Management	The coordinated management of activities which occur on flood liable land.
Floodplain Management Manual	A document by the NSW Government (2001) that provides a guideline for the management of flood liable land. This document describes the process of a floodplain risk management study.
Flood source	The source of the flood waters.
Floodplain Management	A set of conditions and policies which define the benchmark from standard which floodplain management options are compared and assessed.
Flood standard	The flood selected for planning and floodplain management activities. The flood may be an historical or design flood. It should be based on an understanding of the flood behaviour and the associated flood hazard. It should also take into account social, economic and ecological considerations.
Flood storages	Floodplain areas which are important for the temporary storage of flood waters during a flood.
Floodways	Those areas of the floodplain where a significant discharge of flow occurs during floods. They are often aligned with naturally defined channels or overland flow paths. Floodways are areas that, even if they are partially blocked, would cause significant redistribution of flood flows, or a significant increase in flood levels.
Freeboard	A factor of safety usually expressed as a height above the flood standard. Freeboard tends to compensate for the factors such as wave action, localised hydraulic effects, uncertainties in the hydrology, uncertainties in the flood modelling and

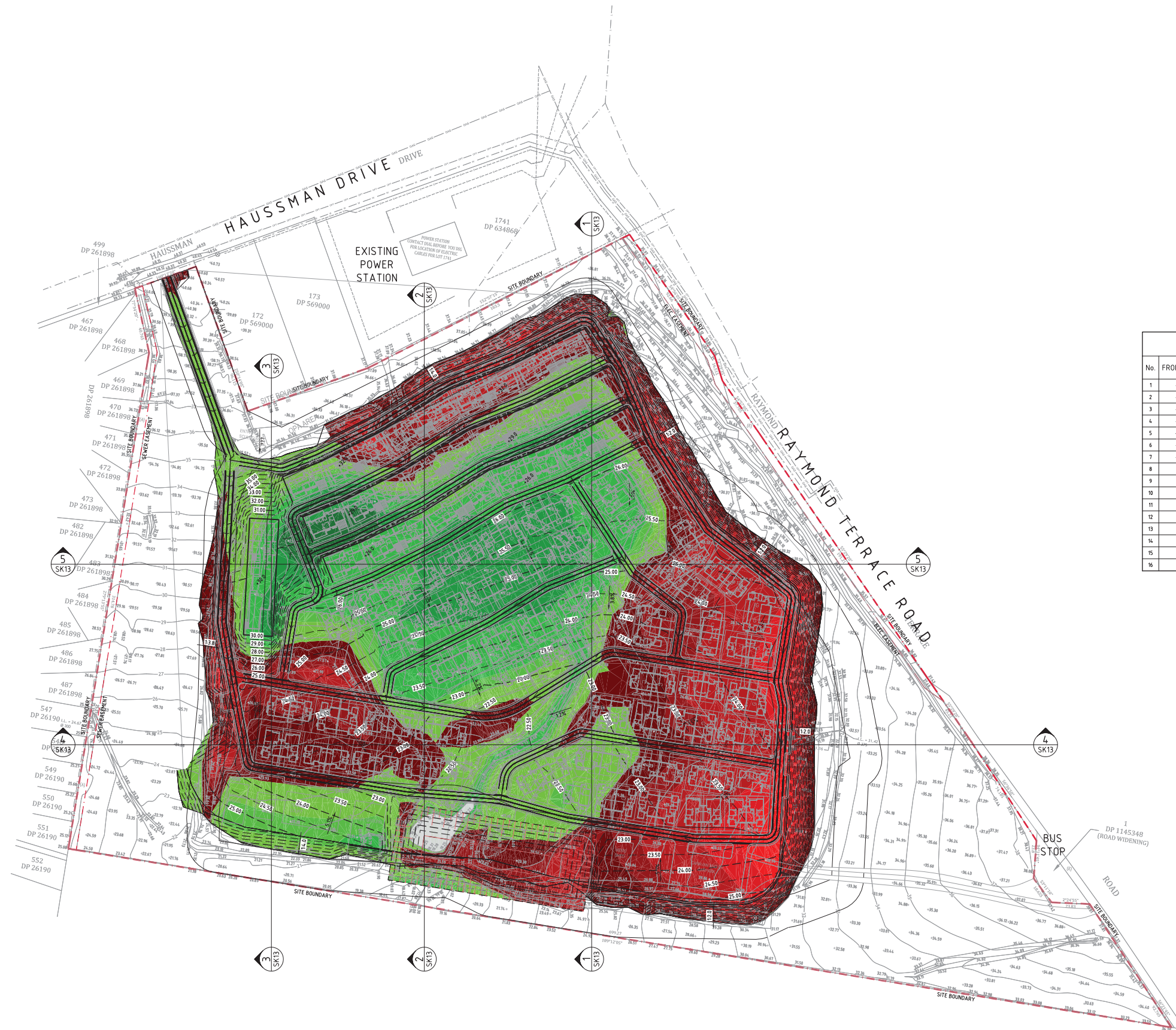
uncertainties in the design flood levels.

Geographical Information System (GIS)	A form of computer software developed for mapping applications and data storage. Useful for generating terrain models and processing data for input into flood estimation models.
High hazard	Danger to life and limb; evacuation difficult; potential for structural damage, high social disruption and economic losses. High hazard areas are those areas subject to a combination of flood depth and flow velocity that are deemed to cause the above issues to persons or property.
Historical flood	A flood which has actually occurred – Flood of Record.
Hydraulic	The term given to the study of water flow.
Hydrograph	A graph showing how flow rate changes with time.
Hydrology	The term given to the study of the rain-runoff process in catchments.
Low hazard	Flood depths and velocities are sufficiently low that people and their possessions can be evacuated.
Map Grid of Australia (MGA)	A national coordinate system used for the mapping of features on a representation of the earth's surface. Based on the geographic coordinate system 'Geodetic Datum of Australia 1994'.
Peak flood level, flow or velocity	The maximum flood level, flow or velocity occurring during a flood event.
MUSIC	Acronym for Model for Urban Stormwater Improvement Conceptualisation. A computer model which is used to simulate rainfall runoff, associated pollutants within the runoff and expected treatment of the pollutants using different treatment measures.
Probable Maximum Flood (PMF)	An extreme flood deemed to be the maximum statistical flood likely to occur at a particular location.
Probable Maximum Precipitation (PMP)	The greatest statistical depth of rainfall for a given duration meteorologically possible over a particular location. Used to estimate the probable maximum flood.
Probability	A statistical measure of the likely frequency or occurrence of flooding.

Riparian Zone	Areas that are located adjacent to watercourses. Their definition is vague and can be characterised by landform, vegetation, legislation or their function.
Runoff	The amount of rainfall from a catchment which actually ends up as flowing water in the river or creek.
Stage	Equivalent to water level above a specific datum- see flood level.
Treatment train	A term used to describe a series of water quality measures which act in conjunction with one another to provide a combined water quality outcome.
Triangular Irregular Network (TIN)	A mass of interconnected triangles used to model three-dimensional surfaces such as the ground (see DTM) and the surface of a flood.
Velocity	The speed at which the flood waters are moving. Typically, modelled velocities in a river or creek are quoted as the depth and width averaged velocity, i.e. the average velocity across the whole river or creek section

Appendix A

DRAWINGS BY COSTIN ROE CONSULTING



DEPTH RANGE				
No.	FROM DEPTH	TO DEPTH	COLOUR	DEPTH RANGE VOLUME
1	-8.000	-7.000	Red	66m
2	-7.000	-6.000	Red	862m
3	-6.000	-5.000	Red	3521m
4	-5.000	-4.000	Red	9042m
5	-4.000	-3.000	Red	18088m
6	-3.000	-2.000	Red	29804m
7	-2.000	-1.000	Red	42473m
8	-1.000	0.000	Red	53129m
9	0.000	1.000	Orange	50036m
10	1.000	2.000	Orange	39910m
11	2.000	3.000	Orange	31052m
12	3.000	4.000	Orange	24551m
13	4.000	5.000	Orange	15284m
14	5.000	6.000	Orange	3986m
15	6.000	7.000	Orange	960m
16	7.000	8.000	Orange	84m

 SITE SHADING PLAN
SCALE 1:1000

10m 0 10 20 30 40 50 60 70 80 90 100m
SCALE 1:1000 AT A0 SIZE SHEET

FOR INFORMATION

ISSUED FOR INFORMATION	17.11.17	E	
ISSUED FOR INFORMATION	02.11.17	D	
ISSUED FOR INFORMATION	31.08.17	C	
ISSUED FOR INFORMATION	01.08.17	B	
ISSUED FOR INFORMATION	20.07.17	A	
AMENDMENTS	DATE	ISSUE	AMENDMENTS

DATE	ISSUE	AMENDMENTS	DATE	ISSUE	AMENDMENTS
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PROJECT
THORNTON NORTH
RETIREMENT VILLAGE
107 HAUSSMAN DRIVE, THORNTON, NSW

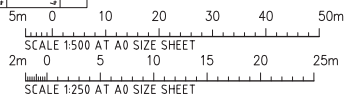
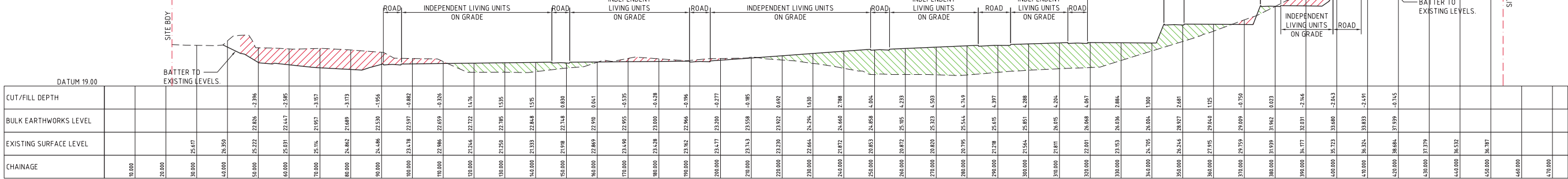
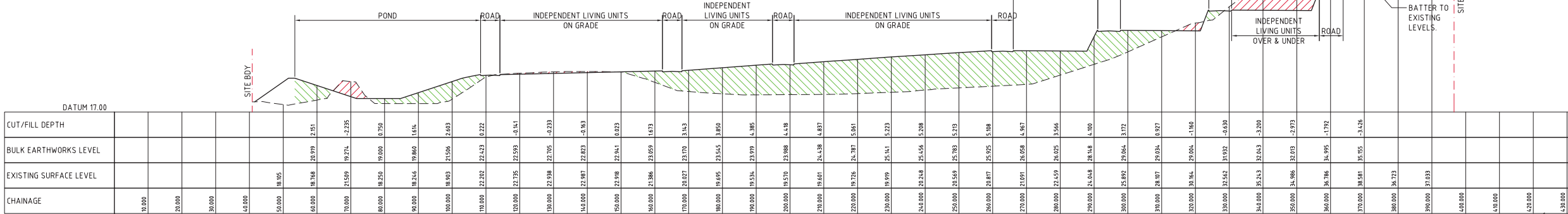
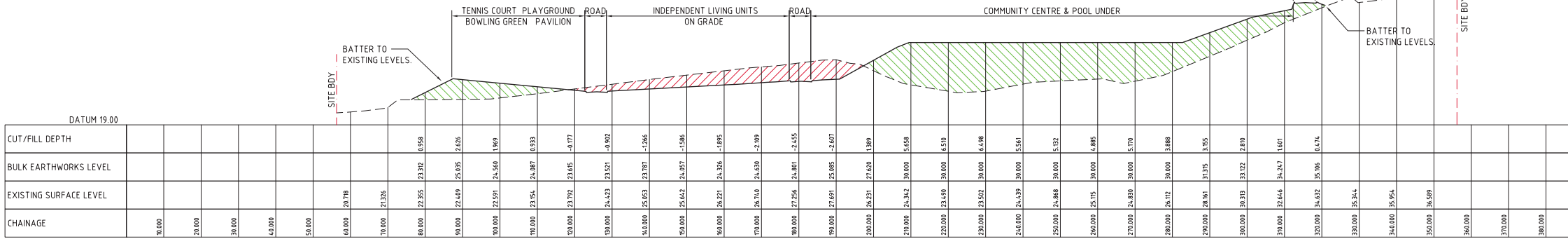
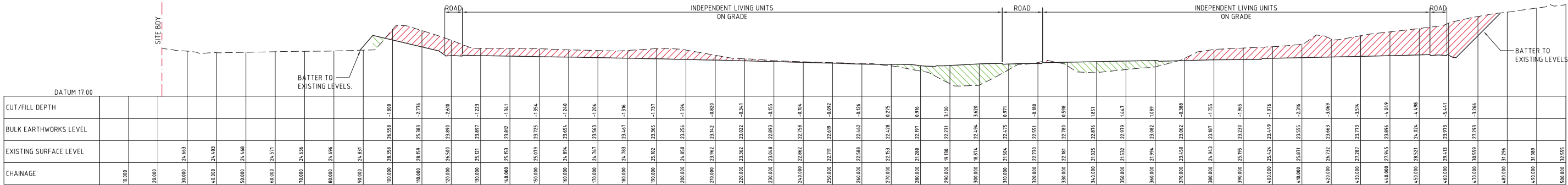
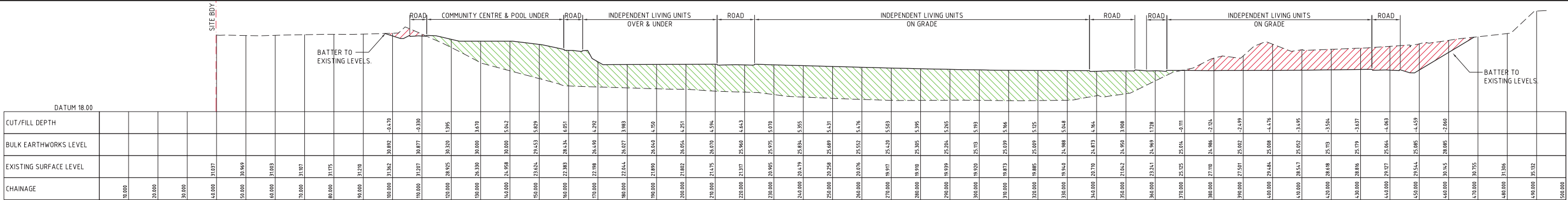


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DRAWING TITLE	SITE SHADING PLAN
DRAWING No	C013452.00-SK12
ISSUE	E



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ISSUED FOR INFORMATION	20.07.17	A	
AMENDMENTS	DATE	ISSUE	AMENDMENTS
	DATE	ISSUE	AMENDMENTS



PROJECT
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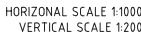
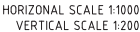
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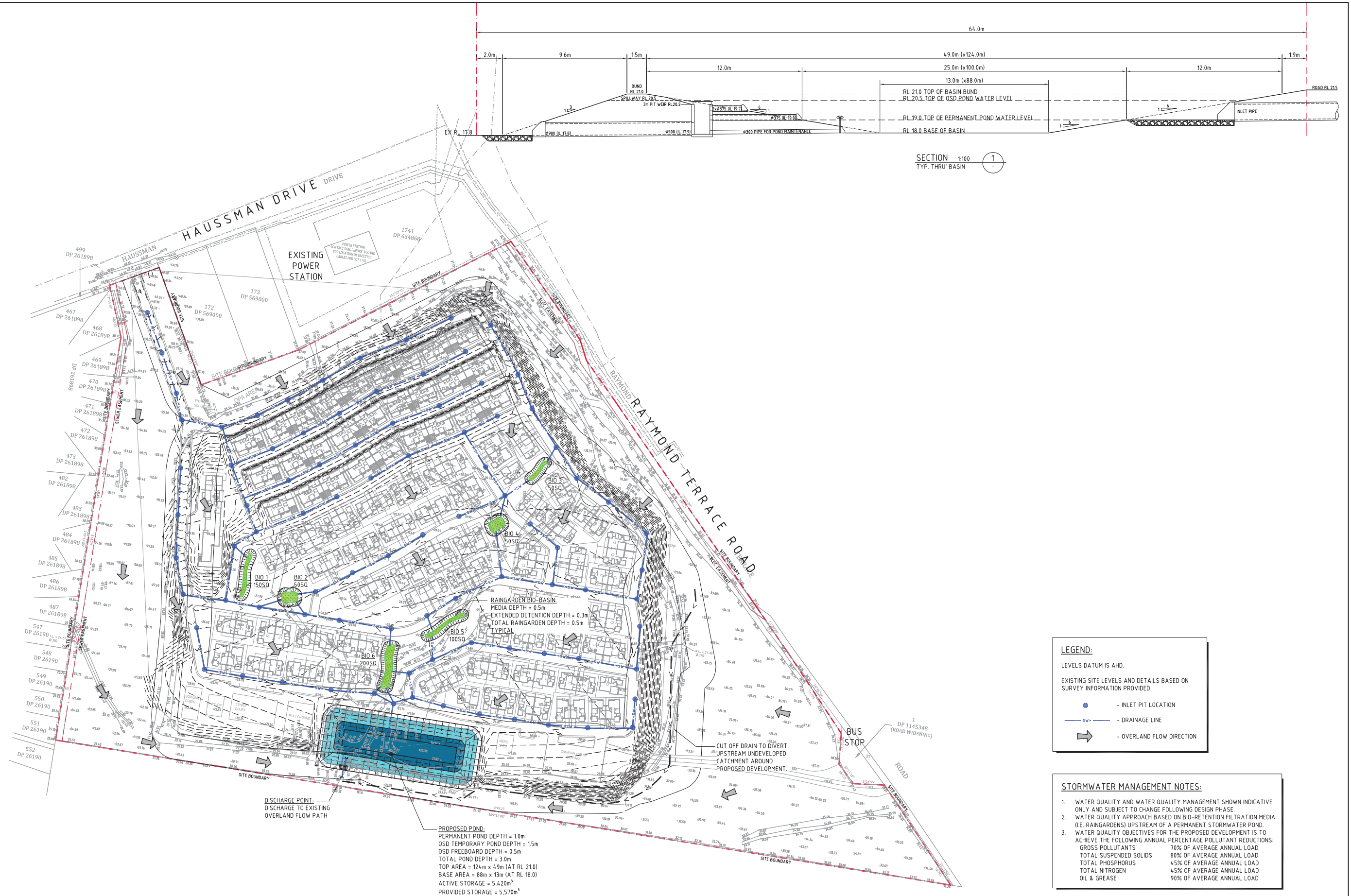
PRECISION | COMMUNICATION | ACCOUNTABILITY

DRAWING TITLE
SITE GRADING SECTIONS

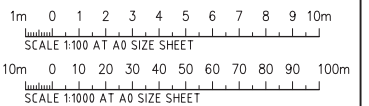
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C013452.00-SK13

ISSUE
E





CONCEPT DRAINAGE PLAN
SCALE 1:1000

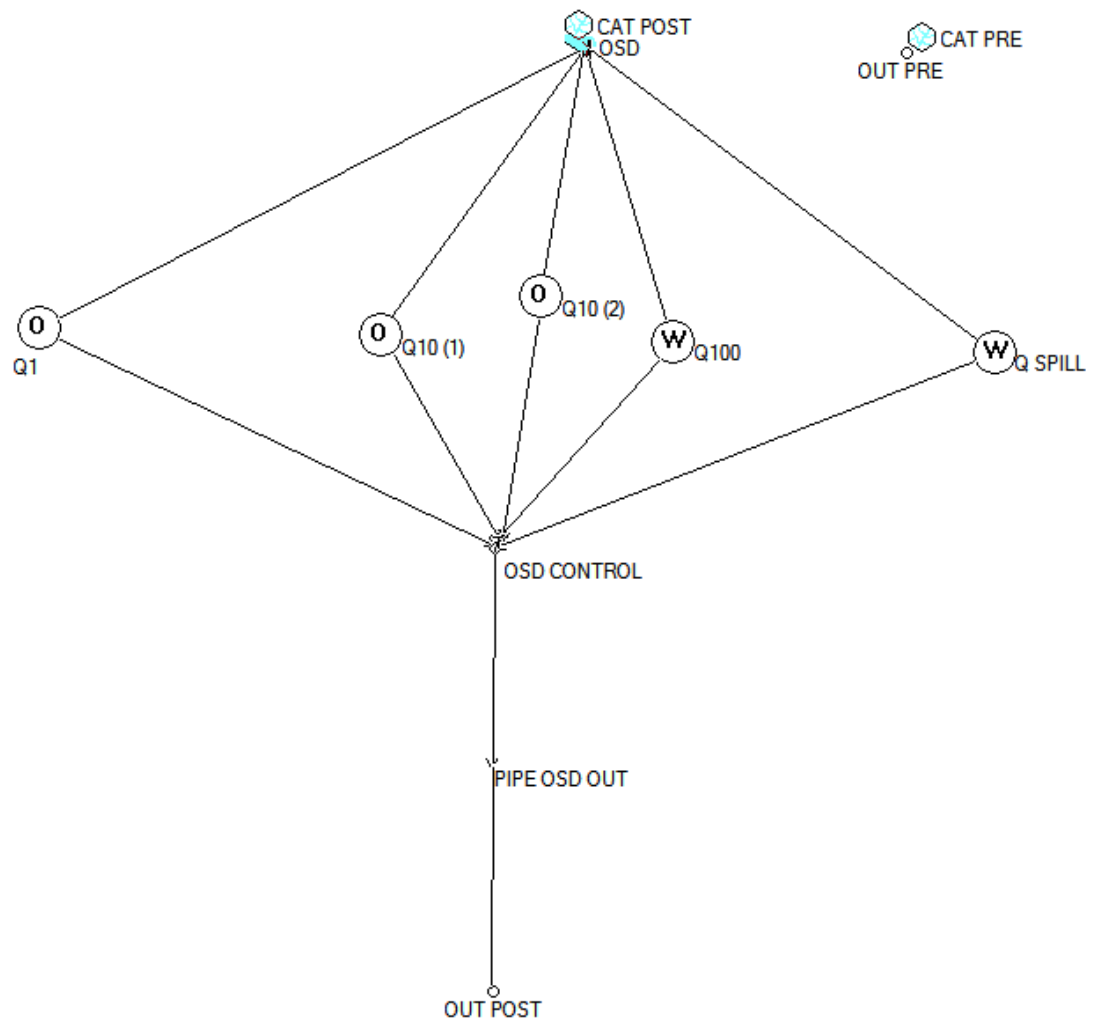


FOR INFORMATION

ISSUED FOR INFORMATION 17.11.17 C ISSUED FOR INFORMATION 02.11.17 B ISSUED FOR INFORMATION 10.08.17 A AMENDMENTS	DATE ISSUE AMENDMENTS	DATE ISSUE AMENDMENTS	AVIDPM PROJECT MANAGEMENT SERVICES	SUITE 1, LEVEL 3 426 KING STREET NEWCASTLE WEST P (02) 4945 7500	PROJECT THORNTON NORTH RETIREMENT VILLAGE 107 HAUSSMAN DRIVE, THORNTON, NSW	Costin Roe Consulting Pty Ltd. Consulting Engineers Level 1, 8 Windmill Street Wahah Bay, Sydney NSW 2000 Tel: (02) 8551-7000 Fax: (02) 8541-3721 email: mail@costinroe.com.au	PRECISION COMMUNICATION ACCOUNTABILITY	DRAWING TITLE CONCEPT DRAINAGE PLAN DRAWING No C013452.00-SK15 ISSUE C
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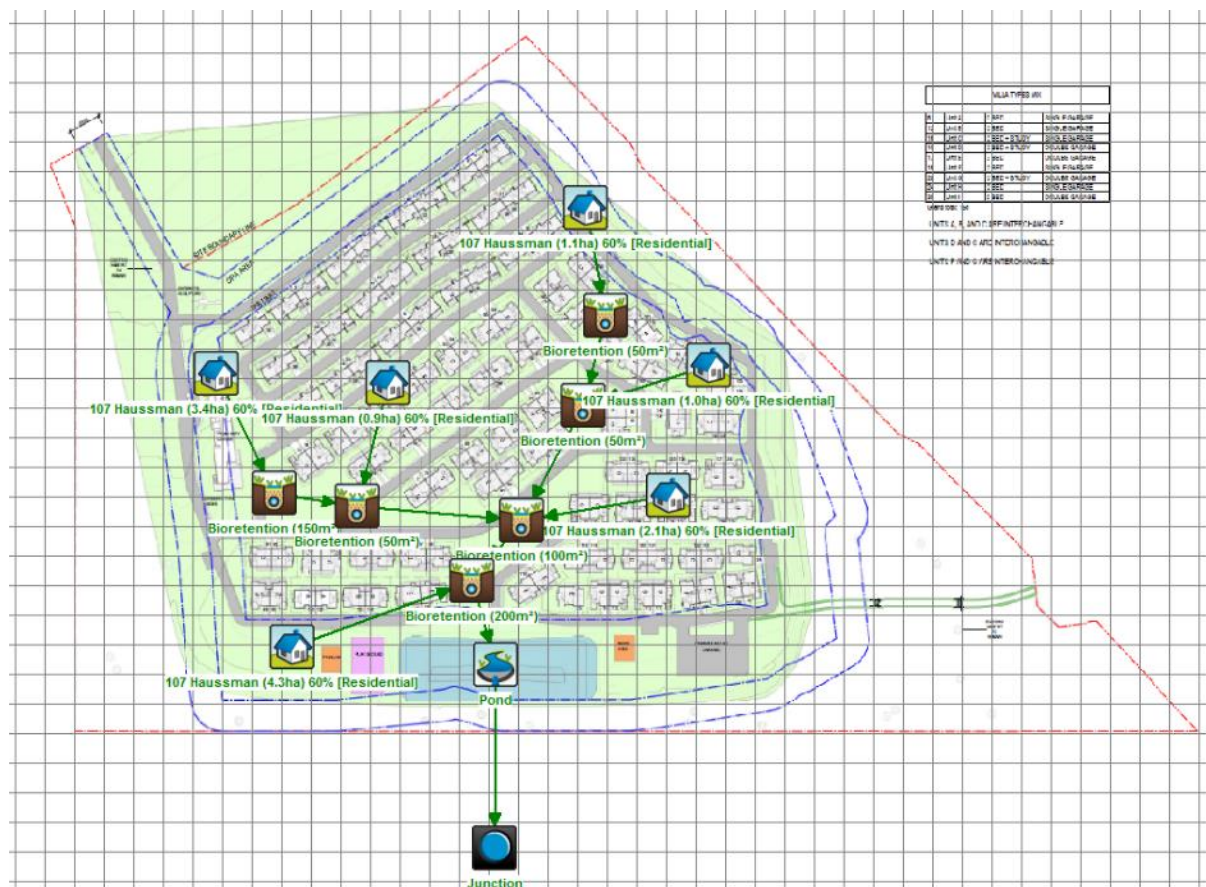
Appendix B

DRAINS MODEL CONFIGURATION



Appendix C

MUSIC MODEL CONFIGURATION



Treatment Train Effectiveness - Junction			
	Sources	Residual Load	% Reduction
Flow (ML/yr)	93.2	87.9	5.6
Total Suspended Solids (kg/yr)	15500	2420	84.4
Total Phosphorus (kg/yr)	26.2	10.6	59.4
Total Nitrogen (kg/yr)	196	108	45.1
Gross Pollutants (kg/yr)	2700	0	100

Appendix D

EROSION CONTROL CHECK SHEET

EROSION AND SEDIMENT CONTROL WEEKLY SITE INSPECTION SHEET

LOCATION
 INSPECTION OFFICER DATE
 SIGNATURE

Legend: ☐ OK ☐ Not OK N/A Not applicable

Item	Consideration	Assessment
1	Public roadways clear of sediment.	.....
2	Entry/exit pads clear of excessive sediment deposition.	.....
3	Entry/exit pads have adequate void spacing to trap sediment.	.....
4	The construction site is clear of litter and unconfined rubbish.	.....
5	Adequate stockpiles of emergency ESC materials exist on site.	.....
6	Site dust is being adequately controlled.	.....
7	Appropriate drainage and sediment controls have been installed prior to new areas being cleared or disturbed.	.....
8	Up-slope “clean” water is being appropriately diverted around/through the site.	.....
9	Drainage lines are free of soil scour and sediment deposition.	.....
10	No areas of exposed soil are in need of erosion control.	.....
11	Earth batters are free of “rill” erosion.	.....
12	Erosion control mulch is not being displaced by wind or water.	.....
13	Long-term soil stockpiles are protected from wind, rain and stormwater flow with appropriate drainage and erosion controls.	.....
14	Sediment fences are free from damage.	.....
15	Sediment-laden stormwater is not simply flowing “around” the sediment fences or other sediment traps.	.....
16	Sediment controls placed up-slope/around stormwater inlets are appropriate for the type of inlet structure.	.....
17	All sediment traps are free of excessive sediment deposition.	.....
18	The settled sediment layer within a sediment basin is clearly visible through the supernatant prior to discharge such water.	.....
19	All reasonable and practicable measures are being taken to control sediment runoff from the site.	.....
20	All soil surfaces are being appropriately prepared (i.e. pH, nutrients, roughness and density) prior to revegetation.	.....
21	Stabilised surfaces have a minimum 70% soil coverage.	.....
22	The site is adequately prepared for imminent storms.	.....
23	All ESC measures are in proper working order.	.....