STORMWATER FLOW AND QUALITY MANAGEMENT PLAN

For a

PROPOSED LOW DENSITY RESIDENTIAL SUBDIVISION

At

lot 273 DP755266. 15 Mulloway Road, Chain Valley Bay

On instruction from
Mr Chris Oliver – Optima Developments

Prepared by

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Document Registration

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Document Registered By	Peter Bacon Principal Consultant

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1. INTRODUCTION

This section provides the background information to the plan.

This Stormwater Quality and Quantity Plan, hereafter referred to as the Stormwater Management Plan, was prepared to demonstrate sustainable management of stormwater within a proposed low density residential subdivision on Lot 273 DP755266. 15 Mulloway Road, Chain Valley Bay. The Stormwater Management Plan aims to be consistent with Central Coast Council's Water Sensitive Urban Design[1] policies and objectives as identified in the MUSIC Link Output. .

The MUSIC-link software for Central Coast Council is used to demonstrate compliance with Council's requirements.

1.1 LOCATION

The subject site is in Chain Valley Bay, which is within the Central Coast Council LGA.

Figure 1.1 shows the site. The site contains some 16.9 ha. The development footprint is 8.15 ha or 48% of the total lot area.

[1] It is noted that Wyong Shire Council's Water Sensitive Urban Design Technical Guideline: Concept Design Tools (dated Nov 2010) was applicable ti this site in September 2021.

Figure 1.1. The subject site is in Chain Valley Bay. Current access is off Mullaway Road. (Image source: NSW Gov).

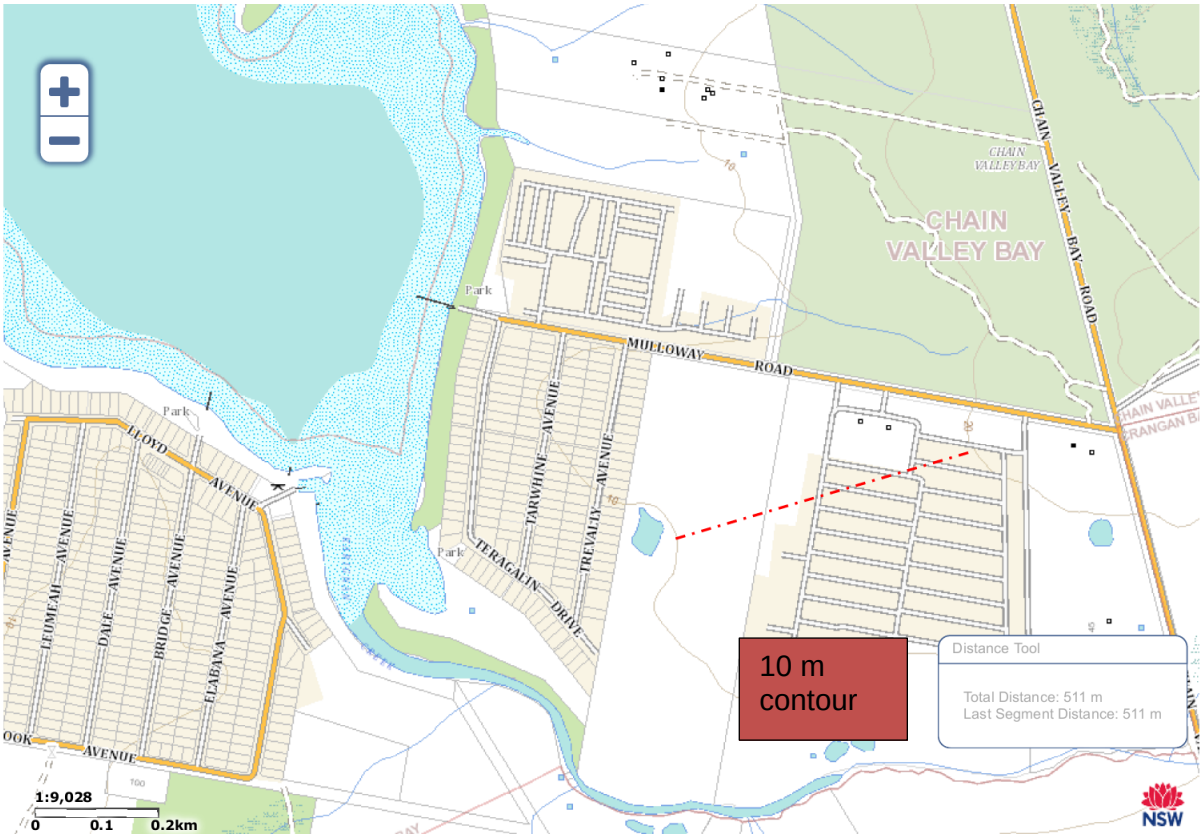


Figure 1.2. Site context (Image source: NSW Gov).

The indicative slope is 2%. The aspect is from N to NW.

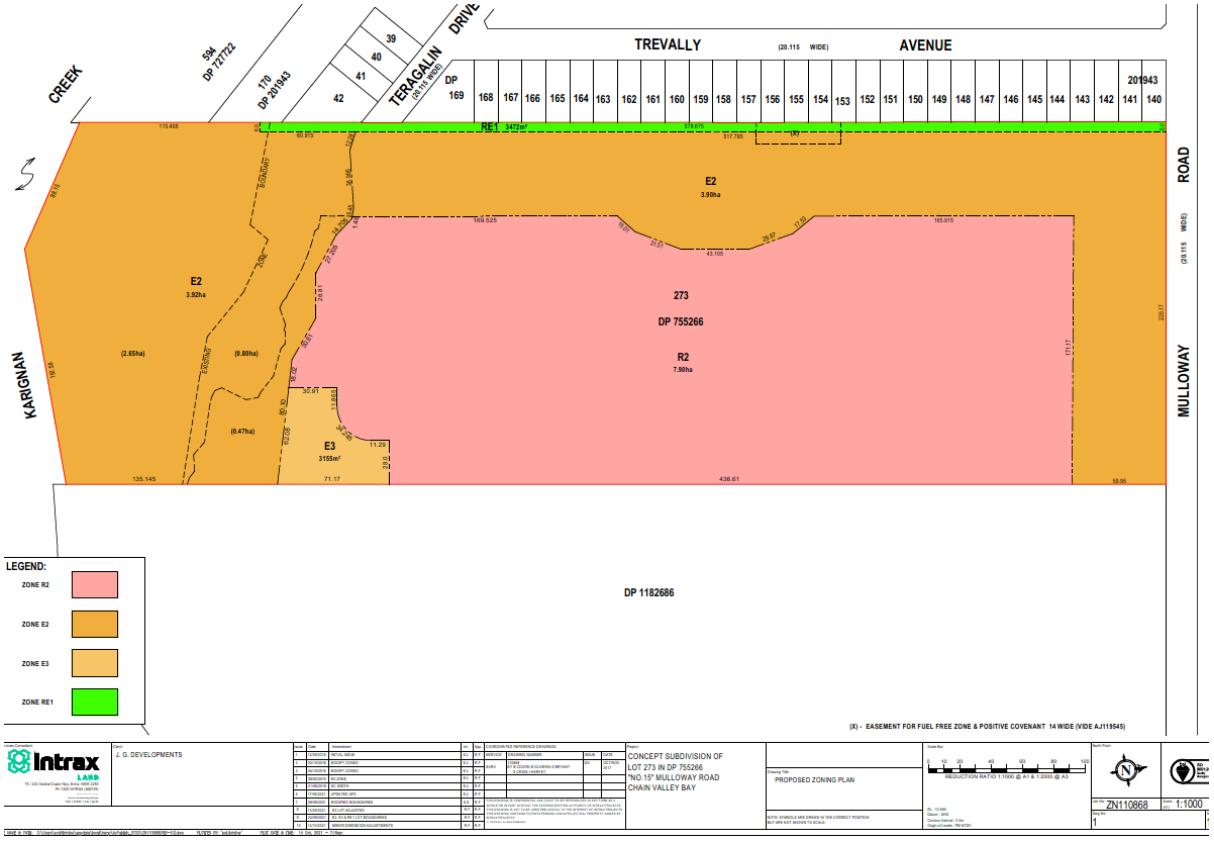


Figure 1.3. Proposed zoning plan (Image source: INTRAX).

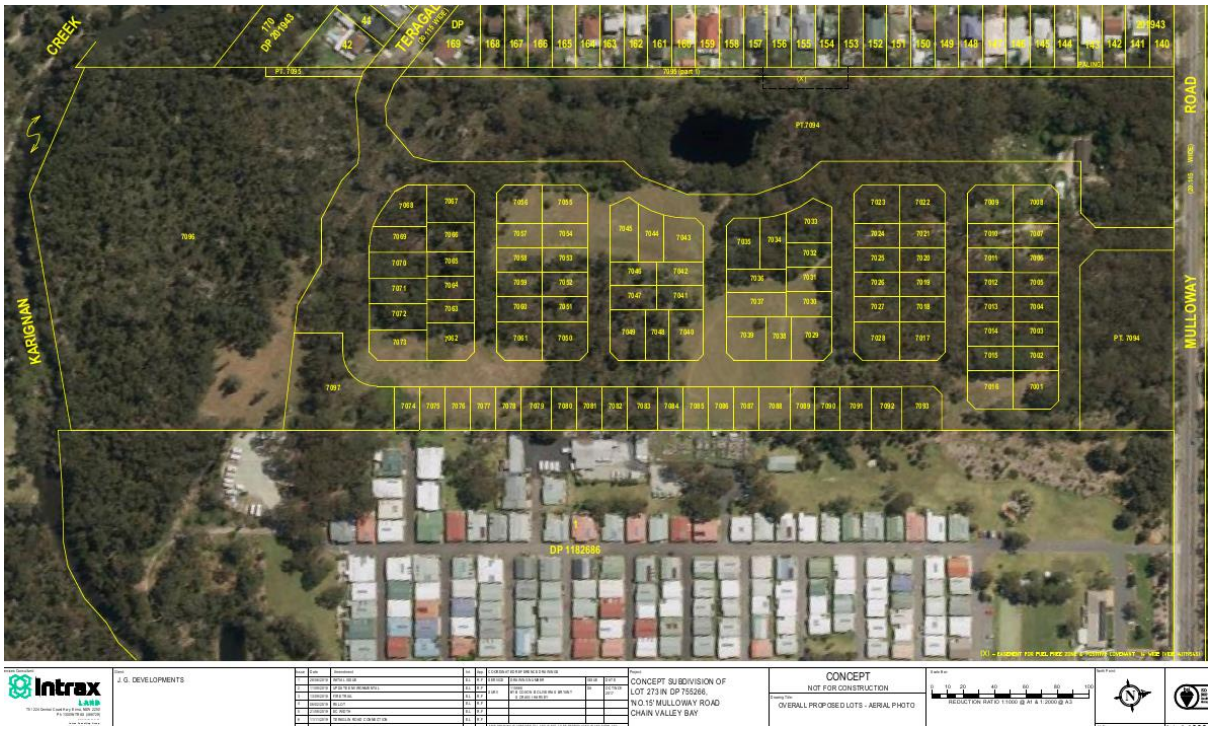


Figure 1.4. The proposed lot layout. (Source: INTRAX). The site drains to Karignan Creek. A small area surrounding an existing dwelling drains to the NW.

1.2 STORMWATER MANAGEMENT OBJECTIVES

The key aim of the stormwater management system is to ensure no increase in peak flow rates compared with current rates. This will be achieved by a combination of onsite rainwater detention and reuse, together with sedimentation pond and a forest based bioretention system designed to attenuate stormwater peak flow.

The combination of detention, reuse and treatment within the wetland system will also reduce the contaminant load exiting the site. A key aim of Water Sensitive Urban Design (WSUD) is to reduce the impact of development on contaminant loads exiting the precinct. Typically, these targets are expressed as the percentage reduction compared with that expected from the same development but without WSUD elements.

The indicative targets used for this low density residential development are taken from the stormwater treatment objectives for Victoria and NSW (Engineers Australia, 2006)

- 80% reduction in mean annual load of total suspended solids (TSS) (kg/y)
- 45% reduction in mean annual load of total phosphorus (P) (kg/y)
- 45% reduction in mean annual load of total nitrogen (N) (kg/y)
- Retention of 100% of litter greater than 5mm for all flows up to the 3 month ARI peak flow
- No visible oils for flows up to the 3-month ARI peak flow.

Additionally, it was expected to have:

- No increase in peak outflow (cubic m/sec)
- 90% reduction in mean annual load of gross pollutants (kg/y)

MUSIC modelling was used to establish the extent to which these criteria were achieved.

Site specific objectives

The subject site has an Endangered Ecological Community within the original lot.

It also requires some areas designated as Asset Protection Zones to manage bushfire hazards.

There is an existing farm dam on site, however bunding to create the dam prevents surface runoff entering it. It is likely that the dam relies on subsurface flows. These flows will be maintained.

The current Stormwater Management Plan aims to ensure peak outflow rate is less than the current rates. The system will also ensure the reduction in contaminant loads meet the Council's WSUD objectives.

2. THE REGULATORY REQUIREMENTS

Central Coast Council uses the MUSIC-Link system developed for Wyong Council to examine the inputs and outputs of the site's MUSIC model. This data is then compared with Council's requirements.

These requirements and the MUSIC Guidelines for Version 6.3 have been used.

Key references

The key MUSIC reference used in developing the model are

- SCA (2012). Using MUSIC in Sydney's Drinking Water Catchment. A Sydney Catchment Authority Standard. Statewater, Parramatta.
- Using MUSIC-link for Wyong Council

Objectives and permissible activities in R2 Low Density Residential Land

The proposed residential area in figure 1.3 is shown as R2 land use zoning. The objects of R2 Landuse zoning are shown below.

Zone R2 Low Density Residential

1 Objectives of zone

• To provide for the housing needs of the community within a low density residential environment.

• To enable other land uses that provide facilities or services to meet the day to day needs of residents.

• To encourage development that is sympathetic to the scenic, aesthetic and cultural heritage qualities of the built and natural environment.

2 Permitted without consent

Home-based child care; Home occupations

3 Permitted with consent

Bed and breakfast accommodation; Boarding houses; Boat sheds; Building identification signs; Business identification signs; Centre-based child care facilities; Community facilities; Dual occupancies; Dwelling houses; Emergency services facilities; Environmental facilities; Environmental protection works; Exhibition homes; Exhibition villages; Flood mitigation works; Group homes; Health consulting rooms; Home businesses; Home industries; Hostels; Kiosks; Neighbourhood shops; Oyster aquaculture; Places of public worship; Pond-based aquaculture; Recreation areas; Respite day care centres; Roads; Secondary dwellings; Semi-detached dwellings; Seniors housing; Sewage reticulation systems; Sewage treatment plants; Shop top housing; Tank-based aquaculture; Water recreation structures; Water recycling facilities; Water supply systems

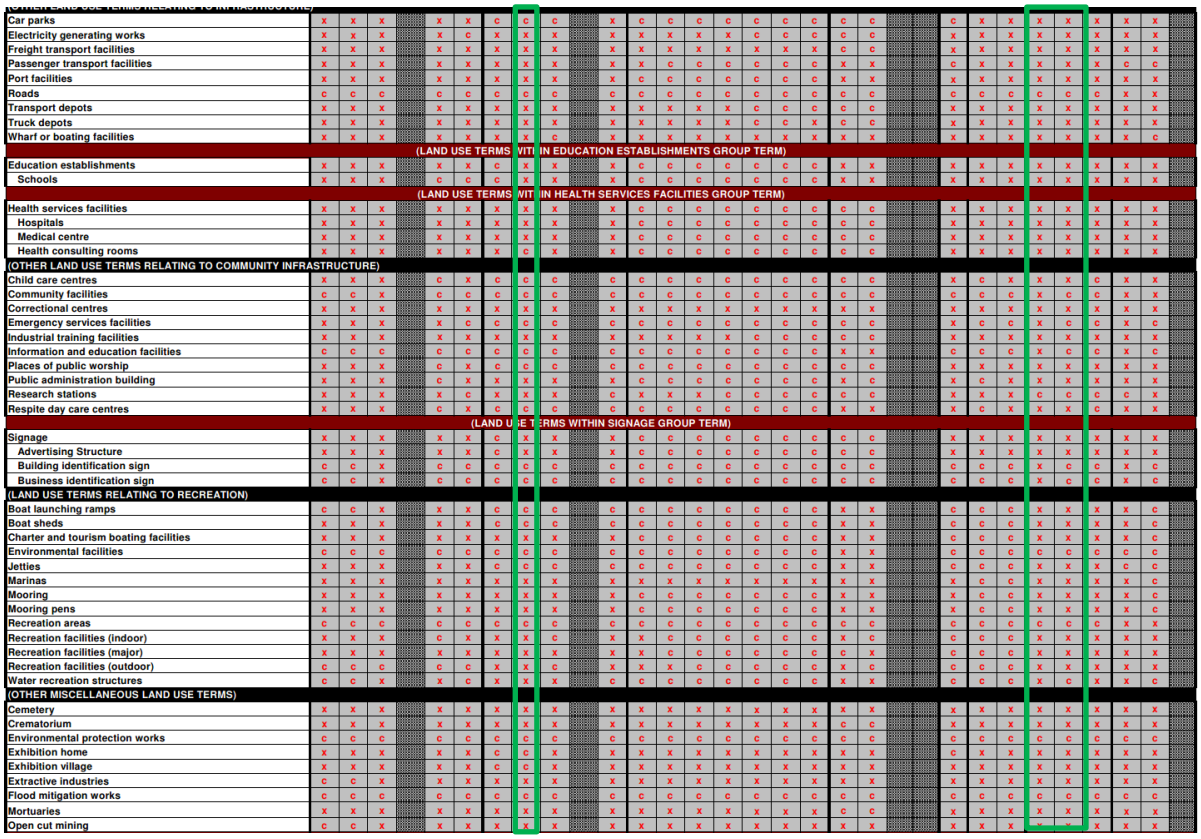
4 Prohibited

Any other development not specified in item 2 or 3

Environmental facilities, environment protection and flood mitigation activities are all permitted with 'Consent' on R2, E2 and E3 zoned land.

The table below shows the landuse matrix.

	Rural						Residential					Business							Industrial				SP3	Recr'n		Env Prot'n			Waterways		
	RU1 Primary Production	RU2 Rural Landscapes	RU3 Forestry	RU4 Primary Production Small Lots	RU5 Village	RU6 Transition	R1 General Residential	R2 Low Density Residential	R3 Medium Density Residential	R4 High Density Residential	R5 Large Lot Residential	B1 Neighbourhood Centre	B2 Local Centre	B3 Commercial Core	B4 Mixed Use	B5 Business Development	B6 Enterprise Corridor	B7 Business Park	IN1 General Industrial	IN2 Light Industrial	IN3 Heavy Industrial	IN4 Working Waterfront	SP3 Tourist	RE1 Public Recreation	RE2 Private Recreation	E2 Environmental Conservation	E3 Environmental Management	E4 Environmental Living	W1 Natural Waterways	W2 Recreational Waterways	W3 Working Waterways
Is the zone used? [please select Y/N for each zone]	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N
(LAND USE TERMS WITHIN AGRICULTURE GROUP TERM)																															
Agriculture	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
Aquaculture	c	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
Extensive agriculture	o	o	x		x	c	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	c	x	x	x	
Bee keeping	o	o	x		x	c	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	c	x	x	x	
Dairy (pasture based)	o	o	x		x	c	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	c	x	x	x	
Intensive livestock agriculture	c	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
Feedlots	c	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
Restricted dairies	c	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
Intensive plant agriculture	c	c	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
Horticulture	c	c	x		x	c	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	c	x	c	x	
Turf farming	c	c	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
Viticulture	c	c	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
(LAND USE TERMS OUTSIDE AGRICULTURE GROUP TERM)																															
Animal boarding or training establishment	c	c	x		x	c	x	x	x		c	x	x	x	x	x	x	x	c	c			x	x	x	x	x	x	c	x	
Farm buildings	c	c	x		x	c	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	c	c	c	x	
Forestry	c	c	o		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
(LAND USE TERMS WITHIN RESIDENTIAL GROUP TERM)																															
Residential Accomodation	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
Attached dwelling	x	x	x		x	x	c	x	c		x	x	x	x	x	x	x	x	x	x			c	x	x	x	x	x	x	x	
Boarding houses	x	x	x		x	x	c	c	c		x	c	c	c	c	x	x	x	x	x			x	x	x	x	x	x	x	x	
Dual occupancies	c	c	x		x	c	c	c	c		c	x	x	x	x	x	x	x	x	x			x	x	x	x	c	x	c	x	
Dual occupancy (attached)	c	c	x		x	c	c	c	c		c	x	x	x	x	x	x	x	x	x			x	x	x	x	c	c	c	x	
Dual occupancy (detached)	c	c	x		x	c	c	c	c		c	x	x	x	x	x	x	x	x	x			x	x	x	x	c	c	c	x	
Dwelling houses	c	c	x		c	c	c	c	c		c	x	x	x	x	x	x	x	x	x			c	x	x	x	c	c	c	x	
Group homes	x	x	x		x	c	c	c	c		c	x	x	x	x	x	x	x	x	x			x	x	x	x	x	c	x	x	
Group home (pemanent)	x	x	x		x	c	c	c	c		c	x	x	x	x	x	x	x	x	x			x	x	x	x	x	c	x	x	
Group home (transitional)	x	x	x		x	c	c	c	c		c	x	x	x	x	x	x	x	x	x			x	x	x	x	x	c	x	x	
Hostels	x	x	x		x	x	c	x	c		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
Multi dwelling housing	x	x	x		x	x	c	x	c		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
Residential flat building	x	x	x		x	x	c	x	c		x	x	x	x	c	x	x	x	x	x			x	x	x	x	x	x	x	x	
Rural worker's dwelling	c	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
Secondary dwellings	x	x	x		c	x	c	c	c		x	x	x	x	x	x	x	x	x	x			c	x	x	x	c	c	x	x	
Semi detached dwelling	x	x	x		x	x	c	c	c		x	x	x	x	x	x	x	x	x	x			c	x	x	x	x	x	x	x	
Seniors housing	x	x	x		x	x	c	x	c		x	x	x	x	c	x	x	x	x	x			x	x	x	x	x	x	x	x	
Residential Care facilities	x	x	x		c	x	c	x	c		x	x	x	x	c	x	x	x	x	x			x	x	x	x	x	x	x	x	
Shop top housing	x	x	x		c	x	c	c	c		x	x	c	c	c	c	c	c	x	x			c	x	x	x	x	x	x	x	
(LAND USE TERMS OUTSIDE RESIDENTIAL GROUP TERM)																															
Home based childcare	o	o	x		o	o	o	o	o		o	o	c	c	c	c	c	c	x	x			x	x	x	x	o	o	x	x	
Home business	c	c	x		c	c	c	c	c		c	c	c	c	c	c	c	c	x	x			c	x	x	x	c	c	x	x	
Home occupations	o	o	x		o	c	o	o	o		o	o	c	c	c	c	c	c	x	x			c	x	x	x	o	o	x	x	
Home occupations (sex services)	c	c	x		c	x	c	x	x		c	c	c	c	c	c	c	x	x	x			x	x	x	x	x	c	x	x	
(LAND USE TERMS WITHIN TOURIST AND VISITOR ACCOMODATION GROUP TERM)																															
Tourist and visitor accommodation	x	x	x		x	x	x	x	c		x	x	c	c	c	x	x	x	x	x			c	x	x	x	x	x	x	x	
Backpackers accommodation	x	x	x		x	x	x	x	c		x	x	c	c	c	x	x	x	x	x			c	x	x	x	x	x	x	x	
Bed and breakfast accommodation	c	c	x		c	c	c	c	c		c	c	c	c	c	x	x	x	x	x			c	x	x	x	c	c	x	x	
Farm stay accommodation	c	c	x		x	x	x	x	x		x	x	c	c	c	x	x	x	x	x			c	x	x	x	c	c	x	x	
Hotel or motel accommodation	x	x	x		c	x	c	x	c		x	x	c	c	c	c	c	c	x	x			c	x	x	x	x	x	x	x	
Serviced apartment	x	x	x		x	x	c	x	c		x	x	c	c	c	c	c	c	x	x			c	x	x	x	x	x	x	x	
(LAND USE TERMS OUTSIDE TOURIST AND VISITOR ACCOMODATION GROUP TERM)																															
Camping grounds	c	c	c		c	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	c	c	x	x	x	x	x	
Caravan parks	x	x	x		x	x	c	x	c		x	x	x	x	x	x	x	x	x	x			c	c	c	x	x	x	x	x	
Eco-tourist facilities	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			c	x	x	c	c	x	x	x	
(LAND USE TERMS WITHIN COMMERCIAL PREMISES GROUP TERM)																															
Commercial premises	x	x	x		x	x	x	x	x		x	c	c	c	c	c	c	x	x	x			x	x	x	x	x	x	x	x	
Business premises	x	x	x		c	x	x	x	x		x	c	c	c	c	c	c	x	x	x			x	x	x	x	x	x	x	x	
Funeral homes	x	x	x		c	x	x	x	x		x	c	c	c	c	c	c	x	x	x			x	x	x	x	x	x	x	x	
Office premises	x	x	x		c	x	x	x	x		x	x	c	c	c	c	c	c	x	x			x	x	x	x	x	x	x	x	
Retail premises	x	x	x		x	x	x	x	x		x	x	c	c	c	x	x	x	x	x			x	x	x	x	x	x	x	x	
Bulky goods premises	x	x	x		x	x	x	x	x		x	x	c	c	c	c	c	x	x	x			x	x	x	x	x	x	x	x	
Cellar door premises	c	c	x		c	x	x	x	x		x	x	c	c	c	x	x	x	x	x			x	x	x	x	x	x	x	x	
Food and drink premises	x	x	x		c	x	x	x	x		x	c	c	c	c	c	c	c	c	c			c	c	c	x	x	x	x	x	
Pubs	x	x	x		c	x	x	x	x		x	c	c	c	c	c	c	c	c	c			c	c	c	x	x	x	x	x	
Restaurants or cafes	x	x	x		c	x	x	x	x		x	c	c	c	c	c	c	c	c	c			c	c	c	x	x	x	x	x	
Take-away food and drink premises	x	x	x		c	x	x	c	x		x	c	c	c	c	c	c	c	c	c			c	c	c	x	x	x	x	c	
Garden centres	x	x	x		c	x	x	x	x		x	x	c	c	c	c	c	c	c	c			x	x	x	x	x	x	x	x	
Hardware and building supplies	x	x	x		c	x	x	x	x		x	x	c	c	c	c	c	c	c	c			x	x	x	x	x	x	x	x	
Kiosks	x	x	c		c	x	x	x	x		x	x	c	c	c	x	c	c	c	c			c	c	c	x	x	x	x	c	
Landscaping material supplies	x	x	x		x	x	x	x	x		x	x	c	c	c	c	c	x	c	c			x	x	x	x	x	x	x	x	
Markets	x	x	x		c	x	x	x	x		x	x	c	c	c	c	c	x	x	x			x	c	c	x	x	x	x	x	
Plant nurseries	x	x	x		c	x	x	x	x		x	x	c	c	c	c	c	x	c	c			x	x	x	x	x	x	x	x	
Roadside stalls	c	c	x		c	x	x	x	x		x	x	c	c	c	x	x	x	x	x			x	x	x	x	c	c	x	x	
Rural supplies	c	x	x		c	x	x	x	x		x	x	c	c	c	c	c	x	c	c			x	x	x	x	x	x	x	x	
Shops	x	x	x		c	x	x	x	x		x	c	c	c	c	c	x	x	x	x			x	x	x	x	x	x	x	x	
Neighbourhood shops	x	x	x		c	x	c	c	c		x	c	c	c	c	c	c	c	c	c			c	x	x	x	x	x	x	x	
Timber yards	x	x	x		x	x	x	x	x		x	x	c	c	c	c	c	x	c	c			x	x	x	x	x	x	x	x	
Vehicle sales or hire premises	x	x	x		x	x	x	x	x		x	x	c	c	c	c	c	x	c	c			x	x	x	x	x	x	x	x	
(LAND USE TERMS OUTSIDE COMMERCIAL PREMISES GROUP TERM)																															
Amusement centres	x	x	x		x	x	x	x	x		x	x	c	c	c	c	c	x	c	c			c	x	c	x	x	x	x	x	
Entertainment facilities	x	x	x		c	x	x	x	x		x	x	c	c	c	c	c	x	x	x			c	c	c	x	x	x	x	x	
Function centres	x	x	x		c	x	x	x	x		x	x	c	c	c	c	c	x	x	x			c	c	c	x	x	x	x	x	
Highway service centres	x	x	x		x	x	x	x	x		x	c	c	c	c	c	c	x	c	c			x	x	x	x	x	x	x	x	
Industrial retail outlets	x	x	x		x	x	x	x	x		x	x	c	c	x	x	x	x	c	c			x	x	x	x	x	x	x	x	
Registered clubs	x	x	x		c	x	x	x	x		x	c	c	c	c	c	c	x	x	x			c	c	c	x	x	x	x	x	
Restricted premises	x	x	x		x	x	x	x	x		x	x	c	c	c	c	c	x	c	c			x	x	x	x	x	x	x	x	
Service stations	x	x	x		c	x	x	x	x		x	c	c	c	c	c	c	x	c	c			x	x	x	x	x	x	x	x	
Sex service premises	x	x	x		x	x	x	x	x		x	x	c	c	x	x	c	c	c	c			x	x	x	x	x	x	x	x	
Veterinary hospitals	c	c	x		c	x	x	x	x		x	c	c	c	c	c	c	c	c	c			x	x	x	x	x	x	x	x	
Wholesale supplies	x	x	x		x	x	x	x	x		x	x	x	x	x	x	c	c	c	c			x	x	x	x	x	x	x	x	
(LAND USE TERMS WITHIN RURAL INDUSTRIES GROUP TERM)																															
Rural industries	c	c	x		x	x	x	x	x		x	x	x	x	x	x	x	x	c	x			x	x	x	x	x	x	x	x	
Agricultural produce industries	c	c	x		x	x	x	x	x		x	x	x	x	x	x	x	x	c	x			x	x	x	x	x	x	x	x	
Livestock processing industries	c	c	x		x	x	x	x	x		x	x	x	x	x	x	x	x	c	x			x	x	x	x	x	x	x	x	
Sawmill or log processing industries	c	c	x		x	x	x	x	x		x	x	x	x	x	x	x	x	c	x			x	x	x	x	x	x	x	x	
Stock and sale yards	c	c	x		x	x	x	x	x		x	x	x	x	x	x	x	x	c	x			x	x	x	x	x	x	x	x	
(LAND USE TERMS WITHIN INDUSTRIES GROUP TERM)																															
Industries	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	c	x			x	x	x	x	x	x	x	x	
Heavy industries	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
Hazardous industry	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
Offensive industry	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	
Light industries	x	x	x		x	x	x	x	x		x	x	x	x	x	x	c	c	c	c			x	x	x	x	x	x	x	x	
High technology industries	x	x	x		x	x	x	x	x		x	x	x	x	x	x	c	c	c	c			x	x	x	x	x	x	x	x	
Home Industry	c	c	x		c	c	c	x	c		x	x	x	x	x	c	c	c	c	c			x	x	x	x	c	c	x	x	



Car parks	x	x	x		x	x	c	c	c		x	c	c	c	c	c	c	c	c		c	x	x	x	x	x	x	x	x
Electricity generating works	x	x	x		x	c	x	x	x		x	x	x	x	x	c	c	c	c		x	x	x	x	x	x	x	x	x
Freight transport facilities	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	c	c		x	x	x	x	x	x	x	x	x
Passenger transport facilities	x	x	x		x	x	x	x	x		x	x	c	c	c	c	c	x	x		c	x	x	x	x	x	c	c	
Port facilities	x	x	x		x	x	x	x	x		x	c	c	c	c	c	c	x	x		x	x	x	x	x	x	x	x	x
Roads	c	c	c		c	c	c	c	c		c	c	c	c	c	c	c	c	c		c	c	c	c	c	c	x	x	
Transport depots	x	x	x		x	x	x	x	x		x	x	x	x	x	c	c	c	c		x	x	x	x	x	x	x	x	x
Truck depots	x	x	x		x	x	x	x	x		x	x	x	x	x	c	c	x	c		x	x	x	x	x	x	x	x	x
Wharf or boating facilities	x	x	x		x	x	x	x	c		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	c
(LAND USE TERMS WITHIN EDUCATION ESTABLISHMENTS GROUP TERM)																													
Education establishments	x	x	x		x	x	c	x	x		x	c	c	c	c	c	c	c	x		x	x	x	x	x	x	x	x	x
Schools	x	x	x		c	c	c	x	x		x	c	c	c	c	c	c	c	x		x	x	x	x	x	x	x	x	x
(LAND USE TERMS WITHIN HEALTH SERVICES FACILITIES GROUP TERM)																													
Health services facilities	x	x	x		x	x	x	x	x		x	c	c	c	c	c	c	c	c		x	x	x	x	x	x	x	x	x
Hospitals	x	x	x		x	x	x	x	x		x	c	c	c	c	c	c	c	c		x	x	x	x	x	x	x	x	x
Medical centre	x	x	x		x	x	x	x	x		x	c	c	c	c	c	c	c	c		x	x	x	x	x	x	x	x	x
Health consulting rooms	x	x	x		x	x	x	c	x		x	c	c	c	c	c	c	c	c		x	x	x	x	x	x	x	x	x
(OTHER LAND USE TERMS RELATING TO COMMUNITY INFRASTRUCTURE)																													
Child care centres	x	x	x		c	x	c	c	c		c	c	c	c	c	c	c	c	c		x	c	x	x	x	c	x	x	
Community facilities	c	c	x		c	c	c	c	c		c	c	c	c	c	c	c	c	c		c	c	c	x	c	c	x	x	
Correctional centres	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	
Emergency services facilities	x	x	x		x	c	c	c	c		c	c	c	c	c	c	c	c	c		x	c	c	x	c	c	x	c	
Industrial training facilities	x	x	x		x	x	x	x	x		x	x	x	x	x	c	c	c	c		x	x	x	x	x	x	x	x	
Information and education facilities	c	c	c		c	c	c	c	c		c	c	c	c	c	c	c	x	x		c	c	c	x	c	c	x	c	
Places of public worship	x	x	x		c	x	c	c	c		c	c	c	c	c	c	c	c	c		x	x	x	x	x	x	x	x	
Public administration building	x	x	x		c	x	x	x	x		x	c	c	c	c	c	c	x	c		x	c	x	x	x	x	x	x	
Research stations	x	x	x		x	c	x	x	x		c	x	x	x	c	c	c	c	c		x	x	x	c	c	c	c	x	
Respite day care centres	x	x	x		c	x	c	c	c		c	c	c	c	c	c	c	x	x		x	c	x	x	x	c	x	x	
(LAND USE TERMS WITHIN SIGNAGE GROUP TERM)																													
Signage	x	x	x		x	x	c	x	x		x	c	c	c	c	c	c	c	c		x	x	x	x	x	x	x	x	
Advertising Structure	x	x	x		x	x	c	x	x		x	c	c	c	c	c	c	c	c		x	x	x	x	x	x	x	x	
Building identification sign	c	c	x		c	c	c	c	c		c	c	c	c	c	c	c	c	c		c	c	c	x	c	c	x	c	
Business identification sign	c	c	x		c	c	c	c	c		c	c	c	c	c	c	c	c	c		c	c	c	x	c	c	x	c	
(LAND USE TERMS RELATING TO RECREATION)																													
Boat launching ramps	c	c	x		x	x	c	c	c		c	c	c	c	c	c	c	x	x		c	c	c	x	x	x	x	c	
Boat sheds	x	x	x		x	x	c	c	c		c	c	c	c	c	c	c	x	x		c	c	c	x	x	x	x	c	
Charter and tourism boating facilities	x	x	x		x	x	x	x	x		x	c	c	c	c	c	c	x	x		c	c	c	x	x	x	x	c	
Environmental facilities	c	c	c		c	c	c	c	c		c	c	c	c	c	c	c	x	x		c	c	c	c	c	c	c	c	
Jetties	x	x	x		x	x	c	c	c		c	c	c	c	c	c	c	x	x		c	c	c	x	x	x	c	c	
Marinas	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	c	c	x	x	x	x	c	
Mooring	x	x	x		x	x	x	x	x		x	c	c	c	c	c	c	x	x		x	c	c	x	x	x	x	c	
Mooring pens	x	x	x		x	x	x	x	x		x	c	c	c	c	c	c	x	x		x	c	c	x	x	x	x	c	
Recreation areas	c	c	c		c	c	c	c	c		c	c	c	c	c	c	c	c	c		c	c	c	c	c	c	x	x	
Recreation facilities (indoor)	x	x	x		c	x	x	x	c		x	x	c	c	c	c	c	x	c		c	c	c	x	x	x	x	x	
Recreation facilities (major)	x	x	x		x	x	x	x	x		x	x	c	c	c	c	c	c	x		c	c	c	x	x	x	x	x	
Recreation facilities (outdoor)	c	c	c		c	c	x	x	c		x	x	x	c	c	c	c	x	c		c	c	c	x	x	x	x	x	
Water recreation structures	c	c	x		x	c	x	x	x		c	c	c	c	c	c	c	x	x		c	c	c	x	c	x	x	c	
(OTHER MISCELLANEOUS LAND USE TERMS)																													
Cemetery	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	
Crematorium	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	c	c		x	x	x	x	x	x	x	x	
Environmental protection works	c	c	c		c	c	c	c	c		c	c	c	c	c	c	c	c	c		c	c	c	c	c	c	c	c	
Exhibition home	x	x	x		x	x	c	c	x		x	x	x	x	x	x	x	x	x		c	x	x	x	x	x	x	x	
Exhibition village	x	x	x		x	x	c	c	x		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	
Extractive industries	c	c	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	
Flood mitigation works	c	c	c		c	c	c	c	c		c	c	c	c	c	c	c	c	c		c	c	c	c	c	c	c	c	
Mortuaries	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	c	c		x	x	x	x	x	x	x	x	
Open cut mining	c	c	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	

3. CURRENT CONDITIONS

3.1 CURRENT LANDFORMS `

The subject site covers 16.68ha. Figure 3.1 shows the highest point is in the eastern side. Most of the site slopes to the west and south. The southern 25% of the site is almost flat.

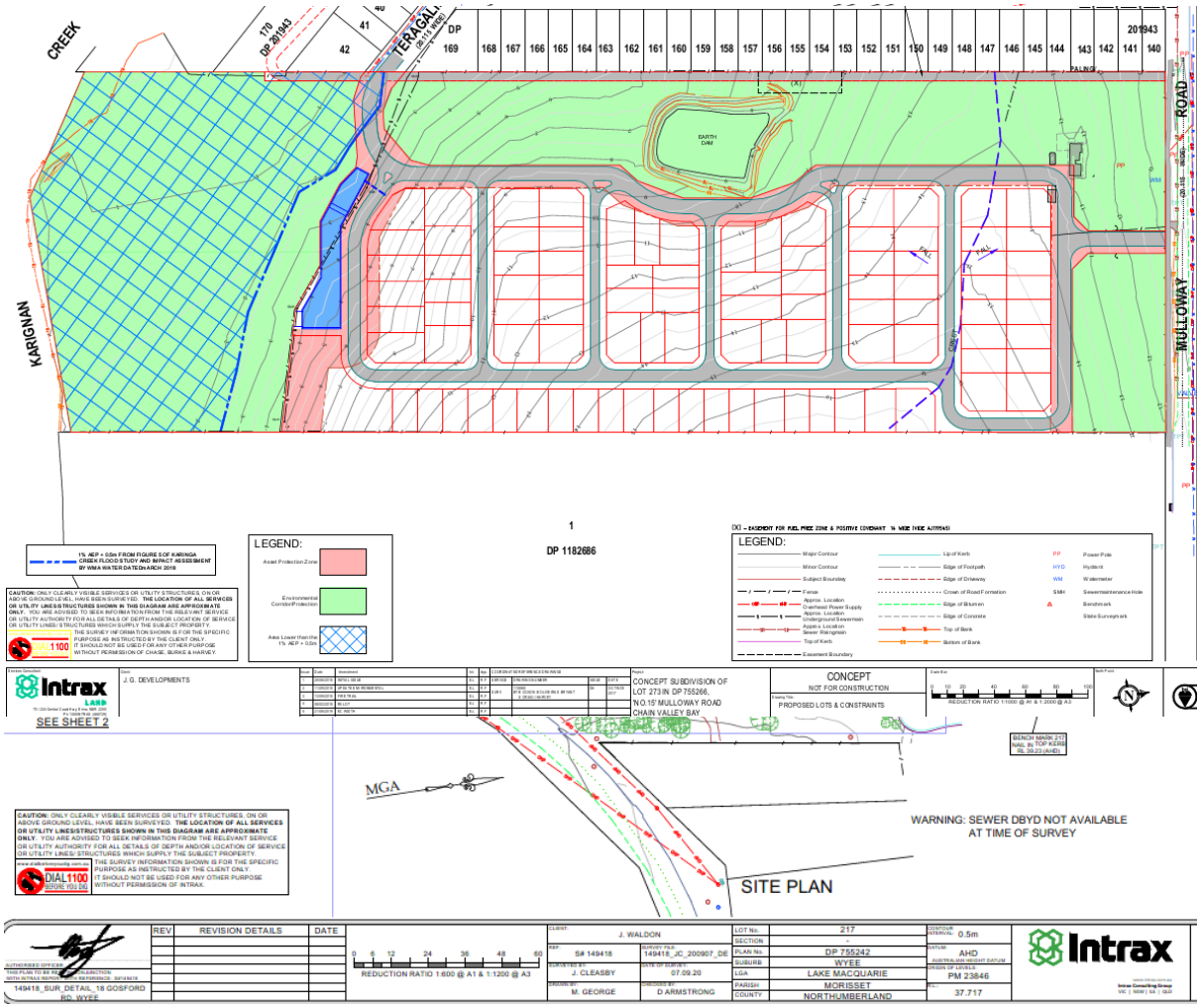


Figure 3.1. Extract of the site survey. NOTE north point (image source INTRAX).

Much of the lot is covered with exotic pasture grasses.

There is also some Endangered Ecological Community (EEC) vegetation to the south of the development area. The site Stormwater Management Plan is designed to ensure no increase in the peak flow into the EEC.

Figure 3.2. Much of the development area is covered in thick pasture.

Figure 3.3. The vegetation is largely Kikuyu dominant improved pasture. There is some fireweed present.

Figure 3.4. Areas with lots of trees have minimal ground cover vegetation.

Figure 3.5. The surface soil is a loam. There is an increase in pebbles frequency with increasing depth.

Figure 3.6. The dam on the western side of the property is surrounded by a 1 to 1.5m high embankment. It is largely hydrologically separated from local overland flow. It is not included as a component of this Stormwater Management Plan.

3.2 SOILS

The site is underlain by the Doyalson Soil Landscape (Murphy, 1993). Table 3.1 shows some characteristics of the soil landscape.

Table 3.1. Attributes of the Gorokan Soil Landscape Group (Murphy, 1993).

Attribute	Doyalson	Comment
Landform	Gently undulating low rises	The site is sand dominant, so flow will be by both surface runoff and subsurface movement largely to the south and therefore to Karignan Creek
Parent material	Conglomerates and pebbly sandstone	Low fertility soils. This is important because the natural runoff is likely to have a relatively low nutrient concentration.
Soils	Moderately deep, with good internal drainage near the surface, but impermeable at depth.	Soils are free draining. "Much of the flow will be subsurface. The site is near the top of a rise the catchment, so there is minimal run-on. Figure 2.5 shows the sand dominant topsoil.
Fertility	Strongly acid and very low fertility	Lawn establishment will require fertilizer. Liming would normally be required.
Topsoil	Loose sand to loamy sand	Free drainage through the topsoil. , but sandy clay loam to sandy clay subsoil acts as throttle, minimising deep drainage.
Subsoil	Varies from sandy clay loam to sandy clay.	Impeded internal drainage in subsoil. This means that once the lower, relatively flat parts of the landscape become saturated, they will rely on runoff.

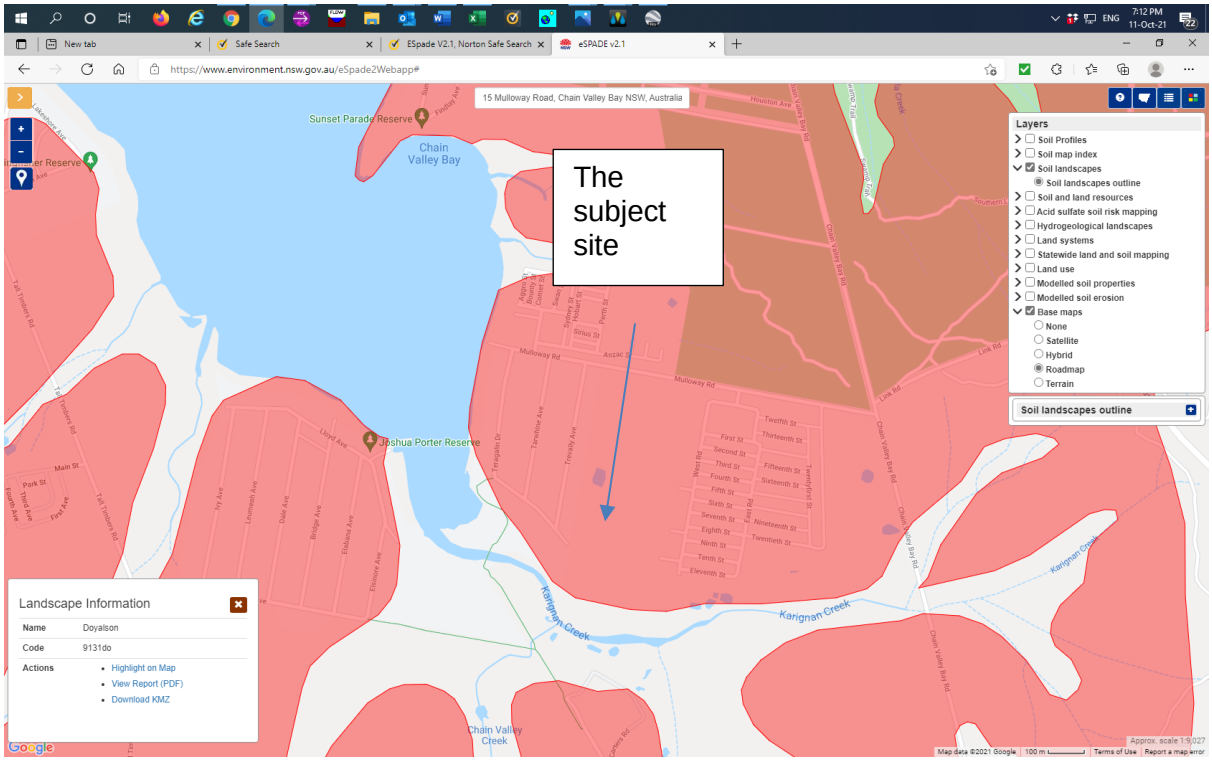


Figure 3.6. The site is underlain by the Doyalson Soil Landscape (Source: NSW Gov).

The soils have minor drainage limitations in the subsoil. This can result in waterlogging on lower slopes where run-on accumulates. This is an issue for the southern portion of the site. However local vegetation is adapted to wet conditions.

It is critical that peak flows are not increased by the development. Additionally, the site drainage should be via a relatively flat scour protection zone that dissipates water energy before the water enters the native forest and flows towards Karignan Creek.

Soil particle size distribution

Soil particle size distribution was assessed as it is a major determinant of stormwater infiltration rate. The results are shown in table 3.2.

Some of the key findings are:

- Gravel comprised 1 to 47% of the sol.
- Coarse sand comprised 11 to 57% of the soil.
- All samples except CVB 1, 30 to 50 cm had less than 10% clay.

Based on silt and clay percentages all but one sample were loamy sands. Sample CVB 1, 0-50 cm was a sandy loam.

Table 3.2. The particle size distribution in four topsoil and four subsoil samples.

SAMPLE ID	Depth increment (cm)	TOTAL GRAVEL > 2 mm	GRAVEL > 4.75 mm	GRAVEL 2.00-4.75 mm	COARSE SAND 200-2000 µm (0.2-2.0 mm)	FINE SAND 20-200 µm (0.02-0.2 mm)	SILT 2-20 µm ISSS	CLAY < 2 µm	Texture triangle
		(% of total oven-dry equivalent)							
CVB 1	10 to 30	37	33	4	22	33	3	5	Loamy sand
CVB 1	30 to 50	15	4	11	33	33	7	12	Sandy loam
CVB 2	0 to 10	1	0	1	57	25	10	8	Loamy sand
CVB 2	10 to 55	33	31	2	11	47	5	4	Loamy sand
CVB 3	0 to 7	2	0	2	37	33	19	9	Loamy sand
CVB 3	7 to 65	30	20	10	26	31	8	5	Loamy sand
CVB 4	6 to 20	47	40	7	27	15	8	4	Loamy sand
CVB 4	20 to 50	23	13	10	29	32	11	5	Loamy sand

In order to ensure a conservative design, the surface soil was assumed to be a sandy loam.

Sand dominant soils have quite different hydraulic characteristics to the WSC (23010). rainfall-runoff characteristic given as default values for low land site. However the more conservative WSC values for low land sites have been used.

3.3 CLIMATE

Climate data was obtained from the Bureau of Meteorology web site. Norah Head is the nearest relevant meteorological station. It is some 11 km south of the subject site.

Table 3.3. Climate data for Norah Head AWS (061366). Rainfall and temperatures since 1995. Source: BoM.

Attributes	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean maximum temperature (Degrees C)	26	26	25	23	20	18	18	19	21	23	24	25	22
Mean minimum temperature (Degrees C)	20	20	19	16	13	11	10	11	13	15	17	19	15
Mean rainfall (mm)	81	118	116	126	128	157	86	70	61	64	91	65	1154
Decile 1 monthly rainfall (mm)	13	27	51	39	16	31	10	9	14	10	21	28	905
Decile 5 (median) monthly rainfall (mm)	72	96	111	97	111	152	63	58	49	57	87	68	1130
Decile 9 monthly rainfall (mm)	172	208	176	266	236	273	181	143	133	96	147	108	1429
Mean number of days of rain >= 1 mm	8	8.6	9.3	9	8.8	10.2	7.3	5.9	7.2	6.8	8.4	6.8	96.3
Mean number of days of rain >= 10 mm	2.3	3.8	3.5	3.7	3.6	4.1	2.9	1.9	2	1.8	2.8	2.3	34.7
Mean number of days of rain >= 25 mm	0.9	1.3	1.5	1.5	1.6	1.9	0.8	0.7	0.5	0.6	0.8	0.4	12.5
Highest daily rainfall (mm)	89	95	130	97	113	235	112	115	61	89	120	79	235
Mean daily solar exposure (MJ/(m*m))	23.4	20.6	17.3	13.6	10.9	8.6	10.3	13.5	17.3	20	21.7	23.3	16.7

Mean daily temperatures range from an average maximum of 26 degrees in January to a mean minimum of 10 degrees in July[2]. The average daily range is 7 degrees. The annual average temperature is 18 degrees. The temperature data suggests a warm temperate climate which would allow year round growth of temperate climate vegetation. Heavy frosts are unlikely.

[2] The subject site is some 5 km from the Pacific Ocean. However, there are several large coastal lakes between the site and the ocean. These would reduce daily temperature range.

The mean monthly rainfall is highest in late autumn/ early winter and least in early spring. This is indicative of a humid temperate climate. Some moisture stress can occur in spring. This will increase demand for irrigation (and therefore more likely drawdown from the proposed rainwater tanks).

Rainfall in excess of 25 mm in a single day is most common in early winter. Flooding of the nearby Endangered Ecological Community (EEC) to the west of the subject site is most likely due to 'Eastern Lows' at this time of year.

There is little difference between the mean and the median annual rainfall. This suggests a relatively small range in variation in annual rainfall. Similarly, there is less than a two-fold variation between the 10 and the 90 percentile rainfall years. This is low compared with much of Australia, suggesting relatively reliable rainfall.

The highest daily total rainfall of 235 mm fell in June. Highest falls occur in winter. This season is when risk of stormwater damage and runoff rate would be greatest.

Solar radiation has the expected annual variation, ranging from 23 MJ/ (m*m/day) in summer to 8 MJ/ (m*m/day) in mid-winter.

3.4 RAINFALL INTENSITY

Rainfall intensity duration data was obtained from the BoM website. The 1987 data method (1987 Australia Rainfall and Runoff, AR&R87), was used because the information is intended to calculate stormwater runoff based on the probabilistic method

Table 3.4. Rainfall intensity expressed in mm/hr. Based on IFD data for the subject site. Source: BoM.

Duration	Duration in min	Annual Exceedance Probability (AEP)						
		63.20%	50%	20%	10%	5%	2%	1%
1 min	1	133	151	214	262	313	388	452
2 min	2	112	128	182	223	267	330	382
3 min	3	104	118	168	205	246	304	352
4 min	4	97.4	111	157	192	229	284	329
5 min	5	91.9	104	148	181	216	267	311
10 min	10	72.3	82.2	116	142	170	211	246
15 min	15	60.3	68.5	96.9	119	142	176	206
20 min	20	52	59.2	83.8	103	123	153	178
25 min	25	46.1	52.4	74.3	91	109	135	158
30 min	30	41.5	47.2	67	82.1	98.3	122	142
45 min	45	32.5	37	52.6	64.4	77.2	95.8	112
1 hour	60	27.2	30.9	43.9	53.8	64.4	79.9	93
1.5 hour	90	21	23.9	33.9	41.5	49.6	61.4	71.3
2 hour	120	17.5	19.9	28.2	34.5	41.2	50.8	58.9
3 hour	180	13.5	15.4	21.7	26.5	31.6	38.9	45.1
4.5 hour	270	10.5	12	16.9	20.5	24.4	30	34.6
6 hour	360	8.83	10	14.1	17.1	20.3	25	28.8
9 hour	540	6.91	7.85	11	13.4	15.9	19.4	22.4

Duration	Duration in min	Annual Exceedance Probability (AEP)						
		63.20%	50%	20%	10%	5%	2%	1%
12 hour	720	5.81	6.6	9.27	11.3	13.3	16.3	18.8
18 hour	1080	4.53	5.16	7.27	8.83	10.5	12.8	14.8
24 hour	1440	3.78	4.31	6.1	7.42	8.8	10.8	12.5
30 hour	1800	3.28	3.74	5.31	6.47	7.69	9.44	10.9
36 hour	2160	2.9	3.32	4.73	5.77	6.86	8.44	9.72
48 hour	2880	2.38	2.73	3.91	4.79	5.71	7.02	8.08
72 hour	4320	1.78	2.04	2.94	3.61	4.32	5.3	6.09
96 hour	5760	1.43	1.64	2.36	2.9	3.48	4.25	4.87
120 hour	7200	1.19	1.37	1.97	2.42	2.9	3.52	4.03
144 hour	8640	1.03	1.18	1.69	2.07	2.47	2.98	3.41
168 hour	10080	0.908	1.04	1.47	1.8	2.14	2.57	2.92

The 50% AEP IFD **does not** correspond to the 2 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 1.44 ARI.
* The 20% AEP IFD **does not** correspond to the 5 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 4.48 ARI.

Table 3.5. Rainfall intensity expressed in mm. Based on IFD data for the subject site. Source: BoM.

Duration	Duration in min	Annual Exceedance Probability (AEP)						
		63.20%	50%	20%	10%	5%	2%	1%
1 min	1	2.22	2.52	3.56	4.36	5.22	6.47	7.53
2 min	2	3.75	4.27	6.06	7.43	8.9	11	12.7
3 min	3	5.19	5.91	8.38	10.3	12.3	15.2	17.6
4 min	4	6.49	7.38	10.5	12.8	15.3	18.9	22
5 min	5	7.66	8.7	12.3	15.1	18	22.3	25.9
10 min	10	12.1	13.7	19.4	23.7	28.3	35.2	41
15 min	15	15.1	17.1	24.2	29.7	35.5	44.1	51.4
20 min	20	17.3	19.7	27.9	34.2	41	50.9	59.4
25 min	25	19.2	21.8	31	37.9	45.4	56.4	65.8
30 min	30	20.7	23.6	33.5	41	49.2	61.1	71.2
45 min	45	24.4	27.8	39.4	48.3	57.9	71.9	83.7
1 hour	60	27.2	30.9	43.9	53.8	64.4	79.9	93
1.5 hour	90	31.5	35.9	50.9	62.3	74.5	92.1	107
2 hour	120	35	39.8	56.4	68.9	82.3	102	118
3 hour	180	40.6	46.2	65.2	79.6	94.8	117	135
4.5 hour	270	47.4	53.8	75.8	92.3	110	135	156
6 hour	360	53	60.2	84.6	103	122	150	173
9 hour	540	62.2	70.6	99.2	120	143	175	202
12 hour	720	69.7	79.2	111	135	160	196	226
18 hour	1080	81.6	92.9	131	159	188	231	266
24 hour	1440	90.8	104	146	178	211	259	299
30 hour	1800	98.3	112	159	194	231	283	327
36 hour	2160	105	120	170	208	247	304	350
48 hour	2880	114	131	188	230	274	337	388

72 hour	4320	128	147	212	260	311	382	439
96 hour	5760	137	157	227	279	334	408	468
120 hour	7200	143	165	237	291	348	423	484
144 hour	8640	148	170	243	298	356	430	491
168 hour	10080	153	174	248	302	360	431	491

4. THE PROPOSAL

4.1 DEVELOPMENT CONFIGURATION

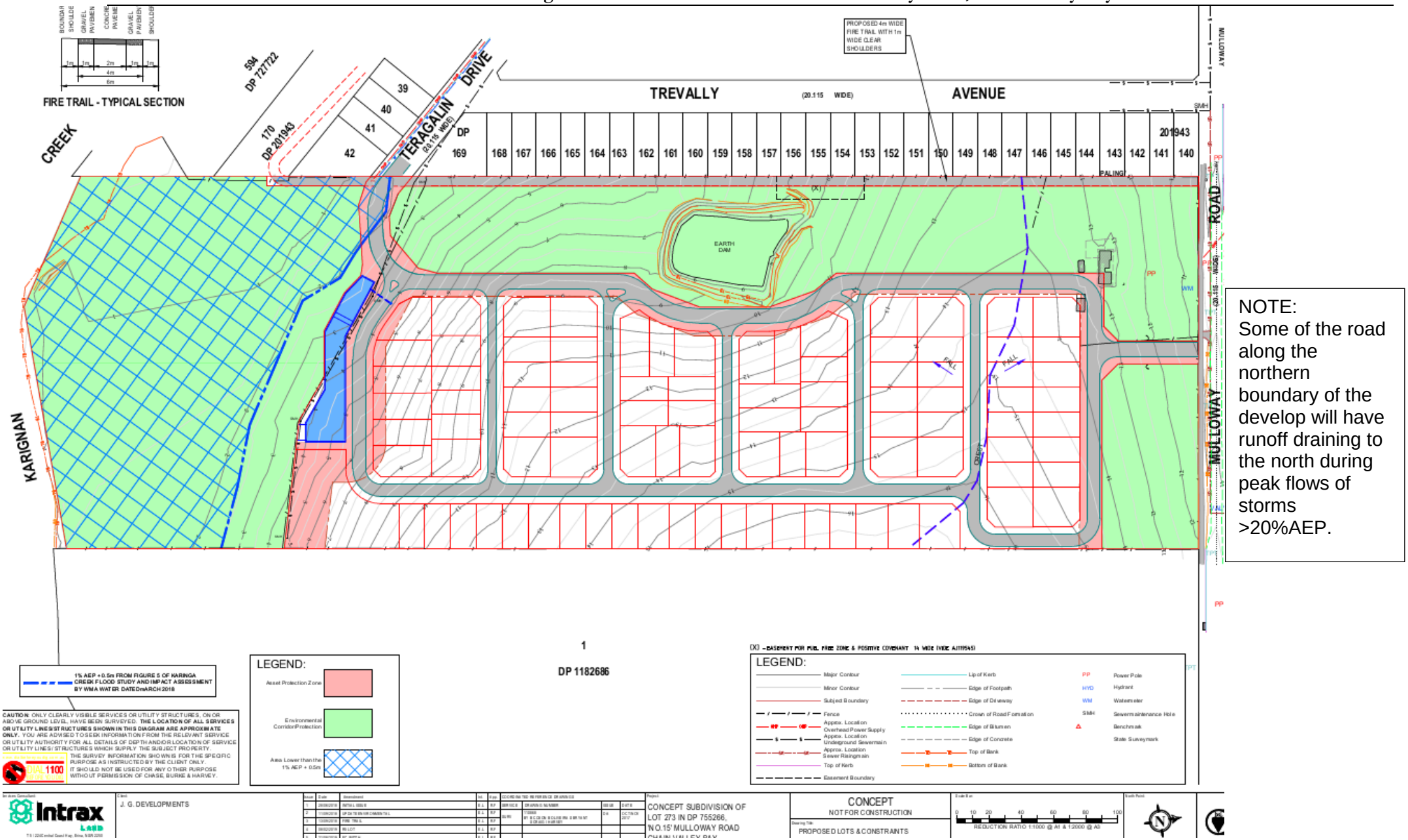
The subject site covers 16.4 ha. The development area is 8.3 ha. It is proposed to subdivide the 8.3 ha site (figure 3.1) into 94 low density residential lots. There will be asset protection zones (APZ) as per the bushfire consultant's recommendations. There is an Endangered Ecological Community (EEC). This has been excluded from the development area.

4.2 SUBDIVISION COMPONENTS

Figure 4.1 shows the conceptual layout.

Key features

- Total site development area 8.296 ha
- 94 dwellings
- Under low to medium storm events (at least to all of the 5%AEP storm), subsurface stormwater pipes will convey the development drainage to a single point in the SW corner.
- The flows will enter a sequence of sedimentation basin, trash rack, and a forested swamp basin.
- In higher flows an increasing portion of stormwater generated in the extreme NW corner of the development will be discharged towards Mulloway Road. This will be road run off from several hundred msq of road . It will be the 'top' of the hydrograph. So the 'first flush' flows containing a high proportion of the contaminant load will have already been conveyed to the Stormwater Treatment Devices I the SW of the site.
- A large lot (no. 7097) in SE corner includes Asset Protection Zone (APZ) in it.
- Assumed roof area is 200 msq for dwellings on 450 msq lots and 250 msq for dwellings on lots >250 msq roofs.
- All 94 dwellings are each connected to a rainwater tank with a minimum effective storage of 5 cubic m. The roof catchment was set at 50% of roof area to allow for dwellings that are not fully and effectively capturing and utilising rainwater.
- The rainwater tank supplies the toilets (0.235 cubic m/day based on 4 bedroom homes),and the gardens (average of 0.15 cubic m/day averaged over a typical year).
- All flow enters a 300 msq sedimentation basin. This basin is 1.2 m deep
- This basin has a trash rack to detain gross pollutants such as PET bottles.
- Excess water overtops the boundary of the basin and enters a 1200 msq forested bio retention basin,
- The forested basin discharges over a low level weir onto riprap that dissipates the outflow.



NOTE:
Some of the road along the northern boundary of the develop will have runoff draining to the north during peak flows of storms >20%AEP.

Figure 4.1. The proposed subdivision layout (Source: INTRAX).

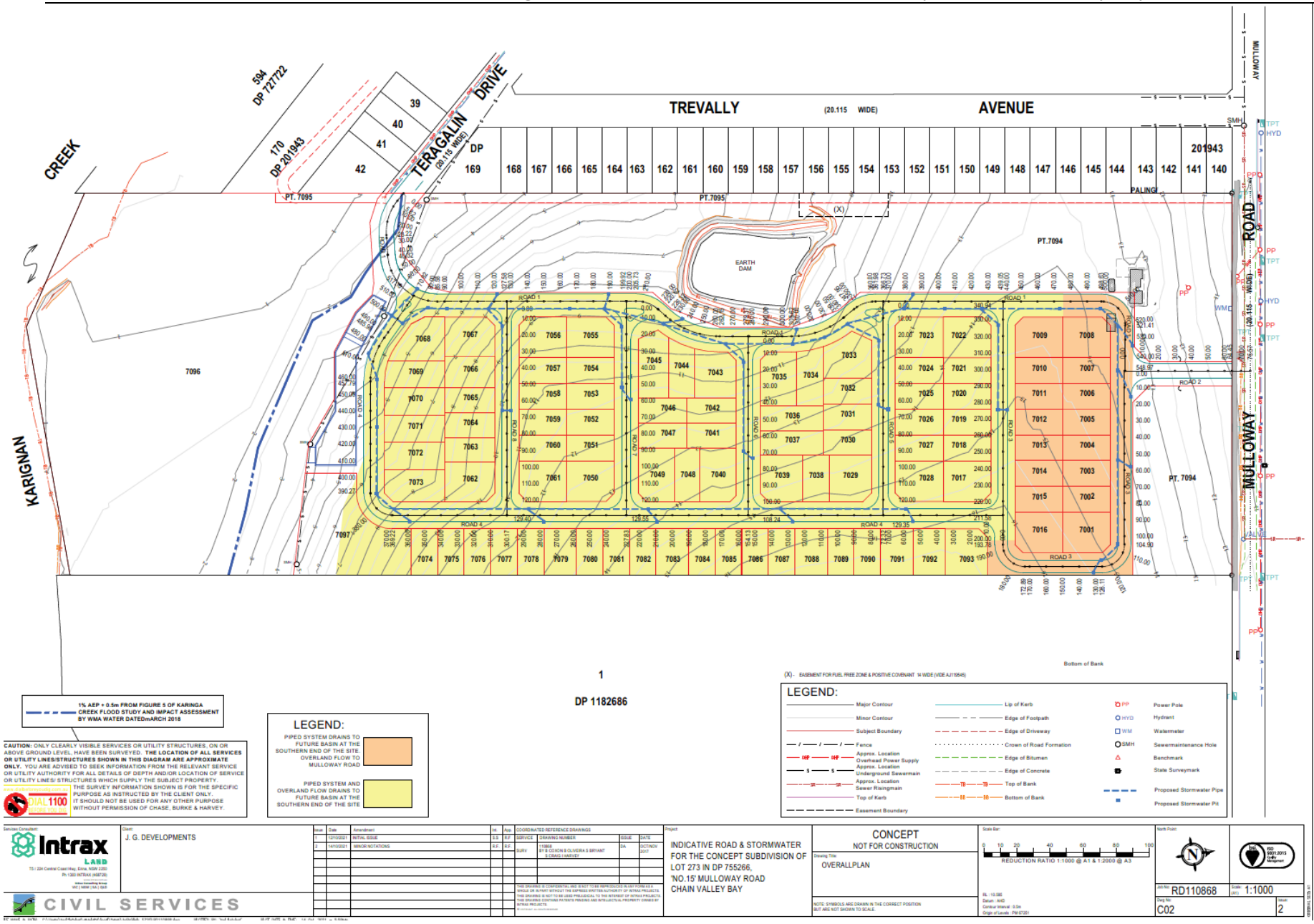


Figure 4.2. The proposed subdivision layout showing catchments(Source: INTRAX)

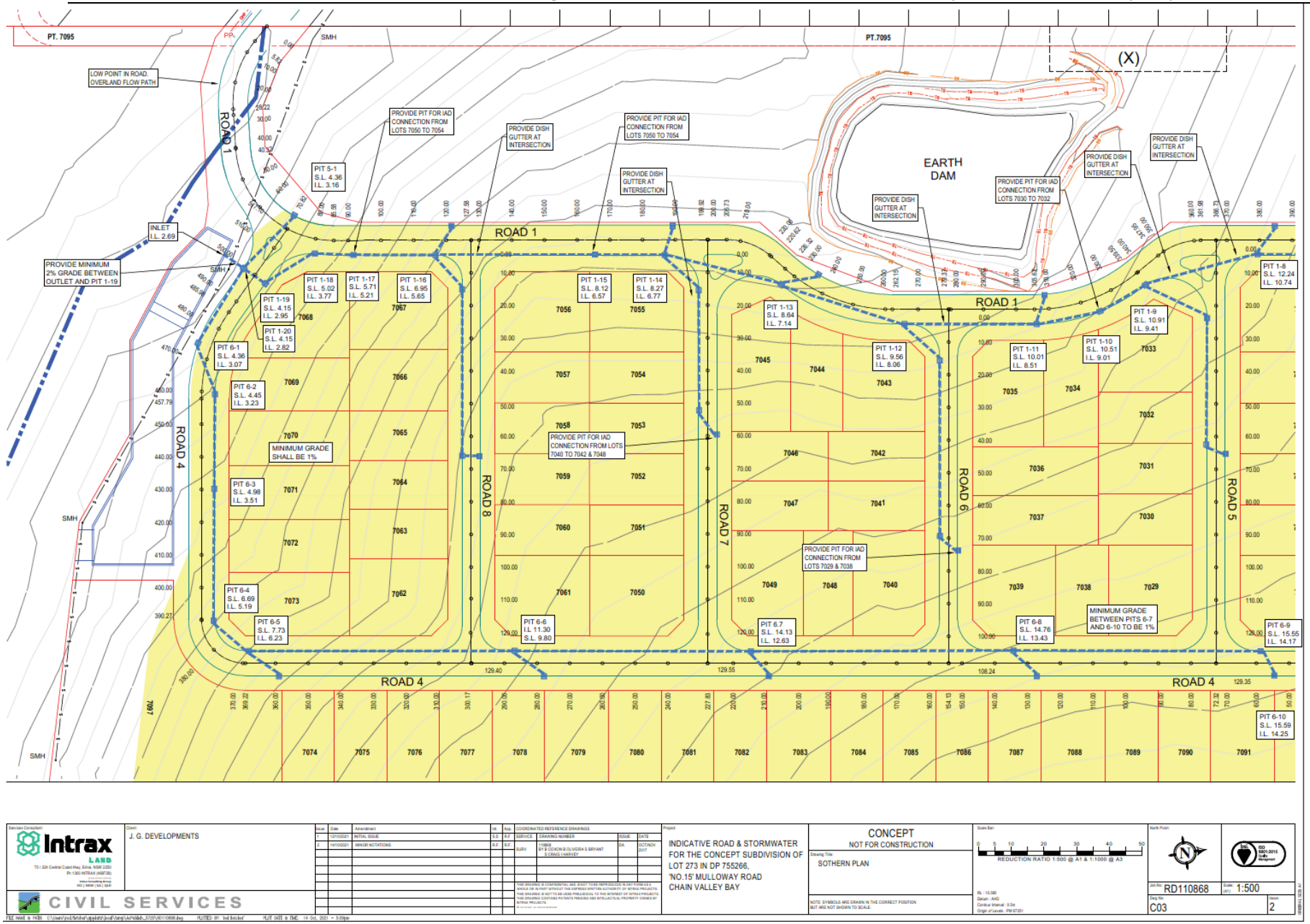


Figure 4.3. The proposed subdivision layout showing southern portion drainage system and associated inverts. (Source: INTRAX)

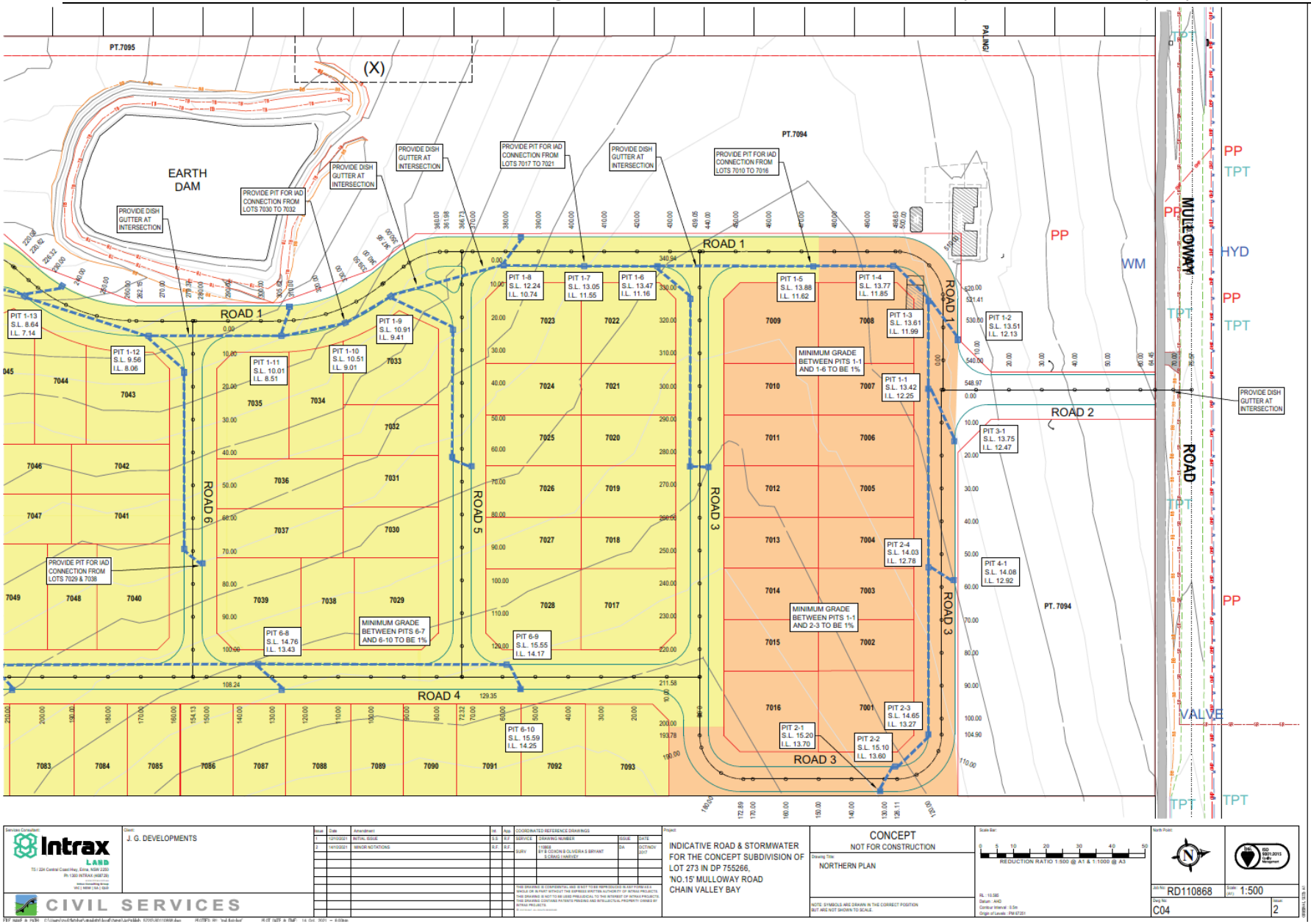


Figure 4.4. The proposed subdivision layout showing northern portion drainage system and associated inverts. (Source: INTRAX)

Figure 4.5. A steel trash rack is effective at detaining a wide range of large particulate matter. A return on the horizontal top of the rack would ensure there is minimal escape of litter during extreme storm events.

Figure 4.6. The forested wetland will have subsurface , porous pipes to facilitate rapid drainage of excess water.

4.3 MUSIC MODEL PARAMETERS

Soil conditions

An examination of the soil during site inspection indicated that the soil typically had a loamy sand to a sandy loam texture in the surface 500 mm (see table 3.2, above).
The slope of the proposed development area is 2 to 6 7%.

The anticipated contaminant concentrations and the reaction rate coefficients were the default coefficients in MUSIC Version 6. Additional information was from SCA (2012) .

The soil parameters for 'lowland' soil from table 4 in WSC (2010) were used. These are conservative values, and are therefore likely to overpredict runoff volume. This is illustrated in table 4.1.

Table 4.2. Soil hydrological parameters (from SCA, 2012 table 4.5, original source Macleod, 2008) and from Table 4 in WSC (2010).

Parameter	Units	Coefficients based on the sandy loam texture on this site	Default coefficients for lowland soils from table 4 of WSC (2010)
Soil properties			
Rainfall runoff threshold from impervious surfaces	mm	1	1
Soil water storage capacity	mm in surface 500 mm	98	100
Initial storage	% of capacity	30	30
Infiltration coefficient -a		250	100
Infiltration coefficient-b		1.3	1
Groundwater properties			
Initial depth	mm	10	10
Daily recharge	%	60	4
Daily baseflow rate	%	45	2
Daily deep seepage rate	%	0	0.4

The critical changes due to using the default WSC coefficients are:

- The likely infiltration coefficient 'a' is only 40% of that expected for the sand dominant soil on the subject site (100 mm/day compared with 250 mm/day)
- Daily recharge % in the default model is only 7% of that expected for soil of this texture (see SCA, 2012)

- Daily base flow % in the default model is only 4% % of that expected for soil of this texture (see SCA, 2012)

All three of these coefficients impact on the runoff volume and consequently the volume of water percolating through the soil. .

Figure 4.7, below shows the rainfall-runoff model (copied from eWater, 2021).

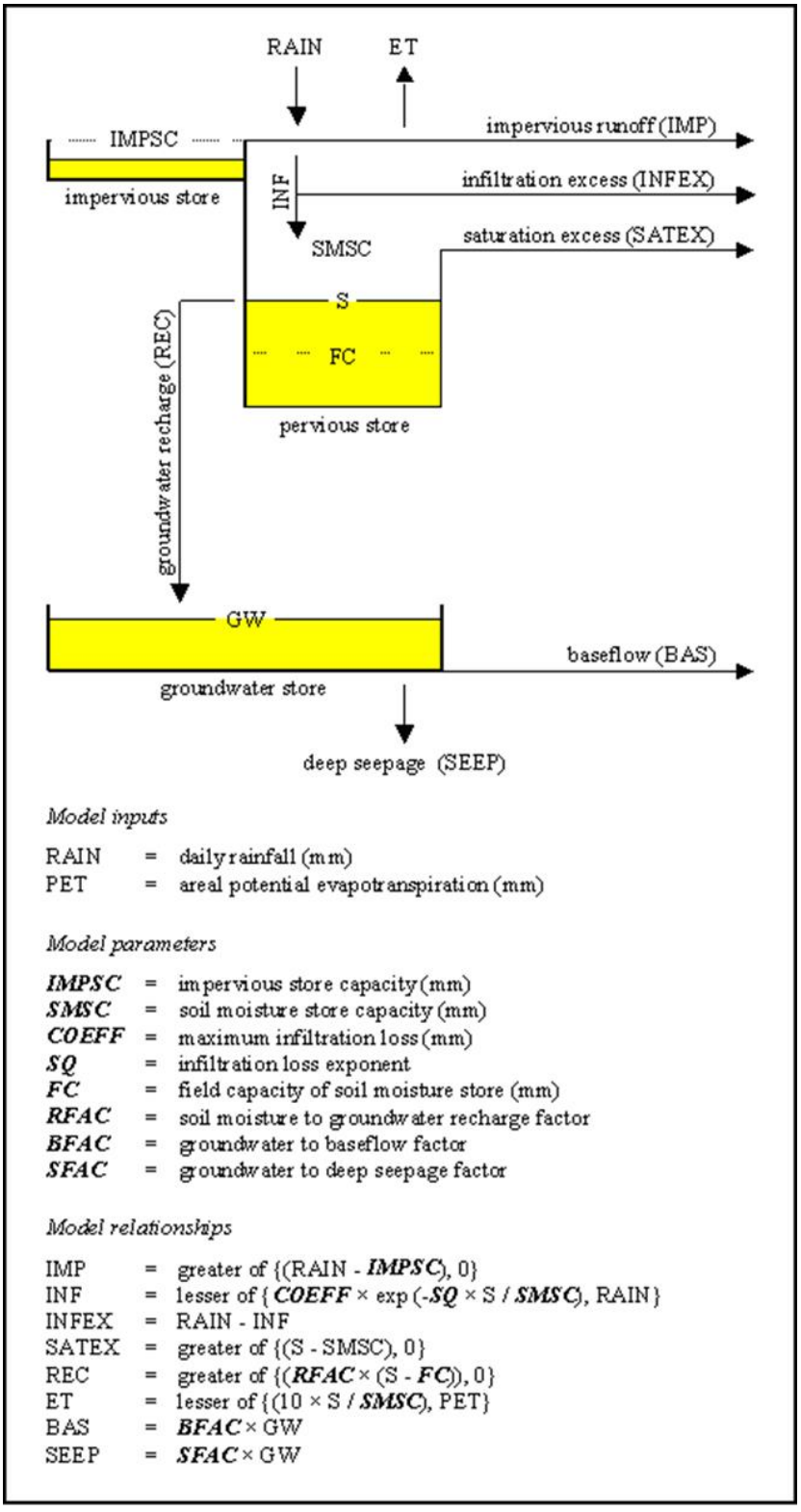


Figure 4.7. The runoff- infiltration model in MUSIC

Pollutant concentration parameters

Pollution management parameters were taken from MUSIC version 6.3, which was the current version in October 2021[3].

These are shown in table 4.3. The pre-development landuse mode was 'forest' (coefficients from MUSIC Version 6.3). It was used in preference to 'agricultural mode' because unlike 'agricultural' landuse, there has been minimal soil disturbance, at least in recent years.

Table 4.3. Assumed contaminant parameters for forests (from SCA 2012, tables 4.6 and 4.7). Based on work of Fletcher et al, 2004).

Contaminant	Flow	Mean (log mg/L)	Std deviation (log mg/L)
Total Suspended Soilds (TSS)	Base flow	0.78	0.130
	Storm flow	1.6	0.200
Phosphorus	Base flow	-1.52	0.130
	Storm flow	-1.10	0.220
Nitrogen	Base flow	-0.52	0.130
	Storm flow	-0.05	0.240

Table 4.4. Assumed contaminant parameters for residential landuse (from SCA 2012, tables 4.6 and 4.7). Based on work of Fletcher et al, 2004). Note that the verges will be treated as residential lands in the MUSIC modelling.

Contaminant	Flow	Mean (log mg/L)	Std deviation (log mg/L)
Total Suspended Soilds (TSS)	Base flow	1.2	0.170
	Storm flow	2.15	0.320
Phosphorus	Base flow	-0.85	0.190
	Storm flow	-0.60	0.250
Nitrogen	Base flow	0.11	0.120
	Storm flow	0.30	0.190

[3] A new version of MUSIC will be released shortly, but it does not yet have MUSIC-link function. So, MUSIC 6.3 has been used below.

Table 4.5. Assumed contaminant parameters for roofs (from SCA (2012) Modelling Guidelines tables 4.6 and 4.7). No base flow runoff is assumed for the roofs.

Contaminant	Flow	Mean (log mg/L)	Std deviation (log mg/L)
Total Suspended Soilds (TSS)	Base flow	Not applicable	Not applicable
	Storm flow	1.30	0.320
Phosphorus	Base flow	Not applicable	Not applicable
	Storm flow	-0.89	0.25
Nitrogen	Base flow	Not applicable	Not applicable
	Storm flow	0.30	0.19

Table 4.6. Assumed contaminant parameters for sealed roads (from SCA (2012) MUSIC Modelling Guidelines tables 4.6 and 4.7). NOTE: The road sealed 'width' is set at 8 m.

Contaminant	Flow	Mean (log mg/L)	Std deviation (log mg/L)
Total Suspended Soilds (TSS)	Base flow	1.20	0.17
	Storm flow	2.43	0.32
Phosphorus	Base flow	-0.85	0.19
	Storm flow	-0.30	0.25
Nitrogen	Base flow	0.11	0.12
	Storm flow	0.34	0.19

The verges were treated as a separate source node in the MUSIC modelling. The parameters were based on residential land use as per table 4.4.

Meteorological data

Meteorological data were obtained from the Bureau of Meteorology (2020) and from Ewater pluviograph data. The pluviograph data was from 1974 to 1993. The average annual rainfall in this period was 1290 mm.

The evapotranspiration data given in table 3 of Wyong Shire Council (2010a) used in MUSIC modelling. This is shown in table 4.6.

Table 4.7. Evapotranspiration data from table 3 of WSC, 2010a).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evapo transpiration	180	135	128	85	58	43	43	58	88	127	152	163

NOTE that the MUSIC-Link data for Lowland soils was used.

Rainwater capture

It is assumed that each dwelling will have a 5 cubic m rainwater tank connected to a minimum of 50% of the roof area. The roof area is assumed to be 200 msq, for lots of 4350 msq and 250 msq for lots >250 msq.

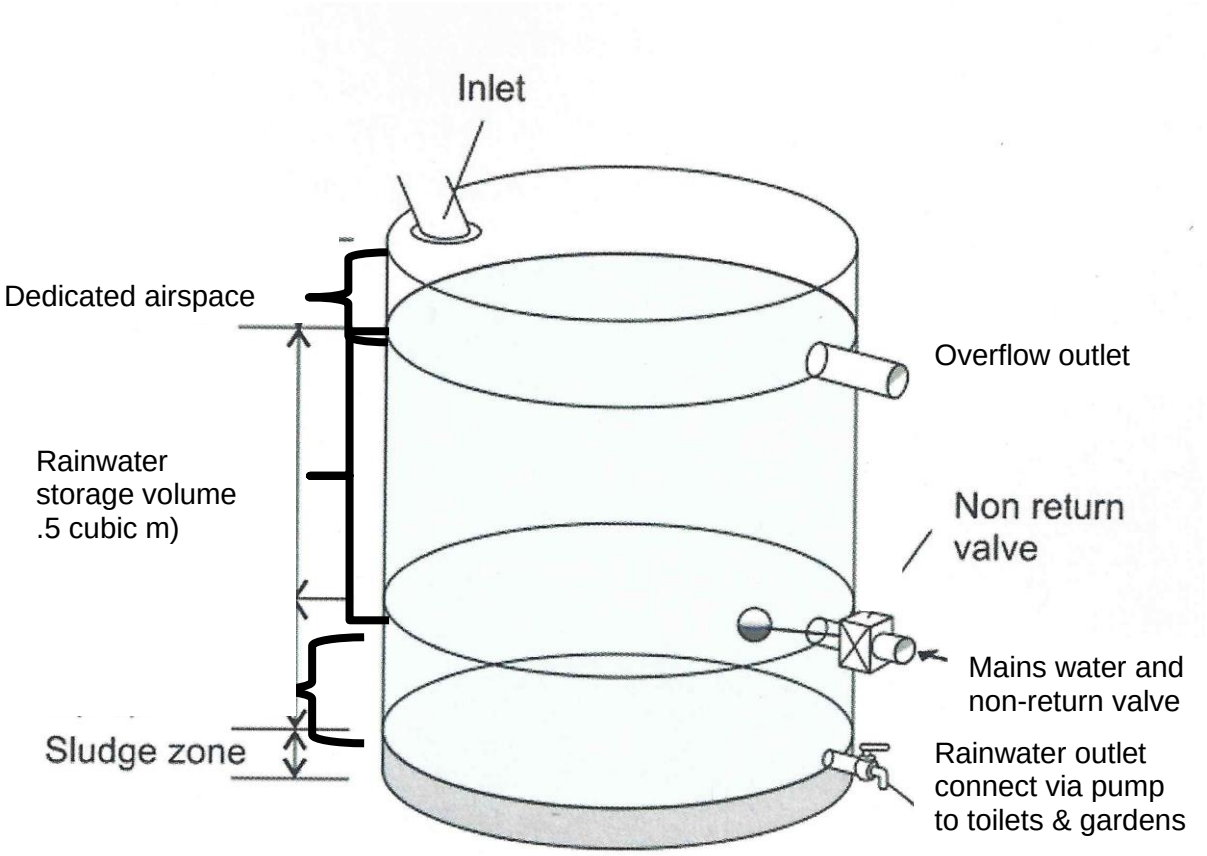


Figure 4.8. The tank design including OSD features (Sources: UPRCMT, 2005, SCA, 2012). The key issue is that it must have at least 5 cubic m of accessible rainwater storage[4].

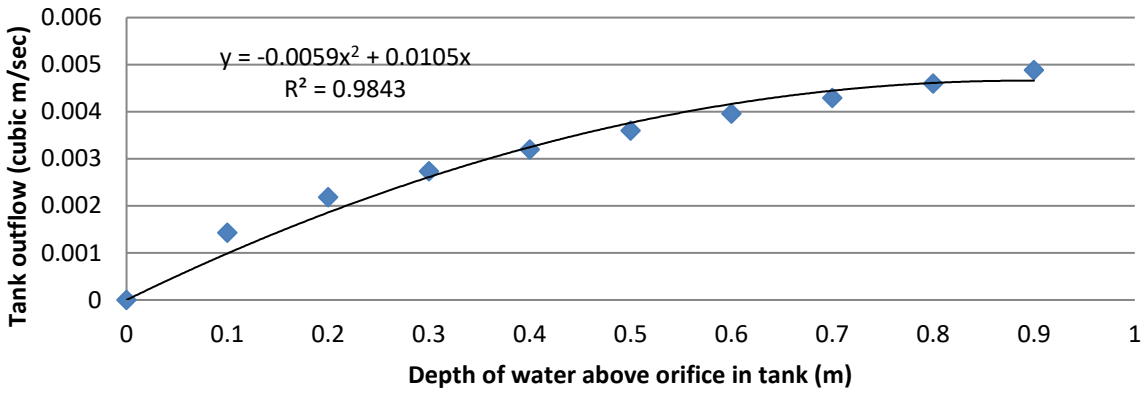
It is expected that the tank will have an inflow connected to the mains system. This will have a backflow prevention device as specified by the Council / Hunter Water.

The inlet and outlet should be a 50 mm ID orifice connected to a stormwater pipe.

Figure 4.3 shows the relationship between outflow rate (cubic m/sec) and height above the 50 mm orifice.

[4] *NOTE that a separate OSD/ stormwater detention pond may be needed to treat road runoff prior to the commencement of home construction. This can be included in the erosion and sediment plan for the site. It should be based on Landcom (2004)-the BLUE Book. The requirements of Chapter 2, Chapter 9 section 9.4 and Appendix M must be incorporated in the site development plan.*
The proposed sedimentation basin should be installed wetland footprint can be initially developed as a detention basin and then converted to a wetland once the roads and road drainage are installed.

Figure 4.9. Rate of outflow at various depths of water above the 50 mm ID orifice in the rainwater tank.



The height vs discharge curve in figure 4.9 was combined with the 100 Y ARI storm event to demonstrate the ability of small tanks to attenuate runoff even in major storms.

Rainwater reuse

Data from Coombes, et al (2003) is summarised in table 4.7.

Table 4.8. Water demands for urban dwellings assuming 4 bedrooms. Derived from Coombes, et al (2003). Presented in table 5.3 in SCA (2012).

Use component	Volume (kL/ 4 bedroom dwelling/day)[5]
Toilets	0.235
Toilets & Laundry	0.470
Toilets & laundry & hot water	0.845
Garden use (varies with current rainfall conditions)	0.15

Table 4.8 shows that the internal use for rainwater assuming 4 bedrooms and water being used in toilets, laundry and the hot water system is 0.845 cubic m/dwelling /day. It was decided to take a more conservative approach as assume the rainwater was only used for toilets. Based on 4 bedrooms, the average rate/day would be 0.235 cubic m/dwelling/day. This use rate was multiplied by the number of dwellings (0.235*94*365 = 8,063 cubic m/year demand).

Additionally, there is an annualised average of 0.15 cubic m/dwelling/day used to irrigate dwelling surrounds. The use rate was multiplied by the number of dwellings (0.15*94*365) = 5147 cubic m/year. This design only irrigated the lawns when the water was in storage and

[5] Each dwelling is assumed to have 4 bedrooms. Obviously, people rather than bedrooms determine flow. Coombs et al (2003), however was based on bedrooms

when there was no substantial rainfall. The rate applied per day was determined by the Potential Evapotranspiration (PET) as per MUSIC model parameters.

The rates and coefficients above were used in MUSIC modelling to determine the effectiveness of rainwater tanks in reducing contaminant export.

Stormwater generation sources within the lot

The assumed site components are set of below

- There is a total of 94 dwellings
- The average roof area, including eves is 200 msq on 450 msq lots and 250 msq on lots>450 msq
- An average of 50% of the roof area drains to a rainwater tank
- Each rainwater tank has an effective volume of 5 cubic m.
- Excess roof runoff is conveyed by pipe to local stormwater pipes.
- Yard drainage is calculated from lot size (msq)-roof area (msq)
- Verges are 4.5m wide on the upper side (includes 1.2m concrete path) and 3.5 m wide on the lower side of the road.
- The road is 8m wide and 100% sealed surface. It is assumed that the road had a centre crown
- The sedimentation basin is 300 msq in area and 1.3 m deep.
- There will be a trash rack between the sedimentation basin and the forested basin.
- The forested basin lot covers 1200 msq.
- APZ s are included as required.

Table 4.8 sets out the stormwater generation areas within the lot.

Table 4.8. The MUSIC model inputs for the various landuses.

Component	Area (ha)	Percentage impervious (%)
Roofs draining to rainwater tank	1.040	100
Roofs NOT draining to rainwater tank	1.040	100
Residue of lots	3.049	82
Verges & nature strips	1.522	70
Roads	1.495	100
Sedimentation basin and forested wetland	0.15	0
Total area	8.296	

The pre-development forest area is 8.296 ha

The MUSIC Model contains information on design components of each of the water quality devices.

Key attributes and coefficients are listed in Appendix 1.

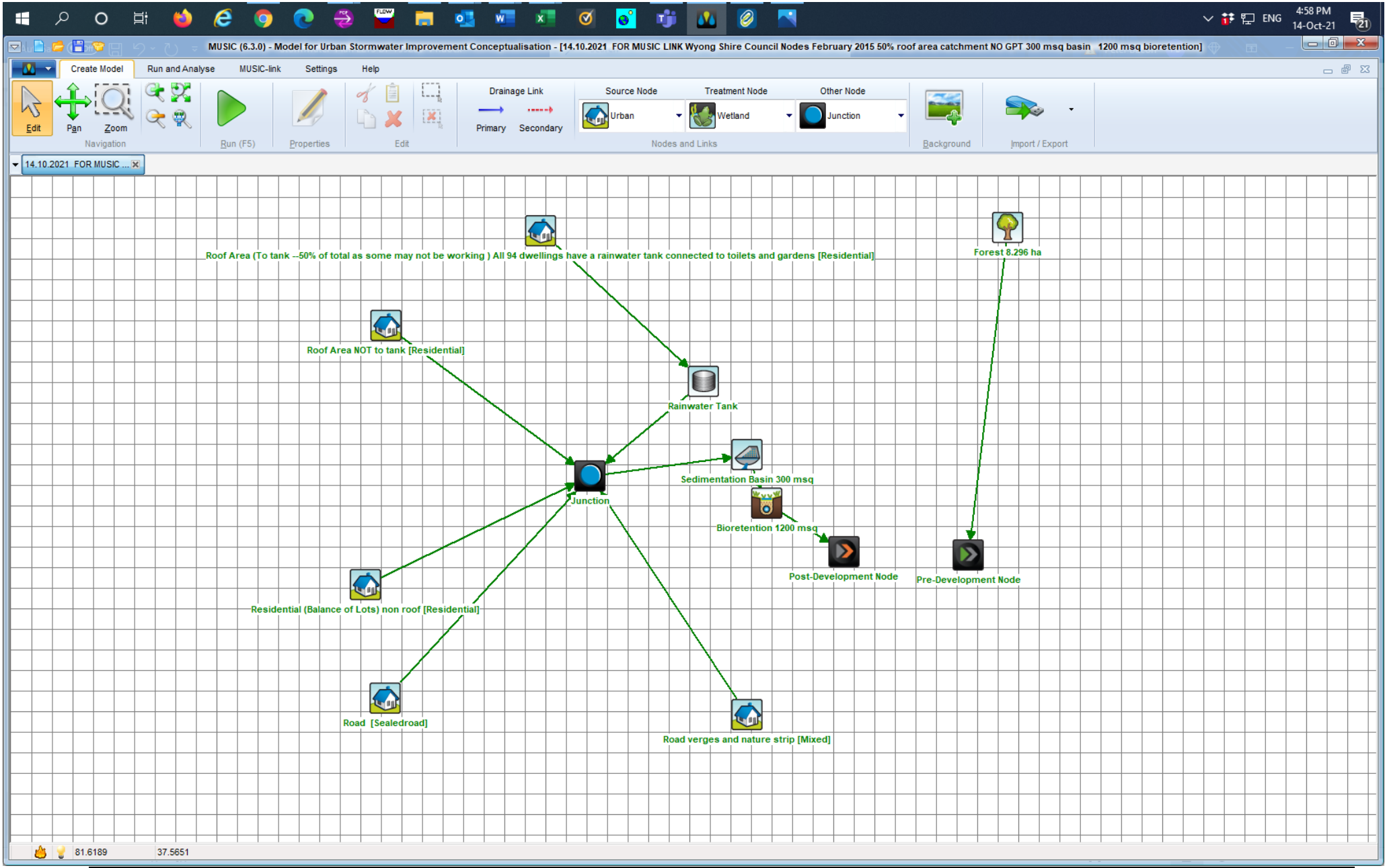


Figure 4.10. Screen print of the MUSIC model.

Rainwater tanks

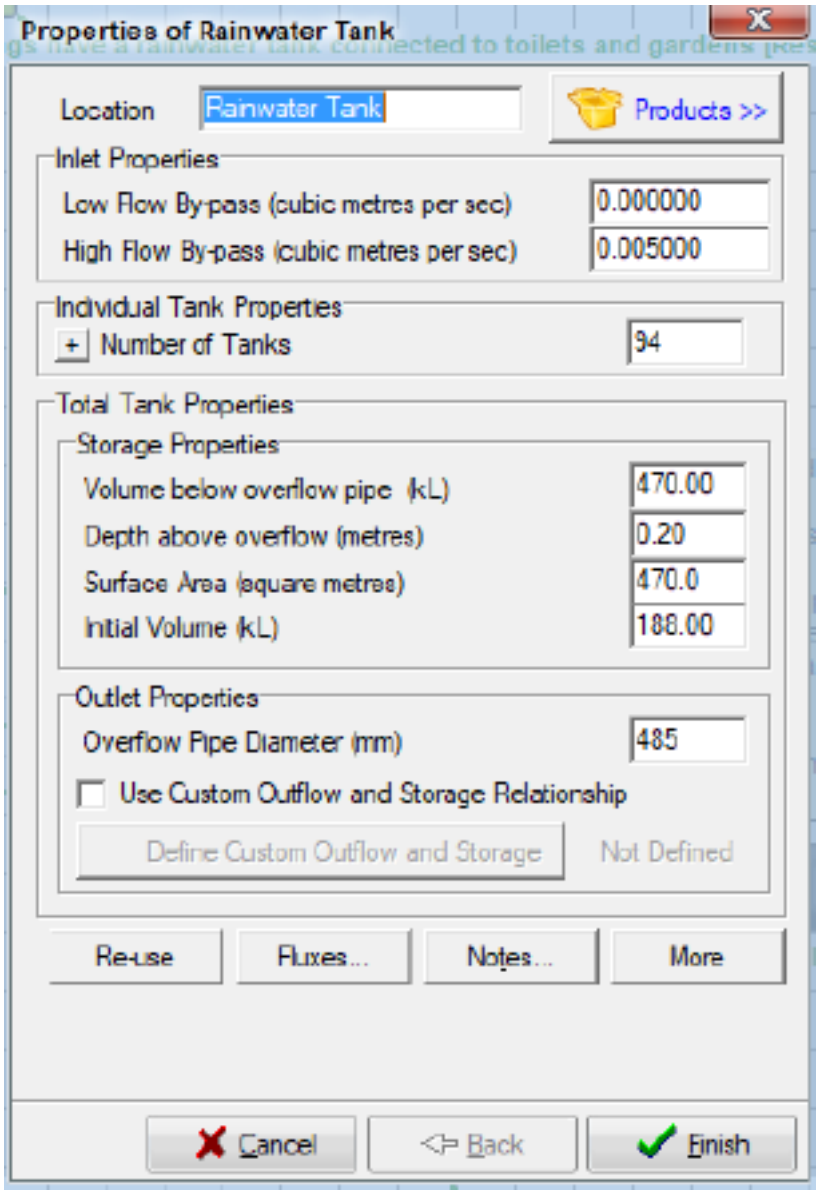


Figure 4.11. Screen shot of the rainwater tank properties.

The volumes are the total for the 94 lots.

Sedimentation basin

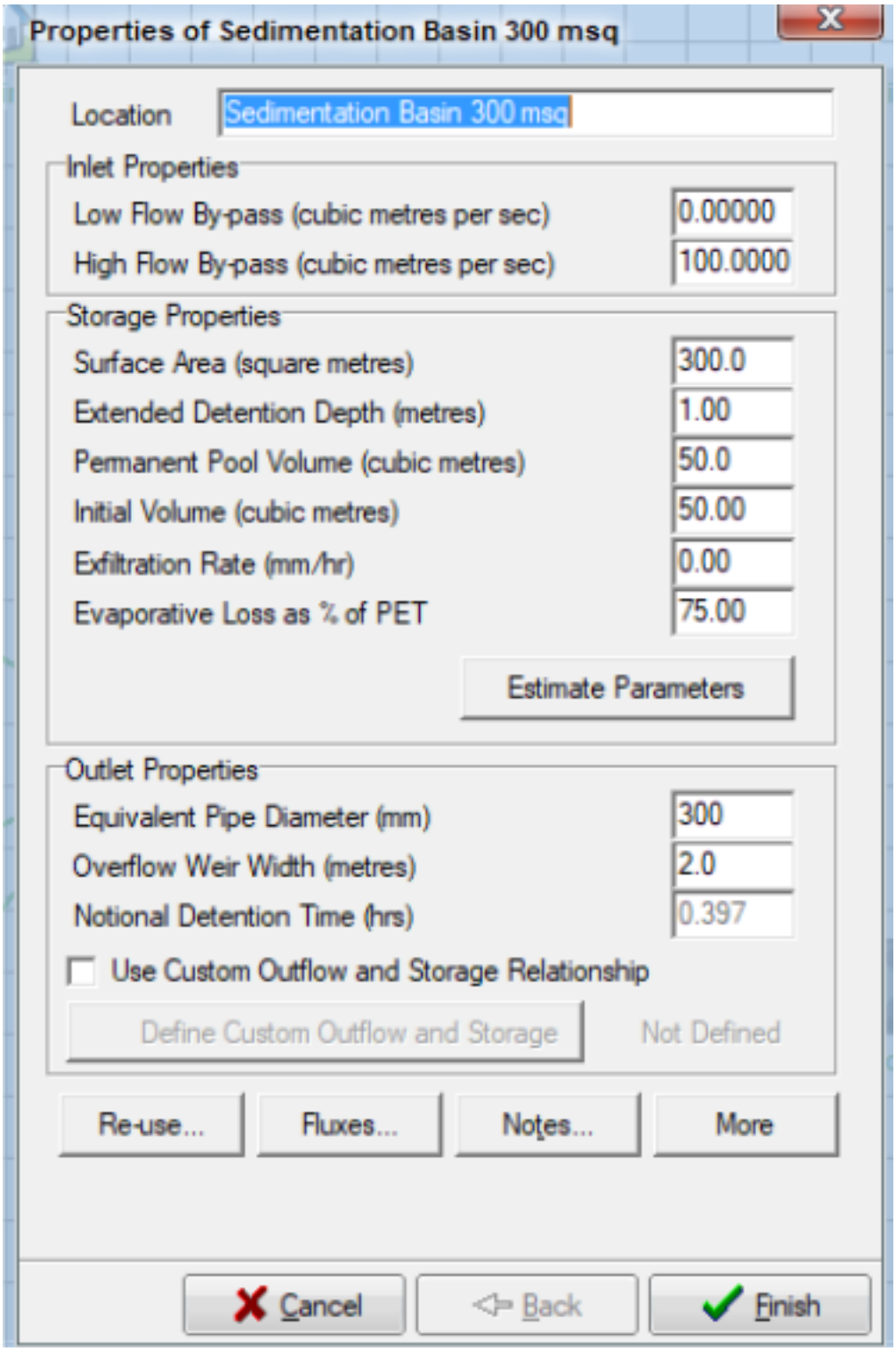


Figure 4.12. The properties of the 300 msq sedimentation basin.

Bioretention basins

The bioretention basin node was used as it is the closest MUSIC source node type to the proposed Swamp Sclerophyll Forest.

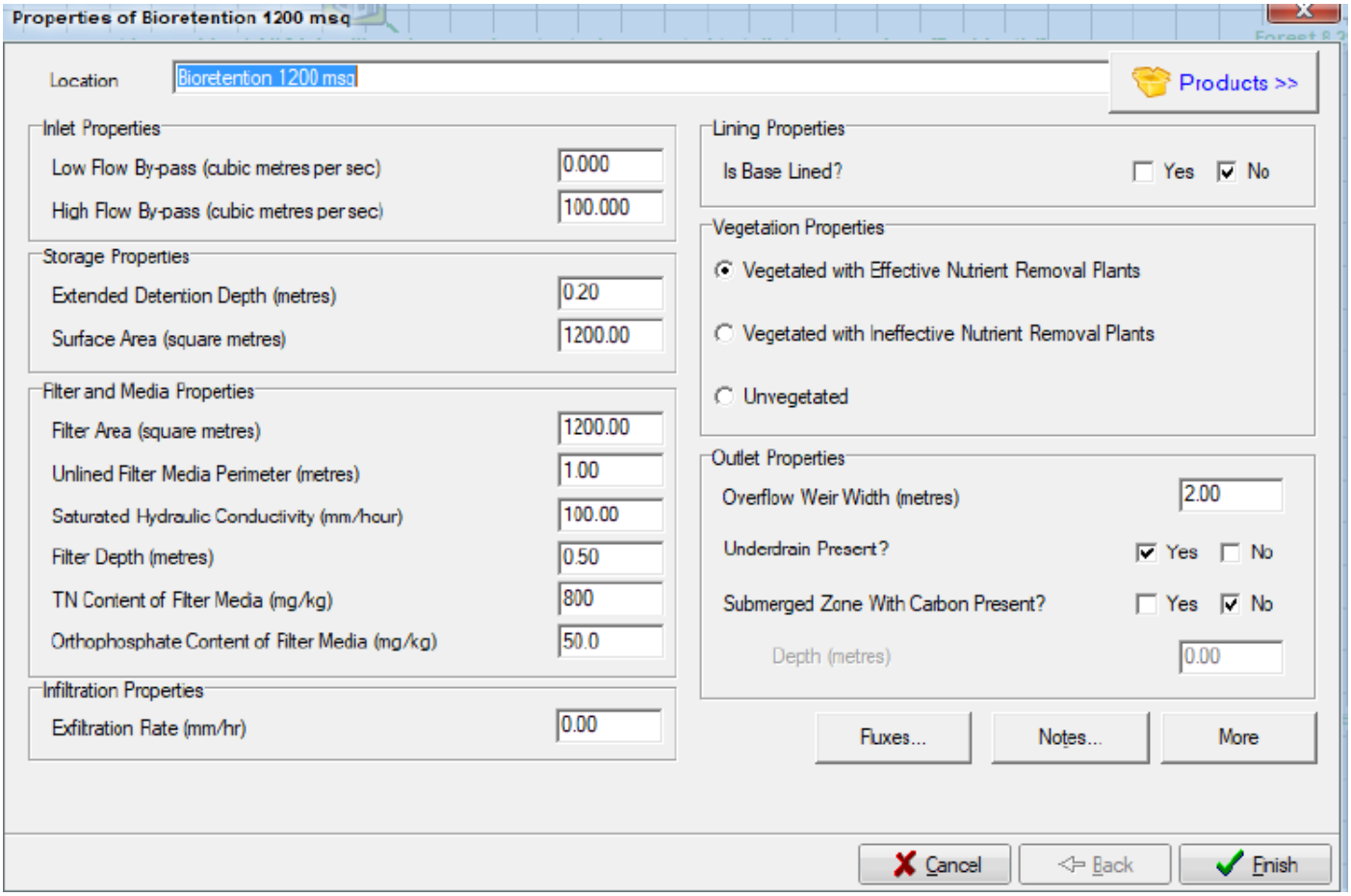


Figure 4.13. The properties of the 1200 msq forested basin.

The proposed vegetation in the Swamp Sclerophyll Forest

Species commonly found in the Swamp Sclerophyll Forest (PCT 1718) are typically moisture loving plants in sandy soils similar to the subject site.

Proposed planting density

- 1 tree every 50m^2,
- 1 sub-canopy tree every 25m^2,
- 1 shrub per 10m^2,
- groundcovers per 1m^2
- 1 vine per 15m^2.

Table 4.9 shows the species and the numbers required for the 1200 msq area..

Table 4.9. Species and plant numbers for the 1200 msq forested basin.

Scientific Name	Common Name	Numbers required
TREES		Assume 1 tree/ 50 msq therefore 24 trees
Angophora costata	Smooth-barked Apple	3
Eucalyptus capitellata	Brown Stringybark	3
Eucalyptus robusta	Swamp Mahogany	12
Melaleuca quinquenervia	Broad-leaved Paperbark	6
SUB-CANOPY		Assume 1 small tree/ 25 msq therefore 48 sub-canopy trees
Glochidion ferdinandi	Cheese Tree	8
Melaleuca sieberi	-	20
Melaleuca linariifolia	Snow in Summer	20
SHRUBS		Assume 1 shrub/ 10 msq therefore 120 shrubs
Acacia longifolia	Sydney Golden Wattle	20
Pultenaea villosa	-	20
Dodonaea triquetra	Hop Bush	30
Leptospermum juniperinum	Prickly teatree	50
GROUNDCOVERS		Assume 3 ground / 1 msq therefore 3600 shrubs
Pultenaea retusa	-	360
Pimelea linifolia	Slender Rice Flower	180
Pteridium esculentum	Bracken	180
Entolasia stricta	Wiry Panic	360
Panicum simile	Two Colour Panic	180
Gahnia clarkei	Tall Saw-sedge	720
Imperata cylindrica	Blady Grass	720
Goodenia heterophylla	Variable Leaved Goodenia	180
Lomandra longifolia	Spiny headed mat rush	720
VINES		Assume 1/15 msq therefore 80 vines
Billardiera scandens	Apple Dumplings	25
Hardenbergia violacea	False Sarsparilla	20
Glycine clandestina	Twining Glycine	45

If a species is not available then add its number to the species already selected. Do not change the species unless the ecologist agrees.

The provenance should be from the Central Coastal are of NSW.

Plants MUST be ordered at least 6 months prior to planting. The forested basin should be prepared at the same time as the roads and street drainage is installed.
Note that the sedimentation basin will act as a sediment collection point during construction. Therefore it must be de-silted prior to commissioning.

5. RESULTS-effects of WSUD actions within the subdivision

Table 5.1 shows the effect of the development with and without WSUD elements.

Table 5.1. Average annual stormwater flows and contaminant loads with and without WSUD elements. The predicted impact of WSUD actions on the change in flow and contaminant loads prior to development and after development + WSUD are also tabulated. Note that the simulation had unlined bioretention basins (Based on MUSIC 6.3 version). The percentage reduction due to WSUD implementation is highlighted in yellow.

Entire site	Pre-development	Development, but no WSUD	Development with WSUD	Percent reduction due to WSUD compared with no WSUD features	Indicative WSUD objectives expressed as a % change[6]	Compliance with WSUD objectives
	Pre	Post	Post			
Flow (ML/yr)	16	28	23	9	Not given	Not given
Total Suspended Solids (kg/yr)	1060	3690	691	91	80	YES
Total Phosphorus (kg/yr)	2.6	7.52	2.54	66	45	YES
Total Nitrogen (kg/yr)	25	61	27	56	45	YES
Gross Pollutants (kg/yr)	14	671	0	100	70	YES

The key predictions from table 5.1

- Use of WSUD resulted in a fall of
  - 9% in annual outflow,
  - 91% in TSS
  - 66% in TP
  - 56% in TN, and
  - 100% in gross pollutant export from the site

  Compared with the development without WSUD.

- The percentage reduction in TSS, TP, TN and GP are all compliant with indicative stormwater quality objectives.

[6] The indicative water contamination load reductions due to SWSUD

- The Development + WSUD result in the following percentage changes compared with the current forested land use:

    - 59% rise in total water export
    - 59% rise in TSS export
    - 82% rise in TP export
    - 76% rise in TN export
    - 100% reduction in gross pollutant export from the site

- The impacts of WSUD on the development comply with indicative WSUD objectives.

It is concluded that the proposed WSUD elements will produce water quality outcomes compliant with indicative water quality objectives.

The peak contaminant concentrations and peak contaminant are also substantially reduced.

6. MAINTENANCE

6.1 WSUD MAINTENANCE PROVISIONS (SOURCE: WSC, 2010C).

WSUD elements require maintenance in order to perform in accordance with their design intent. It is considered essential that provisions are made for maintenance of WSUD elements at the planning and design phase irrespective of Council or private ownership. This section outlines the necessary considerations and requirements in relation to operation and maintenance of WSUD elements.

For industrial and commercial development in the private realm WSUD elements will require a Positive Covenant and a Restriction on Use to be placed on the property title in order to bind all current and future owners to specific maintenance requirements.

6.2 MAINTENANCE REQUIREMENTS

a Maintenance requirements for vegetated stormwater treatment measures include:

i during the plant establishment period (first two years): weed removal and replanting may be required.

ii periodic maintenance should include: removal of accumulated sediments, litter and debris, weeding and replanting as required.

iii three-monthly inspections are recommended for most stormwater treatment measures.

A defects liability period will apply to WSUD elements in accordance with Council's requirements for landscaping projects. The developer and/or owner are then responsible for maintenance of the WSUD element(s) after practical completion is certified and prior to transfer of the asset into Council ownership.

b Operation and maintenance requirements of storage tanks, including rainwater tanks and treated stormwater storage tanks is as follows:

i for rainwater tanks, inspect the roof and gutters, first flush device and inlet/overflow screens each 3-6 months. If necessary, roofs and gutters should be cleaned, overhanging vegetation should be pruned, first flush devices and screens should be cleaned.

ii each 2-3 years, inspect all tanks for sludge accumulation. De-sludging may be periodically required.

iii where pumps are used, consult the manufacturers for maintenance requirements.

c Operation and maintenance requirements of gross pollutants traps (GPTs) are as follows:

i routine quarterly inspection and/or in accordance with manufacturer's recommendations.

ii cleaning and appropriate disposal of gross pollutants to ensure there is sufficient capacity to capture and retain pollutants in the next runoff event. Notwithstanding manufacturer's recommendations, at least 50% capacity should be maintained within the GPT.

6.3 MAINTENANCE ACCESS AND SCHEDULES

a Access to WSUD elements is essential in order to perform routine inspection and maintenance activities. Consideration of maintenance and appropriate access is required at the concept design stage and is to be documented on DA plans . Council should be contacted to ascertain Council's maintenance capability in respect to selection of appropriate WSUD elements and design considerations.

b A maintenance schedule(s) is to be provided at the time of Practical Completion (an indicative one is given below).

This schedule is to detail the necessary maintenance activities and intervention levels that are required for each WSUD element and it should cover at least a ten year period. The information should include but not be limited to the cleaning frequency of GPTs, subsoil line flushing, inspection for scour & erosion at key

areas, capacity at key outlet and overflow points, plant health, vegetation maintenance for conveyance, weed management, filter media replacement etc.

6.4 POSITIVE COVENANT AND RESTRICTION OF USE ON WSUD ELEMENTS

For developments requiring a Positive Covenant and/or Restriction of Use, the applicant shall be responsible for the following:

a to ensure on-going future maintenance of WSUD elements applicants shall create a “Positive Covenant” and “Restriction on the Use of Land” under Section 88B of the Conveyancing Act 1919, burdening the property with the requirement to maintain the WSUD elements. The terms of the instruments are to be generally in accordance with the Council's "terms of Section 88B instrument for protection of WSUD elements" in accordance with Council’s standard terms and definitions.
b create all required easements, rights-of-carriageway, positive covenants, restrictions-on-use or other burdens/benefits, the applicant must submit this with the plan of subdivision or transfer plan. This is to be completed prior to the issue of the Occupancy or Subdivision Certificate.
c a registered surveyor is to provide certification and a “Works-As-Executed drawing” to Council that all physical structures are fully contained within the lot and proposed easements.

6.5 WSUD ELEMENTS TO BE INCLUDED

The various types of WSUD elements located on private property that are to be included in the Positive Covenant are; rainwater tanks, bio-retention systems and constructed wetlands. Some of these WSUD elements will also require a Restriction on the Use of Land.

The maintenance plan below was derived from Landcom (2003).

1.6 MAINTENANCE ACTIVITIES

1. Inspection to identify areas of increased sediment deposition, rill erosion or damage to the surface
2. Inspection of the inlet points, surcharge pits and outlets to identify any scouring, litter accumulation or blockages.
3. Removal of sediments. Especially where the sediment is impeding flow and even distribution of water
4. Repair any damage due to vehicles being driven into the basin
5. Tillage of the basin surface if there are signs of the soil surface clogging.
6. Slashing if there is excessive vegetative growth.
7. Removal of invasive weeds
8. Replanting any bare areas (>10 msq)
9. Removal of litter and debris

Table 6.1 Routine monitoring components and required responses for the wetland system.

Structure	Purpose of monitoring	Performance target	Schedule maintenance or investigation trigger	Immediate action required	Maintenance action required
Land surrounding the basins	Identify wheel ruts, dead plants, overtopping and erosion	No evidence of erosion or damage to the structures, including the surrounding embankments.	Wheel tracks Evident	Evidence of overtopping	Revegetate small bare areas. Suggested vegetation is native couch grass. Contact cleaning contractor. Should be treated quarterly
Trash racks on inlet and outlet	Inlet and outlet trash racks to be cleared of litter	Trash racks cleared of litter	Up to 10% of the trash rack blocked with litter	>30% of the trash rack clogged with litter.	
Inlet structures	Inlets to be cleared of litter.	Clear inlets and downstream area	Partly blocked outlets Obvious sediment accumulation	Mostly blocked	
Underdrains	Ensure flows when basin has free water in it.	Flows obvious when free water is present. Flow ceases when there is no free water on the basin surface.	Minor outflow when water is ponded.	No outflow even after extended ponding	Schedule drain inspection
Sediment	Ensure even distribution of sediment on the basin floor.	Sediment absent	Some obvious accumulation of sediment.	Sediment accumulated to at least half the basin depth	Schedule immediate removal of sediment
Compaction	Ensure the majority of water exits the basin via deep percolation	Water depth falls by 100 mm/hr once inflow ceases	None evident	Water is still present 24 hr after inflows cease.	Check compaction
Plants	Identify is there is extensive plant die-off. Act to maintain plant health.	A healthy vigorous and reasonably even distribution of plants.	Plants are stressed	Lots of dead plants.	Identify cause of die-off. (some plants are seasonal and die-off in winter)

7. CONCLUSIONS

The proposed design for the 94 lot low density residential development aimed to meet the typical WSUD targets including:

- 70% of litter greater than 5mm for all flows up to the 1-year ARI peak flow (predicted result-100%)
- 80% reduction in mean annual load of Total Suspended Solids (kg/y) (predicted result-91 %)
- 45% reduction in mean annual load of total phosphorus (kg/y) (predicted result-66%)
- 45% reduction in mean annual load of total nitrogen (kg/y) (predicted result-56%)

An additional target of no increase in peak outflow (cubic m/sec) was added. The MUSIC model predicts will be slightly less for Development +WSUD compared with pre development conditions.

It is concluded that the design will meet Council's stormwater objectives for the low density development.

8. REFERENCES

Coombes, P. J. and Kunczera, G. (2003). Analysis of the performance of rainwater tanks in Australian capital cities. 28th International Hydrology and Water Resources Symposium, Wollongong, Nov. 2003.

Fletcher, T., Duncan, H., Poelsma, P. and Lloyd, S. (2004). Stormwater flow and quality and the effectiveness of non-propriety stormwater treatment measures. CRCCH, Tech Rep. 04/8.

Macleod, A. (2008). MUSIC calibration based on soil conditions. Proc 2008 NSW and Qld joint SIA conference.

Murphy, C. L (1993). Soil Landscapes of the Gosford-Lake Macquarie 1:100 000 Sheet. Dept Conservation and Land Management. Parramatta, NSW.

NSW Gov (2010). Draft NSW MUSIC Modelling guidelines. Reference R.B17048.001.01

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

9. Appendix 1. MUSIC link report

MUSIC-*link* Report

Project Details		Company Details	
Project:	94 lot subdivision at Chain Valley Bay	**Company:**	Woodlots and Wetlands Pty Ltd
Report Export Date:	14-Oct-21	**Contact:**	Dr Peter Bacon
Catchment Name:	14.10.2021 FOR MUSIC LINK Wyong Shire Council Nodes February 2015 50% roof area catchment NO GPT 300 msq basin 1200 msq bioretention	**Address:**	220 Purchase Road. Cherrybrook. NSW 2126
		Phone:	0427905440
		Email:	woodlots3@bigpond.com
Catchment Area:	8.146ha		
Impervious Area*:	87.66%		
Rainfall Station:	66062 SYDNEY		
Modelling Time-step:	6 Minutes		
Modelling Period:	1-01-1974 - 31-12-1993 11:54:00 PM		
Mean Annual Rainfall:	1297mm		
Evapotranspiration:	1261mm		
MUSIC Version:	6.3.0		
MUSIC-link data Version:	6.34		
Study Area:	Lowland		
Scenario:	Central Coast Development		

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

Treatment Train Effectiveness		Treatment Nodes		Source Nodes	
Node: Post-Development Node	**Reduction**	**Node Type**	**Number**	**Node Type**	**Number**
Flow	8.68%	Rain Water Tank Node	1	Urban Source Node	5
TSS	90.6%	Bio Retention Node	1	Forest Source Node	1
TP	66.2%	Sedimentation Basin Node	1		
TN	56.2%				
GP	100%				

Comments

2 non conformities

The rainwater tanks have an hydraulic threshold of 3500 cubic m/y. This 'only appears in the MUSIC LINK model I the MUSIC Model it is set at zero.. Not sure why??

The notional detention time in the sedimentation basin is below the suggested minimum duration. The soils are dominated by coarse sand and small gravel (see detailed report, the average % of coarse sand Plus small gravel is 54%)). This means the settling velocity will be relatively high (as per Stokes Law). So it is preferable to maximise the forested bio basin area as this area is the major determinant of N and P removal rate.

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Bioretention 1200 msq	Exfiltration Rate (mm/hr)	0	0	0
Bio	Bioretention 1200 msq	Extended detention depth (m)	0.1	0.3	0.2
Bio	Bioretention 1200 msq	Filter depth (m)	0.5	1	0.5
Bio	Bioretention 1200 msq	Orthophosphate Content in Filter (mg/kg)	40	50	50
Bio	Bioretention 1200 msq	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention 1200 msq	Saturated Hydraulic Conductivity (mm/hr)	100	180	100
Bio	Bioretention 1200 msq	Total Nitrogen Content in Filter (mg/kg)	750	950	800
Forest	Forest 8.296 ha	Baseflow Total Nitrogen Mean (log mg/L)	-0.52	-0.52	-0.52
Forest	Forest 8.296 ha	Baseflow Total Phosphorus Mean (log mg/L)	-1.52	-1.52	-1.52
Forest	Forest 8.296 ha	Baseflow Total Suspended Solids Mean (log mg/L)	0.78	0.78	0.78
Forest	Forest 8.296 ha	Stormflow Total Nitrogen Mean (log mg/L)	-0.05	-0.05	-0.05
Forest	Forest 8.296 ha	Stormflow Total Phosphorus Mean (log mg/L)	-1.1	-1.1	-1.1
Forest	Forest 8.296 ha	Stormflow Total Suspended Solids Mean (log mg/L)	1.6	1.6	1.6
Post	Post-Development Node	% Load Reduction	None	None	8.68
Post	Post-Development Node	GP % Load Reduction	90	None	100
Post	Post-Development Node	TN % Load Reduction	45	None	56.2
Post	Post-Development Node	TP % Load Reduction	45	None	66.2
Post	Post-Development Node	TSS % Load Reduction	80	None	90.6
Pre	Pre-Development Node	% Load Reduction	None	None	0
Sedimentation	Sedimentation Basin 300 msq	Exfiltration Rate (mm/hr)	0	0	0
Sedimentation	Sedimentation Basin 300 msq	Extended detention depth (m)	0.25	1	1
Sedimentation	Sedimentation Basin 300 msq	High Flow Bypass Out (ML/yr)	None	None	0
Urban	Residential (Balance of Lots) non roof	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.11
Urban	Residential (Balance of Lots) non roof	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.85
Urban	Residential (Balance of Lots) non roof	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.2
Urban	Residential (Balance of Lots) non roof	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.3	0.3
Urban	Residential (Balance of Lots) non roof	Stormflow Total Phosphorus Mean (log mg/L)	-0.6	-0.6	-0.6
Urban	Residential (Balance of Lots) non roof	Stormflow Total Suspended Solids Mean (log mg/L)	2.15	2.15	2.15
Urban	Road	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.11
Urban	Road	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.85
Urban	Road	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.2
Urban	Road	Stormflow Total Nitrogen Mean (log mg/L)	0.34	0.34	0.34
Urban	Road	Stormflow Total Phosphorus Mean (log mg/L)	-0.3	-0.3	-0.3
Urban	Road	Stormflow Total Suspended Solids Mean (log mg/L)	2.43	2.43	2.43
Urban	Road verges and nature strip	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.11
Urban	Road verges and nature strip	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.85
Urban	Road verges and nature strip	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.2
Urban	Road verges and nature strip	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.3	0.3
Urban	Road verges and nature strip	Stormflow Total Phosphorus Mean (log mg/L)	-0.6	-0.6	-0.6
Urban	Road verges and nature strip	Stormflow Total Suspended Solids Mean (log mg/L)	2.15	2.15	2.15

Only certain parameters are reported when they pass validation

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Roof Area (To tank --50% of total as some may not be working) All 94 dwellings have a rainwater tank connected to toilets and gardens	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.11
Urban	Roof Area (To tank --50% of total as some may not be working) All 94 dwellings have a rainwater tank connected to toilets and gardens	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.85
Urban	Roof Area (To tank --50% of total as some may not be working) All 94 dwellings have a rainwater tank connected to toilets and gardens	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.2
Urban	Roof Area (To tank --50% of total as some may not be working) All 94 dwellings have a rainwater tank connected to toilets and gardens	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.3	0.3
Urban	Roof Area (To tank --50% of total as some may not be working) All 94 dwellings have a rainwater tank connected to toilets and gardens	Stormflow Total Phosphorus Mean (log mg/L)	-0.6	-0.6	-0.6
Urban	Roof Area (To tank --50% of total as some may not be working) All 94 dwellings have a rainwater tank connected to toilets and gardens	Stormflow Total Suspended Solids Mean (log mg/L)	2.15	2.15	2.15
Urban	Roof Area NOT to tank	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.11
Urban	Roof Area NOT to tank	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.85
Urban	Roof Area NOT to tank	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.2
Urban	Roof Area NOT to tank	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.3	0.3
Urban	Roof Area NOT to tank	Stormflow Total Phosphorus Mean (log mg/L)	-0.6	-0.6	-0.6
Urban	Roof Area NOT to tank	Stormflow Total Suspended Solids Mean (log mg/L)	2.15	2.15	2.15

Only certain parameters are reported when they pass validation

Failing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Pre	Pre-Development Node	GP % Load Reduction	90	None	0
Pre	Pre-Development Node	TN % Load Reduction	45	None	0
Pre	Pre-Development Node	TP % Load Reduction	45	None	0
Pre	Pre-Development Node	TSS % Load Reduction	80	None	0
Rain	Rainwater Tank	Threshold Hydraulic Loading for C** (m/yr)	0	0	3500
Sedimentation	Sedimentation Basin 300 msq	Notional Detention Time (hrs)	8	12	0.397

Only certain parameters are reported when they pass validation

NOTE: A successful self-validation check of your model does not constitute an approved model by Central Coast Council
MUSIC-*link* now in MUSIC by eWater – leading software for modelling stormwater solutions

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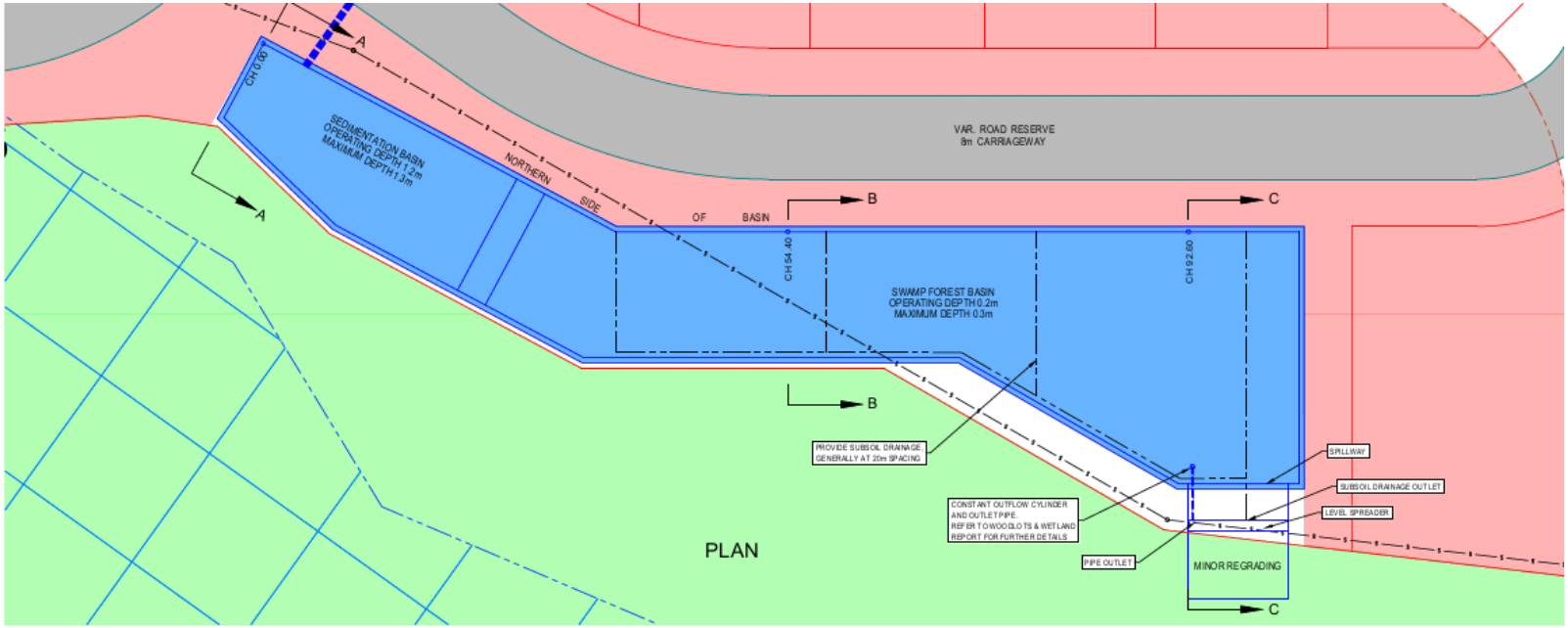
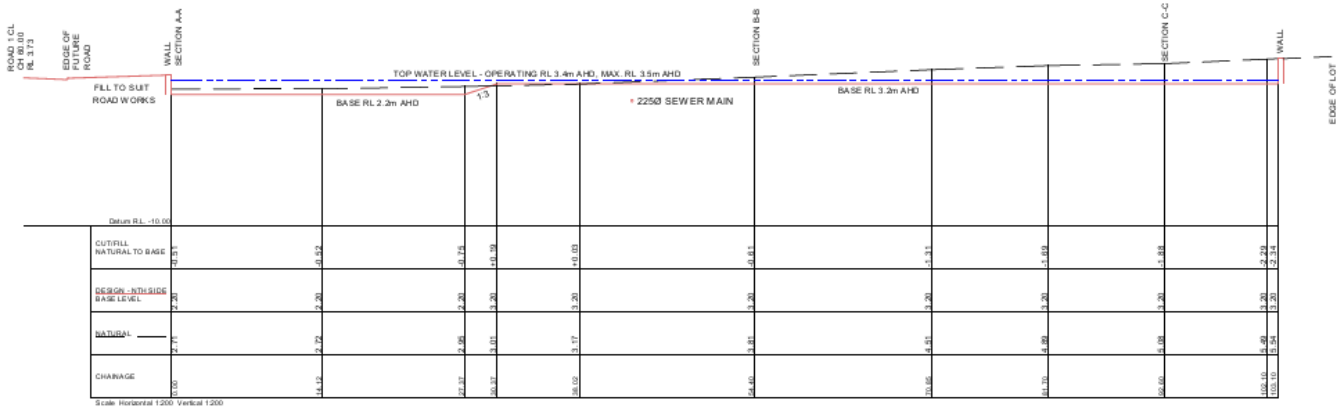
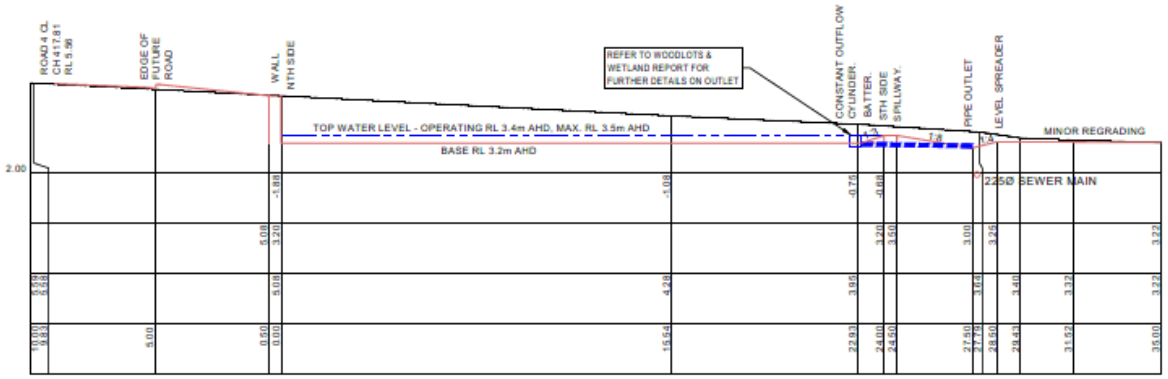
10. Appendix 2 . CONCEPT DESIGN FOR THE FORESTED SWAMP



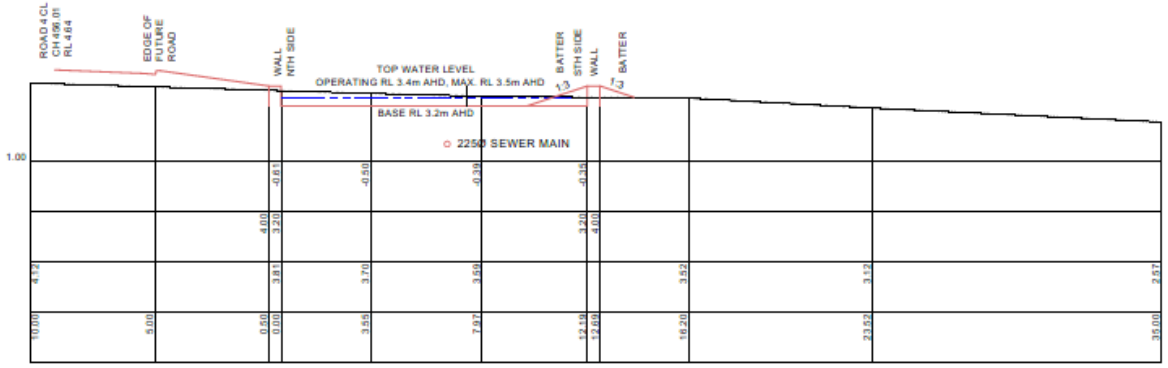


PROFILE ALONG NORTHERN SIDE OF BASIN

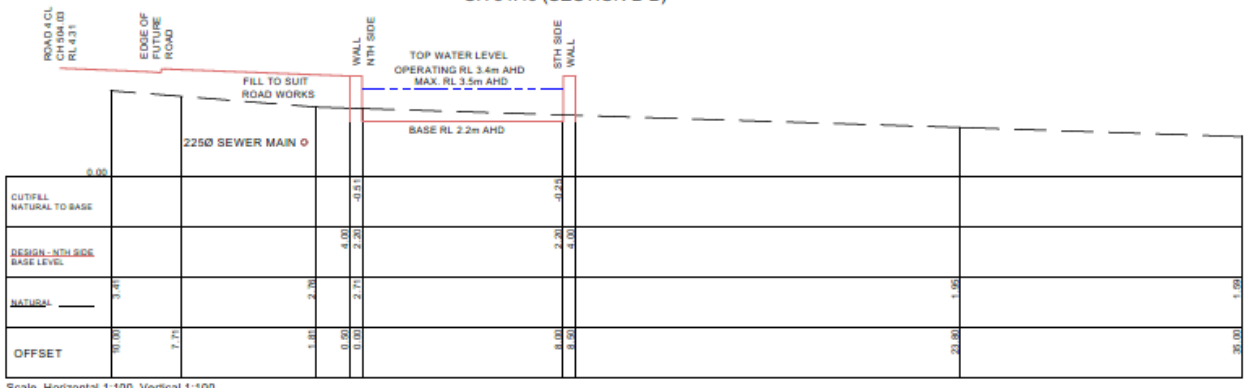
Intrax LAND
CIVIL SERVICES
J.G. DEVELOPMENTS
PROPOSED BASIN FOR THE CONCEPT SUBDIVISION OF LOT 273 IN DP 755266, 'NO.15' MULLOWAY ROAD CHAIN VALLEY BAY
CONCEPT
NOT FOR CONSTRUCTION
PLAN & LONGSECTION
REDUCTION RATIO 1:200 @ A1 & 1:400 @ A3
BN110868
BN110868-1



CH 92.60 (SECTION C-C)



CH 54.40 (SECTION B-B)



Scale Horizontal 1:100 Vertical 1:100

CH 0.00 (SECTION A-A)

Intrax LAND

CIVIL SERVICES

J. G. DEVELOPMENTS

PROPOSED BASIN FOR THE CONCEPT SUBDIVISION OF LOT 273 IN DP 755266, 'NO.15' MULLOWAY ROAD CHAIN VALLEY BAY

CONCEPT
NOT FOR CONSTRUCTION

CROSS SECTIONS

REDUCTION RATIO 1:100 @ A1 & 1:200 @ A3

BN110868

BN110868-2