AFFLUX CONSULTING
STORMWATER MANAGEMENT SOLUTIONS

STORMWATER MANAGEMENT PLAN

99 Bena Rd, Korumburra

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01	15/02/2024	Initial Issue
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Climate Change Statement

A wide range of sources, including but not limited to the IPCC, CSIRO and BoM, unanimously agree that the global climate is changing. Unless otherwise stated, the information provided in this report does not take into consideration the varying nature of climate change and its consequences on our current engineering practices. The results presented may be significantly underestimated; flood characteristics shown (e.g. flood depths, extents and hazards) may be different once climate change is taken into account.

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1. Introduction

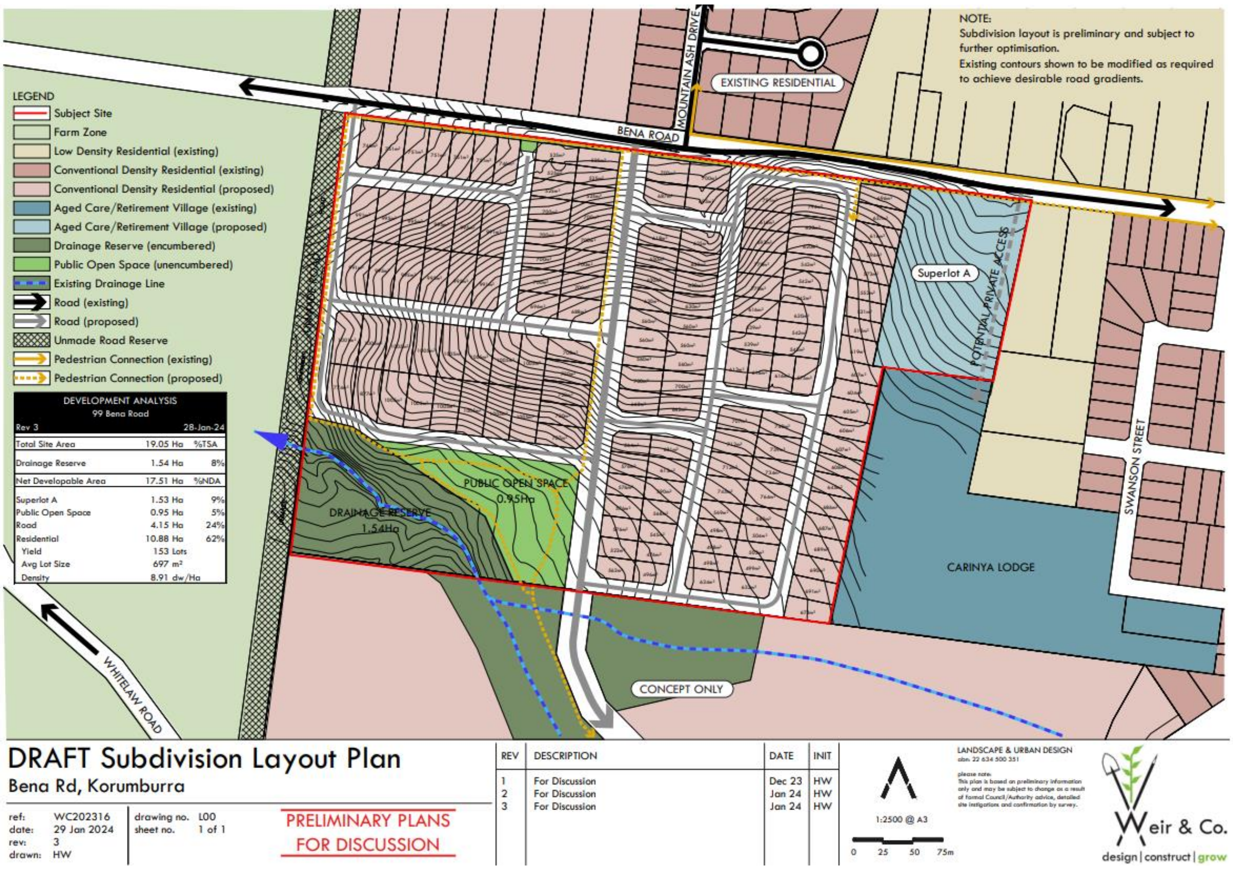
Afflux Consulting have been engaged by Planning Central to prepare a stormwater management plan for the proposed development at 99 Bena Rd, Korumburra (Figure 1). This report will cover the major drainage, flooding and water quality associated with the development. If necessary, it will include an assessment of associated stormwater drainage assets, regional overland flow paths/creek systems and stormwater conditions within neighbouring properties. The intention of this report is to:

- Provide an assessment of major drainage and flooding associated with site;
- Retention of post development flows to pre-development levels;
- Ensure flooding of the site, or potential off-site impacts are reduced or eliminated;
- Ensure safe conveyance of existing overland flow regimes, if required;
- Meet the EPA best practice environmental management (BPEM) water quality requirements;
- Inclusion and consideration of guidelines and advice for stormwater management in line with South Gippsland Shire and West Gippsland CMA requirements; and
- Identification of mitigation and treatment options, if required.

To meet these requirements a range of hydrological, hydraulic and water quality modelling has been undertaken.

The site is influenced by both sheet and concentrated (waterway) flows from the surrounding catchments, and will require careful integration of waterways and overland flow paths. Currently, the site drains to two main catchments; A southerly catchment including defined waterway; and a northerly/eastern catchment draining to an upper tributary of Foster Creek located to the north of the site. The southern catchment is predominantly undeveloped farmland while the eastern catchment is largely standard density residential. The eastern external catchment is generally directed to the north away from the site. The north-east portion of the site also flows to the north and flows into a road crossing within the Petersen Street Reserve. The southern catchment of around 67 ha enters the site by way of an existing natural waterway. A proposed development plan and greater area concept/context plan can be seen in Figure 2 below.

Figure 1. Aerial of site



Source: *Weir&Co – DRAFT Subdivisional Layout Rev 3*

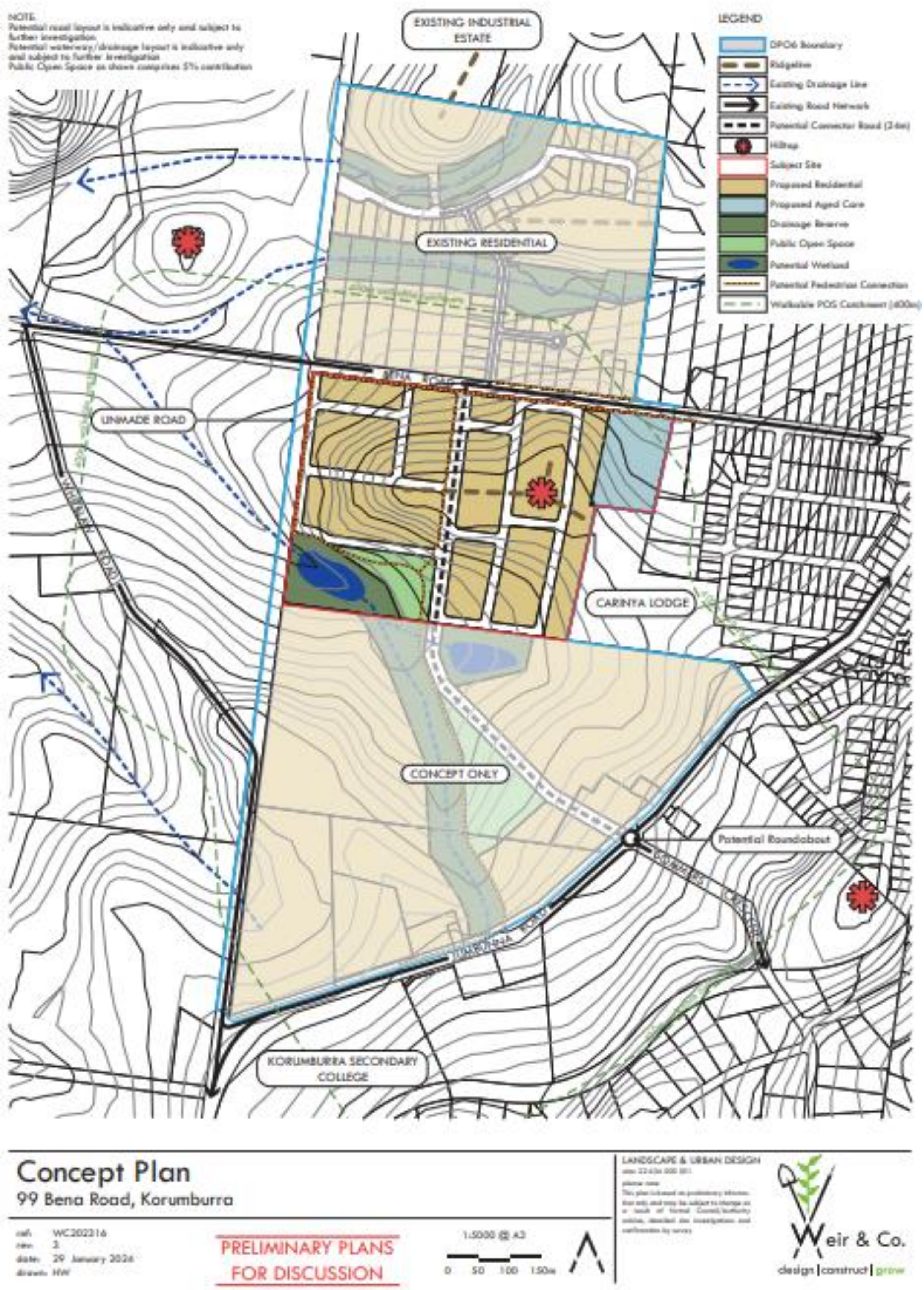


Figure 2. Proposed Development

Source: Weir&Co Concept Plan Rev3

1.1. Information Sources

A number of information sources have been used in the formation of this strategy; these include:

- Site inspection (2021)
- Aerial imagery
- DEPI planning scheme and cadastral information as accessed online 15/01/24
- Discussions with South Gippsland Council
- Discussions and information as provided by [West Gippsland CMA] (ref: WGCMA-F-2023-00478)
- Design Guidelines and Guidelines for Development
- Various Environmental Planning instruments and Planning Frameworks
- Preliminary plans and Site survey received from client
- Past models and existing infrastructure information
- Historic flood and water quality studies
- Topographic information including required LiDAR data sourced commercially.

2. Existing Catchment

The existing catchment has been delineated as the relevant catchment for flows through the site and site outlet below (Figure 3). The broader catchment drains northward towards Bena Road, and discharges to an upper tributary of Foster Creek. The subject site is approximately 19ha and is currently used for cropping purposes. The site has an approximate slope of ~18%. The existing site, and local catchments are shown in Figure 3 below. It is noted that there is a declared waterway through the south west corner of the site, and this will require standard CMA/State Planning Policies setbacks. This has been confirmed with the WGCMA.

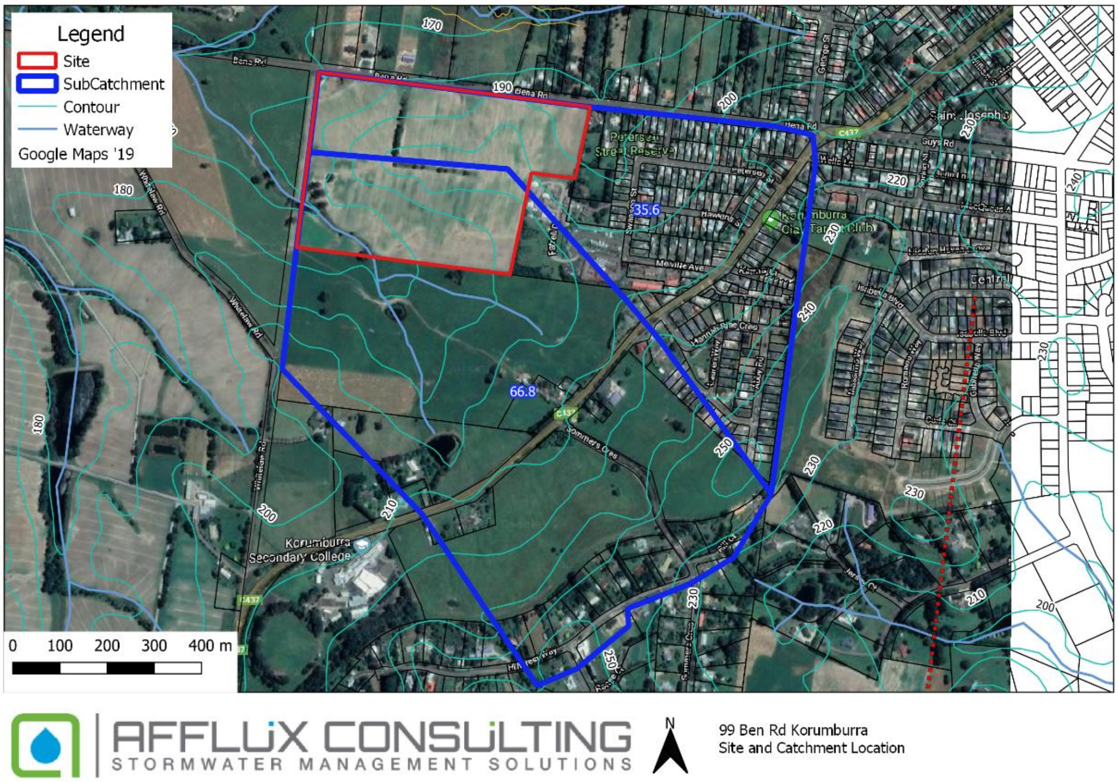


Figure 3. Existing site catchments

2.1. Site Visit

Investigation into the best discharge configuration to meet water management requirements will be undertaken in this report. A number of photos of the existing site can be seen in Figure 4 through Figure 9.

Source: Afflux 2024

Figure 4. Bena Road Low point

Source: Afflux 2024

Figure 5. Bena Rd NE corner looking Sth

Source: Afflux 2024

Figure 6. SE Corner looking north

Source: Afflux 2024

Figure 7. Headwater waterway looking to site

Source: Afflux 2024

Figure 8. Bena Rd low point

Source: Afflux 2024

Figure 9. Site Outfall from Bena

3. Catchment Design Objectives

All development has the potential to adversely affect downstream environments through the effects of stormwater runoff. Increased impervious areas resulting in increased volumetric and peak flows have been extensively researched and linked to downstream environmental degradation. Contaminants in the runoff have also been linked with adverse changes to water quality and stream ecology. The contribution of increased runoff can be linked to downstream flooding and capacity constraints.

To combat these effects, a range of hydrological and water quality mitigation measures have been researched and legislated. The design objectives for this catchment are considered below.

3.1. General Considerations

The Victorian State Planning Policy Framework includes provisions incorporating the provisions for stormwater management in its integrated water management clauses. As part of its planning requirements, the council incorporates BPEM water quality targets, setting out objectives for stormwater runoff.

3.2. Water Quality Requirements

Current water quality guidelines require developers to ensure that water quality for the site meets best practice load-based reduction targets when compared with the unmitigated developed scenario. As listed by the Victorian EPA Best Practice Environmental Management (BPEM) Guidelines (1999), the development must meet the following:

- 80% Total Suspended Solids (TSS) reduction
- 45% Total Nitrogen reduction
- 45% Total Phosphorus reduction
- 70% Gross Pollutant capture

These water quality requirements will be met in water quality treatment recommendations as part of this development.

3.3. Flood Storage Requirements

The development shall be designed to ensure that flows will not increase above the pre-development levels. Generally, this would be applied to only the 1 % Annual Exceedance Probability (AEP) storm and checked at each site discharge point though this assessment should be subject to the context of the site and other surrounding hydraulic reasoning. Attenuation would be applied at an on site detention, and reductions in flow peak would be determined at the outlet of the basin. The size and/or requirement of any on-site detention beyond the scope this report and would form part of a site stormwater management plan.

3.4. Integrated Water Management

Water quality and reuse have interactions relevant to stormwater management requirements. In an attempt to reduce potable water consumption and ensure volumetric flow reductions within waterways, stormwater management incorporates consideration of integrated water management strategies as appropriate to the site.. The provision of water quality requirements alongside reuse opportunities and current planning provisions have been analysed within this report as a part of stormwater management.

Volumetric Reductions

The EPA through the general environmental duty (EPA, 2017) and the Draft Urban stormwater management guidance (EPA 1739.1, 2020) suggests that volumetric reduction should be considered in all urban development where practical. The transitional arrangements ended in July 2023, and the status of the volumetric reduction targets is currently unknown. Given this uncertainty, the stormwater treatments should allow for a degree of flexibility in meeting these targets, with permit conditions written in a way that does not bind any particular solution.

This site is not in a Healthy Waterways priority area, and as such the Mean Annual Rainfall determines the volumetric reduction target as can be seen in (Figure 10) (1,200mm Annual Rainfall).

Table 1: Quantitative performance objectives for urban stormwater

Indicator	Performance objective				
Suspended solids	80% reduction in mean annual load (Note:1)				
Total phosphorus	45% reduction in mean annual load (Note:1)				
Total nitrogen	45% reduction in mean annual load (Note:1)				
Litter	70% reduction of mean annual load				
Flow (water volume)		**Priority areas (Notes 2, 4, 5, 6)**		**Other areas (Notes 3, 4, 5, 6)**	
	rainfall band (ml)	**Harvest/evapotranspire (% mean annual impervious run-off)**	**Infiltrate/filter (% mean annual impervious run-off)**	**Harvest/evapotranspire (% mean annual impervious run-off)**	**Infiltrate/filter (% mean annual impervious run-off)**
	200	93	0	37	0
	300	88	0	35	0
	400	83	0	33	0
	500	77	5	31	4
	600	72	9	29	7
	700	68	11	27	9
	800	64	14	26	11
	900	60	16	24	13
	1000	56	18	22	14
	1100	53	19	21	15
	1200	50	21	20	17
	1300	48	22	19	18
	1400	46	23	18	18
	1500	44	25	18	20
	1600	42	26	17	21
	1700	40	27	16	22
	1800	38	28	15	22

Source: EPA Urban Stormwater Management Guidelines (EPA, 2020)

Figure 10. Quantitative performance objectives

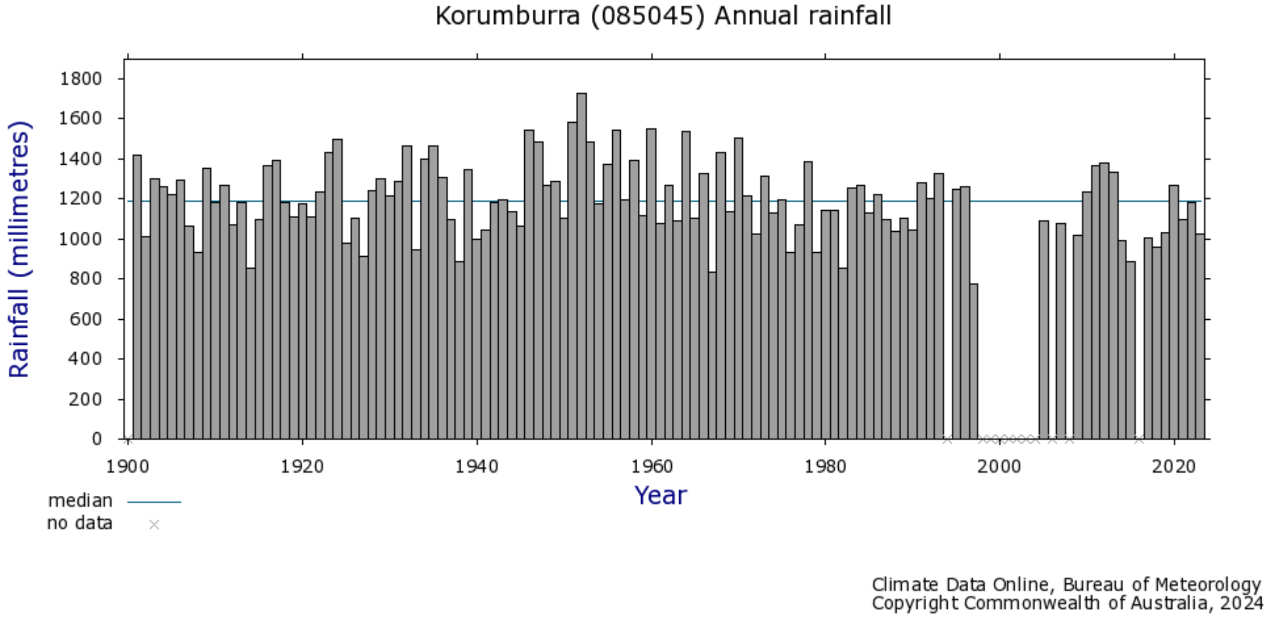


Figure 11. Korumburra Rainfall

3.5. Flood Protection Requirements

Freeboard is incorporated to provide additional flood protection above the designed water surface elevation. Typically used to provide a factor of safety for the finished floor levels and indicates the minimal fill/floor level in developments that are in the vicinity of overland flow paths, open waterways and floodplains.

General practice in Victoria requires a minimum of 0.3m of freeboard is necessary for land adjacent to overland flow paths, and 0.6m for land adjacent to waterways or within floodplains. Freeboard may be incorporated into cross-sections and batters.

(DELWP, 2019)

3.6. Ecological Objectives

This site will discharge into the upper reaches of Foster Creek, before eventually discharging through to the Powlett River. The upper reaches of Foster Creek have been recognised as having an important impact on the health of the Powlett River Estuary and have been included in the Powlett River Estuary Management Plan. As part of this plan this upper reach has been assessed by the Index of Stream Condition as being in "moderate condition" as can be seen in the below Table.

Table 1. Foster Creek Index of Stream Condition

Reach	Hydrology	Physical Form	Streamside Zone	Water Quality	Aquatic Life	ISC Score	Condition
27-5 Powlett Estuary	5	9	4	3	3	22	Poor
27-6 Powlett River	5	8	4	4	3	20	Poor
27-7 Foster Creek	6	9	6	-	4	28	Moderate
27-8 Foster Creek	6	10	5	-	3	25	Moderate

Further to this assessment the South Gippsland Shire has placed an Environmental Significance (ESO) layer on all land outside of the Korumburra township limits (all land downstream of the site). This ESO is related to erosion control measures and is designed to limit the sediment released (erosion) into the stream systems.

Based on these two documents the following measures should be taken into account by this stormwater management plan:

- Strong sediment control within the subdivision to limit downstream sediment accumulation
- Hydrology protection as part of the subdivision

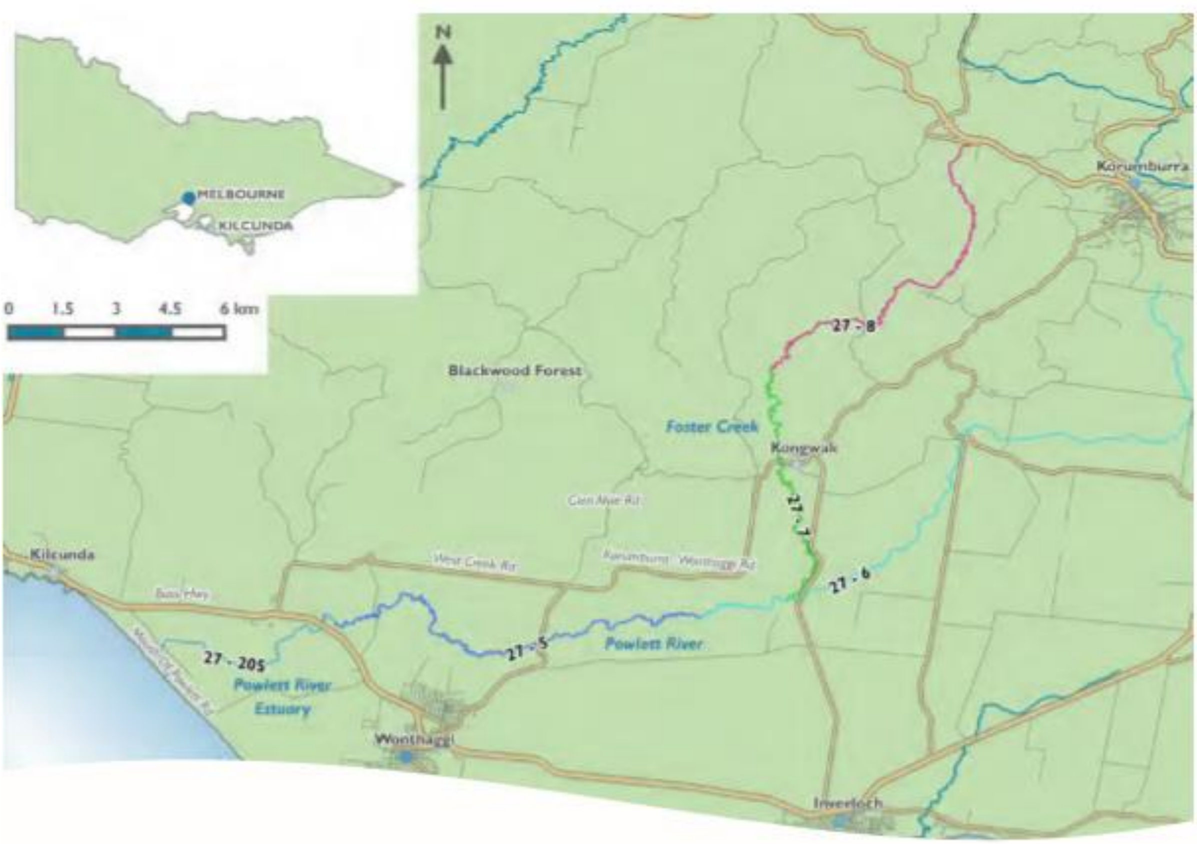


Figure 1 Foster Creek and Powlett River Estuary (WGCMA, 20??)

3.7. Specific Concerns for This Site

Based on the review of the catchment, and listed objectives and requirements the following stormwater elements should be considered for this site:

- Managing flood extents and in particular flows to the waterway to ensure no worsening conditions on adjacent properties
- Fill requirements and waterway offsets
- Existing drainage infrastructure capacity including flooding in the north west corner of the site
- Surrounding existing development constraints
- Site topography and geomorphological interactions with drainage asset locations/proposed water quality treatments
- With two separate systems on the site, the balance between a number of stormwater assets and the stormwater requirements needs to be struck

- South Gippsland Shire have raised maintenance of systems as a major point of discussion for any stormwater assets. As such low maintenance self-sustaining systems should be prioritised.
- Producing a drainage solution with due regard to the ecologically significant landscapes as described upstream and within the site.

4. Hydrology

To evaluate the hydrology of the proposed development a number of hydrological models have been formed and compared. This method has been chosen to best represent hydraulic influences and hydrologic challenges in the area.

4.1. Regional Hydrological Modelling

The primary model for flow evaluations for the site is Monash Universities RORB model. RORB was produced by Laurenson and Mein as a runoff routing model for the production of flood hydrographs. It is considered the industry standard model for Victorian Flood studies.

Existing Conditions

A RORB model was produced for the adjacent subdivision a number of years ago. This model has been repurposed and adjusted for this site. The existing conditions Rorb model (Afflux, 2016) setup can be seen in Figure 2 below with the catchment delineation and reach lengths and locations.

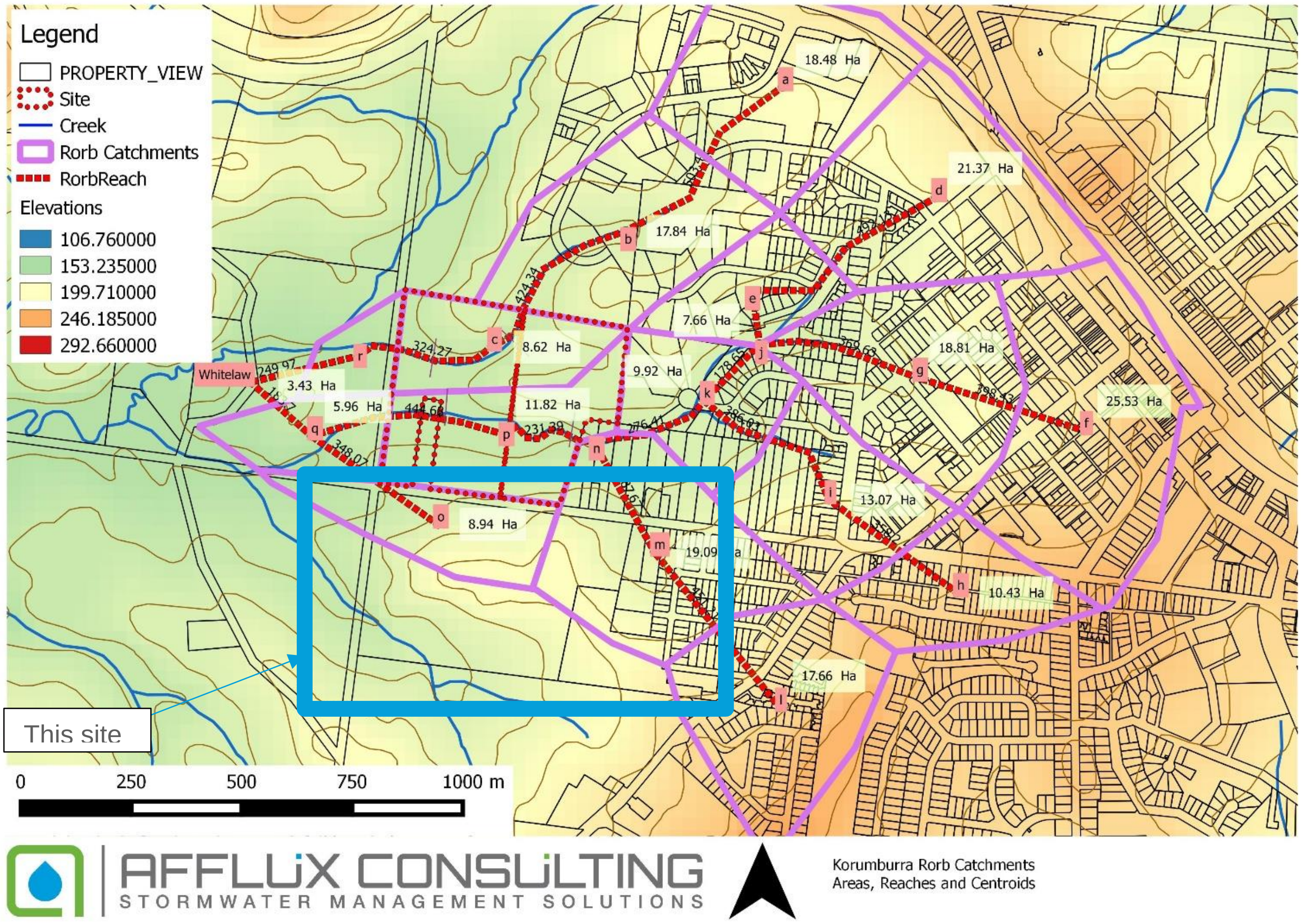


Figure 2 Rorb Layout and Stream Reaches

The selection of both these Impervious fractions (FI), and the reach types influences the timing of flows through the model and in a general sense the peak flows. However, the shape of the hydrograph is then further influenced by the relative delay represented by the *kc* and *m* values as selected by the modeller. The selected existing conditions FI's can be seen in Figure 3 below.

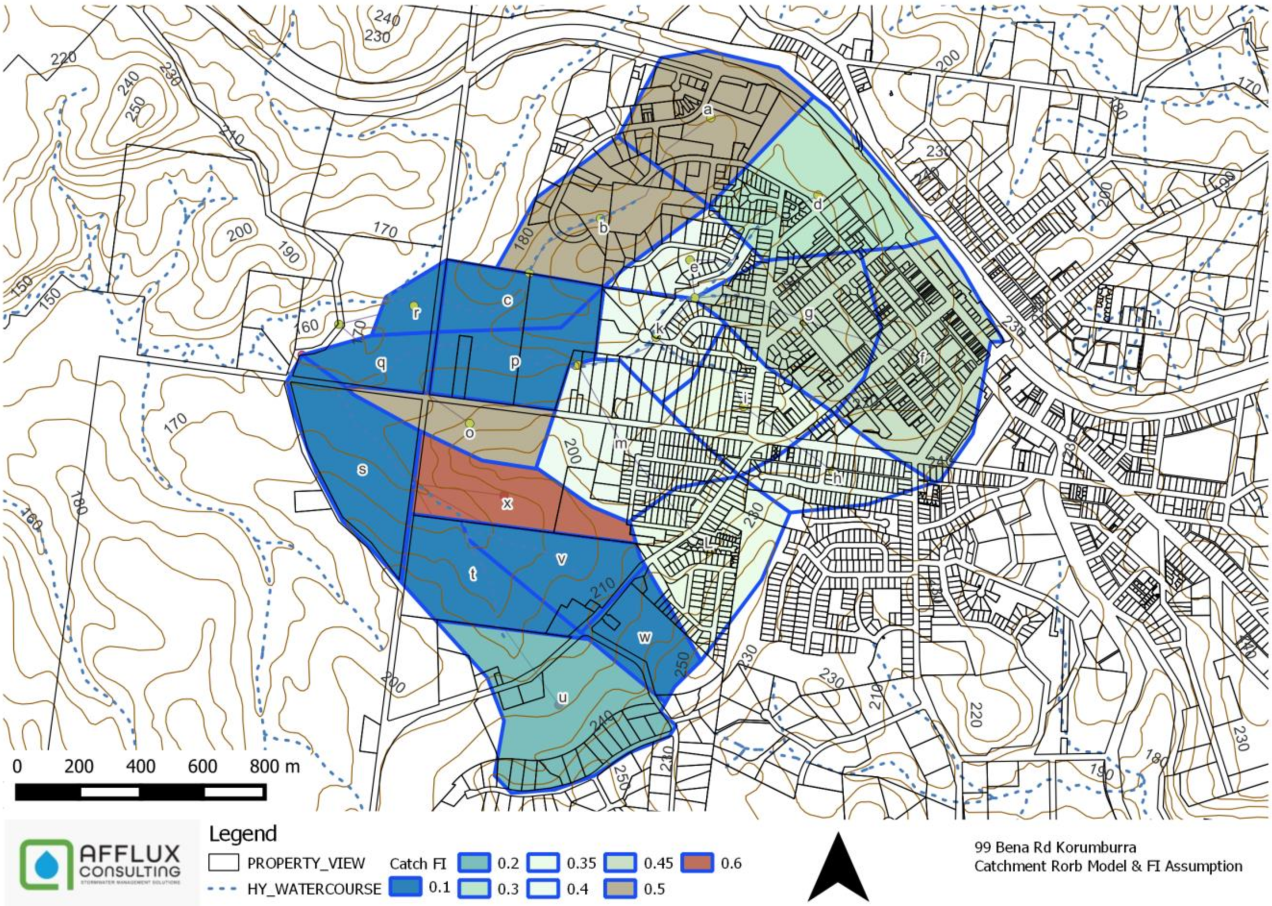


Figure 3 Existing Conditions Fraction Impervious

A range of hydrological estimation methods have been used to Calibrate this model. These were explored in the adjacent site model, with a summary

Summary Flows and Calibration Kc

The existing RORB model was calibrated to a range of design, and a selected set of design parameters were adopted. In all cases the design losses have been kept constant at:

Initial Loss 15mm

Runoff Coefficient 0.6

The following results have been found:

Table 2. Calibration Methods Summary Table

Trial Name	Kc Value	Outlet Flow @ WhitelawRd (m^3/s)
RFFE (ARR 2015)	1.05	17.70 (4.5h)
Pearse et al	1.73	12.15 (2h)
VIC MAR<800mm	3.65	8.24 (9h)
DSE Regional	3.7	8.46 (9h)
Rational Method (35%)	2.0	11.14 (1h)

Based on the range of flows, the Rational Method (35%) flow has been selected as the calibration parameter. This accounts for the predicted shorter duration flows that the steep urbanised catchments should produce.

Given the proximity of this site, it would seem sensible to maintain the same model and calibration for and assessment of this site. Accordingly the model calibration has been updated through an update of the Kc/Dav as shown below.

Table 3. Kc/Dav Manipulation

Parameter	Existing Model (Afflux, 2016)	Extended model
Kc	2.0	1.855
Dav	1.38	1.28
Ratio	1.45	1.45

These parameters have been adopted for this study.

Table 4. Adopted Parameters

Parameter	Value
Kc	1.85
Initial Loss	15mm
RoC	0.6

4.2. Regional Results

Existing Conditions Flows

Both ARR19 and ARR87 IFD and temporal patterns have been run for the model. A sensitivity against more contemporary loss models has also been conducted. All results have been presented at Bena Road as this is major hydraulic control on this system. This crossing can be seen in Figure 12 and has been recently upgraded with a 3m headwall and approximate 2-3m^3/s capacity.

Source: August 2023 Google Maps

Figure 12. Bena Road Crossing and recent upgrades (mid 2023)

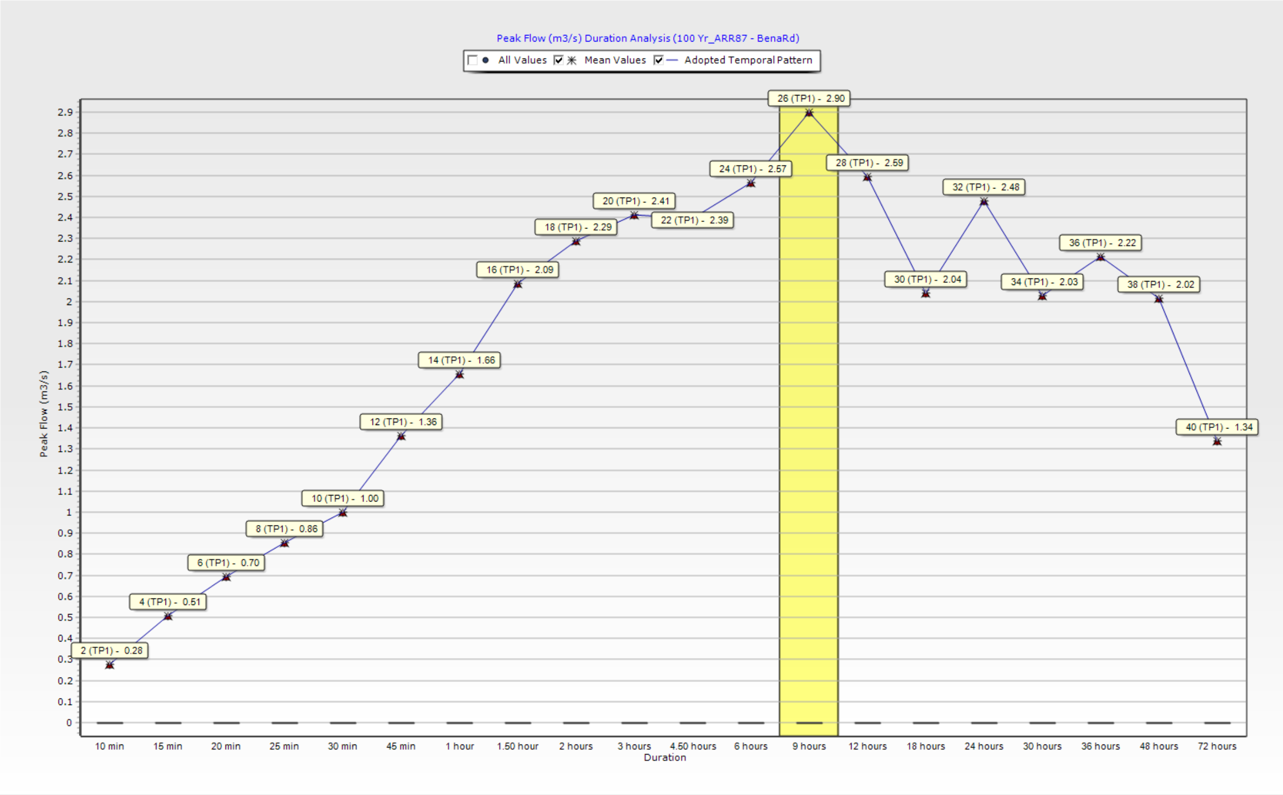


Figure 13. Existing Flows ARR87

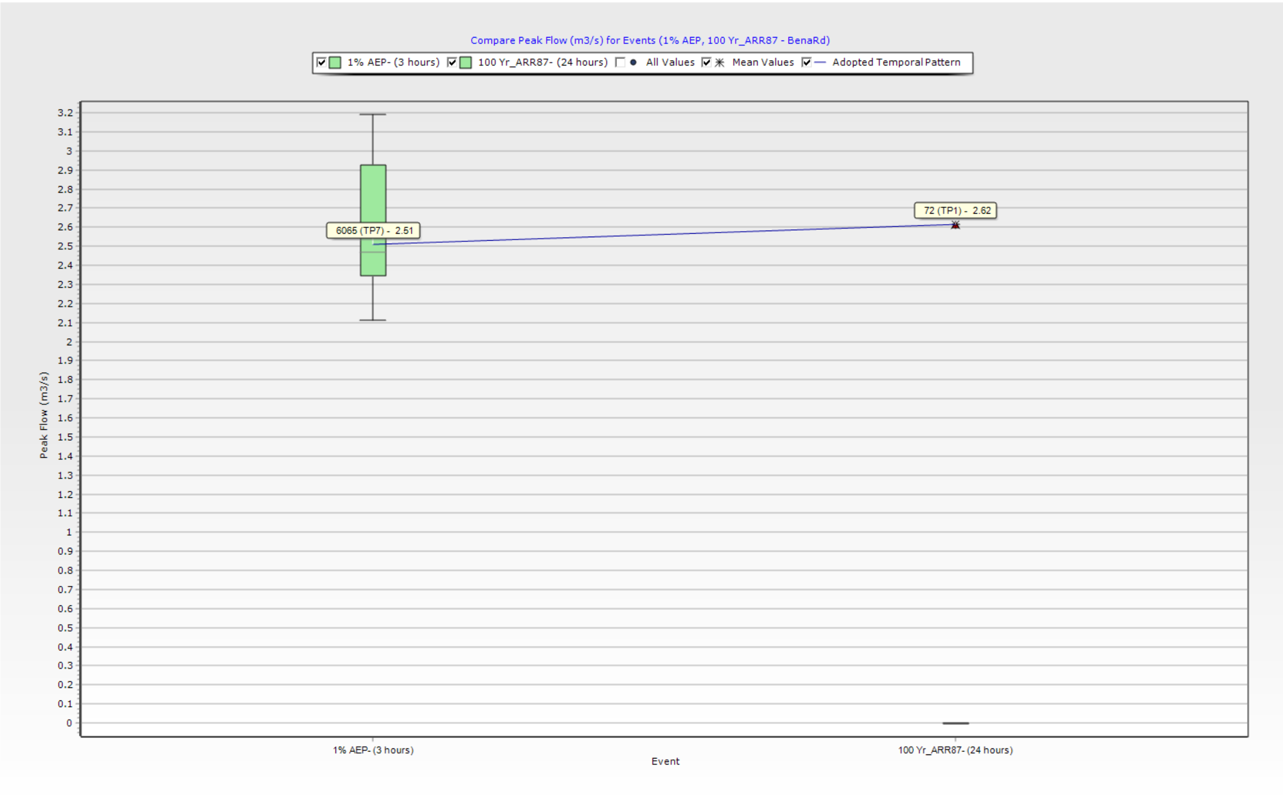


Figure 14. Existing Flows Comparison (ARR87 vs ARR19)

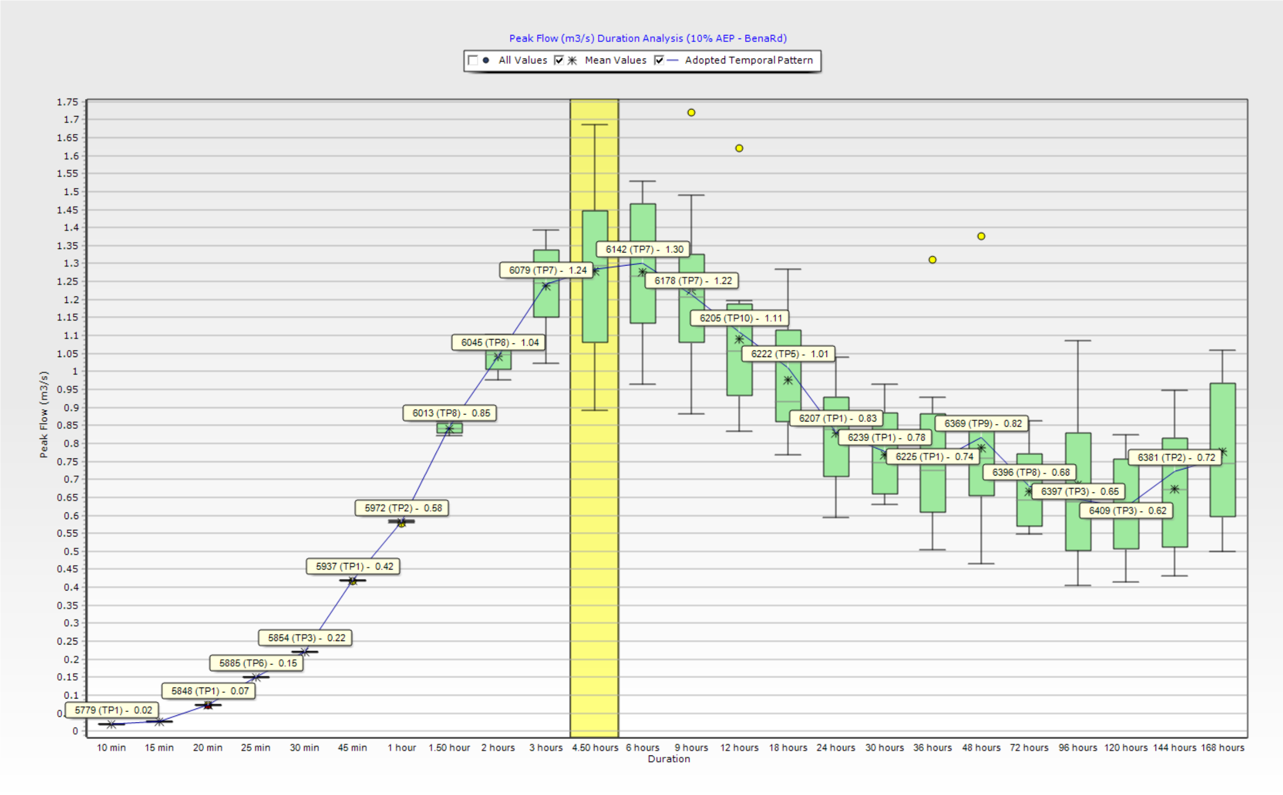


Figure 15. Existing Conditions Flows ARR19 (10% AEP)

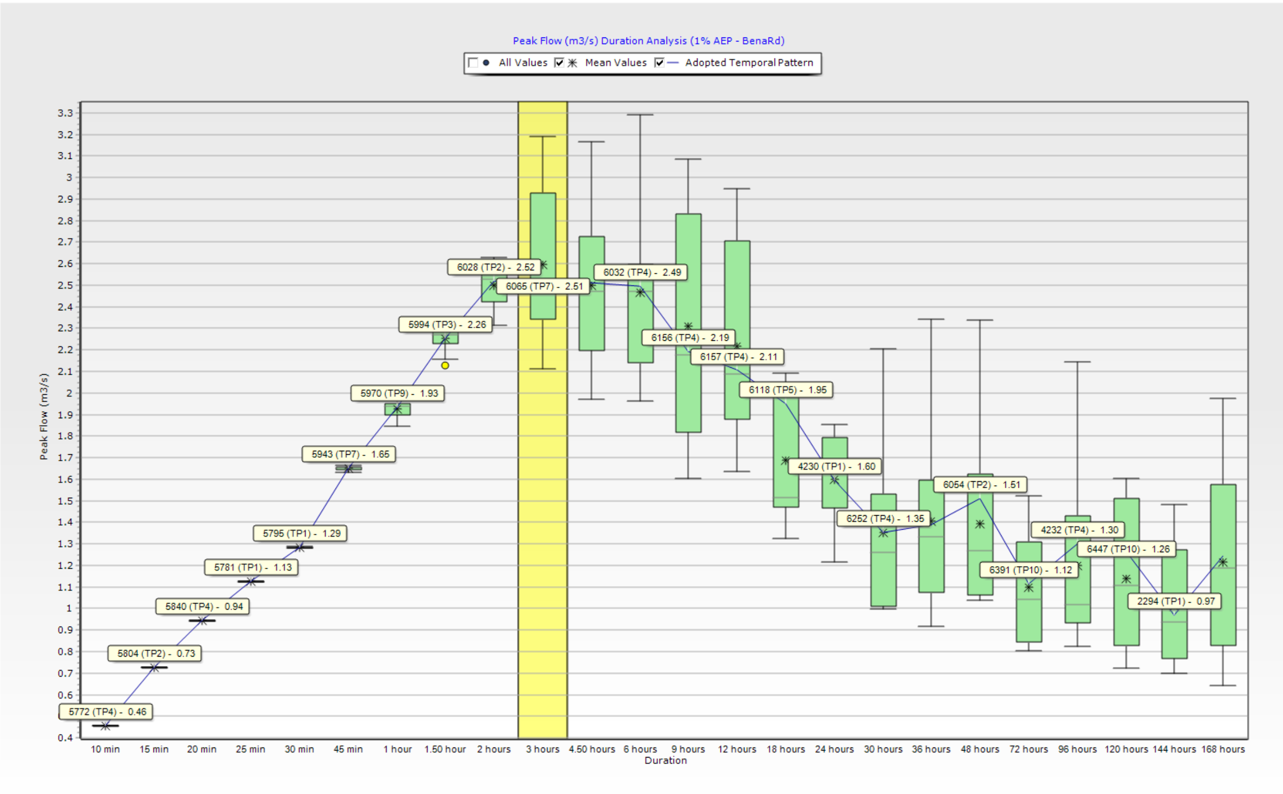
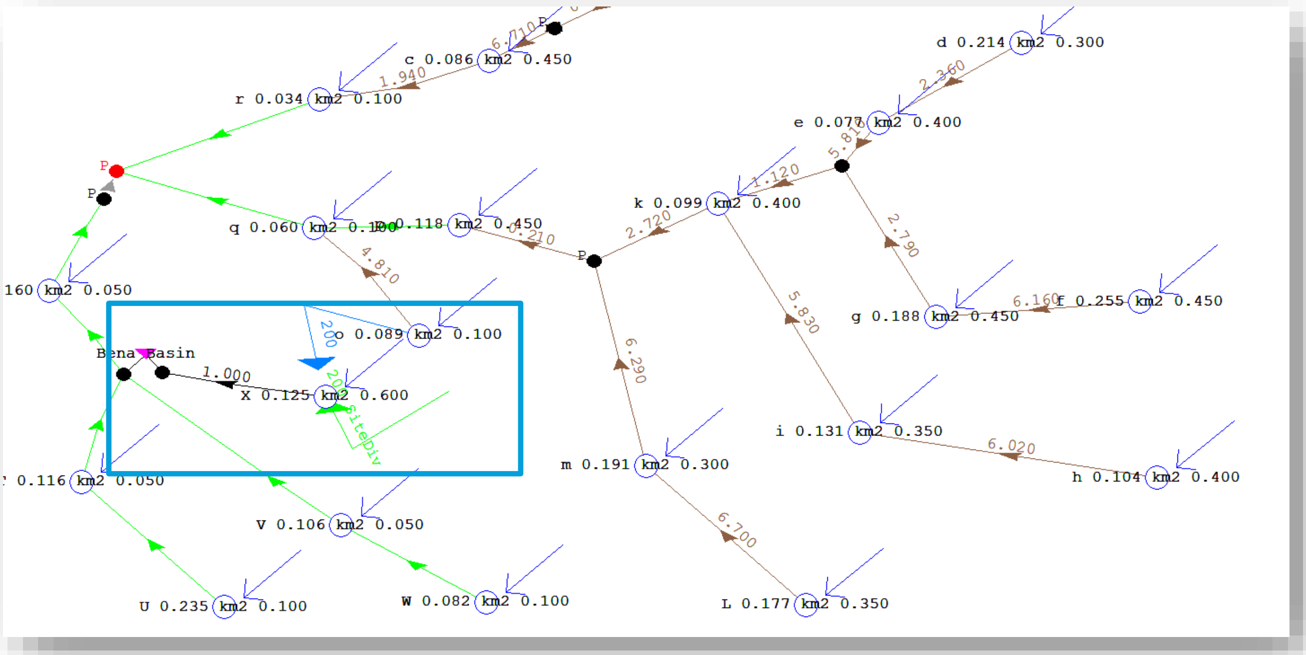


Figure 16. Existing Conditions Flows ARR19 (1% AEP)

Developed Conditions and Attenuation Storage

The development model included a number of changes to represent the development and stormwater strategy, these include:

- A conceptual stage storage was formed based on the concept plan for the site. The design values can be seen in Figure 18 below. A 525mm RCP outlet was used.
- Diversion of piped flows from the catchment O (or Stages 1 and Stage 2 of the development plan). It was assumed that up to 0.6m³/s could be diverted from this catchment, or approximately a 600mm pipe. A more detailed analysis of the divertible flows will be provided at detailed design.
- No detailed model changes to account for the Northeast catchment. This is too fine of a detailed to be calculated with the RORB model and will be detailed by separate methods (below).



Source: Korrumburra_Developed_LargeBasin.catg

Figure 17. Development Model Changes

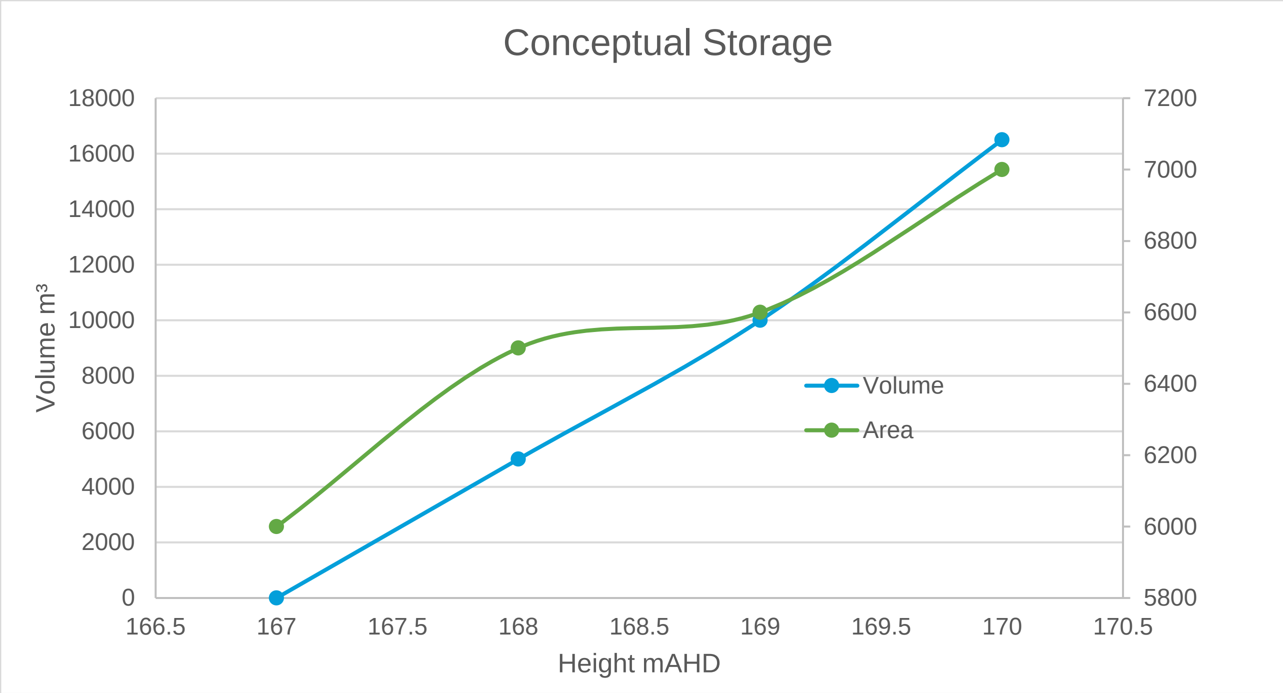


Figure 18. Conceptual Stage

The Mitigated model results in a slight reduction in flows at Bena Road as shown in Table 5. The maximum flood storage for the peak duration is shown in Figure 19.

Table 5. Development Flows

Peak Flows	Bena Rd Existing (m^3/s)	Bena Rd Developed
ARR87	2.90	2.77
ARR19	2.51	2.34

```
Results of routing through special storage Bena Basin
 Peak elevation=  167.77 m
 Peak outflow =     0.41 m³/s (pipe flow)
 Peak storage =     3.86E+03 m³
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Figure 19. Peak Storage Site Basin (note ARR87 conservative)

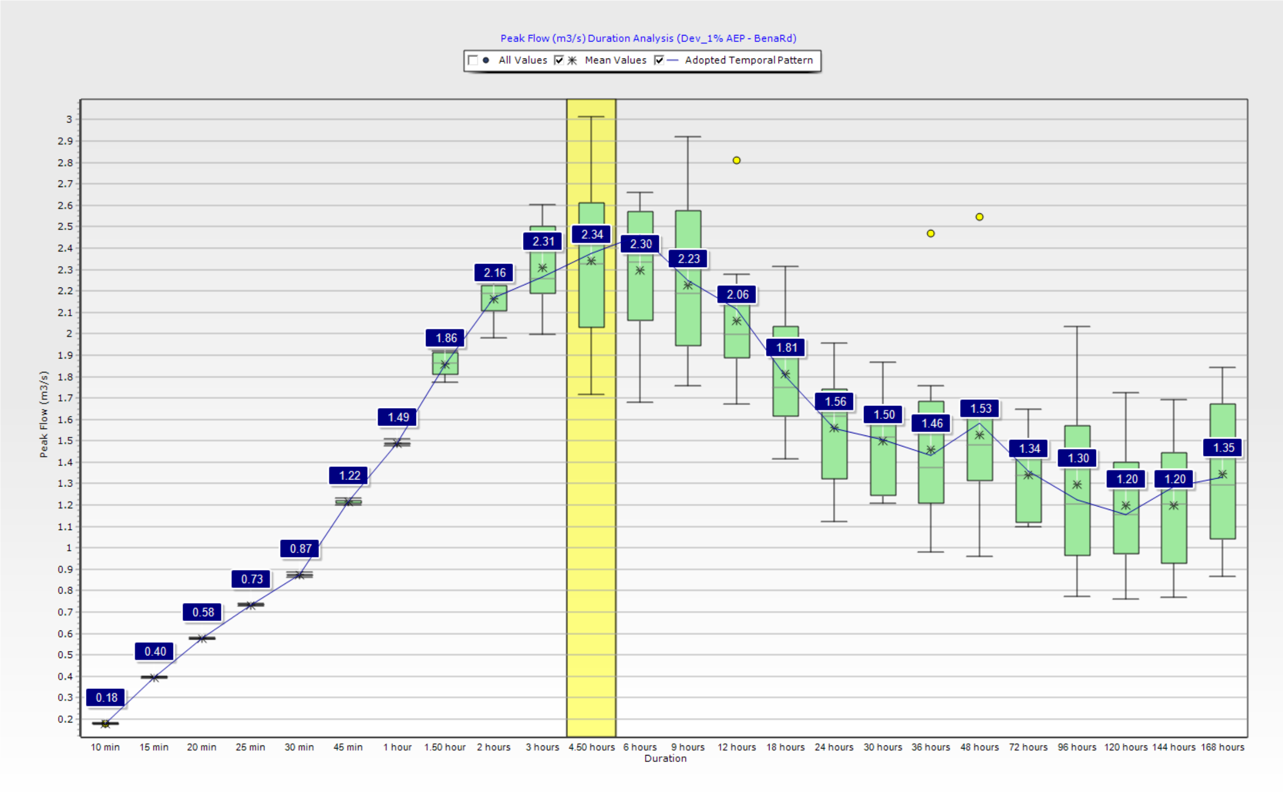


Figure 20. Peak Development Outflow @Bena Road (ARR19)

Climate Change Sensitivity

A sensitivity to Climate Change was tested through the model. The RCP6 2090 climate change factors were applied to the model (9.7% increase) and run through the basin. At Bena Road Crossing the CC run results in approximately 300L/s increase and ~1ML in volume (Figure 21). Leaving the Basin, the mean flow change is significantly less at ~3L/s (Figure 22). Please note that the Interim Climate change factors are expected to change in June 2024 and may be different to this assessment.

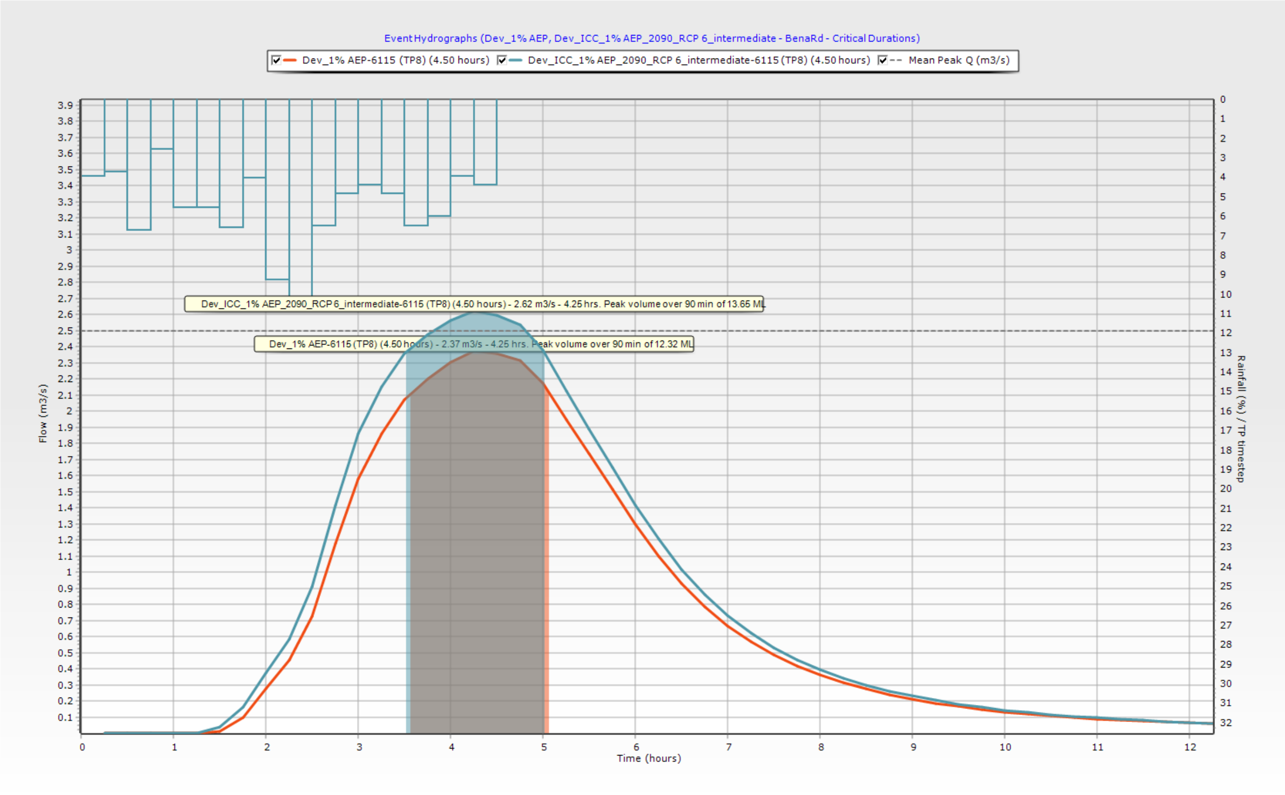


Figure 21. Bena Road Discharge Climate Change

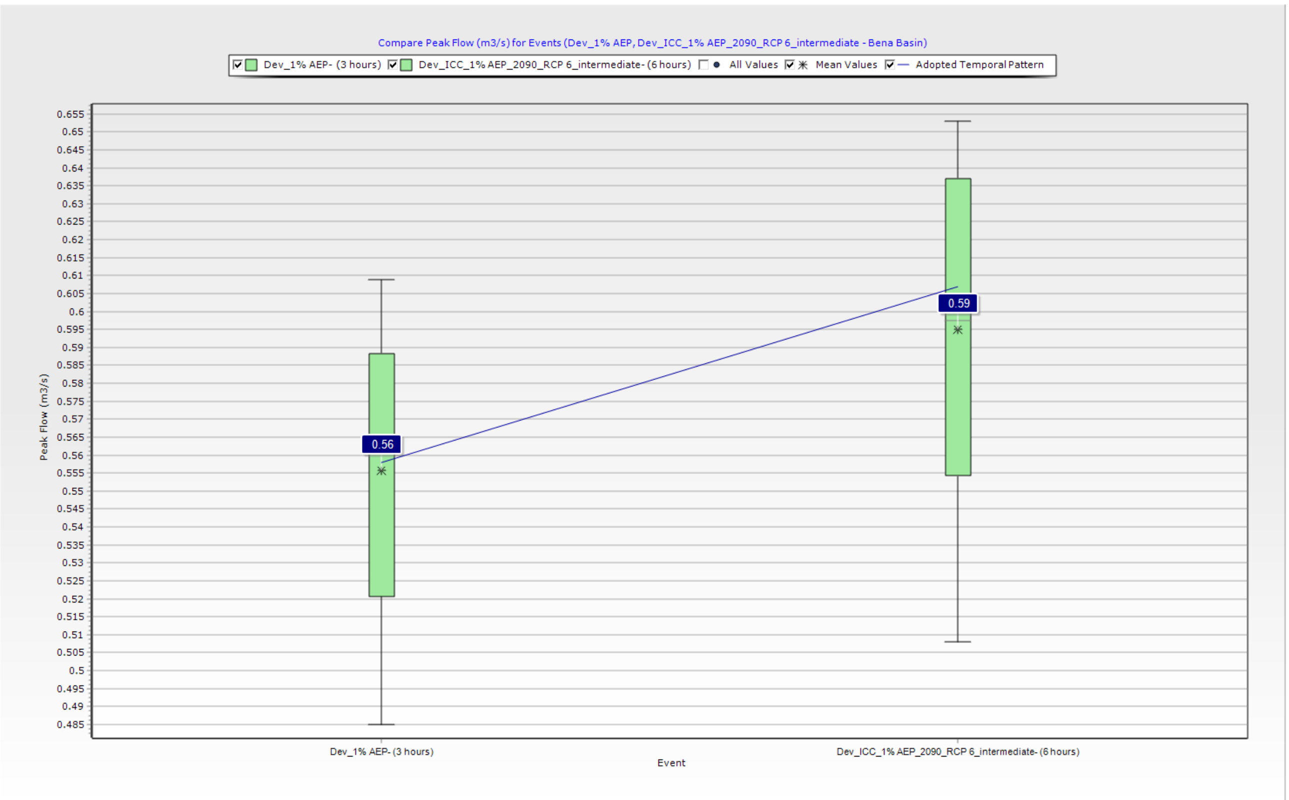


Figure 22. Basin Discharge CC comparison

4.3. North East Catchment Detailed analysis

A small portion of the site will discharge to the North East corner of the development. Whilst every effort to minimise this catchment should be made, and analysis of the peak flow to this catchment needs to be understood. The estimated development catchment to this area is shown in Figure 23 below.

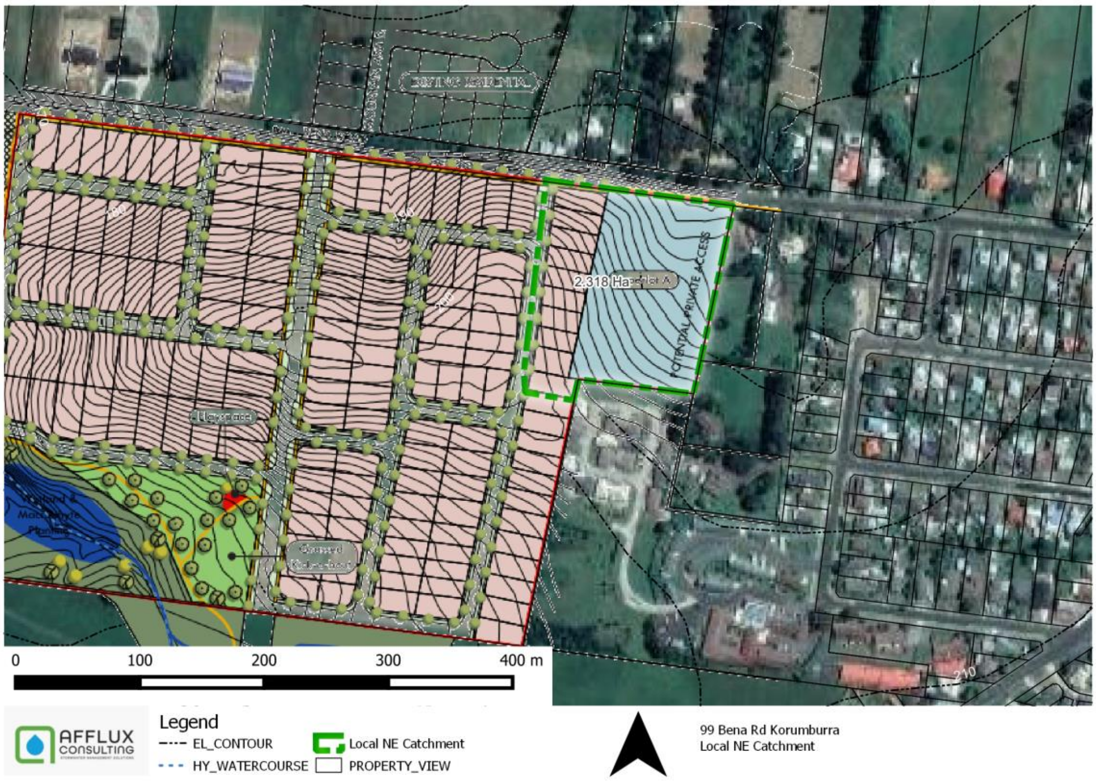


Figure 23. North East Developed Catchment Area

Three methods of flow and attenuation have been estimated for this catchment, these are:

Rainfall on Grid

A detailed Rainfall on Grid (ROG) model of the larger region has been undertaken to understand the flooding regime surrounding the site. The flows from this model can be seen in 0. As can be seen the flow from the site is ~0.08m³/s (magenta), and the flow along the south face of Bena Rd ~0.14m³/s (Blue/Green).

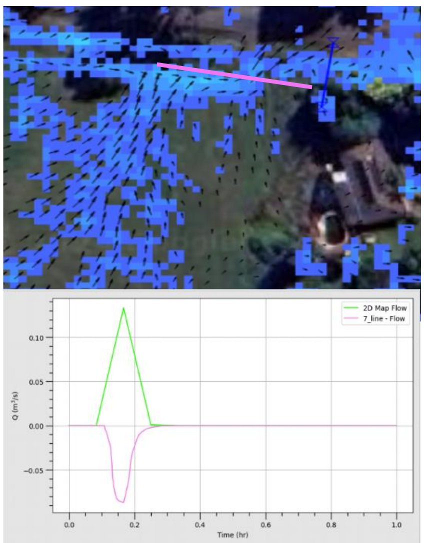


Figure 24. ROG flow Estimations (note Absolute values)

Rational Method Estimation

A Rational Calculation for the rural catchment can be seen in Figure 25

Catchment Characteristics		
Area	2.18	Hectares
fi	0.05	
$^{1}I_{10}$	26.3	mm/hr
Mode of Tc Calculation	0.76A^0.38	
Initiation time (if rqd)	10	minutes
tc (manual input)	11.00	minutes
→ tc	**10.66**	**minutes**

Full Pipe Velocity Calculation		
L	480	m
Upstream Elevation	109.2	m
Downstream Elevation	103.4	m
Slope	0.01	
n*	0.013	
Pipe Diameter	0.450	m
R	0.1125	
→ V	**2.0**	m/s

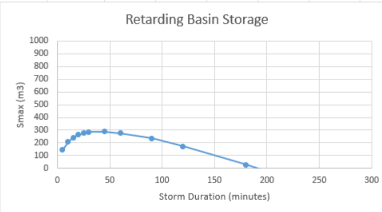
ARI (years)	Q (m^3/s)	I (mm/hr)	tc	Fy	C'10	C10	Cy	Total Area (ha)
1	**0.03**	38.7	10.66	0.80	0.117	0.157	0.125	2.18
2	**0.04**	43.8	10.66	0.85	0.117	0.157	0.133	2.18
5	**0.05**	59.9	10.66	0.95	0.117	0.157	0.149	2.18
10	**0.07**	71.2	10.66	1	0.117	0.157	0.157	2.18
20	**0.08**	82.6	10.66	1.05	0.117	0.157	0.164	2.18
50	**0.11**	98.3	10.66	1.15	0.117	0.157	0.180	2.18
100	**0.13**	111.0	10.66	1.2	0.117	0.157	0.188	2.18

Figure 25. Rational Method Rural Estimation

Based on the flow estimates a storage for this north east catchment should be between 200-300m³ depending on whether a 1% or 10% AEP Existing flow rate is chosen as the attenuation requirement. Practically, an existing 225mm pipe is located in Bena Road, and could be expected to convey approximately 0.08m³/s at the surface grades for the area. This seems to be the most practical response and yields ~260m³ as maximum storage volume.

Catchment Area (A) =	2.18	ha
Runoff Coefficient (100 Year) =	0.6	
100 Year Effective Catchment Area ∑CA =	1.31	ha
Restricted outflow requirement (Qp) =	0.07	m^3/s

Storm Duration	Smax
5	145
10	207
15	242
20	263
25	277
30	285
45	289
60	278
90	234
120	174
180	29
270	-216
Maximum Storage	289



Catchment Area (A) =	2.18	ha
Runoff Coefficient (100 Year) =	0.6	
100 Year Effective Catchment Area ∑CA =	1.31	ha
Restricted outflow requirement (Qp) =	0.14	m^3/s

Storm Duration	Smax
5	124
10	165
15	179
20	179
25	172
30	159
45	100
60	26
90	-144
120	-330
180	-727
270	-1350
Maximum Storage	179

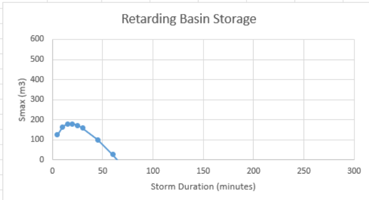


Figure 26. Boyd's volume estimates on 0.07-0.14m³/s existing discharge limits

Estimated 0.08m³/s Existing Capacity

Figure 27. Existing Grated discharge at NE Corner

4.4. Northwest Catchment Detailed analysis

The north west catchment currently discharges to both Bena Road and to the neighbouring road reserve. This catchment approximates Catchment O in the Rorb model as can be seen in Figure 28. Single RORB node flow estimation is discouraged, particularly for such a steep small catchment and as such both the ROG method and RORB estimations are presented below. The proposed diversion adequately reduces the development GAP flow.

Table 6. NW Catchment Flow Estimations

Flow Estimate	ROG (m^3/s)	RORB (Catch O) (m^3/s)
Existing Conditions	~2.2	0.91
Developed Condition		0.58 (0.6 diverted)

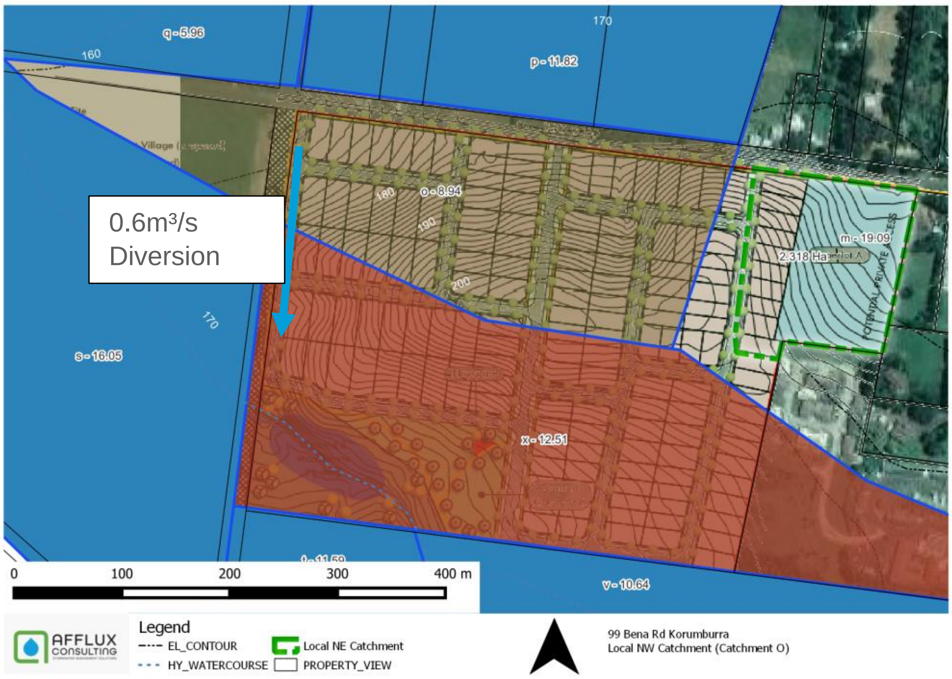


Figure 28. North West Catchment

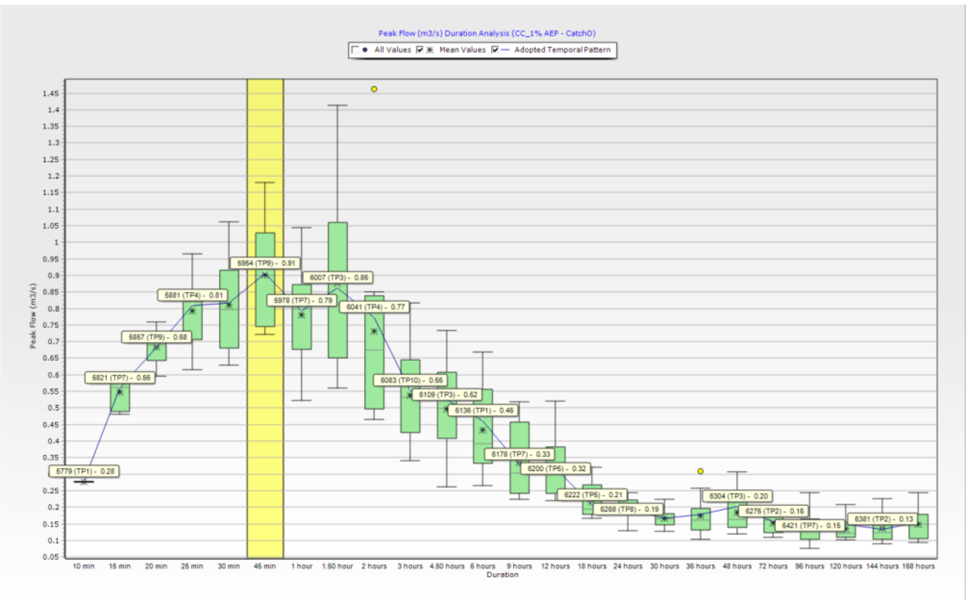


Figure 29. Existing Conditions Flows Catchment O

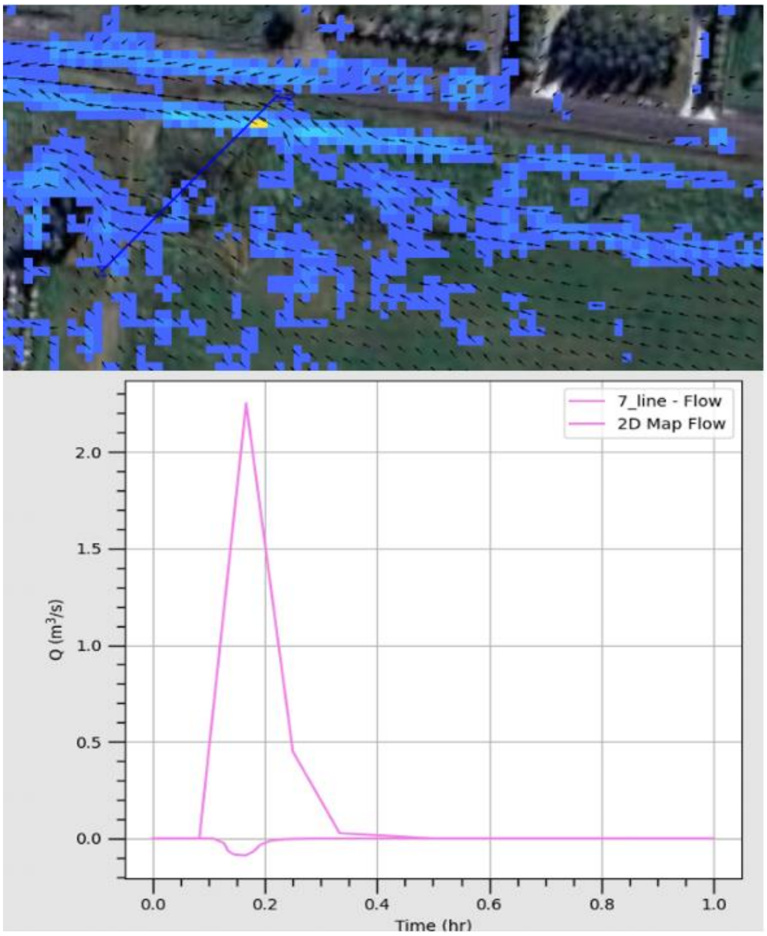


Figure 30. Existing Flows ROG method

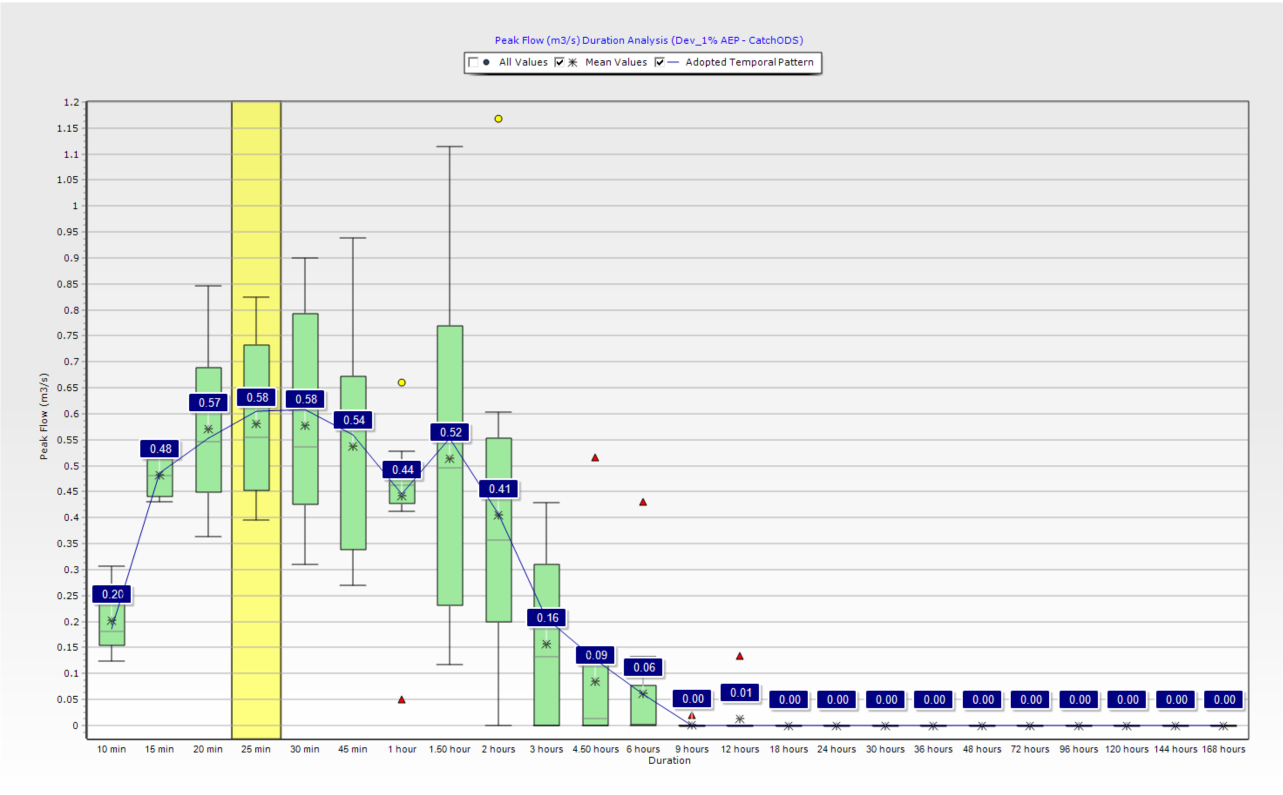


Figure 31. Catchment O DS flow (after pipe diversion)

5. Flood Modelling

As part of flooding investigations for the site, the regional and local stormwater conditions were considered. The major influencing factors include the impact of flooding from rainfall on the immediate catchment as well as interactions with greater regional flows and relevant upstream events. The main considerations include the availability of floodplain storage, safe overland flow conveyance, water surface levels in relation to proposed developed floor levels and any changing impacts to neighbouring properties.

5.1. Topographic Data

The LiDAR data supplied by commercial sources was used as the base information to generate the Digital Elevation Models (DEM), informing surface elevations required for the model. Figure 32 shows the data over the catchment area for the site. LiDAR survey information is shown in Table 7

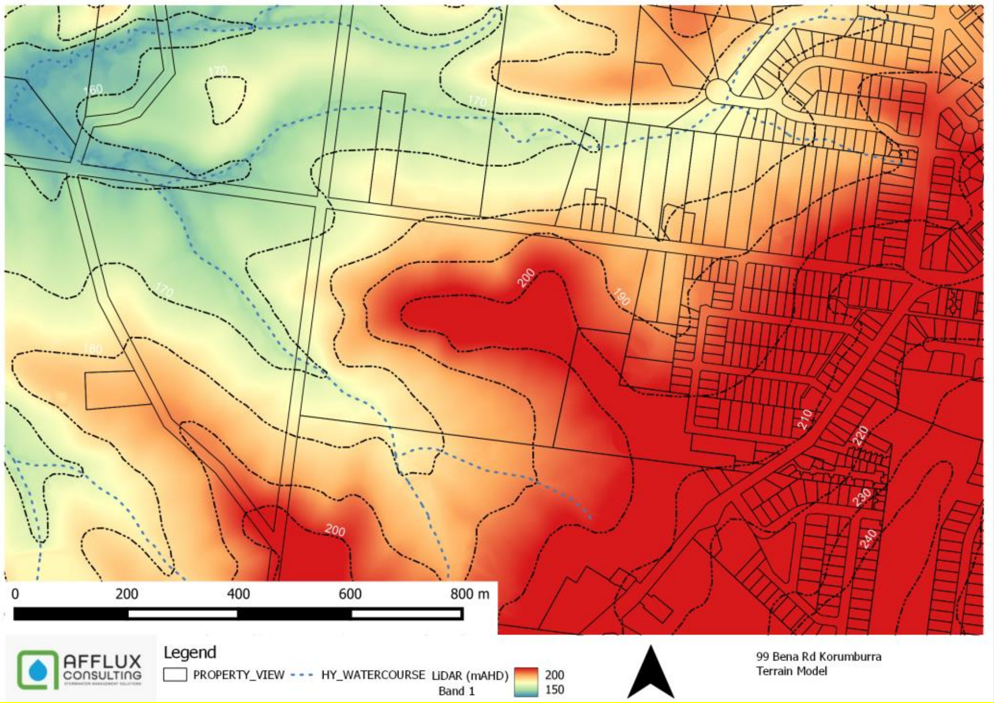


Figure 32. Site topography

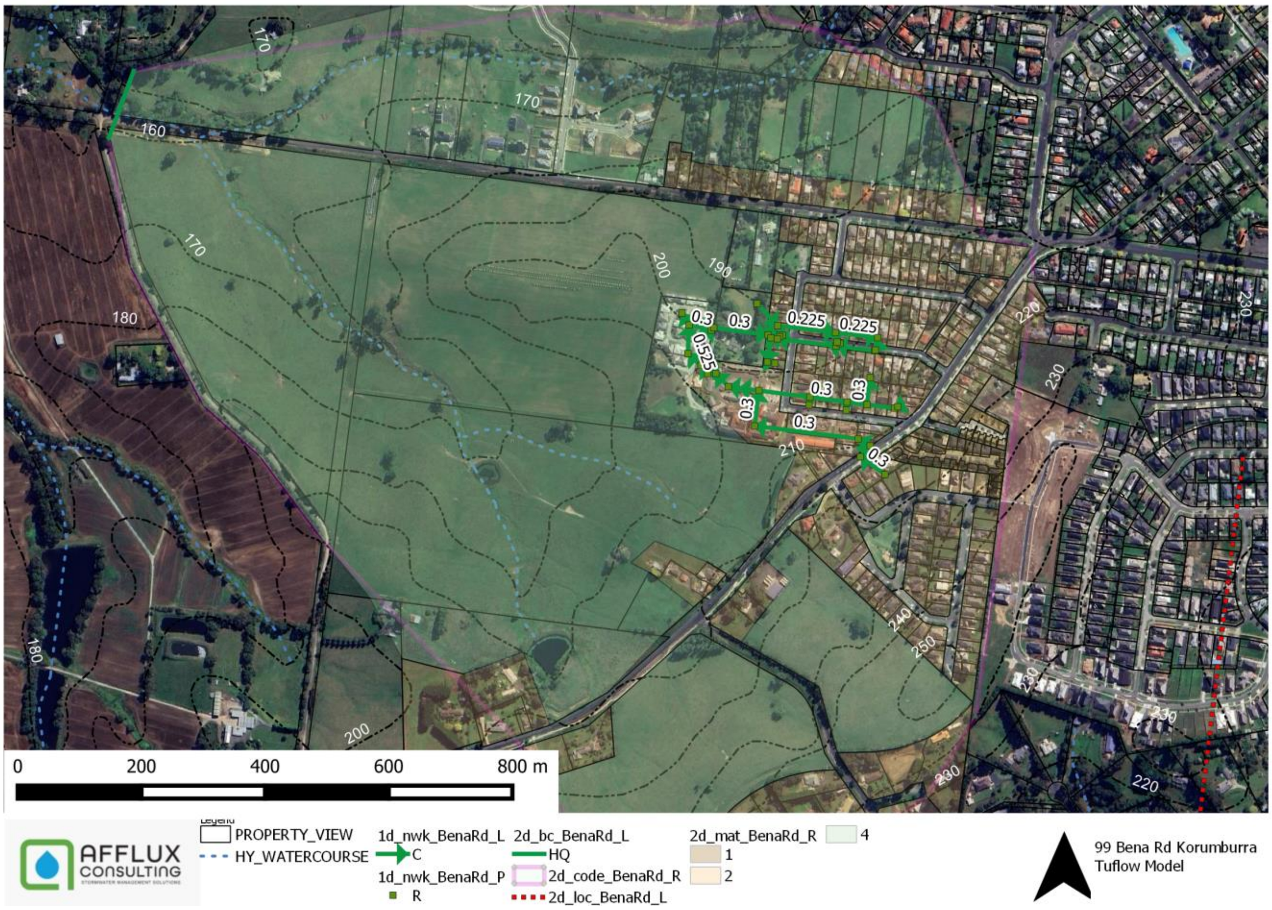
Table 7. LiDAR survey metadata

LiDAR survey metadata	Data
Acquisition Start Date	Nov 2009
Acquisition End Date	May 2012
Horizontal datum	GDA94
Vertical datum	AHD
Map projection	MGA zone 55
Horizontal accuracy	+/- 10 cm
Vertical Accuracy	+/- 20 cm

5.2. Model Parameters

The initial model setup for the catchment model involved accessing survey surface levels and a setup of existing drainage networks for the model area. Model extent is based on topographical catchment boundaries. Land use in the model has been determined based on inspection of aerial imagery and visual inspection and has been used to inform Manning's roughness factors in the model. Downstream boundary conditions have been established based on an examination of topography. This has been set a considerable distance downstream of the proposed assets to ensure no undue model boundary influence.

These assumptions and Manning's roughness values can be seen in Figure 33 below.



Source: Bena_~e1~_~e2~_~e3~.tcf

Figure 33. Model parameters and setup

5.3. Model Reporting and Analysis

The model has been set up to report the following key indicators:

- Water Surface Elevation (WSE) showing the water level relative to a datum (m AHD) at each model grid cell.
- Maximum water depths for each model grid cell.
- Maximum water depths at defined reporting cross sections immediately onto and off the site.
- 2D Time-Series Plot Output (PO) and Map Output data at various locations across 1D and 2D network.

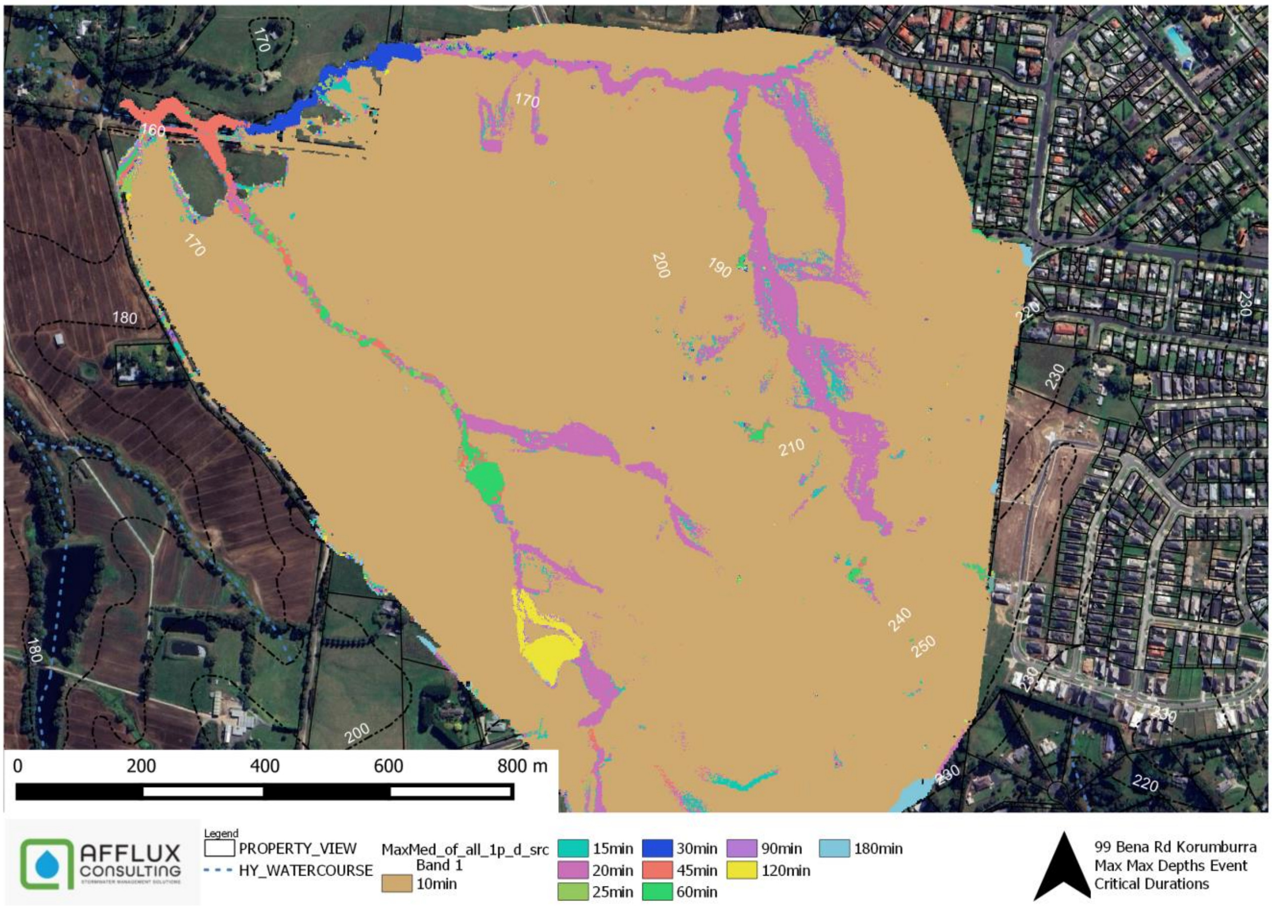
Analysis of results will show WSE and water depth based on flood conditions and will be used to establish flood extents on the property. The 2D Time-Series Plot Output (PO) data provide Flow-Time hydrographs at user-defined locations. Additionally, the 1d connections report Flow-Time hydrographs for assessment and validation of underground drainage network systems.

Water Level Difference maps will be provided to show afflux changes between existing and developed conditions. Additional maps will be produced to provide an assessment of the proposed development against safety criteria. Based on the assessment of these results, recommendations for floor levels, site access, and treatments will be made.

5.4. Ensemble Flood Assessment

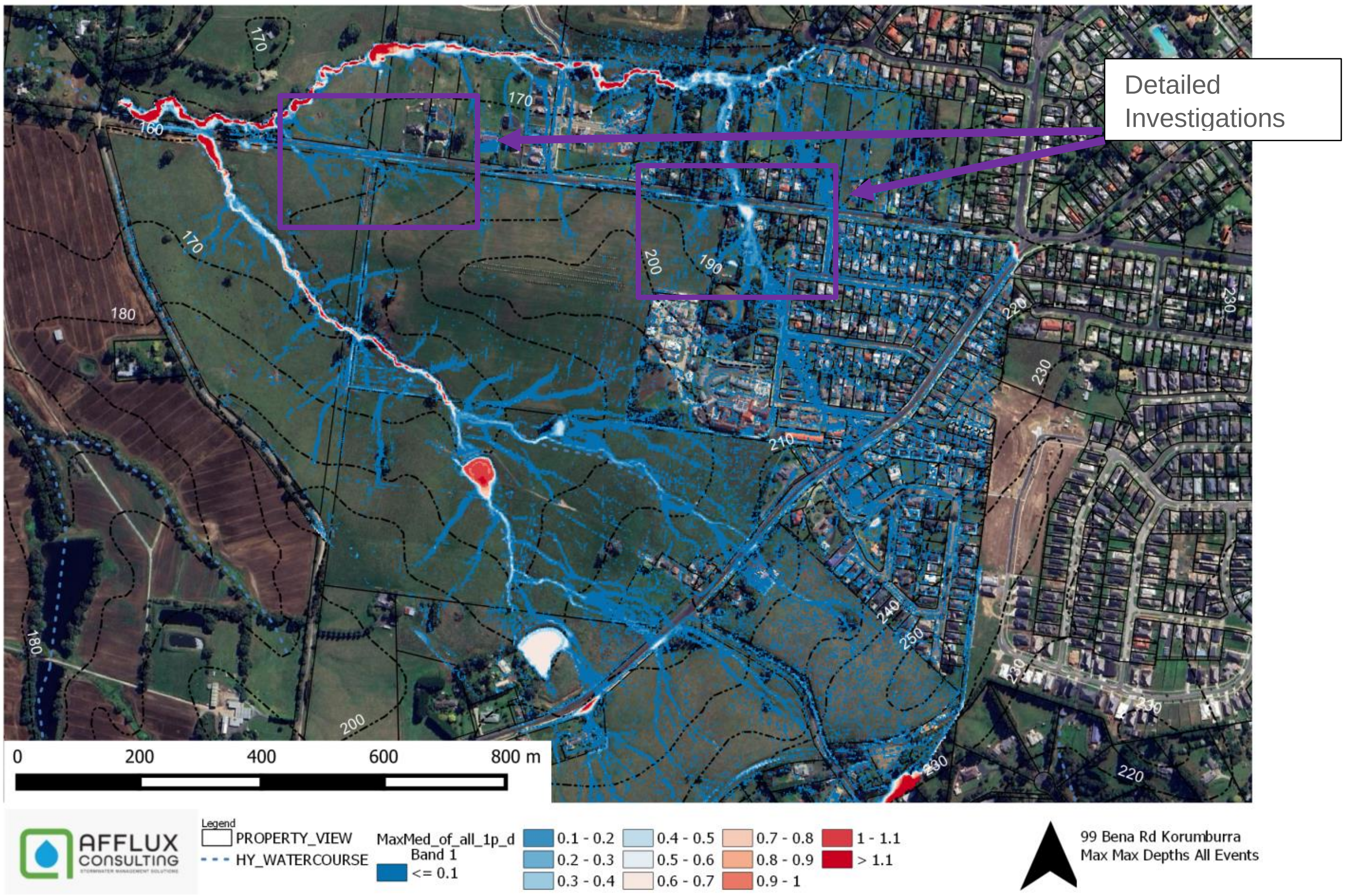
The impact of flooding from rainfall on the relevant regional catchment was assessed using a whole catchment model. To select the design storm, the Tuflow solver was used to run all 10 temporal patterns across a selection of storm durations (10 mins to 3 hours) for the 1% AEP. Utilising the Tuflow post-run processing utilities, in line with the ARR19 recommendations, the peak median temporal pattern and critical storm were selected for design.

The flood depths and peak flows from the critical event in the catchment flood modelling can be seen in (Figure 35) with the maximum depth from all storms and temporal patterns shown. The critical durations and flood depth through the site were found to occur in the10 minute (Figure 34) though the creek interface can be seen to be slightly longer 20 minute storms.



Source: MaxMed_of_all_1p_d_src.flt

Figure 34. Peak time to concentration map for catchment



Source: MaxMed_of_all_1p_d.flt

Figure 35. Catchment flood modelling Maximum Depth Plot from all events

Key Outputs

The key points from this analysis are:

- A significant overland flow path (OFP) occurs to the north east of the site. This flow path travels through existing residential areas, and will need careful flow mitigation.
- Flow estimates from this model can be used to help ascertain flood storage requirements (see Hydrology section)
- The main flow path is highly confined, with very little accumulation on the rest of the site. The sets the majority of the land as a low-risk development site from a flood perspective (as is consistent with an upper headwaters area)
- Bena Road is the major hydraulic control and as such all flow calculations should be performed at this point.

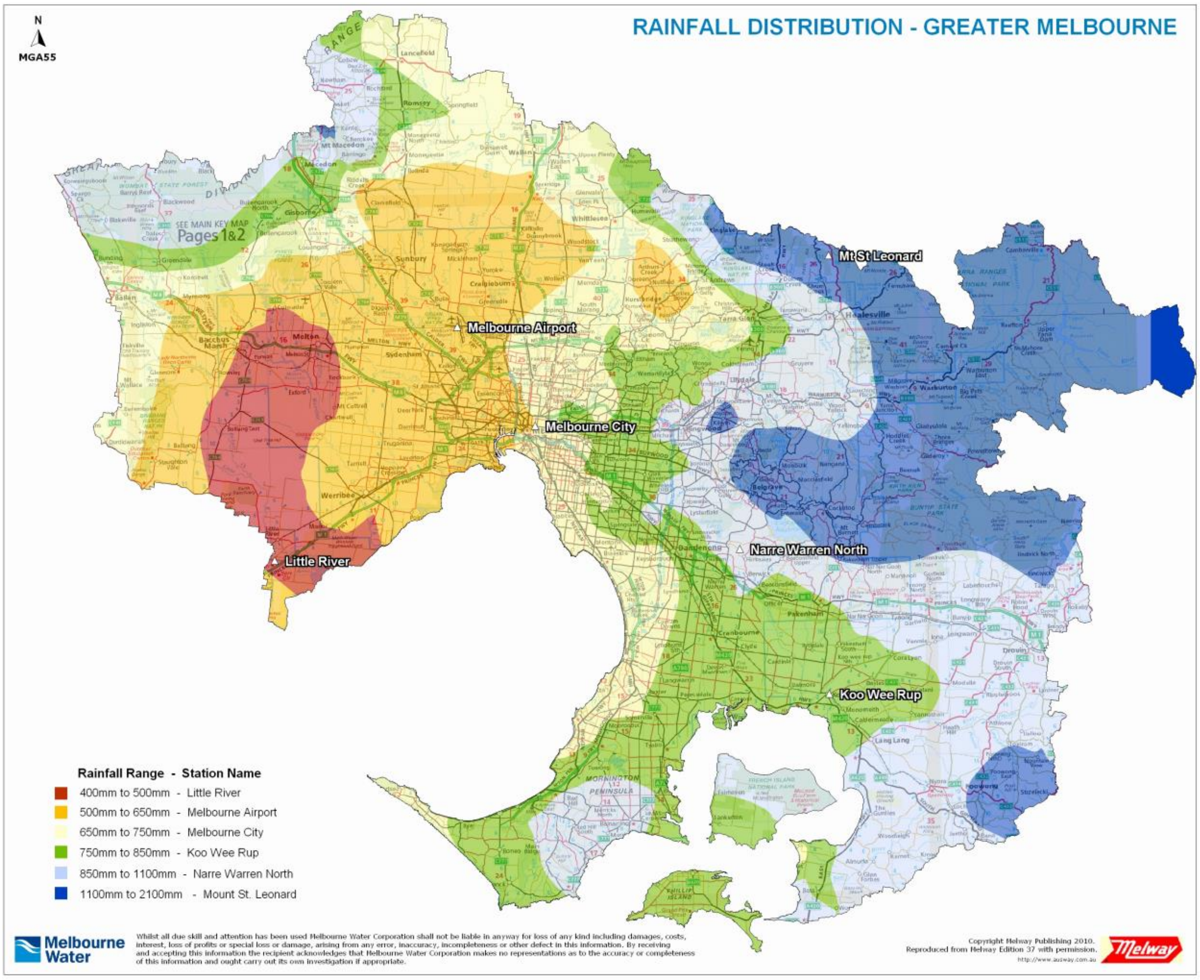
6. Water Quality

The water quality for this site has been assessed for the development. Treatment is modelled to ensure water quality for the site meets best practice load-based reduction requirements. The water quality works must coincide with the proposed development to ensure runoff does not directly discharge into the existing drainage system to the detriment of downstream water quality.

Initial concept level calculations were undertaken to understand stormwater treatment for the site.

6.1. Rainfall Information

To assure a consistent a 10-year rainfall record, the Melbourne Water rainfall templates have been used. The catchment is within the 1200mm/year range and as such the reference decadal rainfall summary of Mt St Leonard 1995-2004 has been applied. Rainfall was run at a 6-minute interval to match the lowest Time of Concentration of the catchment.



Source: Melbourne Water MUSIC Guidelines

Figure 36. Greater Melbourne rainfall distribution

6.2. MUSIC Model Setup

To ensure that the development meets the BPEM requirements of Clause 56-7.04 a MUSIC model (v6) has been created for the catchment. MUSIC modelling is an industry standard approach to determine water quality treatment and sequencing. Guidance for model inputs was sourced from the IDM as well as Melbourne Water's MUSIC guidelines.

In order to reach BPEM Guidelines the model has been set up with the following notes:

- The model has been designed in alignment with proposed layout.
- The model is built using the most recent guidelines including soil losses field capacity.
- The model is built with an assumed 350mm EDD.
- The model is built using rainfall templates that include 10-year periods of rainfall data;
- The measured catchments are in alignment with hydrological models; and
- Source node sub-catchment areas for the development are separated by impervious fraction as per Table 8, in alignment with MUSIC guidelines.

All other parameters were set as per Melbourne Water Guidelines.

Table 8. Sub-catchment areas and impervious fraction

Catchment Name	Area (ha)	FI (existing)	FI (developed)
North	6.7	0.05	0.6
NE	2.2	0.05	0.6
West	2.5	0.05	0.6
South	7.65	0.05	0.4

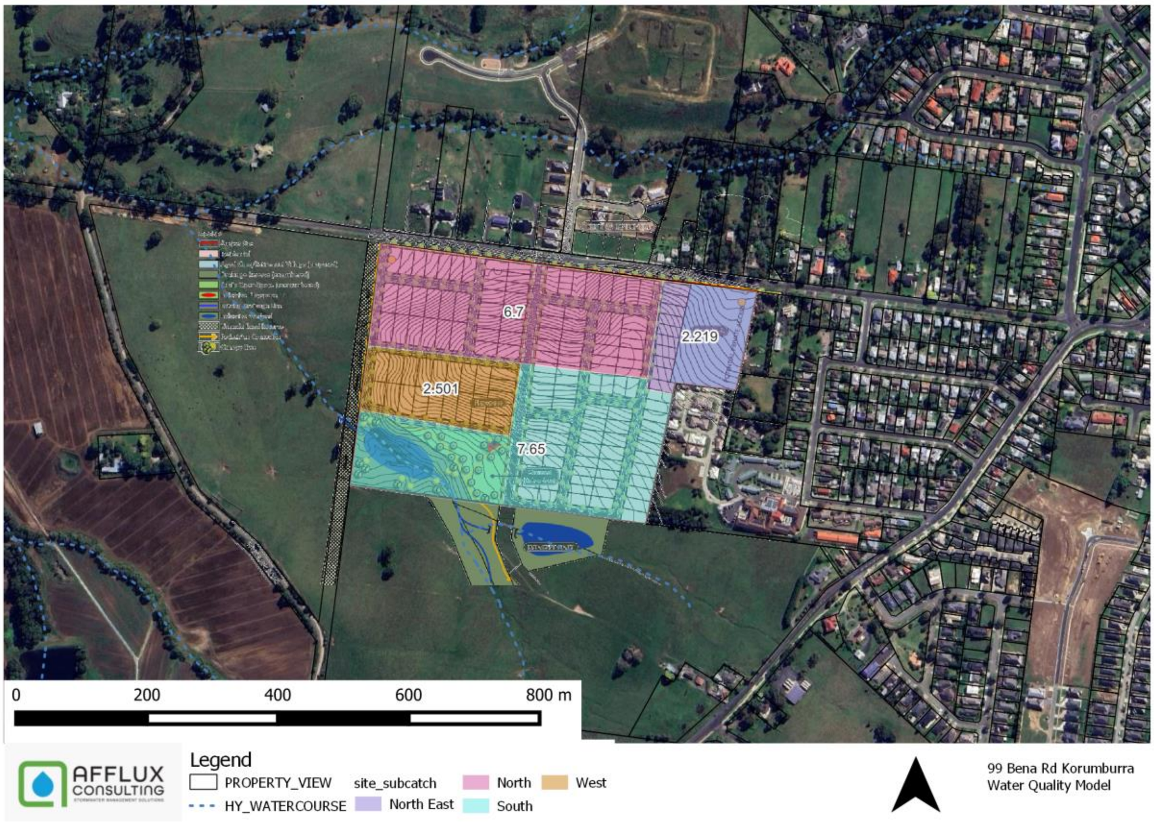


Figure 37. Water Quality Catchments

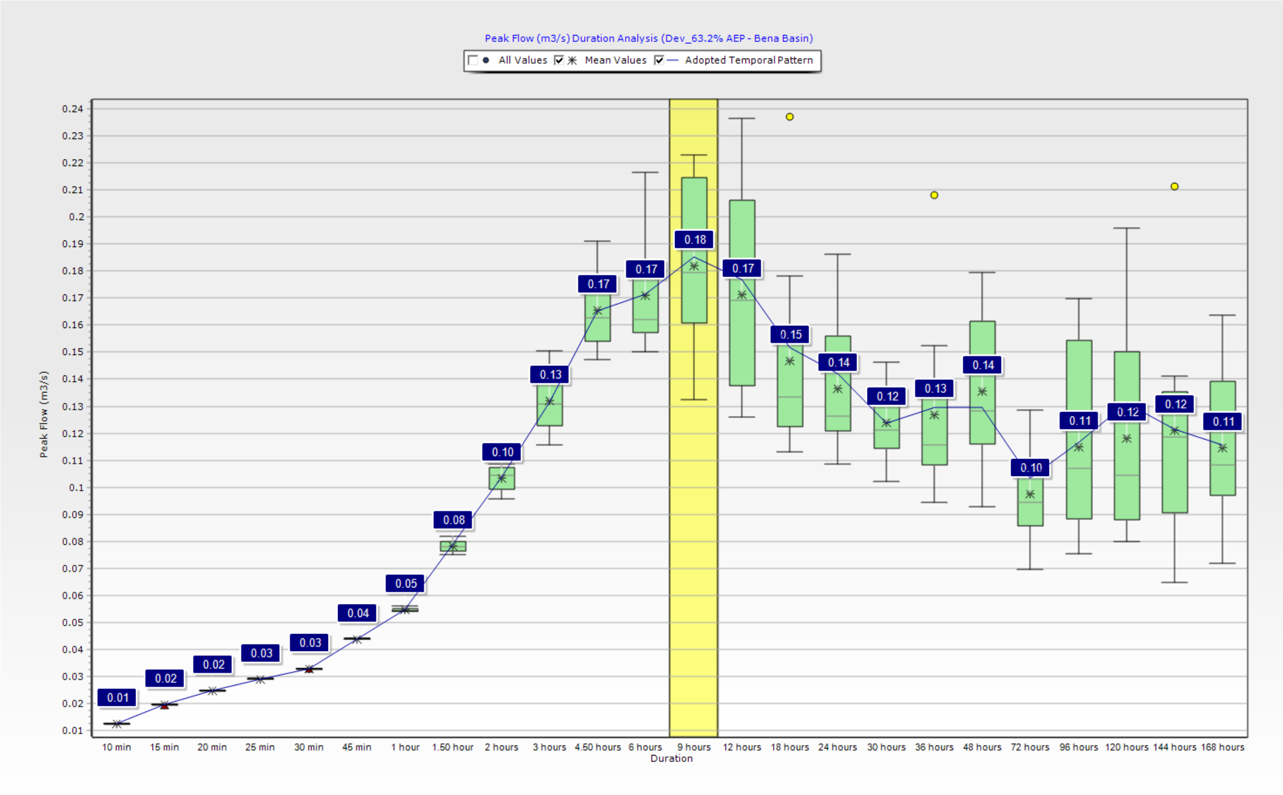


Figure 38. Treatment Inflows

6.3. Proposed Treatment

Runoff from the developed catchment will be treated by a treatment train system to ensure the development does not result in significant degradation of downstream waterways and optimum stormwater treatment at site outlet. It is recommended that the development is treated by an on-site WSUD system. The results of the MUSIC simulation provide an estimation of the expected nutrient reduction performance as shown in Figure 39.

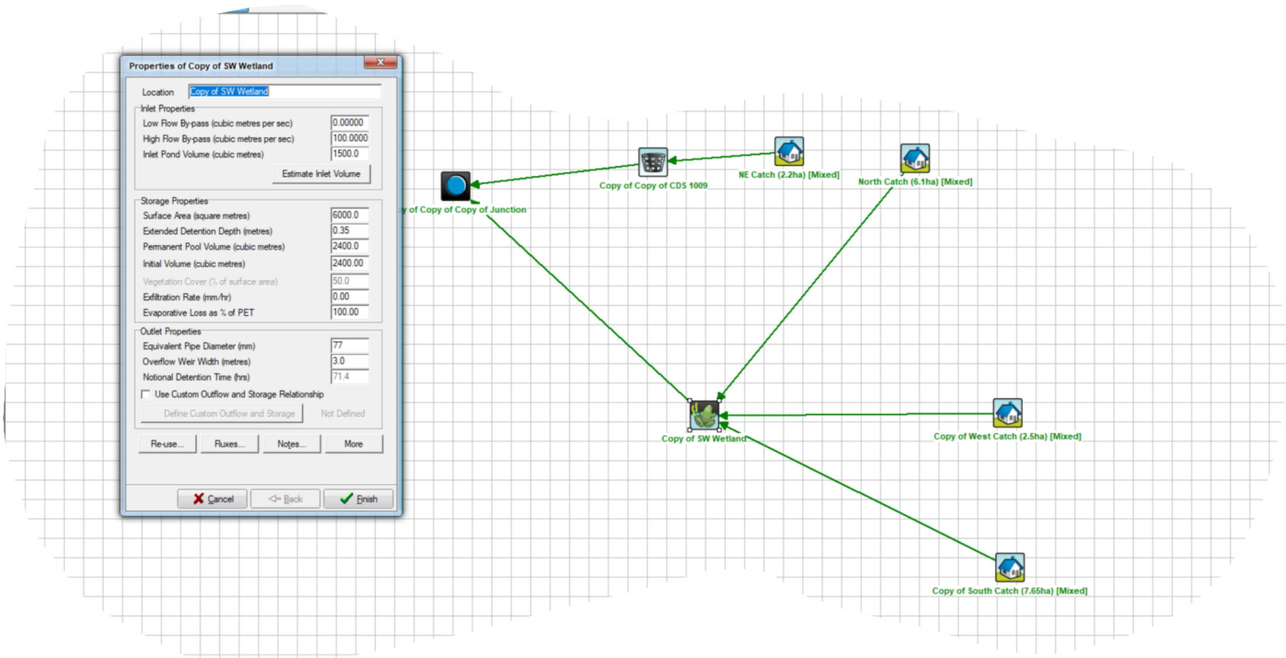


Figure 39. MUSIC Model Setup

Table 9. Summary Stormwater Treatment Requirements

Treatment	Size Requirement
NE GPT	Rocla CDS 1009
SW Wetland	6000m²
SW Sediment Pond	1000m³
NW	Divert low flow to wetland (or GPT if not available)

6.4. Sediment Control

Control of sediment from a developed area is an important consideration for both the hydraulic function of drainage and water quality assets.

Sediment build-up can lead to the failure of pipe networks (through blockage) and biological systems (through blockage and bypass). It is recommended that all local pipe network outlets, where possible, end in a sediment pond before discharge to the waterway or wetland.

Given the scale of the residential development, sediment ponds are recommended as a suitable intervention. Maintenance requirements are an important consideration when allowing for reserve areas. Practical sediment pond sizes are limited to a minimum 300m², with access and sediment dry-out areas adding up to approximately 20% to the required footprint area.

Sedimentation basins were sized using the Fair and Geyer equations, with the results summarised below. This has then been modelled in MUSIC as a sediment basin node.

Source	**Parameter**	**Basin 1**
Melbourne Water requires R = 95% for a 125 micrometer particle	Target	Clay
Pond shape assumption (Figure 10.5)	λ	0.26
	n	1.35
From Table 1	Vs (m/s)	0.011
Use rational method to obtain 1 Year ARI flow for sub catchment	Q (m³/s)	0.18
Area of basin	A (m²)	1000.0
	$\frac{V_s}{Q/A}$	61.11
What batter slope is used to contol the cut to depth	Batter Slope	3.00
What is the ratio of the longest cross section to the shortest	Aspect Ratio	3.00
EDD	d_e (m)	0.20
Depth of permanent pool	d_p (m)	0.25
Lower of 1m or d_p	d* (m)	0.25
	$\frac{(d_e+d_p)}{(d_e+d^*)}$	1.0
Fraction of Initial Solids Removed	**R =**	**99%**
(Keep changing surfae area until 95% solids removed)		

Figure 40. Sedimentation Basin Sizing - Fair and Geyer

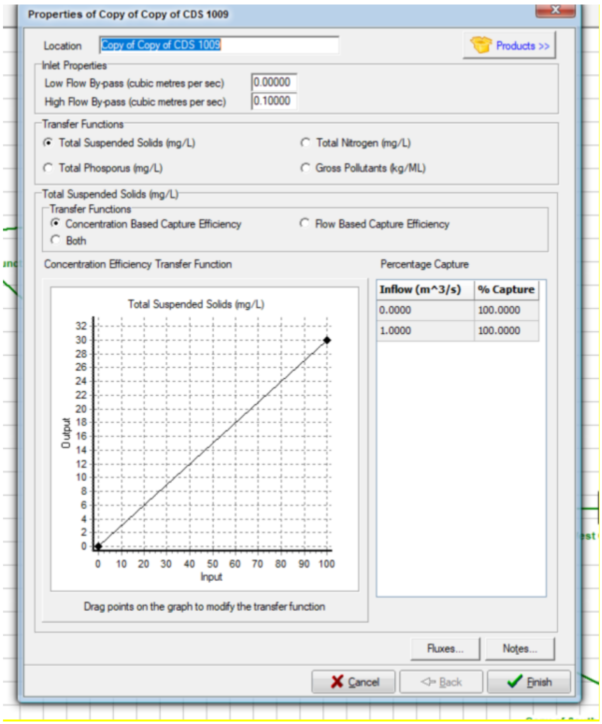
Table 10. Sediment Basin Cleanout Parameters

Source		**Basin 1**
Just urban catchment considered	Catchment Area (ha)	10.00
(Willing and Partners 1992)	Sediment load (m³/ha/yr)	1.60
(Alison et al 1998)	Gross Pollutant Load (m³/ha/yr)	0.40
Maximum Allowed Cleanout Frequency	**Cleanout frequency required (yr)**	**6.3**
Assumes cleanout when basin permanent pool 50% full		

6.5. Gross Pollutant Trap (GPT)

The north east catchment in particular is not able to be diverted to the sediment pond and as such a GPT is recommended to minimise sediment load to the waterway to the east.

Generally, a GPT is limited to areas where the discharging catchment is either 10Ha or less, or of a potential high gross pollutant load (High likelihood of disposable rubbish or other). Again, generally a Continuous Deflection type of GPT is recommended, though site characteristics should be considered.



Source:. BenaRd_10yStLeonard.sqz

Figure 41. MUSIC GPT Design Inputs

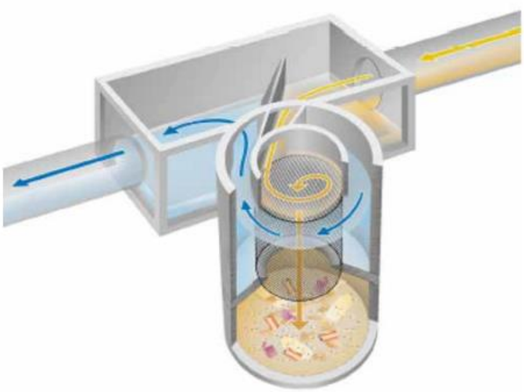


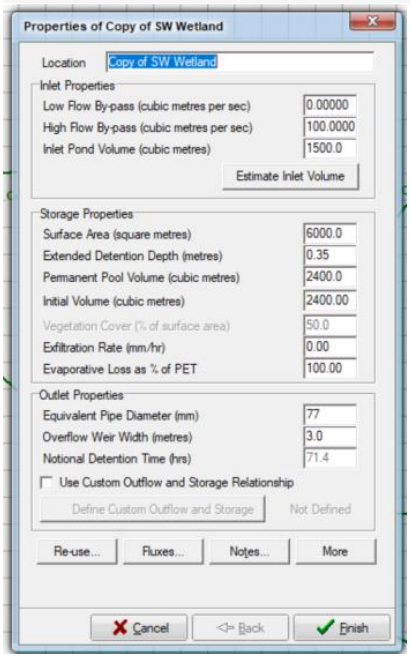
Figure 42. Recommended GPT CDS type

6.6. Wetlands

Wetlands are designed to treat the nutrient loads associated with the three-month flow or equivalent from a development site. This wetland will be an offline wetland with bypass system. An example of this type of system has been provided below.

Table 11. Sediment Basin Parameters

Sediment Pond	Sed Pond Size (m2)	Target Size	Achievement Rate	Maintenance requirement
Sediment Pond	1000	125 micrometre	97%	7.5 years Cleanout
Macrophyte zone	6,000	TN 45%	45.	20-30 year Replacement



Source:. BenaRd_10yStLeonard sqz

Figure 43. MUSIC Wetland Design Inputs

Source: Afflux designs

Figure 44. Schematic representation of a similar bypass wetland in Drouin

Figure 45. Drouin Wetland and Bypass Channel

6.7. Volumetric Reductions

As detailed in the catchment objectives the EPA volumetric ambition is to achieve a 20% reduction in total volume change to this catchment. Whilst this is not considered a requirement under the planning scheme, it should be considered as a consideration in the development plan.

Realistically, for this site with no immediate public water demand (oval or sports fields), the only realistic volume reduction method is through rainwater tanks plumbed to toilet use. The MUSIC model was modified to include a 2KL tank on each of the 152 lots with a 20L/pp/pd demand, and an assumed 4 person per lot occupation. The MUSIC model assumptions can be seen in Figure 46, with the water balance from these assumptions shown in Figure 47.

As can be seen an approximate 3% volumetric reduction can be achieved. If the wetland evaporation is included this reduction can be increased to approximately 5%. This is well below the EPA recommendation of 20% (Figure 10) but is all that would reasonably be available for this catchment without a more regional approach (Council led) being adopted.

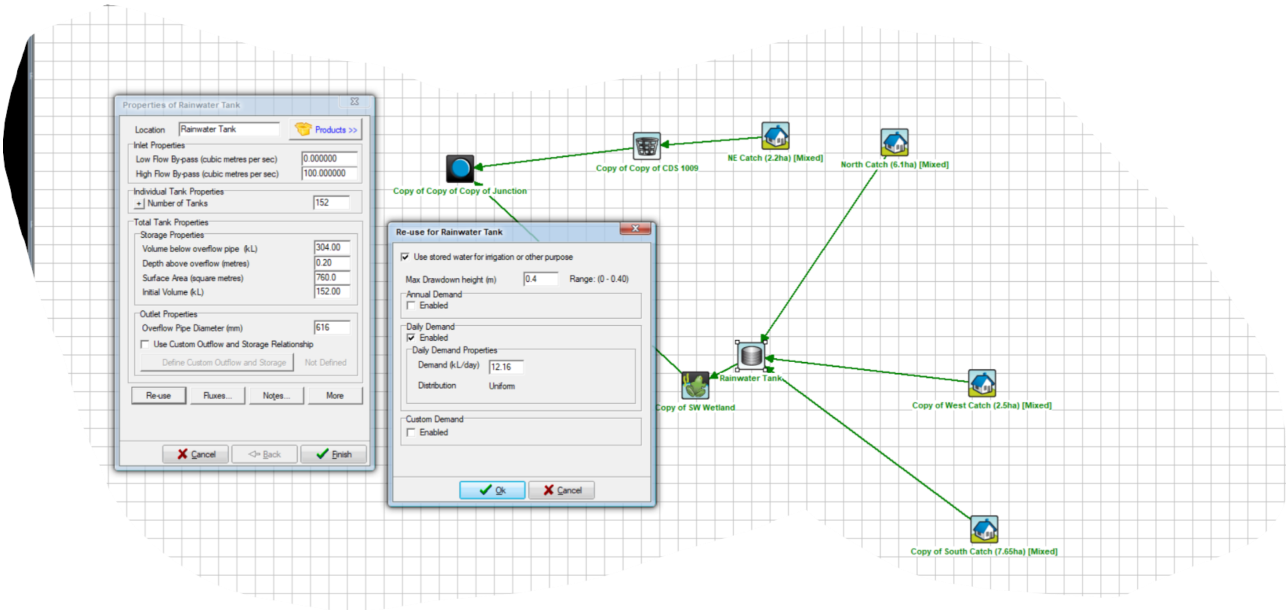


Figure 46. Rainwater Tank Assumptions

Node Water Balance - Rainwater Tank

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	GP (kg/yr)
Flow In	132.95	19801.40	45.20	354.87	3949.23
ET Loss	0.00	0.00	0.00	0.00	0.00
Infiltration Loss	0.00	0.00	0.00	0.00	0.00
Low Flow Bypass Out	0.00	0.00	0.00	0.00	0.00
High Flow Bypass Out	0.00	0.00	0.00	0.00	0.00
Pipe Out	127.04	12804.10	34.31	318.13	0.00
Weir Out	1.54	261.31	0.59	4.48	0.00
Transfer Function Out	0.00	0.00	0.00	0.00	0.00
Reuse Supplied	4.44	133.11	0.73	9.24	0.00
Reuse Requested	4.44	0.00	0.00	0.00	0.00
% Reuse Demand Met	100.00	0.00	0.00	0.00	0.00
% Load Reduction	3.29	34.02	22.79	9.09	100.00

Decimal Places 2

Figure 47. Node Water Balance

7. Channel Form

The channel through the waterway needs to perform a number of aesthetic, stability, vegetation and habitat and recreational outcomes for the site. A well-designed channel will be a community asset for many years to come.

In this case, the wetland has been designed to occupy the valley floor, and all upstream flows have been designed to bypass the wetland. For this preliminary concept design only high-level calculations have been performed, and as such it is recommended that a functional design report including detailed modelling of the ultimate system be required as a permit condition.

The waterway is considered a 2nd order stream according to the Strahler System (Figure 48) typically requiring a minimum 40m corridor (20m each side of waterway). Often however Councils enforce a minimum 30m either side of the waterway. This has been reinforced by the WGCMA response in Appendix A. The wetland and bypass channel dimensions have been estimated below based on the assumption that the full 10% AEP flows should bypass.

Figure 2. The Strahler System

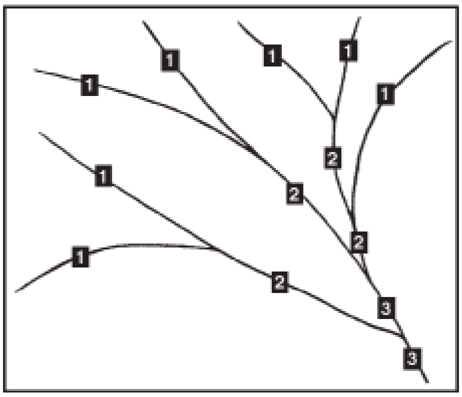
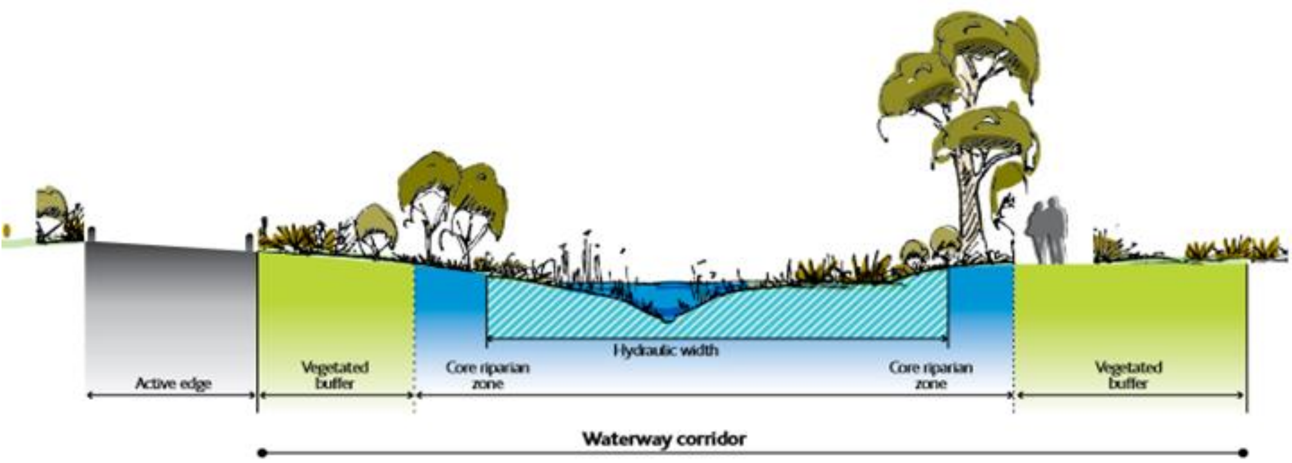


Table 1. Recommended riparian corridor (RC) widths

Watercourse type	VRZ width (each side of watercourse)	Total RC width
1st order	10 metres	20 m + channel width
2nd order	20 metres	40 m + channel width
3rd order	30 metres	60 m + channel width
4th order and greater (includes estuaries, wetlands and any parts of rivers influenced by tidal waters)	40 metres	80 m + channel width

Figure 48. Strahler System Corridor Requirements (DPI NSW)



Source: Melbourne Water Waterway Corridor Guideline

Figure 49. Proposed example of waterway cross section design

In this case the waterway reserve has been set at more than 70m in all cases, with the existing vegetation and possible future extension of reserve considered in the development plan. A full waterway management plan including vegetation details will be required at functional design stage of the wetland.

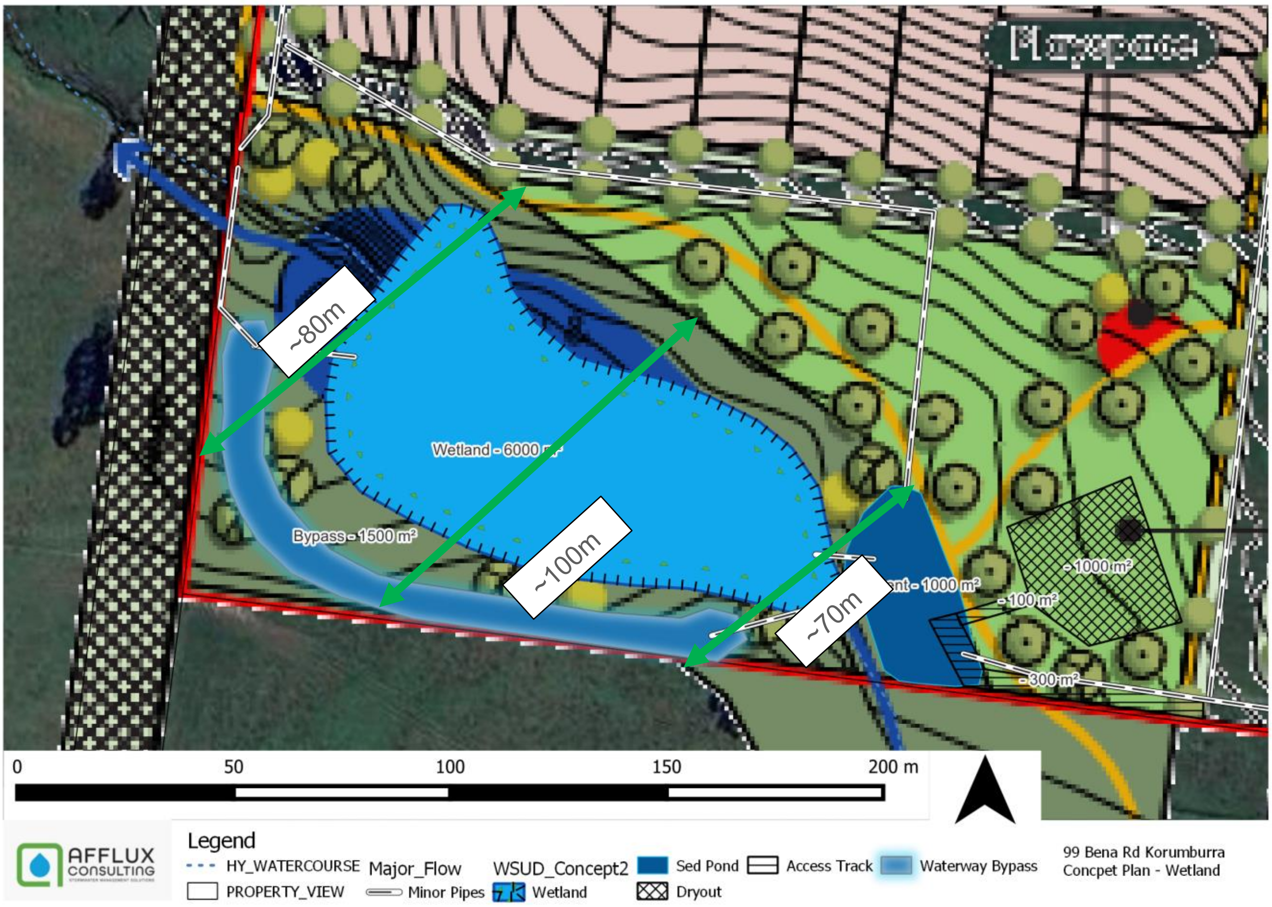


Figure 50. Proposed Waterway Reserves

Figure 51. Estimated Bypass and Floodplain Flows

Input Parameters

Flow rate Q	1.6	m^3/s	***Flow rate of the channel***
Top width	5	m	
Batter slope = 1:	5.00		***Ratio of vertical to horizontal (insert 0 if it is a rectangular section)***
Material/Type	2.2.3 Earth, fairly uniform section (Dense weeds or aquatic plants in deep channels)		
Channel Condition	Bad		
Channel Slope	0.0322		***Slope of the channel*** 31.0559

Check: OK, Input parameters are fine, calculations are correct

Output Parameters

Top width	5	m
Bottom width	2.45	m
Depth	0.26	m
Cross sectional area	0.95	m^2
Batter length	1.30	m
Wetter perimeter	5.05	m
Manning's n	0.035	
Hydraulic radius R	0.19	m
Velocity	1.68	m/s
Froude Number	1.06	

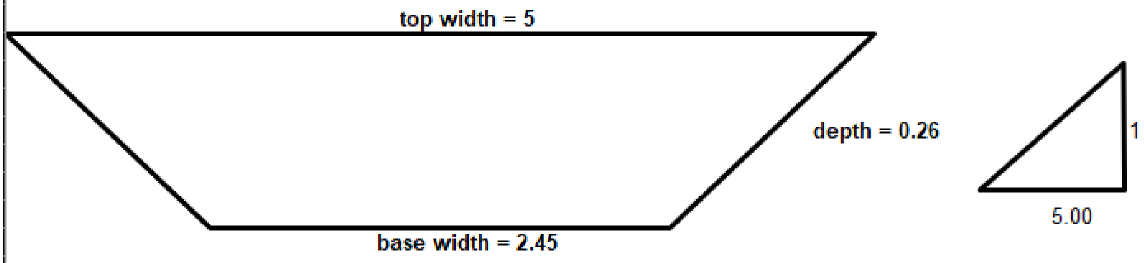


Figure 52. Estimated Bypass Chanel Dimensions

8. Design Requirements

In modelling flood interactions across the site, design requirements are highlighted to reduce the impact of the development on neighbouring properties and surrounding water systems, while increasing amenity for future residents.

8.1. Development staging and interim treatments

To ensure safe development staging the Draft Subdivisional layout plan was used (Figure 53).

In order to achieve water quality objectives, a number of interim treatment elements will be required. Interim staging works have been explored here to ensure site runoff is sufficiently treated before impacting the environment. These works have been estimated for the provision of a staging plan, detailed calculations should be submitted as part of the engineering works for each stage. The proposed site works to be completed as part of this development are:

Stage 1/2 – Implementation of temporary storage and sediment basin in Stage 2 area to ensure flow and water quality impacts are minimised. Approximate sizing:

- Storage - ~200m^3 (includes all of stage 2)
- Sediment ~300m^2 basin

Stages 3 – Drain as much of stage 3 towards the Stage 2 temp basin as possible.

Stage 4 - Remove Temp basin, implement catchment bypass pipe from Stage 2. Temporary storage and water quality in wetland footprint

- Storage - ~900m^3 (includes all of stage 2)
- Sediment ~1000m^2 basin

Stage 5 onwards - wetland completion and implementation of full strategy

The Super lot in the north east corner is expected to be developed privately and will need to implement the recommended storage and GPT devices as part of the development if and when it is constructed. It is largely considered as a standalone development front from a stormwater perspective.

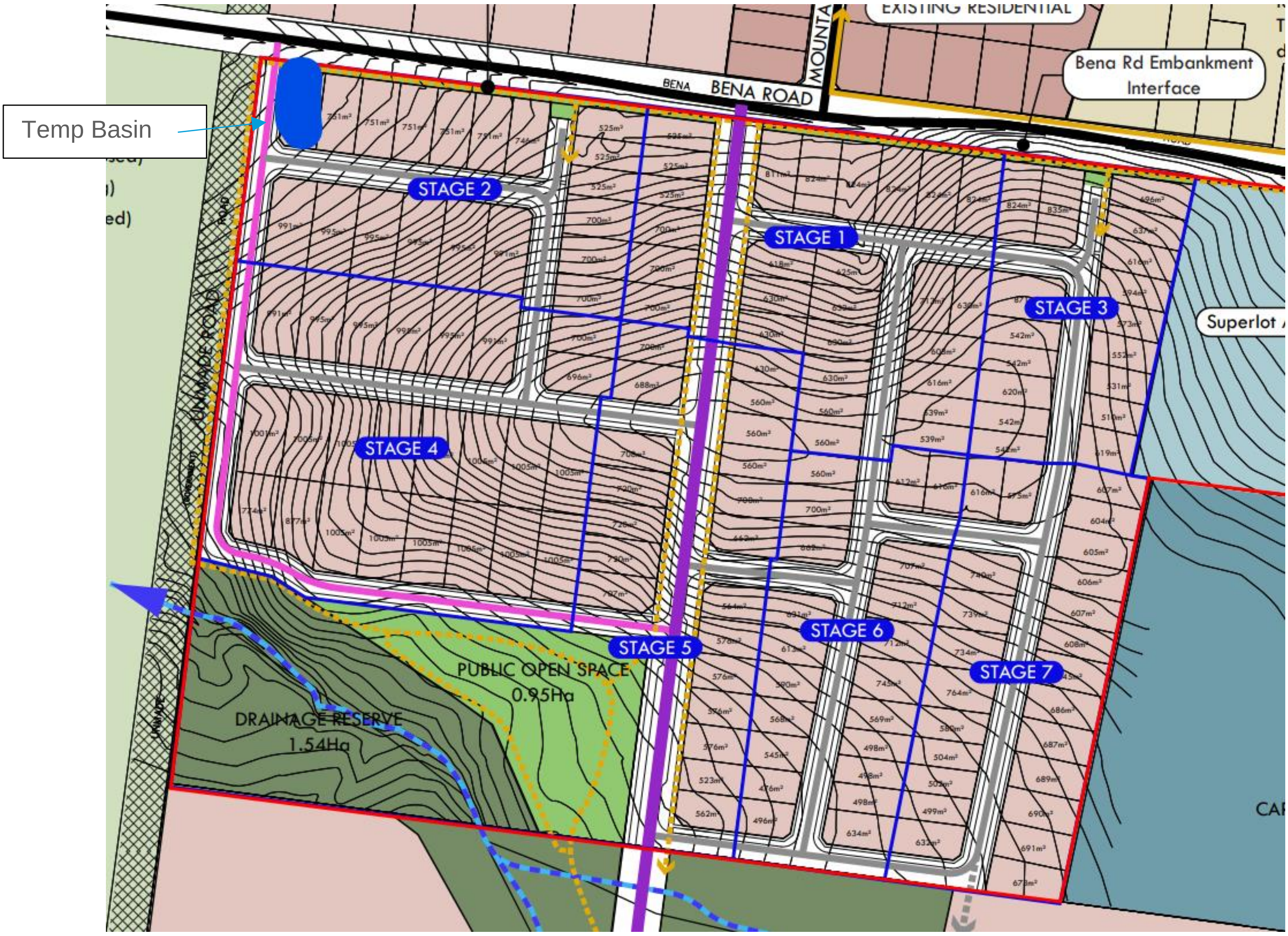


Figure 53. Staging plan

8.2. Flow Paths and Drainage

A concept drainage plan of the site has been developed to determine how the site can manage surface water. This concept considers the runoff from the developed site as well as upstream surface water from the existing waterway systems.

Site Controls and Legal Point of Discharge

The existing conditions of the site help to determine both the development potential, but also the drainage treatments for the area. The most significant aspects in this respect are the downstream conditions.

The site has 3 existing outfalls to the North East (drainage pit - Figure 27 ~0.1m³/s capacity), North West – existing swale drain (Figure 54, ~0.5m³/s capacity), and the Creek line to the South West (~2.7m³/s capacity).

Figure 54. NW Discharge location

Major and Minor Drainage

The road network is expected to carry runoff from the site to the outlet. Figure 55 shows the proposed flow direction during a major storm, with an emphasis on draining towards treatment systems where reasonable.

The largest catchment for any given road network is approximately 4.7Ha. This yields a 1% AEP flow of approximately 0.9m^3/s, with an approximate gap flow of less than half of this number. Given this is such a small overland flow, no further hazard calculation is required on the proposed road networks.

Figure 55. Proposed major flow direction.

8.3. Site Storage

The ultimate flood storage for the site is achieved through a combination of drainage channels and catchment attenuation basins. The major storage for the majority of the site will be located above the wetland in the South West corner.

High level attenuation basin designs were analysed for the site. With assumptions including:

- Batter slopes of 1:6
- Outfall pipe size of 525mm selected for desired outflow attenuation, balancing the pipe size and constructability.
- Flood storage of approximately 3,800m³ as detailed in Figure 19

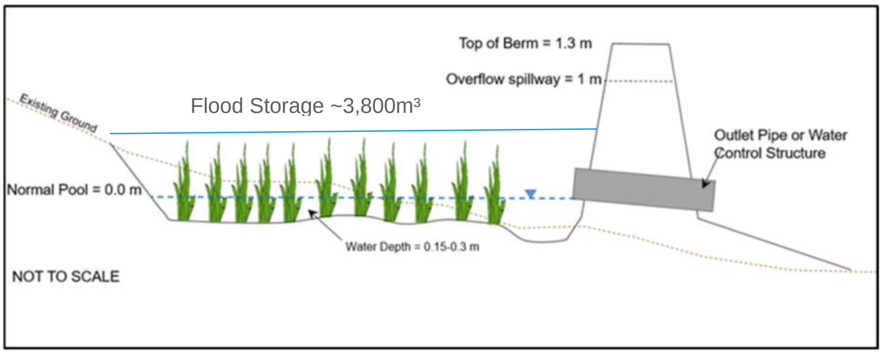


Figure 56. Retarding basin concept design

The smaller north west catchment storage includes the following assumptions:

- Super lot is owned by a single party, this may include a body corporate arrangement
- If owned by a body corporate it is expected that the storage would be located underground and included as part of the road network. Similarly the GPT would come under body corporate management and maintenance.
- If the super lot became a freehold development it would be expected that a small basin be constructed in the north west corner of the site. This may include a sediment pond dependent on final development typology.
- In either case it is expected that a condition of permit would include a minimum 260m³ of storage, and a level of sediment control consistent with the BPEM requirements (80% TSS removal). Nutrient removal would not be expected as this is covered by an oversized wetland in the broader development.

8.4. Water Quality

The water quality for the site can be met through:

- 1,000m² Sediment Pond
- 6,000m² wetland macrophyte zone
- GPT's to protect North East discharge.
- Low flow pipe diversions to creek system

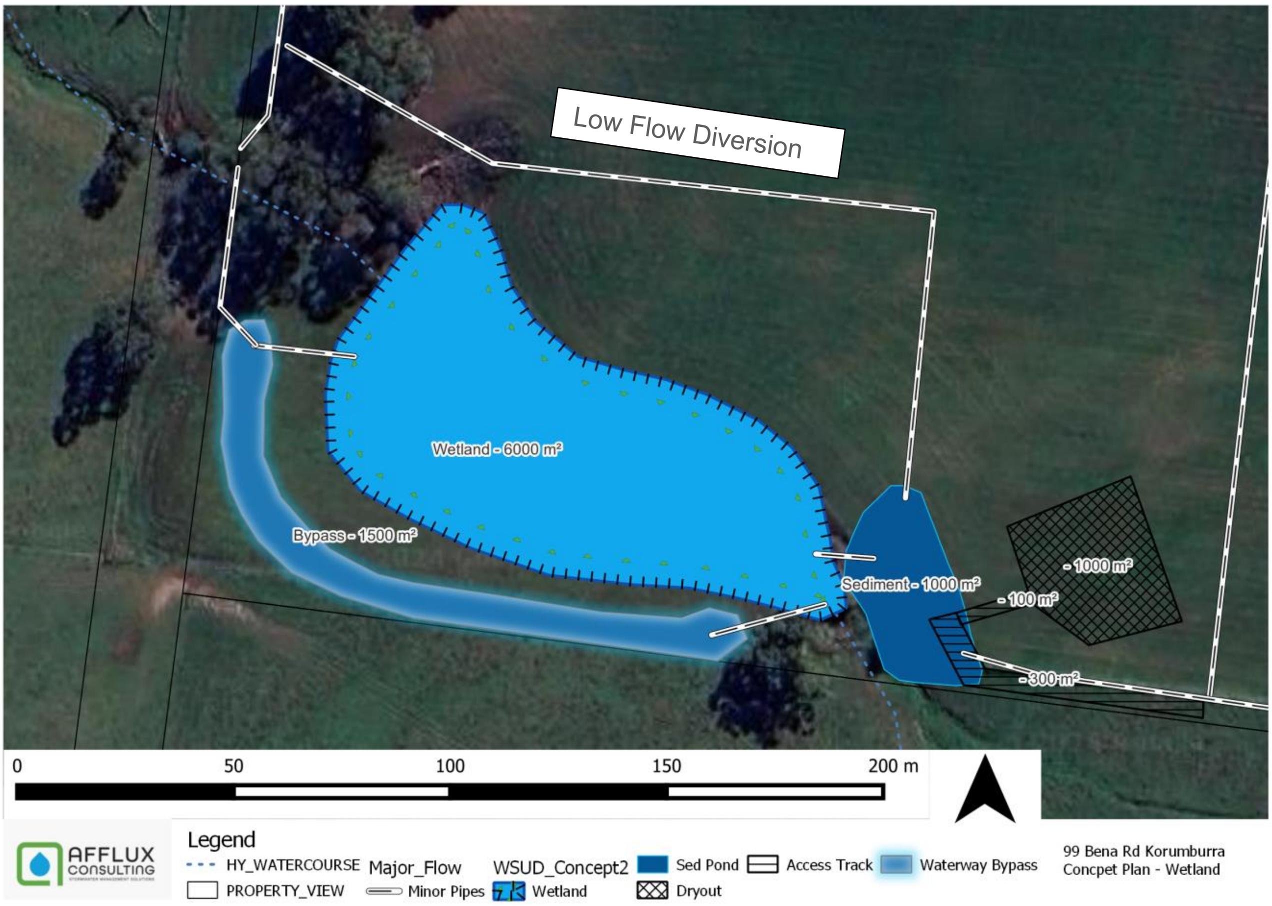


Figure 57. Water Treatment Concept

8.5. Asset Access

Access to the water quality asset is an important Council consideration for future maintenance. This asset will be directly accessed from the subdivision with the following requirements:

- Minimum 4m crushed rock access track generally in accordance with the Melbourne Water access track requirements.
- Sediment dry out grassed open space of approximately 1,000m²
- Footpaths around wetland system, ideally 3m wide.

These spatially located requirements can be seen in Figure 58

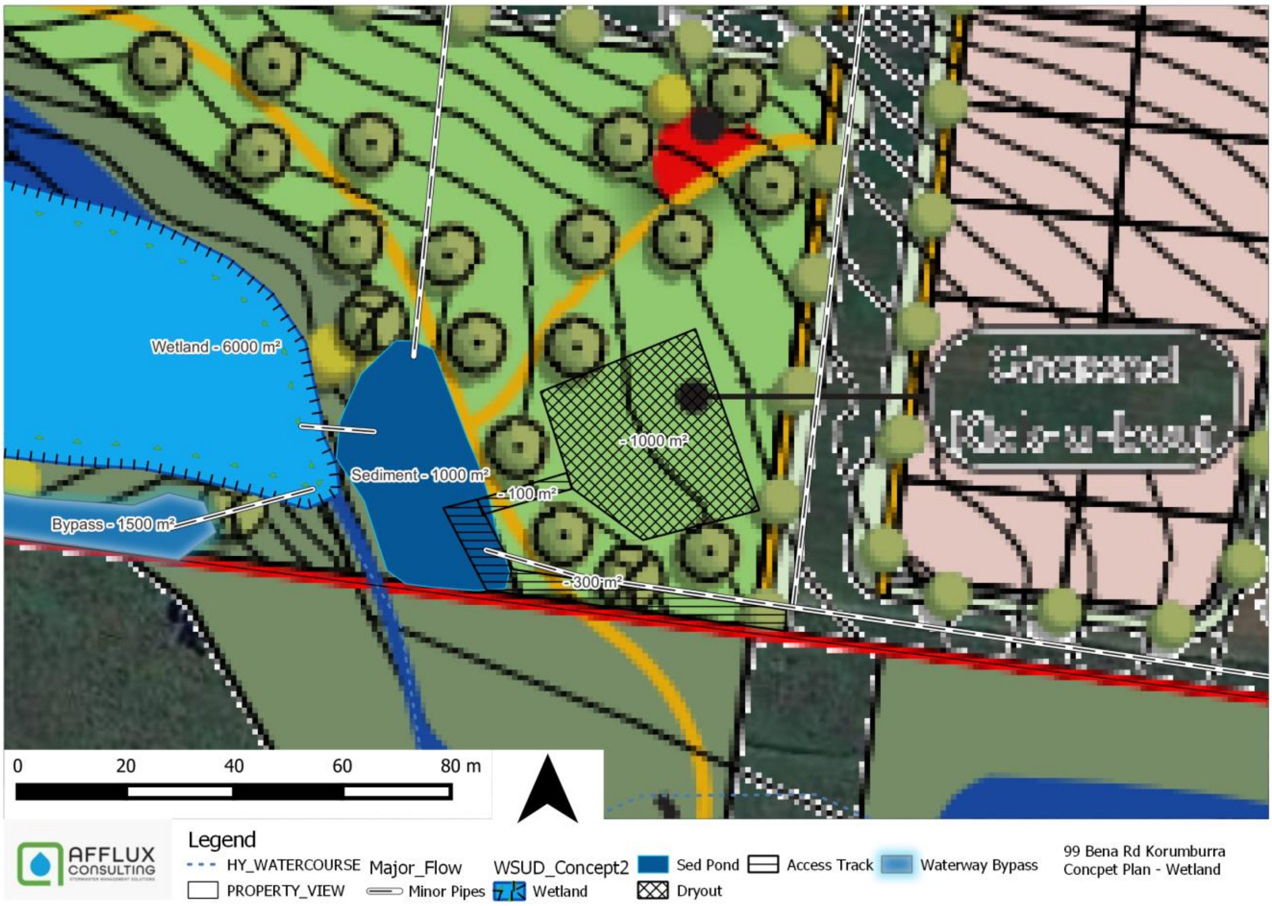


Figure 58. Proposed Access Arrangements

9. Concept Plan

An initial drainage concept plan has been developed, including treatment sizes, waterway offsets and existing major flow paths, and is shown in Figure 59 below.

Considerations for the concept drainage plan have included:

- The topography of the site makes consolidating site discharge a significant challenge and as such, three discharge points have been recommended.
- Separating catchments in this way has resulted in one large wetland and storage to meet the bulk of the sites requirements. Minor diversion pipes are expected to enhance this concept.
- A GPT and minor storage unit will be required to treat gross pollutants and flow for the north east catchments
- The concept plan below assumes an offline wetland layout and makes particular use of the flatter areas and avoidance of major tree systems. Access and maintenance requirements have been detailed.

Figure 59. Indicative Drainage Concept Plan - Waterway Realignment

10. Conclusions

This report presents a stormwater management plan for the proposed development at 99 Bena Rd, Korumburra within South Gippsland Council. The site has important interactions with its immediate catchment, and these interactions have been considered in this report. In order to maintain the behaviour of the hydraulic systems, including flood plain storage and water quality requirements, this report presents the following requirements:

- Construction of a 6,000m^2 wetland system and associated sediment pond
- Waterway bypassing and waterway management plan requirements
- Large catchment storage within wetland system to attenuate flows from the bulk of the site.
- Catchment diversion pipes from the north west catchment to the south west to reduce impact on Bena Road
- Catchment storage within the planned super lot to the north east to minimise impact on existing drainage lines
- Temporary management requirements for development staging.

Based on these requirements, it can be expected that no increase in flow magnitude downstream of the site will occur from this development. In addition with the allocated drainage areas the water quality treatments can meet the contemporary nutrient and sediment expectations.

11. Abbreviations and glossary

For clarification, provided are terms referred to within this report and their definitions as applicable to stormwater and water engineering.

TERM (Abbreviation)	DEFINITION
Afflux	A measure of the increase in water elevation (or flood level difference) at a given location, relative to the water elevation that would have occurred.
Alluvium\alluvial material	Extensive deposits of sand, silt and/or clay formed by a river or flood, typically forming a floodplain. Alluvium is generally unconsolidated.
Annual Exceedance Probability (AEP)	The likelihood of a storm event or flood occurring or being exceeded within any year. Where, $AEP = 1 - e^{(\frac{-1}{ARI})}$
Attenuation	Reduction in the magnitude of a flood peak
Australian Rainfall and Runoff (ARR)	Australian Rainfall and Runoff guidelines document.
Average Recurrence Interval (ARI)	A statistical estimate of the average length of time (in years) between equivalent (or larger) flood events. Note. Events do not occur at regular intervals. This is an average and not the expected elapsed time until the next exceedance. e.g. a "100 year ARI flood event" has a 1% exceedance probability each year.
Australian Height Datum (AHD)	Vertical height in meters above the mean sea level.
Baseflow	The slow component of catchment runoff, not immediately in response to a storm event. Encompasses interactions with seepage and groundwater discharge into a waterway.
BPEM	Best practice environmental management guidelines used for planning, designing or managing stormwater systems or urban land uses
Catchment	The upstream land and water surface area that drains to a specified location under consideration.
Consequence	Outcome or impact of an event.
Critical Sorm Duration	The length of time of a rainfall event that results in the peak flow or level at a particular location of interest for a given AEP.
Cumec	An abbreviation of cubic meters per second, a unit of discharge (m^3/s)
Drainage Network **or System**	A system of natural or constructed flow paths within a catchment used to convey runoff to its outlet. This may include surface or subsurface systems such as pipes, channels, gutters, overland flow paths, culverts, water storages, etc.

Design Event	A probabilistic or statistical flood or rainfall event used for flood/flow estimation processes for a given AEP.
DELWP	Department of Environment, Land, Water and Planning
EPA	Environmental protection agency
Extended Detention	Distance above normal water level in where stormwater is temporarily stored
Evaporation	The transfer of water, as vapour, from a water surface to the air
Evapotranspiration	The transfer of water, as vapour, from near the earth's surface to the air. Includes open water surfaces, ice, frost, soil and transpiration from plants.
Freeboard	The difference in height between the calculated water surface elevation and the top, obvert, crest of a structure or the floor level of a building, provided for the purpose of ensuring a safety margin above the calculated design water elevation.
Flood	Inundation of normally dry land by water that has exceeded the capacity of the normal confines of waterbodies, water storages or watercourses.
Flood Frequency	Descriptor for the annual exceedance probability or average recurrence interval of a flood
Floodplain	The land area which experiences flooding during high discharge events.
Hazard	Potential for damage or harm. Considered alongside consequence and likelihood of occurrence.
Hydrological Analysis	Developing and understanding a set of relationships to determine how rainfall is converted into runoff or streamflow (includes consideration of climate, losses, soil types, etc).
Hydraulic Design	The process of numerically analysing actual or expected flow conditions (such as water surface elevation and velocity) associated with a given hydraulic structure or overland flow.
Infiltration	The downward movement of water into a catchment surface or infiltration system. Largely governed by soil conditions, vegetation and antecedent moisture content.
Loss rate	Removal (loss) of water from the rate of rainfall that occurs during the process of forming stormwater runoff. Usually measured in units of mm/hr. The assumed loss rate usually varies across the drainage catchment in accordance with known or assumed surface conditions.
Local Authority	Any local or regional external authorities (including local and State Governments or non-government authorities) that have a legal interest in the regulation or management of a given activity, or the land on which the activity is occurring, or is proposed to occur.
Manning's 'n' Roughness Coefficient	The numerical representation of the hydraulic roughness of a conduit, flow path or channel as used in the Manning's formula.
Rainfall Excess	The portion of rainfall that contributes to streamflow
Rainfall Intensity	The rate at which rain falls, typically measured in mm/hour.

Runoff	The part of rainfall (or snow/hail) not lost to infiltration, evaporation, transpiration or depression storage that flows from the catchment area past a specified point.
Sedimentation Basin	A basin or tank in which sediment collects primarily through the actions of gravitational settlement. The basin facilitates low-velocity, low-turbulent flows to facilitate the settling of coarse sediment particles from stormwater runoff.
Soil Erosion	The detachment and transportation of soil and its deposition at another site by wind, water or gravitational effects. Although a component of natural erosion, it becomes the dominant component of accelerated erosion as a result of human activities, and includes the removal of chemical materials.
Stage	Elevation of the water surface in a stream measure to some convenient datum
Storm	In hydrology this includes any rainfall event. Unlike common usage implying a period of extreme weather with intense rain and strong wind.
Stormwater Flooding	Inundation by local runoff caused by heavier than usual rainfall. Stormwater inundation is caused by local runoff before it has entered a watercourse or joined watercourse flow. In a rural setting and within large rural allotments, we define stormwater flooding as sheet flow caused by local runoff before it has concentrated into a watercourse, including a drainage channel, stream, gully, creek, river, estuary, lake or dam, or any associated water holding structure.
Surface Water or Inundation	Any water collecting on the ground or in an open drainage system or receiving water body. In this report we use these terms to discuss water before it is categorised into flood, stormwater or other.
Temporal pattern	The time sequence of rainfall intensity. A representation of the variability of rainfall throughout a storm event.
Water Balance	An account of all the water in a specified system. Includes measurement of all inflows, outflows and changes in stored water volumes.
Wetland	A natural or constructed area of land inundated temporarily or permanently with shallow water that is usually slow moving or stationary

12. References

Ball, J., Babister, M., Nathan, R., Weeks, W., Weinmann, E., Retallick, M., and Testoni, I. (Editors). (2019). *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia: Geoscience Australia.

Coombes, P. and Roso, S. (Editors). (2019). *Runoff in Urban Areas, Book 9 in Australian Rainfall and Runoff - A Guide to Flood Estimation*, Commonwealth of Australia: Geoscience Australia.

Local Government Infrastructure Design Association. (2019). *Infrastructure design manual*, Version 5.30. Golden Square: LGIDA.

Melbourne Water. (2007). *Principles for Provision of Waterway and Drainage Services for Urban Growth*, Melbourne Water

Melbourne Water. (2013). *Waterway Corridors: Guidelines for greenfield development areas within the Port Phillip and Westernport Region*, Melbourne Water

Melbourne Water. (2018). *Healthy Waterways Strategy,* Melbourne Water Corporation

Melbourne Water. (2018). *MUSIC Guidelines; Input parameters and modelling approaches for MUSIC users in Melbourne Water's service area.* Melbourne Water.

Melbourne Water. (2019). *Constructed Waterway Design manual*. Melbourne Water Corporation

Melbourne Water. (2019). *Flood Mapping Projects Guidelines and Technical Specifications*, Melbourne Water Corporation

Melbourne Water. (2020). *Constructed wetlands design manual*. Melbourne Water Corporation

The State of Victoria Department of Environment, Land, Water and Planning. (2019). *Guidelines for Development in Flood-prone Areas*, Department of Environment, Land, Water and Planning

Victoria Stormwater Committee. (1999). *Urban Stormwater: Best Practice Environmental Management Guidelines*, CSIRO.

13. Appendix A – WGCMA Advice

OFFICIAL

West Gippsland
Catchment Management Authority

25 years of catchment health

WGCMA Ref: WGCMA-F-2023-00478
Document No: 1
Council Ref: 2023/83
Date: 26 June 2023

admin@vcat.vic.gov.au

Senior Registrar
Victorian Civil and Administrative Tribunal

Dear Sir/Madam,

VCAT Reference No.: P709/2023

Property: **Street:** 99 Bena Road, Korumburra Vic 3950
Cadastral: Lot 1 PS321371, Parish of Korumburra

Regarding: **Statement of Grounds**

The West Gippsland Catchment Management Authority has no record of a referral from South Gippsland Shire Council for development at the above address, and as such has not been able to assess the detail of the proposal. The property contains a designated waterway that is likely to be adversely impacted by residential development without adequate consideration and planning.

Given our lack of involvement to date, the West Gippsland Catchment Management Authority does not wish to be a party to the appeal in relation to the above matter, however we request that the following conditions be included in any Planning Permit or Development Plan issued as a result of this proceeding:

1. Prior to Certification of Stage 1 of the subdivision, a Stormwater Management Plan (SMP) which identifies appropriate Water Sensitive Urban Design features to provide stormwater treatment to meet best practice guidelines must be submitted to the satisfaction of West Gippsland Catchment Management Authority. The SMP must clearly identify how stormwater runoff from the entire development will be managed and treated prior to discharge to the designated waterways including the proposed timing of works, and must quantify the reduced loads of sediment, nutrient and gross pollutants in kg/year.

2. Prior to the issue of a Statement of Compliance for each stage of the subdivision, the relevant water quality treatment works outlined in the Stormwater Management Plan must be undertaken to the satisfaction of West Gippsland Catchment Management Authority.

3. Prior to Certification of the stage/s of the subdivision containing the designated waterway a Waterway Management Plan (WMP) must be endorsed in writing by the West Gippsland Catchment Management Authority. The WMP must include:

   a. Details of existing environmental values.
   b. Details of any initial stabilisation and vegetation works.
   c. A landscape plan for revegetation of land within a 30 metre buffer either side of the waterway, including a species list and proposed density of the plantings. The vegetation must be representative of the Ecological Vegetation Class for the site. Any area required to be cleared of vegetation to create defendable space must not encroach into the required revegetation within the waterway buffer.
   d. A maintenance plan detailing the sequencing and periods of short, medium and long term actions, including inspections, and the parties responsible for each action.

4. Prior to the issue of a statement of Compliance for the Stage/s of the subdivision containing the designated waterway, the waterway management works, including any revegetation, outlined in the Waterway Management Plan must be undertaken to the satisfaction of West Gippsland Catchment Management Authority.

Should you have any queries, please do not hesitate to contact me on 1300 094 262 or email planning@wgcma.vic.gov.au. To assist the Authority in handling any enquiries please quote **WGCMA-F-2023-00478** in your correspondence with us.

Yours sincerely,

Penny Phillipson
Acting Executive Manager - Statutory Planning

Cc: South Gippsland Shire Council, Hillview Rise Pty Ltd C/- glenn@planningcentral.com.au

For information on this report:

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