STORMWATER MANAGEMENT PLAN

40 Butlers Road, Kilmore

Date	8 December 2020
Version	V01b
Author	Chris Beardshaw
Client	Allequip Construction Pty Ltd

Document History

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1. Introduction

This report forms a stormwater management plan for the proposed Butlers Rd and associated catchment. The site is located approximately 1.7km north-west of Kilmore town centre and is bounded by Kilmore-Lancefield Rd to the north, Butlers Rd to the east, Kilmore Public Cemetery to the west and existing parcels to the south (see Figure 1).

This report will cover the major drainage, flooding and water quality associated with the development, the creek and neighbouring properties. The intention of this report is to meet and, in some cases, exceed the standard requirements of:

- Retention of post development flows to pre-development levels
- Ensure flooding of the site, or potential off-site impacts are reduced or eliminated
- Meet the EPA best practice environmental management (BPEM) water quality requirements

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

The development site is approximately 1.8 hectares in total. Key features of the site include an existing waterway through the parcel, and a small pond/depression to the north of the site. 2 x 750mm Dia culverts drain the site northwards under Kilmore-Lancefield Rd.

This investigation discusses stormwater treatment of the proposed development and wider catchment implications including minor and major drainage aspects, flood impacts and general drainage layouts for the site. In addition, a review of previous modelling was conducted to ensure that current engineering standards were applied. The investigation has been completed with an awareness of the waterway features lying north of Kilmore-Lancefield Rd, which this site eventually drains through.

The proposed development plan can be seen in Figure 2 and combines over 100 lots, with medium density, commercial and recreational areas. The existing watercourse is also shown, running south to north towards Kilmore-Lancefield Rd.

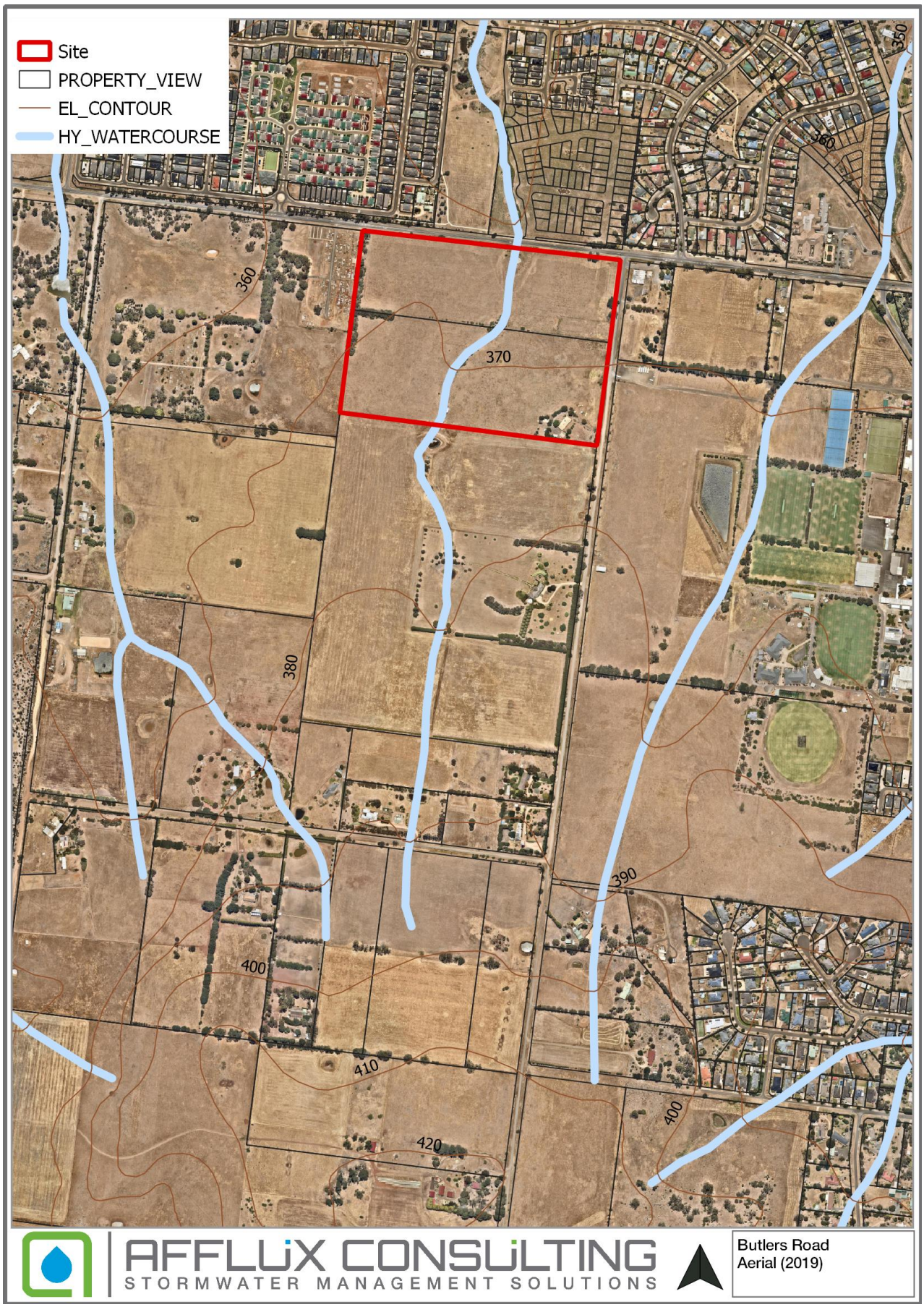


Figure 1. *Aerial of site*

Figure 2. *Proposed Development*

1.1. Information Sources

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

- Site inspection
- DEPI planning scheme and cadastral information as accessed online August 2019
- Discussions with Mitchel Shire Council
- Discussions and information as provided by GBCMA
- Site survey received from client
- Required Lidar data sourced commercially

2. Background Information

2.1. Existing Catchment

The existing catchment has been delineated as the relevant catchment for flows through the site and site outlet below (Figure 3).

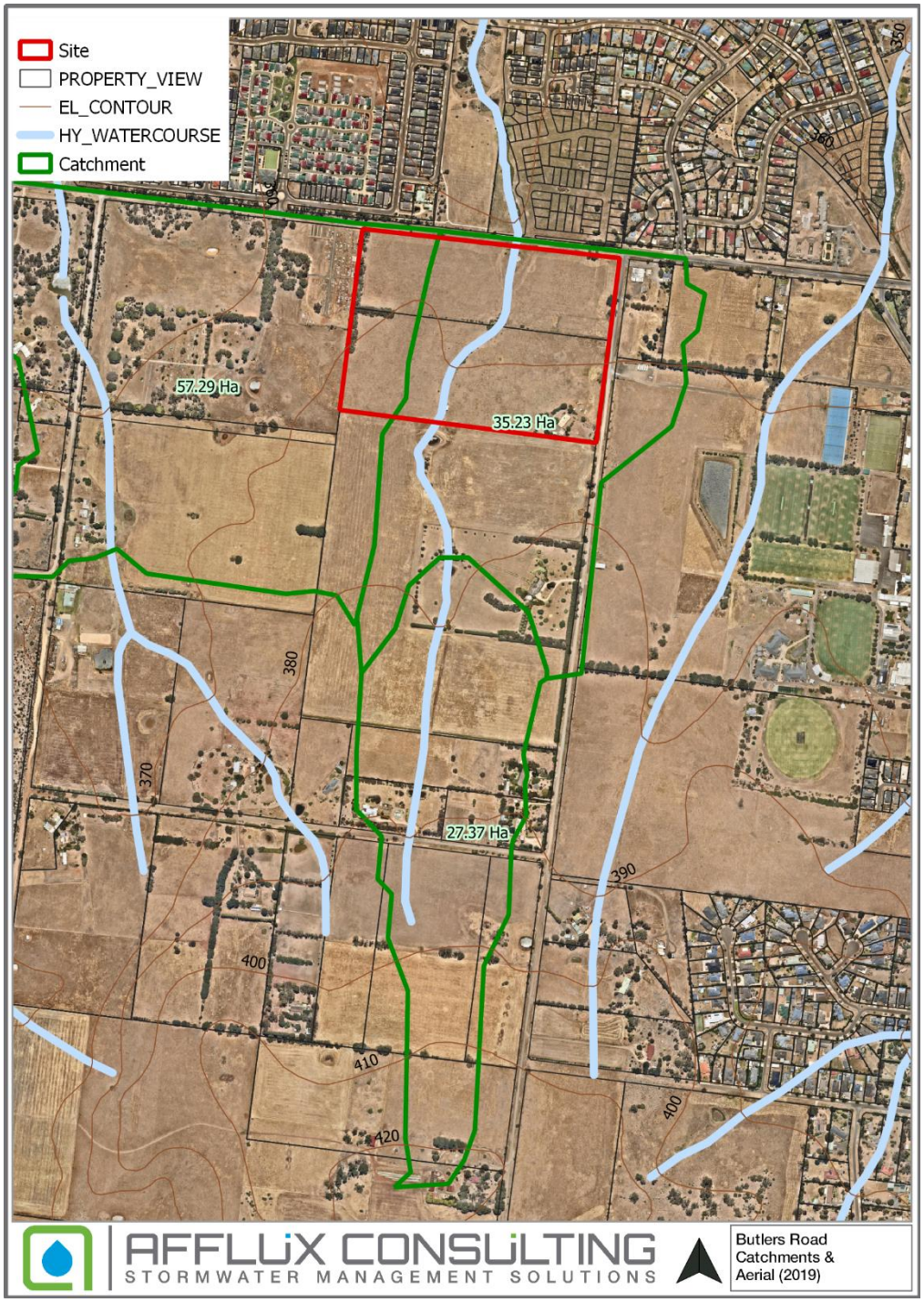
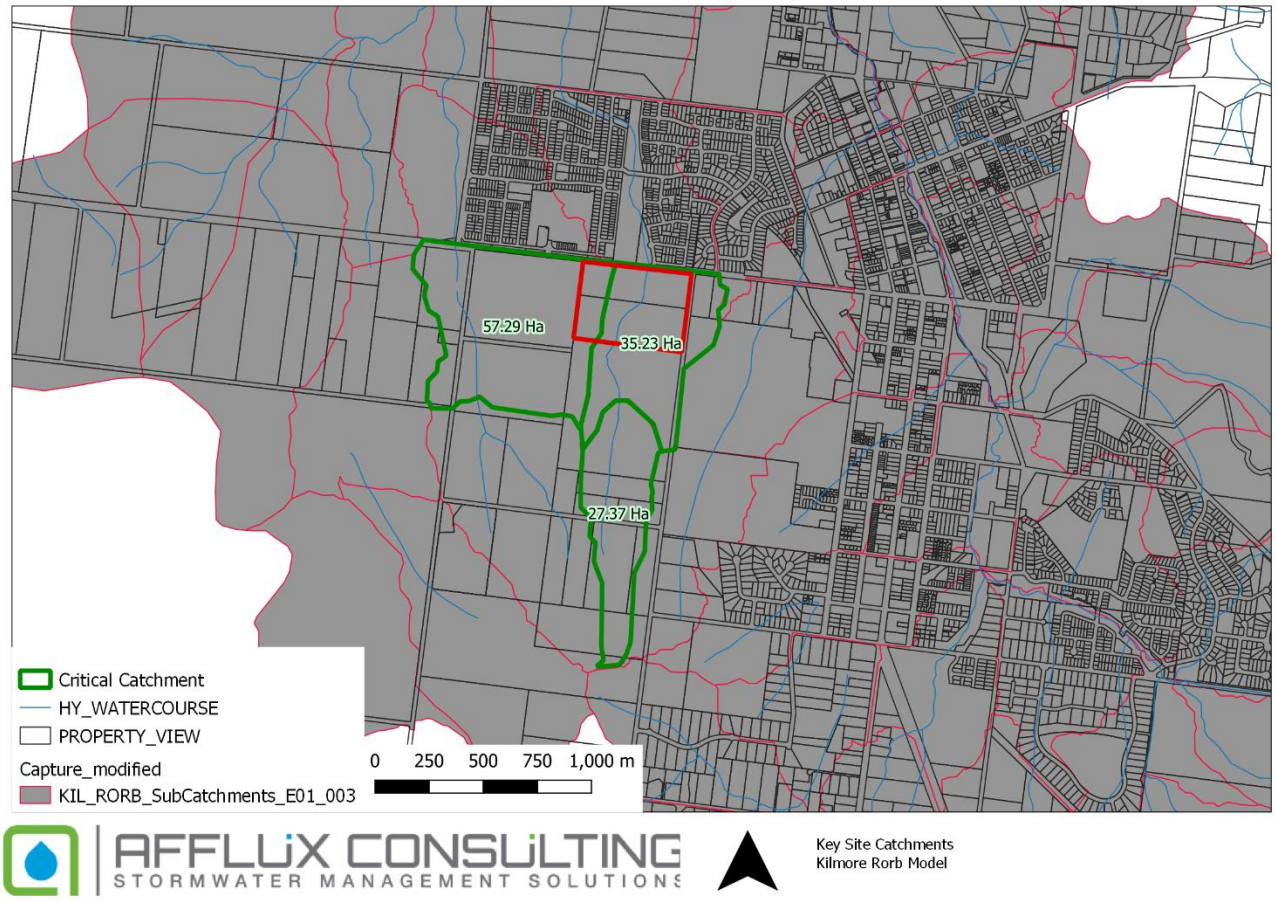


Figure 3. *Existing catchment*

The Subject Site sits between currently developing parcels to the south and rural land to the north. The existing site features a large farm dam which is currently used for stock and farming use. The dam sits on the waterway which passes through the site, an arm of the upper reaches of Ryan's Creek. The major control for the site, and all of the downstream waterway are the culverts on Lancefield Road. These are critical to controlling the downstream flows.

The catchment upstream of the site is in the order of 40 Ha with an average fraction imperviousness of 0.19 in the RORB model as made available from the CMA (KIL_E01_003.catg, WBM-BMT). There are several large farm dams within this catchment which are not shown in the RORB modelling which may further attenuate flows. From aerial photography, these dams appear to be online with large embankments.

The contributing catchment, and key downstream extents (area for which the hydrology from this site is critical) is shown below in Figure 4



Source: Afflux (KIL_E01_003.catg)

Figure 4. *Local Catchments*

2.2. Site Visit

A number of photos of the existing site can be seen in Figure 5 through Figure 10 including key items such as the hydraulic control (pipes) at Lancefield Road.

Source: *Looking North-West Across Site*

Figure 5. *Site visit*

Source: *Looking West (Butlers Road)*

Figure 6. *Site visit*

Source: Looking South @ waterway

Figure 7. *Site visit*

Source: DS Lancfield Pipe Setup

Figure 8. *Site visit*

Source: Twin 750dia under Lancefield

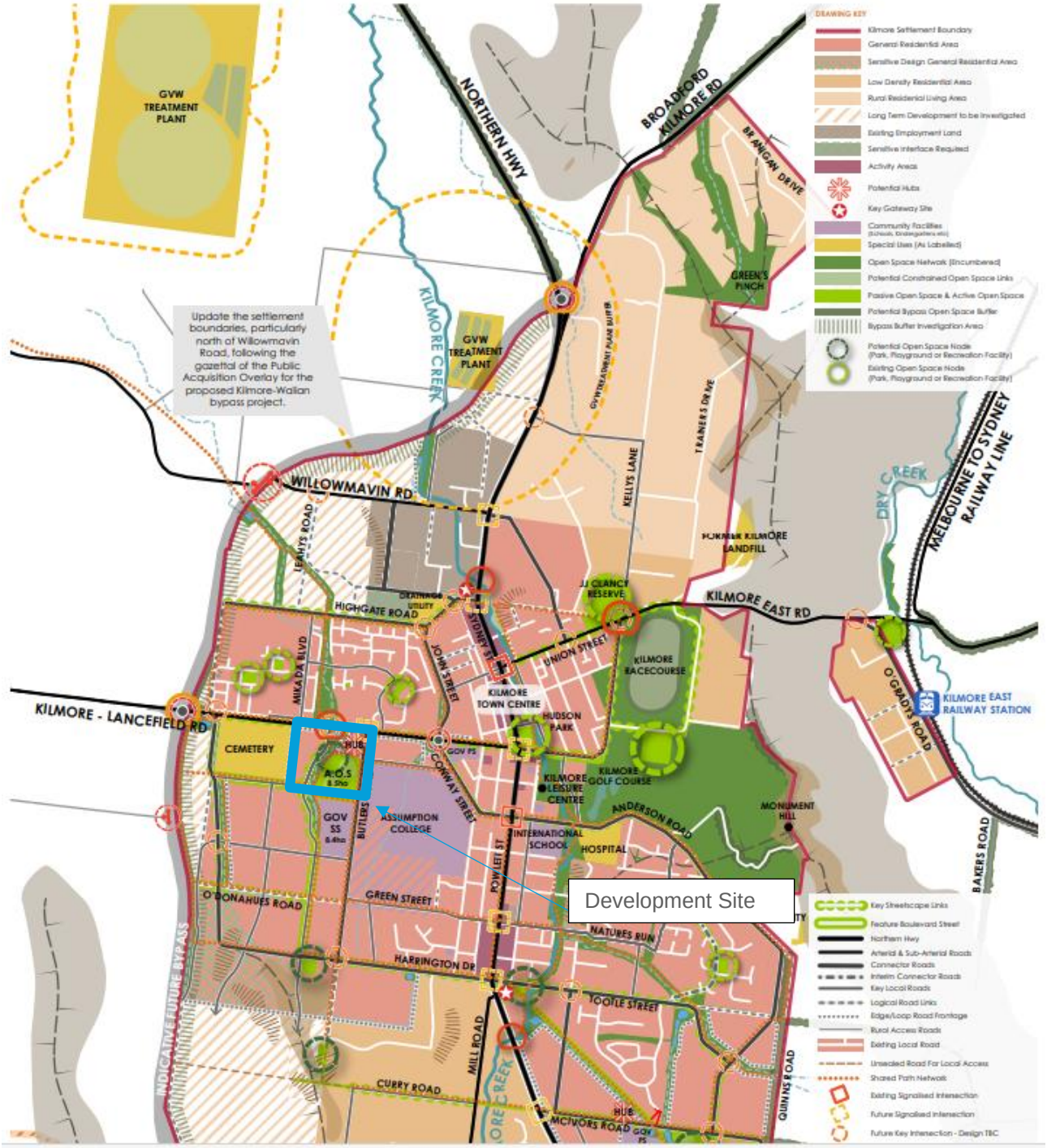
Figure 9. *Site visit*

Source: Twin 600 under footpath

Figure 10. *Site visit*

2.3. Structure Plan Framework

The Kilmore Structure Plan (KSP) formed by Mitchell Shire Council in 2016 provides the underlying framework for the development of the land. The proposed land uses can be seen in Figure 11. The proposed drainage objectives from this study can be seen in Table 1 that this SWMP will seek to meet.



Source: Kilmore Structure Plan (MSC,2016)

Figure 11. *Kilmore Structure Plan*

DN 1	**To focus on holistic and coordinated water sensitive urban design approaches to stormwater treatment and management in Kilmore's Growth areas.**
DN 1.1	Require preparation of a fully costed sub-catchment wide drainage schemes as a precondition of any further rezoning or development within Kilmore growth precincts as identified in Chapter 4 and Chapter 5.
DN 1.2	Require development in Kilmore's growth precincts to provide drainage infrastructure in accordance with the drainage strategy.
DN 1.3	Support drainage strategies that prioritise centralised wetlands, retarding basin and other systems that minimise future maintenance obligations.
DN 1.4	Avoid small scale, localised and fragmented stormwater systems, such as swales and rain gardens, which generate significant future maintenance obligations.
DN 1.5	Avoid site specific, ad hoc and temporary stormwater systems that do not contribute to the overall drainage strategy.
DN 1.6	Support delivery of stormwater works by development proponents in lieu of cash contributions
DN 2	**To protect and enhance key watercourses and drainage lines for their natural, environmental and recreational value.**
DN 2.1	Improve the Kilmore Creek and environs by supporting revegetation, creek stabilisation and landscape improvement works within the existing corridor.
DN 2.2	Require retention of key drainage lines and watercourses as part of a drainage strategy generally in accordance with Figure 44.
DN 2.3	Require implementation of appropriate buffers to watercourses and drainage lines identified at the Precinct level.
DN 2.4	Reinforce the important role of drainage reserves and infrastructure through implementation of appropriate planning controls which reflect their public purpose.
DN 2.5	Balance the environmental and recreational values of existing drainage lines, with other key development objectives and efficiencies when determining which drainage lines to retain in their natural state.
DN 3	**To equitably and fairly share the cost of delivery of higher order infrastructure that benefits an entire Precinct.**
DN 3.1	Require proponents within growth precincts to enter into an agreement with Council regarding sharing the cost and deliver of drainage infrastructure in accordance with the implementation requirements outlined within Chapter 5.
DN 4	**To manage the risk of flooding within existing, established areas of Kilmore.**
DN 4.1	Support implementation of the recommendations of the Kilmore Township Flood Mapping and Intelligence Study 2016, including introduction of recommended zoning and overlay provisions associated with flood risk and management.
DN 4.2	Require new development that increases the extent of impervious surface within established areas of Kilmore to adequately treat and manage stormwater on site before discharging to the stormwater system.
DN 4.3	Support improvements to site specific drainage and flooding issues.
DN 5	**To encourage innovative, sustainable and energy efficient approaches to the provision of services.**
DN 5.1	Support innovation and sustainable drainage solutions that will have a net community benefit.

Source: Kilmore Structure Plan (MSC,2016)

Table 1. Drainage Objectives

For the specific development area, the following plan has been presented. Note that

Source: Kilmore Structure Plan (MSC,2016)

Figure 12. *Priority Site Development Requirements*

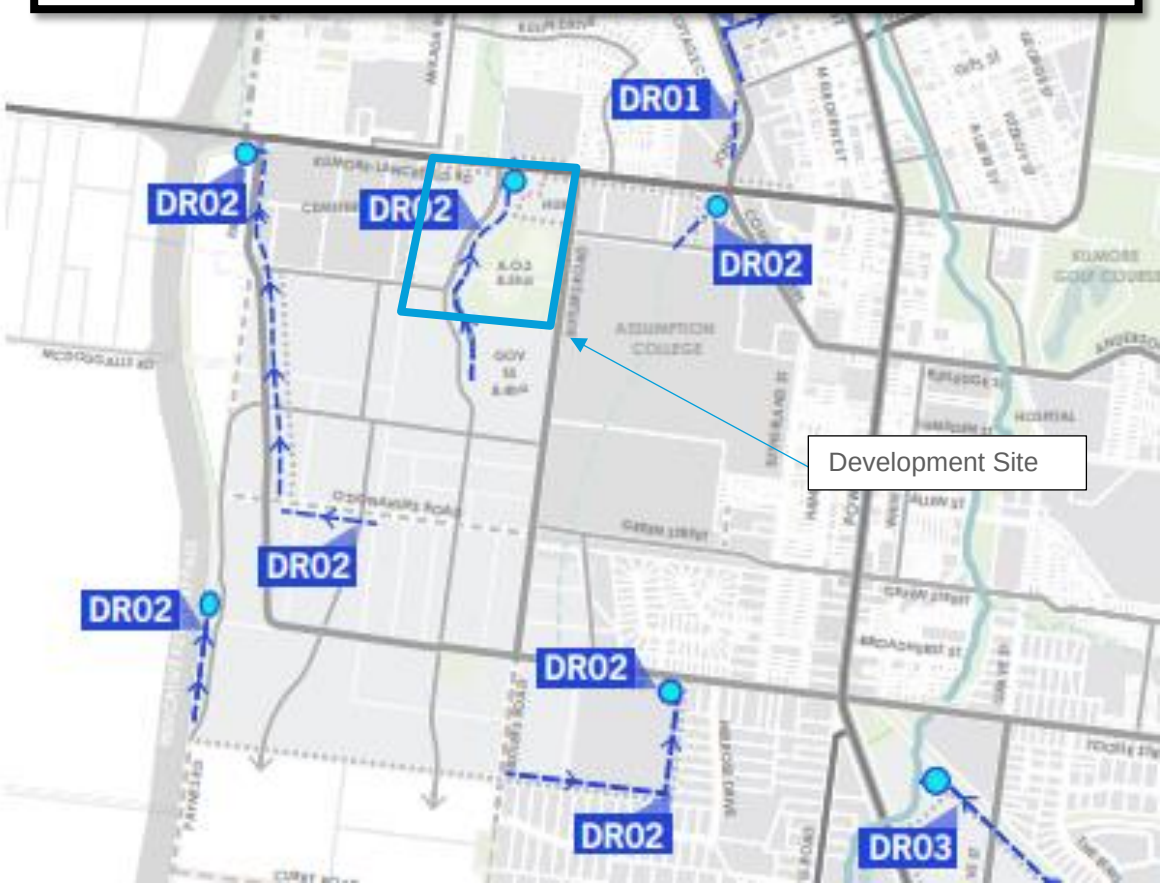
The key hydrological points from these plans include:

- The General residential area should have a diversity of housing between 500-800m² or a Fraction Impervious of around 0.6 (as recommended by Melbourne Water and industry standard)
- The Medium Density sites should have a FI of around 0.75 (as recommended by Melbourne Water and industry standard)
- The Drainage strategy needs to consider upstream development and provide a path forward for development

2.4. Proposed Framework Infrastructure Plan

A proposed Infrastructure framework plan was associated with the KSP to outline the major infrastructure requirements and funding sources. The drainage infrastructure for this area can be seen in Figure 13. No Legend is provided, but it assumed from this that waterway works are represented by the blue line, and retardation/water quality is represented by the cyan circle (this guidance is given in the KSP). All works are proposed to be developer funded, though no indication as to how cross boundary catchment contribution is to be distributed (other than KSP DN 3.1). State Government funding is provided for the major A.O.S. on the site, and some part of this may be attributable to water features – particularly if stormwater harvesting for irrigation is adopted.

Project Number	Project Description	Infrastructure Level	Funding Category	Delivery Responsi-bility	Main Catchment	Source of External Usage	Priority	Strategic Justification
Utilities and Drainage								
DR01	Drainage associated with Precinct 1A	Local	DCP/ICP	Council/ Developers	Existing	N/A	Med	Construction of drainage infrastructure (pipes) within existing Kilmore township area to support existing drainage requirements.
DR02	Drainage associated with Precinct 2 (West Precinct)	Local	DCP/ICP	Council/ Developers	P2	N/A	Med	To cater for drainage requirements of development of P2
DR03	Drainage associated with Precinct 3 (South East Precinct)	Local	DCP/ICP	Council/ Developers	P3	N/A	Med	To cater for drainage requirements of development of P3



Source: Kilmore Infrastructure Framework

Figure 13. *Utilities and Drainage Infrastructure*

2.5. Other Supporting Drainage Studies

A PlanRight drainage strategy for the area was produced in October 2017 to support the rezoning of the land. The executive strategy from this report can be seen in Figure 14 below and recommends between 6ML and 36ML of storage depending on catchment assumption. The report also identifies the hydraulic control at Lancefield Road and recommends an event-based retention, this assumption will be challenged in this report.

Address	40 Butlers Road, Kilmore
Proposed Development	Residential Subdivision
Proposed Use	Residential subdivision. The proposed layout covers one property, staging is unknown.
Existing water bodies and watercourses.	There are currently 3 primary water bodies (dams) located within the catchment area. These water bodies are linked together by a watercourse (channel) that develops at Odonahues Road and continues through the proposed development to the north side of Kilmore-Lancefield Road.
Existing runoff generation	Existing stormwater runoff is estimated at 1516 litres per second for the entire catchment area and 445 litres per second for the proposed subdivision in isolation.
Retention required for 100 year ARI event with outflow	Required retention for the entire catchment area is estimated at 36,168 cubic meters. Required retention for the proposed development in isolation is estimated at 5715 cubic meters.
Recommendations/Actions	- Stormwater runoff from the catchment upstream of the proposed development to be retained at alternative locations. - Investigation of the possibility of utilising a proposed sporting field within the subdivision as an emergency retention basin. - Stormwater runoff outflow under Kilmore-Lancefield Road to be limited to pre-development flows based on a 5 year ARI rainfall event. - Detailed investigation and preliminary design of the retention basin to be carried out, with consideration for all stakeholder and public interests.

Table 1: Executive Summary

Source: PlanRight (Oct 2017)

Figure 14. *PlanRight Drainage Strategy*

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 contained in the runoff have also been linked with adverse changes to both water quality and stream ecology. Finally, the contribution of increased runoff can be linked to downstream flooding and capacity constraints.
To combat these affects a range hydrological and water quality mitigation measures have been researched and legislated in Victorian planning schemes and key objectives outlined in the KSP (2016). 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. Michell Shire Council, as part of its planning requirements, incorporates BPEM water quality targets, setting out objectives for stormwater runoff.

3.2. Water Quality Requirements

Current water quality requirements as listed by the Victorian EPA Best Practice Environmental Management (BPEM) Guidelines are:

- 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 as part of this development.

3.3. Flood Storage Requirements

The site shall be designed to ensure that flows are not to increase above the pre-development levels. Generally, this would be applied to the 100-year Average Recurrence Interval (ARI) storm only and checked at each of the site discharge points. Attenuation will be applied at the basin to be designed and reductions in flow peak will be determined at the outlet of the basin and in this case at Lancefield Road.

3.4. Flood Protection Requirements

All lots within the development will be provided at least 300mm freeboard above any predicted 100-year Riverine ARI flood level (with floors a further 300mm higher). All retardation infrastructure will be designed to be cut into the natural surface avoiding any potential dam wall construction issues. Local stormwater protection may have a lower level of freeboard (300mm).

3.5. Ecological Requirements

A Flora and Fauna assessment of the site was undertaken by Hamilton Environmental Services in July 2016 to better understand the existing habitat on site. Summarizing the major points of this report:

- There was a limited survey time and the weather conditions on the day of observation were cold, wet and windy.
- All of the assessed area is highly modified, has been long-term grazed by stock and has been fully cleared, and hence there is highly simplified indigenous vegetation structure with a no effective understorey and a dominant introduced annual ground layer across all of the site, and no evidence of any remnant vegetation;
- There is no scattered remnant large trees, while there was a range of planted non-indigenous native woody vegetation found in the western Plantation, and there was no fallen wood left on ground, and no standing dead trees;
- The likely presence of both a fox and feral cat population.
- There were no Remnant Patches of native vegetation identified, and no Vegetation Quality Assessment (Habitat Hectares Assessment) was required.
- There were no indigenous trees found on the property. There are planted non-indigenous native trees within the Plantation Zone (Yellow Gum; see Fig. 2-2), and there are several mature Radiata Pine individuals on both the eastern and northern boundaries.
- The central north-south aligned drainage line maintains the same ground layer composition as the surrounding open paddock areas, but is lined by naturalised Hawthorn, that in some sections of the drainage line is quite dense.

From this it can be taken that the existing creek (drainage) line is highly modified and infested with Hawthorn. It is therefore suggested that any waterway works concentrate on reconstruction and re-establishment rather than conservation of existing assets.

3.6. Specific Challenges for this site

Reviewing the site objectives against the existing conditions and KSP objectives, the following specific challenges for this site include:

- Maintaining the existing hydrology at Lancefield Road is a key outcome for this area. The flood management downstream of this area is already compromised (see Section 6), no flow increases can be allowed past this existing hydraulic control (pipes).
- Water quality and the integration of water harvesting at this site. With the imminent changes to the EPA BPEM regulations, and the proposal for sports ovals within the site, a harvesting component should be a must have in this development. (see Section 7)
- Ensuring low enough outfall for all blocks within the development. The creek invert is little more than several hundred millimetres from the land surface under existing conditions. Reconstruction and rehabilitation of the creek is required for both hydrological (increased development flows), ecological (restoration of endemic habitat) and hydraulic connection. (see Section 5)
- Consideration of Harvesting for irrigation associated with the A.O.S. within the development area

4. Hydrology

To evaluate the hydrology of the proposed development a number of hydrological models have been formed and compared.

4.1. RORB Model

The RORB model from the Kilmore Creek Flood Study has been provided by Council and GBCMA's consultants for the purposes of this investigation. The model has been analysed for the regions relevant to this site, but no greater review has been undertaken. All results from this model are assumed to be approved and accurate representations of the area. The RORB model as supplied can be seen in Figure 15 below.

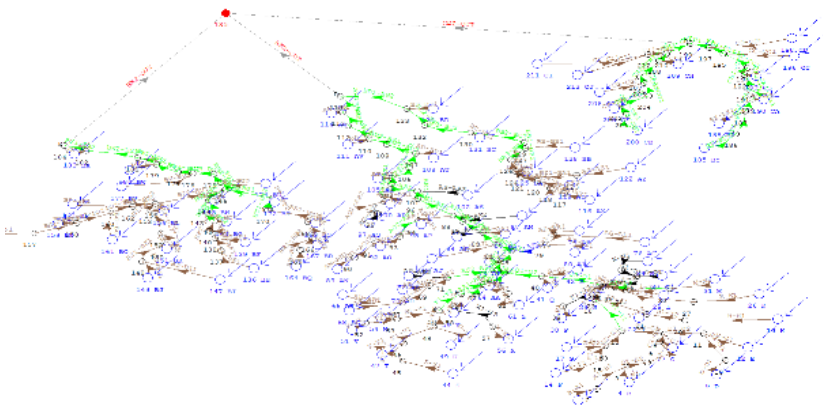
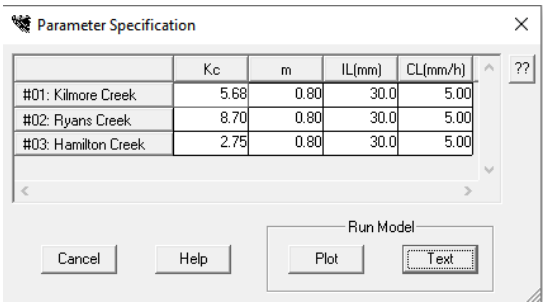


Figure 15. *As Supplied RORB Model*

4.1.1. Modelling Parameters

The model upstream of the subject site comprises of catchments BQ, BR and BS (see Figure 3). This portion of the model was reviewed for adequacy. The several large farm dams are not shown in the model and would be expected to have an impact on final flows through the subject site as shown in the flood modelling Figure 3. It is hence assumed that the flows from the RORB model for the subject site are conservative, and it is likely that the flood modelling associated with this Rorb model better represents the flooding in this area. The reach lengths were also updated to match measurements taken from GIS.

No other changes were made to the RORB model and all run parameters from the flood study were adopted and considered fit for purpose. The



	Kc	m	IL(mm)	CL(mm/h)
#01: Kilmore Creek	5.68	0.80	30.0	5.00
#02: Ryans Creek	8.70	0.80	30.0	5.00
#03: Hamilton Creek	2.75	0.80	30.0	5.00

Source: WBM, Kilmore Flood Study

Figure 16. *Rorb model Parameters*

4.2. Existing Conditions ARR87 Site Flows

Using the WBM model and ARR87 methodologies the proposed flows at Lancefield Road are listed in Table 2 below. As can be seen in the development of land upstream of this hydraulic control significantly increases run-off from the area.

Table 2. Catchment flows at Lancefield Road with Varying Fraction Impervious

Source: KIL_E01_003_Afflux_noRB.catg

1% AEP Duration Storm	Existing Conditions Flows (m^3/s)*	Developed Conditions Site Only Flows (m^3/s)	Developed Conditions Entire Catchment Flows (m^3/s)**
10m	0.48	3.91	7.07
15m	0.58	3.80	7.37
20m	0.45	3.73	7.05
25m	0.53	3.25	7.62
30m	0.59	3.36	6.88
45m	1.90	4.01	6.13
1h	2.10	4.04	7.87
1.5h	2.13	4.88	8.20
2h	2.40	5.01	8.96
3h	2.36	2.72	5.27
4.5h	2.36	3.72	6.00
6h	1.97	3.08	4.66
9h	3.53	3.96	4.37
12h	3.11	3.57	3.99
18h	1.47	1.89	2.38
24h	1.82	2.12	2.52
30h	1.21	1.49	1.92
36h	0.97	1.18	1.60
48h	1.30	1.56	2.02
72h	0.85	1.06	1.34

* Note this is catchment flow only, the influence of the hydraulic control (pipes @ Lancefield) are not included

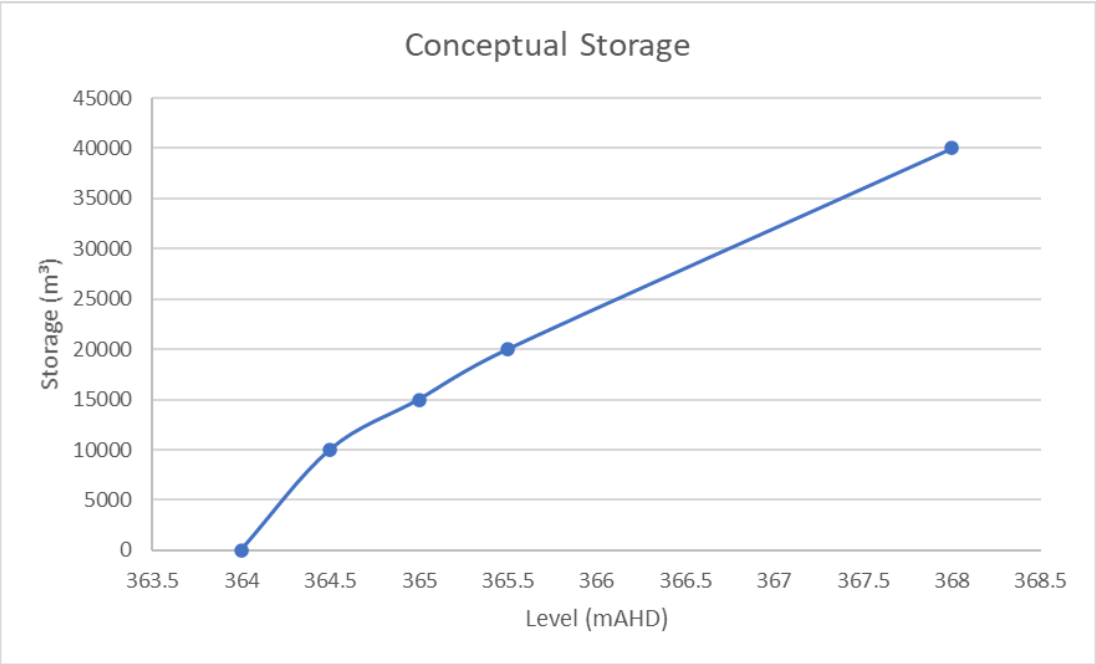
** Entire Catchment set at 0.6 FI to test assumption. This is a conservative estimation.

4.3. Post Development Modelling

4.3.1. Post Development – Subject Site only

The proposed model was updated to include a basin within the development. The results of this modelling are shown here. A conceptual storage to elevation relationship for a basin was formed based on the existing contours of the site (Figure 17**Error! Reference source not found.**). This conceptual storage can be seen in Figure 17 below.

The adjusted flows at Lancefield road are shown in Table 3 below. The peak flow in and flow out maximum storage values have been checked and can be seen to be between 11 ML and 15ML.



Source: Afflux 2020

Figure 17. *Conceptual Flood Storage at Lancefield Road*

4.3.2. Post Development – Ultimate Fully Developed conditions

To check this storage value against complete catchment development, the Fraction Impervious of the model was adjusted to 60% for both of the upstream catchments. This is a very conservative method, with actual FI's expected to be well below this value when land uses (including sporting fields) and final development mixes are taken into account. It does however give the designers a feel for the total catchment storage required if built in a single location. The peak storage was found to be ~19ML for the 9hr event as can be seen in Figure 18 below.

```
Results of routing through special storage ButlersRB
 Peak elevation=  365.36 m
 Peak outflow =     2.56 m³/s (pipe flow)
 Peak storage =     1.86E+04 m³
```

Figure 18. *Peak Storage Entire Catchment Developed (FI 60%)*

Based on this it can be seen that a single storage may be a very efficient attenuation method in this catchment, can negotiations with Council should be undertaken to distribute costs for a single basin strategy. Note this analysis is a higher order analysis than the quoted numbers in the PlanRight report, accounting for the lower storage. Also note that detailed design should be completed in ARR19 hydrology. Large storage differences are not expected with this change, however peak flows may vary within the waterway.

Table 3. Developed flows with Basin for subject site (40 Butlers Rd only)

1% AEP Duration Storm	Flow Out @ Lancefield (m^3/s)	Dev Flow into Basin (m^3/s)	Peak Storage (m^3)
10m	0.03	3.91	
15m	0.04	3.80	
20m	0.06	3.73	
25m	0.06	3.25	
30m	0.07	3.36	
45m	0.19	4.01	
1h	0.32	4.04	
1.5h	0.51	4.88	
2h	0.75	5.01	10,800 m^3
3h	0.98	2.72	
4.5h	1.05	3.72	
6h	1.06	3.08	
9h	1.78	3.96	15,200 m^3
12h	1.49	3.57	
18h	1.04	1.89	
24h	1.22	2.12	
30h	1.06	1.49	
36h	0.85	1.18	
48h	0.88	1.56	
72h	0.50	1.06	

5. Flood Conditions

In 2017 the GBCMA undertook a flood modelling program for the Kilmore region to better understand the flood risks and development requirements in the area. As shown in Figure 20, these tributary exhibits flow within the creek corridor, with minimal breakout. In addition the site is mainly affected by the tributary flooding through and around the existing site dam, with little sheet flow. This is highlighted in Figure 20, and can be seen that the major flows are expected in either the long duration 9hr flows, or shorter 15 minute site flows.

These flood characteristics help inform the greater stormwater design response for the site and are important in the waterway design considerations.

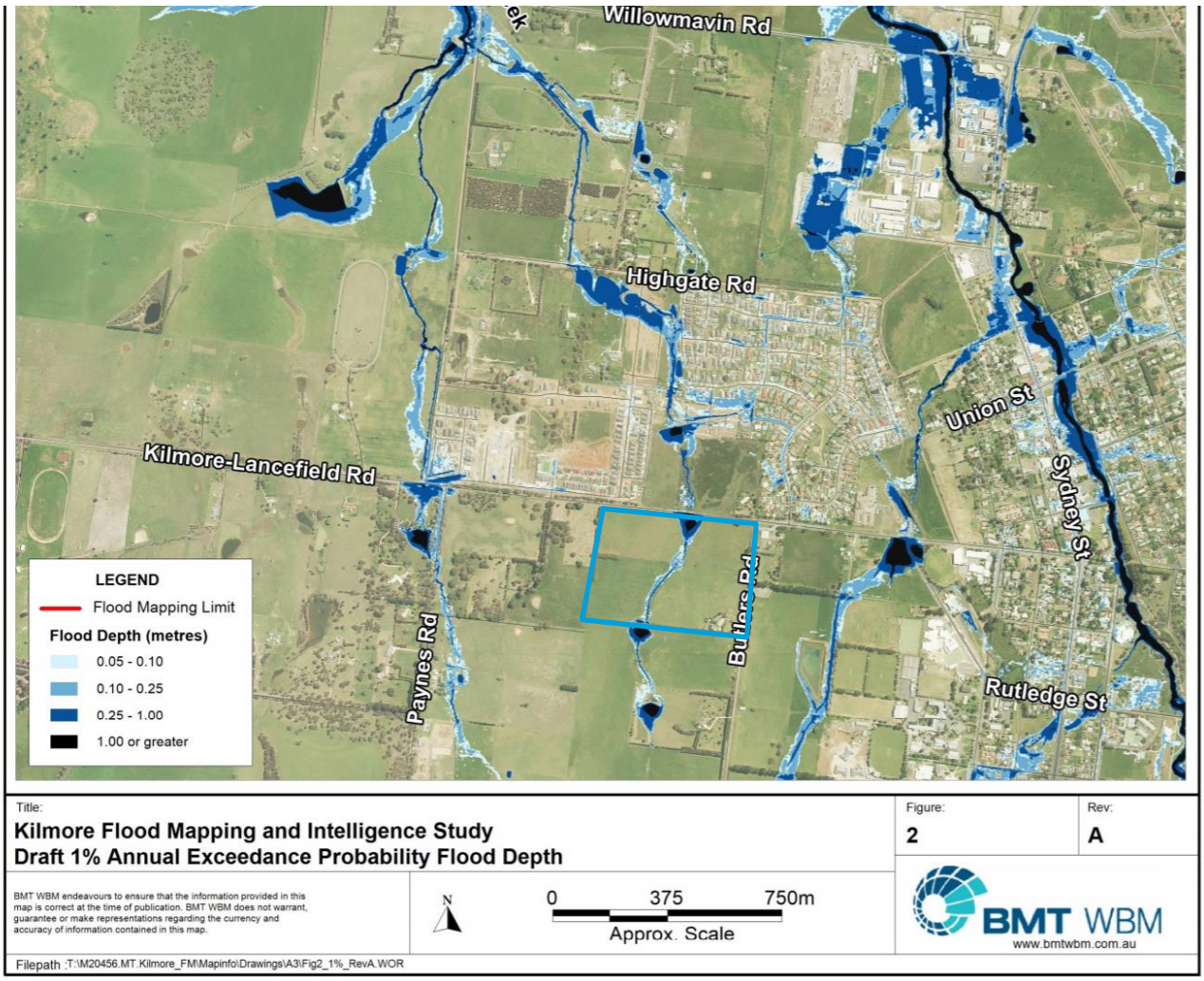


Figure 19. *Kilmore Flood Study (WBM, 2017)*

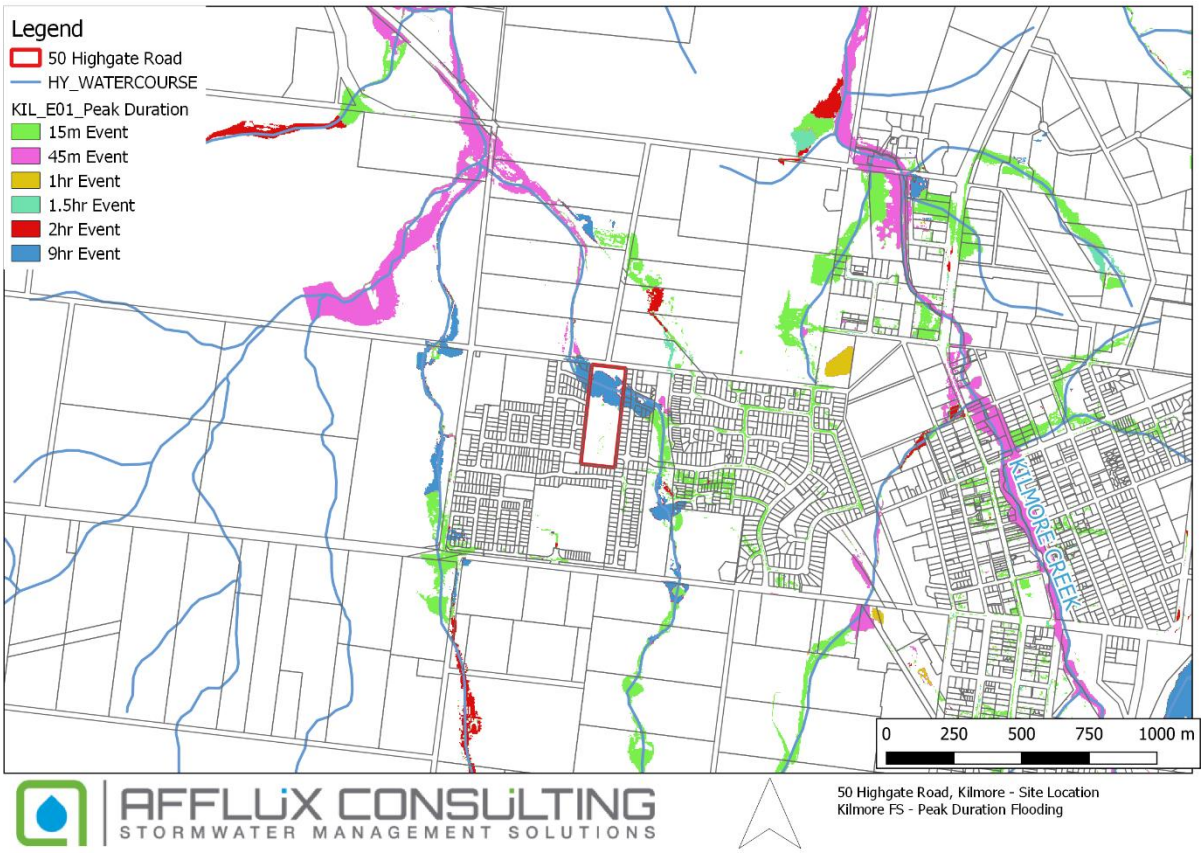


Figure 20. *Catchment Peak Duration Analysis (note sheet flow removed)*

6. Waterway Requirements

The creek offsets and protection zones will be a primary concern of GBCMA and Council in the development of this parcel. This Section describes the proposed offsets.

6.1. Offsets and Zones

Although in a GBCMA area, the Melbourne Water guidelines have been used to help define the required offsets using the Waterway Corridors Guidelines. The proposed offsets and zones have primarily been based on a Strahler stream order, and other identified site features. This part of the creek has been determined as a 1st Order Creek as per the GBCMA advice and Strahler order confirmed in Figure 21 below.

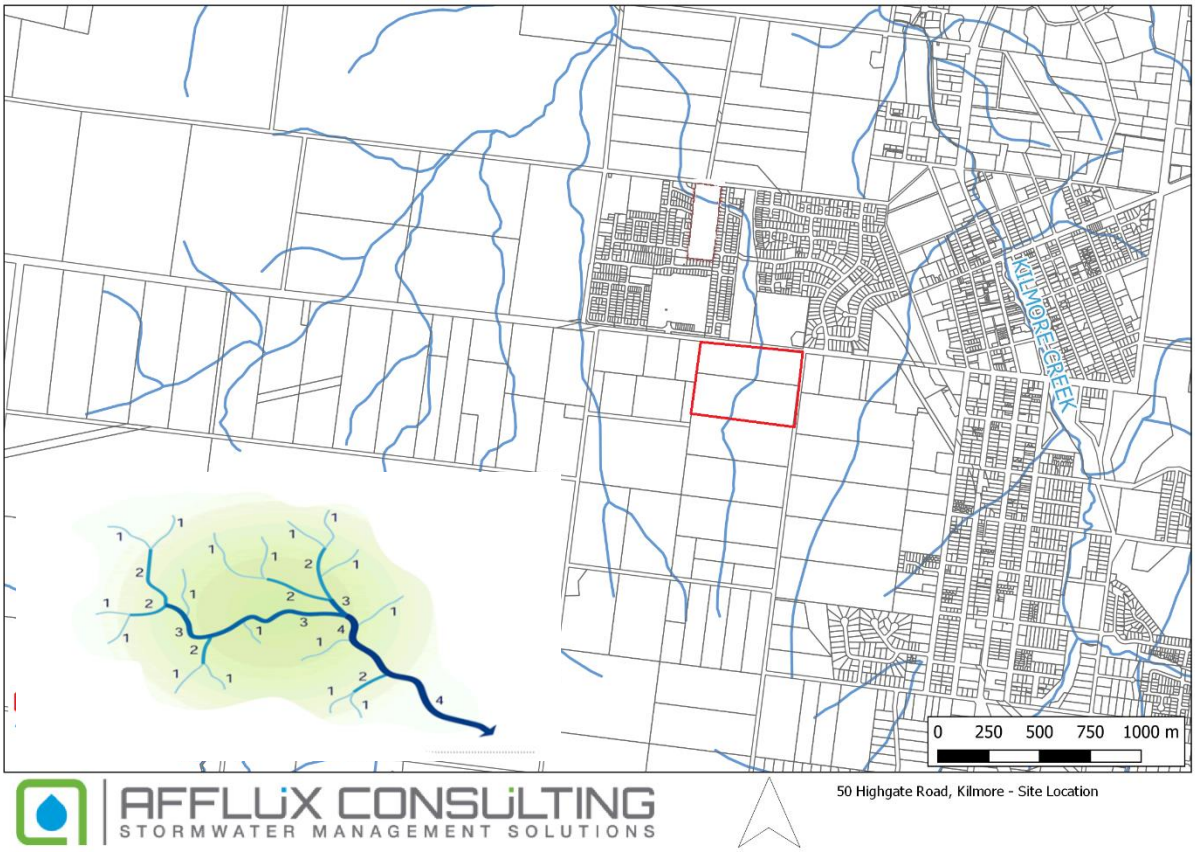


Figure 21. *Creek Strahler Order*

This would result in a 30m wide corridor depending on bank location (noting the existing waterway has a top of bank width of less than 3m, and is in very poor ecological condition). However, as highlighted above this section of creek will need to be completely reconstructed as part of the development and removal of online stream dam.

If continuing with using the Melbourne Water guidelines, this would result in a 20m setback as the design flow is less than 4m³/s on a relatively steep grade (resulting in a hydraulic width of less than 5m). However, given that the downstream corridors are all set at 30m, and the reference planning documents (KSP, 2016) define a 30m corridor would seem to be the most logical corridor width.

OVERALL SETBACK WIDTH (M)	CORE RIPARIAN ZONE WIDTH (M)	VEGETATED BUFFER WIDTH (M)
20 m	10 m	10 m
30 m	20 m	10 m
50 m	40 m	10 m

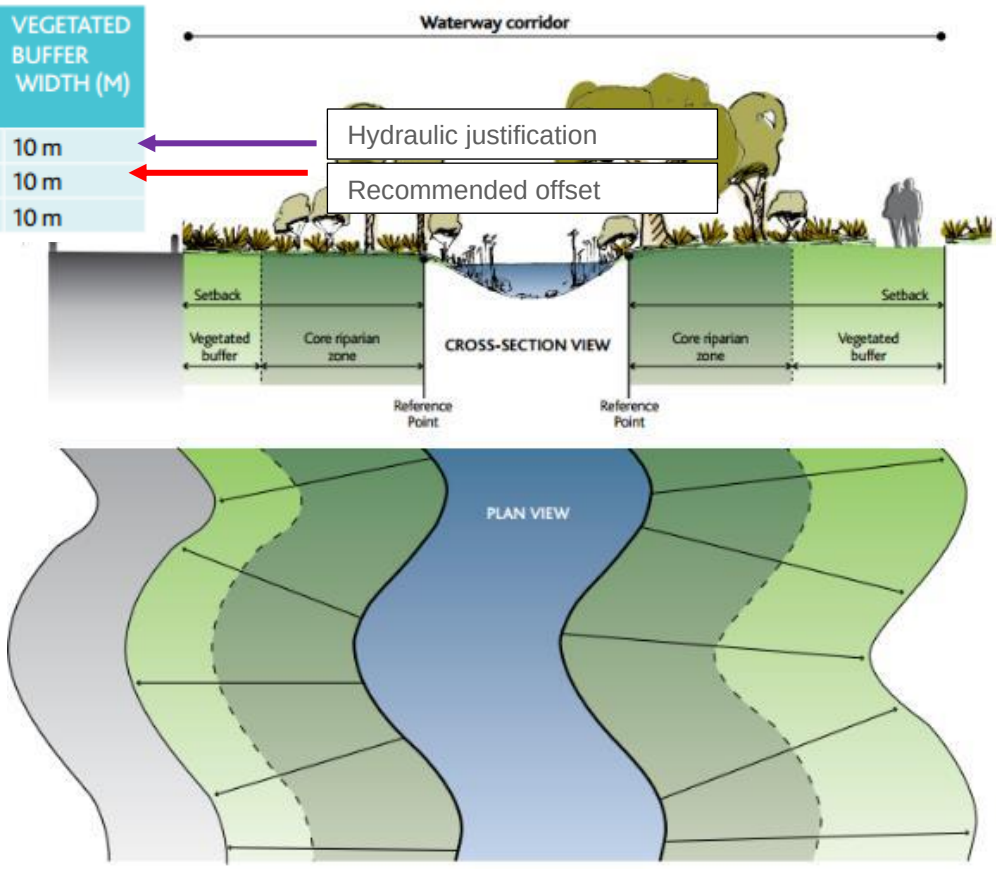


Figure 22. *Waterway Offset Requirements (Waterway Corridor Guidelines)*

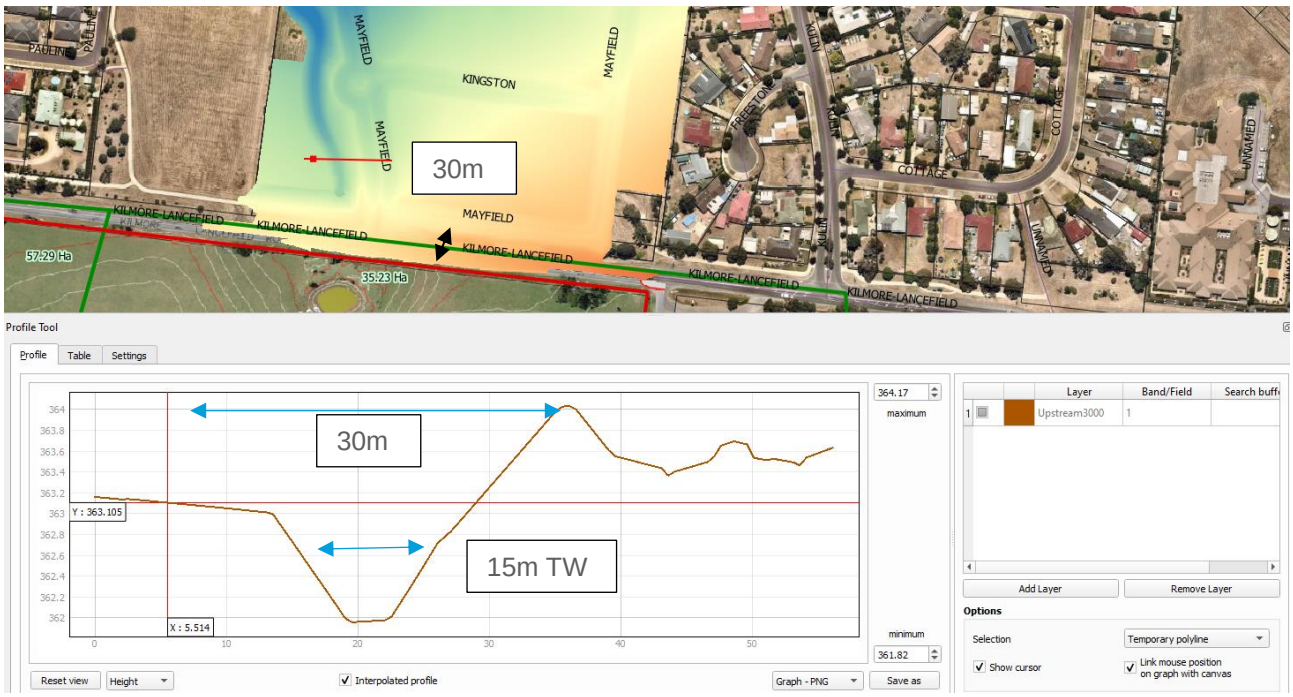


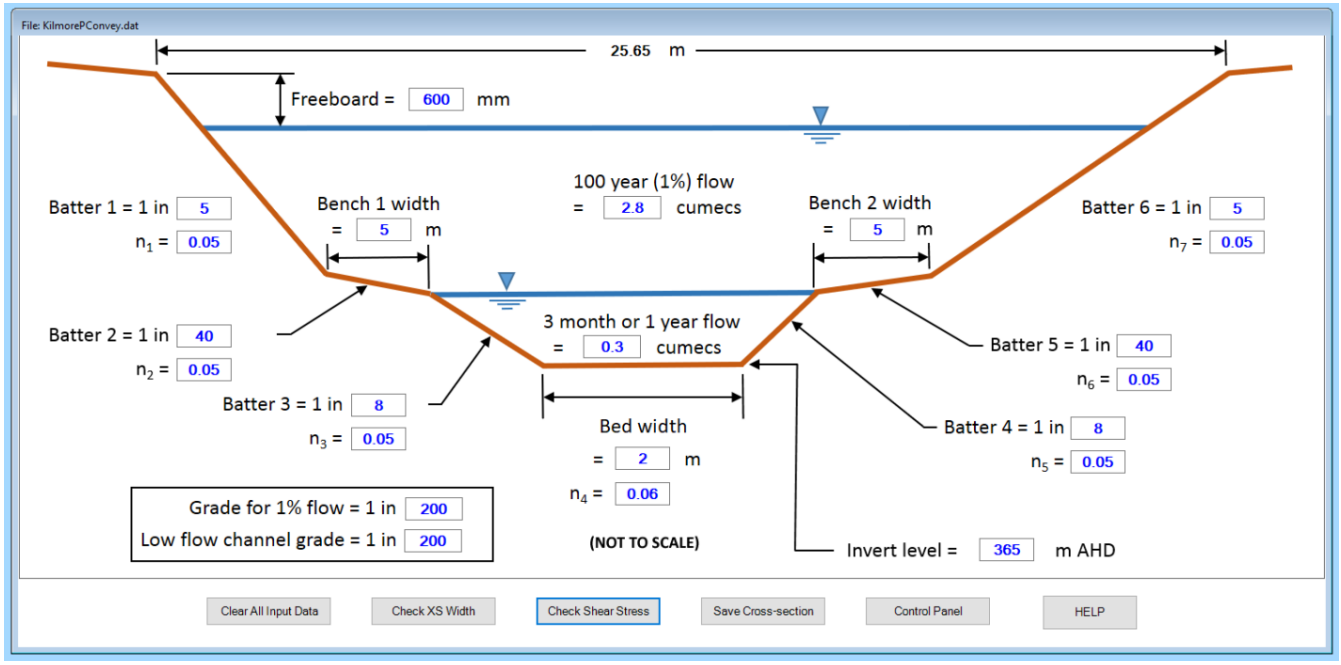
Figure 23. *Downstream designed waterway and corridor width*

6.2. Waterway Grade and Form

Through the subject site, the waterway grades from 372.5m AHD to the culvert inverts of 363.2 at Lancefield Road over a distance of approximately 390m. This is a grade of approximately 1:40 and is far too steep for a stable waterway with the increased flows associated with the urban development of the area. A suggested grade of closer to 1:200 is suggested for waterways in this area, and a number of rock chutes will be required to meet this grading.

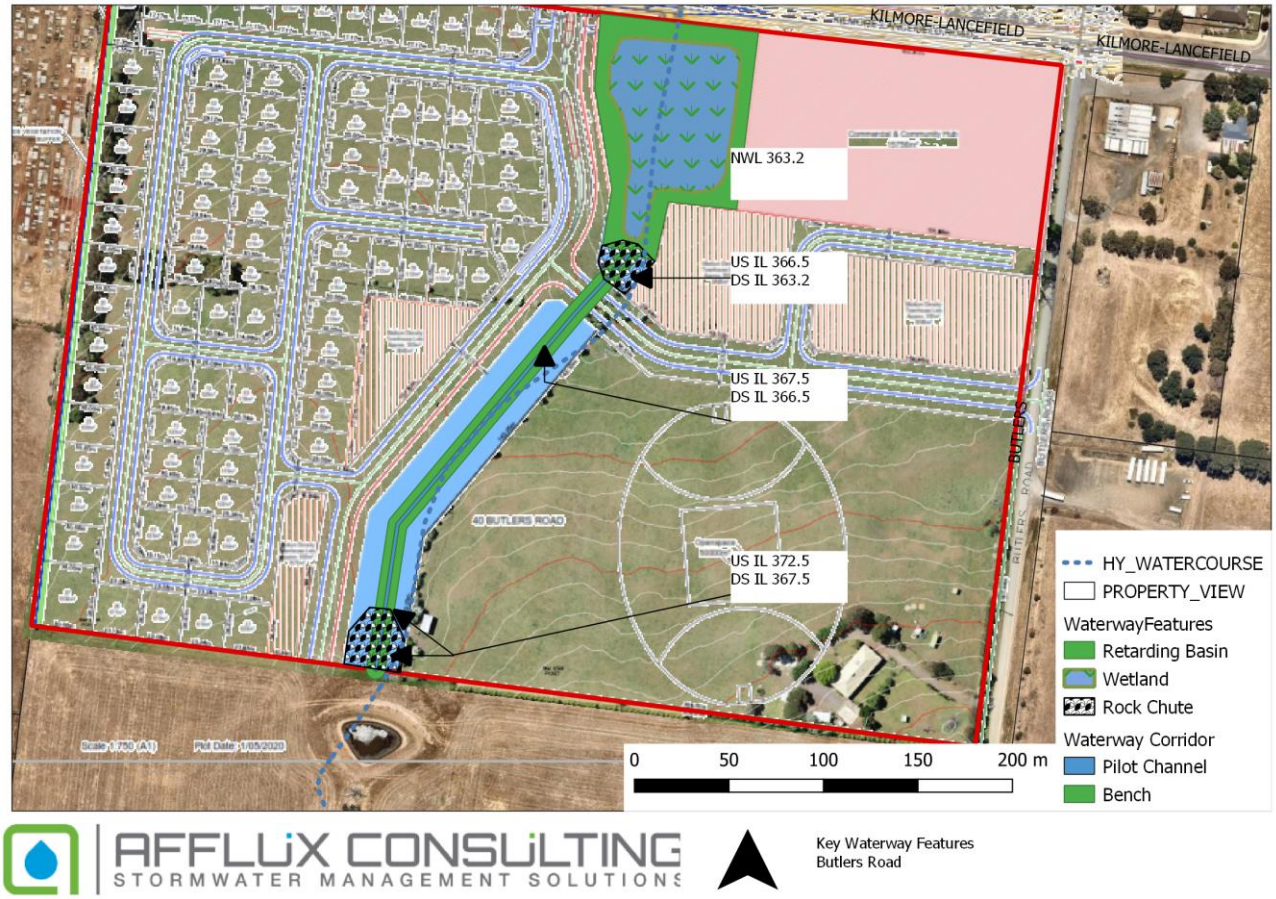
The approximate flow from the upstream development is around 3m³/s as derived from the catchment developed model. This figure needs to be tightened as part of the detailed design, and in line with the catchment storage decisions. At this stage however it seems like the most likely order of magnitude for the flow. Using PC-Convey's new waterway designer, a preliminary waterway section has been formed and is shown in Figure 24. The results, and importantly the shear stress's associated with this design can be seen in Appendix A. In all cases this channel design is a low energy environment, minimising future waterway risk.

A proposed layout of the waterway with indicative invert levels can be seen in Figure 25. The capacity of this cross section has also been checked in Figure 26 and as can be seen the section will maintain 600mm on unencumbered area at the design flow. The section will also maintain 300mm of freeboard with a flow of up to 9.5m³/s allowing significant redundant capacity should future conditions change.



Source: PC-Convey – (KilmorePConvey.dat)

Figure 24. *Proposed Preliminary Waterway Design*



AFFLUX CONSULTING
STORMWATER MANAGEMENT SOLUTIONS

Key Waterway Features
Butlers Road

Figure 25. *Proposed Waterway Size and Inverts*

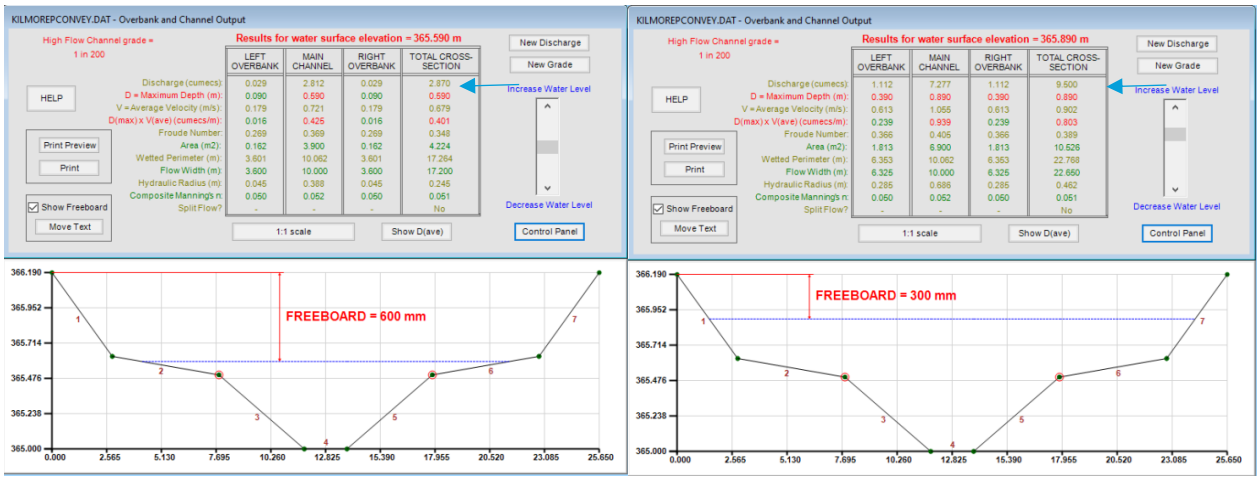


Figure 26. *Waterway Capacity and Freeboard @3m³/s and 9.5m³/s*

7. Water Quality

The water quality for the site can be met through two main measures:

- Given the size of the blocks and capacity for potential water reuse, it is recommended that each property have a 5000L rainwater tank installed, plumbed in for toilet flushing and garden use as a minimum

7.1. Music Setup

A MUSIC model for the site was set up for the development catchment. The rainfall used was the 10-year dataset for Melbourne City as shown in Figure 27 below. The development catchments as shown in Figure 28 were delineated and a fraction impervious applied. All other standard Melbourne Water parameters were adopted, and an audit report can be seen in Appendix B.

The resulting MUSIC model can be seen in Figure 29, with the results shown in Figure 30. As can be seen with the available footprint within the retarding basin the BPEM requirements can be easily met. Testing of the model has shown that up to ~10ha of upstream land could also be met with this basin size. Further refinement of the wetland will be undertaken at Functional Design stage, and is subject to discussions on landholder contributions and other technical detail, however at this stage it can be clearly stated that the land allocation is large enough to meet the water quality requirements.

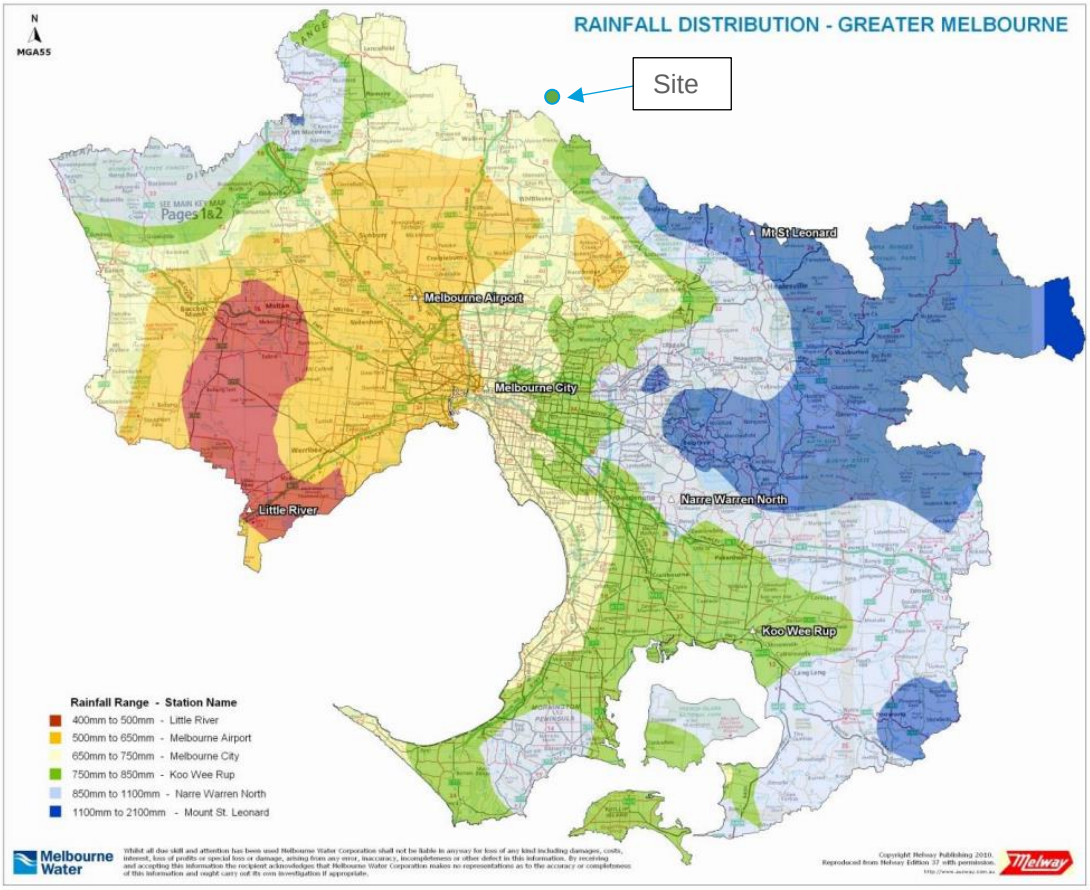


Figure 27. *Rainfall Station Used (Melbourne City)*

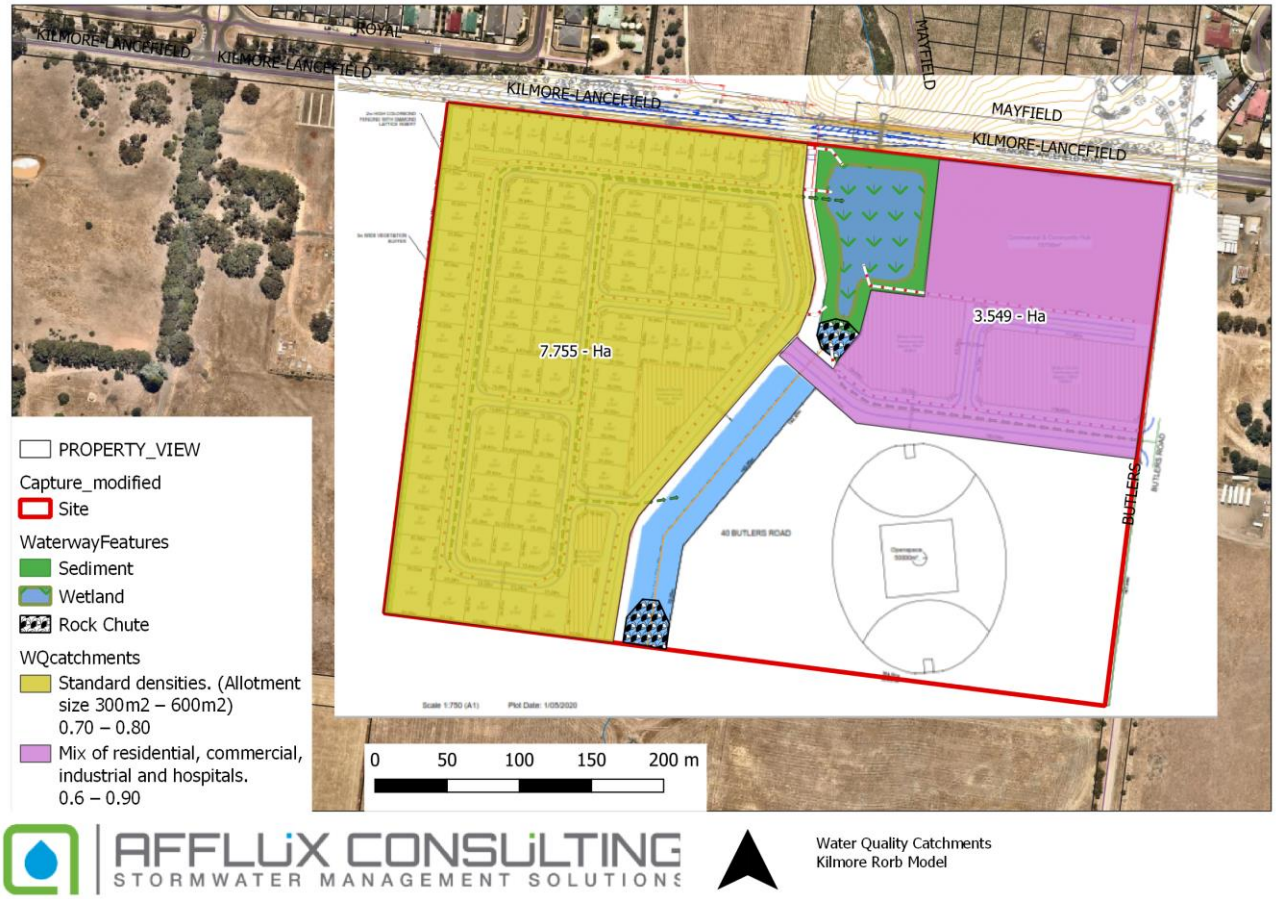


Figure 28. *Water Quality Catchments*

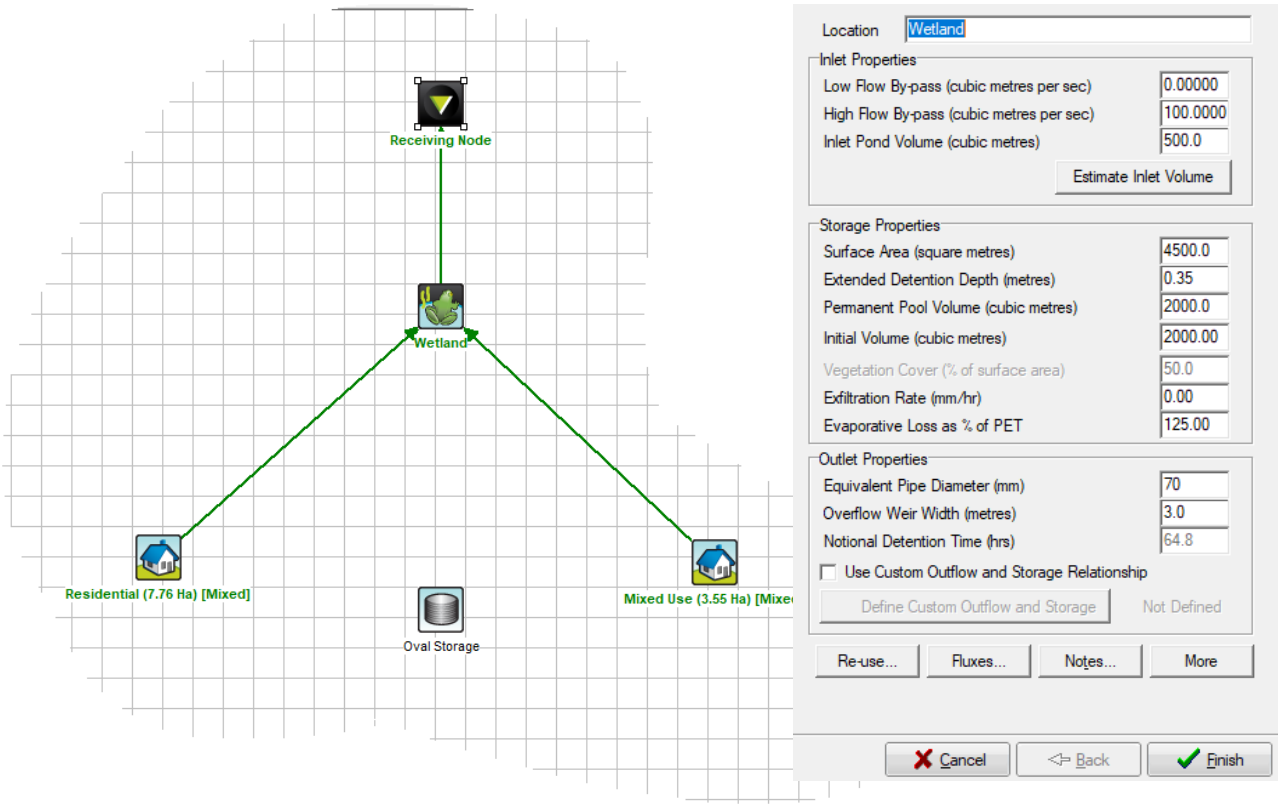


Figure 29. *MUSIC model setup*

	Sources	Residual Load	% Reduction
Flow (ML/yr)	52.2	46.7	10.5
Total Suspended Solids (kg/yr)	10100	1250	87.6
Total Phosphorus (kg/yr)	21	4.9	76.7
Total Nitrogen (kg/yr)	148	63.9	56.9
Gross Pollutants (kg/yr)	1970	0	100

Figure 30. *MUSIC model treatment results*

7.2. MUSIC Harvesting Option

Given the proximity of the wetland to the proposed sporting grounds a stormwater harvesting integrated water management scheme should be considered as part of the subdivision. A high-level water balance has been undertaken in this report to investigate whether this should be further pursued as part of functional design.

Based on other projects around Melbourne, the average water demand for a single oval is around 6ML per year. More water can always be used, and depending on the standard and type of use may be justified, but 6ML gives a reasonable standard and has been stated as the average use by a number of Councils.

The entire catchment upstream of the development site was added to the model, and a relatively small oval storage of 120kL (again a standard header tank size for oval systems) was added to the model. The model setup can be seen in Figure 31.

As can be seen in Figure 32 the requested 6ML is met ~87% of the time, even with such a small storage. This is above the industry recommendation of 80% demand minimum, and proves that this is a worthwhile undertaking. This concept with remove a further ~1-2% of nitrogen from the catchment as part of the reuse. Obviously much larger water demand efficiency and nitrogen removal can be met by using larger storages and demands, and this should be explored as part of discussions with Council. Ultimately Council will be the owners of these assets and pumps, and they will need to consider the cost benefits of the water reuse. At current costs, assuming a $3/kL rate the water costs for this asset will be in the order of $20,000 per/annum.

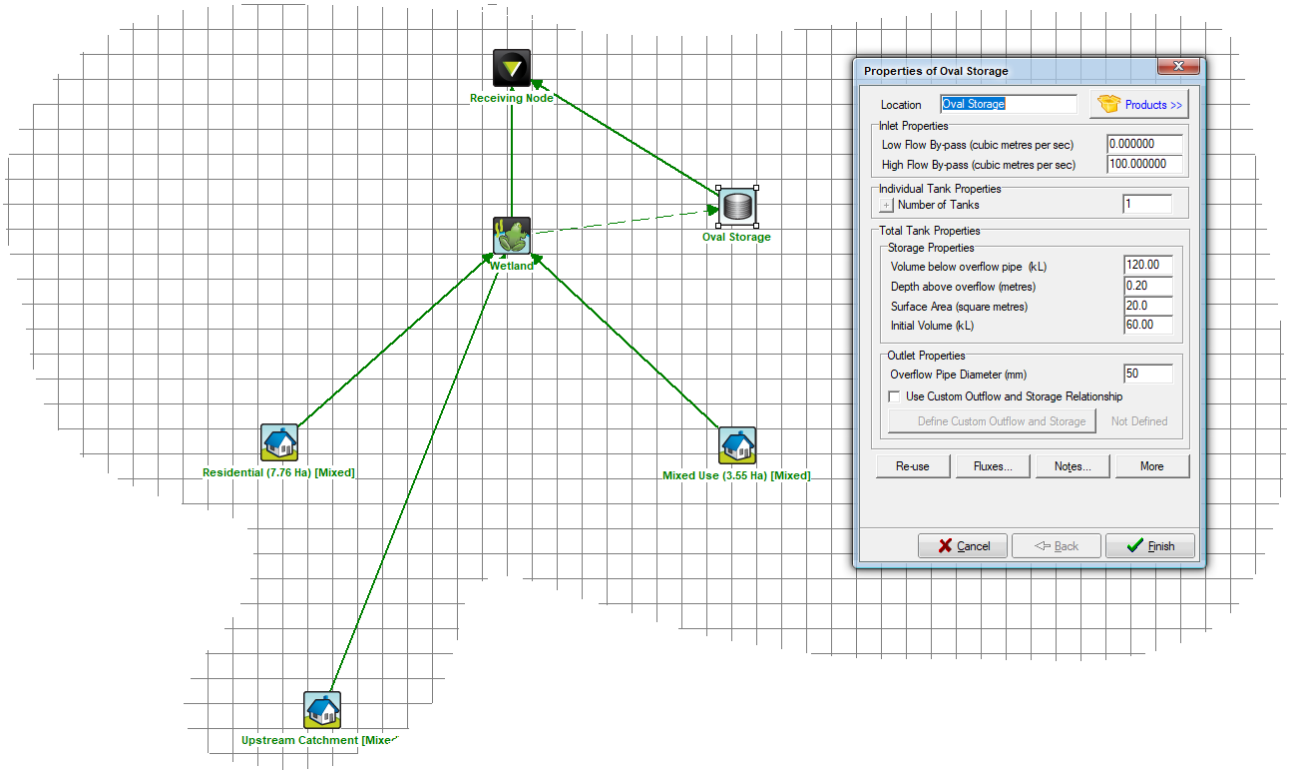


Figure 31. *Harvesting Model Setup*

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	GP (kg/yr)
Flow In	96.86	594.04	5.87	105.80	0.00
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	50.31	326.02	3.21	54.46	0.00
Weir Out	41.55	269.19	2.64	45.97	0.00
Transfer Function Out	0.00	0.00	0.00	0.00	0.00
Reuse Supplied	5.21	36.86	0.36	5.62	0.00
Reuse Requested	6.00	0.00	0.00	0.00	0.00
% Reuse Demand Met	86.69	0.00	0.00	0.00	0.00
% Load Reduction	5.16	-0.20	0.31	5.07	0.00

Decimal Places 2

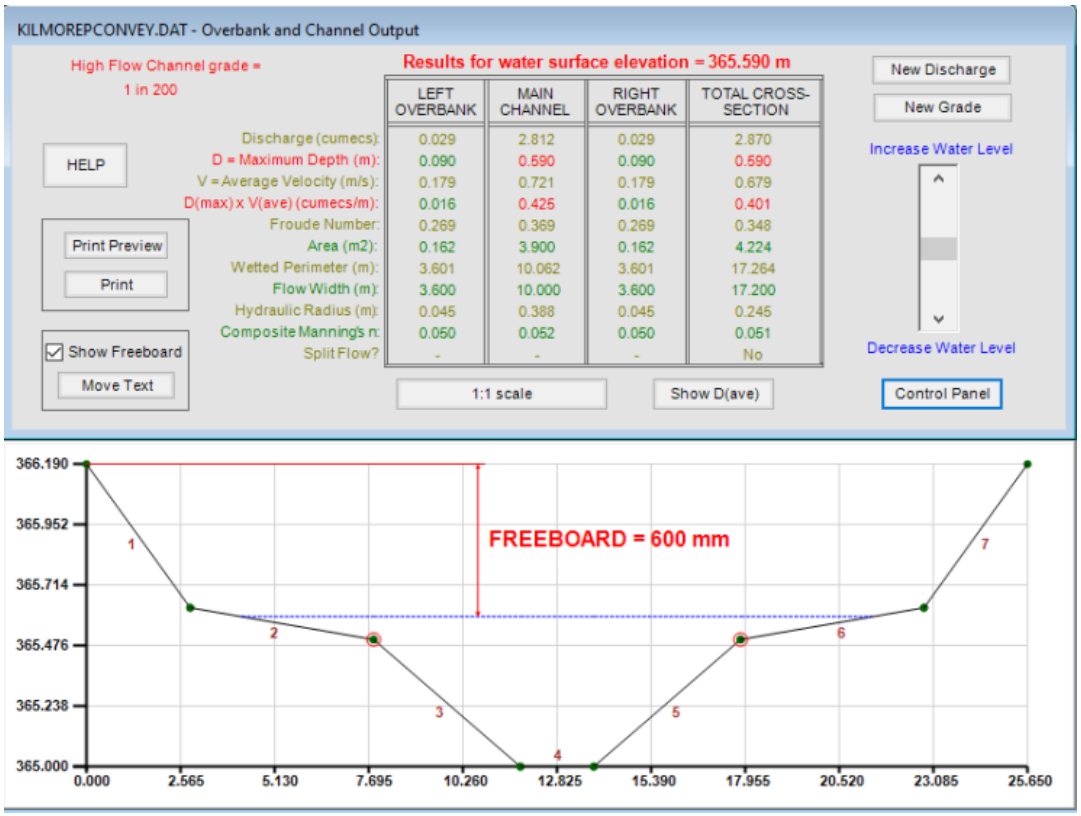
Figure 32. *Harvesting Storage Water Balance*

8. Design Requirements

In modelling stormwater interactions associated with this development the following design requirements have become clear.

8.1. Lot Levels & Encumbered Areas

The waterway and retarding basin areas have been conceptually designed to contain all flows and major floods within designated areas. A freeboard of 600mm should be applied to maximum waterway flood levels, currently this freeboard is being applied within the channel itself as shown in Figure 33. Based on this the expected 1% AEP encumbered areas are shown in Figure 34.



	LEFT OVERBANK	MAIN CHANNEL	RIGHT OVERBANK	TOTAL CROSS-SECTION
Discharge (cumecs):	0.029	2.812	0.029	2.870
D = Maximum Depth (m):	0.090	0.590	0.090	0.590
V = Average Velocity (m/s):	0.179	0.721	0.179	0.679
D(max) x V(ave) (cumecs/m):	0.016	0.425	0.016	0.401
Froude Number:	0.269	0.369	0.269	0.348
Area (m2):	0.162	3.900	0.162	4.224
Wetted Perimeter (m):	3.601	10.062	3.601	17.264
Flow Width (m):	3.600	10.000	3.600	17.200
Hydraulic Radius (m):	0.045	0.388	0.045	0.245
Composite Manning's n:	0.050	0.052	0.050	0.051
Split Flow?	-	-	-	No

Figure 33. *Waterway Freeboard*

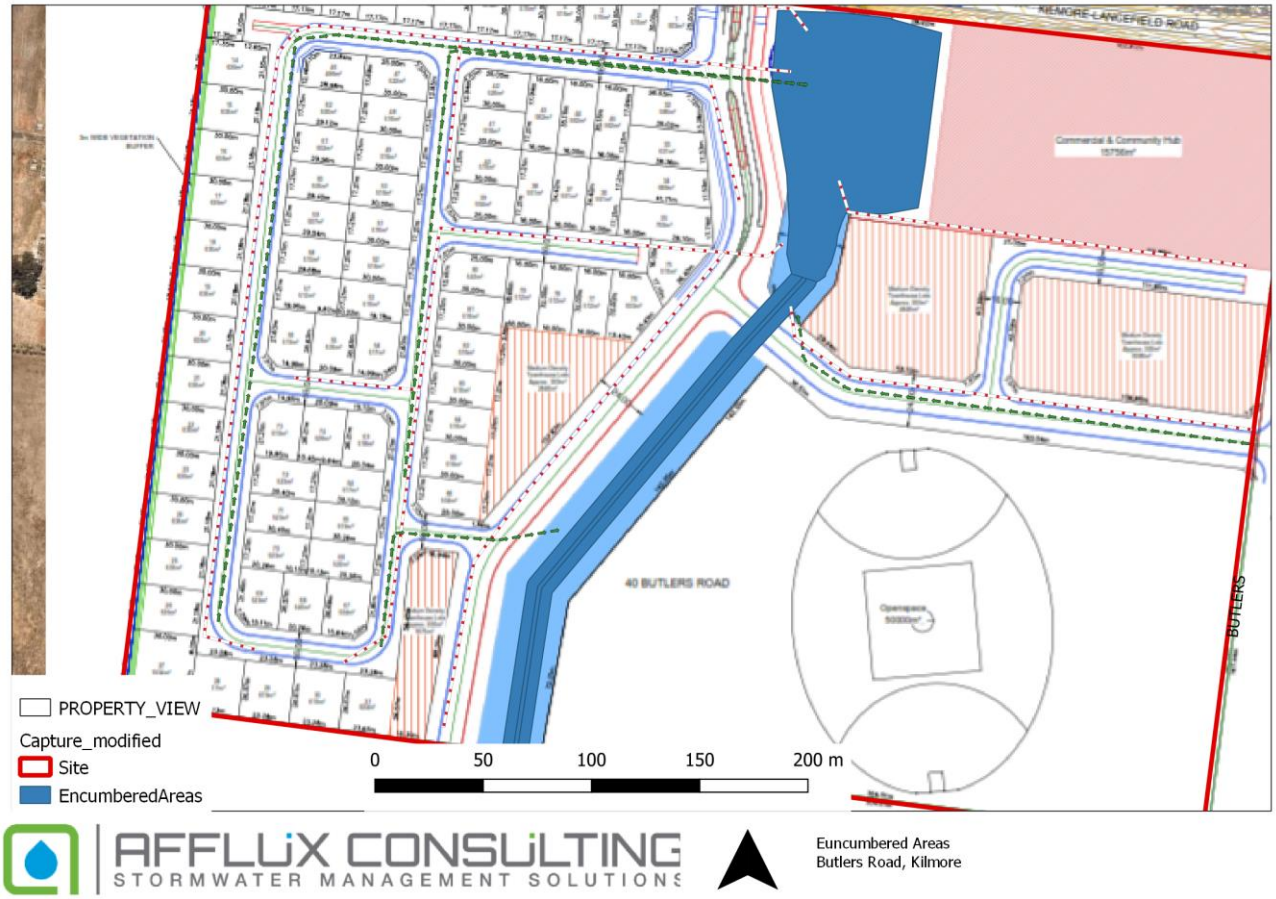


Figure 34. *Conceptual Encumbered Flood Areas*

8.2. Flow Paths and Drainage

The major and minor flow paths have been shown in Figure 35 below. As can be seen all piped connections are directly into the wetland system and major overland flow paths have been directed to the basin. To check the road capacity of the overland flow paths a Rational Method calculation of the larges flow path catchment (western sub-catchment – 4.8Ha) has been undertaken in Table 4 below. As can be seen the biggest GAP flow for this catchment will be approximately ~0.24m³/s. Given this very low flow no capacity check has been performed. Any subdivisional road cross section is expected to have an order of magnitude more flow capacity than this.

Table 4. Largest sub-catchment flows

ARI (years)	Q (m^3/s)	I (mm/hr)	tc	Fy	C'10	C10	Cy	Total Area (ha)
1	**0.08**	35.9	14.21	0.80	0.138	0.215	0.172	4.8
2	**0.10**	40.6	14.21	0.85	0.138	0.215	0.182	4.8
5	**0.15**	56.4	14.21	0.95	0.138	0.215	0.204	4.8
10	**0.20**	68.2	14.21	1	0.138	0.215	0.215	4.8
20	**0.24**	80.6	14.21	1.05	0.138	0.215	0.225	4.8
50	**0.32**	98.4	14.21	1.15	0.138	0.215	0.247	4.8
100	**0.39**	113.1	14.21	1.2	0.138	0.215	0.257	4.8

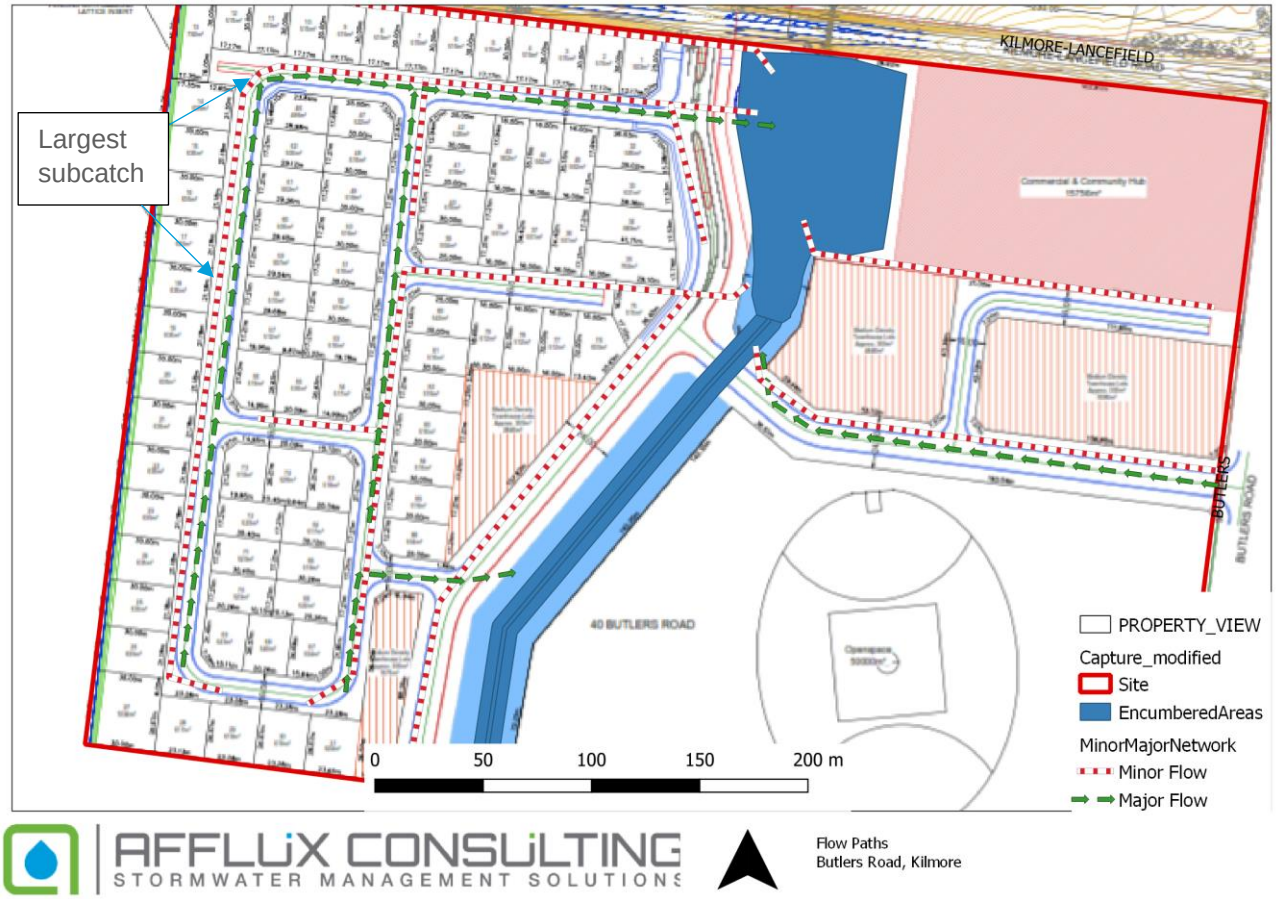


Figure 35. *Minor and Major Network*

8.3. Temporary Requirements

Temporary requirements are put in place on a subdivision to prevent individual stages adversely affecting the downstream environment. As has been shown in the Hydrology section, full development of this site alone will approximately double the existing flows downstream of Lancefield Road. As such it is clear that storage will be required at some point during the development of the site.

Given the current dam and road crossing arrangements at Lancefield Road, there is some buffer to the hydrological effects of development. The existing dam has approximately ~1,500m³ of capacity before overtopping. Using industry ratios this should allow up to **3Ha** of land to be developed before additional temporary storage is required. This would be typical of a single stage.

After this point it is suggested that a ratio of 500m³ of storage per hectare of development be maintained until approximately 50% of the development is completed. After this point the full retardation volume (at least 15,000m³) should be installed. Temporary sediment management should also be employed during this time, with a sediment basin of at least 500m² used until the 50% of development is completed, with planning and installation of the wetland to follow.

9. Conclusions

This report presents a stormwater management plan for the proposed development at Butlers Road, Kilmore. The site has important interactions with the upper tributaries of Ryan's Creek, as well as 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:

- The site will require approximately 15ML of storage as a minimum as part of full development of the site. Further negotiations with council regarding catchment contributions should be undertaken if this basin is to cater for full development upstream. Land area for this basin has been set aside in the development plan
- A wetland of approximately 5,000m² is required for the site, and will account for some additional upstream catchment. Land area for this wetland has been set aside in the development plan
- Temporary works are required throughout the development of the site, and have been listed in this report
- A constructed waterway is recommended for the site to safely convey future development flows. A low shear stress design has been recommended in this report and the reserves for this are adequate in the development plan

These works as presented should enable development to proceed with minimal impact to overall hydrology of the area while providing amenity to new dwellings.

10. References

Hamilton Environmental Services, 2020, *Flora and Fauna Assessment and Net Gain and Loss Reporting – Butlers Road Precinct, Kilmore*

Mitchell Shire Council, 2016, *Kilmore Structure Plan GUIDING THE GROWTH OF KILMORE*

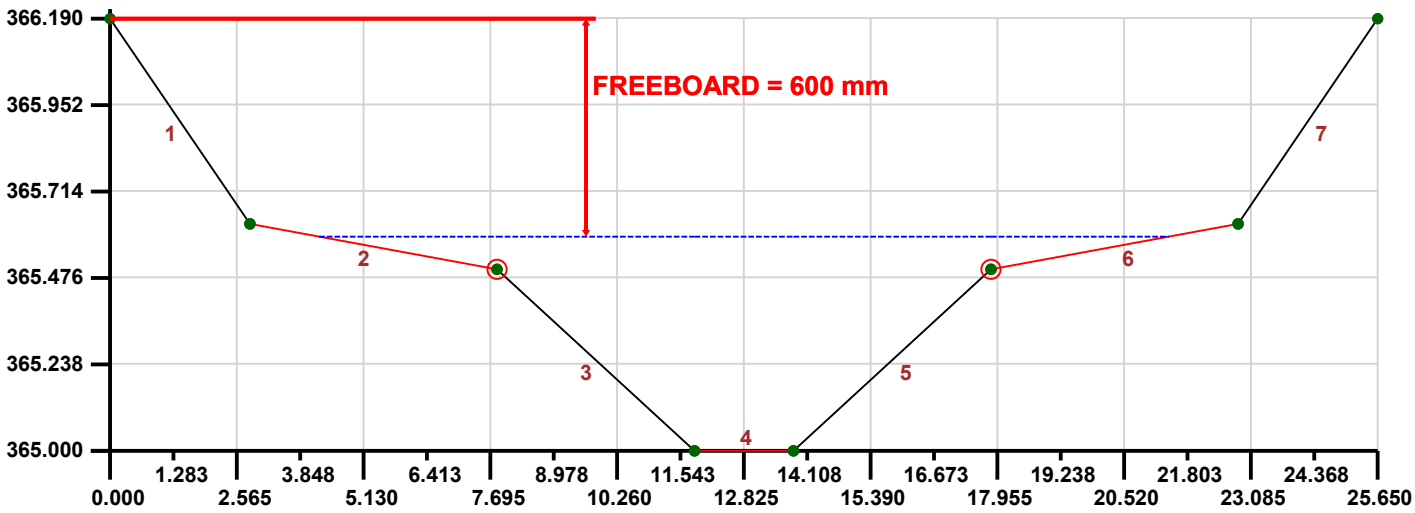
Mitchell Shire Council, 2017, *Kilmore Infrastructure Framework*

PlanRight, 2017, *Drainage Strategy Residential Development Butlers Road, Kilmore*

Appendix A – Shear Stress Analysis

PROJECT: ButlersKilmore
Print-out date: 17/11/2020 - Time: 9:10
Data File: KilmorePConvey.dat

1. CROSS-SECTION:



2. RESULTS SUMMARY:

Results for water surface level = 365.590 m. Water density = 1000.0 kg/m3. Gravity = 9.80 m/s2.
1% waterway (High Flow Channel) grade = 1 in 200, Main/Low Flow Channel grade = 1 in 200.
Reporting average shear stresses. Red Segments on graph show maximum FACTORED average shear stresses.
Unfactored shear stresses are calculated using du Boys' equation (1879), and then factored up using bank (side) and bed factors in accordance with Melbourne Water's Constructed Waterway Design Manual (December 2019).
The cross-section is not on a bend.

2.1 Discharges and Velocities
Left Overbank (LOB) discharge = 0.029 cumecs. LOB average velocity = 0.179 m/s.
Main/Low Flow Channel (M/LFC) discharge = 2.812 cumecs. M/LFC average velocity = 0.721 m/s.
Right Overbank (ROB) discharge = 0.029 cumecs. ROB average velocity = 0.179 m/s.
Total discharge = 2.870 cumecs. Cross-section average velocity = 0.679 m/s.

2.2 Shear Stresses
Maximum (factored) average shear stress = 31.102 N/m2 in Segment 4.
Maximum (factored) average Left Overbank shear stress = 3.174 N/m2 in Segment 2.
Maximum (factored) average Main/Low Flow Channel shear stress = 31.102 N/m2 in Segment 4.
Maximum (factored) average Right Overbank shear stress = 3.174 N/m2 in Segment 6.

3. SHEAR STRESS DETAILS:

3.1 Left Overbank results

Segment Number	Average Shear Stress Results (Unfactored (Ave.) and Factored Shear Stresses are in N/m2)								
	D Max (m)	A (m2)	W.P. (m)	H.R. (m)	Ave.	Side Factor	Bed Factor	Bend Factor	Factored
2	0.090	0.16	3.60	0.04	2.20	N/A	1.44	1.00	3.17

3.2 Main/Low Flow Channel results

Segment Number	Average Shear Stress Results (Unfactored (Ave.) and Factored Shear Stresses are in N/m2)								
	D Max (m)	A (m2)	W.P. (m)	H.R. (m)	Ave.	Side Factor	Bed Factor	Bend Factor	Factored
3	0.590	1.36	4.03	0.39	18.99	1.63	N/A	1.00	30.86
4	0.590	1.18	2.00	0.39	18.99	N/A	1.64	1.00	31.10
5	0.590	1.36	4.03	0.39	18.99	1.63	N/A	1.00	30.86

3.3 Right Overbank results

Segment Number	Average Shear Stress Results (Unfactored (Ave.) and Factored Shear Stresses are in N/m2)								
	D Max (m)	A (m2)	W.P. (m)	H.R. (m)	Ave.	Side Factor	Bed Factor	Bend Factor	Factored
6	0.090	0.16	3.60	0.04	2.20	N/A	1.44	1.00	3.17

4. CROSS-SECTION DATA:

	LEFT HAND POINT		RIGHT HAND POINT		
SEGMENT NO.	CHAINAGE (m)	R.L. (m)	CHAINAGE (m)	R.L. (m)	MANNING'S N
1	0.000	366.190	2.825	365.625	0.050
2	2.825	365.625	7.825	365.500	0.050
3	7.825	365.500	11.825	365.000	0.050
4	11.825	365.000	13.825	365.000	0.060
5	13.825	365.000	17.825	365.500	0.050
6	17.825	365.500	22.825	365.625	0.050
7	22.825	365.625	25.650	366.190	0.050

Appendix B – MUSIC Auditor Report

Date Completed: 18-11-20
MUSIC Guideline Audited: 2016 Guidelines
MUSIC Version Audited: 6.2 or 6.3
Filename is ButlersRdKilmore.mrt
PDF Download

Source Nodes				
Parameter	User Input	Check	Guideline	Comments
Node Residential (7.76 Ha) does not have any errors. (Node 1)				
Node Mixed Use (3.55 Ha) does not have any errors. (Node 2)				
Node Upstream Catchment does not have any errors. (Node 6)				

Treatment Nodes				
Parameter	User Input	Check	Guideline	Comments
Wetland (Node 3) Music Help				
Overflow weir width (m)	3	<	10	Warning - check is large enough to ensure wetland can overflow freely, if not may result in system filling to unrealistic depths. FAQ
Oval Storage (Node 5) Music Help				
Permanent pool volume (m3)	120	>	2 * 20 = 40	Guidelines for depths. Deep active storage volume for tank, check there is sufficient head and depth to groundwater for subsurface tanks. FAQ
Annual Demand Value (ML/year)	6	not equal		Check reuse demands are justified and reasonable.
Annual Demand Distribution	PET	not one of	PETSubRain;	It is recommended that PET - Rain is generally used in preference to PET based distribution for systems where the irrigation system will shut off during rain. PET may be used for automated timer systems without rain detection. A monthly distribution may be used in place of PET - Rain where a user estimated distribution is preferred, the suitability of this should be checked.

Catchment Details				
Parameter	User Input	Check	Guideline	Comments
End Date	31/12/1961 23:54:00	not one of	31/12/2001 11:54:00 PM;31/12/1980 11:54:00 PM;31/12/1961 11:54:00 PM;31/12/1980 11:54:00 PM;31/12/1993 11:54:00 PM;31/12/2004 11:54:00 PM	Should be based one of the recommended Melbourne Water regional templates unless an alternative period is provided and justified.

For information on this report:

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Principle Engineer

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