

AFFLUX CONSULTING
STORMWATER MANAGEMENT SOLUTIONS

STORMWATER STRATEGY

DPO 06, Garfield West

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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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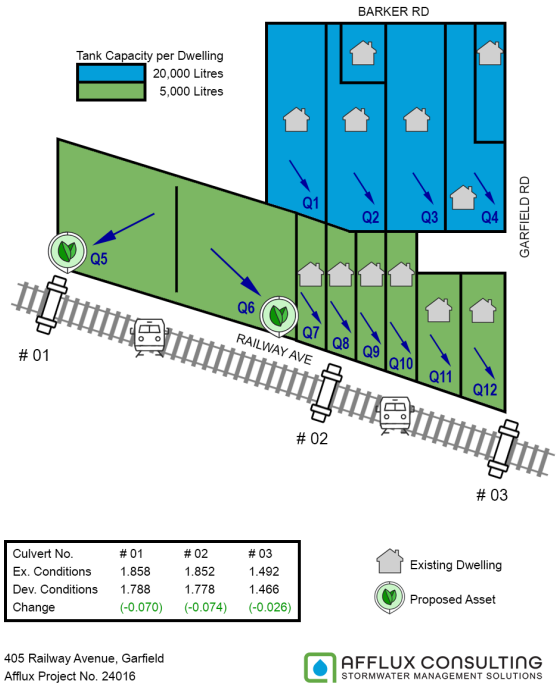
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Executive Summary

The DPO6 area within Garfield township provides an opportunity for increased housing within an existing township with relatively easy access to both public and private transport. To satisfy the stormwater requirements for this development area a substantial amount of detailed stormwater modelling has been completed. The requirements for stormwater flow attenuation for the southern portion of the development area is summarised in the infographic and Treatment Table below.



	Catch 3a	Catch 3b	Catch 5	Catch 6	Catch 10a	Catch 10b	Catch 20
Properties on Site	Q3	Q4	Q10, Q11, Q12	Q1, Q2	Q5	Q6	Q7, Q8, Q9
Estimated lots per property	3	2	24	5	18	27	4
Rainwater Tank Size (Litres)	20,000	20,000	5,000	20,000	5,000	5,000	5,000
Total Rainwater Tank Detention (m^3)	60	40	120	100	90	135	20
Storage Basin Detention (m^3)	N/A	N/A	N/A	N/A	550	900	N/A
Total Onsite Stormwater Detention (m^3)	60	40	120	100	640	1035	20
Further WSUD Required	Yes	Yes	Yes	Yes	No	No	Yes
PSD (l/s) (1%AEP)	681	677	957	1340	441	1260	799
PSD (l/s) (10%AEP)	478	475	685	941	314	879	550

1. Introduction

Afflux Consulting have been engaged by Miller Merrigan to complete a stormwater strategy for the proposed development plan area DPO 06, Garfield West (Figure 1). This report will cover the major drainage, flooding and water quality associated with the development area. 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.
- Inclusion and consideration of guidelines and advice for stormwater management in line with Cardinia Shire Council and Melbourne Water; and
- Identification of mitigation and treatment options, if required.

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

It should be noted that a regional model has been developed for this assessment at the request of Cardinia Council. This is a significant amount of work and takes into account many other development parcels. The limitations of the system have been documented as part of this process, and the best possible hydrological outcome reached. Given the terrain, vegetation and existing development form there are limited hydrological mitigations available for the area.

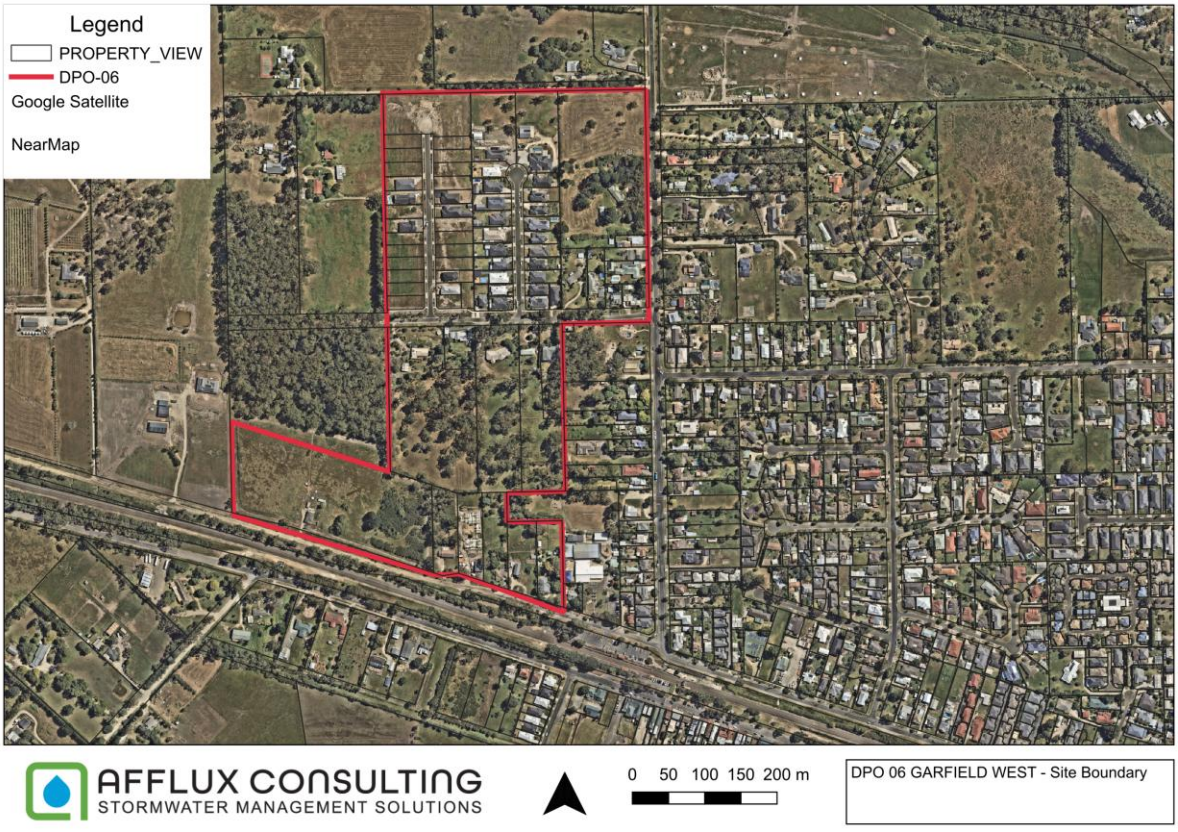


Figure 1. Aerial of site

1.1. Information Sources

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

- Site inspection
- Aerial imagery
- DEPI planning scheme and cadastral information as accessed online (2024)
- Discussions with Cardinia Shire Council
- 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
- Topographic information including required LiDAR data sourced commercially.

2. Existing Catchment Conditions

The existing catchment and site outlets can be seen below (Figure 2). The catchment drains south towards the railway line under which it crosses and drains towards Thirteen-mile drain. The western portion of the catchment consists primarily of existing vegetation, with the catchment to the east consisting of developed residential land. The development area is approximately 23.1ha. The Upper catchments have a steep slope of approximately 10%, leveling off as it nears the railway line to 5-7% as shown in Figure 2.

The key catchment features include:

- Ridge line running along the northern extent of the current township. The below catchments run along the ridge with acknowledgement of the title boundaries
- Hydraulic control of the railway line. The railway line is a major control to all flows coming from the high land to the north to the low ground to the south. Flows need to be maintained at the Railway line to ensure no referral is required to VicTrack (or DTP).
- Thirteen Mile Drain is the eventual outfall, starting at the corner of Beswick St and Thirteen Mile Drain Road. Local Pipe Networks – as shown
- Nar Nar Goon – Longwarry Road is a secondary control with smaller (assumed Country Roads Board) installed pipes. In general, these are smaller than the railway crossings, but have an overland flow function
- Easement drain running in line with Beswick St – this conveys flows to Thirteen Mile Drain

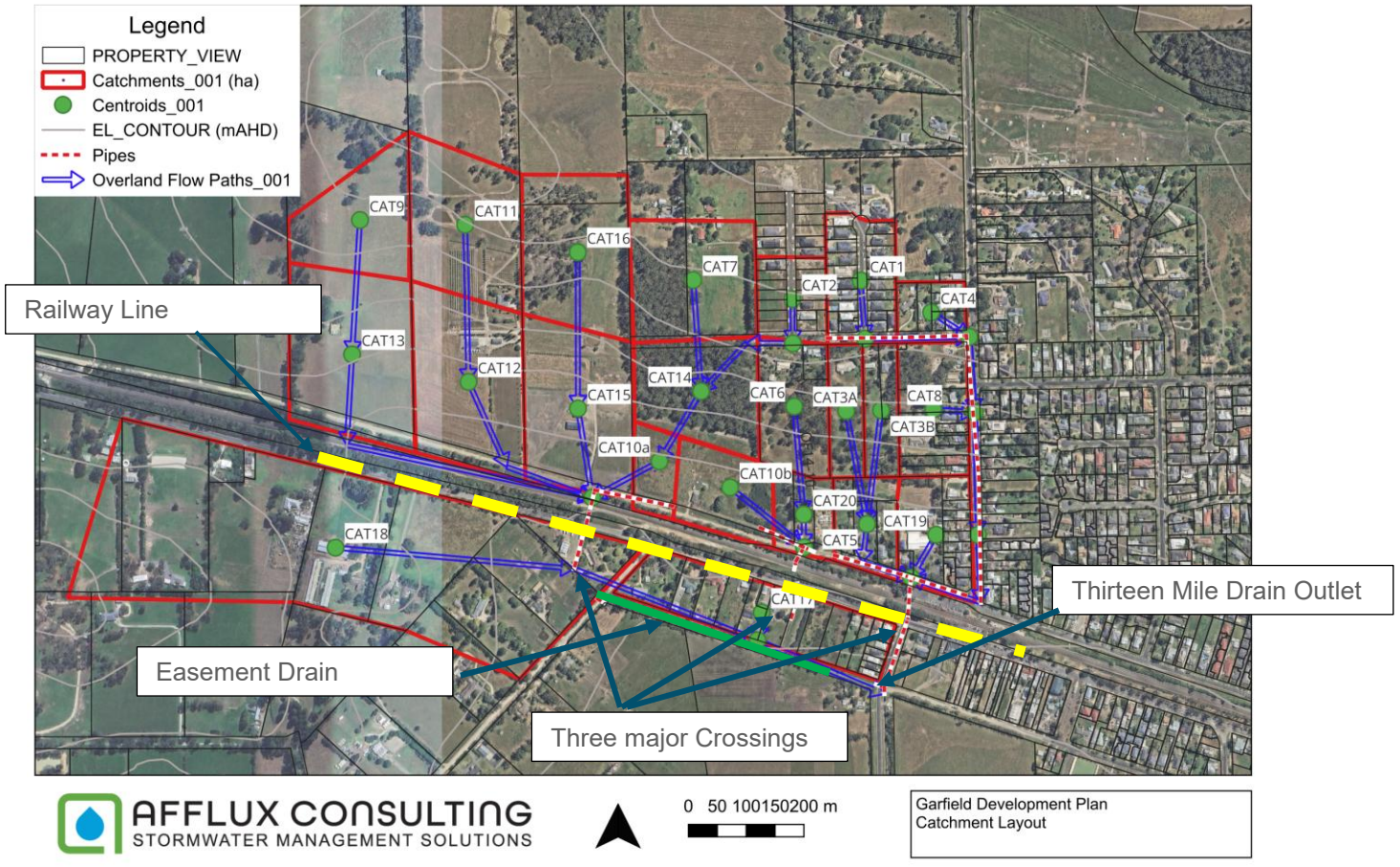


Figure 2. Existing catchment

2.1. Site Visit

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



Source: Afflux

Figure 3. Railway looking towards site



Source: Afflux

Figure 4. Central Railway Outlet (#2)



Afflux

Figure 5. Western Railway Outlet(#1)



Source: Afflux

Figure 6. Eastern Railway Outlet (#3)



Source: Afflux

Figure 7. Easement Drain



Source: Afflux

Figure 8. Thirteen Mile Drain Township outlet

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 for each individual development. At this higher stormwater strategy stage these have not been implicitly modelled, but are considered conceptually.

3.3. 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. Generally, when implementation is appropriate, flows from the site will be reduced due to reuse and provision of alternative water sources. Recommended water saving and reuse targets must be explored alongside water quality requirements as reuse results in an improved capacity to meet TN removal. Thereby allowing opportunities to reduce treatment downstream. 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.

3.4. 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. Attenuation would be applied at an onsite 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.

3.5. Flood Protection Requirements

All lots within the development will be provided at least 300mm freeboard above any predicted 1 % Riverine AEP 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). All flows to be maintained prior to Railway Ave to ensure no referral required to Department of Transport.

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. To appropriately capture the developments impacts on the local system a sub-regional DRAINS model has been developed.

4.1. Sub-Catchment Delineation - Drains

The catchments, and their assumptions are shown below. It is noted that this study is focussed on the catchments that drain south to the 13 Mile Drain. The development areas (i.e. areas that could expect to be further subdivided and an increase in houses) are considered as shown in Figure 11. There are some parts of the broader development area (**Error! Reference source not found.**) that drain north to separate c atchments. These areas have not been considered as part of this modelling and would be expected to be covered in a separate assessment.

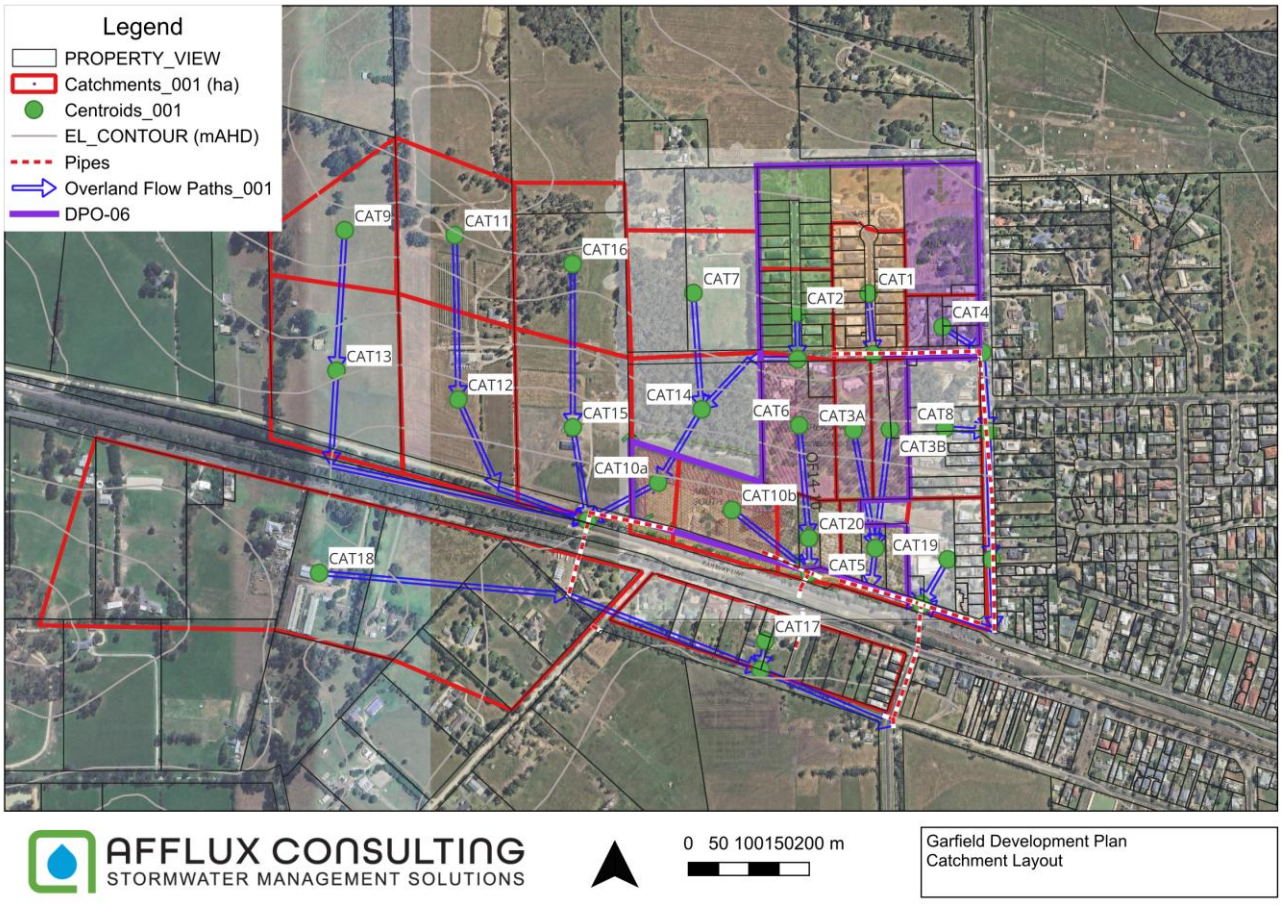


Figure 9. Sub-Regional Catchments

Table 1. Sub-catchment characteristics

Catchment Name	Area (ha)	FI (existing)	FI (developed)
Cat 1	2.65	67	67
Cat 2	1.74	63	63
Cat 3a	1.4	5	15
Cat 3b	1.39	5	10
Cat 4	1.26	26	26
Cat 5	1.771	5	22
Cat 6	2.75	5	19
Cat 7	4.96	5	5
Cat 8	2.79	26	26
Cat 9	3.5	5	5
Site - Cat 10a	0.93	5	60
Site - Cat 10b	2.6	5	60
Cat 11	4.83	5	5
Cat 12	5.57	5	5
Cat 13	6.08	5	5
Cat 14	3.78	5	5
Cat 15	5.3	5	5
Cat 16	4.96	5	5
Cat 17	4.57	5	5
Cat 18	22.8	5	5
Cat 19	2.72	50	50
Cat 20	1.42	50	60

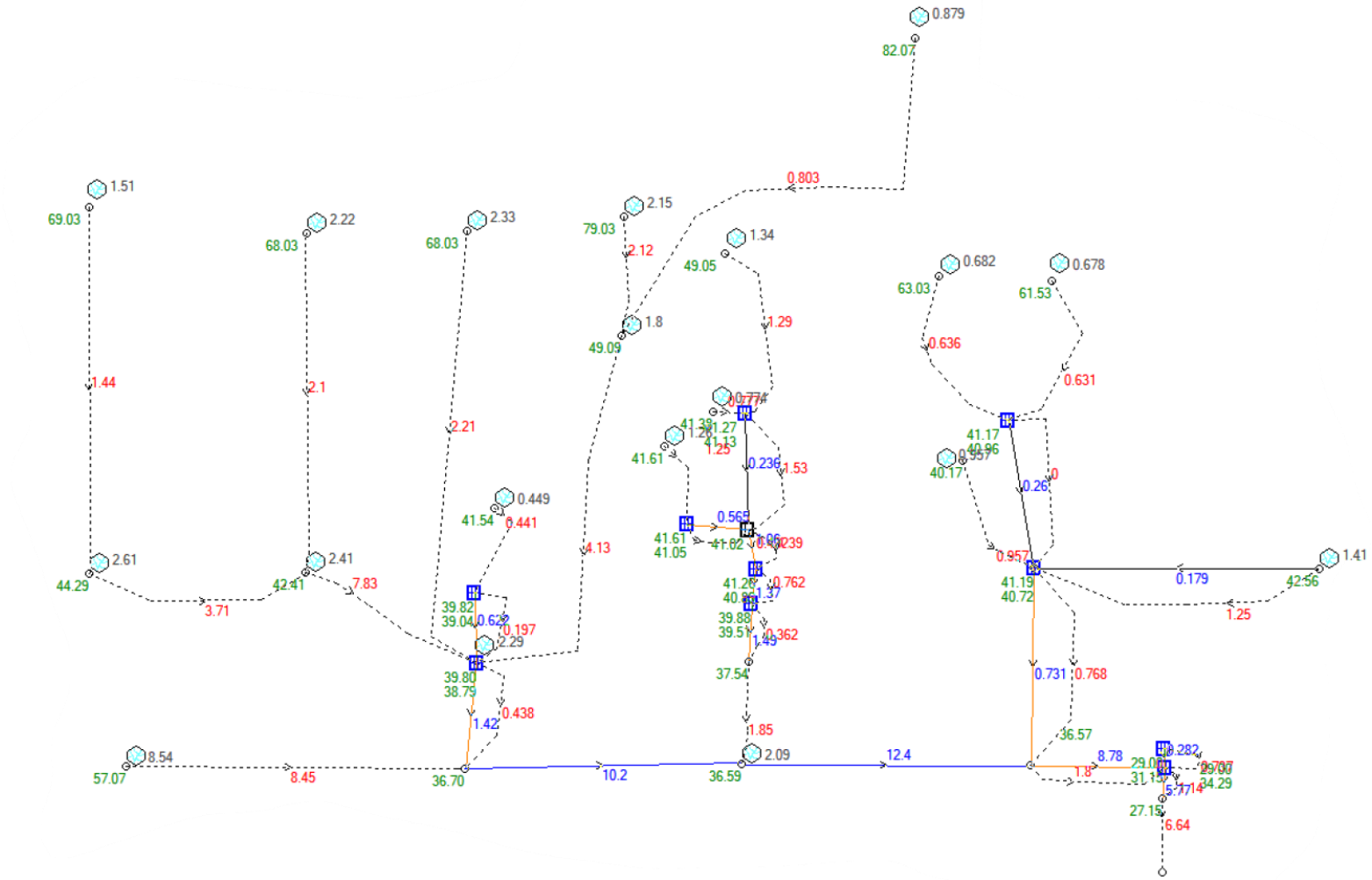


Figure 10. Representation of Existing Conditions DRAINS model

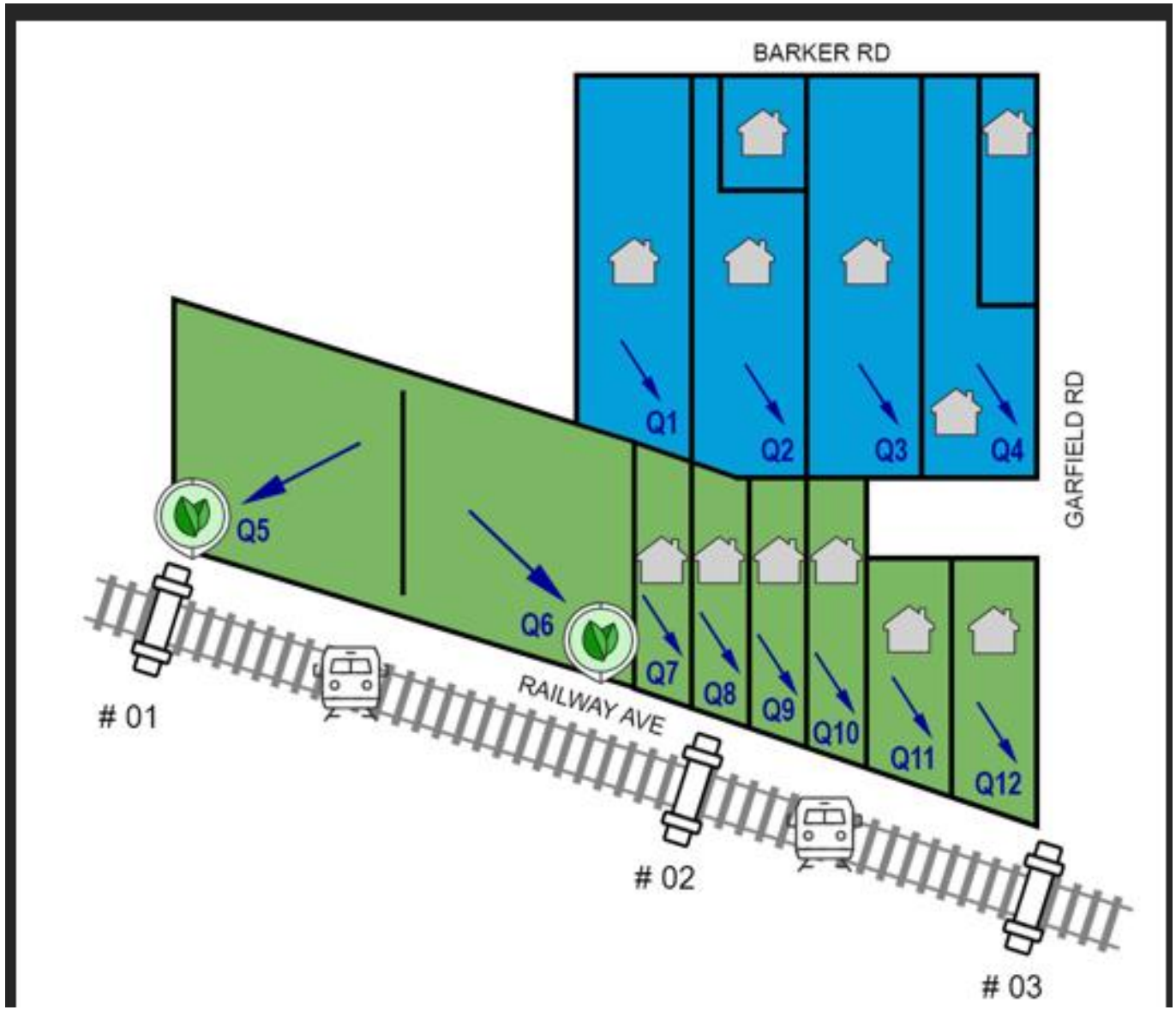


Figure 11. Conceptual Development Area Catchment (note only future developable areas shown)

4.2. Rainfall Losses

In addition, the ARR Data Hub provides recommendations for losses as shown below in Figure 12 and Figure 13. The ARR19 tool estimates losses and reductions using the information from Data Hub. The supplied loss file was found to be suitable with loss factors appropriate to the catchment, given the predominantly rural catchment. Once the estimated rainfall magnitudes are decided upon, the hydraulic model is used to distribute the flows.

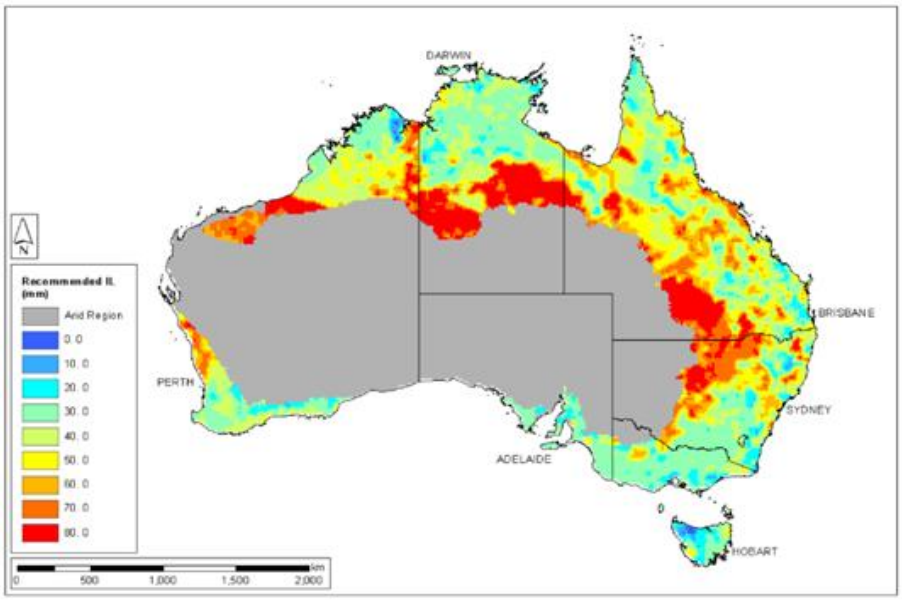


Figure 12. ARR 2016 recommended Initial Loss

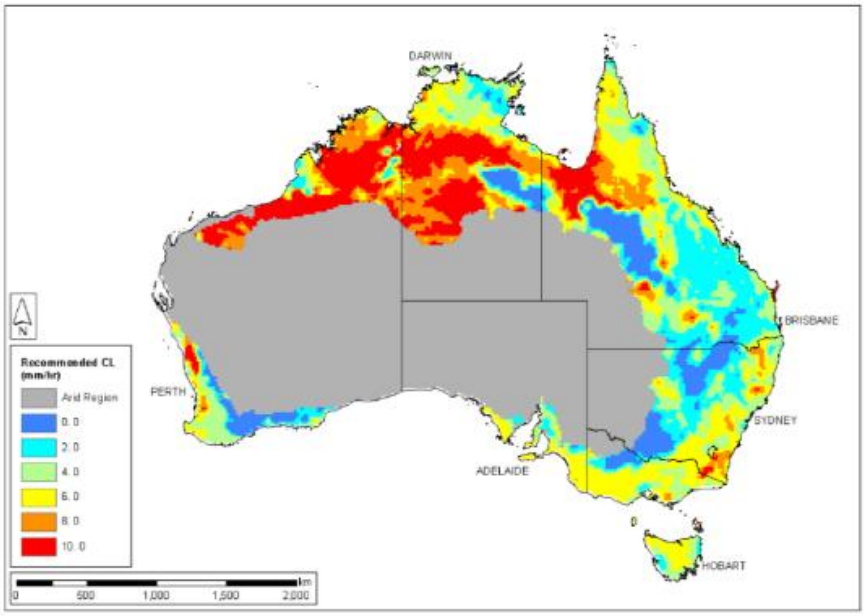


Figure 13. ARR 2016 recommended Continuing Loss

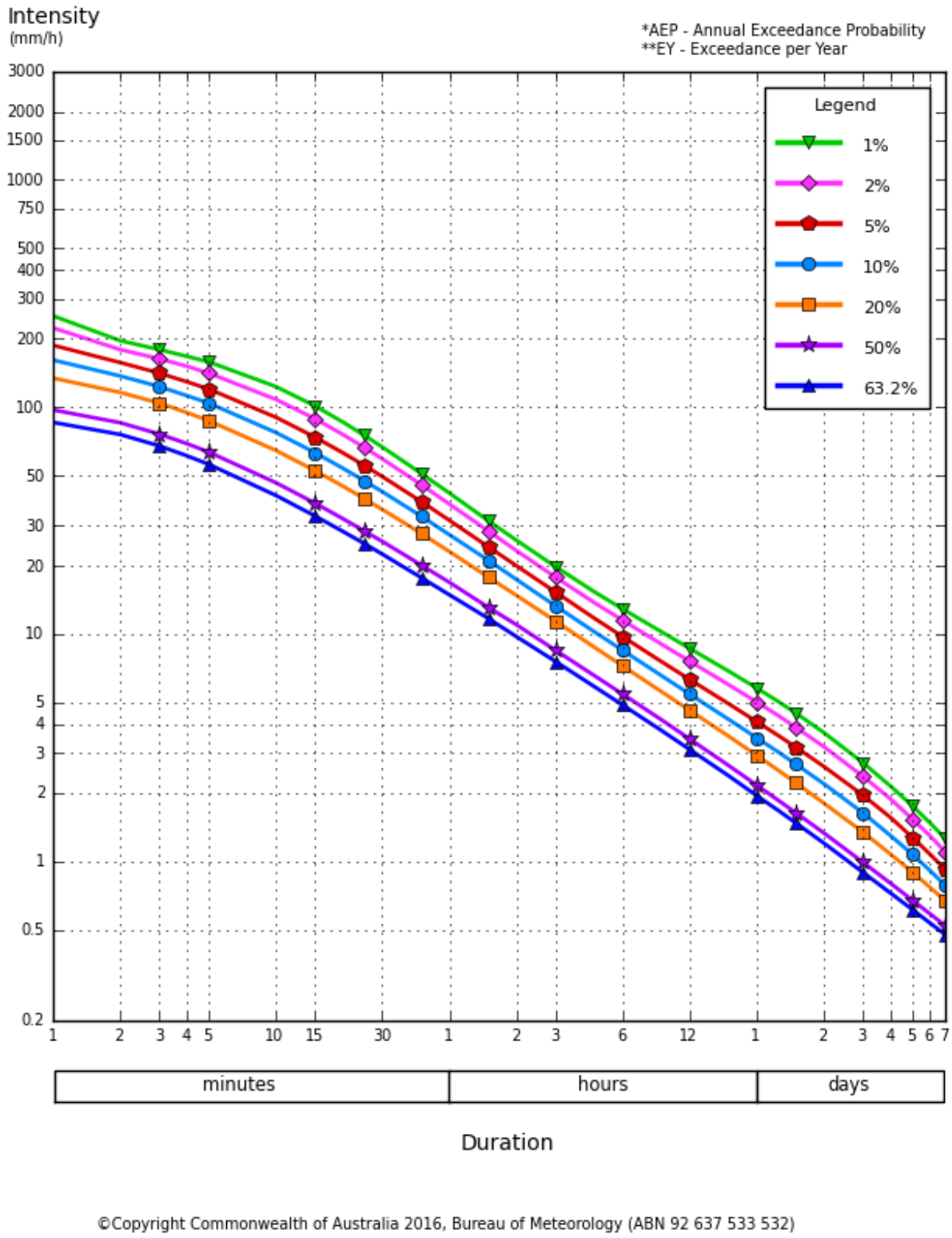


Figure 14. Rainfall Intensity data (mm/hr)

Once the estimated rainfall magnitudes were decided upon, the hydraulic model was used to distribute the flows using the ARR2019 Ensemble Event approach.

4.3. Hydrological Modelling - DRAINS

The site's 1% AEP (Annual Exceedance Probability) flood discharge was estimated following ARR 2019 (Australian Rainfall and Runoff, 2019) processes. The rainfall excess was determined for each sub-catchment using the DRAINS Stormwater Drainage System design and analysis.

The ARR19 tool for DRAINS was used to process the information from the online ARR Data Hub. As such, the following inputs were adopted to process the results.

The Ensemble Event approach was adopted using a set of 10 temporal rainfall patterns from gauged local catchments. The run suite included the 20 min to 72-hour storm durations for each of the temporal patterns used to derive a set of hydrographs for each event AEP and critical duration. Each hydrograph was run through the hydrologic model; only the mean for the critical duration storm results was selected for design as recommended. The temporal rainfall patterns were taken from the ARR Data Hub as per guidelines, and as shown below, the “Southern Slopes - Mainland” data set was applicable for this site.

An Initial and continuing loss (IL-CL) model was created to maximise the rainfall on the site. Losses were applied based on the imperviousness of the catchment.

Table 2. Estimated loss model

Model Name	Details
Region	Southern Slopes
Loss Model	Initial-Continuing Loss
Impervious Losses	IL: 1 mm CL: 0 mm/h
Pervious Losses	IL: 28mm CL: 1.6mm/h
ARR Data Hub Location	S E

4.4. Existing Conditions Results

The model derived for existing conditions was created through a combination of council provided surveys and observations on site visits. Three outfall locations are located in the region, crossing under the railway line and travelling in open channel drains to the final outfall at thirteen-mile drain, a lined drainage channel with depth of 1.2m.

The overall upper catchment is very steep with very little formal drainage systems. Heavy rainfall events are primarily conveyed along the side of the railway lines. The key assessment sites are at each of the existing railway culverts.

Overall Drainage Flows

The Peak Flows for Existing Conditions can be seen in Figure 15. The comparison points are shown in Table 3.

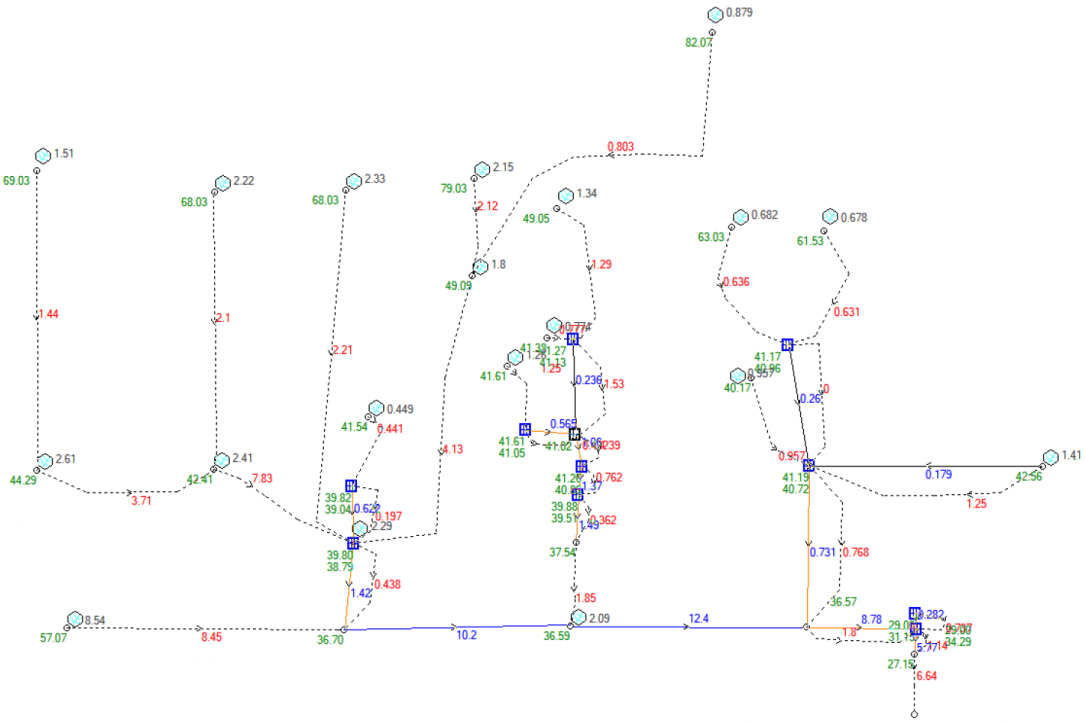


Figure 15. Existing Conditions Flow Estimates (1% AEP – all durations)

Table 3. Catchment Flow Estimates Existing Conditions

Outfall Name	DPO Contributing Catchment Area (ha)	Existing Conditions - Flow Rate (m^3/s)	
		10% AEP	1% AEP
Culvert 01	2.67	1.858	1.858
Culvert 02	6.77	1.46	1.852
Culvert 03	4.55	0.878	1.492

4.5. Developed Conditions Results

The Existing Model was adapted for developed conditions. The proposed strategy for management of flows in the developed scenario involves two forms of on site retardation. The structure of these is discussed further in this section but the overall approach adopted is to apply:

- Rainwater Tanks applied to each the DPO 06 Properties (Properties Q1-Q4 and Q7-Q12)
- Two storage basins integrated into Catch 10a and 10b and Rainwater Tanks (Q5 and Q6)
- All rainwater tanks have been assumed to start with 50% of the storage full. Obviously this is a highly variable assumption.

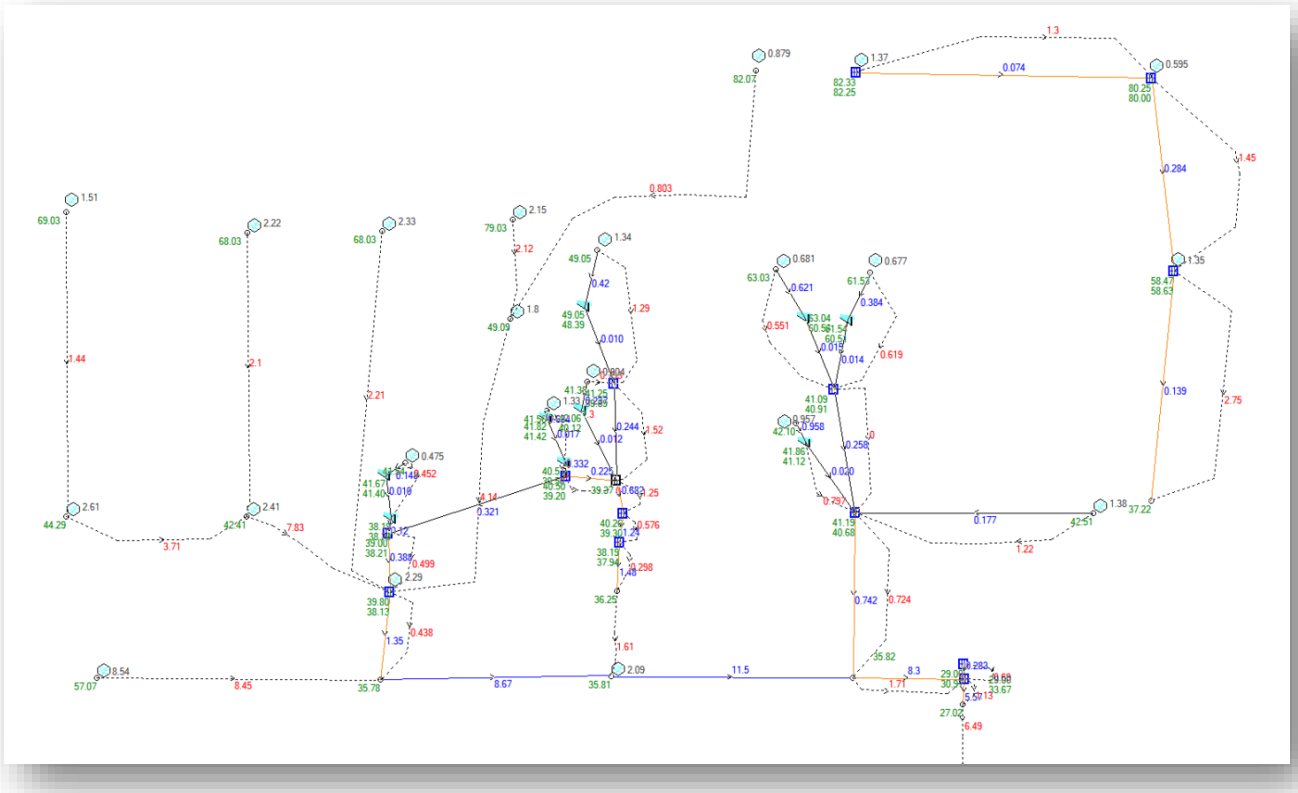


Figure 16. Developed Conditions Flow Estimates (1% AEP – all durations)

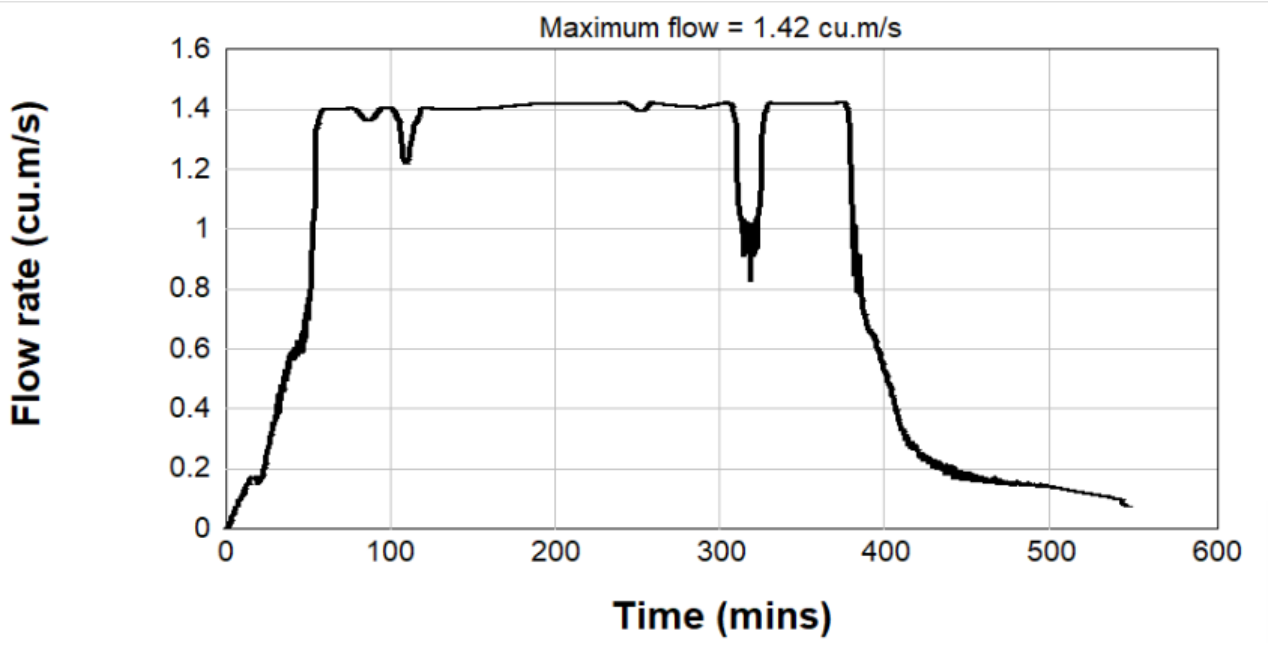


Figure 17. Median Hydrograph Developed Conditions 1 % AEP – Culvert 01

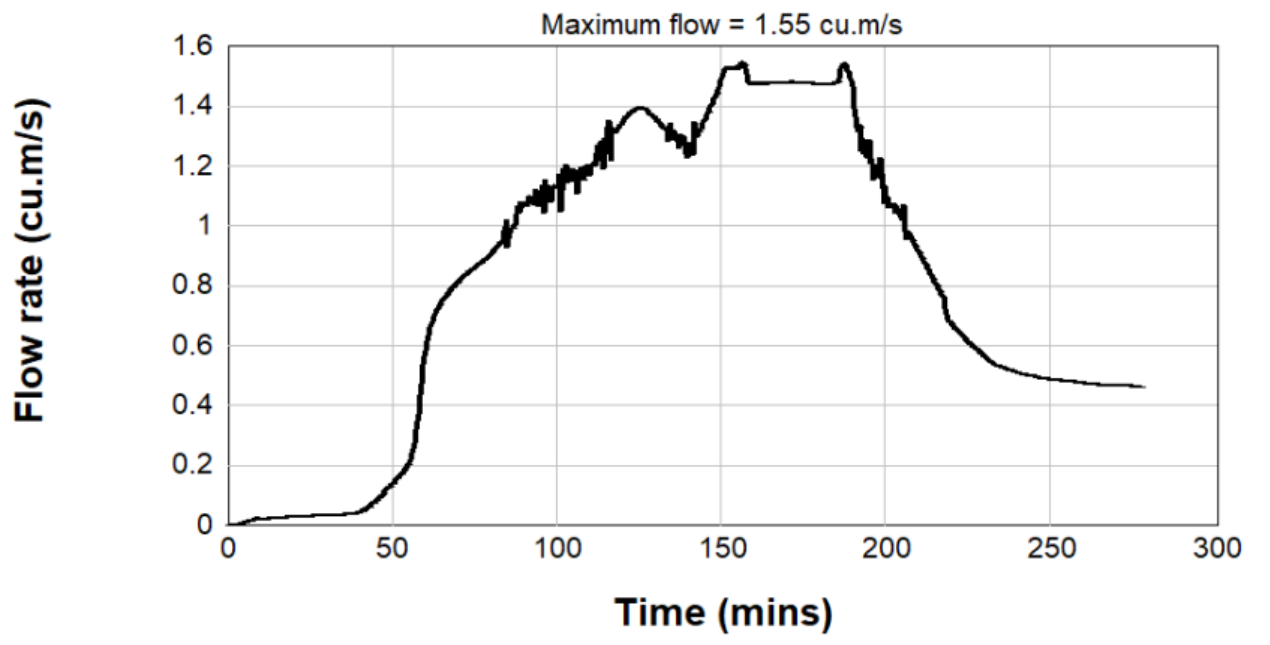


Figure 18. Median Hydrograph Developed Conditions 1 % AEP – Culvert 02

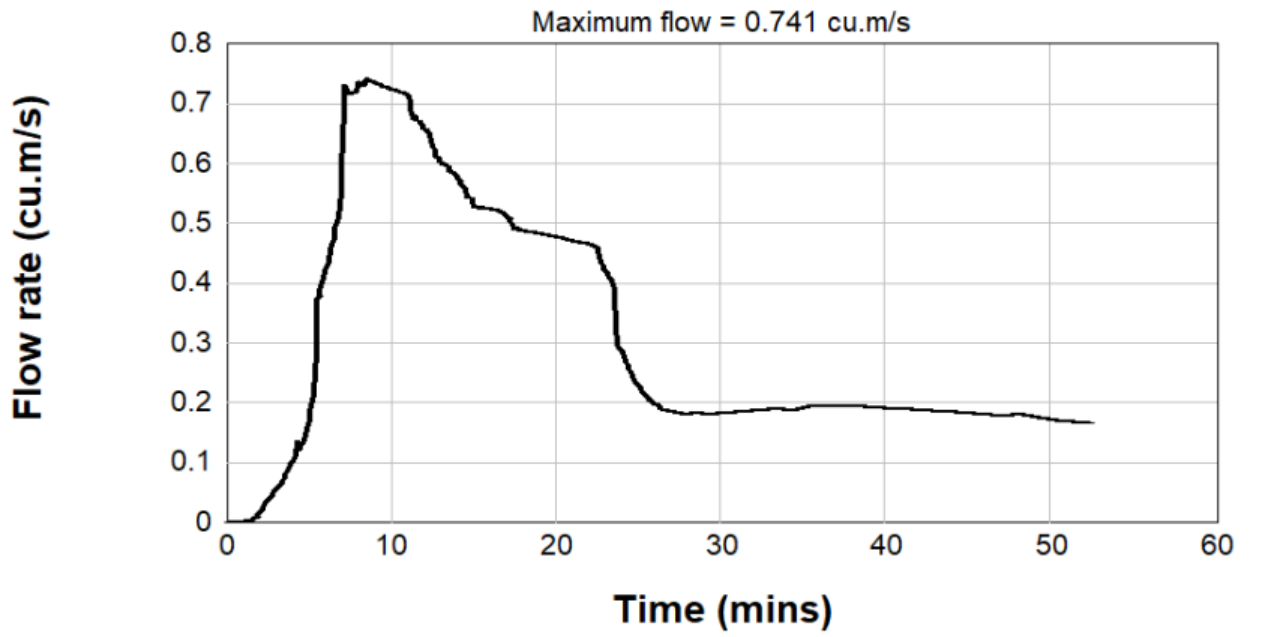


Figure 19. Median Hydrograph Developed Conditions 1 % AEP – Culvert 03

Site Catchment Peak Flow Checks

The proposed development plan area drains north to south with three outfall crossing points under the railway. This results in the catchment splitting between the three drainage points in the developed model, referred to as Culvert 01 (to the west), Culvert 02 (central) and Culvert 03 (to the east). These are illustrated in the infographic in Figure 20.

Table 4. DPO-06 Catchment Flows

Catchment Name	Catchment Area (ha)	Existing Conditions - Flow Rate (m^3/s)		Rational Check (ex)	Developed Conditions - Flow Rate (m^3/s)	
		10% AEP	1% AEP	1%AEP	10% AEP	1% AEP
Cat 3a	1.4	0.48	0.64	0.36	0.48	0.68
Cat 3b	1.39	0.47	0.63	0.35	0.47	0.68
Cat 5	1.771	0.69	0.96	0.43	0.69	0.96
Cat 6	2.75	0.94	1.34	0.62	0.94	1.34
Cat 10a*	0.93	0.32	0.44	0.25	0.335	0.47
Cat 10b*	2.6	0.88	1.26	0.59	0.935	1.33
Cat 20	1.42	0.55	0.77	0.37	0.52	0.80

* Pre-Basin Flows – Basins and balance pipe further reduce Culvert #2 catchment increases and balance network.

Table 5. Catchment Outfall Flow Comparison

Outfall Name	DPO Contributing Catchment Area (ha)	Existing Conditions - Flow Rate (m^3/s)		Developed Conditions - Flow Rate (m^3/s)	
		10% AEP	1% AEP	10% AEP	1% AEP
Culvert 01	2.67	1.858	1.858	1.748	1.788
Culvert 02	6.77	1.46	1.852	1.23	1.778
Culvert 03	4.55	0.878	1.492	0.922	1.466

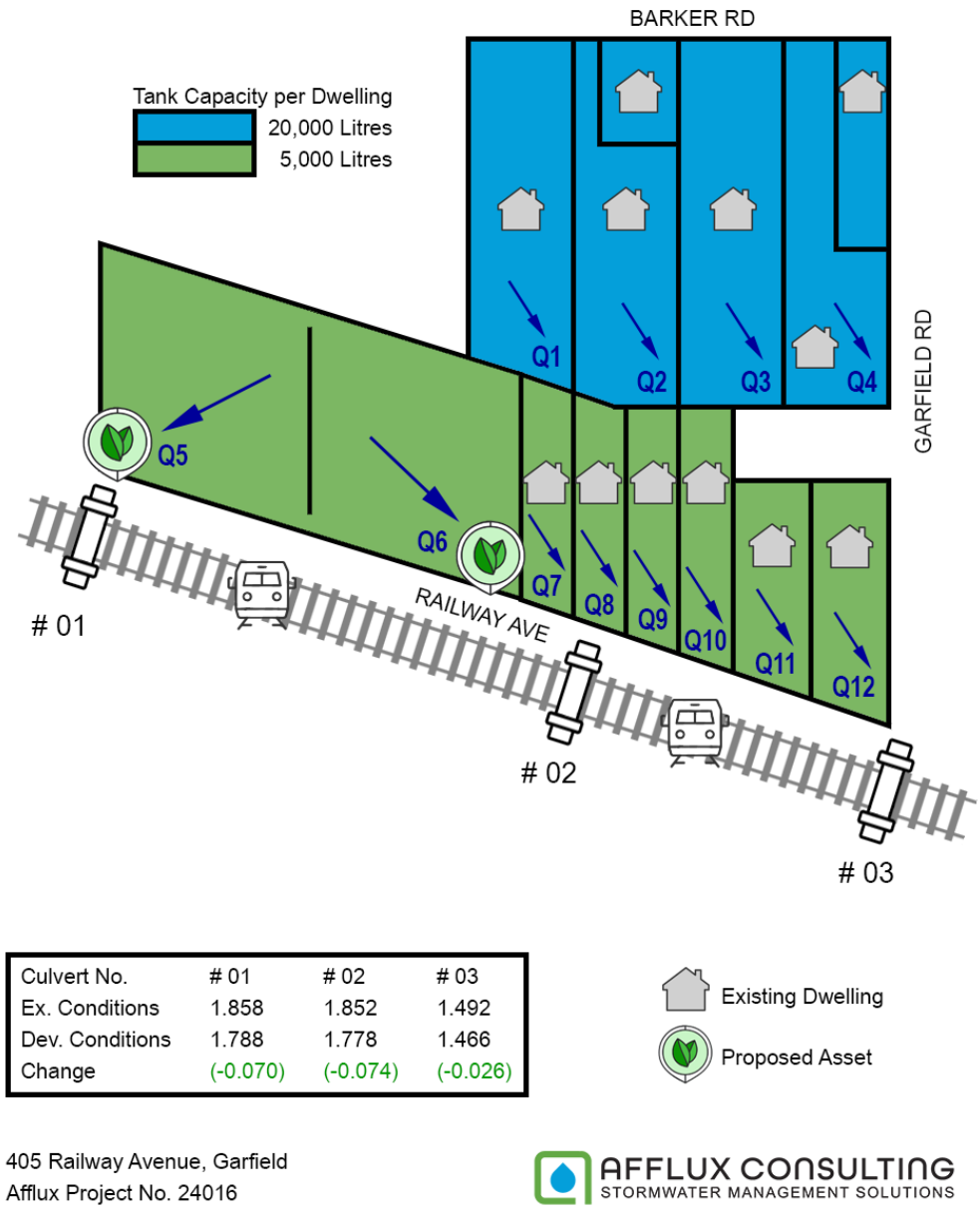


Figure 20. Proposed Outfall Structure of Development area

Developed Conditions Preferred Mitigation

A significant amount of modelling was undertaken to find an acceptable outcome on the downstream system. The storage outcomes need to be balanced against a number of other development requirements, including but not limited to:

- Vegetation and Bandicoot Corridor outcomes
- Bushfire Risks
- Equitable drainage requirements
- Minimum development yields

Upgrades to the model to manage the increased flows of the developed site include two storage basins in the Q5 and Q6 parcels to retard flows, in addition to a series of pipe upgrades. The system to the west of the site has more capacity than the eastern system, and as such a decision to push as much flow as possible to the smaller western catchment has been made.

As the areas drainage system is underdeveloped, any alterations to the area will have a greater impact on the flow rates than a simple “flow matching approach” that would be traditionally adopted (and requires ~600m³ of storage as calculated by Boyd’s method). The outfall at the southwestern basin for Cat 10a, is under much greater pressure and has limited capacity. This was the original primary outfall; however, the basin capacity requirement was too great and required a balance pipe to be utilised conveying some of the flow to the Cat 10b basin. A large 900mm pipe has been adopted for this balance pipe, to provide additional storage in a flood event.

It is also suggested that a dedicated rainwater tanks requirement be adopted for the site (and greater area) to further maximise local storage. A 5kL rainwater tank per lot assumption has been adopted in the water quality modelling, and it is suggested that each tank include 50% of airspace with slow discharge (leaky tank) for and additional ~40kL of flood storage (assuming 40 lots).

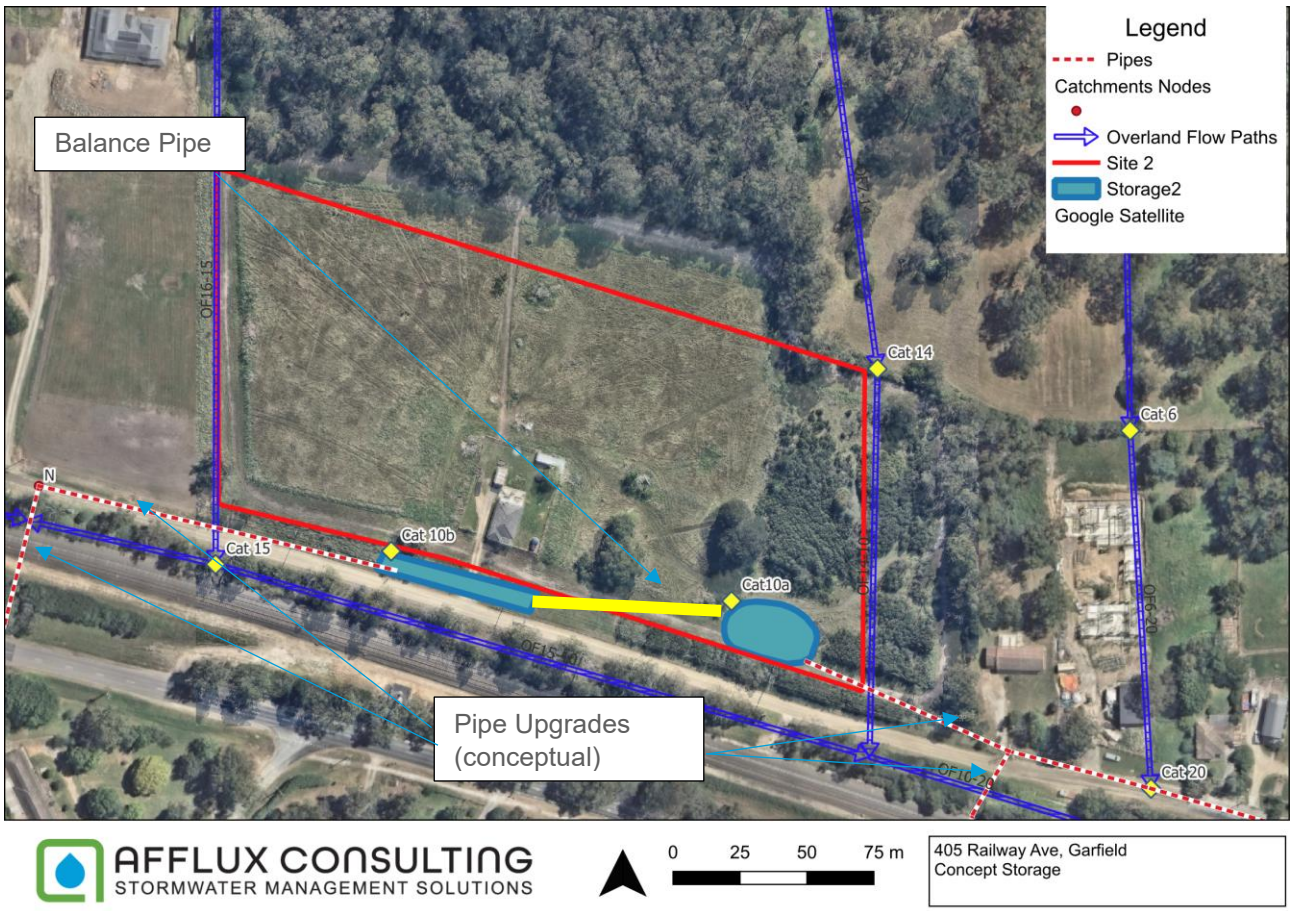


Figure 21. Q5/Q6 Storage Concept

4.6. Hydrology Summary

The flow derivations for this steep local catchment, with significant hydraulic controls is a complex task that requires both hydrological estimation, and hydraulic representation. This has been attempted in DRAINS to give the best estimates available of the system.

In its absence, the best estimation of local hydrology available has been made, with the following recommendations:

- Rainwater Tank Storages
- A preference to push flows from the local catchment towards the larger and more controlled outfall to the west of the site is recommended. The eastern outfalls are much more constrained with larger development catchments directed towards them. In addition, the crossing closest to the site has unresolved road crossing interactions.
- A storage system slightly larger than a simplistic calculation method would give is recommended. In this case, on Catchment 10, two storages in addition to the rainwater tanks are proposed with a balance pipe between them.
- The flow regulation has maintained for a 1% AEP with flows crossing the railway at each of the three crossing points maintained.

5. 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.

5.1. Site Storage

The ultimate flood storage for the site is achieved through a combination of rainwater tanks, drainage channels and catchment attenuation basins.

Given the catchment layout and available outfall locations, two retarding basins were sized for the major development site at Q5 and Q6. The catchment naturally drains both east and west given the high point in the centre of the site. As the regions drainage system is relatively undeveloped it was considered more apt to split the outfall between two drainage systems.

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

- Batter slopes 1:5
- Outfall pipe size of 450mm selected for desired outflow attenuation, balancing the pipe size and constructability.

The attenuation basins have preliminarily been sized at **550m³** for Cat10a and **900m³** for Cat10b on site storage. These basins are detailed in below.

Table 6. Proposed Stormwater Flows Management

	Catch 3a	Catch 3b	Catch 5	Catch 6	Catch 10a	Catch 10b	Catch 20
Properties on site	Q3	Q4	Q10, Q11, Q12	Q1, Q2	Q5	Q6	Q7, Q8, Q9
Estimated lots per property	3	2	24	5	18	27	4
Rainwater Tank Size (Litres)	20,000	20,000	5,000	20,000	5,000	5,000	5,000
Total Rainwater Tank Detention (m^3)	60	40	120	100	90	135	20
Storage Basin Detention (m^3)	N/A	N/A	N/A	N/A	550	900	N/A
Total Onsite Stormwater Detention (m^3)	60	40	120	100	640	1035	20
Further WSUD Required	Yes	Yes	Yes	Yes	No	No	Yes
PSD (l/s) (1%AEP)	681	677	957	1340	441	1260	799
PSD (l/s) (10%AEP)	478	475	685	941	314	879	550

5.2. Water Quality

The water quality for the site can be met through:

- Given the size of the blocks and capacity for potential water reuse, it is recommended that each property have a 5000 L rainwater tank installed, plumbed in for toilet flushing and garden use as a minimum
- An assumption of 20L per person per day has been assumed in the water quality calculations
- Small tertiary systems within the major storages to be detailed in a site SWMP.

Given the minimal impact expected from this small subdivision amongst the larger catchment, no temporary works are required for the site, and the inclusion of additional on-site treatment assets will provide negligible improvement to scheme water quality.

6. Conclusions

This report presents a stormwater strategy for the proposed development area DPO 06, Garfield West within Cardinia Shire 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:

- Each of the properties require flow management at a minimum of 5,000L or 20,000L rainwater tanks per lot.
- Two onsite storage/retention basins should be utilised with capacities of 550m^3 for Cat 10a and 900m^3 for Cat 10b. Additionally a balance pipe of 900mm should convey flow between these two basins. This will provide more than adequate storage for the 10% AEP scenario and substantial storage requirements for the 1% AEP event.
- Crossing upgrades over Railway Ave to the existing railway crossing swales is expected. In this conceptual modelling these have been assumed to be 450mm.
- All works in this report have been set to a conceptual nature in line with a Development Approval context, detailing of the works would be expected at a design stage.

It is also acknowledged the below stipulations from council regarding the proposed development plan:

Regarding the "Stormwater Management Strategy" flexibility will need to be provided in the subdivision design to accommodate the western storage basin within the property boundaries if the following cannot be satisfied with the current proposal to use the roadside swale as a storage solution:

- *Storage capacity requirements for the 1 in 100-year event.*
- *The roadside swale basin will need to empty completely following a rainfall event as Council would not accept ongoing standing water in the road reserve.*
- *The roadside swale storage proposal would need to meet all safety requirements, e.g.: safety barriers for vehicles and pedestrians if required.*

Due to the constrained area to fit some of the items Council needs to keep some flexibility and also have some firm requirements.

7. 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.
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.
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.
EPA	Environmental protection agency

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.
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.
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.
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.
Temporal pattern	The time sequence of rainfall intensity. A representation of the variability of rainfall throughout a storm event.

8. 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.

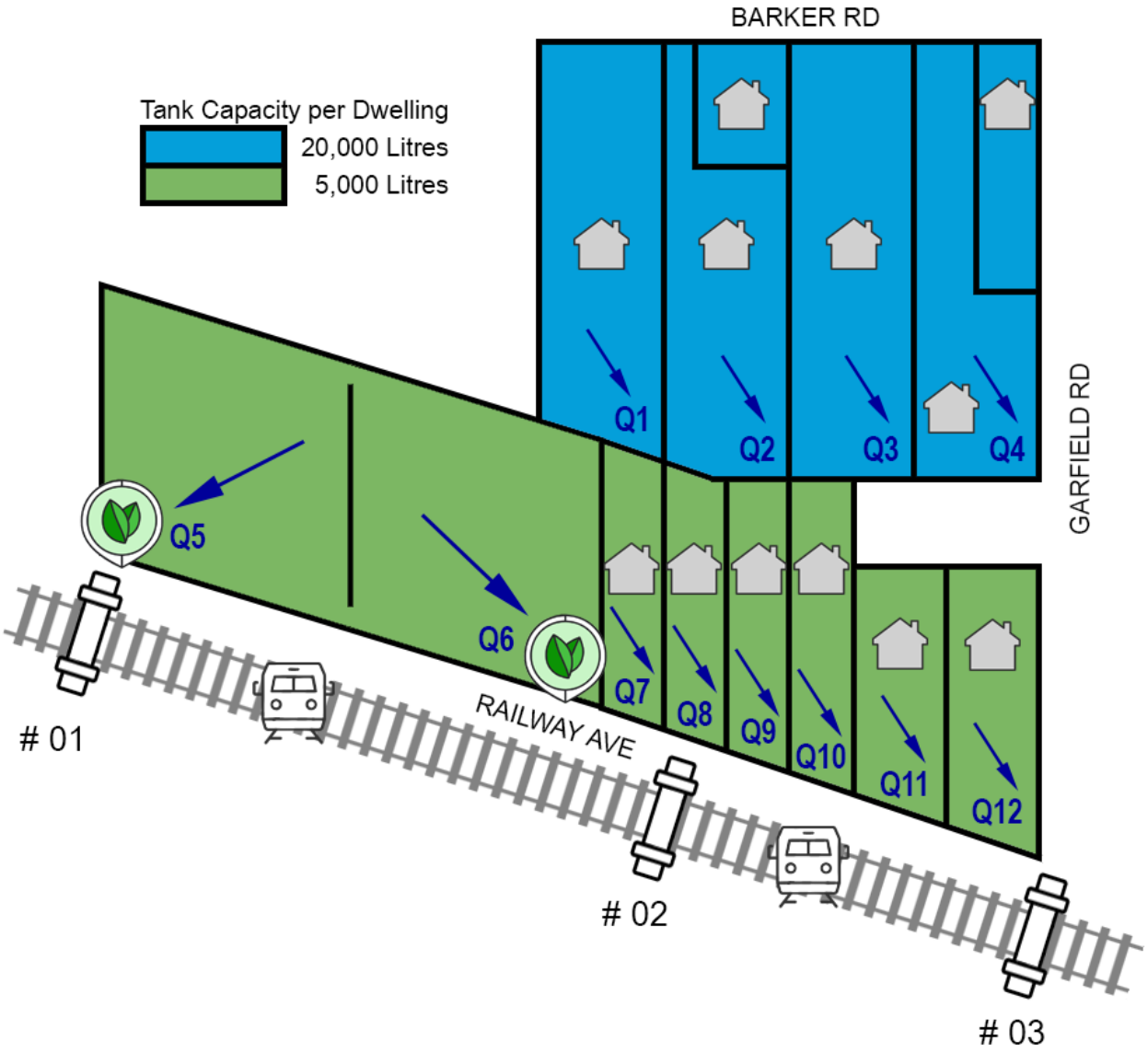
Coombes, P. and Roso, S. (Editors). (2019). *Runoff in Urban Areas, Book 9 in Australian Rainfall and Runoff - A Guide to Flood Estimation*, Commonwealth of Australia: Geoscience Australia.

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

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.

Appendix A - Area Hydrology Infographics



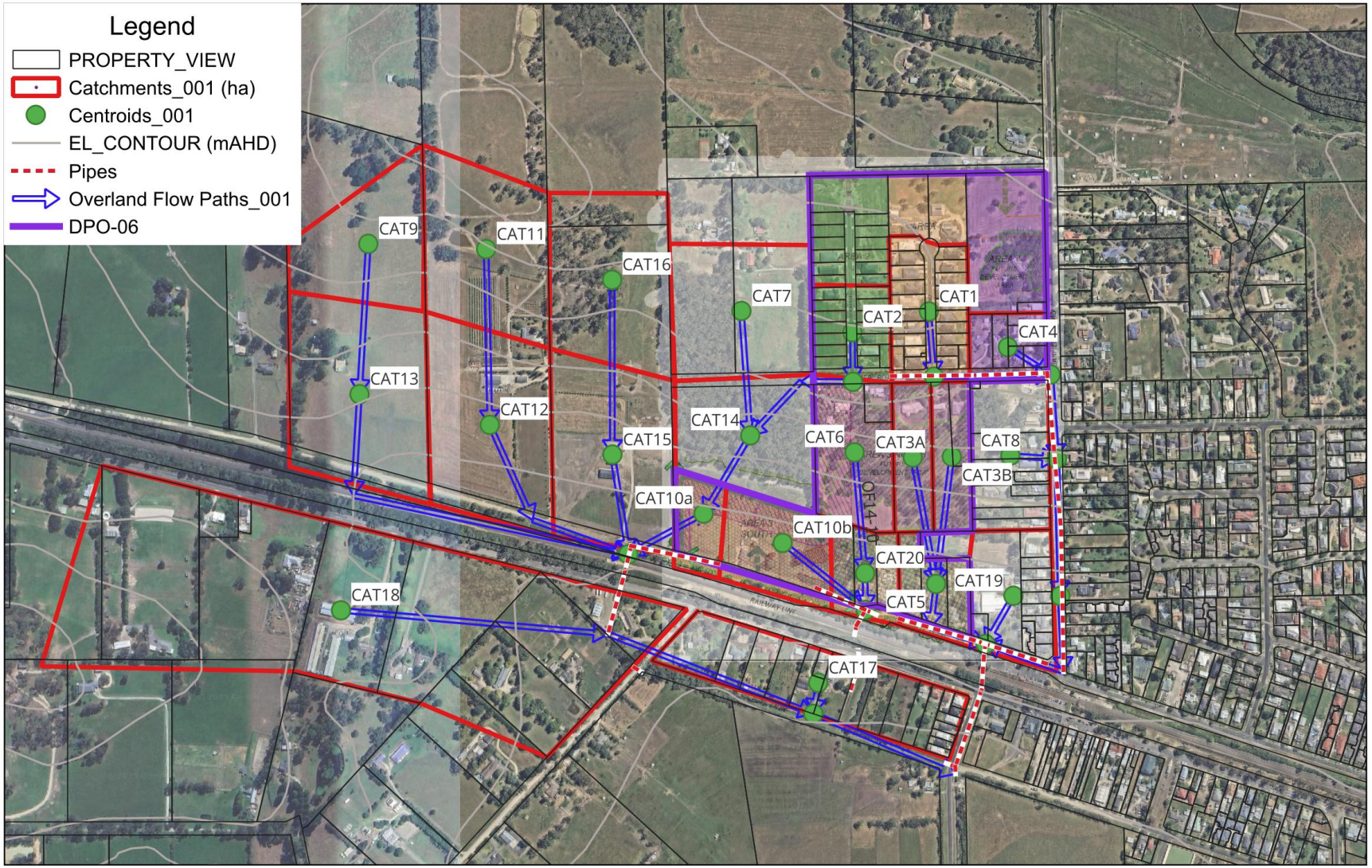
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Dev. Conditions	1.788	1.778	1.466
Change	(-0.070)	(-0.074)	(-0.026)

Existing Dwelling

Proposed Asset

405 Railway Avenue, Garfield
Afflux Project No. 24016

AFFLUX CONSULTING
STORMWATER MANAGEMENT SOLUTIONS



AFFLUX CONSULTING
STORMWATER MANAGEMENT SOLUTIONS

Garfield Development Plan
Catchment Layout

	Catch 3a	Catch 3b	Catch 5	Catch 6	Catch 10a	Catch 10b	Catch 20
Properties on Site	**Q3**	**Q4**	**Q10, Q11, Q12**	**Q1, Q2**	**Q5**	**Q6**	**Q7, Q8, Q9**
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