Lilydale Quarry Planning Scheme Amendment (Balance Land)

Stormwater Strategy

Reeds Consulting

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Contents

1 Introduction

Reeds Consulting has engaged Incitus to undertake a Stormwater Strategy for the subdivision and development of Lilydale Quarry, the portion of land associated with the Lilydale Quarry Planning Scheme Amendment (Balance Land).

Lilydale Quarry is a former quarry site occupying a site of approximately 162 ha located approximately 33 km east of Melbourne in Lilydale. The site is bounded by Hull Road to the south, Mooroolbark Road to the west, Maroondah Highway to the north and Lillydale Lake to the east. The site is traversed from north to south along the western portion by the Lilydale rail line.

Stage 1, located in the south-west corner, has a planning permit and it addressed by a separate stormwater strategy. This strategy addresses the stormwater servicing requirements for the balance of the site. It is approximately 144 ha in size. The overall site and Stage 1 are illustrated in **Figure 1.1** below.

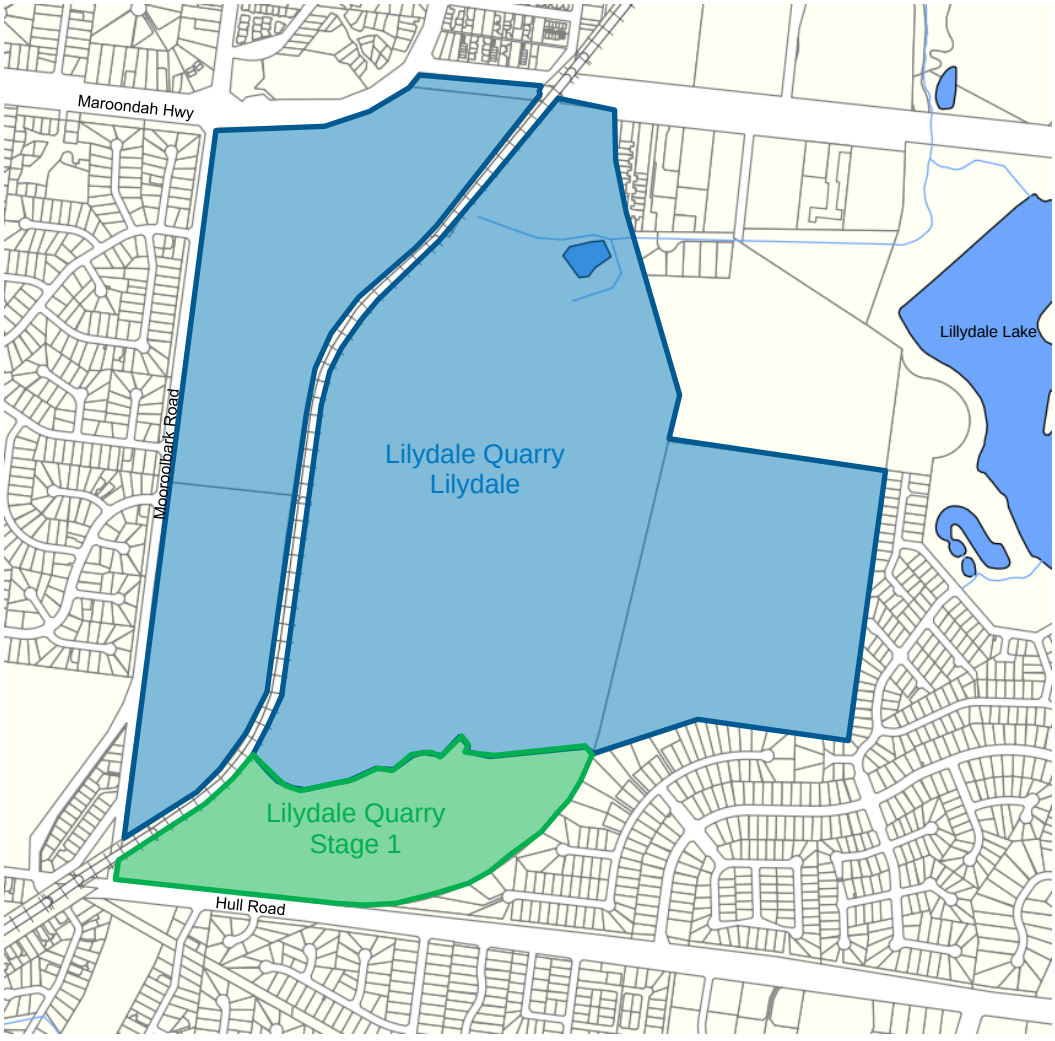

Figure 1.Lilydale Quarry, Lilydale

Urbanisation leads to an increase in stormwater runoff and a subsequent increase in pollutant wash-off. It also has detrimental effects on the receiving waterways. In determining the urban structure, it is critical that assets required for drainage purposes are determined early so that the impacts from the increase of stormwater runoff due to urbanisation can be mitigated and all new development can proceed without the risk of flooding, of flooding neighbouring properties and without impacting on the natural environment, receiving waterways and ultimately, Port Phillip Bay.

Undertaking a drainage assessment of the catchment that identifies the quantity of runoff, the conveyance of this runoff, the need to retard the runoff and the treatment and / or reuse of the runoff will assist in determining the assets and / or land-take required for the stormwater management of this catchment. It will also identify the location of all stormwater assets.

Liveability and resilience should be incorporated into all new developments. With respect to stormwater management, this involves utilising the stormwater as an asset for the community whilst ensuring fundamentals such as flood protection, safety with respect to flow management and water supply security are maintained. This can be achieved through incorporation of best planning practices for stormwater management during the development of the urban structure.

This Stormwater Strategy for the development of Lilydale Quarry outlines a management plan for the stormwater that is generated from the urbanisation of the land. It identifies the assets required to manage the increased surface water runoff from urbanisation and sets a framework to achieve the intent of the stormwater assets. The surface water management for the site has been optimised and designed to achieve multiple benefits for the community and the environment.

2 Catchment Characteristics

The Lilydale Quarry was used as an active quarry site with open cut excavation for many years. It has resulted in an excavation pit with a depth of approximately 125 m in the site, with overburden of spoil removed from the pit and placed around the site. The pit will be filled over the years to come and the site regraded to suit urbanisation.

The site will generally drain to 2 locations; the south-west of the site where a small catchment including most of Stage 1 will discharge towards Melbourne Water's Mooroolbark Drain; and to the east of the site where the balance will drain towards Lillydale Lake. The stormwater strategy undertaken for Stage 1 of Lilydale Quarry addresses the stormwater servicing requirements for the catchment discharging towards the Mooroolbark Drain. The balance of the site discharges towards the Lillydale Lake, with 2 discharge locations along the eastern boundary. The southern discharge location will enter the Lillydale Lake Retarding Basin. The northern discharge location will bypass the Lillydale Lake retarding basin to the north, and connect to Melba Avenue Main Drain prior to discharging into Olinda Creek.

The catchment draining towards Mooroolbark Drain is approximately 39 ha and includes the Stage 1 development. The catchment draining towards Lillydale Lake Retarding Basin is approximately 58 ha including approximately 3 ha of external catchment contributing from the south. The catchment draining towards the Melba Avenue Main Drain is approximately 99 ha including approximately 23 ha of external catchment contributing from the north-west. **Figure 2.1** depicts the general site characteristics.

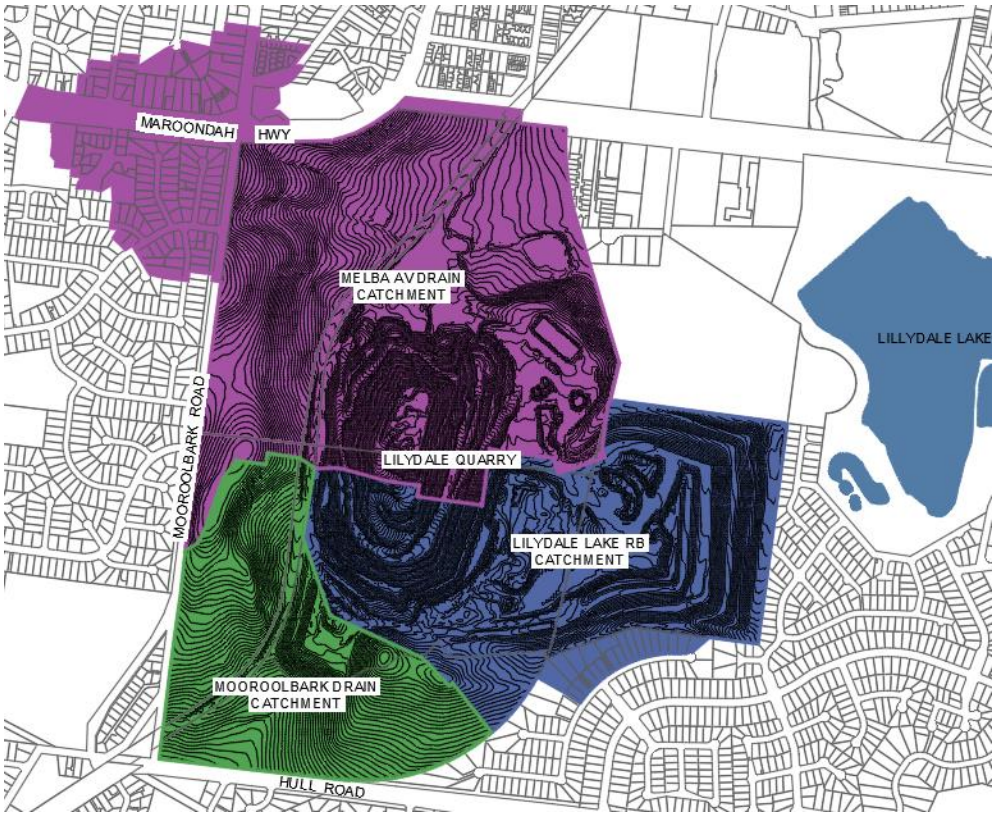

Figure 2.1 Catchment Characteristics of Lilydale Quarry, Lilydale

3 Stormwater Quantity

The drainage system for the redevelopment of Lilydale Quarry will be designed to prevent property flooding occurring in a 1% Average Exceedance Probability (AEP) storm event and the stormwater runoff can be safely conveyed through the development. To achieve this, the development will adopt a minor / major drainage system philosophy.

The development, although predominately residential, will consist of conventional housing and townhouses, and the potential development of the central area will include apartments and mixed-use type facilities. Consideration has been given to areas of the development potentially having higher runoff than the conventional residential areas to ensure the estimated stormwater runoff from the development is reflective of the urbanisation of the site.

3.1 Minor Drainage System

The minor drainage system will consist of a subsurface pipe network designed to capture and convey all stormwater runoff generated from the catchment for rainfall events up to and including the 18% Annual Exceedance Probability (AEP) design storm for residential catchments.

For catchments that have an area less than 60 ha, the system will be designed in accordance with Council standards and the Victorian Planning Authority's Engineering Design and Construction Manual. Catchments exceeding 60 ha will be designed in accordance with Melbourne Water standards.

3.2 Major Drainage System

The primary objective of the major drainage system is to provide flood protection for the allotments based on the 1% AEP storm event and to ensure the overland flow can be safely conveyed through the development. This will be via overland flow paths contained within road reserves prior to discharging into the proposed drainage reserve.

The development is not located within a Melbourne Water Development Services Schemes (DSS). Advice received from Melbourne Water has indicated that the Lillydale Lake Retarding Basin has the capacity to receive the stormwater runoff generated from the urbanisation of the catchment and no retardation is required for the catchment discharging to the retarding basin. As no regional scale retardation has been provided for the development of the catchment discharging north of the Lillydale Lake Retarding Basin, the development must include on-site retardation to mitigate the stormwater runoff discharging from the site. Melbourne Water has specified the allowable discharge from this catchment as the capacity of the downstream infrastructure.

The development of Lilydale Quarry will be designed so that all allotments will be set a minimum of 600 mm above the 1% AEP flood level in drainage reserves, or 150 mm above the overland flow conveyed through the road reserves, whichever is greater.

3.2.1 On-site Retardation Mooroolbark Drain Catchment

The Stage 1 development of Lilydale Quarry has addressed the retardation requirements for the catchment discharging to Mooroolbark Drain. The stormwater strategy undertaken for Stage 1 should be read in conjunction with this report.

The development of the Mooroolbark Drain catchment, Lilydale Quarry is to limit the stormwater runoff discharging from the site to the capacity of the downstream infrastructure. The Melbourne Water Flood Mitigation Report for Upper Brushy Creek does not indicate any flooding between the outfall of the existing catchment encompassing Lilydale Quarry and the Greenslopes Retarding Basin therefore the pre-development flow has been adopted as the allowable discharge.

Melbourne Water has provided Incitus with the RORB model for the catchment. RORB was adopted as the design runoff routing model for generation of flows and simulation of storages catchment. RORB generates catchment runoff based on the selection of local rainfall intensity frequency duration data and appropriate loss models.

As the Melbourne Water RORB model only contains 2 sub-areas for Lilydale Quarry, an extract of the RORB model has been created with parameters adopted modified based on the revised average routing distance and overall area. Refer to **Appendix A** for the RORB parameters adopted. The catchment plan indicating boundaries and reach lengths is included in **Appendix A**.

The amended RORB model indicated that the pre-development peak 1% AEP design flow for Lilydale Quarry discharging at Hull Road is 1.3 m^3/s. This flow has been adopted as the allowable discharge.

The model was then adapted to reflect the development of Lilydale Quarry with a residential land-use. A retarding basin has been included at Hull Road to mitigate the stormwater runoff discharging from the site to pre-development magnitudes.

A retarding basin has also been included for this catchment upstream of the crossing of the rail line, located north west of the Hull Road retarding basin. The basin here has been included to restrict runoff generated from the urbanisation of the catchment crossing the rail line.

A basin with a storage volume of 3,940 m^3 has been included in a 1.23 ha drainage reserve. The peak 1% AEP discharge crossing the rail line at this location is 0.44 m^3/s. High-level conceptual design indicates a peak 1% AEP flood level of 129.15 m AHD with a base level of 128.5 m AHD and a proposed 750 mm diameter culvert crossing of the railway.

Figure 3.1 depicts the drainage reserve for the retarding basin to be known as Mooroolbark Drain West Railway Retarding Basin. This asset will be transferred to Council following a standard defects period.

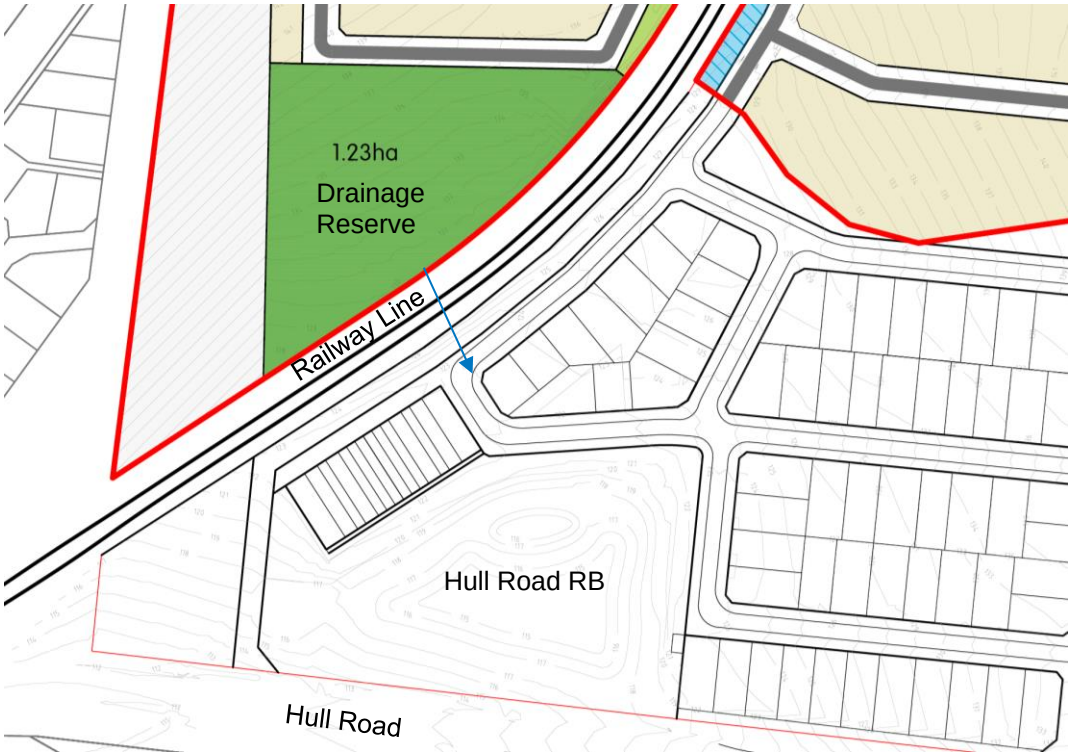

Figure 3.1 Drainage Reserve for Retarding Basin West of the Railway Line

It has been determined that the Hull Road retarding basin will require a storage volume of 3,150 m^3 to mitigate the stormwater runoff generated from the urbanised catchment to a peak 1% AEP discharge of 0.94 m^3/s. The discharge from the basin will connect to the drainage system in Hull Road. The peak flood level in the retarding basin will be 116.01 m AHD. **Figure 3.2** depicts the intent for the Hull Road retarding basin and catchment. This asset will be transferred to Council following a standard defects period.

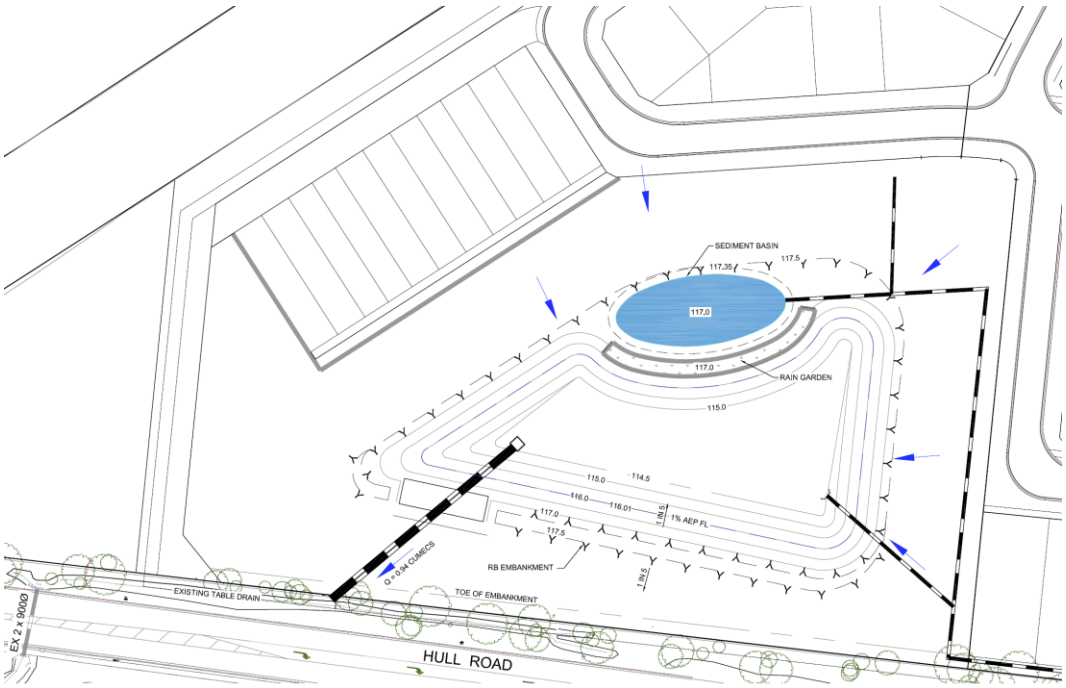

Figure 3.2 481 Hull Road Retarding Basin, Lilydale Quarry

3.2.2 On-site Retardation Melba Avenue Main Drain Catchment

The original instruction for the development of the Melba Avenue Main Drain catchment, Lilydale Quarry was to limit the stormwater runoff discharging from the site to the capacity of the downstream infrastructure.

However, since the original plan, Yarra Ranges Shire Council requested an increase to the recreation reserve, encompassing the land formerly allowed for a drainage reserve to facilitate the retardation and treatment of this catchment.

A RORB model generated for the catchment has been added to the overall Olinda Creek catchment RORB model. Refer to **Appendix A** for the RORB parameters adopted. The catchment plan indicating boundaries and reach lengths is included in **Appendix A**.

The model was updated to simulate the runoff generated from the urbanisation of the Melba Avenue Main Drain catchment and assess peak flows discharging from the Lillydale Lake retarding basin, located downstream of the site in the Lillydale Lake parklands.

An options analysis was undertaken on various scenarios for the development and the catchment. The results indicated that adopting no retardation for this catchment ensured the peak 1% AEP design flow in Olinda Creek at the Maroondah Highway of 34.2 m^3/s was maintained. Options which included retardation of this catchment resulted in a marginal increase to the peak 1% AEP design flow in Olinda Creek at Maroondah Highway. Therefore, no retardation has been included for this catchment.

3.2.3 Peak Development Flows

The peak development flows are generated from the development of the site. The peak flows will be conveyed safely through the site utilising pipe infrastructure and road reserves for overland flow conveyance.

Mooroolbark Drain Catchment

The peak 1% AEP design development flow entering the Hull Road retarding basin is 4.1 m^3/s. The peak 1% AEP design flows discharging from this retarding basin is 1.0 m^3/s.

Lillydale Lake Retarding Basin Catchment

The peak 1% AEP design development flow discharging from the Lilydale Quarry development to the Lillydale Lake Retarding Basin is 9.0 m^3/s. Melbourne Water have previously advised that no retardation is required for this catchment and that retardation can occur within the Lillydale Lake retarding basin.

A RORB model generated for the catchment has been added to the overall Olinda Creek catchment RORB model. Refer to **Appendix A** for the RORB parameters adopted. The catchment plan indicating boundaries and reach lengths is included in **Appendix A**.

Melba Avenue Main Drain Catchment

The peak 1% AEP design development flow discharging from the site around the Melba Avenue Main Drain is 7.9 m^3/s. An options analysis was undertaken on the impacts the development of the Lilydale Quarry site has on the overall Olinda Creek catchment. The analysis has indicated that discharging the Melba Avenue Main Drain catchment with no retardation will reduce impacts to the peak 1% AEP design flows for Olinda Creek at the Maroondah Highway.

Retarding this flow will result in the peak outflow from the Melba Avenue Main Drain catchment coinciding with the higher flows discharging from the Lillydale Lake Retarding Basin. Discharging flows without retardation from this catchment will ensure the peak flow from this catchment enters Olinda Creek prior to the peak flow from Lillydale Lake Retarding Basin. Thus, discharging the peak flows from the catchment without retardation results in the same peak flow for the 1% AEP storm event in Olinda Creek at Maroondah Highway as the existing conditions.

The flows exceeding the capacity of the existing Melba Avenue Main Drain will be conveyed from the site to Olinda Creek in a subsurface pipe to ensure no additional inundation is experienced to surrounding properties.

3.3 Overland Flow Safety

It is imperative that the development conveys the overland flows safely along road reserves. This requires ensuring the overland flow along major flow paths complies with floodway safety requirements. The recommended safety limits for residential developments are as follows (from the *Guidelines for Development in Flood Affected Areas* and adapted from Australian Rainfall and Runoff):

At the entrance to lots and access ways:

- V.dmax <= 0.3 m^2/s
- Vmax <= 2.0 m/s
- dmax <= 0.30 m

For small cars and children:

- V.dmax <= 0.3 m^2/s
- Vmax <= 3.0 m/s
- dmax <= 0.30 m

For the minimum road grades to comply with the engineering standards, the maximum overland flow which can be safely conveyed (but not contained) along a typical 16 m road reserve is 3 m^3/s. These figures have been based on 1 dimensional steady state hydraulic modelling using the software program HEC-RAS.

The drainage system for the development of Lilydale Quarry will be designed for safe conveyance of overland flow.

4 Stormwater Quality Treatment

The State Environment Protection Policy (Waters of Victoria) defines the required water quality conditions for urban waterways. The aim of stormwater quality treatment is to reduce typical pollutant loads from urban areas to Best Management Practices as defined in the following targets:

Table 4.1 Best Practice Pollutant Reduction Targets

Pollutant	Performance Objective
Total Suspended Solids (TSS)	80% reduction from typical urban load
Total Phosphorous (TP)	45% reduction from typical urban load
Total Nitrogen (TN)	45% reduction from typical urban load
Gross Pollutants (GP)	70% reduction from typical urban load

Source: Urban Stormwater: Best Practice Environmental Management Guidelines – Victorian Stormwater Committee, 1999.

The development will provide on-site treatment to achieve best practice pollutant reduction targets.

4.1.1 Mooroolbark Drain Catchment

The Stage 1 development of Lilydale Quarry has addressed the stormwater quality treatment requirements for the catchment discharging to Mooroolbark Drain. The stormwater strategy undertaken for Stage 1 should be read in conjunction with this report.

The Mooroolbark Drain catchment of Lilydale Quarry will include a sediment basin and a rain garden to provide treatment to the stormwater runoff generated form the urbanisation of the catchment. The stormwater quality treatments will be located in the drainage reserve assigned for the retarding basin at Hull Road, creating a multifunctional stormwater asset.

Table 4.2 outlines the pollutant reduction target and the performance of the on-site treatment proposed.

Table 4.2 Lilydale Quarry Mooroolbark Drain Catchment Treatment Performance

Pollutant	Source Load (kg/yr)	Load Reduction (kg/yr)	% Reduction
Total Suspended Solids (TSS)	33,170	6,800	80%
Total Phosphorous (TP)	70.87	31.57	55%
Total Nitrogen (TN)	520	290	45%
Gross Pollutants (GP)	6,732	0	100%

The proposed inclusion of the treatment within the Hull Road retarding basin drainage reserve is illustrated in **Figure 4.1**. These assets will be transferred to Council following a standard defects period. The maintenance of the system will be in accordance with Council's maintenance requirements. Alternatively, the maintenance can be in accordance with guidelines produced by Melbourne Water and the Facility for Advancing Water Biofiltration should Council not have specific maintenance requirements for these assets.

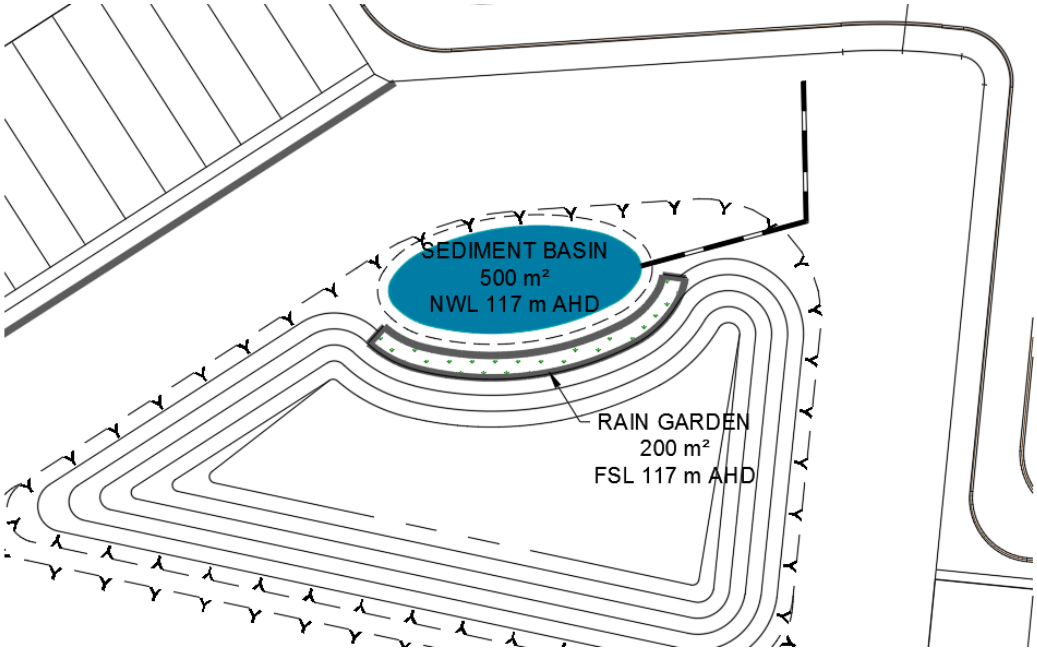

Figure 4.1 Proposed Treatment Layout for Mooroolbark Drain Catchment

4.1.2 Lillydale Lake Retarding Basin Catchment

The Lillydale Lake Retarding Basin catchment will include a constructed wetland system to provide treatment to the stormwater runoff generated form the urbanisation of the catchment. The stormwater quality treatment will be located in the drainage reserve prior to discharging into the Lillydale Lake parklands.

The constructed wetland system, consisting of a sediment pond and macrophyte zone, will have a treatment footprint of 1.15 ha to achieve best practice pollutant reduction targets for the site discharging at this location. The constructed wetland system will be situated in a 2.45 ha drainage reserve and will be designed in accordance with Melbourne Water guidelines for constructed wetlands.

The asset will be transferred to Melbourne Water following a standard defects period. The maintenance of the system will be in accordance with Melbourne Water maintenance requirements for a constructed wetland system.

Table 4.3 outlines the performance of the on-site treatment proposed for the Lillydale Lake Retarding Basin catchment.

Table 4.3 Lilydale Quarry Lillydale Lake Retarding Basin Catchment Treatment Performance

Pollutant	Source Load (Site only) (kg/yr)	Load Reduction (kg/yr)	% Reduction
Total Suspended Solids (TSS)	61,280	50,700	83%
Total Phosphorous (TP)	131.41	90.9	69%
Total Nitrogen (TN)	950.8	428	45%
Gross Pollutants (GP)	12,445	12,445	100%

Figure 4.2 illustrates a potential layout for the constructed wetland system in the drainage reserve to treat the Lillydale Lake Retarding Basin catchment. It is proposed the constructed wetland system will have a normal water level of 110.65 m AHD.

Figure 4.2 Proposed Treatment Layout for Lillydale Lake Retarding Basin Catchment

Whilst the treatment for this catchment has been modelled utilising a constructed wetland system, further regard may be given to other water quality and Ecologically Sustainable Development measures during the detailed design phase such as bioretention systems, alternative water source harvesting and reuse, porous paving, etc.

4.1.3 Melba Avenue Main Drain Catchment

The Melba Avenue Main Drain catchment aims to include a constructed wetland system to provide treatment to the stormwater runoff generated from the urbanisation of the catchment. The stormwater quality treatment will be located in a parcel of Council owned land within the Lillydale Lake parklands.

The constructed wetland system, consisting of a sediment pond and macrophyte zone, will have a treatment footprint of 1.13 ha to achieve best practice pollutant reduction targets for the site discharging at this location. The constructed wetland system will be situated in a 3.23 ha overall proposed drainage reserve and will be designed in accordance with Melbourne Water guidelines for constructed wetlands.

The asset will be transferred to Melbourne Water following a standard defects period. The maintenance of the system will be in accordance with Melbourne Water maintenance requirements for a constructed wetland system.

Table 4.4 outlines the performance of the on-site treatment proposed for the Melba Avenue Main Drain catchment.

Table 4.4 Lilydale Quarry Melba Avenue Main Drain Catchment Treatment Performance

Pollutant	Source Load (Site only) (kg/yr)	Load Reduction (kg/yr)	% Reduction
Total Suspended Solids (TSS)	80,700	72,400	90%
Total Phosphorous (TP)	170.5	126.2	74%
Total Nitrogen (TN)	1,248	560	45%
Gross Pollutants (GP)	16,610	16,610	100%

Figure 4.3 illustrates a potential layout for the constructed wetland system in the drainage reserve to treat the Melba Avenue Main Drain catchment. It is proposed the constructed wetland system will have a normal water level of 105 m AHD.

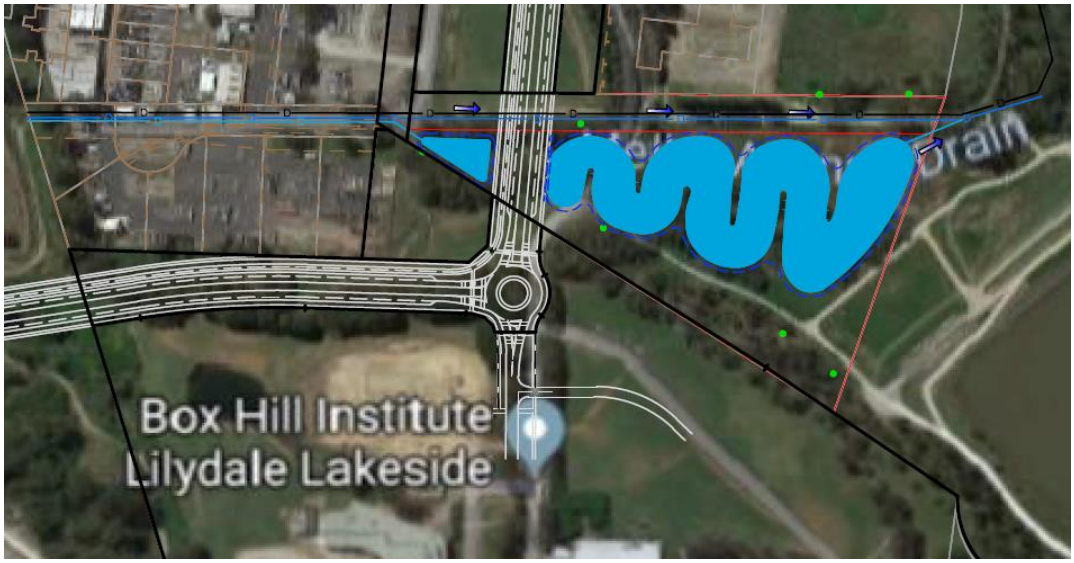

Figure 4.3 Proposed Treatment Layout for Melba Avenue Main Drain Catchment

Should the design of the constructed wetland system encounter unforeseen problems and the footprint requires a reduction, the development will work with authorities to identify other appropriate locations for treatment of the runoff generated from this catchment; or otherwise revert back to the on-site treatment proposal that was removed to accommodate Council's request for a larger regional open space asset to be located at the north of the site.

5 Outfall Arrangement

5.1.1 Mooroolbark Drain Catchment

The Stage 1 development of Lilydale Quarry has addressed the outfall requirements for the catchment discharging to Mooroolbark Drain. The stormwater strategy undertaken for Stage 1 should be read in conjunction with this report.

It is intended that the development of the Mooroolbark Drain catchment of the Lilydale Quarry will utilise the existing catchment outlet, which is 2 x 900 mm diameter pipe culverts crossing of Hull Road. Flow will discharge from these pipe culverts to the south and be conveyed via an existing table drain through the future arterial road land, prior to capture by a grated pit and discharge into Melbourne Water's Greenslopes retarding basin from the existing 1650 mm diameter pipe. The proposed outfall is indicated in **Figure 5.1**.

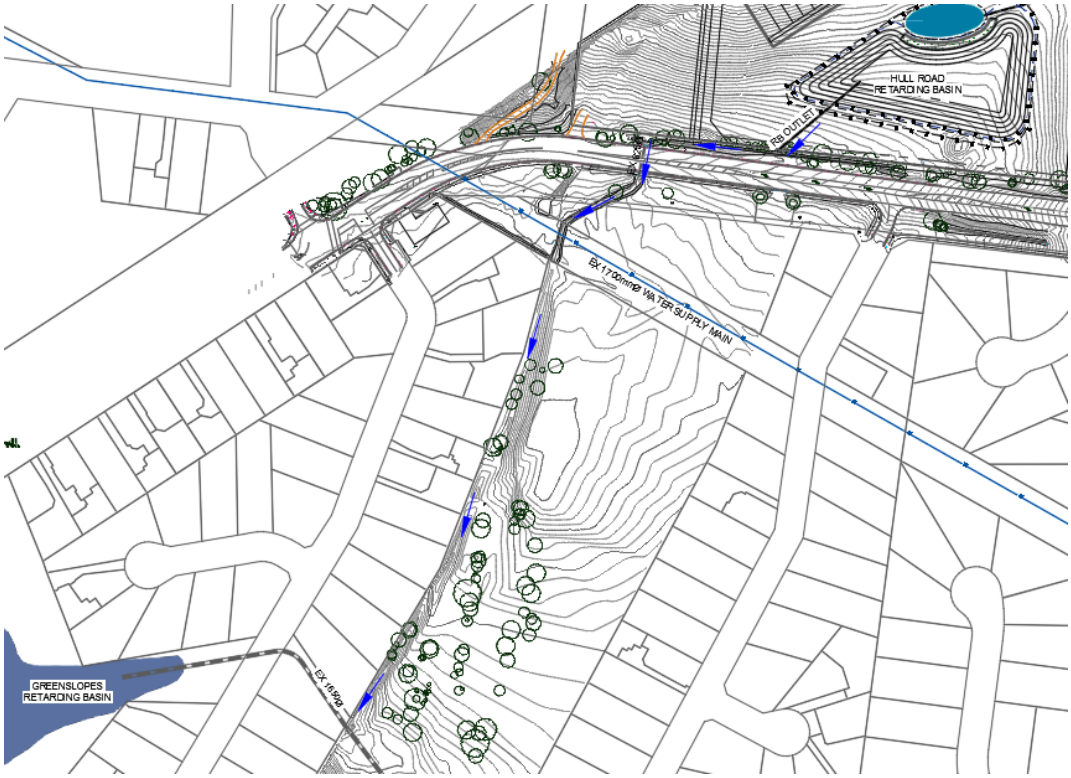

Figure 5.1 Proposed Outfall for Mooroolbark Drain Catchment

The flows discharging are equivalent to the pre-development magnitudes, and a flood study undertaken by Melbourne Water does not indicate properties between the future arterial road and the Greenslopes Retarding basin are subject to flooding. Therefore, it is proposed to utilise the existing table drain.

5.1.2 Lillydale Lake Retarding Basin Catchment

The development will acquire a 35 m wide strip of land from the Box Hill Institute located immediately north of the existing residential properties on Rockys Way to provide this catchment with a free draining outfall and prevent the occurrence of any adverse flooding to neighbouring properties.

The 35 m wide strip of land will contain a low flow pipe and a grassed channel to convey flows from the drainage reserve to the lake and provide a shared path connection between the development of Lilydale Quarry and Lillydale Lake parklands. The low flow pipe will provide an outlet from the wetland to the lake. The grassed channel will convey the gap flow from the catchment to the lake and will contain the shared path connection between the development and the Lillydale Lake Parklands. The shared path will be set above the 10% AEP design flood level in the grassed channel. It is envisaged the low flow pipe will be a 750 mm diameter pipe and convey the 4 Exceedances per Year flow. The gap flow is the difference between the 1% AEP design flow and the flow conveyed in the pipe.

The 35 m wide corridor allows for freeboard to be contained within the grassed channel whilst also providing sufficient verge for maintenance access, terrestrial planting and a shared user path. A potential cross section for the grassed channel is illustrated in **Figure 5.2**.

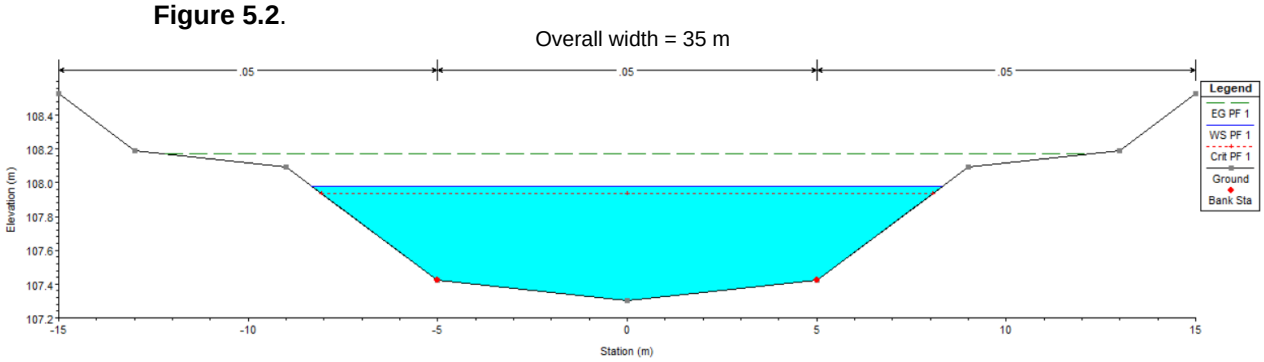

Figure 5.2 Proposed Lillydale Lake Catchment Outfall Channel Typical Section

The layout of the proposed outlet for the Lillydale Lake Retarding Basin catchment is depicted in **Figure 5.3**.

Figure 5.3 Proposed Lillydale Lake Retarding Basin Catchment Outfall Pipe and Channel

5.1.3 Melba Avenue Main Drain Catchment

The development will discharge the regular flows up to the 4 EY towards the proposed wetland. The flows in excess of the 4 EY up to and including the 1% AEP design storm will be conveyed from the site to Olinda Creek in a pipe duplicating the alignment of the Melba Avenue Main Drain. It is estimated that a 1350 mm diameter will be required to convey the gap flows from the site to Olinda Creek. An 825 mm diameter RCP will divert the 4EY flows to the wetland for treatment.

The proposed outfall for the Melba Avenue Main Drain catchment is illustrated in **Figure 5.4**.

Figure 5.4 Proposed Melba Avenue Main Drain Catchment Outfall

6 Conclusion

The development of Lilydale Quarry is required to meet the drainage standards specified by the Shire of Yarra Ranges and Melbourne Water.

The development will provide pipe drainage infrastructure to convey the 1 in 5 (18%) AEP design flows and minimise nuisance flooding occurrences in regular rainfall events. The gap flows, i.e. the difference between the 1% AEP design flows and the pipe flows, will be safely conveyed through the development along road reserve corridors. Where the gap flows are too large to be safely conveyed via road reserves, the pipe infrastructure will be increased to convey a greater magnitude flow and provide safe overland flow conveyance.

On-site retardation will be provided in a basin located at Hull Road to mitigate the runoff discharging from the site to pre-development magnitudes. No retardation is required for the catchment discharging to the Lillydale Lake Retarding Basin as Melbourne Water has advised that the existing retarding basin has capacity for the urbanised flows from this catchment. The Melba Avenue Main Drain catchment will discharge to Olinda Creek without any flow mitigation to ensure there is no increase in peak 1% AEP design flow for Olinda Creek at Maroondah Highway.

Allotments will achieve relevant freeboard from the 1% AEP flood levels associated the overland flows in road reserves or drainage reserves, whichever is greater.

The development will provide on-site treatment to achieve best practice pollutant reduction targets. The treatment assets include a sediment basin and rain garden located in the proposed Hull Road retarding basin drainage reserve. The Lillydale Lake Retarding Basin catchment and Melba Avenue Main Drain catchment will provide constructed wetland systems to achieve best practice pollutant reductions for the stormwater runoff from the urbanisation of the catchments.

The outlet for Mooroolbark Drain catchment is existing and free draining. The outlet for the Melba Avenue Main Drain catchment will be constructed with the development and will be free draining. The outlet for the Lillydale Lake Retarding Basin catchment will be constructed with the development and will be free draining.

The comprehensive development zone schedule requires that a Stormwater Management Strategy is prepared for each precinct before a permit can be granted by Council. The Stormwater Management Strategy for each precinct should include (where relevant):

- An assessment of how the objectives of the *Lilydale Quarry Planning Scheme Amendment Integrated Water Management Strategy* have been addressed;
- An assessment of how the objectives of the *Lilydale Quarry Planning Scheme Amendment (Balance Land) Stormwater Strategy* have been addressed;
- Specific approaches to capture, treat and reuse stormwater across the Precinct;
- Details of proposed urban water management, including water supply, wastewater, flood resilience, urban waterway health, and management of public spaces;
- Details of potable water use, wastewater and stormwater capture, reuse and discharge processes in accordance with best practice water sensitive urban design principles;
- Design detail to ensure flooding on and off site and downstream is managed and there is no deterioration in water quality in the area surrounding the land as a result of development.

7 References

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Melbourne Water, 2005, WSUD Engineering Procedures: Stormwater

SKM, July 2014, Lilydale Quarry Urban Renewal Project, Integrated Water Management Strategy

Appendix A – RORB Parameters

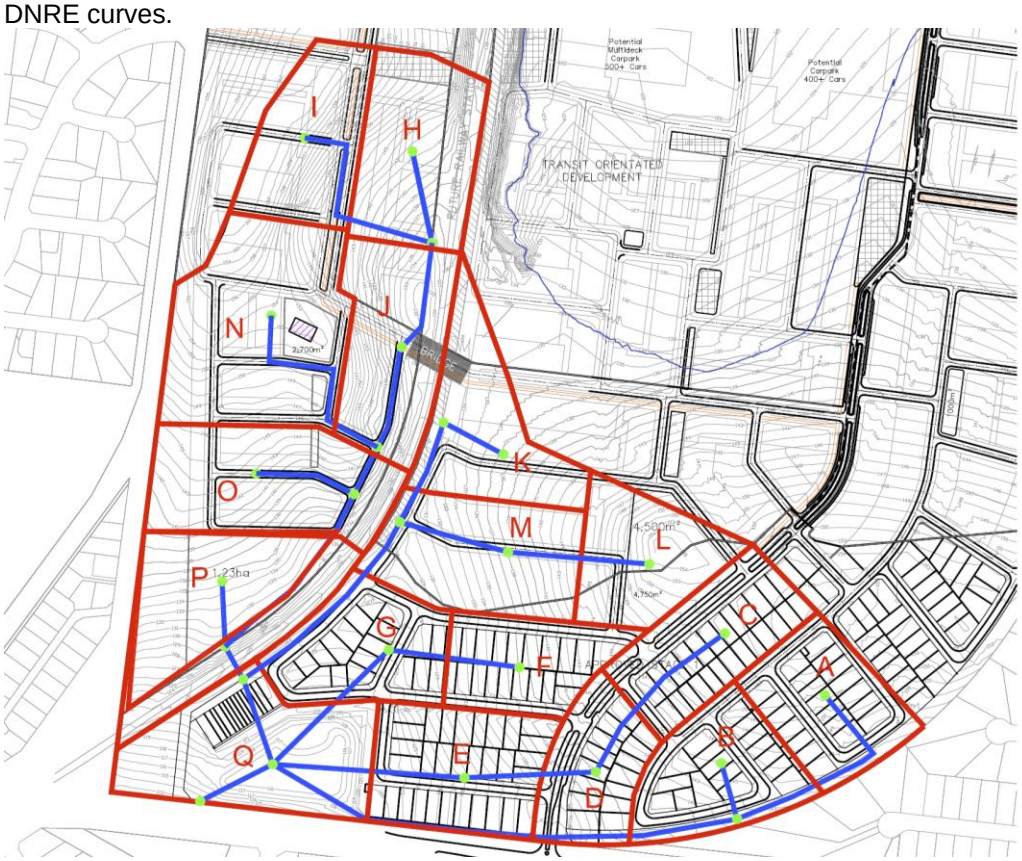
Mooroolbark Drain Model

RORB File	Lilydale Quarry Stg 1 200331.catg
kc	1.20
m	0.8
IL	15 mm
RoC	0.6 (1% AEP)
Location	Latitude -37.775; Longitude 145.333
Temporal Pattern	ARR 2019 Point Temporal Patterns
Spatial Pattern	Uniform
Aerial Reduction Factor	Based on ARR 2019 (Book 2 Chapter 4)
Loss Factor	Constant with ARI

File created as an extract from model supplied by Melbourne Water, 5560Exist.cat. Model supplied had kc = 9.143, dav = 3.27 km, kc/dav = 2.796

Revised model dav = 0.43 km, therefore kc = 1.20 (note:: Dav is different for developed catchment)

Adopted kc is a good fit between the ARR kc value and the DVA kc value. Predevelopment flows fit to DNRE curves.



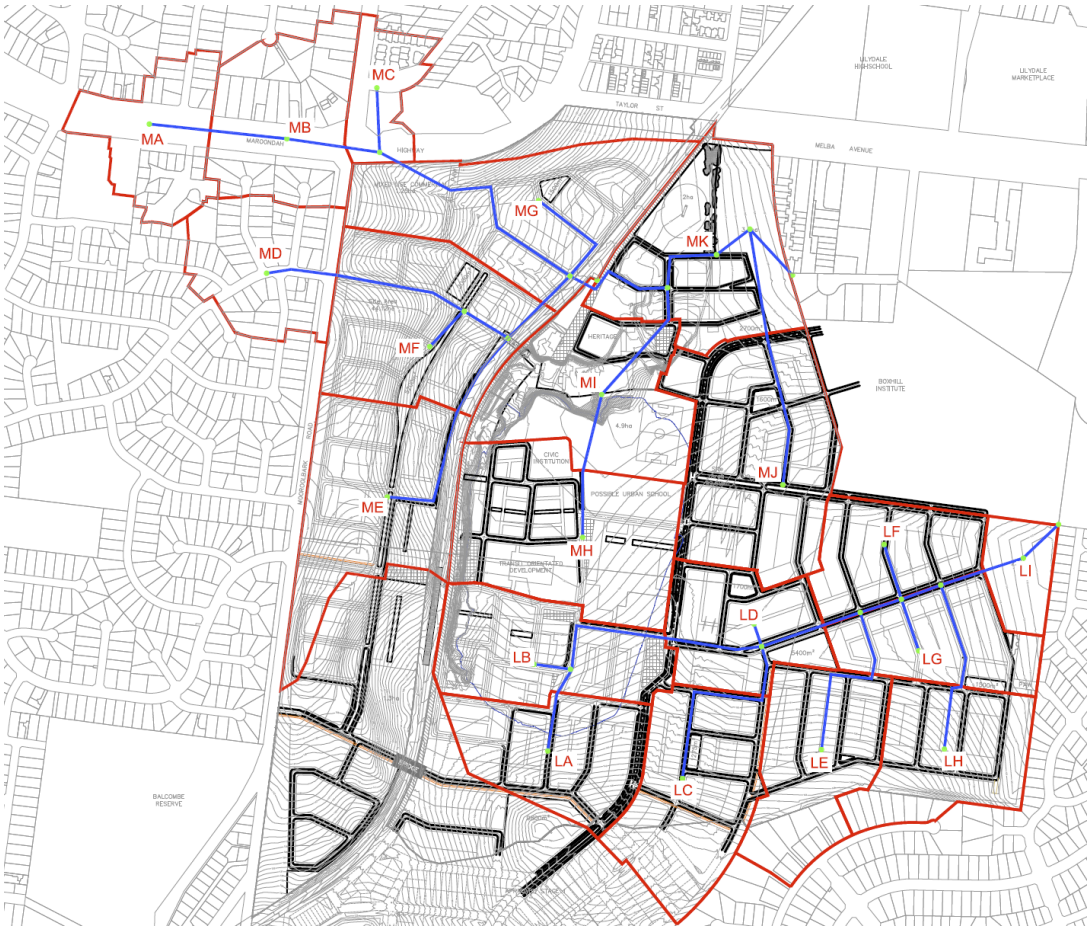
Mooroolbark Drain Catchment RORB Model Sub Areas

Olinda Creek Catchment Model

RORB File	OlindaCk_Sep20 with Kinley.cat
kc	13.01
m	0.8
IL	20 mm
RoC	0.6 (1% AEP)
Location	Latitude -37.776874; Longitude 145.370114
Temporal Pattern	ARR 2019 Point Temporal Patterns
Spatial Pattern	Uniform
Aerial Reduction Factor	Based on ARR 2019 (Book 2 Chapter 4)
Loss Factor	Constant with ARI

File created as an extract from model supplied by Melbourne Water, OlindaCk_Aug13.cat. Model supplied had kc = 13.0, dav = 13.42 km, kc/dav = 0.969.

Revised model dav = 13.43 km, therefore kc = 13.01.



Amended Olinda Creek Catchment RORB Model Sub Areas

Appendix B – Intensity Frequency Duration Data

Lilydale Quarry Intensity Frequency Duration Table

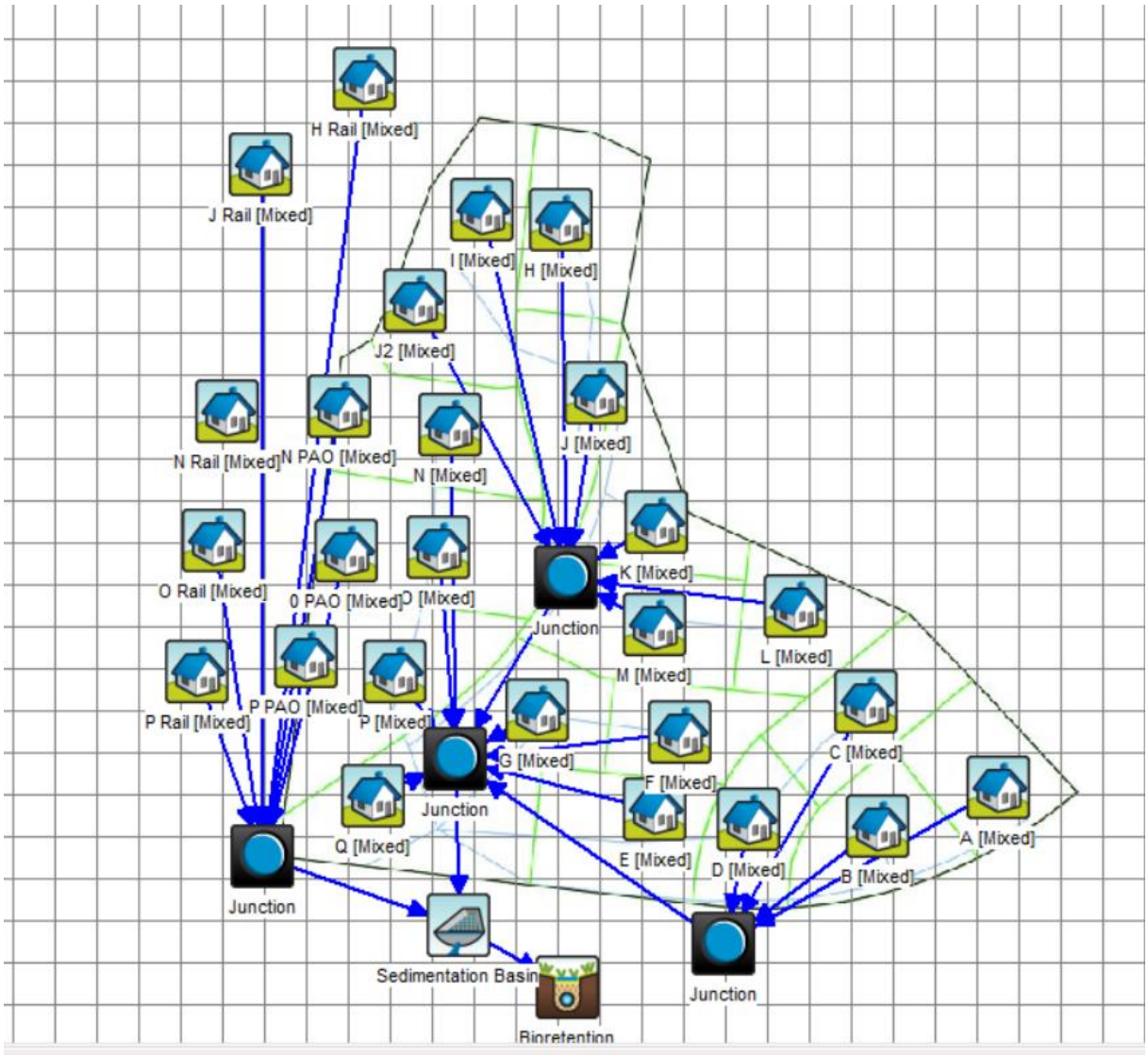
Label: Lilydale Quarry
Latitude: -37.775
Northing: 145.333
Latitude: Nearest grid cell: 37.7625 (S)
Longitude: Nearest grid cell: 145.3375 (E)

Duration	Average Exceedance Probability						
	1EY	0.5EY	0.2EY / 18%	10%	5%	2%	1%
1 min	94.3	105	139	164	190	227	256
2 min	79.4	87.3	113	131	148	170	187
3 min	71.6	78.9	103	120	136	158	174
4 min	65.7	72.6	95.2	111	127	149	166
5 min	60.9	67.4	89	105	120	142	159
10 min	45.5	50.6	67.7	80.2	93.3	112	127
15 min	37	41.2	55.1	65.3	76.1	91.4	104
20 min	31.5	35	46.8	55.4	64.4	77.2	87.7
25 min	27.6	30.7	40.9	48.3	56	66.9	75.8
30 min	24.7	27.4	36.4	42.9	49.7	59.2	66.8
45 min	19.1	21.2	27.9	32.7	37.6	44.4	49.8
1 hour	15.9	17.5	23	26.8	30.7	36	40.2
1.5 hour	12.2	13.4	17.4	20.3	23.1	26.9	29.9
2 hour	10.1	11.1	14.4	16.7	18.9	22	24.5
3 hour	7.82	8.58	11	12.8	14.5	16.9	18.7
4.5 hour	6.05	6.65	8.57	9.92	11.3	13.2	14.7
6 hour	5.06	5.57	7.21	8.37	9.56	11.2	12.6
9 hour	3.94	4.35	5.69	6.65	7.65	9.06	10.2
12 hour	3.3	3.65	4.83	5.68	6.57	7.83	8.87
18 hour	2.56	2.85	3.83	4.55	5.3	6.38	7.26
24 hour	2.13	2.38	3.24	3.87	4.54	5.48	6.25

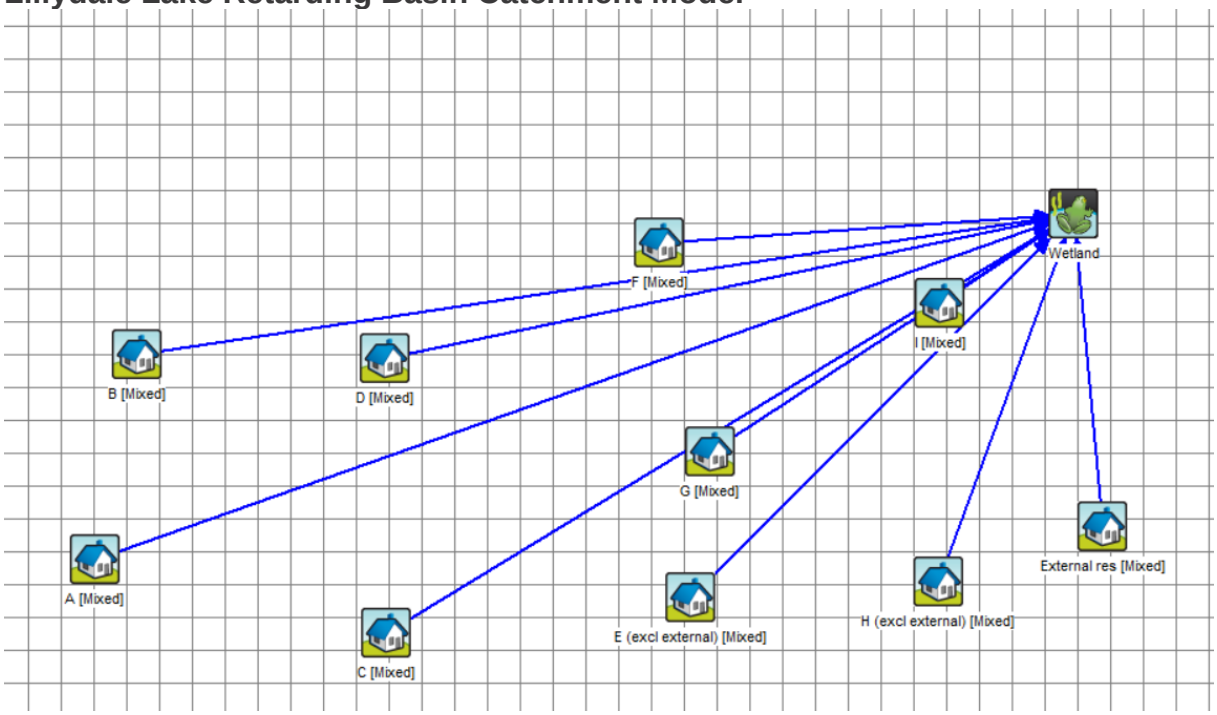
Duration	Average Exceedance Probability						
	1EY	0.5EY	0.2EY / 18%	10%	5%	2%	1%
30 hour	1.84	2.07	2.83	3.4	4	4.84	5.51
36 hour	1.63	1.83	2.52	3.04	3.59	4.34	4.94
48 hour	1.34	1.51	2.09	2.53	2.99	3.6	4.09
72 hour	1	1.13	1.56	1.89	2.24	2.67	3.01
96 hour	0.807	0.905	1.24	1.5	1.77	2.1	2.35
120 hour	0.68	0.76	1.03	1.23	1.46	1.72	1.92
144 hour	0.591	0.657	0.876	1.04	1.23	1.44	1.61
168 hour	0.524	0.58	0.76	0.888	1.06	1.23	1.38

Appendix C – MUSIC Models

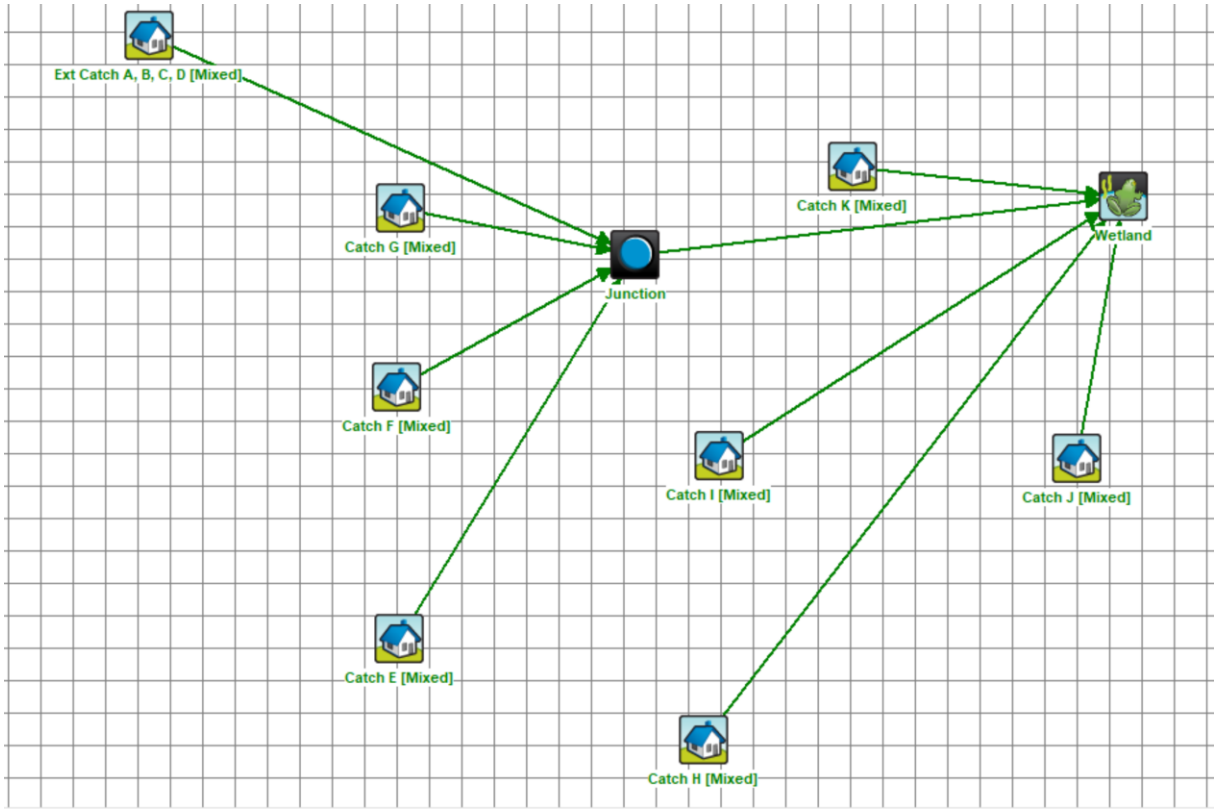
Mooroolbark Drain Catchment Model



Lillydale Lake Retarding Basin Catchment Model



Melba Avenue Main Drain Catchment Model



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