BASS COAST SHIRE COUNCIL

Drainage Strategy for Wonthaggi North East PSP

Stormwater Management Plan




October 2019

V2015_011-REP-001

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CONTENTS

Appendices

List of Figures

List of Tables

1. INTRODUCTION

Engeny have been engaged by Bass Coast Shire Council (BCSC) to assess the drainage and stormwater treatment requirements for the Wonthaggi North East Development Precinct. The strategy describes the required infrastructure necessary to facilitate the development of this area and meet the legislative requirement for the management of stormwater.

1.1 Assumptions

Given that the planning for the Wonthaggi North East PSP area is occurring in parallel with the development of this drainage strategy a number of assumptions have been made about the final layout of the development area. This includes the following:

- Development density of 13 houses per hectare
- Fraction impervious of the final development area of 0.65 (in line with the housing density above)
- Existing conditions flood mapping reveals a large area of land within the development area adjacent to Korumburra Wonthaggi Road is subject to flooding in the 1 % AEP event. It has been assumed that this area can be used for stormwater treatment
- The development area will need to meet best practice treatment of stormwater prior to discharging into the Powlett River
- All drains discharging into an existing or proposed waterway will first receive primary sediment removal treatment (through sedimentation basins)
- Discussions with WGCMA have confirmed that there is no requirement to retard flows to predevelopment peak flows for major storm events (such as the 1 % annual exceedance probability (AEP) event) prior to discharge to the Powlett River. Increased runoff as a result of development in more frequent storm events could mean downstream land owners are subject to more frequent inundation, hence peak flows from the 63 % and 39 % AEP events have been analysed in order to ensure predevelopment peak flows in these events are not exceeded after development.

2. MANAGEMENT OF FLOWS

The Wonthaggi North East development area is in a location which is prone to widespread flooding in the 1 % Annual Exceedance Probability (AEP) event. **Appendix A** shows the 1 % AEP flood extent under current existing conditions. The catchments in the north western part of the development area was not included in the flood model as the terrain is well defined with clear valleys and distinct low points which represent the existing overland flow paths.

The flooding displayed in **Appendix A** is caused by the large upstream catchment areas, flat topography of the area and the existing Korumburra-Wonthaggi Road embankment. To enable the development of this land, the inflows from external catchments will need to be managed as will the runoff from the developing areas.

2.1 External catchments

There are a number of external catchments which will drain into the development area. To the west of the development area there are some existing urban catchments, while to the south and east there are large rural catchments. The external catchments which drain into the development area are shown in **Appendix B**. To ensure the dwellings within the development area are not impacted by flooding up to the 1 % AEP event the flows from the external catchments will need to be conveyed around and/or through the development area.

2.2 Pipes and roadways

The drainage design within the development areas should follow the major / minor principle set out in the Infrastructure Design Manual. Where 1 % AEP flows are less than 10 m^3/s a combination of piping the 18 % AEP flows and having the “gap” flow to safely be conveyed along a future road has been adopted as a suitable drainage solution. Where flows are above 10 m^3/s it is generally difficult to convey them safely along a road with a pipe underneath. In these areas open waterways have been proposed.

It is important that the development plans for these areas allow for a road network to convey runoff in major storms through to the waterways. This scenario applies for the existing urban catchments and for some of the smaller rural catchments which flow into the development area. **Appendix C** shows the proposed stormwater management strategy including the preliminary pipe flow locations entering the development area from the external urban and rural catchments. **Appendix D** includes the recommended points of discharge and pipe alignments connecting into primary treatment infrastructures for each internal catchment.

2.3 Constructed waterways

Engeny understands that the existing waterways within the development area have been significantly modified from their natural form and most are what would be classified as rural drains. These drains are suitable for management of flows in a rural environment but do not provide an adequate level of service in an urban setting.

Where the flow in the 1 % AEP event is greater than 10 m^3/s a constructed waterway is proposed. Constructed waterways should be sized to convey the full 1 % AEP flow with 600 mm freeboard to any adjacent dwellings. They should be designed with a pilot channel capable of conveying regular flows. Constructed waterways offer improved environmental and aesthetical outcomes over an open drain as they can provide habitat for native fauna and flora while still providing the drainage utility. Other benefits include public amenity and the opportunity for shared paths to link communities. Engeny recommend that Council adopt Melbourne Water's Constructed Waterway Guidelines and Waterway Corridor Guideline documents as a basis for the design of waterways in the precinct given that Bass Coast Shire Council does not have its own guideline in this area.

Council should require roads be built on either side of the waterway corridor where possible to promote passive surveillance of the waterways to reduce the risk of rubbish dumping and also to allow for maintenance access along the waterway. With the current location of the eastern waterway roads will only be able to be built along the western side of the waterway within the development area as the eastern boundary is on the edge of the development area.

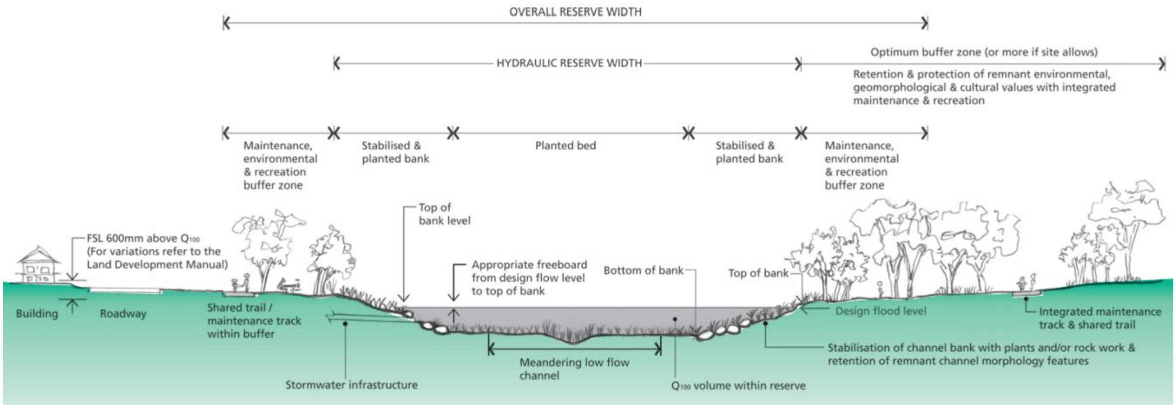


Figure 2.1 Schematic example of a constructed waterway (source MW constructed waterway guidelines)

Appendix C shows the proposed constructed waterway alignments. The development area will require two constructed waterways, referred to in this document as the east and west waterways. The west waterway more or less follows the existing waterway drainage lines through the area. The West Gippsland Catchment Management Authority (WGCMA) have requested a 60 m waterway corridor downstream of McGibbonys Road through to the proposed wetlands adjacent to the Korumburra Wonthaggi Road. Upstream of McGibbonys Road the proposed waterway corridor width varies between 55 and 23 m. Approved development plans for Parklea Estate and Powlett Ridge Estate have been provided by council indicating the land designated for the proposed west waterway. Although the overall waterway corridor width varies from Powlett Ridge Estate down to Parklea Estate, the land takes set out in the approved development plans have been adopted in this document.

The location of the east waterway is somewhat flexible in some areas given the very flat topography closer to the proposed wetlands. There is a defined low point in the Bass Highway where the upstream end of the waterway is proposed to begin. Downstream of this it is recommended that the waterway run along the edge of the development area where council has expressed a preference for locating the waterway within the development boundary. Although locating the waterway along the boundary of the development area is unusual, it will effectively ensure the shallow but widespread flow paths from the rural catchments are safely intercepted and conveyed, without sheet flow into urban properties. Alternatively, locating the waterway elsewhere would mean that the safe conveyance of these external flows would be significantly dependent on the capacity and location of the road networks within the development area.

Table 2.1 below summarises the required hydraulic widths and total corridor widths of the waterways within the development area. All Proposed corridor widths tabulated below (excluding waterway reaches 17-18, 22-23, 23-24) include an allowance for vehicle access on both sides of the waterway, alternatively if future road alignments already provide this access, waterway widths can be reduced in accordance with Melbourne Water's Constructed Waterways Guidelines Appendix C contains a plan showing the locations of each of the waterways.

Table 2.1 Waterway corridor widths

Waterway Reach	Required hydraulic width	Proposed corridor width
Eastern Waterway		
3-4	30	55
4-5	30	60
5-6	50	60
6-7	50	60
7-8	50	60
8-9	50	60
Western Waterway		
17-18	22	40
19-20	31	55
20-21	32	55
22-23	34	60

Waterway Reach	Required hydraulic width	Proposed corridor width
23A-23B	35	60
23C-24	35	60
24-25	35	60

The widths upstream of McGibbonys Road and through Powlett Ridge Estate on the western waterway have been documented in this report to match the widths and locations from previous work, approved development plans and from consultation with landowners as they hydraulically can still convey the 1 % AEP flows. Adjustments to the total corridor width in approved development areas may be required however to provide access to both sides of the waterway in accordance with Melbourne Water's Guidelines.

The Eastern Waterway has been assumed to have a shared path/road on one side of the waterway across the entire length where the other side could require the addition of a shared trail or maintenance track as outlined in Melbourne Water's Waterway Corridors Guideline (2013). The Eastern Waterway has been located on the edge of the development in order to protect the development area from flooding and to ensure that there are no adverse flooding impacts as a result of development on the existing land to the east of the development area. It may be possible to move the proposed waterway further west into the development area, however it will be very challenging to convey the shallow overland sheet flow from the farmland east of the development area into the waterway without increasing flood depths on the farmland. If the waterway was moved west dwellings to the east of the waterway would need to be built on fill pads set above the 1 % AEP flood level. Consideration would also need to be given to maintaining safe access to these dwellings during flood events.

2.4 Discharge to Powlett River

A detailed analysis of the peak 63 % AEP and 39 % AEP flows was undertaken using RORB. As the Wonthaggi North East Development area discharges through existing properties prior to discharging into the Powlett River, these flows were analysed in order to ensure sufficient flood storage was incorporated in the stormwater strategy such that flows did not increase from the existing predevelopment flows minimising impacts to downstream land owners and erosion to the receiving waterway.

2.4.1 RORB Model Validation

A key step in the development of the hydrologic model is the validation process. This process ensures that appropriate model parameters are adopted to reflect how runoff is routed through the catchment.

Three (3) separate RORB model's were developed to represent the catchments draining into each of the proposed Wetland 1, Wetland 2 and Wetland 3 and 4 locations.

RORB Model for Wetland 1 Catchment

The existing conditions RORB model for the area draining into the proposed Wetland 1 location was validated using the Rural Rational method as per Australian Rainfall and Runoff at the Korumburra-Wonthaggi Road embankment located at the northern end of the development area. The peak 1 % AEP flow at this location was further confirmed with flows from TUFLOW. Table 2.2 summarises the hydrologic model validation process and shows that there is little difference between the 1 % AEP flow from the RORB model, rational method and Tuflow model outputs.

Table 2.2 Validation of existing conditions RORB model for Wetland 1 catchment

Parameter	Value
Catchment area	34 km^2
Adopted k_c	5.32
RORB (1 % AEP flow)	58.0 m^3/s
Rural Rational Method (1 % AEP flow)	57.7 m^3/s
Existing conditions TUFLOW (1 % AEP flow)	55 m^3/s

Other key RORB parameters adopted in this model (based on Melbourne Water's Guidelines and Technical Specifications (November 2012)) are:

- m = 0.8
- Initial loss = 25 mm (For the Existing conditions RORB Model)
- Initial loss = 15 mm (For the Developed conditions RORB Model)
- RORB Runoff coefficients:
  - 100 year ARI runoff coefficient = 0.60
  - 50 year ARI runoff coefficient = 0.55
  - 20 year ARI runoff coefficient = 0.45
  - 10 year ARI runoff coefficient = 0.35
  - 5 year ARI runoff coefficient = 0.25
  - 2 year ARI runoff coefficient = 0.22
  - 1 year ARI runoff coefficient = 0.20

The developed conditions RORB model was setup based on this validated existing conditions RORB model where the development area was assigned a consistent fraction Impervious of 65 %. This adopted value aims to reflect the proposed general residential zones occupying much of the overall development in addition to minor areas allocated to industrial and commercial land uses.

The peak 1 % AEP flows at the downstream ends of both west and east waterways were compared to the values derived from the urban rational method calculations used to size the waterways. Table 2.3, shown below provides a summary of the associated peak flows for each of the calculation methods. The table shows that the flows are comparable and a good match between the RORB model and the Rational Method calculation has been achieved.

Table 2.3 Summary of 1 % AEP peak flows derived from various calculation methods for developed conditions

Location	Urban Rational Method (m^3/s)	RORB (m^3/s)
D/S end of West Waterway (location 25 on plan in Appendix C)	22.8	21.8
D/S end of East Waterway (location 9 in plan in Appendix C)	36.0	38.8

<u>RORB Model for Wetland 2 Catchment</u>

The existing conditions RORB model for the catchment draining into the proposed Wetland 2 location was validated using the rational method. The following provides details on the parameters used, with Table 2.4 displaying the resultant comparison of flows:

- K_c = 0.33
- m = 0.8
- Initial loss = 15 mm (For the Existing conditions RORB Model)
- Initial loss = 10 mm (For the Developed conditions RORB Model)
- RORB Runoff coefficients consistent with those adopted for Wetland 1 catchment model

Table 2.4 Validation of existing conditions RORB model for Wetland 2 catchment

Calculation Method	1 % AEP Flow (m^3/s)
Rational Method	5.2
RORB	5.1

RORB Model for Wetland 3 and 4 Catchment

The existing conditions RORB model for the catchment draining into the proposed Wetland 3 location was validated using the rational method. A value of 1.05 was adopted for the routing parameter where all other inputs were consistent with the modelling approach adopted for the modelling of the Wetland 2 catchment. Table 2.5 presents a comparison of the resultant flows using the rational method and validated RORB model.

Table 2.5 Validation of existing conditions RORB model for Wetland 3 and 4 catchment

Calculation Method	1 % AEP Flow (m^3/s)
Rational Method	10.6
RORB	10.3

2.4.2 Required Retardation Storages

The retardation storages required to ensure development peak flows are retarded back to existing pre-development flows for the frequent flow events were modelled in RORB at each of the proposed wetland locations shown in **Appendix C**. The hydrologic model was rerun where the outlet configuration was modified until the outflow was equivalent to or lower than the existing pre-development 63 % AEP (1 year ARI) and 39 % AEP (2 year ARI) peak flows respectively. The resultant peak flood storages for the 39 % AEP have been recorded in Table 2.6.

Although Wetland 3 and 4 will be located on land which is owned by different developers, the assets will be linked with a culvert across Wentworth Road for future development conditions and two separate outfalls across Heslop road under interim conditions. As part of a separate scope of work, Engeny developed functional design plans for these wetlands. This design work included:

- 12D terrain modelling which allowed for the specific representation of batters, an embankment, maintenance tracks, sediment ponds and sediment drying areas.
- Estimate of the actual flood storage available within each wetland asset using the developed design Digital Elevation Model (DEM).
- Refined RORB modelling which included the stage versus storage relationship produced from the design DEM.
- Design of the Wetland outlet configurations for Wetland 4 and 3 across Wentworth Road and Heslop Road with consideration of surveyed data provided for the existing culvert crossing.

Based on the refined terrain and RORB modelling undertaken for the functional design of Wetland 3 and 4, these assets have the capacity to retard flows for the 69 % AEP and 39

% AEP events. Retardation of the peak 1 % AEP developed conditions flow back to the peak pre-developed flow was also possible by incorporating an embankment. Further discussion on the outfall arrangement for major storm events across Heslop Road is provided within Section 2.5.2.

The modelling and representation of stage versus storage relationships for Wetland 1 and 2 are of a conceptual level. Due to this the required retardation volume has not allowed for the retardation of 1 % AEP flows. Further design work could be undertaken to determine the extent of flood storage available at each location however it is not expected to be critical for downstream land owners as discussed within Section 2.4.4.

Table 2.6 Required 39 % AEP retardation storage volumes

Asset	39 % AEP Required Retardation Volume (ML)
WL1	191
WL2	8.21
WL3	12.4
WL4	9.18

As noted within Table 2.6 the retardation storage volume required for Wetland 1 is 191 ML. This has assumed the proposed filling of the low-lying areas adjacent to the retarding basin to enable development of that land. Figure 2.2 shows the proposed footprint that the retarding basin would require, with the existing 1 % AEP flood extent overlain in the background. The exact location and shape of the retarding basin and wetland could be refined in the detailed design to accommodate an alternative development layout provided that the total volume of storage is maintained. The current location is aimed at minimising the excavation costs by utilising low lying areas which are currently subject to flooding in a 1 % AEP event. The area of land required for the retarding basin is 18.4 ha, of which 4.8 ha is also being utilised as the wetland. This means that 13.6 ha will be required for retarding purposes only. This land will be subject to frequent inundation, occurring multiple times each year. Consideration should be given to how this area is landscaped as the infrastructure and vegetation will need to be able to survive regular periods of inundation. Swampy, floodplain or ephemeral vegetation would be best suited to these conditions.

Figure 2.2 Proposed retarding basin extent

2.4.3 Comparison of Existing and Developed Flows

Table 2.7, Table 2.8, Table 2.9 and Table 2.10 summarise the peak existing and developed conditions flows at each of the proposed wetland locations. These flows were obtained from RORB which was used to determine the food storages required at each outlet.

Table 2.11 provides a summary of the existing and developed peak flows for the 18 % and 1 % AEP storm events at different locations with reference to the plan in **Appendix C**. These flows were obtained using the Rational Method and formed the basis behind the sizing of the eastern and western constructed waterways.

Table 2.7 Wetland 1 Peak RORB Flows

Event	Existing Conditions Flows (m³/s)			Developed Conditions Flows (m³/s)		
	Inflow	Outflow	Culvert flow[1]	Inflow	Outflow	Culvert flow[1]
63 % AEP	6.3	4.8	6.8	10.1	4.5	6.8
39 % AEP	7.5	5.7	8.1	11.7	5.2	7.9
18 % AEP	10.7	8.9	12.7	16.7	11.6	15.4
1 % AEP	59.2	58.1	58.1	71.0	69.6	69.6

Table 2.8 Wetland 2 Peak RORB Flows

Event	Existing Conditions Flow (m³/s)	Developed Conditions Flow (m³/s)	
	Inflow	Inflow	Outflow
63 % AEP	0.71	3.43	0.67
39 % AEP	0.90	4.12	0.86
18 % AEP	1.21	5.49	1.30
1 % AEP	5.13	13.45	5.80

Table 2.9 Wetland 3 Peak RORB Flows

Event	Existing Conditions Flow (m³/s)	Developed Conditions Flow (m³/s)	
	Inflow	Inflow	Outflow
63 % AEP	1.21	2.09	0.90
39 % AEP	1.64	2.60	1.00
18 % AEP	2.21	3.65	1.41
1 % AEP	10.28	8.81	3.03

[1] Culvert flow refers to the total peak flows crossing Korumburra-Wonthaggi Road from the development area including the external catchment entering the channel which runs along the northern boundary of the development area.

Table 2.10 Wetland 4 Peak RORB Flows

Event	Existing Conditions Flow (m^3/s)	Developed Conditions Flow (m^3/s)	
	Inflow	Inflow	Outflow
63 % AEP	0.65	2.00	0.49
39 % AEP	0.85	2.51	0.57
18 % AEP	1.21	3.52	0.99
1 % AEP	6.08	8.56	3.68

Table 2.11 Comparison of existing and developed Rational Method flows

Location	Existing		Developed	
	18 % AEP (m^3/s)	1 % AEP (m^3/s)	18 % AEP (m^3/s)	1 % AEP (m^3/s)
Location 4	5.8	13.0	6.0	13.4
Location 5	5.7	12.8	6.0	13.3
Location 6	11.8	26.0	13.0	28.6
Location 7	11.7	25.6	13.0	28.5
Location 8	15.4	33.9	17.3	38.0
Location 9	14.7	32.1	16.5	36.0
Location 18	4.4	10.1	6.1	13.9
Location 20	5.4	12.3	7.6	17.1
Location 21	5.9	13.1	8.2	18.3
Location 23	7.5	16.5	10.7	23.7
Location 23B	7.5	16.6	10.9	24.0
Location 24	7.4	16.3	10.1	22.3
Location 25	7.5	16.6	10.4	22.8

2.4.4 Impacts on peak flows in major events

The WGCMA and BCSC were consulted extensively during the development of this drainage strategy. The WGCMA and BCSC have identified that the farmland north of Korumburra Wonthaggi Road and Heslops Road is subject to flooding. A large part of this land makes up the flood plain of the Powlett River, with the area subject to flooding shown in the land subject to inundation overlay (LSIO) which is part of the Bass Coast planning scheme. The land identified as being at risk of flooding is based on the 1 % AEP flood extent. Figure 2.3 shows the extent of the land impacted by the LSIO relative to the proposed development area and proposed infrastructure. There is currently no detailed flood modelling information available for the Powlett River floodplain which would help to define the expected extent of inundation in more frequent events.

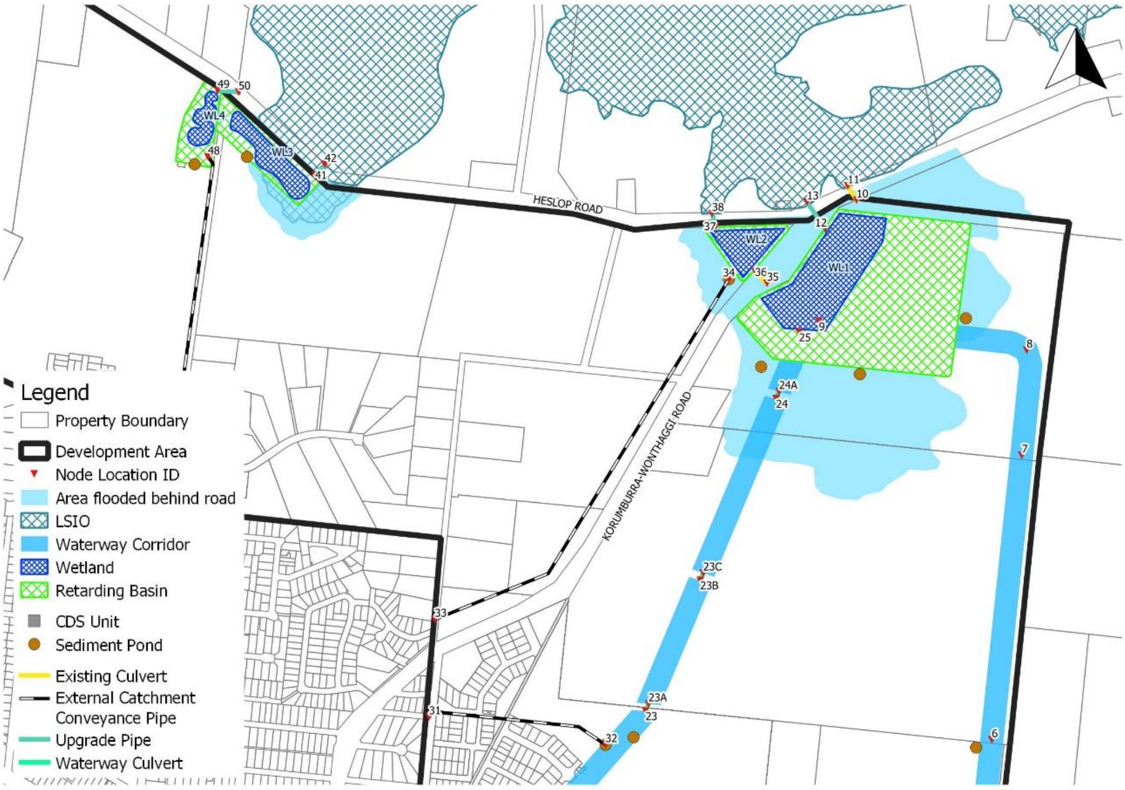


Figure 2.3 Powlett River floodplain as shown by LSIO

The development of the Wonthaggi North East PSP will increase the peak 1 % AEP flows compared with existing conditions along the tributaries which discharge into the Powlett River system. Table 2.7, Table 2.8, Table 2.9 and Table 2.10 shown above displays the expected change in peak 1 % AEP flows at each of the proposed wetland discharge locations. Each of these proposed wetlands will discharge onto the Powlett River floodplain.

The existing drainage infrastructure to the north of Korumburra Wonthaggi Road and Heslops Road has not been sized to convey the existing 1 % AEP peak flows from the proposed development catchments. The existing drainage infrastructure is typical of what would be expected in a rural area, where frequent flows are conveyed through man made open channels and larger flows will break out of the channels and be conveyed across the floodplain to the receiving waterway, in this case the Powlett River. The existing drainage infrastructure is configured in this way as it is relatively cheap to construct and maximises the land available for farming activities.

As discussed in Section 2.4.2 the peak flows cannot increase for the 63 % and 39 % AEP events which are the more frequent events. In events larger than the 39 % AEP event it is not proposed to retard the flows back to the existing condition flow. Further detailed terrain modelling may indicate the opportunity to incorporate more storage or embankments (as was the case for Wetland 3 and 4) however an allowance for this has not been made for the concept modelling undertaken for Wetland 1 and 2. This is particularly the case as provision of retarding for these larger events may require very large amounts of land and high expenditure to gain the storage volumes necessary. There will be an impact on the downstream landowner in the form of larger peak flows through the property in large storm events from these local catchments. The land that these flows would impact is currently flood prone and used for farming purposes. Based on the information available to Engeny we do not believe that any dwellings would be impacted by the calculated increase in peak flows. The proposed system is unlikely to significantly affect the flooding on the properties north of Korumburra – Wonthaggi road as the major flows, flood volumes and duration of flooding that affect this area are related to the very large rural catchment of the Powlett River and not the small area of development in Wonthaggi North East.

2.5 Level of Service to Existing and Proposed Roads

2.5.1 Korumburra-Wonthaggi Road

As shown in **Appendix A**, under existing conditions the north-eastern end of the development area is prone to flooding due to the relatively flat terrain which permits water to bank up behind the existing Korumburra-Wonthaggi Road embankment. According to the existing conditions TUFLOW model the 1 % AEP event water surface elevation in this area reaches a level of 16.3 m AHD.

RORB was used in order to assess the varying peak elevations for different AEP events in addition to the impact of development flows to the road's level of service. The existing conditions inflows and outflows were represented by including a storage node where a stage storage relationship of the relatively flat terrain was utilised ensuring the relationship covered the whole extent of the 16.3 m AHD water surface area. The outlet configuration of this storage was also represented with the two sets of existing culverts as well as a series of weirs representing the varying levels of the road embankment. Table 2.12 shown below provides a summary of these outlet parameters.

Table 2.12 Summary of outlet configuration for storage upstream of Korumburra-Wonthaggi Road

Outlet Type	Description
Culvert	3No. x 1200 mm x 1200 mm at invert level of 14.7 m AHD
Culvert	4No. x 1200 mm x 1200 mm at invert level of 14.3 m AHD
Culvert	1No. x 600 mm at invert of 14.5 m AHD
Road Embankment	Total Length of 770 m at elevations between 16.12 - 16.58 m AHD

Utilising this outlet configuration and the stage storage relationship, a 1 % AEP peak elevation of 16.28 m AHD was estimated at the upstream side of the road embankment, a very close match to the TUFLOW flood model water surface elevation of 16.30 m AHD. These similar peak elevations confirm the validity of the RORB model and thus the same storage parameters were used to assess the impact of the road embankment in different AEP events in addition to the impacts from the proposed development.

As shown in Table 2.13, under developed conditions, the peak flood elevation does not increase significantly in comparison to the existing conditions values in the 1 % AEP event. The flows have increased by 20 % in the 1 % AEP event as a result of increased runoff from the development area.

A scenario was run to determine the number of culverts required to ensure the existing road embankment does not overtop in the 1 % AEP event. An additional 14 x 1200 mm diameter culverts would be required to convey the full 1 % AEP flow of 64.4 m^3/s under the road. This would result in a peak elevation of 16.10 m upstream of the road. This is just below the lowest point in the road and does not provide any significant freeboard to the road surface. The cost of these culverts assuming a length of 20 m and a contingency of 35 %, was estimated at $895,000.

Table 2.13, shown below provides a summary of the 1 % AEP Results from the various RORB scenarios described above. The table shows that by conveying the flow under Korumburra-Wonthaggi Road with additional pipes the peak flow rate in the 1 % AEP event can be reduced slightly, compared to allowing the road to overtop under developed conditions. It has been assumed that these additional culverts would be located at Location 12-13 shown within **Appendix C**.

Table 2.13 Summary of 1 % AEP RORB results at proposed Wetland 1 Location

	Existing	Developed	Developed with no overtopping of Existing Road in 1 %AEP Storm event
Duration	12 hr	9 hr	9 hr
Peak Elevation	16.28 m	16.31 m	16.07 m
Peak Outflow	58.1 m^3/s	69.6 m^3/s	64.9 m^3/s
Peak Storage	225 ML	268 ML	228 ML
Outlet Culverts	3No. x 1200 mm x 1200 mm 4No. x 1200 mm x 1200 mm 1No. x 600 mm	3No. x 1200 mm x 1200 mm 4No. x 1200 mm x 1200 mm 1No. x 600 mm	3No. x 1200 mm x 1200 mm 4No. x 1200 mm x 1200 mm 1No. x 600 mm 14No. x 1200 mm dia

2.5.2 Heslop Road

Wetland 2, 3 and 4 are located directly upstream of Heslop Road. As Engeny have completed a functional design of Wetland 3 and 4, the section below includes the culverts proposed from the functional level modelling undertaken. The Wetland 2 culvert outlet however includes the culvert size required to convey the peak 1 % and 18 % AEP developed flows. These options give Council an indication of what assets would be required to achieve the different levels of service for Heslop Road downstream of Wetland 2.

<u>Wetland 2</u>

The proposed culverts downstream of Wetland 2 are in addition to the existing 3 x 1500 mm diameter culverts currently present under Heslop Road. It has been assumed that these existing culverts at location 37-38 (as shown on the plan in Appendix C) are currently at capacity as they are conveying the flows from the catchment south of Korumburra-Wonthaggi Road. The timing of peak events between the local catchment and the larger catchment south of Korumburra Road could be further investigated as if the peaks do not coincide smaller culverts may be able to provide the same level of service.

The local catchment entering Wetland 2 (north of Korumburra-Wonthaggi Road) with a peak flow of 5.5 m^3/s and 13.5 m^3/s for the 18 % AEP and 1 % AEP events respectively require additional culverts to convey the retarded flows under Heslop Road. As a spillway set just above the 39 % AEP water surface elevation within the RORB model represents the high flow outlet structure of the wetland/ retarding basin, the area provides some retardation of the 18 % AEP and 1 % AEP flows. Table 2.15 summarises the culvert sizes required to convey these peak flows, noting that due to the low-lying road levels of 15.28 m AHD and the retarding basin peak 1 % AEP flood level of 15.76 m AHD, the raising of the road or an embankment would be required particularly east of the existing Heslop Road culvert crossing. The table also includes a cost estimate for each crossing assuming a pipe length of 20 m and a 35 % contingency.

Table 2.14 Culvert sizing for Heslop Road downstream of Wetland 2 (Location 37-38)

Location	Culvert Required for 18 % AEP			Culvert Required for 1 % AEP		
Wetland 2	1No. x 750 Ø	1.3 m^3/s	$42,000	1No. x 1650 Ø	5.80 m^3/s	$134,000

Wetland 3 and 4

The functional design of Wetland 3 and 4 has allowed for further investigations into the existing culvert crossings and terrain level constraints. The following was proposed within the functional design plans submitted to Council:

- A 1050 mm diameter pipe outfall from Wetland 4 into an open channel running along the northern side of Heslop Road (intended to convey the 18 % AEP peak flows at a minimum under interim conditions whilst Wetland 3 is under construction).
- A high flow spillway across Wentworth Road from Wetland 4 into Wetland 3 (intended to function as the interim conditions high flow path under interim conditions prior to the construction of Wetland 3 and construction of 1050 mm diameter connection pipe).
- Addition of a new 1200 x 450 box culvert crossing Heslop Road beside existing 2No. x 1200 x 450 box culverts downstream of the proposed Wetland 3 location.
- An embankment along the north eastern boundary of Wetland 3 at 14.9 m AHD to achieve a 1 % AEP level of service for Heslop Road.

Table 2.15 provides a summary of the pipe capacity, size and associated cost for these Wetland 3 and 4 outfalls. The cost estimate for each crossing assumes a 35 % contingency.

Table 2.15 Culvert sizing for Heslop Road downstream of Wetlands 3 and 4

Location	Pipe Capacity (m^3/s)	Size (mm)	Cost
Wetland 4 (location 49-50)	2.1	1No. x 1050 Ø	$155,000
Wetland 3 (location 41-42)	3.03	3No. x 1200 x 450	$426,000

3. STORMWATER TREATMENT

The stormwater runoff generated from the development will need to be treated in accordance with Clause 56 of the planning scheme and the State Environment Protection Policy Waters of Victoria. These documents require stormwater to be treated in accordance with the Best Practice Environmental Management Guidelines (BPEMG). This requires that pollutants be removed from the stormwater before it is discharged into “receiving waters”. The receiving waters for the development area is the Powlett River. Table 3.1 shows the required percentage reductions for the key pollutants.

Table 3.1 Required pollutant removal

Pollutant	Required percentage reduction
Total Suspended Solids (TSS)	80 %
Total Phosphorus (TP)	45 %
Total Nitrogen (TN)	45 %
Gross Pollutants	70 %

Engeny has created a MUSIC (Model for Urban Stormwater Improvement Conceptualisation) model of the development area to assess the effectiveness of different treatment units.

3.1 Required infrastructure

Council has expressed a preference for centralised stormwater treatment infrastructure to help minimise the maintenance associated with the assets. Providing centralised assets also helps to reduce the total overall cost and can allow for assets to be located in logical areas, such as within flood affected land which could otherwise not be developed.

To most effectively meet the best practice guideline criteria and to also protect the constructed waterways from high sediment loads it is proposed to use a series of sedimentation basins and wetlands. A Continuous Deflection Separation (CDS) unit (or similar) is also recommended to treat stormwater from Catchment G, upstream of Bass Highway as the catchment is relatively small and would seem impractical to pipe flows into the Downstream Sediment Basin. These units are propriety sediment removal devices which are installed underground requiring significantly less land take whilst achieving comparable sediment load reductions to small sedimentation basins.

Appendix C shows a layout plan with the location of the proposed assets. The installation of rainwater tanks connected to all new residential properties is also proposed. Although these rainwater tanks will not significantly reduce the peak runoff flows from the development area in major storms they will reduce the total runoff volume requiring treatment and retardation in addition to providing a valuable water source alternative to potable water.

Table 3.2 shows the proposed size of each of the sedimentation basins. In order to protect the constructed waterways from high sediment loads all stormwater will be discharged into a sedimentation basin rather than directly into the waterways. This may result in the need to construct drainage pipes running in parallel to the waterway for short lengths to convey the stormwater to the sedimentation ponds and limit the number of discharge points into the waterway. The sizes of the sedimentation basins in the table refer to the area of each asset at Normal Water Level. The total land required for each asset, including allowances for maintenance tracks and battering was determined by providing a 10 metre buffer to each of the asset's area at Normal Water Level with an additional area corresponding to the sediment drying area based on the volume of sediment accumulated. The 10 metre buffer allowance assumes a 1 in 5 batter for a depth of 2 metres. This approach was appropriate for most of the sediment basins as they are located on relatively flat terrain.

Table 3.2 Sedimentation basin stormwater treatment assets

Asset ID	Area at Normal Water Level (m^2)	Area Required for Sediment Drying (m^2)	Estimated Total Asset footprint (allowing for 10 m buffer for maintenance and battering) (m^2)
SB1	600	325	2500
SB2	600	375	2500
SB3	500	262	2200
SB4	780	617	3100
SB5	740	550	2900
SB6	700	509	2900
SB7	840	675	3300
SB8	900	761	3400
SB9	600	293	2400
SB10	860	714	3300
SB11	750	582	2400
SB11A	900	732	2700
SB12	600	109	2200

Asset ID	Area at Normal Water Level (m^2)	Area Required for Sediment Drying (m^2)	Estimated Total Asset footprint (allowing for 10 m buffer for maintenance and battering) (m^2)
SB13	450	76	1900
SB14	450	84	1900

The total land required for the wetlands is shown in Table 3.3. This assessment took into consideration the slope of the existing terrain, the invert of proposed and existing culverts in addition to the downstream road levels. It was considered that a 25 % additional land take plus a 10 m buffer of the macrophyte treatment area (area at normal water level) should be made for land budgeting purposes. The exact land take requirements will need to be refined in the functional design stages with further consideration of the terrain.

Table 3.3 Wetland stormwater treatment assets

Asset ID	Wetland Area at Normal Water Level (m^2)	25 % Increase to Area(m^2)	Estimated Total Asset footprint (allowing for 10 m buffer for maintenance and battering) (m^2)
WL1	38,000	47,500	57,500
WL2	8,000	10,000	17,000
WL3	13,220	16,525	27,600
WL 4	5,850	7,313	16,500

The results from the MUSIC modelling including pollutant removal rates from the developing areas are shown below in Table 3.4.

The table shows that more than 100 % of total suspended solids and gross pollutants from the new development are being removed. This is due to the additional pollutant loads being treated by the wetlands from the external rural catchments in additional to the developing catchment. Note that gross pollutants do not just include litter from urban areas, but also includes leaf litter and vegetation from both urban and rural areas.

Table 3.4 Stormwater treatment results for development area only

	Pollutant Load from Developable Area (kg/yr)	Pollutant Load Removed (kg/yr)	% of Development Pollutant Load Removed
Total Suspended Solids (kg/yr)	656,630	727,000	110.7 %
Total Phosphorus (kg/yr)	1,401	1,310	93.5 %
Total Nitrogen (kg/yr)	10,274	4,700	45.7 %
Gross Pollutants (kg/yr)	134,218	245,995	183.3 %

Table 3.5 shows the treatment results for the entire catchment including the large external rural catchments draining into the development area. There is no requirement to treat the existing upstream rural catchments to best practice as part of the development.

Table 3.5 Stormwater treatment results for entire catchment including external rural catchment areas

	Pollutant Load from Entire Catchment (including External Rural Catchments) (kg/yr)	Pollutant Load Removed (kg/yr)	% of Entire Catchment Pollutant Load Removed
Total Suspended Solids (kg/yr)	1,360,000	727,000	53 %
Total Phosphorus (kg/yr)	3,390	1,310	39 %
Total Nitrogen (kg/yr)	25,200	4,700	19 %
Gross Pollutants (kg/yr)	246,000	245,995	100 %

3.2 Sedimentation Basins

The following design parameters have been used for the sedimentation basins:

- Extended detention depth: 0.35 m
- 1 in 8 batter slopes for the first 0.5 m of depth (for safety)
- 1 in 3 batter slopes below 0.5 m depth.

A clean out frequency of 3 years has been adopted for all sedimentation basins within the development area. They have also been sized to effectively treat both internal and external catchments where applicable. This has been done to ensure that the maintenance frequency is not increased as a result of sizing the asset to only treat the developing area catchment when there are additional external catchments entering the area. This approach alternatively means that the sedimentation basins are sized to treat the developing catchment areas with a clean out frequency of 5 years.

3.3 Wetlands

The concept level design of the wetland, including estimates of land requirements have been undertaken in accordance with Melbourne Water's wetland design guidelines. The following design parameters have been used for each of the wetlands:

- Extended detention depth: 0.35 m
- Notional detention time of approximately 72 hours
- Inlet Pond Volume of zero as the sedimentation basins were modelled as individual units and sized using the above assumptions
- Permanent Pool depth of 0.4 m.

It should be noted that Wetland 1 in particular receives flows from large external rural catchments which behave in a hydrologically different way to developed catchments. Rural catchments tend to generate a greater base flow of runoff for many days or weeks following a rainfall event, whereas urban catchments will typically have a short sharp flow response and then stop flowing. The outlet arrangement on this wetland will need to allow for this large rural catchment to ensure that the water levels can rise and fall within the wetland and that it does not become drowned out permanently. Details of how the outlet arrangement connects to the Powlett River have not been considered explicitly as part of this study, however this should be further investigated during the functional design of these assets.

3.4 Rainwater tanks

Implementing rainwater tanks as part of this strategy is proposed in order to help reduce the total size and cost of treatment infrastructure by reducing the total annual volume of runoff requiring treatment. The rainwater tanks are to be installed on each property and should be plumbed to the toilets to ensure a regular reuse demand. They should also be available for garden irrigation. As irrigation demand can be highly variable depending on weather conditions and the habits of dwelling occupiers no reuse for gardening has been assumed in the modelling. The tanks will help to reduce the total volume of stormwater runoff entering the drains and waterways as some of the runoff will be captured by the rainwater tanks and will be reused by the residents of the dwelling. It has been assumed that the rainwater tanks would not reduce the peak runoff from the catchments during a storm event, as it is not proposed to mandate either low flow outlets or smart tanks in this area.

Engeny has modelled a scenario where each house is fitted with a rainwater tank plumbed to the toilet. The following assumptions were made

- 13 dwellings per hectare
- 200 m^2 of roof area per dwelling connected to a tank
- 2 kL tank per dwelling
- Reuse rate of 16.5 L/person/day from toilet flushing
- 3 people per house
- Total reuse rate of 49.5 L/dwelling/day.

Rainwater tanks were not modelled in areas where existing development or approved development plans exist as these have already been approved without the requirement of rainwater tank installations. These exclusions include sub-catchments K and Part of H, M, O, J, I and Q. These sub-catchments make up parts of the Parklea and Powlett Ridge Estates.

3.5 Benefits of Implementing Rainwater tanks

In order to clearly quantify the benefits of implementing rainwater tanks within the development area, Engeny has modelled an option excluding rainwater tanks where all runoff has been directed into the downstream sedimentation basin. By doing this, Wetland Area 1 would need to be increased in size to ensure the same pollutant removal targets are achieved. These reduced stormwater treatment results are summarised in Table 3.6.

Table 3.6 Stormwater treatment results for development area excluding Rainwater tanks

	Pollutant Load from Developable Area (kg/yr)	Pollutant Load Removed (kg/yr)	% of Development Pollutant Load Removed
Total Suspended Solids (kg/yr)	656,630	705,000	107.4 %
Total Phosphorus (kg/yr)	1,401	1,270	90.7 %
Total Nitrogen (kg/yr)	10,374	4,400	42.4 %
Gross Pollutants (kg/yr)	134,218	245,995	183.3 %

These results indicate that by excluding rainwater tanks, Wetland 1 area would need to be increased by 19 % where construction costs would in total cost $690,000 more. This does not include the additional costs required for the retardation of the peak 63 % and 39 % AEP Flows.

3.6 Stormwater Harvesting

The large wetlands proposed for stormwater treatment provide an opportunity for stormwater harvesting. Wetland 1 in particular provides a significant opportunity given the current proposal for open space to be located in the vicinity of the wetland, which could be a possible reuse demand centre. The developing catchment flowing into wetland 1 is approximately 400 ha, in addition to the external catchments which will also flow into this wetland. It would be reasonable and beneficial to harvest the additional flows that the urbanisation of the development area will create. It will still be necessary to maintain outflows from the wetland system which are equal to the predevelopment outflows to ensure that the downstream waterway and water licence holders are not adversely impacted.

Based on a simple analysis using MUSIC modelling software it has been estimated that there is approximately 1,920 ML available for harvesting each year. This should be confirmed with a more detailed analysis and licencing requirements will likely apply for a stormwater diversion for harvesting. This volume of water would be far more than the demand for open space irrigation water in the immediate region.

If stormwater harvesting is implemented then additional water storage should be constructed adjacent to the wetland where harvesting is proposed. The most cost effective storage would be an open water body which would be integrated into the wetland system.

4. COST ESTIMATES

Engeny have undertaken a high level cost estimate for each of the stormwater treatment and conveyance assets proposed in this strategy. These indicative costs are based on the Melbourne Water DSS Costing Spreadsheet. **Appendix E** provides a summary of this spreadsheet. A plan displaying the relevant Asset IDs at each of the areas of interest has been provided in **Appendix F**.

The following assumptions have been applied to the cost estimates:

- Land acquisition costs have been excluded
- Additional excavation/fill requirements have been estimated based on assumed invert levels of existing pipes and 1 m contour data. Further functional design work should be undertaken to refine the cost estimates
- Costs of landscaping (other than wetland planting) and other infrastructure such as shared paths have been excluded, however an estimate of the total land area required has been made
- An excavation depth of 1.5 metres from the cutline to the normal water level of all stand-alone sediment ponds has been assumed. This assumption has been made to allow for pipes entering the sedimentation basin to daylight into the basin assuming a pipe diameter of approximately 750 mm with 750 mm of cover.
- Stand-alone sediment basins have not accounted for additional costs associated with the inclusion of a litter trap or high-flow bypass.
- A contingency of 35 % has been applied.

The total cost of the conveyance related drainage assets is $25,284,000 and the total cost of stormwater treatment assets is $10,070,000. Table 4.1 to Table 4.5 contain a breakdown of the indicative cost for each conveyance and treatment asset.

Table 4.1 Estimated costs of Constructed Waterway assets

Asset	Cost
East Waterway	
Waterway 3-4	$633,000
Waterway 4-5	$712,000
Waterway 5-6	$2,627,000
Waterway 6-7	$2,666,000

Asset	Cost
Waterway 7-8	$1,062,000
Waterway 8-9	$2,115,000
West Waterway	
Waterway 17-18	$405,000
Waterway 19-20	$752,000
Waterway 20-21	$1,154,000
Waterway 22-23	$1,723,000
Waterway 23A-23B	$877,000
Waterway 23C-24	$1,241,000
Waterway 24-25	$422,000
Waterway Cost Subtotal	**$16,389,000**

Table 4.2 Estimated costs of culvert assets

Asset	Size (mm)	Cost
Industrial Boulevard Crossing (Location 16-17)	3No. x 1350Ø	$215,000
Bass Coast Highway (Location 18-19)	3No. x 1500Ø	$255,000
Bass Coast Highway (Location 2-3)	3No. x 1500Ø	$255,000
McGibbonys Rd (Location 21-22)	4No. x 1650Ø	$494,000
Proposed Minor Road (Location 23-23A)	4No. x 1650Ø	$494,000
Proposed Minor Road (Location 23B-23C)	4No. x 1650Ø	$494,000
Proposed boulevard connector road (Location 24)	4No. x 1650Ø	$494,000
Korrumburra-Wothaggi Road Embankment (Location 12-13)	14No. x 1200Ø	$895,000
Heslop Road (Location 37-38) downstream of WL2	1No. 1650Ø	$134,000
Heslop Road (Location 41-42) downstream of WL3	3No. x 1200 x 450	$426,000

Asset	Size (mm)	Cost
Heslop Road (Location 49-50) downstream of WL4	1No. x 1050Ø	$155,000
Heslop Road (Location 45-46) downstream of SB12	4No. x 750Ø	$127,000
Culvert Cost Subtotal		**$4,438,000**

Table 4.3 Estimated costs of drainage pipe assets

Asset	Diameter (mm)	Cost
1-2	1350	$471,000
15-16	1050	$472,000
14-16	1050	$365,000
26-17	1350	$233,000
27-28	1200	$433,000
30-28	825	$26,000
28-29	1200	$196,000
31-32	1200	$569,000
33-34	900	$901,000
39A-39C	600	$60,000
39C-40	600	$43,000
47-47A	750	$53,000
47A-40	750	$127,000
40-48	900	$450,000
43-45	450	$58,000
Pipe cost Subtotal		**$4,457,000**

Table 4.4 Estimated costs of Stormwater Treatment assets

Asset	Cost
SB1	$207,000
SB2	$208,000
SB3	$186,000
SB4	$227,000
SB5	$219,000
SB6	$230,000
SB7	$239,000
SB9	$207,000
SB12	$206,000
SB13	$175,000
SB14	$175,000
Wetland 1 (incl. SB8)	$3,439,000
Wetland 2 (incl. SB10)	$1,017,000
Wetland 3 (incl. SB11)	$1,935,000
Wetland 4 (incl. SB11A)	$1,400,000
Total	**$10,070,000**

Table 4.5 Estimated costs of Wetland 1 Retarding Basin

Asset	Cost
WLRB1	$4,328,000

Note that at this stage no allowance has been made for the construction of a stormwater harvest holding storage which could be associated with Wetland 1. A copy of the costing spreadsheet has been provided to Council and a summary of the cost breakdown is included in **Appendix E**. It should also be noted that 35 - 45 % of the total cost of each of the wetland assets is in the disposal of excess cut. The assumption has been made that

80 % of the cut material will be disposed of offsite. If this material can be used for filling developable land nearby there could be significant cost savings for the construction of these assets.

5. CONCLUSIONS

Effectively managing stormwater and flooding issues will be important to ensuring successful development in the Wonthaggi North East PSP. A portion of the development area directly south of Korumburra Wonthaggi Road is subject to significant flooding under existing conditions. Managing the flooding risk in this area is an important part of the infrastructure proposed by the PSP.

Trunk drainage will be provided through the PSP by a network of constructed waterways and underground piped drainage. Stormwater treatment will be provided by a series of sedimentation basins located adjacent to the constructed waterways and upstream of the wetlands. Wetlands will provide the majority of the stormwater treatment and nutrient removal in the development area. Rainwater tanks are also proposed for all new dwellings within the development area. These tanks will help to contribute to an integrated water cycle management approach by reducing potable water demand and reducing total volumes of stormwater discharged into the receiving waterway. The proposed stormwater treatment infrastructure achieves the best practice management targets for nutrient removal for the precinct area.

The proposed stormwater infrastructure will ensure that there is no increase in the peak flow rates downstream of the development area for the 68 % and 39 % AEP events (1 year and 2 year ARI) by utilising retarding basins. This will ensure that regular flows through the properties downstream of the development area do not increase in magnitude. It is not proposed to prevent increases in flows for events more frequent than the 39 % AEP. The proposed development is unlikely to significantly affect peak flooding experienced on the properties north of Korumburra – Wonthaggi Road and Heslops Road as the major flows, flood volumes and duration of flooding that affect this area are related to the very large rural catchment of the Powlett River and not the relatively smaller area of development in Wonthaggi East. The land use in these areas is agriculture/farming and there are no dwellings that would be impacted by an increase in peak flows from the development area in events up to the 1 % AEP (1 in 100 year ARI) event. The drainage existing channel through this area is small relative to the existing and developed 1 % AEP event flows which are expected from the development area. In these large events the majority of the flow will be conveyed via wide relatively slow moving overland flow paths.

All lots that are to be developed to the south of Wonthaggi-Korumburra Road will need to be filled to 600 mm above the 1 % AEP flood level for this area. This will mean that all lots in this area should be filled to approximately 16.7 m AHD, 600 mm above the developed conditions1 % AEP flood level of 16.1 m AHD at this location.

6. RECOMMENDATIONS

The results of this study recommend that a number of drainage and stormwater infrastructure works be constructed within the PSP.

Two constructed waterways are proposed through the development area to provide drainage outfalls. Table 6.1 shows the required hydraulic width (for flow conveyance) and proposed total waterway corridor width of each of these waterways. There are two developments within the Wonthaggi North East PSP area which were approved prior to this study (Parklea Estate and Powlett Ridge Estate). In these areas it is understood that waterway width may be narrower than would ideally be the case, however the width of the corridor is sufficient to accommodate the minimum hydraulically required width so the flows can be safely conveyed through these estates. The proposed waterway corridor widths are in accordance with Melbourne Water Constructed Waterway Guidelines. It is recommended that these guidelines be adopted for the waterways within the development area.

Table 6.1 Waterway corridor widths summary

Waterway Reach	Required hydraulic width	Proposed corridor width
Eastern Waterway		
3-4	30	55
4-5	30	60
5-6	50	60
6-7	50	60
7-8	50	60
8-9	50	60
Western Waterway		
17-18	22	40
19-20	31	55
20-21	32	55
22-23	34	60
23A-23B	35	60
23C-24	35	60

Waterway Reach	Required hydraulic width	Proposed corridor width
24-25	35	60

There is some flexibility in the final location of the eastern waterway through the development area. This waterway serves the dual purpose of providing a drainage outfall for the development and also incepts sheet flow from the large rural catchment to the east of the development area during flood events. The exact alignment of the waterway as it approaches Wetland 1 could be adjusted to suit a future development layout.

Table 6.2 shows the treatment size and total land area required for the sediment basins and wetlands which are proposed within the development area. These assets should be constructed in accordance with Melbourne Water's Constructed Wetlands Design Manual or an approved alternative design criteria.

Table 6.2 Sediment Basin and Wetland stormwater treatment assets summary

Asset ID	Treatment area at NWL (m^2)	Total asset footprint (m^2)
SB1	600	2500
SB2	600	2500
SB3	500	2200
SB4	780	3100
SB5	740	2900
SB6	700	2900
SB7	840	3300
SB8	900	3400
SB9	600	2400
SB10	860	3300
SB11	750	2400
SB11A	900	2700
SB12	600	2200
SB13	450	1900

Asset ID	Treatment area at NWL (m^2)	Total asset footprint (m^2)
SB14	450	1900
WL1	38,000	57,500
WL2	8,000	17,000
WL3	13,220	27,600
WL4	5,850	16,500

In addition to the wetlands, 13.6 ha will be required for retardation at wetland 1. This area will be subject to frequent flooding (multiple times each year) and should be landscaped in a suitable manner. Paths or boardwalks through this area would need to be designed to withstand the effects of frequent inundation.

For this study the wetland and retarding basin have been located in the lowest lying areas to minimise the total excavation required and construction costs. The exact location and configuration of wetland 1 and the surrounding retarding basin area could be adjusted to suit the topography or proposed development layout in the future. The total sizes of the assets shown will need to be maintained even if the location is adjusted to better suit a proposed development layout.

Culverts have been sized for the crossings on Heslops Road and Korumburra-Wonthaggi Road to ensure that the 1 % AEP flow can be conveyed under the road. Table 6.3 shows the sizes and costs of the culverts required. The existing road is subject to frequent flooding, as such it may be necessary to raise the road in localised areas to prevent frequent inundation.

Due to the extensive upgrade, further consultation should be undertaken with VicRoads to determine if the 1 % AEP event needs to be conveyed under Korumburra-Wonthaggi Road or if a lower level of service would be acceptable, for example the 2 % AEP event. Consideration should also be given to the potential impact on the downstream waterway/drain of effectively concentrating the 1 % AEP flow at this point. Erosion protection works may be required through some sections of this channel or at the culvert outlet depending on the final design configuration adopted.

Table 6.3 Korumburra-Wonthaggi Road and Heslop Road Culvert sizing summary

Asset	Size (mm)	Cost
Korumburra-Wonthaggi Road (Location 12-13)	14No. x 1200Ø	$895,000
Heslop Road (Location 37-38) downstream of WL2	1No. 1650Ø	$134,000

Asset	Size (mm)	Cost
Heslop Road (Location 49-50) downstream of WL4	1No. x 1050 Ø	$155,000
Heslop Road (Location 41-42) downstream of WL3	3No. x 1200 x 450	$426,000
Heslop Road (Location 45-46) downstream of SB12	4No. x 750Ø	$127,000

7. QUALIFICATIONS

a. In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

b. Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

c. Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

   (i) Additional sources of information not presently available (for whatever reason) are provided or become known to Engeny; or

   (ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

d. Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the works, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works. All limitations of liability shall apply for the benefit of the employees, agents and representatives of Engeny to the same extent that they apply for the benefit of Engeny.

e. This document is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this report.

f. If any claim or demand is made by any person against Engeny on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the report or information therein, Engeny will rely upon this provision as a defence to any such claim or demand.

g. This report does not provide legal advice.

8. REFERENCES

Infrastructure Design Manual, September 2016.

Constructed Waterways in Urban Developments Guidelines, 2009, Melbourne Water Corporation.

Constructed wetland design guidelines, 2017, Melbourne Water Corporation, https://www.melbournewater.com.au/planning-and-building/standards-and-specifications/design-wsud/pages/constructed-wetlands-design-manual.aspx

Waterway Corridors - Guidelines for Greenfield Development Areas within the Port Phillip and Westernport Region, 2013, Melbourne Water Corporation.

9. ABBREVIATIONS

AEP – Annual Exceedance Probability. The probability that a given rainfall total accumulated over a given duration or peak flow rate at a point in a catchment will be exceeded in any one year

AHD – Australian Height Datum. The datum that sets mean sea level as zero elevation. Mean sea level was determined from observations recorded by 30 tide gauges around the coast of the Australian continent for the period 1966–1968.

ARI – Annual Recurrence Interval. The average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration, or of a peak flow rate at a point in a catchment. It is implicit in this definition that the periods between exceedances are generally random.

BCSC – Bass Coast Shire Council

LSIO – Land Subject to Inundation Overlay

MUSIC – Model for Urban Stormwater Improvement Conceptualisation, used to model the effectiveness of proposed stormwater treatment assets

PSP – Precinct Structure Plan

RB – Retarding Basin

RORB – RunOff Routing Burroughs. An industry standard package used in hydrologic modelling (the “Burroughs” refers to the fact that the original software package was developed and maintained on a Burroughs B6700 computer)

SB – Sedimentation Basin

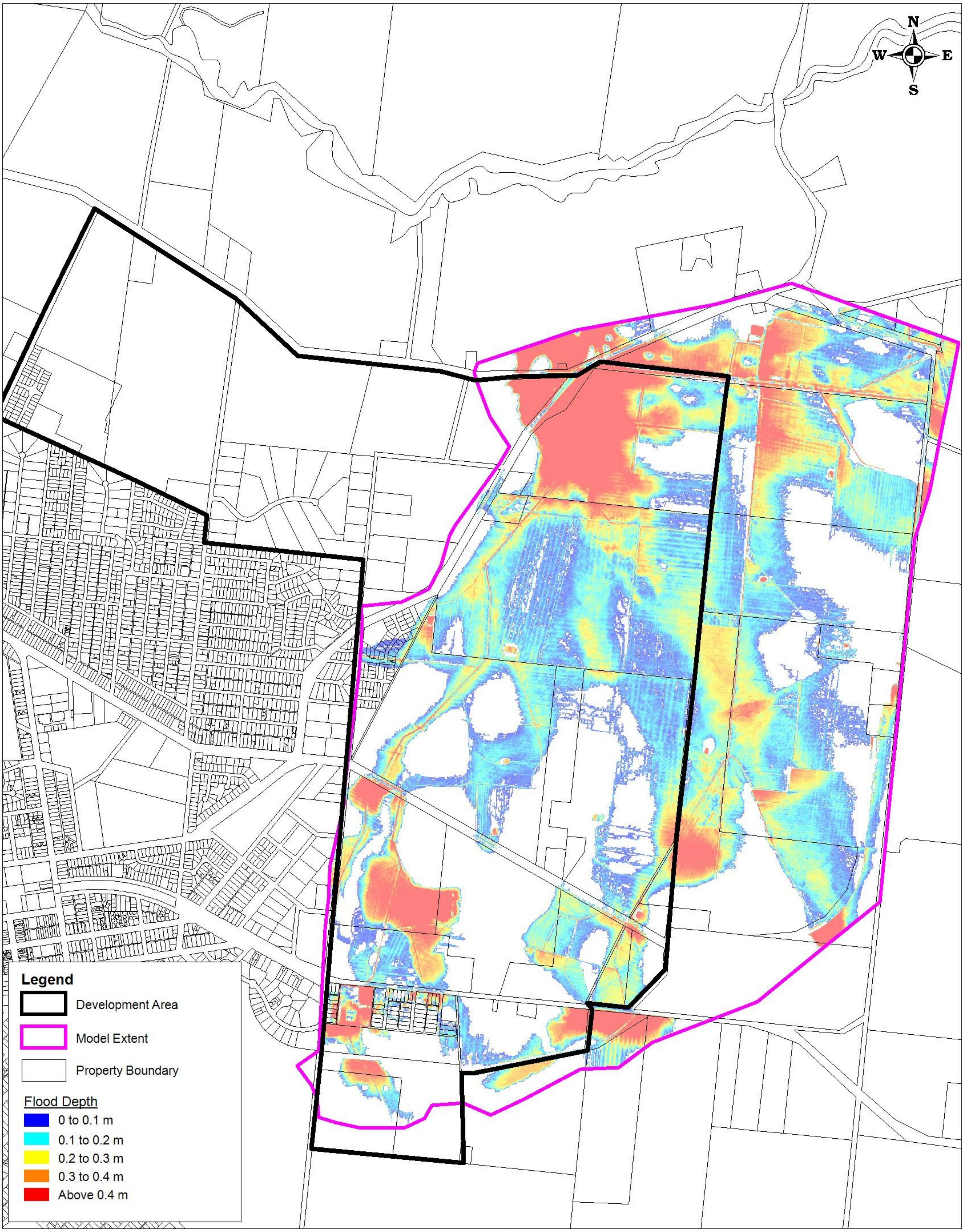
TUFLOW – Two-dimension Unsteady FLOW. The name of an industry standard flood modelling package

WGCMA – West Gippsland Catchment Management Authority

WL - Wetland

APPENDIX A

Existing Conditions 1 % AEP Flooding



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E: melb@engeny.com.au

ENGENY WATER MANAGEMENT

BASS COAST

0 300 600

Scale in metres (1:15,000 @ A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

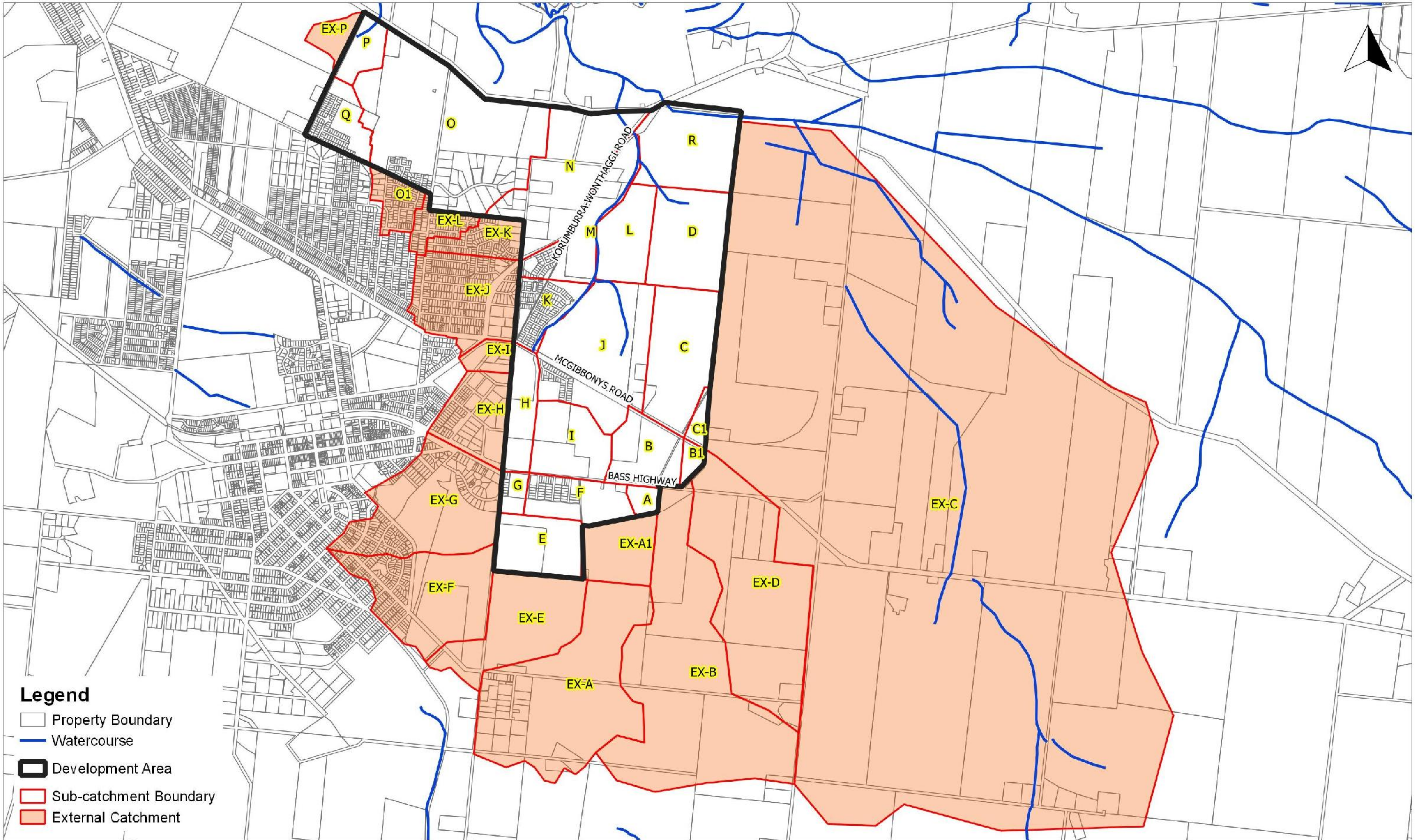
Wonthaggi North East PSP Drainage

100yr ARI Existing Conditions Flood Depth

Job Number: V2015_002
Revision: 1
Drawn: MM
Checked: GO
Date: 8 May 2017

APPENDIX B

External Catchments Map



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ENGENY WATER MANAGEMENT

BASS COAST

200 0 200 400 600 800 m

Scale in metres (1:26000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

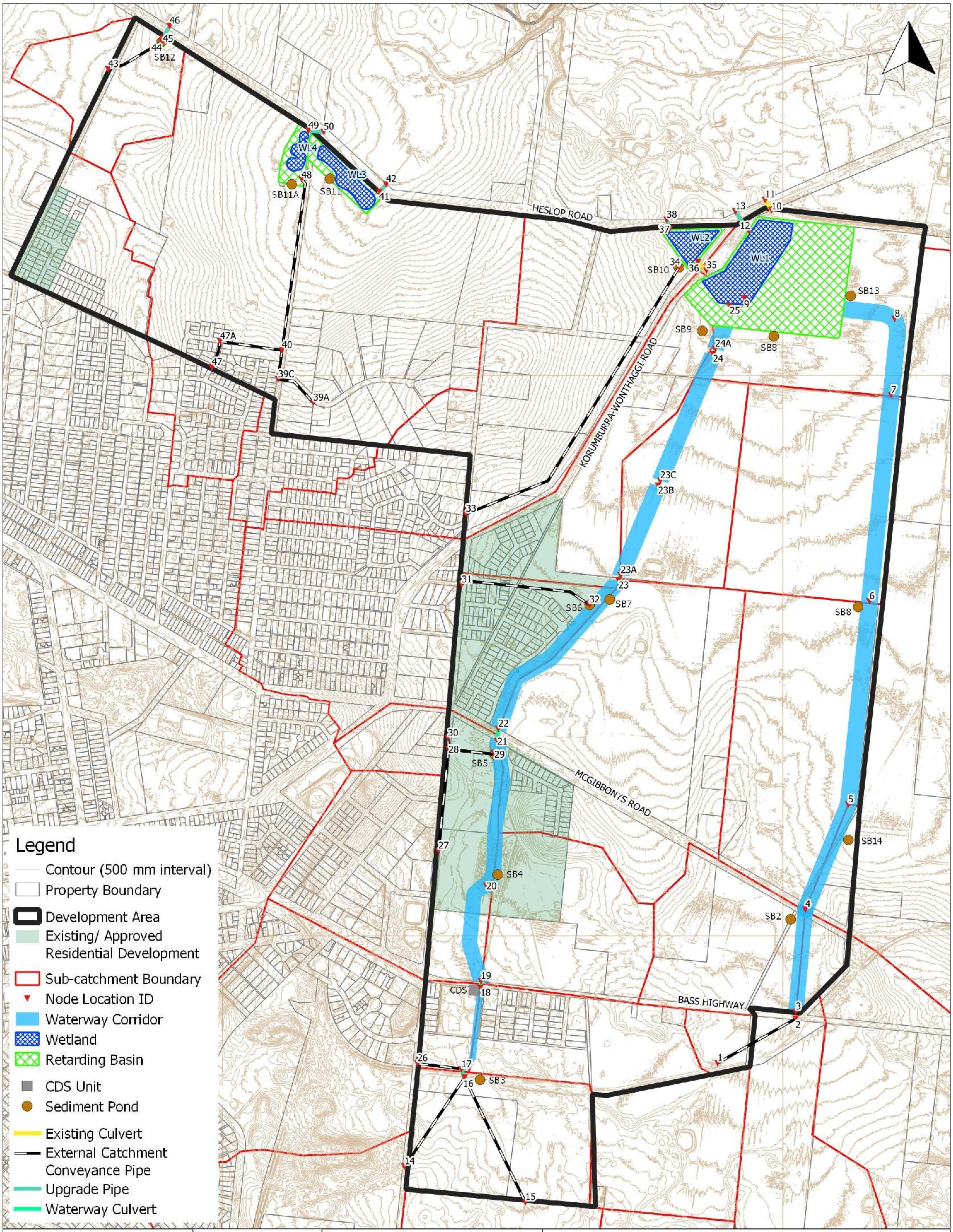
Wonthaggi North PSP Drainage

External Catchments Draining into Development Area

Job Number: V2015_002
Revision: 2
Drawn: MM
Checked: GO
Date: 24/9/2019

APPENDIX C

Proposed Stormwater Infrastructure Layout



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ENGENY WATER MANAGEMENT

BASS COAST

240 0 240 m

Scale in metres (1:12000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

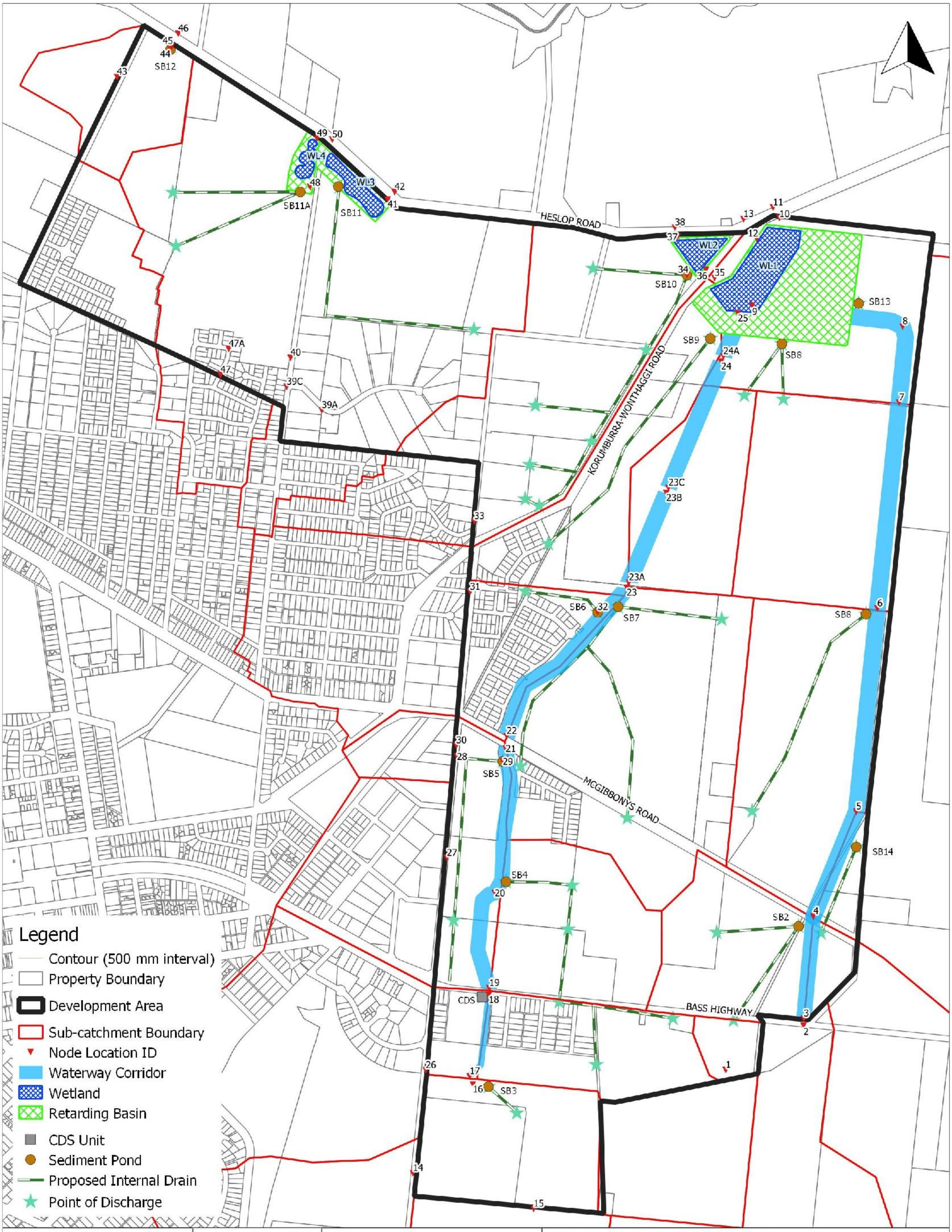
Wonthaggi North PSP Drainage

Proposed Stormwater Infrastructure Layout Plan

Job Number: V2015_002
Revision: 2
Drawn: MM
Checked: GO
Date: 25/9/2019

APPENDIX D

Layout of Proposed Points of Discharge for Development



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ENGENY
WATER MANAGEMENT

BASS COAST

240 0 240 m

Scale in metres (1:12000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

Wonthaggi North PSP Drainage

Proposed Points of Discharge
Layout Plan

Job Number: V2015_002
Revision: 2
Drawn: MM
Checked: GO
Date: 21/10/2019

APPENDIX E

Summary of Cost Estimates

Waterways detailed costs

Reference	Design Flow $Q_{100\ year}$	Pilot Channel.																
		Design Flow $Q_{1\ year}$	Length L	NS Elev u/s	NS Elev d/s	Grade (1 in ...)	Manning's 'n'	Side Slope	Base Width (B_1)	Pilot Channel Depth (d_1)	Pilot Channel x-sect Area	Velocity v_p	Pilot Channel Top Width	Pilot Channel Q_{full}	Volume	Excavation Rate	Vegetation Rate	Cost
	m^3/s	m^3/s	m	m	m				m	m	m^2	m/s	m	m^3/s	m^3	$\$/m^3$	$\$/m^2$	$
Eastern Waterway																		
3-4	13.35	2.67	367	22.00	20.02	185	0.050	3	6.5	0.50	4.0	0.82	9.50	3.27	1,466	8.20	13.40	$58,677
4-5	13.26	2.65	404	20.02	17.83	185	0.050	3	7.0	0.50	4.3	0.82	10.00	3.49	1,718	8.20	13.40	$68,253
5-6	28.64	5.73	729	17.83	16.79	700	0.050	3	10.0	0.90	11.4	0.61	15.40	6.99	8,336	8.20	13.40	$218,853
6-7	28.50	5.70	740	16.79	15.74	700	0.050	3	10.0	0.90	11.4	0.61	15.40	6.99	8,457	8.20	13.40	$222,034
7-8	38.00	7.60	274	15.74	15.34	700	0.050	3	10.0	1.00	13.0	0.65	16.00	8.44	3,565	8.20	13.40	$88,018
8-9	36.03	7.21	545	15.34	14.56	700	0.050	3	10.0	1.00	13.0	0.65	16.00	8.44	7,089	8.20	13.40	$175,041
Western Waterway																		
17-18	13.87	2.77	306	23.62	21.70	160	0.050	3	3.0	0.80	4.3	1.04	7.80	4.51	1,322	8.20	13.40	$42,823
19-20	17.07	3.41	369	21.65	19.80	200	0.050	3	4.0	0.80	5.1	0.97	8.80	4.95	1,892	8.20	13.40	$59,077
20-21	18.32	3.66	528	19.80	18.48	400	0.050	3	4.0	1.00	7.0	0.77	10.00	5.40	3,697	8.20	13.40	$101,086
22-23	23.75	4.75	703	18.38	16.82	450	0.050	3	4.0	1.00	7.0	0.73	10.00	5.09	4,923	8.20	13.40	$134,621
23A-23B	24.05	4.81	346	16.78	16.01	450	0.050	3	4.0	1.00	7.0	0.73	10.00	5.09	2,424	8.20	13.40	$66,288
23C-24	22.29	4.46	488	15.96	14.88	450	0.050	3	4.0	1.00	7.0	0.73	10.00	5.09	3,419	8.20	13.40	$93,493
24A-25	22.84	4.57	163	14.83	14.47	449	0.050	3	4.0	1.00	7.0	0.73	10.00	5.10	1,138	8.20	13.40	$31,125

Reference	Main Channel													
	Design Flow Q_{100} - Pilot Channel Q_{full}	Main Channel Depth (d_2)	Base Width (B_2)	Manning's 'n'	Side Slope	Area A	Velocity v	Freeboard	Top Width with freeboard	Channel Capacity Q_{full}	Excavation Area	Excavation Volume V	Excavation and Disposal Rate	Cost
	m^3/s	m	m			m^2	m/s	m	m	m^3/s	m^2	m^3	$\$/m^3$	$
Eastern Waterway														
3-4	10.09	0.60	17.50	0.05	5	12.3	0.95	0.60	30	11.71	28.2	10,335	$24	$243,913
4-5	9.76	0.60	18.00	0.05	5	12.6	0.95	0.60	30	12.02	28.8	11,642	$24	$274,740
5-6	21.64	0.90	35.00	0.05	5	35.6	0.65	0.60	50	23.25	63.8	46,493	$24	$1,097,232
6-7	21.50	0.90	35.00	0.05	5	35.6	0.65	0.60	50	23.25	63.8	47,169	$24	$1,113,180
7-8	29.56	1.10	33.00	0.05	5	42.4	0.73	0.60	50	31.11	70.6	19,345	$24	$456,538
8-9	27.58	1.10	33.00	0.05	5	42.4	0.73	0.60	50	31.11	70.6	38,471	$24	$907,914
Western Waterway														
17-18	9.36	0.80	7.80	0.05	5	9.4	1.11	0.60	22	10.52	20.7	6,340	$24	$149,632
19-20	12.12	0.80	16.80	0.05	5	16.6	1.08	0.60	31	17.96	33.3	12,310	$24	$290,518
20-21	12.92	0.80	18.00	0.05	5	17.6	0.77	0.60	32	13.52	35.0	18,485	$24	$436,244
22-23	18.65	1.00	18.00	0.05	5	23.0	0.82	0.60	34	18.93	41.6	29,259	$24	$690,521
23A-23B	18.95	1.00	19.00	0.05	5	24.0	0.83	0.60	35	19.86	43.2	14,961	$24	$353,090
23C-24	17.20	1.00	19.00	0.05	5	24.0	0.83	0.60	35	19.85	43.2	21,102	$24	$498,005
24A-25	17.74	1.00	19.00	0.05	5	24.0	0.83	0.60	35	19.87	43.2	7,025	$25	$172,820

Reference		Reinstatement					Pool and Riffle				Total Cost
		Revegetation Area	Revegetation Rate	Topsoiling	Topsoiling Rate	Cost	No. of Pools and Riffles	Rockwork Volume	Rockwork Rate	Cost	Total Estimated Basic Cost excluding Land Acquisition
		m^2	$\$/m^2$	m^2	$\$/m^2$	$	no.	m^3	$\$/m^3$	$	$
Eastern Waterway											
3-4		7,330	$12	7,330	$3	$113,615	2.48	262	200	$52,370	$468,575
4-5		8,084	$12	8,084	$3	$125,308	2.69	296	200	$59,173	$527,474
5-6		25,234	$12	25,234	$3	$391,124	2.92	1,194	200	$238,731	$1,945,939
6-7		25,601	$12	25,601	$3	$396,808	2.96	1,213	200	$242,515	$1,974,537
7-8		9,323	$12	9,323	$3	$144,503	1.10	487	200	$97,367	$786,427
8-9		18,540	$12	18,540	$3	$287,373	2.18	982	200	$196,438	$1,566,766
Western Waterway											
17-18		4,284	$12	4,284	$3	$66,402	2.81	205	200	$40,908	$299,764
19-20		8,128	$12	8,128	$3	$125,982	2.40	406	200	$81,188	$556,765
20-21		11,619	$12	11,619	$3	$180,096	3.30	687	200	$137,440	$854,865
22-23		16,880	$12	16,880	$3	$261,646	4.14	947	200	$189,385	$1,276,173
23A-23B		8,658	$12	8,658	$3	$134,203	1.98	481	200	$96,240	$649,821
23C-24		12,212	$12	12,212	$3	$189,282	2.79	693	200	$138,588	$919,368
24A-25		4,066	$12	4,066	$3	$63,015	0.93	229	200	$45,842	$312,802

Drainage pipes detailed costs

Pipe Ref.	Upstream Area A	Cumulative Upstream Area ΣA	5 Year ARI Runoff Coefficient C_5	ARI (y)	Effective Area A_e	Cumulative Effective Area ΣA_e	Time of Concentration t_c	Rainfall Intensity I_y	Design Flow Q_y	Length L	NS Elev u/s	NS Elev d/s	Slope S	Pipe Diameter	Pipe Type/Backfill	No of Pipes	Full Flow Q_{full}	Full Velocity v_{full}	Time in Pipe t_{pipe}	Pipe/Crossing Cost		Total Estimated Basic Cost (incl. 35 % contingency)
	ha	ha			ha	ha	min	mm/hr	m³/s	m	m	m	1 in ...	mm			m³/s	m/s	min	Condition	$	$
1-2	138.79	138.790	0.23	5	32.30	32.298	51.31	24.73	2.22	320	22.84	22.00	380	1350	IFJ-100% FCR	1	2.74	1.91	2.79	Greenfields	$349,120	$471,000
15-16	53.77	53.770	0.20	5	10.75	10.754	36.47	30.33	0.91	490	28.25	27.25	490	1050	IFJ-100% FCR	1	1.23	1.42	5.74	Greenfields	$349,513	$472,000
14-16	61.81	61.810	0.30	5	18.54	18.539	15.41	49.04	2.53	379	31.70	27.00	81	1050	IFJ-100% FCR	1	3.04	3.51	1.80	Greenfields	$270,156	$365,000
26-17	72.69	72.690	0.50	5	36.45	36.455	18.75	44.20	4.48	158	28.25	26.75	105	1350	IFJ-100% FCR	1	5.20	3.63	0.72	Greenfields	$172,269	$233,000
27-28	29.00	29.000	0.43	5	12.41	12.406	14.25	51.05	1.76	360	23.50	22.26	290	1200	IFJ-100% FCR	1	2.29	2.02	2.97	Greenfields	$320,760	$433,000
30-28	7.91	7.910	0.48	5	3.79	3.793	10.95	58.17	0.61	40	22.40	22.26	286	825	IFJ-100% FCR	1	0.85	1.59	0.42	Greenfields	$19,480	$26,000
28-29	36.91	36.910	0.44	5	16.20	16.199	17.22	46.26	2.08	163	22.26	21.40	190	1200	IFJ-100% FCR	1	2.83	2.50	1.09	Greenfields	$145,500	$196,000
31-32	48.76	48.760	0.49	5	23.82	23.822	18.25	44.85	2.97	473	21.95	18.34	131	1200	IFJ-100% FCR	1	3.41	3.01	2.62	Greenfields	$421,443	$569,000
33-34	21.44	21.440	0.47	5	10.01	10.014	14.07	51.38	1.43	1200	23.50	14.60	135	900	IFJ-100% FCR	1	1.56	2.45	8.16	Greenfields	$667,200	$901,000
39A-39C	5.61	5.610	0.50	5	2.81	2.805	10.02	60.67	0.47	144	25.16	24.00	124	600	IFJ-100% FCR	1	0.55	1.95	1.23	Greenfields	$44,208	$60,000
39C-40	10.57	10.570	0.50	5	5.29	5.285	11.25	57.42	0.84	105	24.00	21.00	35	600	IFJ-100% FCR	1	1.04	3.68	0.47	Greenfields	$32,143	$43,000
47-47A	12.92	12.920	0.47	5	6.09	6.094	12.53	54.48	0.92	92	24.00	22.25	53	750	IFJ-100% FCR	1	1.54	3.48	0.44	Greenfields	$39,100	$53,000
47A-40	12.92	12.920	0.47	5	6.09	6.094	11.69	56.35	0.95	221	22.25	20.50	126	750	IFJ-100% FCR	1	0.99	2.24	1.64	Greenfields	$ 93,713	$127,000
40-48	23.49	23.490	0.48	5	11.38	11.379	13.36	52.74	1.67	600	20.50	13.85	90	900	IFJ-100% FCR	1	1.91	3.00	3.34	Greenfields	$333,600	$450,000
43-45	8.19	8.190	0.20	5	1.64	1.638	16.31	47.61	0.22	210	24.50	22.25	93	450	IFJ-100% FCR	1	0.30	1.86	1.89	Greenfields	$43,260	$58,000

Wetlands detailed costs

REFERENCE	TREATMENT POND SIZING (Using MUSIC)									
	NWL (m AHD)	$Level_{cutline}$ (m AHD)	Extended Detention Depth (m)	Permanent Pond Depth (m)	Basin Area (m^2)	Depth TED to Cutline (m)	Area at base (m^2)	AREA at Top of EDD (m^2)	Total Treatment Pond, incl. Batters (m^2)	Treatment Pond Excavation Volume (m^3)
WL1	14.3	15.2	0.35	0.4	38000	0.55	34,693	40,215	44,969	62,049
WL2	14	14.7	0.35	0.4	8000	0.35	6,505	9,026	10,448	11,234
WL3	13.0	14.0	0.35	0.4	13220	0.65	11,286	14,533	17,938	37,472
WL4	13.3	15.5	0.35	0.4	5850	1.85	4,577	6,730	13,929	27,979

REFERENCE		PLANTING & EARTHWORKS													WETLAND FOOTPRINT AREA	
		Grassing Area	Aquatic Vegetation Area	Terrestial Vegetation Area	Stripping and stockpiling of 250mm Topsoil	Topsoiling	Additional Excavation (top of cutline, if required)	Total Excavation Volume	Disposal of surplus soil	Clay lining @ 300mm thickness	Rockwork/Concrete Base Area	First clean out	Access Track Area	COST	TOTAL	Total Estimated Basic Cost incl. 35 % contingency
		(m^2)	(m^2)	(m^2)	(m^2)	(m^2)	(m^3)	(m^3)	(m^3)	(m^2)	(m^2)	$	(m^2)	$	m^2	$
WL1		5,043	38,000	2,551	46,394	40,551		62,535	50,028	38,800	198	$21,100	150	$2,547,333	53,800	$3,438,900
WL2		1,781	8,000	1,381	12,062	9,381	8,600	20,369	16,295	8,900	257	$21,100	150	$753,166	17,000	$1,016,774
WL3		4,250	13,220	1,775	20,795	14,995		39,738	35,562	14,770	680	$21,100	150	$1,433,045	38,000	$1,934,611
WL4		8,045	5,850	1,341	16,786	7,191		33,444	26,755	7,400	680	$21,100	150	$1,037,115	38,000	$1,400,105

Retarding basin detailed costs

Ref	Description				Qty	Unit	Rate	Estimated Basic Cost	Estimated Basic Cost (incl 35 % Contingency)
							($/unit)	$	$
WL1									
Excavation Volume equals the storage required to retard developed 39 % AEP flows back to existing conditions flow	Land Acquisition								
		Developable land			0.00	ha	$0		**$ -**
		Land within drainage / electricity easement			0.00	ha	$0		**$ -**
	Embankment								
		Construction and Compaction			0	m³	23.60	$ -	
		Topsoiling			0	m²	3.10	$ -	
		Grassing			0	m²	2.10	$ -	
	Outlet Works	(Select outlet type)	Pipe						
	-	-				m	0.00	$ -	
	Input data here	**====>**			0	m	0.00	$ -	
	Culvert - Base slab (For box type only)				0	m	0.00	$ -	
	Culvert - Link slab (For box type only)				0	m	0.00	$ -	
	Laying & Installation							$ -	
	Inlet / Outlet Structures				2	no.	$5,160	$ 10,320	
	Construct Spillway				0	item	$48,000	$ -	
	Earthworks								
		Excavation			201,000	m³	8.20	$1,648,200	
		Disposal of surplus soil (50%)			100,500	m³	15.40	$1,547,700	
		Grassing			0	m²	2.10	$ -	
							Subtotal	**$3,206,220**	
							Subtotal (Incl. 35 % Contingency	**$4,328,000**	

Sedimentation basin detailed costs

		POND SIZING (Using Fair & Geyer Equation)														
REFERENCE	Sediment Basin Type	Batter Slope (NWL to Base)	Upstream Untreated Residential Area	Q_3 DESIGN FOR TREATMENT	Permanent Pond Depth, dp	Extended Detention Depth,de	Depth below permanent pool that is sufficient to retain sediment, d*	Hydraulic Efficiency (λ)	Basin Area (NWL)	Capture Efficiency	Cleanout Frequency (years)	Storage volume for drying	Area for drying the sediments	Area at base	AREA at Top of EDD	Total Area, incl. batters & drying area
		1 in ..	(ha)	(m^3/s)	(m)	(m)	(m)		(m^2)	%	years	(m^3)	(m^2)	(m^2)	(m^2)	(m^2)
SB1	Stand Alone	3	34.8	0.48	1.5	0.35	1.00	0.26	600	97 %	3.0	162	324	89	894	2,431
SB2	Stand Alone	3	40.00	0.44	1.5	0.35	1.00	0.26	600	98 %	3.0	188	376	89	894	2,483
SB3	Stand Alone	3	28.16	0.49	1.5	0.35	1.00	0.26	500	97 %	3.0	131	262	41	770	2,166
SB4	Stand Alone	3	66.60	0.79	1.5	0.35	1.00	0.26	780	97 %	3.0	310	620	187	1,112	3,073
SB5	Stand Alone	3	59.6	0.83	1.5	0.35	1.00	0.26	740	96 %	3.0	275	549	164	1,064	2,927
SB6	Stand Alone	3	55.23	0.79	1.5	0.35	1.00	0.26	700	96 %	3.0	254	509	142	1,016	2,811
SB7	Stand Alone	3	73	0.90	1.5	0.35	1.00	0.26	840	96 %	3.0	336	673	221	1,184	3,237
SB9	Stand Alone	3	31	0.31	1.5	0.35	1.00	0.26	600	99 %	3.0	147	295	89	894	2,402
SB12	Stand Alone	3	11	0.20	1.5	0.35	1.00	0.26	600	99 %	3.0	52	105	89	894	2,212
SB13	Stand Alone	3	8	0.12	1.5	0.35	1.00	0.26	450	99 %	3.0	38	76	19	707	1,875
SB14	Stand Alone	3	9	0.13	1.5	0.35	1.00	0.26	450	99 %	3.0	43	86	19	707	1,884

	PLANTING & EARTHWORKS											
REFERENCE	Grassing Area	Terrestial Vegetation Area	Stripping and stockpiling of 250mm Topsoil	Topsoiling	Additional Excavation (top of cutline, if required)	Inlet Pond Excavation Volume	Disposal of surplus soil	Clay lining @ 300mm thickness	Rockwork/Concrete Base Area	First clean out	Access Track Area	COST
	(m²)	(m²)	(m²)	(m²)	(m³)	(m³)	(m³)	(m²)	(m²)	$	(m²)	$
SB1	1,537	294	2,431	294		2,473	1,978	600	227	$21,100	150	$118,453
SB2	1,590	294	2,483	294		2,473	1,978	600	227	$21,100	150	$118,725
SB3	1,397	270	2,166	270		2,120	1,696	500	164	$21,100	150	$102,848
SB4	1,961	332	3,073	332		3,104	2,483	780	187	$21,100	150	$132,999
SB5	1,863	324	2,927	324		2,964	2,372	740	164	$21,100	150	$126,841
SB6	1,795	316	2,811	316		2,824	2,259	700	293	$21,100	150	$134,870
SB7	2,052	344	3,237	344		3,314	2,651	840	221	$21,100	150	$142,010
SB9	1,508	294	2,402	294		2,473	1,978	600	227	$21,100	150	$118,300
SB12	1,318	294	2,212	294		2,473	1,978	600	227	$21,100	150	$117,312
SB13	1,168	257	1,875	257		1,942	1,554	450	134	$21,100	150	$94,318
SB14	1,177	257	1,884	257		1,942	1,554	450	134	$21,100	150	$94,367

		OUTLET STRUCTURE							SED BASIN FOOTPRINT AREA	Total Cost	Total Cost
REFERENCE		No. of drop pits	Length of Pipe	Pipe Diameter	No. of Pipes	Qfull	Outlet Structures Allowance	COST	TOTAL	Total Estimated Basic Cost excluding Land Acquisition	Total Estimated Basic Cost including 35 % contingency
			(m)	(mm)		(m^3/s)	$	$	m^2	$	$
SB1		1	25	600	1	0.43	$10,320	$35,245	2,431	$153,698	$207,493
SB2		1	25	600	1	0.43	$10,320	$35,245	2,483	$153,970	$207,860
SB3		1	25	600	1	0.43	$10,320	$35,245	2,166	$138,093	$186,425
SB4		1	25	600	1	0.43	$10,320	$35,245	3,073	$168,244	$227,129
SB5		1	25	600	1	0.43	$10,320	$35,245	2,927	$162,086	$218,816
SB6		1	25	600	1	0.43	$10,320	$35,245	2,811	$170,115	$229,656
SB7		1	25	600	1	0.43	$10,320	$35,245	3,237	$177,255	$239,295
SB9		1	25	600	1	0.43	$10,320	$35,245	2,402	$153,545	$207,286
SB12		1	25	600	1	0.43	$10,320	$35,245	2,212	$152,557	$205,952
SB13		1	25	600	1	0.43	$10,320	$35,245	1,875	$129,563	$174,910
SB14		1	25	600	1	0.43	$10,320	$35,245	1,884	$129,612	$174,976

Culverts detailed costs

Industrial Boulevard Crossing (Location 16-17)							
	Design ARI	100					
	Design Flow (m^3/s)	9.1					
	Pipe diameter (mm)	1350					
	Installation (Laying)	RRJ-100% FCR	3	20	m	$1,463	$87,780.00
	Headwalls & Endwalls		6	2.18	m^3	$2,676	$35,002.08
	Installation (Road, Rail factors)	Major Council Roads					$26,334.00
	Allowance for Service Alterations		Factor			1.00	$0.00
	Traffic management		item				$10,290.00
	Minor regrading of channel d/s of culverts					item	
						Subtotal	**$159,406**

Subtotal (incl.35 % contingency) **$215,000**

Bass Coast Highway (Location 18-19)							
	Design ARI	100					
	Design Flow (m^3/s)	13.9					
	Pipe diameter (mm)	1500					
	Installation (Laying)	RRJ-100% FCR	3	20	m	$ 1,779	$106,740.00
	Headwalls & Endwalls		6	2.48	m^3	$ 2,676	$39,818.88
	Installation (Road, Rail factors)	Major Council Roads					$32,022.00
	Allowance for Service Alterations		Factor			1.00	$0.00
	Traffic management		item				$10,290.00
	Minor regrading of channel d/s of culverts					item	
						Subtotal	**$188,871**

Subtotal (incl.35 % contingency) **$255,000**

McGibbonys Rd (Location 21-22)							
	Design ARI	100					
	Design Flow (m³/s)	18.32					
	Pipe diameter (mm)	1650					
	Installation (Laying)	RRJ-100% FCR	4	20	m	$2,127	$170,160.00
	Headwalls & Endwalls		6	4.3	m³	$2,676	$92,054.40
	Installation (Road, Rail factors)	Major Council Roads					$51,048.00
	Allowance for Service Alterations	Yes	Factor			1.25	$42,540.00
	Traffic management		item				$10,290.00
	Minor regrading of channel d/s of culverts					item	
						Subtotal	**$366,092**
						Subtotal (incl. 35 % contingency)	**$494,000**

Proposed Minor Road (Location 23-23A)							
	Design ARI	100					
	Design Flow (m^3/s)	23.04					
	Pipe diameter (mm)	1650					
	Installation (Laying)	RRJ-100% FCR	4	20	m	$2,127	$170,160.00
	Headwalls & Endwalls		6	4.3	m^3	$2,676	$92,054.40
	Installation (Road, Rail factors)	Major Council Roads					$51,048.00
	Allowance for Service Alterations	Yes	Factor			1.25	$42,540.00
	Traffic management		item				$10,290.00
	Minor regrading of channel d/s of culverts					item	
						Subtotal	**$366,092**
						Subtotal (incl. 35 % contingency)	**$494,000**

Proposed Minor Road (Location 23B-23C)							
	Design ARI	100					
	Design Flow (m^3/s)	28.92					
	Pipe diameter (mm)	1650					
	Installation (Laying)	RRJ-100% FCR	4	20	m	$2,127	$170,160.00
	Headwalls & Endwalls		6	4.3	m^3	$2,676	$92,054.40
	Installation (Road, Rail factors)	Major Council Roads					$51,048.00
	Allowance for Service Alterations	Yes	Factor			1.25	$42,540.00
	Traffic management		item				$10,290.00
	Minor regrading of channel d/s of culverts					item	
						Subtotal	**$366,092**
						Subtotal (incl. 35 % contingency)	**$494,000**

Proposed boulevard connector road (Location 24-24A)							
	Design ARI	100					
	Design Flow (m^3/s)	24.01					
	Pipe diameter (mm)	1650					
	Installation (Laying)	RRJ-100% FCR	4	20	m	$2,127	$170,160.00
	Headwalls & Endwalls		8	5.08	m^3	$2,676	$92,054.40
	Installation (Road, Rail factors)	Major Council Roads					$51,048.00
	Allowance for Service Alterations	Yes	Factor			1.25	$42,540.00
	Traffic management		item				$10,290.00
	Minor regrading of channel d/s of culverts					item	
						Subtotal	**$366,092**

Subtotal (incl. 35 % contingency) **$494,000**

Bass Coast Highway (2-3)							
	Design ARI	100					
	Design Flow (m^3/s)	13.3					
	Pipe diameter (mm)	1500					
	Installation (Laying)	RRJ-100% FCR	3	20	m	$2,127	$106,740.00
	Headwalls & Endwalls		6	2.48	m^3	$2,676	$39,818.88
	Installation (Road, Rail factors)	Major Council Roads					$32,022.00
	Allowance for Service Alterations	Yes	Factor			1.25	$0.00
	Traffic management		item				$10,290.00
	Minor regrading of channel d/s of culverts					item	
						Subtotal	**$188,871**
						Subtotal (incl. 35 % contingency)	**$255,000**

Korrumburra-Wothaggi Road Embankment (Location 12-13)	*Developed with no overtopping of Existing Road in 1 %AEP Storm event						
	Design ARI	100					
	Design Flow (m^3/s)	SIZED USING RORB					
	Pipe diameter (mm)	1200					
	Installation (Laying)	RRJ-100% FCR	14	20	m	$ 1,198	$335,440.00
	Headwalls & Endwalls		28	1.77	m^3	$ 2,676	$132,622.56
	Installation (Road, Rail factors)	Major Council Roads					$100,632.00
	Allowance for Service Alterations	Yes	Factor			1.25	$83,860.00
	Traffic management		item				$10,290.00
	Minor regrading of channel d/s of culverts					item	
						Subtotal	**$662,845**
						Subtotal (incl. 35 % contingency)	**$895,000**

Heslops Road (Location 37-38) downstream of WL2							
	Design ARI	100					
	Design Flow (m3/s)	5.8					
	Pipe diameter (mm)	1650					
	Installation (Laying)	RRJ-100% FCR	1	20	m	$2,127	$42,540.00
	Headwalls & Endwalls		2	4.3	m3	$2,676	$23,013.60
	Installation (Road, Rail factors)	Major Council Roads					$12,762.00
	Allowance for Service Alterations	Yes	Factor			1.25	$10,635.00
	Traffic management		item				$10,290.00
	Minor regrading of channel d/s of culverts					item	
						Subtotal	**$99,241**
						Subtotal (incl. 35% contingency)	**$134,000**

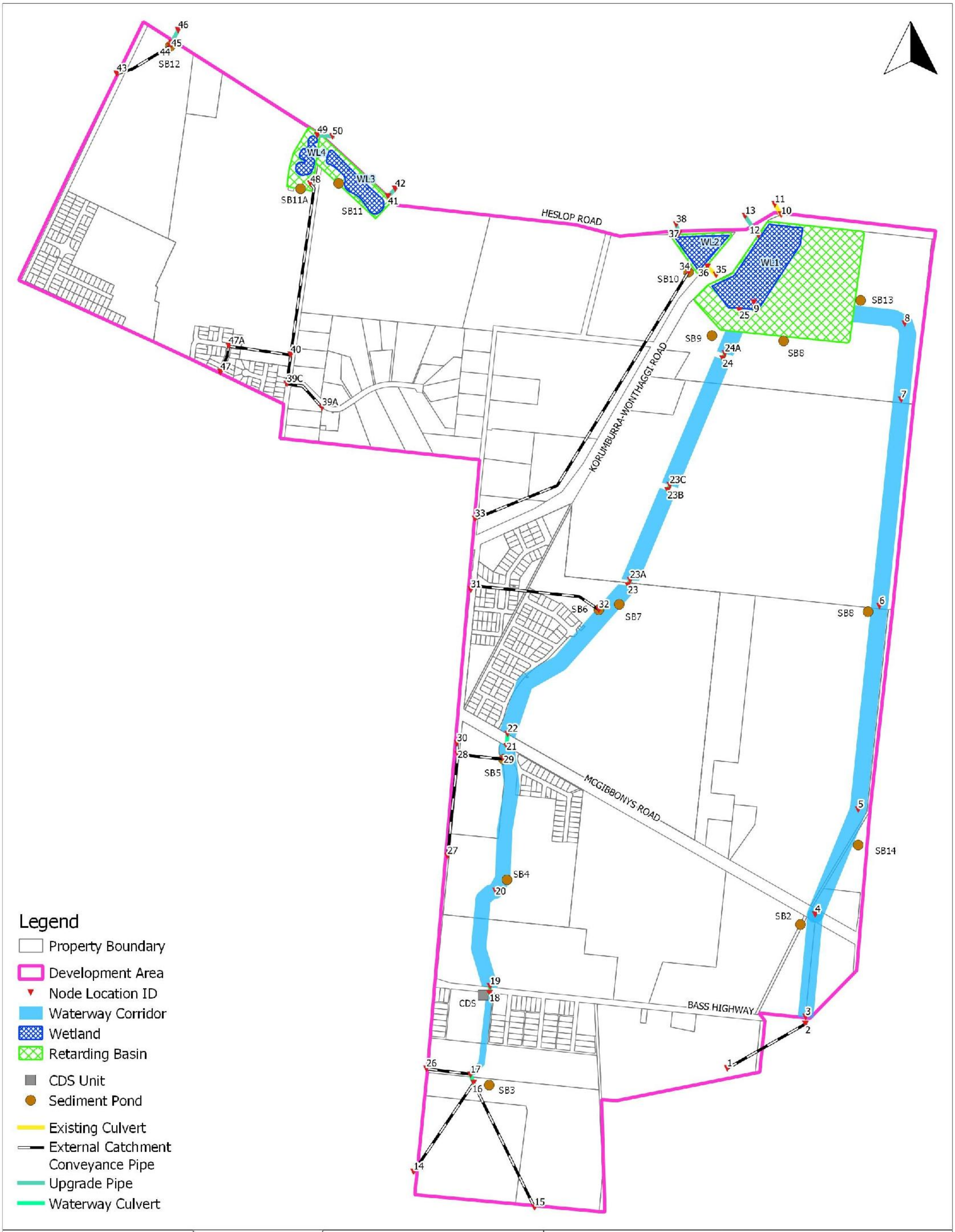
Heslops Road (Location 49-50) downstream of WL4							
	Design ARI	>5yr					
	Design Flow (m³/s)	2.0					
	Pipe diameter (mm)	1050					
	Installation (Laying)	RRJ-100% FCR	1	65	m	$955	$62,075.00
	Headwalls & Endwalls		2	1.52	m3	$2,676	$8,135.04
	Installation (Road, Rail factors)	Major Council Roads					$18,622.50
	Allowance for Service Alterations	Yes	Factor			1.25	$15,518.75
	Traffic management		item				$10,290.00
	Minor regrading of channel d/s of culverts					item	
						Subtotal	$114,641
						Subtotal (incl. 35 % contingency)	$155,000

Heslops Road (Location 41-42) downstream of WL3							
	Design ARI	100					
	Design Flow (m3/s)	3.03					
	Supply - Crown Units	1200 x 450	2	40	m	$ 622	$ 49,760
	Supply - Base Slab		3	40	m	$ 505	$ 60,600
	Supply - Link Slab		1	40	m	$ 505	$ 20,200
	Installation (Laying)		3	40	m	$ 1,632	$ 88,128
	Headwalls & Endwalls		6	1.31	m³	$ 2,676	$ 20,953
	Installation (Road, Rail factors)	Major Council Roads					$ 65,606
	Allowance for Service Alterations	No	Factor			1.00	$ -
	Traffic management		item				$ 10,290
						Subtotal	$315,537
						Subtotal (incl. 35 % contingency)	$426,000

Heslops Road (Location 45-46) downstream of SB12							
	Design ARI	100					
	Design Flow (m³/s)	3.14					
	Pipe diameter (mm)	750					
	Installation (Laying)	RRJ-100% FCR	4	20	m	$528	$42,240.00
	Headwalls & Endwalls		8	0.87	m³	$2,676	$18,624.96
	Installation (Road, Rail factors)	Major Council Roads					$12,672.00
	Allowance for Service Alterations	Yes	Factor			1.25	$10,560.00
	Traffic management		item				$10,290.00
	Minor regrading of channel d/s of culverts					item	
						Subtotal	**$94,387**
						Subtotal (incl. 35 % contingency)	**$127,000**

APPENDIX F

Layout of Costing Asset IDs



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ENGENY WATER MANAGEMENT

BASS COAST

240 0 240 m

Scale in metres (1:12000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

Wonthaggi North PSP Drainage

Costing Node ID Locations
Layout Plan

Job Number: V2015_002
Revision: 2
Drawn: MM
Checked: GO
Date: 21/10/2019